HyPerformance® Plasma HPR400XD®

Auto gas

Instruction manual

806160 – Revision 4

Hypertherm®

Register your new Hypertherm system

Register your product on-line at **www.hypertherm.com/registration** for easier technical and warranty support. You can also receive updates on new Hypertherm products and a free gift as a token of our appreciation.

For your records

Serial number: ______________________________

Purchase date: ______________________________

Distributor: ______________________________

____

____

Maintenance notes:

____

____

____

____

____

____

HyPerformance Plasma
HPR400XD Auto Gas

Instruction Manual

(P/N 806160)

Revision 4 – June, 2015

Hypertherm Inc.
Hanover, NH USA
www.hypertherm.com

Hypertherm Inc.
Etna Road, P.O. Box 5010
Hanover, NH 03755 USA
603-643-3441 Tel (Main Office)
603-643-5352 Fax (All Departments)
info@hypertherm.com (Main Office Email)
800-643-9878 Tel (Technical Service)
technical.service@hypertherm.com (Technical Service Email)
800-737-2978 Tel (Customer Service)
customer.service@hypertherm.com (Customer Service Email)
866-643-7711 Tel (Return Materials Authorization)
877-371-2876 Fax (Return Materials Authorization)
return.materials@hypertherm.com (RMA email)

Hypertherm Plasmatechnik GmbH
Technologiepark Hanau
Rodenbacher Chaussee 6
D-63457 Hanau-Wolfgang, Deutschland
49 6181 58 2100 Tel
49 6181 58 2134 Fax
49 6181 58 2123 (Technical Service)

Hypertherm (S) Pte Ltd.
82 Genting Lane
Media Centre
Annexe Block #A01-01
Singapore 349567, Republic of Singapore
65 6841 2489 Tel
65 6841 2490 Fax
65 6841 2489 (Technical Service)

Hypertherm (Shanghai) Trading Co., Ltd.
Unit 301, South Building
495 ShangZhong Road
Shanghai, 200231
PR China
86-21-60740003 Tel
86-21-60740393 Fax

Hypertherm Europe B.V.
Vaartveld 9
4704 SE
Roosendaal, Nederland
31 165 596907 Tel
31 165 596901 Fax
31 165 596908 Tel (Marketing)
31 165 596900 Tel (Technical Service)
00 800 4973 7843 Tel (Technical Service)

Hypertherm Japan Ltd.
Level 9, Edobori Center Building
2-1-1 Edobori, Nishi-ku
Osaka 550-0002 Japan
81 6 6225 1183 Tel
81 6 6225 1184 Fax

Hypertherm Brasil Ltda.
Rua Bras Cubas, 231 – Jardim Maia
Guarulhos, SP - Brasil
CEP 07115-030
55 11 2409 2636 Tel
55 11 2408 0462 Fax

Hypertherm México, S.A. de C.V.
Avenida Toluca No. 444, Anexo 1,
Colonia Olivar de los Padres
Delegación Álvaro Obregón
México, D.F. C.P. 01780
52 55 5681 8109 Tel
52 55 5683 2127 Fax

Hypertherm Korea Branch
#3904 Centum Leaders Mark B/D,
1514 Woo-dong, Haeundae-gu, Busan
Korea, 612-889
82 51 747 0358 Tel
82 51 701 0358 Fax

12/2/13

Introduction

Hypertherm's CE-marked equipment is built in compliance with standard EN60974-10. The equipment should be installed and used in accordance with the information below to achieve electromagnetic compatibility.

The limits required by EN60974-10 may not be adequate to completely eliminate interference when the affected equipment is in close proximity or has a high degree of sensitivity. In such cases it may be necessary to use other measures to further reduce interference.

This cutting equipment is designed for use only in an industrial environment.

Installation and use

The user is responsible for installing and using the plasma equipment according to the manufacturer's instructions.

If electromagnetic disturbances are detected then it shall be the responsibility of the user to resolve the situation with the technical assistance of the manufacturer. In some cases this remedial action may be as simple as earthing the cutting circuit, see *Earthing of the workpiece*. In other cases, it could involve constructing an electromagnetic screen enclosing the power source and the work complete with associated input filters. In all cases, electromagnetic disturbances must be reduced to the point where they are no longer troublesome.

Assessment of area

Before installing the equipment, the user shall make an assessment of potential electromagnetic problems in the surrounding area. The following shall be taken into account:

a. Other supply cables, control cables, signaling and telephone cables; above, below and adjacent to the cutting equipment.

b. Radio and television transmitters and receivers.

c. Computer and other control equipment.

d. Safety critical equipment, for example guarding of industrial equipment.

e. Health of the people around, for example the use of pacemakers and hearing aids.

f. Equipment used for calibration or measurement.

g. Immunity of other equipment in the environment. User shall ensure that other equipment being used in the environment is compatible. This may require additional protection measures.

h. Time of day that cutting or other activities are to be carried out.

The size of the surrounding area to be considered will depend on the structure of the building and other activities that are taking place. The surrounding area may extend beyond the boundaries of the premises.

Methods of reducing emissions

Mains supply

Cutting equipment must be connected to the mains supply according to the manufacturer's recommendations. If interference occurs, it may be necessary to take additional precautions such as filtering of the mains supply.

Consideration should be given to shielding the supply cable of permanently installed cutting equipment, in metallic conduit or equivalent. Shielding should be electrically continuous throughout its length. The shielding should be connected to the cutting mains supply so that good electrical contact is maintained between the conduit and the cutting power source enclosure.

Maintenance of cutting equipment

The cutting equipment must be routinely maintained according to the manufacturer's recommendations. All access and service doors and covers should be closed and properly fastened when the cutting equipment is in operation. The cutting equipment should not be modified in any way, except as set forth in and in accordance with the manufacturer's written instructions. For example, the spark gaps of arc striking and stabilizing devices should be adjusted and maintained according to the manufacturer's recommendations.

Cutting cables

The cutting cables should be kept as short as possible and should be positioned close together, running at or close to the floor level.

Equipotential bonding

Bonding of all metallic components in the cutting installation and adjacent to it should be considered.

However, metallic components bonded to the workpiece will increase the risk that the operator could receive a shock by touching these metallic components and the electrode (nozzle for laser heads) at the same time.

The operator should be insulated from all such bonded metallic components.

Earthing of the workpiece

Where the workpiece is not bonded to earth for electrical safety, nor connected to earth because of its size and position, for example, ship's hull or building steel work, a connection bonding the workpiece to earth may reduce emissions in some, but not all instances. Care should be taken to prevent the earthing of the workpiece increasing the risk of injury to users, or damage to other electrical equipment. Where necessary, the connection of the workpiece to earth should be made by a direct connection to the workpiece, but in some countries where direct connection is not permitted, the bonding should be achieved by suitable capacitances selected according to national regulations.

Note: The cutting circuit may or may not be earthed for safety reasons. Changing the earthing arrangements should only be authorized by a person who is competent to assess whether the changes will in crease the risk of injury, for example, by allowing parallel cutting current return paths which may damage the earth circuits of other equipment. Further guidance is provided in IEC 60974-9, Arc Welding Equipment, Part 9: Installation and Use.

Screening and shielding

Selective screening and shielding of other cables and equipment in the surrounding area may alleviate problems of interference. Screening of the entire plasma cutting installation may be considered for special applications.

Attention

Genuine Hypertherm parts are the factory-recommended replacement parts for your Hypertherm system. Any damage or injury caused by the use of other than genuine Hypertherm parts may not be covered by the Hypertherm warranty, and will constitute misuse of the Hypertherm Product.

You are solely responsible for the safe use of the Product. Hypertherm does not and cannot make any guarantee or warranty regarding the safe use of the product in your environment.

General

Hypertherm Inc. warrants that its Products shall be free from defects in materials and workmanship for the specific periods of time set forth herein and as follows: if Hypertherm is notified of a defect (i) with respect to the plasma power supply within a period of two (2) years from the date of its delivery to you, with the exception of Powermax brand power supplies, which shall be within a period of three (3) years from the date of delivery to you, and (ii) with respect to the torch and leads within a period of one (1) year from its date of delivery to you, with the exception of the HPRXD short torch with integrated lead, which shall be within a period of six (6) months from the date of delivery to you, and with respect to torch lifter assemblies within a period of one (1) year from its date of delivery to you, and with respect to Automation products one (1) year from its date of delivery to you, with the exception of the EDGE Pro CNC, EDGE Pro Ti CNC, MicroEDGE Pro CNC, and ArcGlide THC, which shall be within a period of two (2) years from the date of delivery to you, and (iii) with respect to HyIntensity fiber laser components within a period of two (2) years from the date of its delivery to you, with the exception of laser heads and beam delivery cables, which shall be within a period of one (1) year from its date of delivery to you.

This warranty shall not apply to any Powermax brand power supplies that have been used with phase converters. In addition, Hypertherm does not warranty systems that have been damaged as a result of poor power quality, whether from phase converters or incoming line power. This warranty shall not apply to any product which has been incorrectly installed, modified, or otherwise damaged.

Hypertherm provides repair, replacement or adjustment of the Product as the sole and exclusive remedy, if and only if the warranty set forth herein properly is invoked and applies. Hypertherm, at its sole option, shall repair, replace, or adjust, free of charge, any defective Products covered by this warranty which shall be returned with Hypertherm's prior authorization (which shall not be unreasonably withheld), properly packed, to Hypertherm's place of business in Hanover, New Hampshire, or to an authorized Hypertherm repair facility, all costs, insurance and freight pre paid by the customer. Hypertherm shall not be liable for any repairs, replacement, or adjustments of Products covered by this warranty, except those made pursuant to this paragraph and with Hypertherm's prior written consent.

The warranty set forth above is exclusive and is in lieu of all other warranties, express, implied, statutory, or otherwise with respect to the Products or as to the results which may be obtained therefrom, and all implied warranties or conditions of quality or of merchantability or fitness for a particular purpose or against infringement. The foregoing shall constitute the sole and exclusive remedy for any breach by Hypertherm of its warranty.

Distributors/OEMs may offer different or additional warranties, but Distributors/OEMs are not authorized to give any additional warranty protection to you or make any representation to you purporting to be binding upon Hypertherm.

Patent indemnity

Except only in cases of products not manufactured by Hypertherm or manufactured by a person other than Hypertherm not in strict conformity with Hypertherm's specifications and in cases of designs, processes, formulae, or combinations not developed or purported to be developed by Hypertherm, Hypertherm will have the right to defend or settle, at its own expense, any suit or proceeding brought against you alleging that the use of the Hypertherm product, alone and not in combination with any other product not supplied by Hypertherm, infringes any patent of any third party. You shall notify Hypertherm promptly upon learning of any action or threatened action in connection with any such alleged infringement (and in any event no longer than fourteen (14) days after learning of any action or threat of action), and Hypertherm's obligation to defend shall be conditioned upon Hypertherm's sole control of, and the indemnified party's cooperation and assistance in, the defense of the claim.

Limitation of liability

In no event shall Hypertherm be liable to any person or entity for any incidental, consequential direct, indirect, punitive or exemplary damages (including but not limited to lost profits) regardless of whether such liability is based on breach of contract, tort, strict liability, breach of warranty, failure of essential purpose, or otherwise, and even if advised of the possibility of such damages.

National and local codes

National and local codes governing plumbing and electrical installation shall take precedence over any instructions contained in this manual. In no event shall Hypertherm be liable for injury to persons or property damage by reason of any code violation or poor work practices.

Liability cap

In no event shall Hypertherm's liability, if any, whether such liability is based on breach of contract, tort, strict liability, breach of warranties, failure of essential purpose or otherwise, for any claim, action, suit or proceeding (whether in court, arbitration, regulatory proceeding or otherwise) arising out of or relating to the use of the Products exceed in the aggregate the amount paid for the Products that gave rise to such claim.

Insurance

At all times you will have and maintain insurance in such quantities and types, and with coverage sufficient and appropriate to defend and to hold Hypertherm harmless in the event of any cause of action arising from the use of the products.

Transfer of rights

You may transfer any remaining rights you may have hereunder only in connection with the sale of all or substantially all of your assets or capital stock to a successor in interest who agrees to be bound by all of the terms and conditions of this Warranty. Within thirty (30) days before any such transfer occurs, you agree to notify in writing Hypertherm, which reserves the right of approval. Should you fail timely to notify Hypertherm and seek its approval as set forth herein, the Warranty set forth herein shall be null and void and you will have no further recourse against Hypertherm under the Warranty or otherwise.

Section 1

SAFETY

In this section:

RECOGNIZE SAFETY INFORMATION

The symbols shown in this section are used to identify potential hazards. When you see a safety symbol in this manual or on your machine, understand the potential for personal injury, and follow the related instructions to avoid the hazard.

FOLLOW SAFETY INSTRUCTIONS

Carefully read all safety messages in this manual and safety labels on your machine.

- Keep the safety labels on your machine in good condition. Replace missing or damaged labels immediately.
- Learn how to operate the machine and how to use the controls properly. Do not let anyone operate it without instruction.
- Keep your machine in proper working condition. Unauthorized modifications to the machine may affect safety and machine service life.

DANGER WARNING CAUTION

American National Standards Institute (ANSI) guidelines are used for safety signal words and symbols. The signal word DANGER or WARNING is used with a safety symbol. DANGER identifies the most serious hazards.

- DANGER and WARNING safety labels are located on your machine near specific hazards.
- DANGER safety messages precede related instructions in the manual that will result in serious injury or death if not followed correctly.
- WARNING safety messages precede related instructions in this manual that may result in injury or death if not followed correctly.
- CAUTION safety messages precede related instructions in this manual that may result in minor injury or damage to equipment if not followed correctly.

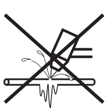
INSPECT EQUIPMENT BEFORE USING

All cutting equipment must be inspected as required to make sure it is in safe operating condition. When found to be incapable of reliable and safe operation, the equipment must be repaired by qualified personnel prior to its next use or withdrawn from service.

RESPONSIBILITY FOR SAFETY

The person or entity responsible for the safety of the workplace must:

- Make sure that operators and their supervisors are trained in the safe use of their equipment, the safe use of the process, and emergency procedures.
- Make sure that all hazards and safety precautions identified herein are communicated to and understood by workers before the start of work.
- Designate approved cutting areas and establish procedures for safe cutting.
- Be responsible for authorizing cutting operations in areas not specifically designed or approved for such processes.
- Make sure that only approved equipment, such as torches and personal protective equipment, are used.
- Select contractors who provide trained and qualified personnel, and who have awareness of the risks involved, to do cutting.
- Tell contractors about flammable materials or hazardous conditions that are specific to the site, or hazardous conditions that they may not be aware of.
- Make sure that the quality and quantity of air for ventilation is such that personnel exposures to hazardous contaminants are below the allowable limits.
- Make sure that ventilation in confined spaces is sufficient to allow adequate oxygen for life support, to prevent accumulation of asphixiants or flammable explosive mixtures, to prevent oxygen-enriched atmospheres, and to keep airborne contaminants in breathing atmospheres below allowable limits.



A PLASMA ARC CAN DAMAGE FROZEN PIPES

Frozen pipes may be damaged or can burst if you attempt to thaw them with a plasma torch.

STATIC ELECTRICITY CAN DAMAGE PRINTED CIRCUIT BOARDS

Use proper precautions when handling printed circuit boards:

- Store printed circuit boards in anti-static containers.
- Wear a grounded wrist strap when handling printed circuit boards.

GROUNDING SAFETY

Work lead Attach the work lead securely to the workpiece or the cutting table with good metal-to-metal contact. Do not connect it to the piece that will fall away when the cut is complete.

Cutting table Connect the cutting table to an earth ground, in accordance with appropriate national and local electrical regulations.

Input power

- Make sure to connect the power cord ground wire to the ground in the disconnect box.
- If installation of the plasma system involves connecting the power cord to the power supply, make sure to connect the power cord ground wire properly.
- Place the power cord's ground wire on the stud first, then place any other ground wires on top of the power cord ground. Tighten the retaining nut.
- Tighten all electrical connections to avoid excessive heating.

ELECTRICAL HAZARDS

- Only trained and authorized personnel may open this equipment.
- If the equipment is permanently connected, turn it off, and lock out/tag out power before the enclosure is opened.
- If power is supplied to the equipment with a cord, unplug the unit before the enclosure is opened.
- Lockable disconnects or lockable plug covers must be provided by others.
- Wait 5 minutes after removal of power before entering the enclosure to allow stored energy to discharge.
- If the equipment must have power when the enclosure is open for servicing, arc flash explosion hazards may exist. Follow **all** local requirements (NFPA 70E in the USA) for safe work practices and for personal protective equipment when servicing energized equipment.
- Prior to operating the equipment after moving, opening, or servicing, make sure to close the enclosure and make sure that there is proper earth ground continuity to the enclosure.
- Always follow these instructions for disconnecting power before inspecting or changing torch consumable parts.

ELECTRIC SHOCK CAN KILL

Touching live electrical parts can cause a fatal shock or severe burn.

- Operating the plasma system completes an electrical circuit between the torch and the workpiece. The workpiece and anything touching the workpiece are part of the electrical circuit.
- In machine torch applications, never touch the torch body, workpiece, or water in a water table when the plasma system is operating.

Electric shock prevention

All plasma systems use high voltage in the cutting process (200 to 400 VDC are common). Take the following precautions when operating this system:

- Wear insulated gloves and boots, and keep your body and clothing dry.
- Do not stand, sit, or lie on – or touch – any wet surface when using the plasma system.
- Insulate yourself from the work and ground using dry insulating mats or covers big enough to prevent any physical contact with the work or ground. If you must cut in or near a damp area, use extreme caution.
- Provide a disconnect switch close to the power supply with properly sized fuses. This switch allows the operator to turn off the power supply quickly in an emergency situation.
- When using a water table, make sure that it is correctly connected to an earth ground.
- Install and ground this equipment according to the instruction manual and in accordance with national and local regulations.
- Inspect the input power cord frequently for damage or cracking of the cover. Replace a damaged power cord immediately. **Bare wiring can kill.**
- Inspect and replace any worn or damaged torch leads.
- Do not pick up the workpiece, including the waste cutoff, while you cut. Leave the workpiece in place or on the workbench with the work lead attached during the cutting process.
- Before checking, cleaning, or changing torch parts, disconnect the main power or unplug the power supply.
- Never bypass or shortcut the safety interlocks.
- Before removing any power supply or system enclosure cover, disconnect electrical input power. Wait 5 minutes after disconnecting the main power to allow capacitors to discharge.
- Never operate the plasma system unless the power supply covers are in place. Exposed power supply connections present a severe electrical hazard.
- When making input connections, attach a proper grounding conductor first.
- Each plasma system is designed to be used only with specific torches. Do not substitute other torches, which could overheat and present a safety hazard.

CUTTING CAN CAUSE FIRE OR EXPLOSION

Fire prevention

- Make sure the cutting area is safe before doing any cutting. Keep a fire extinguisher nearby.
- Remove all flammables within 35 feet (10 m) of the cutting area.
- Quench hot metal or allow it to cool before handling or before letting it touch combustible materials.
- Never cut containers with potentially flammable materials inside – they must be emptied and properly cleaned first.
- Ventilate potentially flammable atmospheres before cutting.
- When cutting with oxygen as the plasma gas, an exhaust ventilation system is required.

Explosion prevention

- Do not use the plasma system if explosive dust or vapors may be present.
- Do not cut pressurized cylinders, pipes, or any closed containers.
- Do not cut containers that have held combustible materials.

WARNING
Explosion Hazard
Argon-Hydrogen and Methane

Hydrogen and methane are flammable gases that present an explosion hazard. Keep flames away from cylinders and hoses that contain methane or hydrogen mixtures. Keep flames and sparks away from the torch when using methane or argon-hydrogen plasma.

WARNING
Explosion Hazard
Underwater Cutting with Fuel Gases
Containing Hydrogen

- Do not cut underwater with fuel gases containing hydrogen.
- Cutting underwater with fuel gases containing hydrogen can result in an explosive condition that can detonate during plasma cutting operations.

WARNING
Explosion Hazard
Hydrogen Detonation with Aluminum Cutting

When you use a plasma torch to cut aluminum alloys under water or on a water table, a chemical reaction between the water and the workpiece, parts, fine particles, or molten aluminum droplets generates significantly more hydrogen gas than occurs with other metals. This hydrogen gas may get trapped under the workpiece. If exposed to oxygen or air, the plasma arc or a spark from any source can ignite this trapped hydrogen gas, causing an explosion that may result in death, personal injury, loss of property, or equipment damage.

Consult with the table manufacturer and other experts prior to cutting aluminum to implement a risk assessment and mitigation plan that eliminates the risk of detonation by preventing hydrogen accumulation.

Also, make sure that the water table, fume extraction (ventilation), and other parts of the cutting system have been designed with aluminum cutting in mind.

Do not cut aluminum alloys underwater or on a water table unless you can prevent the accumulation of hydrogen gas.

Note: With proper mitigation, most aluminum alloys can be plasma cut on a water table. An exception is aluminum-lithium alloys. **Never cut aluminum-lithium alloys in the presence of water.** Contact your aluminum supplier for additional safety information regarding hazards associated with aluminum-lithium alloys.

MACHINE MOTION CAN CAUSE INJURY

When an original equipment manufacturer (OEM) makes a cutting system by combining Hypertherm equipment with other equipment, the end-use customer and the OEM are responsible for providing protection against the hazardous moving parts of this cutting system. However, we advise the following to prevent operator injury and equipment damage:

- Read and follow the instruction manual provided by the OEM.
- Maintain a restricted-access area larger than the maximum movement range of the cutting system's moving parts.
- Where there is a risk of collision, do not allow personnel or equipment near the cutting system's moving parts.
- Avoid accidental contact with the CNC touchscreen or joystick. Accidental contact can activate commands and result in unintended motion.
- Do not service or clean the machinery during operation.
- If servicing is required, enable the safety interlock or disconnect and lock out/tag out power to disable the motors and prevent motion.
- Allow only qualified personnel to operate, maintain, and service the machinery.

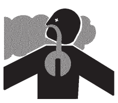
COMPRESSED GAS EQUIPMENT SAFETY

- Never lubricate cylinder valves or regulators with oil or grease.
- Use only correct gas cylinders, regulators, hoses, and fittings designed for the specific application.
- Maintain all compressed gas equipment and associated parts in good condition.
- Label and color-code all gas hoses to identify the type of gas in each hose. Consult applicable national and local regulations.

GAS CYLINDERS CAN EXPLODE IF DAMAGED

Gas cylinders contain gas under high pressure. If damaged, a cylinder can explode.

- Handle and use compressed gas cylinders in accordance with applicable national and local regulations.
- Never use a cylinder that is not upright and secured in place.
- Keep the protective cap in place over the valve except when the cylinder is in use or connected for use.
- Never allow electrical contact between the plasma arc and a cylinder.
- Never expose cylinders to excessive heat, sparks, slag, or open flame.
- Never use a hammer, wrench, or other tool to open a stuck cylinder valve.



TOXIC FUMES CAN CAUSE INJURY OR DEATH

The plasma arc by itself is the heat source used for cutting. Accordingly, although the plasma arc has not been identified as a source of toxic fumes, the material being cut can be a source of toxic fumes or gases that deplete oxygen.

The fumes produced vary depending on the metal that is cut. Metals that may release toxic fumes include, but are not limited to, stainless steel, carbon steel, zinc (galvanized), and copper.

In some cases, the metal may be coated with a substance that could release toxic fumes. Toxic coatings include, but are not limited to, lead (in some paints), cadmium (in some paints and fillers), and beryllium.

The gases produced by plasma cutting vary based on the material to be cut and the method of cutting, but may include ozone, oxides of nitrogen, hexavalent chromium, hydrogen, and other substances if such are contained in or released by the material being cut.

Caution should be taken to minimize exposure to fumes produced by any industrial process. Depending on the chemical composition and concentration of the fumes (as well as other factors, such as ventilation), there may be a risk of physical illness, such as birth defects or cancer.

It is the responsibility of the equipment and site owner to test the air quality in the cutting area and to make sure that the air quality in the workplace meets all local and national standards and regulations.

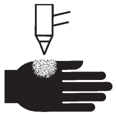
The air quality level in any relevant workplace depends on site-specific variables such as:

- Table design (wet, dry, underwater).
- Material composition, surface finish, and composition of coatings.
- Volume of material removed.
- Duration of cutting or gouging.
- Size, air volume, ventilation, and filtration of the workplace.
- Personal protective equipment.
- Number of welding and cutting systems in operation.
- Other workplace processes that may produce fumes.

If the workplace must conform to national or local regulations, only monitoring or testing done at the site can determine whether the workplace is above or below allowable levels.

To reduce the risk of exposure to fumes:

- Remove all coatings and solvents from the metal before cutting.
- Use local exhaust ventilation to remove fumes from the air.
- Do not inhale fumes. Wear an air-supplied respirator when cutting any metal coated with, containing, or suspected to contain toxic elements.
- Make sure that those using welding or cutting equipment, as well as air-supplied respiration devices, are qualified and trained in the proper use of such equipment.
- Never cut containers with potentially toxic materials inside. Empty and properly clean the container first.
- Monitor or test the air quality at the site as needed.
- Consult with a local expert to implement a site plan to make sure air quality is safe.



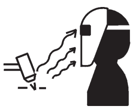
A PLASMA ARC CAN CAUSE INJURY AND BURNS

Instant-on torches

- A plasma arc ignites immediately when the torch switch is activated.

The plasma arc will cut quickly through gloves and skin.

- Keep away from the torch tip.
- Do not hold metal near the cutting path.
- Never point the torch toward yourself or others.



ARC RAYS CAN BURN EYES AND SKIN

Eye protection Plasma arc rays produce intense visible and invisible (ultraviolet and infrared) rays that can burn eyes and skin.

- Use eye protection in accordance with applicable national and local regulations.
- Wear eye protection (safety glasses or goggles with side shields, and a welding helmet) with appropriate lens shading to protect your eyes from the arc's ultraviolet and infrared rays.

Skin protection Wear protective clothing to protect against burns caused by ultraviolet light, sparks, and hot metal.

- Wear gauntlet gloves, safety shoes, and hat.
- Wear flame-retardant clothing to cover all exposed areas.
- Wear cuffless trousers to prevent entry of sparks and slag.

Also, remove any combustibles, such as a butane lighter or matches, from your pockets before cutting.

Cutting area Prepare the cutting area to reduce reflection and transmission of ultraviolet light:

- Paint walls and other surfaces with dark colors to reduce reflection.
- Use protective screens or barriers to protect others from flash and glare.
- Warn others not to watch the arc. Use placards or signs.

Arc current	Minimum protective shade number (ANSI Z49.1:2012)	Suggested shade number for comfort (ANSI Z49.1:2012)	OSHA 29CFR 1910.133(a)(5)	Europe EN168:2002
Less than 40 A	5	5	8	9
41 A to 60 A	6	6	8	9
61 A to 80 A	8	8	8	9
81 A to 125 A	8	9	8	9
126 A to 150 A	8	9	8	10
151 A to 175 A	8	9	8	11
176 A to 250 A	8	9	8	12
251 A to 300 A	8	9	8	13
301 A to 400 A	9	12	9	13
401 A to 800 A	10	14	10	N/A

PACEMAKER AND HEARING AID OPERATION

Pacemaker and hearing aid operation can be affected by magnetic fields from high currents.

Pacemaker and hearing aid wearers should consult a doctor before going near any plasma arc cutting and gouging operations.

To reduce magnetic field hazards:

- Keep both the work lead and the torch lead to one side, away from your body.
- Route the torch leads as close as possible to the work lead.
- Do not wrap or drape the torch lead or work lead around your body.
- Keep as far away from the power supply as possible.

NOISE CAN DAMAGE HEARING

Cutting with a plasma arc can exceed acceptable noise levels as defined by local regulations in many applications. Prolonged exposure to excessive noise can damage hearing. Always wear proper ear protection when cutting or gouging, unless sound pressure level measurements taken at the site have verified personal hearing protection is not necessary per relevant international, regional, and local regulations.

Significant noise reduction can be obtained by adding simple engineering controls to cutting tables such as barriers or curtains positioned between the plasma arc and the workstation, and/or locating the workstation away from the plasma arc. Implement administrative controls in the workplace to restrict access and limit operator exposure time, and screen off noisy areas and/or take measures to reduce reverberation in cutting areas by putting up noise absorbers.

Use ear protectors if the noise is disruptive or if there is a risk of hearing damage after all other engineering and administrative controls have been implemented. If hearing protection is required, wear only approved personal protective equipment such as ear muffs or ear plugs with a noise reduction rating appropriate for the situation. Warn others near the cutting area of possible noise hazards. In addition, ear protection can prevent hot splatter from entering the ear.

DRY DUST COLLECTION INFORMATION

In some workplaces, dry dust can represent a potential explosion hazard.

The U.S. National Fire Protection Association's NFPA standard 68, "Explosion Protection by Deflagration Venting," provides requirements for the design, location, installation, maintenance, and use of devices and systems to vent combustion gases and pressures after any deflagration event. Consult with the manufacturer or installer of any dry dust collection system for applicable requirements before you install a new dry dust collection system or make significant changes in the process or materials used with an existing dry dust collection system.

Consult your local "Authority Having Jurisdiction" (AHJ) to determine whether any edition of NFPA standard 68 has been "adopted by reference" in your local building codes.

Refer to NFPA standard 68 for definitions and explanations of regulatory terms such as deflagration, AHJ, adopted by reference, the Kst value, deflagration index, and other terms.

Note 1 – Unless a site-specific evaluation has been completed that determines that none of the dust generated is combustible, then NFPA standard 68 requires the use of explosion vents. Design the explosion vent size and type to conform to the worst-case Kst value as described in Annex F of NFPA standard 68. NFPA standard 68 does not specifically identify plasma cutting or other thermal cutting processes as requiring deflagration venting systems, but it does apply these new requirements to all dry dust collection systems.

Note 2 – Users should consult and comply with all applicable national, state, and local regulations. Publications do not intend to urge action that is not in compliance with all applicable regulations and standards, and this manual may never be construed as doing so.

LASER RADIATION

Exposure to the laser beam from a laser pointer can result in serious eye injury. Avoid direct eye exposure.

On products that use a laser pointer for alignment, one of the following laser radiation labels has been applied on the product near where the laser beam exits the enclosure. The maximum output (mV), wavelength emitted (nM), and, if appropriate, pulse duration are also provided.

Additional laser safety instructions:

- Consult with an expert on local laser regulations. Laser safety training may be required.
- Do not allow untrained persons to operate the laser. Lasers can be dangerous in the hands of untrained users.
- Do not look into the laser aperture or beam at any time.
- Position the laser as instructed to avoid unintentional eye contact.
- Do not use the laser on reflective workpieces.
- Do not use optical tools to view or reflect the laser beam.
- Do not disassemble or remove the laser or aperture cover.
- Modifying the laser or product in any way can increase the risk of laser radiation.
- Use of adjustments or performance of procedures other than those specified in this manual may result in hazardous laser radiation exposure.
- Do not operate in explosive atmospheres, such as in the presence of flammable liquids, gases, or dust.
- Use only laser parts and accessories that are recommended or provided by the manufacturer for your model.
- Repairs and servicing **must** be performed by qualified personnel.
- Do not remove or deface the laser safety label.

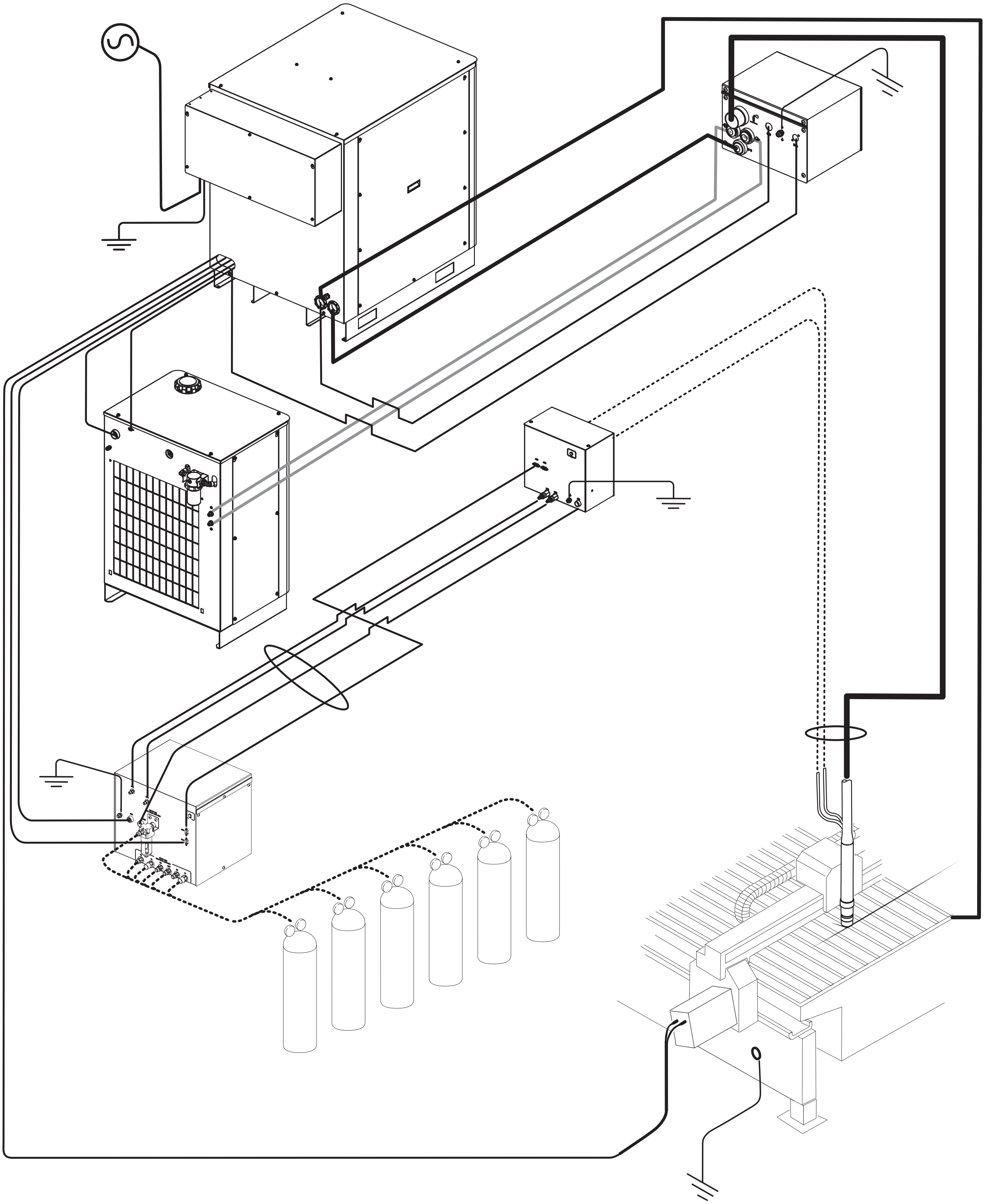
ADDITIONAL SAFETY INFORMATION

1. ANSI Standard Z49.1, Safety in Welding and Cutting, American Welding Society, 550 LeJeune Road, P.O. Box 351020, Miami, FL 33135
2. ANSI Standard Z49.2, Fire Prevention in the Use of Cutting and Welding Processes, American National Standards Institute, 1430 Broadway, New York, NY 10018
3. ANSI Standard Z87.1, Safe Practices for Occupation and Educational Eye and Face Protection, American National Standards Institute, 1430 Broadway, New York, NY 10018
4. AWS F4.1, Recommended Safe Practices for the Preparation for Welding and Cutting of Containers and Piping That Have Held Hazardous Substances, American Welding Society, 550 LeJeune Road, P.O. Box 351040, Miami, FL 33135
5. AWS F5.2, Recommended Safe Practices for Plasma Arc Cutting, American Welding Society, 550 LeJeune Road, P.O. Box 351040, Miami, FL 33135
6. CGA Pamphlet P-1, Safe Handling of Compressed Gases in Cylinders, Compressed Gas Association, 1235 Jefferson Davis Highway, Arlington, VA 22202
7. CSA Standard W117.2, Code for Safety in Welding and Cutting, Canadian Standards Association Standard Sales, 178 Rexdale Boulevard, Rexdale, Ontario M9W 1R3, Canada
8. NFPA Standard 51B, Cutting and Welding Processes, National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471
9. NFPA Standard 70, National Electrical Code, National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471
10. OSHA, Safety and Health Standards, 29FR 1910 U.S. Government Printing Office, Washington, D.C. 20402
11. AWS Safety and Health Fact Sheets, American Welding Society, 550 LeJeune Road, P.O. Box 351040, Miami, FL 33135, www.aws.org/technical/facts/

Section 2

SPECIFICATIONS

In this section:



System description

General

HyPerformance plasma systems are designed to cut a wide range of thicknesses of mild steel, stainless steel and aluminum.

Power supply

The power supply is a 400-amp, 200-VDC constant-current supply. It contains the circuitry to ignite a torch. The power supply has a serial interface to provide communication with a CNC controller.

Cooler

The cooler contains a heat exchanger and pump that reduces the temperature of the coolant that flows to the torch. It also contains flow and temperature sensors that ensure the cooling system is working properly.

Ignition console

The ignition console uses a spark-gap assembly. The ignition console converts 120 VAC control voltage from the power supply into high-frequency and high-voltage pulses (9-10 kV) to break over the torch electrode-nozzle gap. The high-voltage, high-frequency signal is coupled to the cathode lead and pilot arc lead.

Selection console

The selection console manages the selection and mixing of the plasma gases. It contains motor valves, solenoid valves and pressure transducers. It also contains a control board, an AC relay board and a power distribution board. The selection console has an LED lamp that illuminates when power is supplied to the system.

Metering console

The metering console controls the flow rate of the gases to the torch in real time. It also controls the gas portion of the LongLife® process. The metering console contains proportional control valves, a PC control board and a power distribution board.

Torch

The dross-free cutting capacity of the torch is 40 mm (1.5 in) for HyDefinition cutting. The production pierce capacity is 50 mm (2 in) for mild steel, 45 mm (1.75 in) for stainless steel, and 40 mm (1.5 in) for aluminum. The maximum cutting capability (edge start) is 80 mm (3 in) for mild steel, stainless steel, and aluminum.

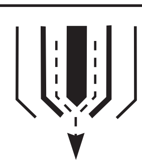
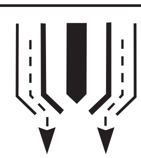
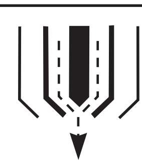
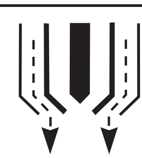
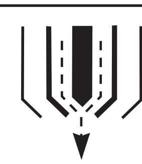
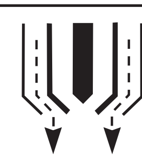
Specifications

System gas requirements

Gas quality and pressure requirements			
Gas type	**Quality**	**Pressure +/- 10%**	**Flow rate**
O_2 oxygen	99.5% pure Clean, dry, oil-free	793 kPa / 8 bar 115 psi	4250 l/h 150 scfh
N_2 nitrogen	99.99% pure Clean, dry, oil-free	793 kPa / 8 bar 115 psi	11610 l/h 410 scfh
Air	* Clean, dry, oil-free per ISO 8573-1 Class 1.4.2	793 kPa / 8 bar 115 psi	11330 l/h 400 scfh
H35 argon-hydrogen	99.995% pure (H35 = 65% Argon, 35% Hydrogen)	793 kPa / 8 bar 115 psi	4250 l/h 150 scfh
F5 nitrogen-hydrogen	99.98% pure (F5 = 95% Nitrogen, 5% Hydrogen)	793 kPa / 8 bar 115 psi	4250 l/h 150 scfh
Ar argon	99.99% pure Clean, dry, oil-free	793 kPa / 8 bar 115 psi	4250 l/h 150 scfh

* ISO standard 8573-1 Class 1.4.2 requirements are:

- Particulates – no more than 100 particles per cubic meter of air at a size of 0.1 to 0.5 microns in the largest dimension and 1 particle per cubic meter of air at a size of 0.5 to 5.0 microns in the largest dimension.
- Water – the pressure dewpoint of the humidity must be less than or equal to 3° C (37.4° F).
- Oil – the concentration of oil can be no more than 0.1 mg per cubic meter of air.

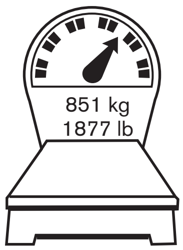
	Mild steel		**Stainless steel**		**Aluminum**	
						
Gas types	Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas
Cutting 30 to 50 A	O_2	O_2	N_2 & F5	N_2	Air	Air
Cutting 80 A	O_2	Air	F5	N_2	–	–
Cutting 130 A	O_2	Air	N_2 & H35	N_2	H35 & Air	N_2 & Air
Cutting 200 A	O_2	Air	N_2 & H35	N_2	N_2 & H35	N_2
Cutting 260 A	O_2	Air	N_2 & H35	N_2 & Air	N_2 & H35	N_2 & Air
Cutting 400 A	O_2	Air	N_2 & H35	N_2 & Air	N_2 & H35	N_2 & Air

Power supply

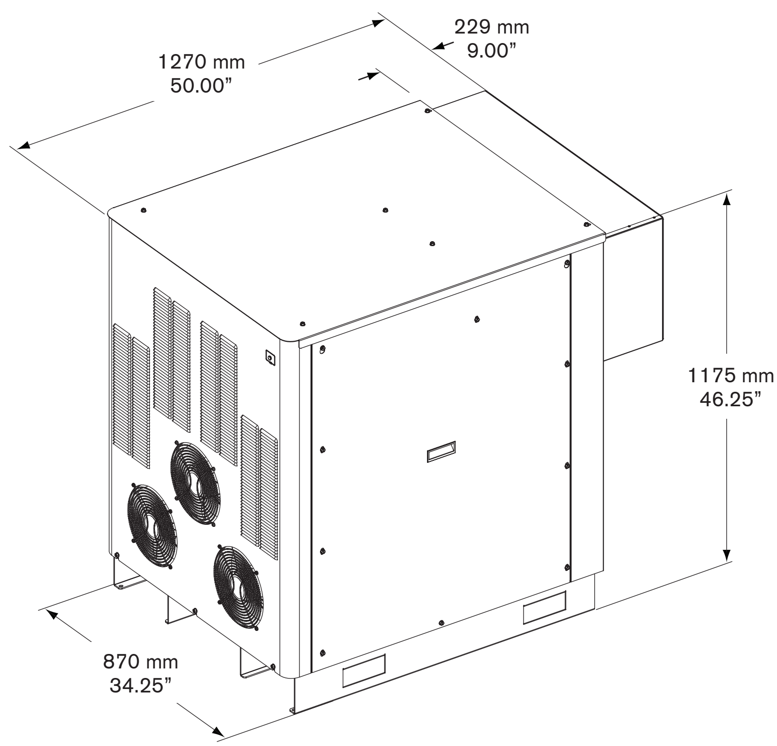
General	
Maximum OCV (U_0)	360 VDC
Maximum output current (I_2)	400 Amps
Output voltage (U_2)	50 – 200 VDC
Duty cycle rating (X)	100% @ 80 kw, 40° C (104° F)
Ambient temperature/Duty cycle	Power supplies will operate between -10° C and +40° C (+14° and 104° F)
Power factor (cosϕ)	0.98 @ 400 ADC output
Cooling	Forced air (Class F)
Insulation	Class H

Power supply part numbers		AC Voltage (U_1)	Phase	Frequency (Hz)	Amperage (I_1)	Regulatory approval	Power kVA (+/- 10%) (U_1 x I_1 x 1.73)
Without Hypernet	With Hypernet						
078523	078570	200/208	3	50/60	262/252	CSA	90.6
078524	078571	220	3	50/60	238	CSA	90.6
078525	078572	240	3	60	219	CSA	90.6
078526	078573	380*	3	50/60	138	CCC	90.6
078527	078574	400	3	50/60	131	CE/GOST-R	90.6
078528	078575	440	3	50/60	120	CSA	90.6
078529	078576	480	3	60	110	CSA	90.6
078530	078577	600	3	60	88	CSA	90.6

* The 380 volt CCC regulatory approval only applies to 50 Hz operation

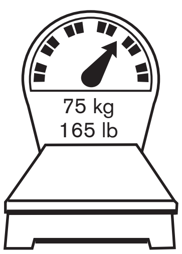


Approximate weight of the heaviest unit

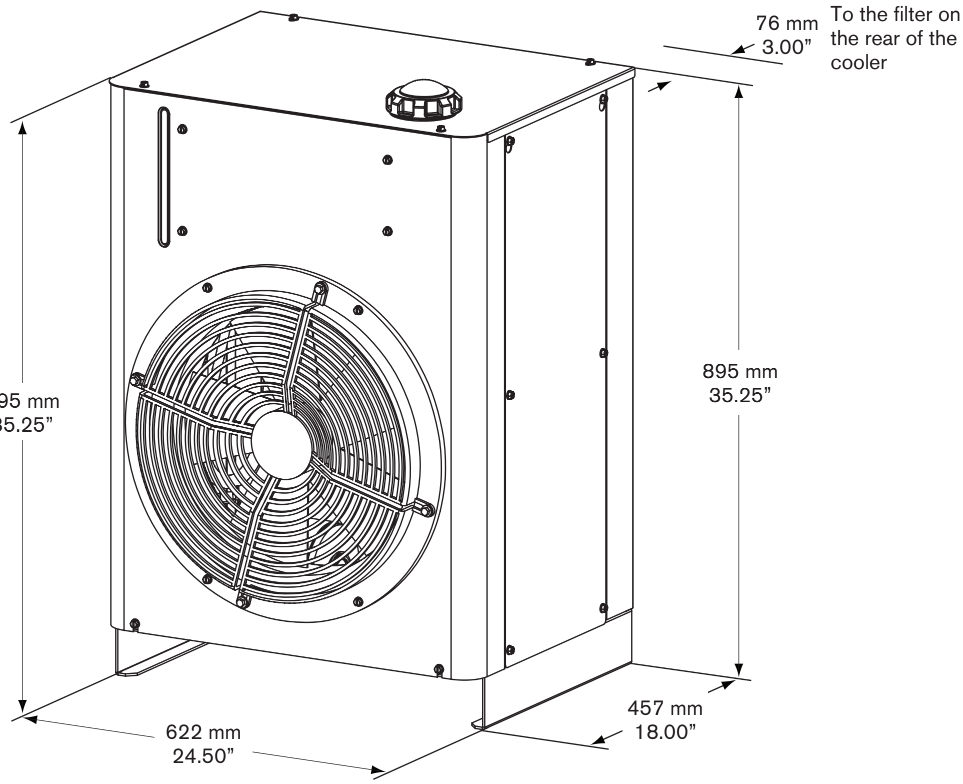


Cooler – 078531

- The cooling system can contain up to 34.5 liters (9 gallons) of coolant.
- Maximum cable length from the cooler to the power supply is 4.57 meters (15 ft).
- Maximum hose length from the cooler to the ignition console is 76.2 meters (250 ft).
- Allow 1 m (3 ft) of space on all sides of the cooler for ventilation and service.

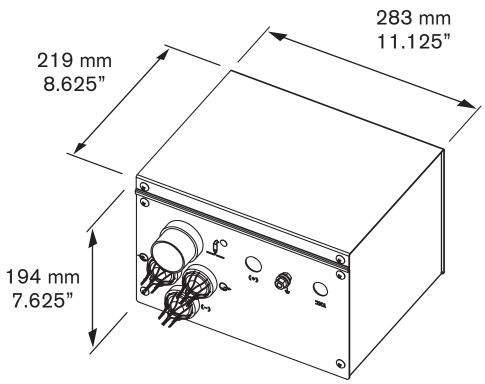


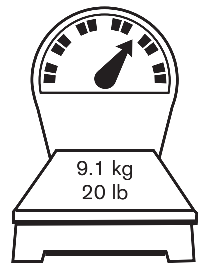
Weight with no coolant

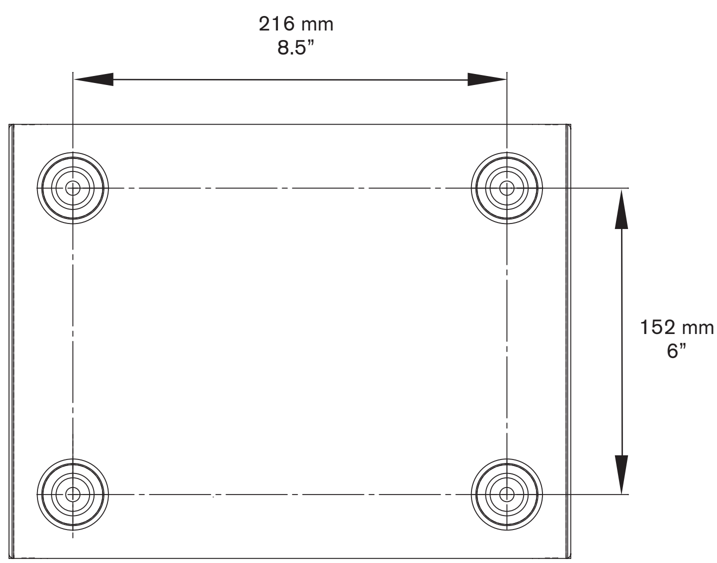


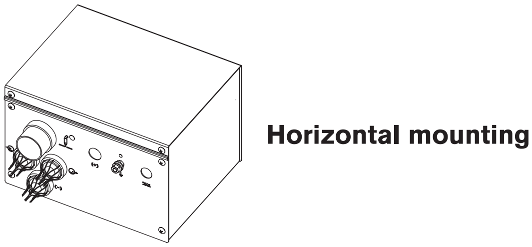
Ignition console – 078172

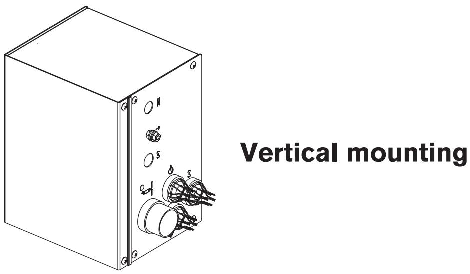
- The ignition console can be mounted remotely on the cutting table's bridge. See *Installation* section for details.
- Maximum cable length from the ignition console to the torch lifter station is 15 m (50 ft). Allow room to remove the top for servicing.
- The ignition console may be mounted horizontally or vertically.

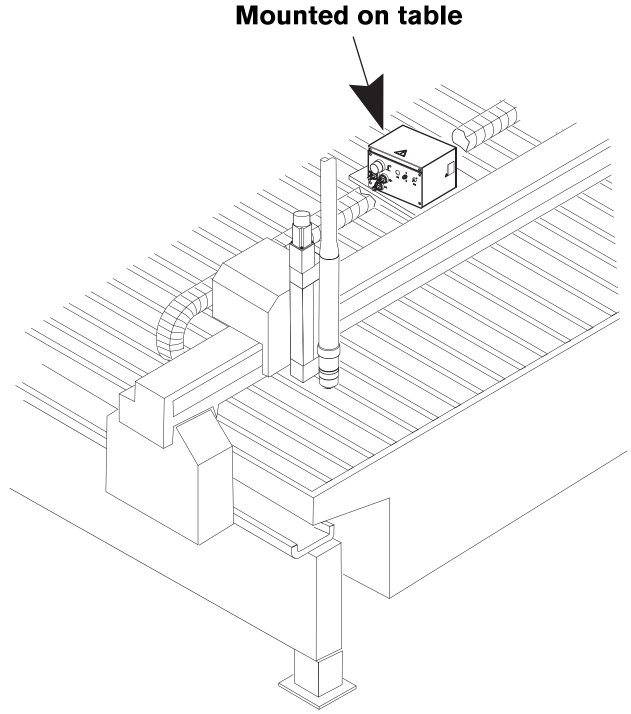






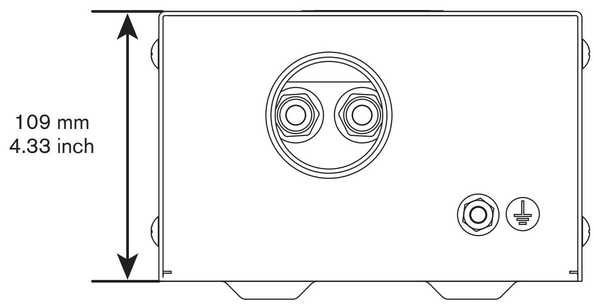

Horizontal mounting

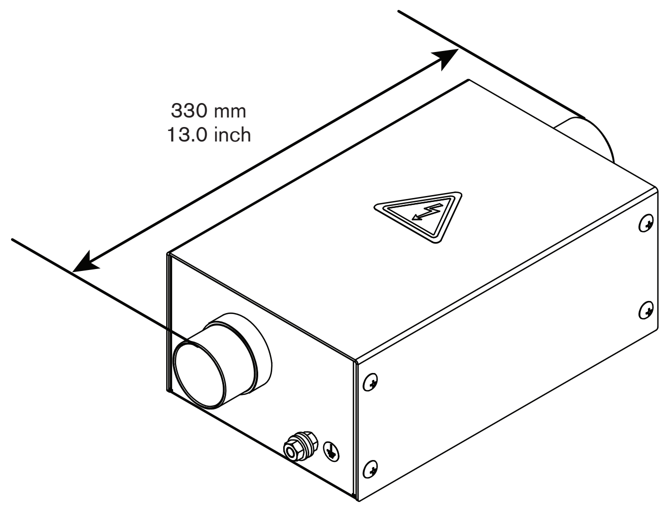

Vertical mounting

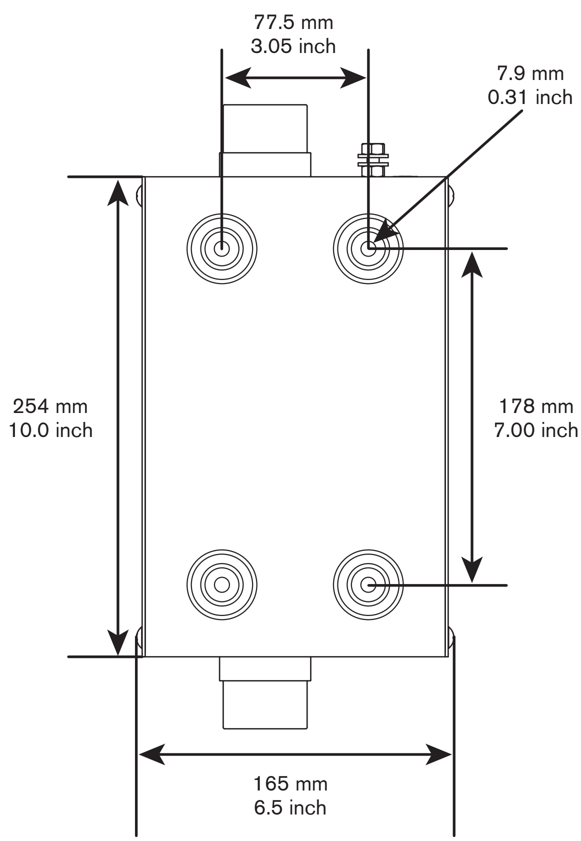

Mounted on table

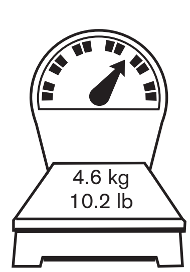
Torch lead junction box (Optional) – 078619

- The junction box provides increased installation flexibility by creating a break point in the leads between the ignition console and torch to facilitate easier replacement of torch leads in certain applications.
- Maximum combined lead length from the ignition console to the torch must be less than or equal to:
  - 20 m (65 feet) for HPR130XD / HPR260XD
  - 15 m (50 feet) for HPR400XD / HPR800XD



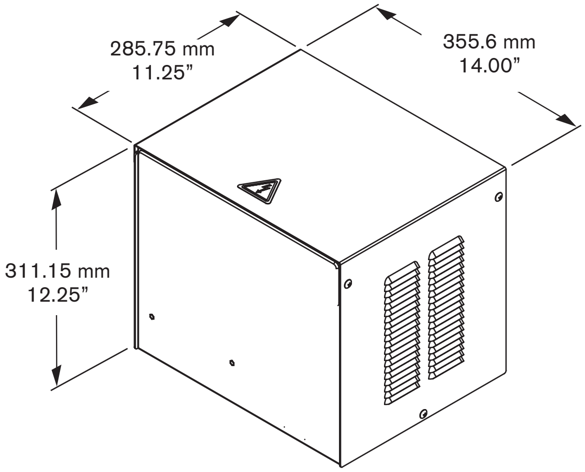


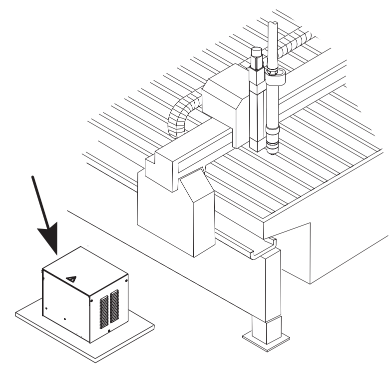


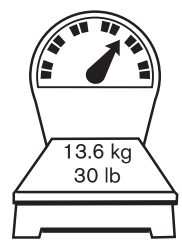


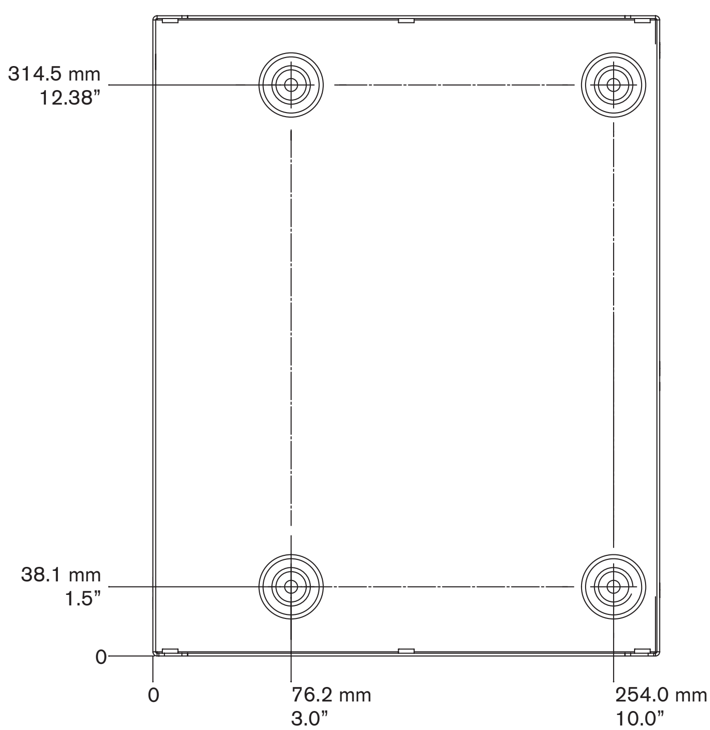
Selection console – 078533

- Maximum cable length from the power supply to the selection console is 75 m (250 ft).
- Maximum cable length from the selection console to the metering console is 20 m (65 ft).
- Mount the selection console on top of the power supply or near the CNC on the cutting table. Allow room to open the top for servicing.



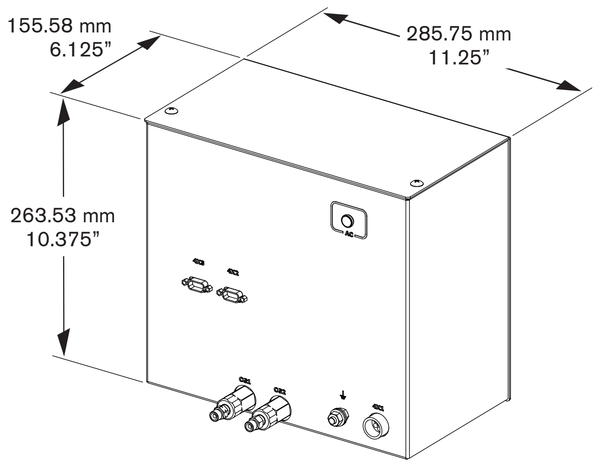


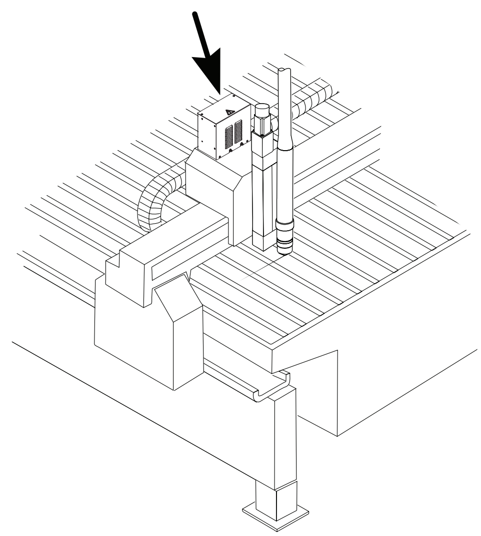


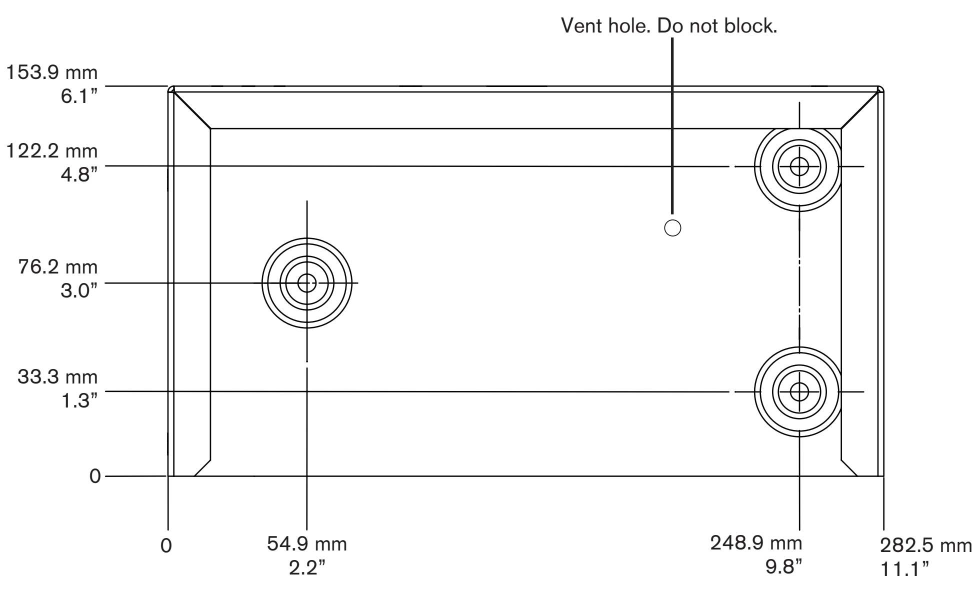


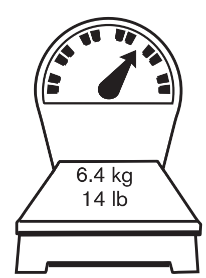
Metering console – 078535

- Maximum cable length from the metering console to the torch lifter station is 1.8 m (6 ft).
- Mount the metering console to the torch carriage on larger tables. On smaller tables it can be mounted to a bracket just above the bridge.
- The vent hole on the console must be kept clear at all times.



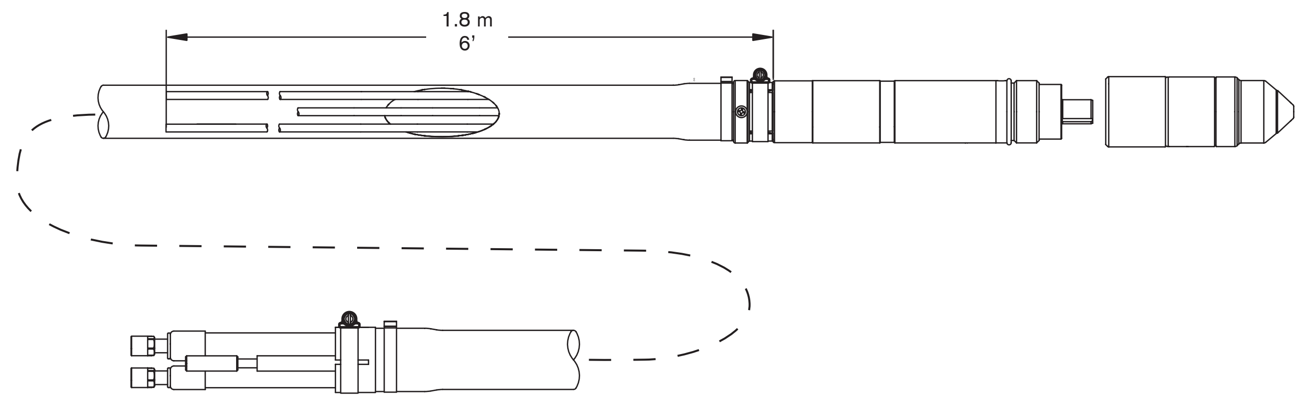


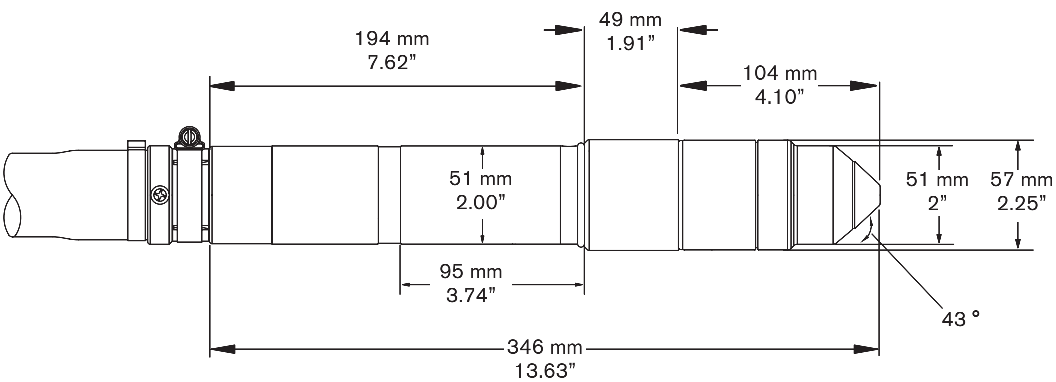


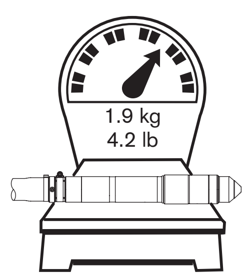


Torch – 228354

- The outside diameter of the torch mounting sleeve is 50.8 mm (2.0 in).
- The minimum bend radius for the torch leads is 152.4 mm (6.0 in).

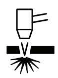
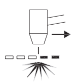
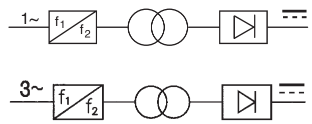
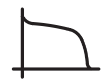
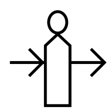
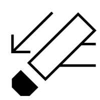
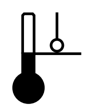






IEC symbols

The following symbols may appear on the power supply data plate, control labels, switches, LEDs, and LCD screen.

	Direct current (DC)
	Alternating current (AC)
	Plasma torch cutting
	Plate metal cutting
	Expanded metal cutting
	Gouging
	AC input power connection
	The terminal for the external protective (earth) conductor
I	Power is ON
O	Power is OFF
	An inverter-based power source, either 1-phase or 3-phase
	Volt/amp curve, “drooping” characteristic
	Power is ON (LED)
	System fault (LED)
	Inlet gas pressure fault (LCD)
	Missing or loose consumables (LCD)
	Power supply is out of temperature range (LCD)

Symbols and Marks

Your product may have one or more of the following markings on or near the data plate. Due to differences and conflicts in national regulations, not all marks are applied to every version of a product.

S mark

The S mark indicates that the power supply and torch are suitable for operations carried out in environments with increased hazard of electrical shock according to IEC 60974-1.

CSA mark

Products with a CSA mark meet the United States and Canadian regulations for product safety. The products were evaluated, tested, and certified by CSA-International. Alternatively, the product may have a mark by one of the other Nationally Recognized Testing Laboratories (NRTL) accredited in both the United States and Canada, such as Underwriters Laboratories, Incorporated (UL) or TÜV.

CE mark

The CE marking signifies the manufacturer's declaration of conformity to applicable European directives and standards. Only those versions of products with a CE marking located on or near the data plate have been tested for compliance with the European Low Voltage Directive and the European Electromagnetic Compatibility (EMC) Directive. EMC filters needed to comply with the European EMC Directive are incorporated within versions of the product with a CE marking.

Eurasian Customs Union (CU) mark

CE versions of products that include an EAC mark of conformity meet the product safety and EMC requirements for export to Russia, Belarus, and Kazakhstan.

GOST-TR mark

CE versions of products that include a GOST-TR mark of conformity meet the product safety and EMC requirements for export to the Russian Federation.

C-Tick mark

CE versions of products with a C-Tick mark comply with the EMC regulations required for sale in Australia and New Zealand.

CCC mark

The China Compulsory Certification (CCC) mark indicates that the product has been tested and found compliant with product safety regulations required for sale in China.

UkrSEPRO mark

The CE versions of products that include a UkrSEPRO mark of conformity meet the product safety and EMC requirements for export to the Ukraine.

Serbian AAA mark

CE versions of products that include a AAA Serbian mark meet the product safety and EMC requirements for export to Serbia.

Section 3

INSTALLATION

In this section:

Upon receipt

- Verify that all system components on your order have been received. Contact your supplier if any items are missing.
- Inspect the system components for any physical damage that may have occurred during shipping. If there is evidence of damage, refer to *Claims.* All communications regarding claims must include the model number and serial number located on the rear of the power supply.

Claims

Claims for damage during shipment – If your unit was damaged during shipment, you must file a claim with the carrier. Hypertherm will furnish you with a copy of the bill of lading upon request. If you need additional assistance, call Customer Service listed in the front of this manual, or your authorized Hypertherm distributor.

Claims for defective or missing merchandise – If any of the merchandise is defective or missing, contact your supplier. If you need additional assistance, call Customer Service listed in the front of this manual, or your authorized Hypertherm distributor.

Installation requirements

All installation and service of the electrical and plumbing systems must conform to national and local electrical and plumbing codes. This work should be performed only by qualified, licensed personnel.

Direct any technical questions to the nearest Hypertherm Technical Service Department listed in the front of this manual, or your authorized Hypertherm distributor.

Noise levels

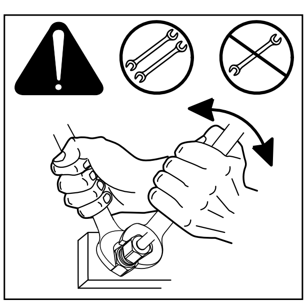
Acceptable noise levels as defined by national and local codes may be exceeded by this plasma system. Always wear proper ear protection when cutting or gouging. Any noise measurements taken are dependant on the specific environment in which the system is used. See also *Noise can damage hearing* in the *Safety* section of this manual. Specific information by product can be found in the Hypertherm downloads library at:

https://www.hypertherm.com/Xnet/library/DocumentLibrary.jsp

Select the product you are looking for from the Product Type drop down menu, choose “Regulatory” from the Category drop down menu, and choose “Acoustical Noise Data Sheets” from the Sub Category drop down menu. Hit Submit.

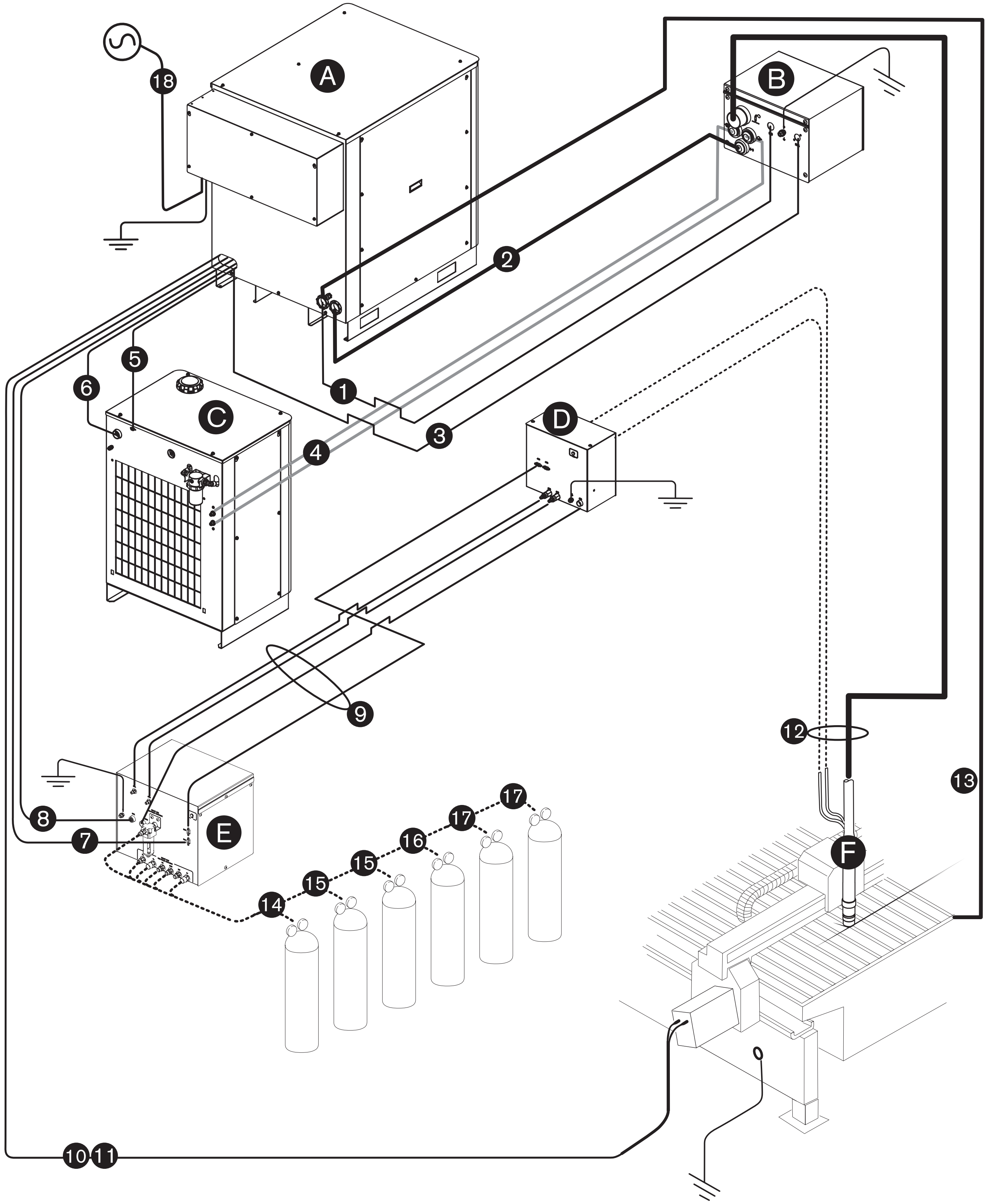
Placement of system components

- Place all system components in position prior to making electrical, gas, and interface connections. Use the diagram in this section for component-placement guidelines.
- Ground all system components to earth. See *Recommended grounding and shielding practices* in this section for details.
- To prevent leaks in the system, tighten all gas and water connections as shown below:



Torque specifications			
Gas or water hose size	**kgf-cm**	**lbf-in**	**lbf-ft**
Up to 10 mm (3/8 in)	8.6-9.8	75-85	6.25-7
12 mm (1/2 in)	41.5-55	360-480	30-40

Installation requirements



System components

- A Power supply
- B Ignition console
- C Cooler
- D Metering console
- E Selection console
- F Torch

Cables and hoses

1. Pilot arc lead
2. Negative lead
3. Ignition console power cable
4. Coolant hoses
5. Cooler control cable
6. Cooler power cable
7. Selection console control cable
8. Selection console power cable
9. Selection console to metering console hose and lead assembly
10. CNC interface cable
11. Optional CNC interface cable for systems with multiple power supplies
12. Torch lead assembly
13. Work lead

Supply gas hoses

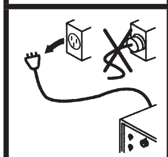
14. Oxygen
15. Nitrogen or argon
16. Air
17. Argon-hydrogen (H35) or nitrogen-hydrogen (F5)

Customer-supplied power cable

18. Main power cable

Recommended grounding and shielding practices

WARNING!
ELECTRIC SHOCK CAN KILL



Disconnect electrical power before performing any maintenance.

All work requiring the removal of the plasma system cover must be performed by a qualified technician.

See the *Safety* section of your manual for more safety precautions.

Introduction

This section describes practices for grounding and shielding to protect a plasma cutting system against radio frequency interference (RFI) and electromagnetic interference (EMI) (also called *noise*). It also describes the DC power ground and the service ground. The diagram at the end of this section shows these types of grounds in a plasma cutting system.

Note: The grounding practices in this section have been used on many installations with excellent results, and Hypertherm recommends that these practices be a routine part of the installation process. The actual methods used to implement these practices may vary from system to system, but should remain as consistent as possible. However, due to the variation in equipment and installations, these grounding practices may not succeed in every case to eliminate RFI/EMI noise issues.

Types of grounding

Service ground (also called safety ground or potential earth (PE) ground) is the grounding system that applies to the incoming line voltage. It prevents a shock hazard to any personnel from any of the equipment or the cutting table. It includes the service ground coming into the plasma system and other systems such as the CNC and the motor drives, as well as the supplemental ground rod connected to the cutting table. In the plasma circuits, the ground is carried from the plasma system chassis to the chassis of each separate console through the interconnecting cables.

DC power ground (also called cutting current ground) is the grounding system that completes the path of the cutting current from the torch back to the plasma system. It requires that the positive lead from the plasma system be firmly connected to the cutting table ground bus with a properly sized cable. It also requires that the slats, on which the workpiece rests, make firm contact with the table and the workpiece.

RFI and EMI grounding and shielding is the grounding system that limits the amount of electrical noise emitted by the plasma and motor drive systems. It also limits the amount of noise that is received by the CNC and other control and measurement circuits. The grounding practices described in this section mainly target RFI and EMI grounding and shielding.

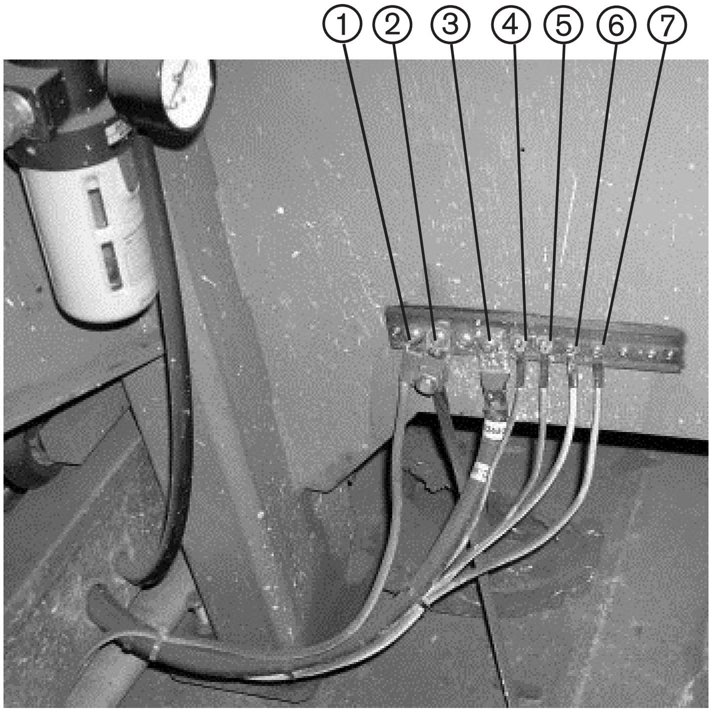
Grounding Practices

1. Unless noted, use only 13.3 mm^2 (6 AWG) welding cables (047040) for the EMI ground cables shown on the diagram at the end of this section.
2. The cutting table is used for the common, or star, EMI ground point and should have threaded studs welded to the table with a copper bus bar mounted on them. A separate bus bar should be mounted on the gantry as close to each motor as possible. If there are motors at each end of the gantry, run a separate EMI ground

cable from the far motor to the gantry bus bar. The gantry bus bar should have a separate, heavy EMI ground cable 21.2 mm^2 (4 AWG; 047031) to the table bus bar. The EMI ground cables for the torch lifter and the RHF console must each run separately to the table ground bus.

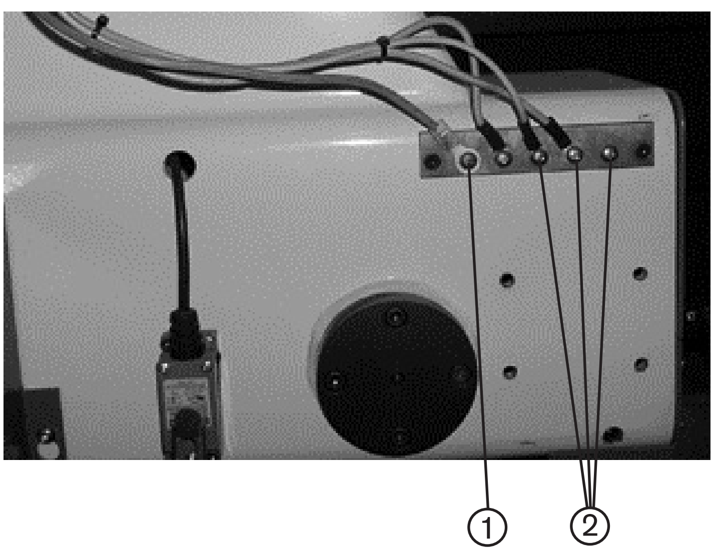
3. A ground rod that meets all applicable local and national electrical codes must be installed within 6 m (20 ft) of the cutting table. This is a PE ground and should be connected to the cutting table ground bus bar using 13.3 mm^2 (6 AWG) green and yellow grounding cable (047121) or equivalent.
4. For the most effective shielding, use the Hypertherm CNC interface cables for I/O signals, serial communication signals, between plasma systems in multi-drop connections, and for interconnections between all parts of the Hypertherm system.
5. All hardware used in the ground system must be brass or copper. While you can use steel studs welded to the cutting table for mounting the ground bus, no other aluminum or steel hardware can be used in the ground system.
6. AC power, PE, and service grounds must be connected to all equipment according to local and national codes.
7. For a system with a remote high frequency console (RHF), the positive, negative, and pilot arc leads should be bundled together for as long a distance as possible. The torch lead, work lead, and the pilot arc (nozzle) leads may be run parallel to other wires or cables only if they are separated by at least 150 mm (6 inches). If possible, run power and signal cables in separate cable tracks.
8. For a system with an RHF console, the ignition console should be mounted as closely as possible to the torch, and must have a separate ground cable that connects directly to the cutting table ground bus bar.
9. Each Hypertherm component, as well as any other CNC or motor drive cabinet or enclosure, must have a separate ground cable to the common (star) ground on the table. This includes the ignition console, whether it is bolted to the plasma system or to the cutting table.
10. The metal braided shield on the torch lead must be connected firmly to the ignition console and to the torch. It must be electrically insulated from any metal and from any contact with the floor or building. The torch lead can be run in a plastic cable tray or track, or covered with a plastic or leather sheath.
11. The torch holder and the torch breakaway mechanism – the part mounted to the lifter, not the part mounted to the torch – must be connected to the stationary part of the lifter with copper braid at least 12.7 mm (0.5 inches) wide. A separate cable must run from the lifter to the gantry ground bus bar. The valve assembly should also have a separate ground connection to the gantry ground bus bar.
12. If the gantry runs on rails that are not welded to the table, then each rail must be connected with a ground cable from the end of the rail to the table. The rail ground cables connect directly to the table and do not need to connect to the table ground bus bar.
13. If you are installing a voltage divider board, mount it as closely as possible to where the arc voltage is sampled. One recommended location is inside the plasma system enclosure. If a Hypertherm voltage divider board is used, the output signal is isolated from all other circuits. The processed signal should be run in twisted shielded cable (Belden 1800F or equivalent). Use a cable with a braided shield, not a foil shield. Connect the shield to the chassis of the plasma system and leave it unconnected at the other end.
14. All other signals (analog, digital, serial, and encoder) should run in twisted pairs inside a shielded cable. Connectors on these cables should have a metal housing. The shield, not the drain, should be connected to the metal housing of the connector at each end of the cable. Never run the shield or the drain through the connector on any of the pins.

The following picture shows an example of a cutting table ground bus. The components shown here may differ from your system.



1 Gantry ground bus
2 Ground rod
3 Plasma system lead (+)
4 Remote high frequency (RHF) console
5 CNC enclosure
6 Torch holder
7 Plasma system chassis

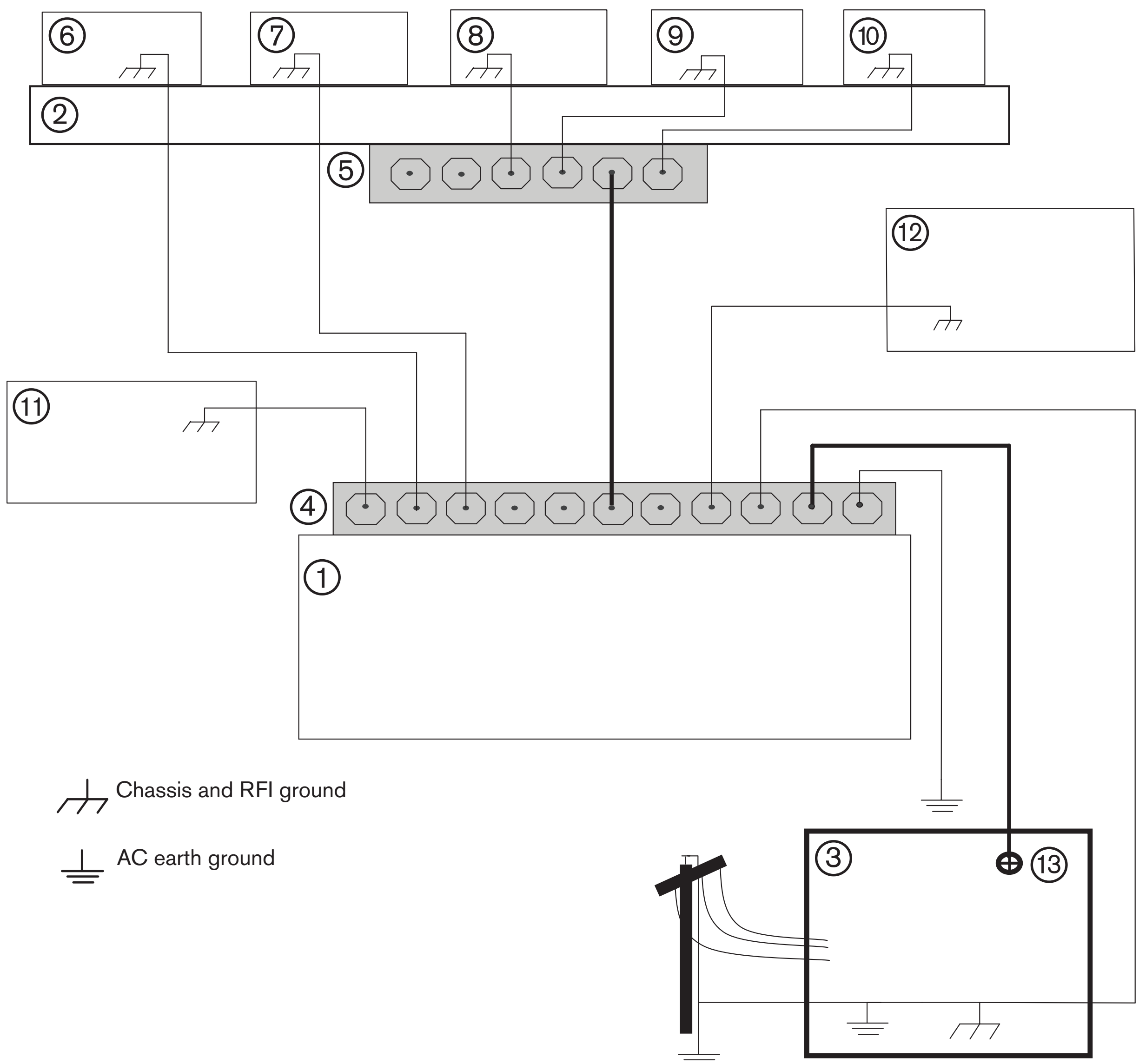
The following picture shows an example of a gantry ground bus. It is bolted to the gantry, close to the motor. All of the individual ground cables from the components mounted on the gantry connect to the bus. A single heavy cable then connects the gantry ground bus to the table ground bus.



1 Cable to the cutting table ground bus
2 Ground cables from components on the gantry

Grounding diagram

The following diagram shows an example of grounding the components in a plasma cutting system.



1	Cutting table
2	Gantry
3	Plasma system
4	Table ground bus bar
5	Gantry ground bus bar
6	Torch height control lifter (ArcGlide®, Sensor™ THC, Sensor PHC, or other)
7	RHF console (not on all systems). Connect to table ground bus bar.
8, 9	System-specific component such as metering console, gas console, or selection console
10	CNC chassis
11	Torch height control module (ArcGlide, Command® THC)
12	System-specific component such as a cooler or chiller
13	DC power ground

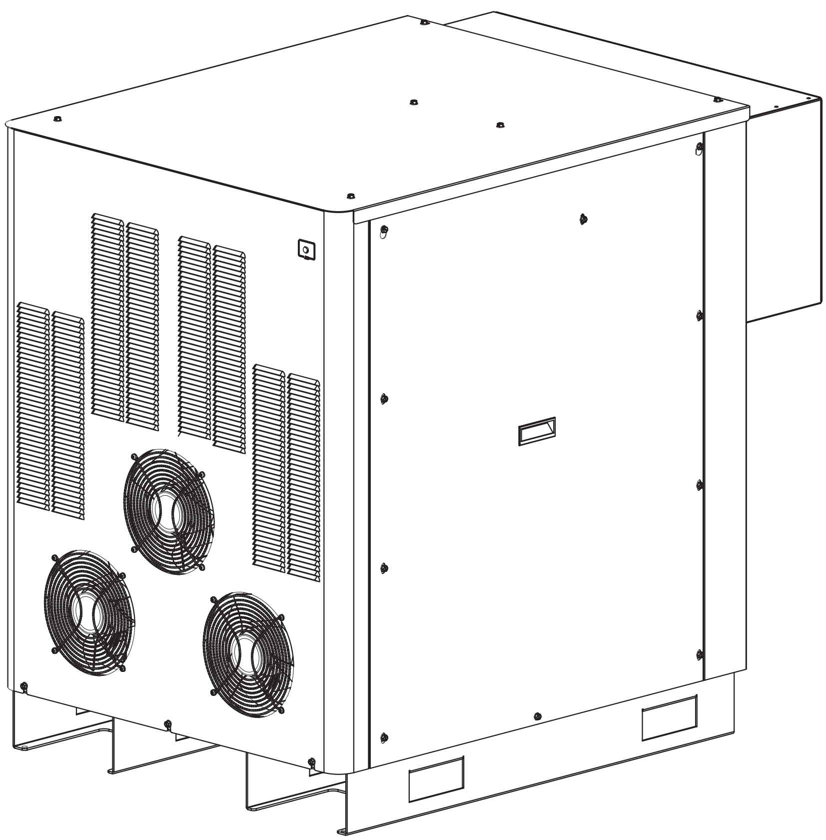
Ⓐ Placement of the power supply

		DANGER **ELECTRIC SHOCK CAN KILL**
Remove all electrical connections to the power supply before moving or positioning. Transporting the unit can cause personal injury and equipment damage.		

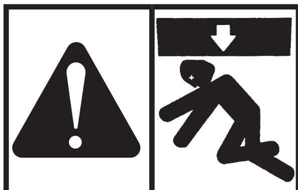
The power supply can be moved by forklift but the forks must be long enough to extend the entire length of the base. Take care when lifting so that the underside of the power supply is not damaged. The forks must also be centered front to back and side to side to prevent tipping while moving. Fork lift speeds should be kept to a minimum, especially when making a turn or going around a corner.

- Place the power supply in an area that is free of excessive moisture, has proper ventilation and is relatively clean. Allow 1 m (3 ft) of space on all sides of the power supply for ventilation and service.
- Cooling air is drawn in through the front panel and is exhausted through the rear of the unit by a cooling fan. Do not place any filter device over the air intake locations, which reduces cooling efficiency and VOIDS THE WARRANTY.
- Do not place the power supply on an incline greater than 10° to prevent it from toppling.

HPR400XD power supplies with serial number HPR400-000560 or later can be upgraded to a HPR800XD primary or secondary power supply.



Lifting the power supply

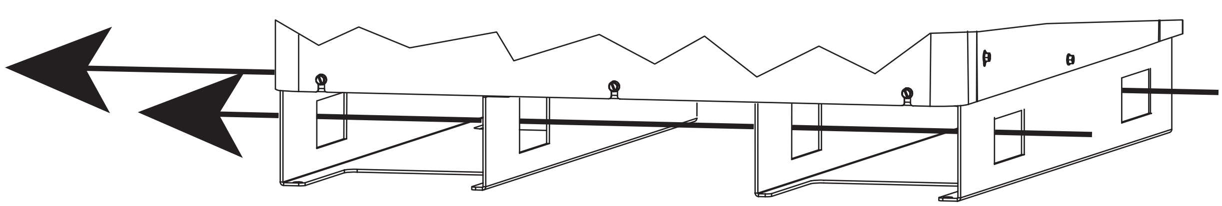


DANGER

The HPR400XD power supply weighs approximately 746 kg (1645 lbs). 1 or 2 person manual pushing or lifting could cause injury. Use appropriate lifting aids and techniques when moving a power supply

A strap kit (228336) for lifting the HPR400XD is available from Hypertherm. The strap kit should only be used to lift the HPR400 as outlined herein. Before using the strap kit, the customer understands and assumes exclusive responsibility for supplying personnel trained and qualified to operate forklifts, cranes, hoists and other lifting devices to lift or move the power supply. All movement of the power supply must be done in compliance with applicable local laws and regulations. All handling equipment must be evaluated for each application and inspected and tested before each use. The power supply can be moved by forklift, but the forks must be long enough to extend the entire length of the base. Take care when lifting so that the underside of the power supply is not damaged. The customer agrees to observe and ensure compliance with the following:

- The straps and other handling equipment must comply with applicable local standards, laws and regulations.
- The rated capacity, design factor, and efficiency rating of the lifting system, including the straps sold by Hypertherm, may be affected by wear, misuse, overloading, corrosion, deformation, intentional alteration, age, and other use conditions. An inspection of the straps by qualified personnel should be conducted before each use. Worn or damaged straps may not be used, nor may they be altered or modified in any way.
- All 4 loops at the ends of the straps must be securely and properly attached to the lifting mechanism.
- The power supply is a nonsymmetrical load; ensure that an analysis by a qualified person is performed properly to balance the load to prevent tipping and overloading of any one strap.
- All enclosure panels must be securely fastened before lifting the power supply.
- The lifting mechanism must be rated for the appropriate weight and be suitable for the strap size.
- Each strap should pass through all 4 holes in the base of the power supply and should not be twisted, constricted, bunched or pinched.



Correct path for lifting straps

- Straps shall not be shortened or lengthened by knotting, twisting, choker hitching, or other means.
- The power supply should be lifted slowly, not more than 203 mm (8 in.) above the floor, to insure that the weight is evenly distributed.
- The power supply should be moved slowly to prevent sudden acceleration and deceleration when moving.
- Access to the area should be restricted when moving or lifting to prevent injury of personnel if the power supply shifts or tips.

- Personnel should never be allowed to place themselves or any part of the body under the equipment, or between the equipment and walls or other solid objects.
- Store straps in a proper manner such that they are not subjected to mechanical, chemical, or ultraviolet damage, or to extreme temperatures.

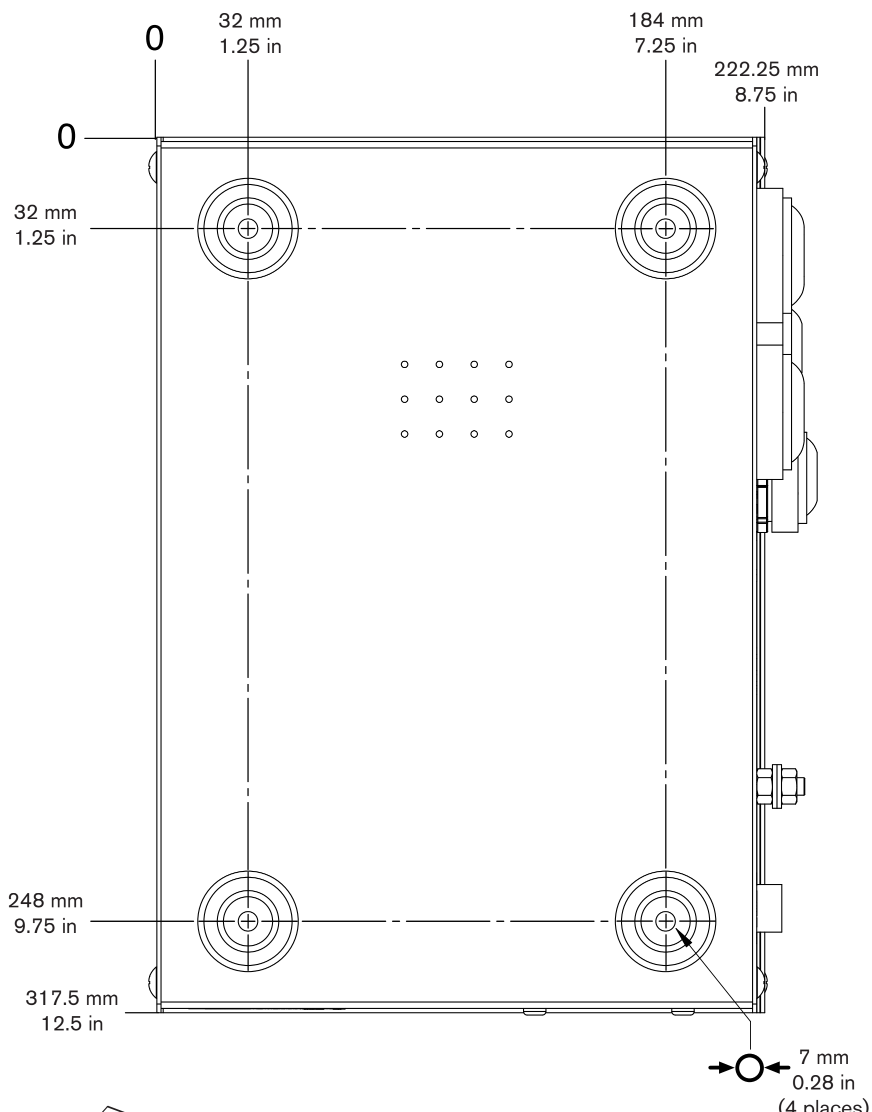
In the United States, OSHA regulates slings in 29 CFR 1910.184. This regulation covers general requirements, basic definitions, safe operating practices, inspections of the various types of slings. Read the OSHA regulations and OSHA sling guidelines carefully before moving the power supply, and observe all requirements and recommendations for safe handling in 29 CFR 1910.184 and other applicable sections. If there is any question respecting the interpretation or application of these or other OSHA regulations, you should consult appropriate legal counsel.

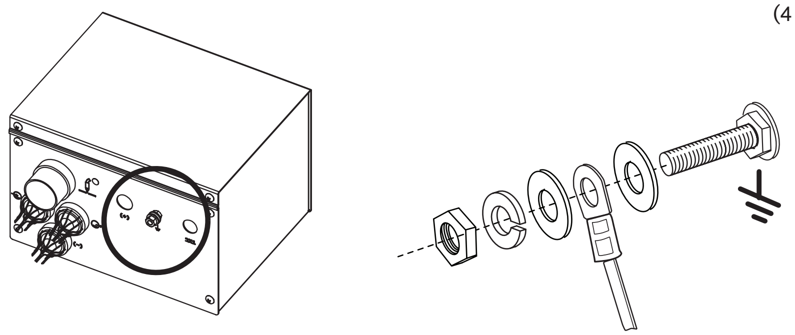
Hypertherm slings are not for sale In Europe, where locally purchased slings are required to have “CE Marking.” In the UK the interpretation of the European Directives translated into the following UK Statutory Instruments (SI): SI 2306 PUWER, The Provision and Use of Work Equipment Regulations and SI 2307 LOLER, Lifting Operations Lifting Equipment Regulations. Reference to the European Directives may not be construed to mean that the strap kit may be used in other countries or jurisdictions.

The body responsible for the workplace where the equipment is to be installed needs to ensure all applicable local regulations are followed, and Hypertherm assumes no responsibility or liability therefore. The customer assumes exclusive responsibility for ensuring that all local laws and regulations are followed, including those applicable to the use of equipment and work place conditions.

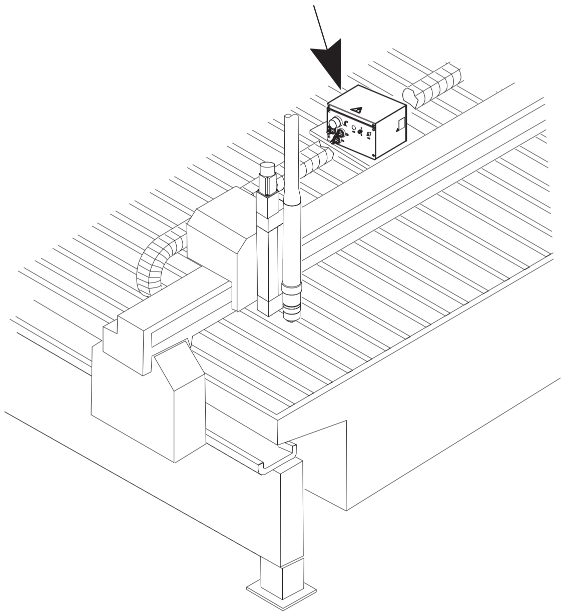
B Install the ignition console

- Mount the ignition console in a vertical or horizontal position.
- Allow room to remove the top for servicing

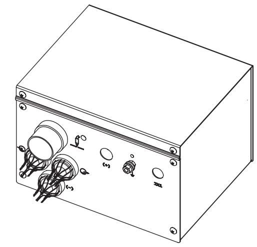




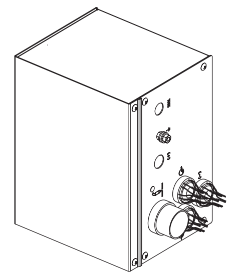
Ignition console grounding



Horizontal RHF mounting



Vertical RHF mounting

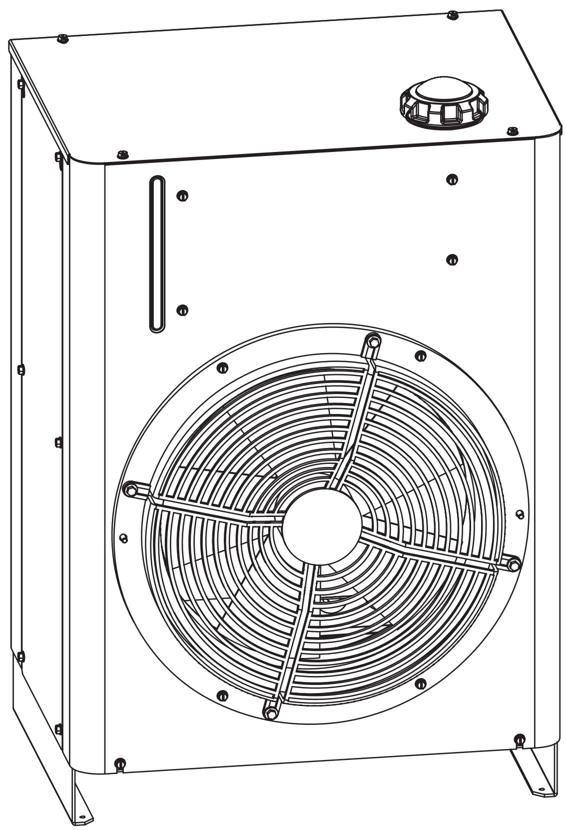


Ⓒ Placement of the cooler

- Place the cooler in an area that is free of excessive moisture, has proper ventilation, and is relatively clean. Allow 1 m (3 ft) of space on all sides of the power supply for ventilation and service.

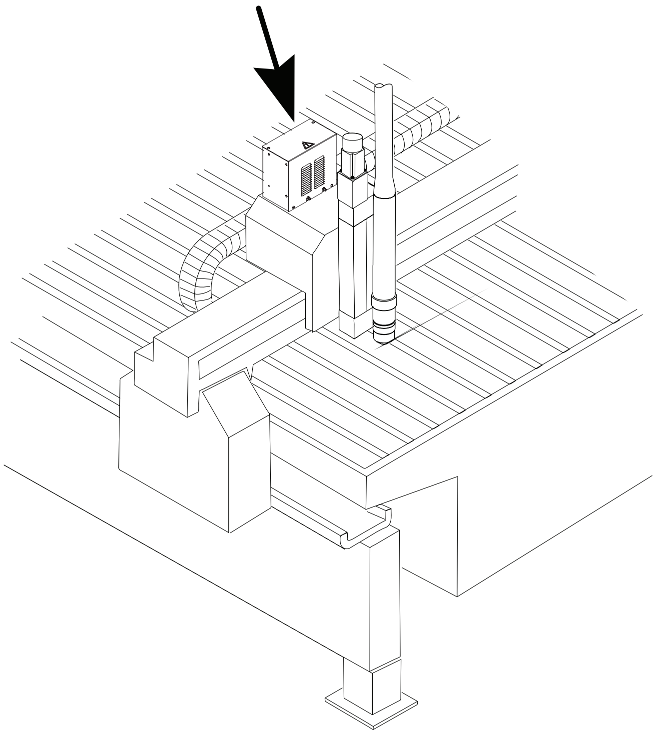
- Cooling air is drawn in through the front panel and is exhausted through the rear of the unit by a cooling fan. Do not place any filter device over the air intake locations, which reduces cooling efficiency and VOIDS THE WARRANTY.

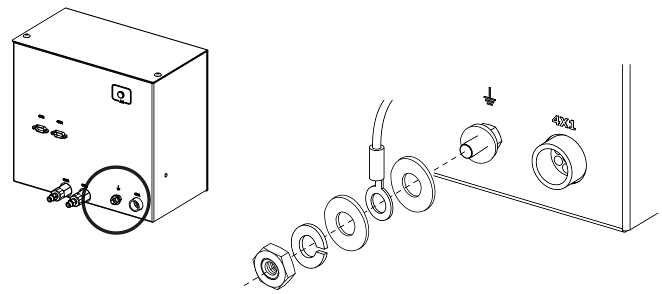
- Do not place the cooler on an incline greater than 10° to prevent it from toppling.



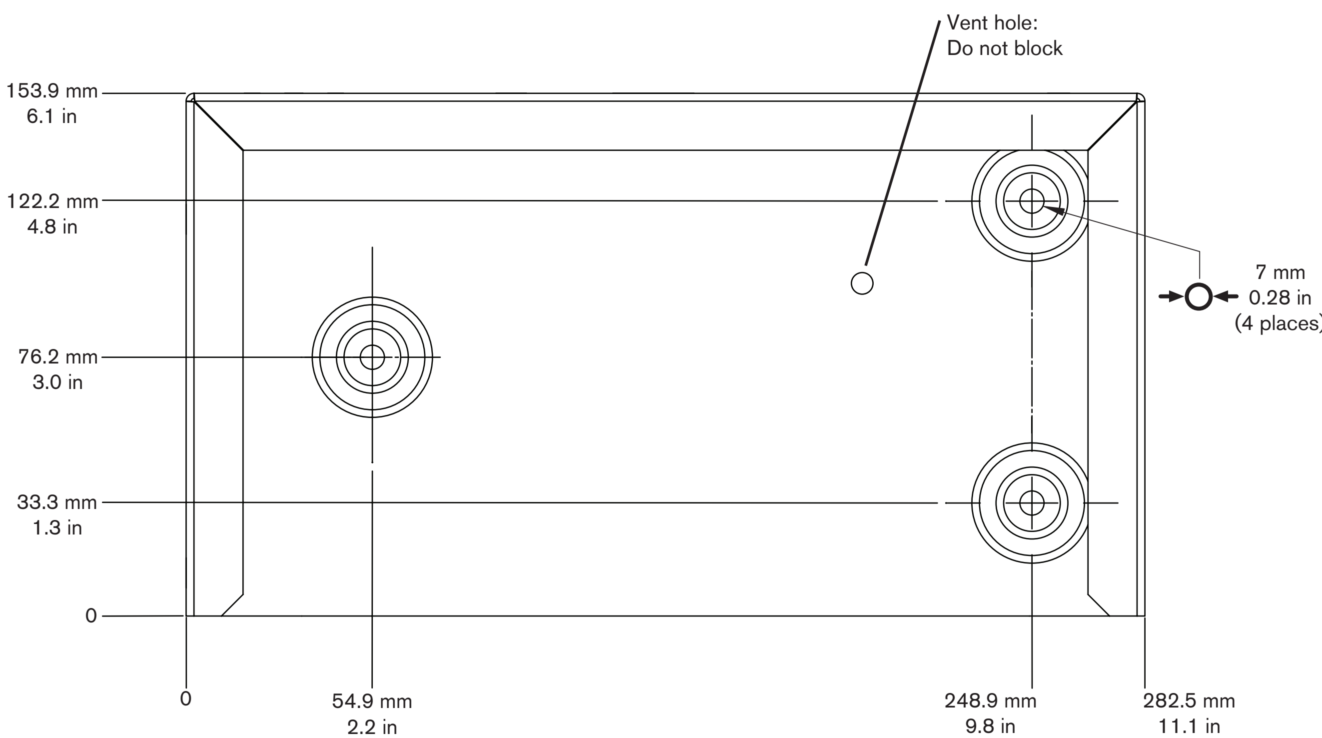
D Install the metering console

- Mount the metering console near the torch lifter station. The maximum length of the gas hoses between the metering console and the torch is 1.8 m (6 ft).



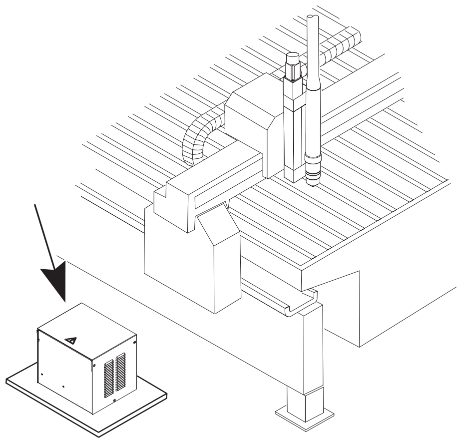


Metering console grounding

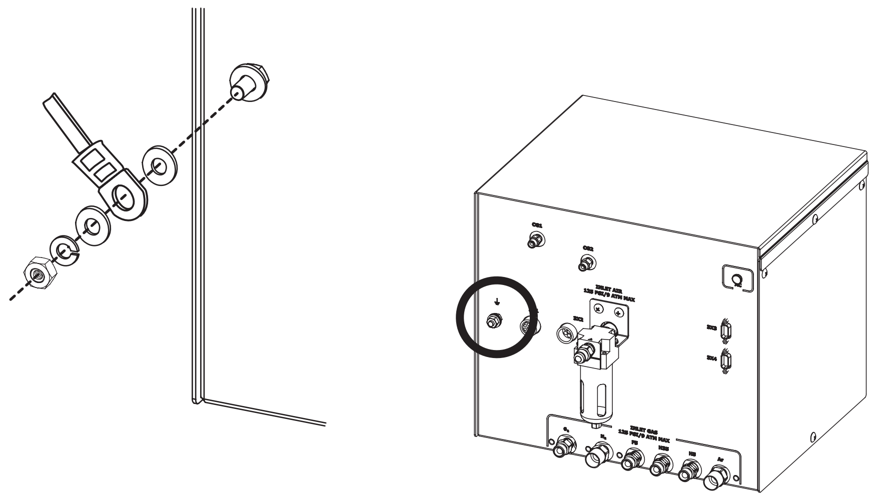


Placement of the selection console

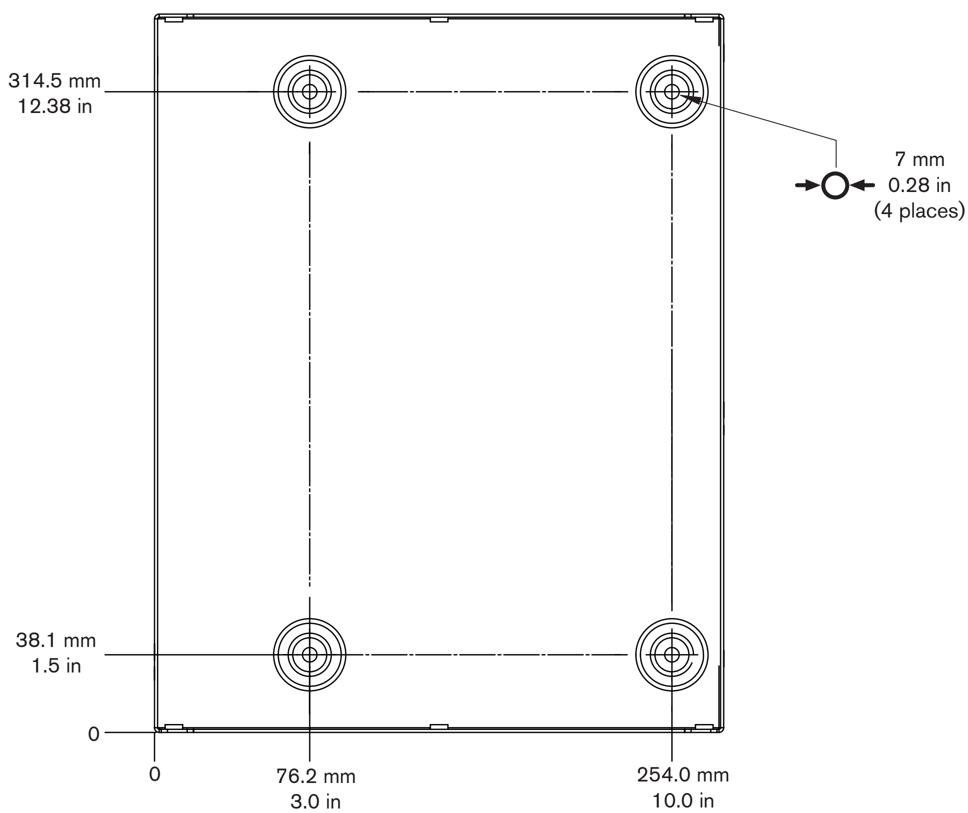
- Mount the selection console near the cutting table. Allow room to remove the top and right side cover for servicing. Preferred orientation is shown in the figure below. The maximum length of cables between the power supply and selection console is 75 m (250 ft). The maximum length of cables and hoses between the selection console and the metering console assembly is 20 m (65 ft).



Preferred selection console orientation



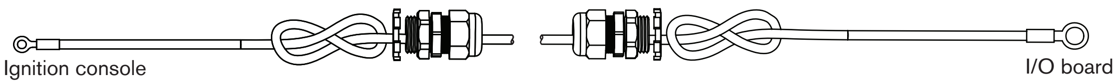
Selection console grounding



This page is blank intentionally

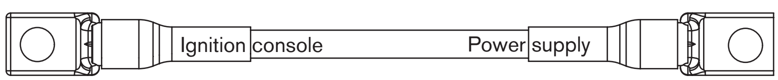
Power supply to ignition console leads

❶ Pilot arc lead

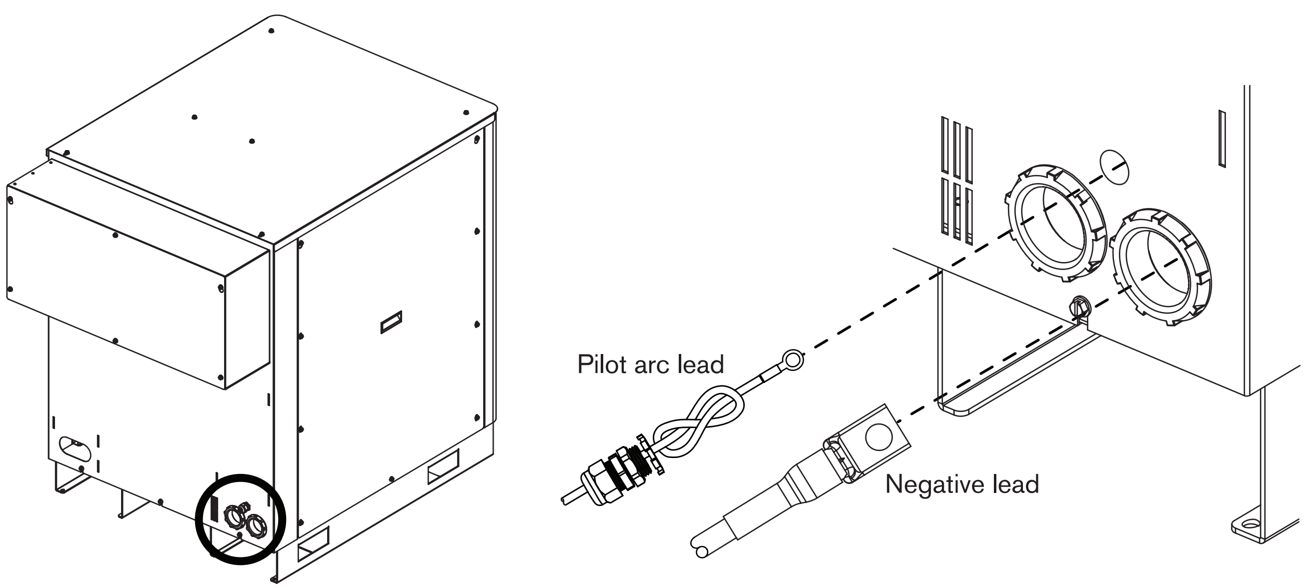


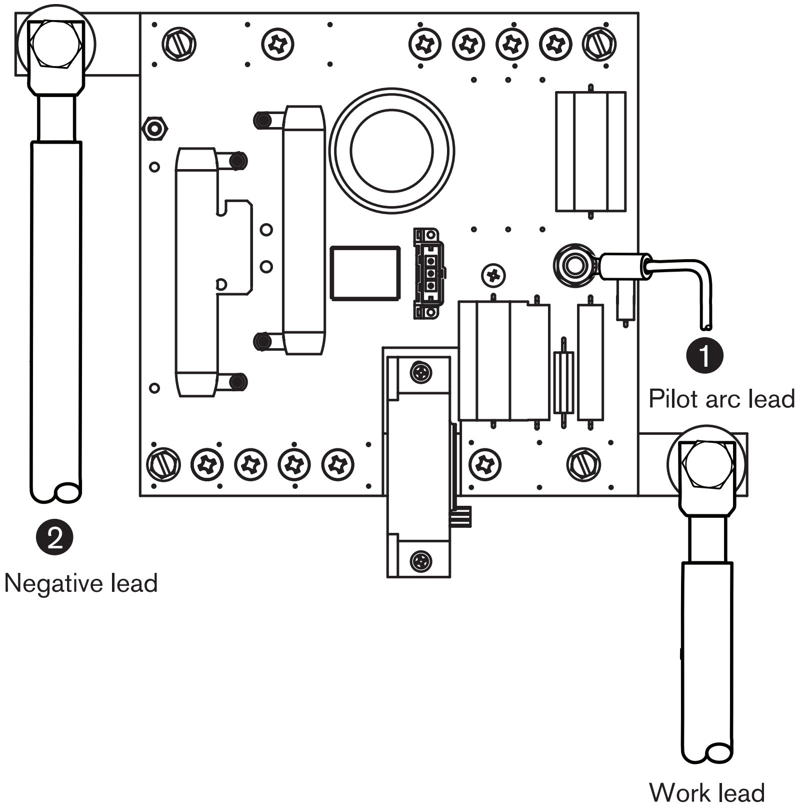
Part no.	Length	Part no.	Length
123820	3 m (10 ft)	123735	25 m (82 ft)
123821	4.5 m (15 ft)	123668	35 m (115 ft)
123666	7.5 m (25 ft)	123669	45 m (150 ft)
123822	10 m (35 ft)	123824	60 m (200 ft)
123667	15 m (50 ft)	123825	75 m (250 ft)
123823	20 m (65 ft)		

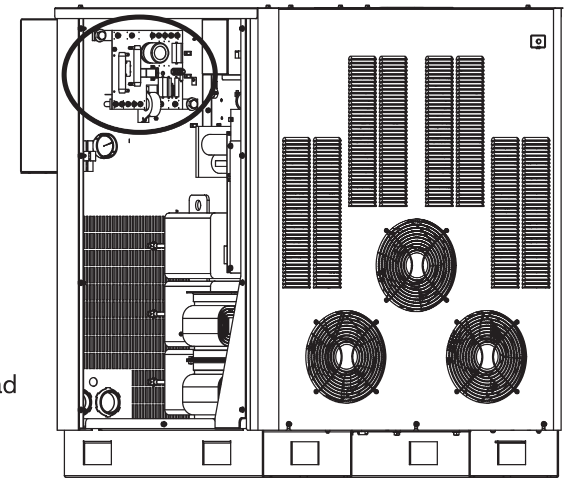
❷ Negative lead

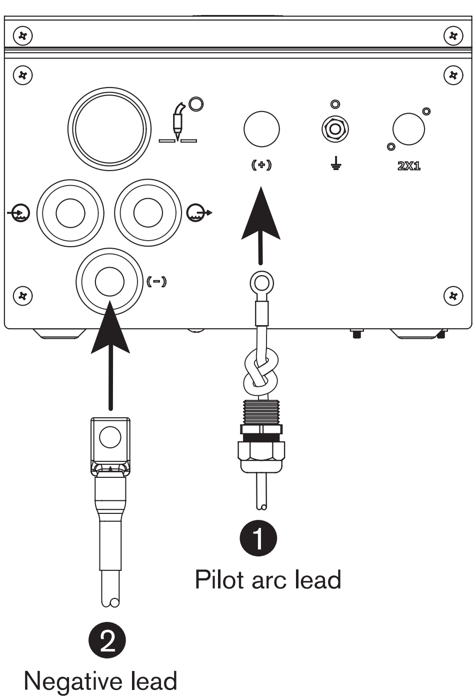


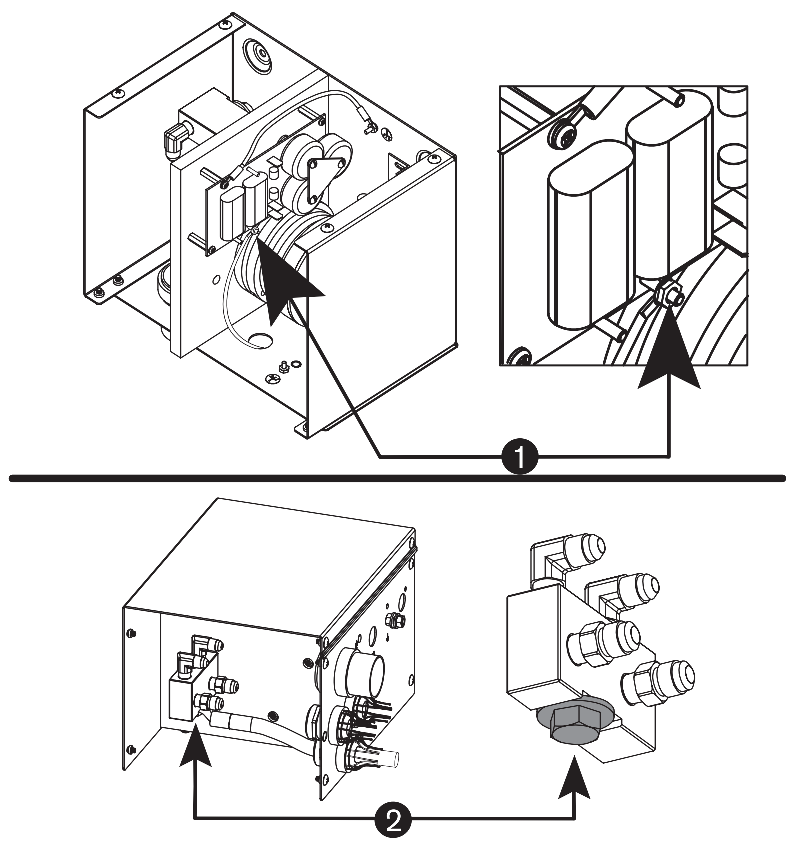
Part no.	Length	Part no.	Length
123418	3 m (10 ft)	123996	25 m (82 ft)
023382	4.5 m (15 ft)	123997	35 m (115 ft)
023078	7.5 m (25 ft)	023081	45 m (150 ft)
123994	10 m (35 ft)	023188	60 m (200 ft)
023079	15 m (50 ft)	023815	75 m (250 ft)
123995	20 m (65 ft)		



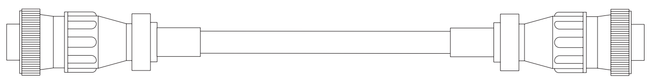

1
Pilot arc lead
2
Negative lead
Work lead




(+)
2X1
(–)
1
Pilot arc lead
2
Negative lead


1
2

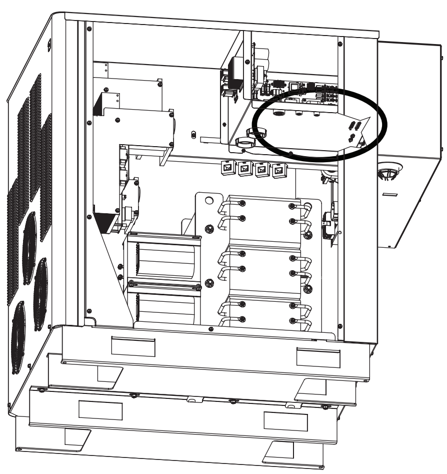
❸ Ignition console power cable

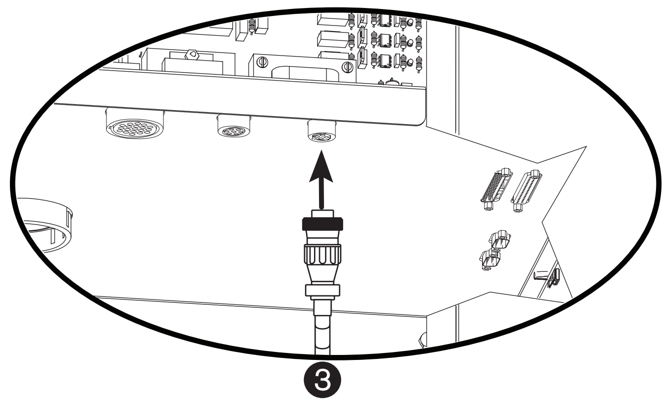


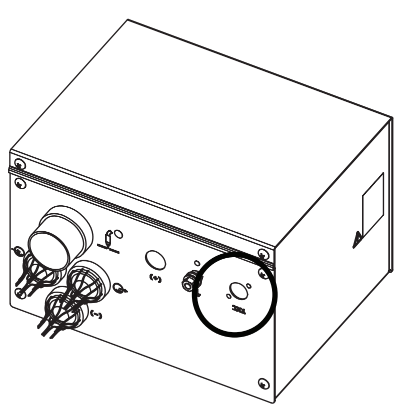
Female end to ignition console

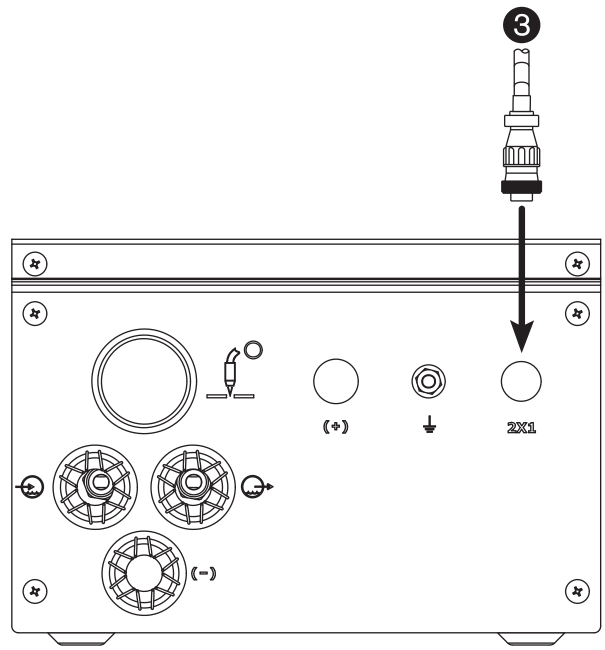
Part no.	Length	Part no.	Length
123419	3 m (10 ft)	123425	22.5 m (75 ft)
123834	4.5 m (15 ft)	123736	25 m (82 ft)
123420	6 m (20 ft)	123426	30 m (100 ft)
123670	7.5 m (25 ft)	123672	35 m (115 ft)
123422	9 m (30 ft)	123938	37.5 m (125 ft)
123835	10 m (35 ft)	123673	45 m (150 ft)
123423	12 m (40 ft)	123837	60 m (200 ft)
123671	15 m (50 ft)	123838	75 m (250 ft)
123836	20 m (65 ft)		

Cable signal list – power supply to ignition console		
Power supply end		**Ignition console end**
Pin No.	Description	Pin No.
1	120 VAC-Hot	1
2	120 VAC-Return	2
3	Ground	3
4	Not used	4



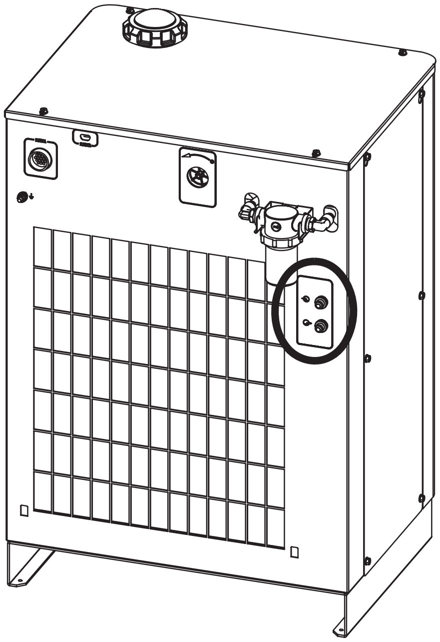


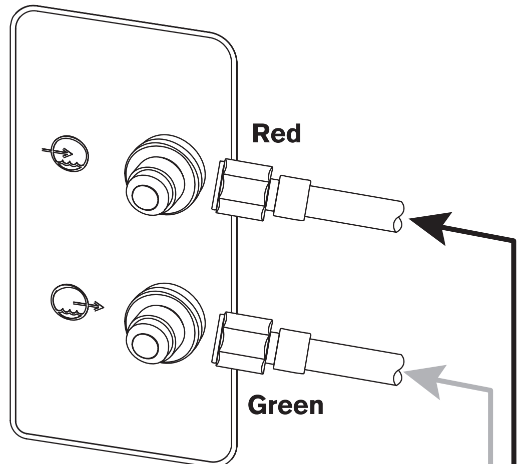




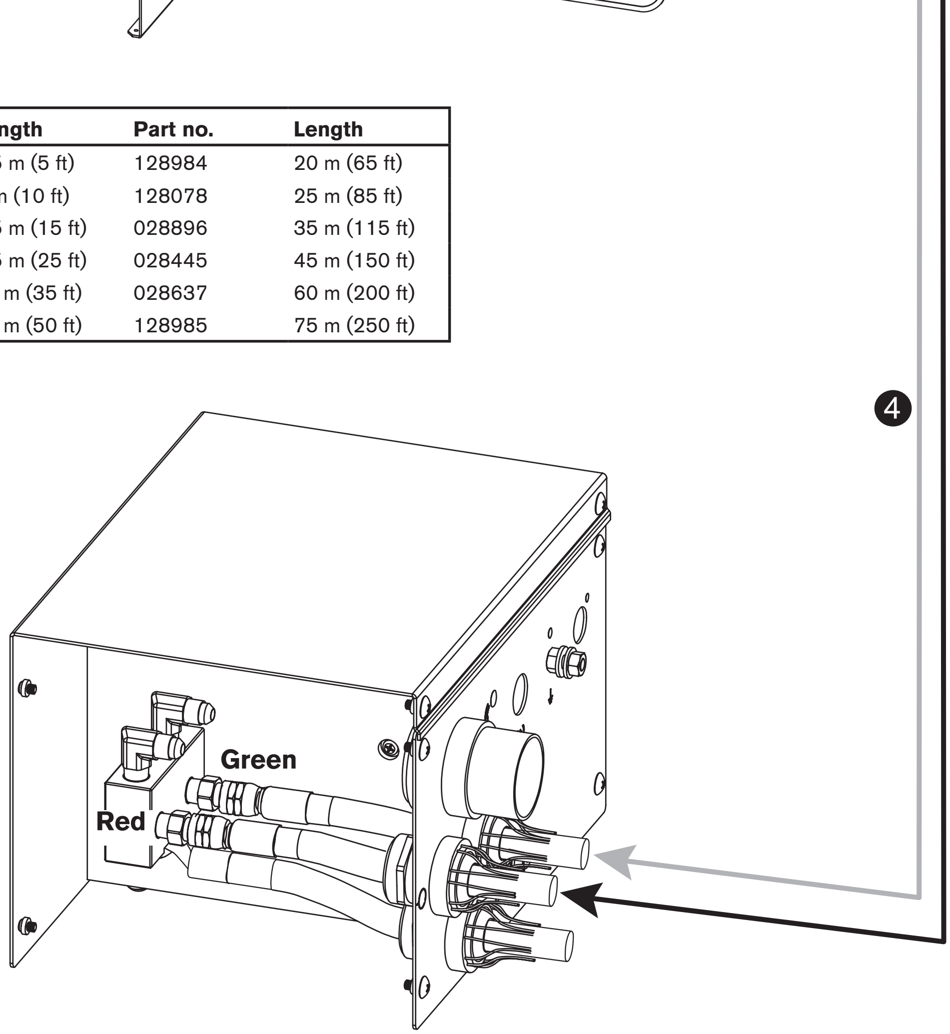
❹ Coolant hoses

Caution: **Never use PTFE tape on any joint preparation.**



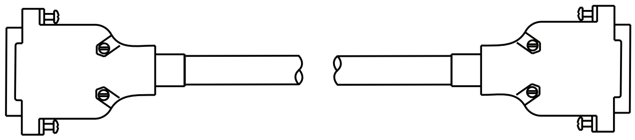


Part no.	Length	Part no.	Length
128499	1.5 m (5 ft)	128984	20 m (65 ft)
028652	3 m (10 ft)	128078	25 m (85 ft)
028440	4.5 m (15 ft)	028896	35 m (115 ft)
028441	7.5 m (25 ft)	028445	45 m (150 ft)
128173	10 m (35 ft)	028637	60 m (200 ft)
028442	15 m (50 ft)	128985	75 m (250 ft)



Power supply to cooler cables

5 Control cable

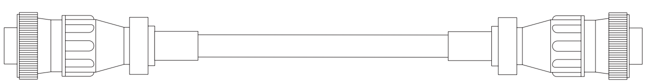


Female end to cooler

Part no.	Length
123844	1.5 m (5 ft)
123784	3 m (10 ft)
123839	4.5 m (15 ft)

Cable signal list – power supply to cooler (9-pin DSUB connectors)						
Power supply end				**Cooler end**		
Pin No.	Wire color	Input/Output	Description	Pin No.	Input/Output	Function
2	Black	Input/Output	CAN L	2	Input/Output	CAN communication
3	Black	Input	CAN ground	3	Output	Power ground
7	Red	Input/Output	CAN H	7	Input/Output	CAN communication
9	Red	Input	Not used	9	Output	Not used

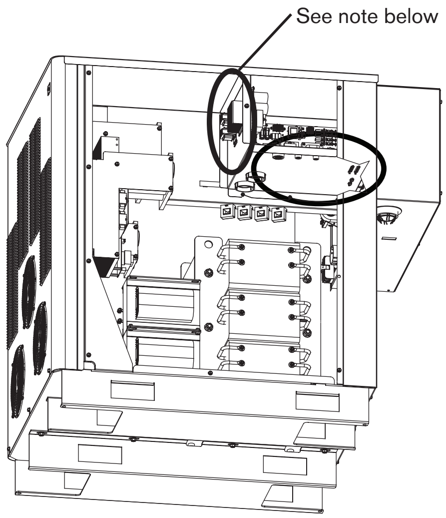
6 Power cable

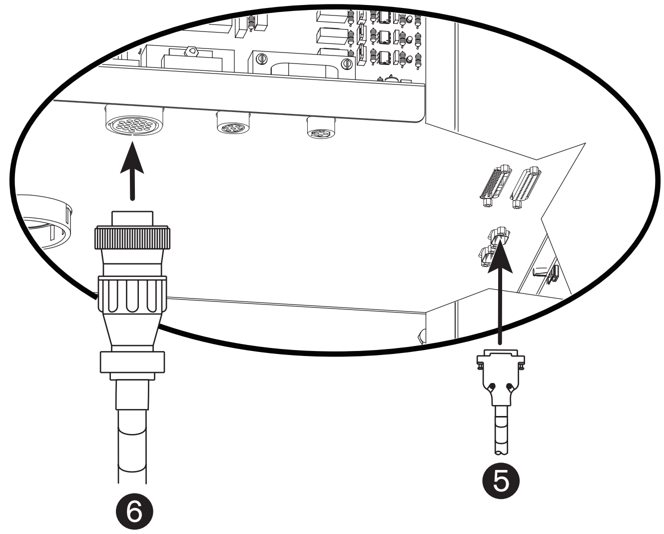


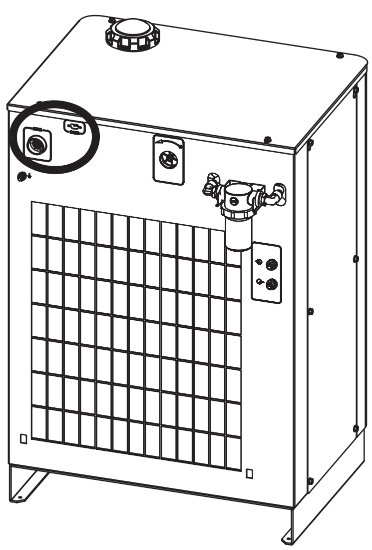
Female end to cooler

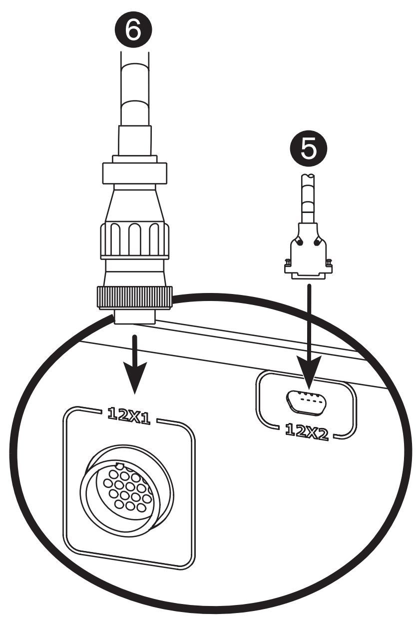
Part no.	Length
123979	1.5 m (5 ft)
123980	3 m (10 ft)
123981	4.5 m (15 ft)

Cable signal list – power supply to cooler				
Power supply end			**Cooler end**	
Pin No.	Wire color	Description	Pin No.	Function
8	Black	120 VAC-Hot	8	Coolant solenoid (V1)
13	White	120 VAC-Return	13	Coolant solenoid (V1)
4		Shield	4	Ground
12	Black	240 VAC-Hot	12	Cooler fan
16	Yellow	240 VAC-Return	16	Cooler fan
7		Shield	7	Ground
11	Black	240 VAC-Hot	11	Pump motor
15	Blue	240 VAC-Return	15	Pump motor
6		Shield	6	Ground





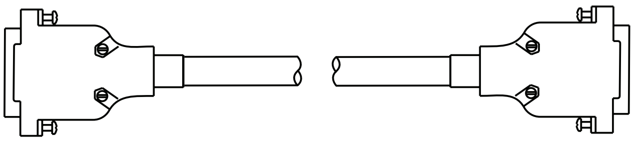




Note: The inductor on the pump motor drive board makes a noise during operation that has been described as a “hum”, “sing”, and “click”. This is normal and can be disregarded.

Power supply to selection console cables

7 Control cable



Part no.	Length	Part no.	Length
123784*	3 m (10 ft)	123841	20 m (65 ft)
123839	4.5 m (15 ft)	123737	25 m (82 ft)
123963	6 m (20 ft)	123738	35 m (115 ft)
123691	7.5 m (25 ft)	123739	45 m (150 ft)
123840	10 m (35 ft)	123842	60 m (200 ft)
123711	15 m (50 ft)	123843	75 m (250 ft)

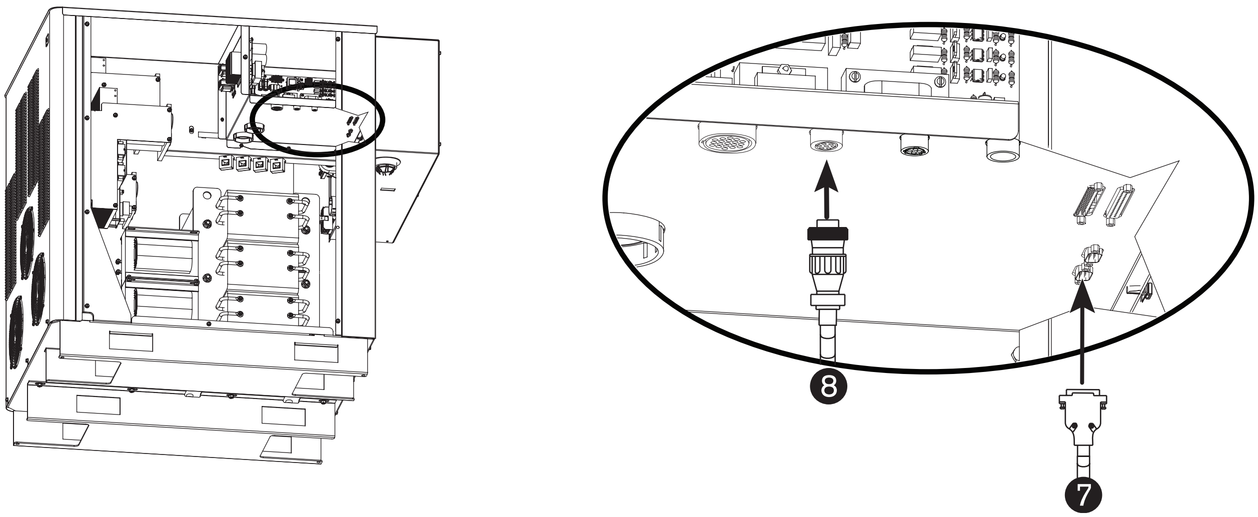
Cable signal list – power supply to selection console					
Power supply end			**Gas console end**		
Pin No.	Input/Output	Description	Pin No.	Input/Output	Function
1		Not used	1		Not used
6		Not used	6		Not used
2	Input/Output	CAN L	2	Input/Output	CAN serial communication
7	Input/Output	CAN H	7	Input/Output	CAN serial communication
3		CAN ground	3		CAN ground reference
9		Not used	9		Not used
8		Not used	8		Not used
4		Not used	4		Not used
5		Not used	5		Not used

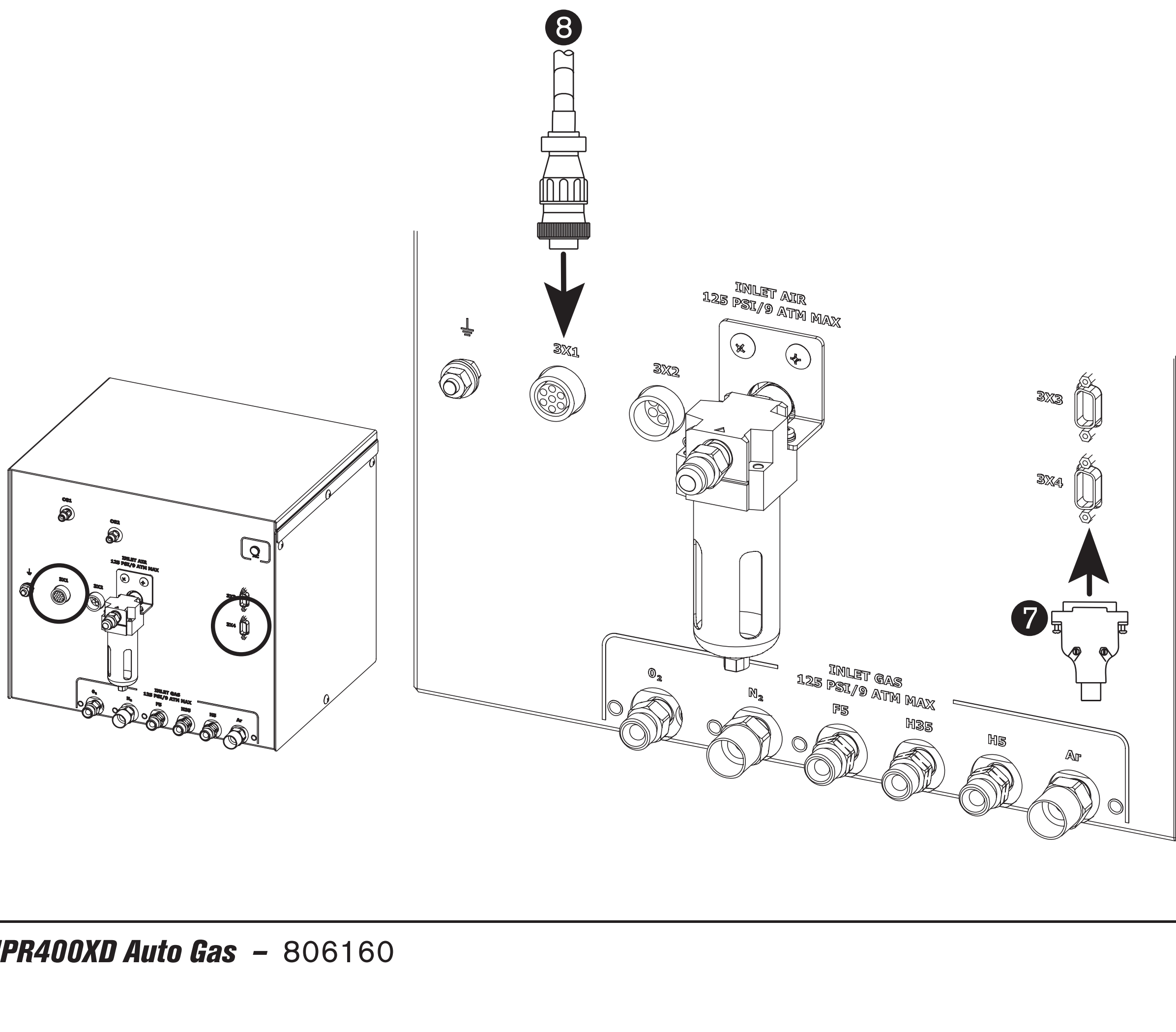
8 Power cable

Part no.	Length	Part no.	Length
123785*	3 m (10 ft)	123848	20 m (65 ft)
123846	4.5 m (15 ft)	123740	25 m (82 ft)
123964	6 m (20 ft)	123676	35 m (115 ft)
123674	7.5 m (25 ft)	123677	45 m (150 ft)
123847	10 m (35 ft)	123849	60 m (200 ft)
123675	15 m (50 ft)	123850	75 m (250 ft)

Cable signal list – power supply to selection console		
Power supply end		**Gas console end**
Pin No.	Description	Pin No.
1	120 VAC-Hot	1
2	120 VAC-Return	2
3	Ground	3
4	Not used	4
5	Not used	5
6	24 VAC-Hot	6
7	24 VAC-Return	7

* Cable numbers 123784 and 123785 are for use with systems that have the gas console mounted on the power supply


8
7

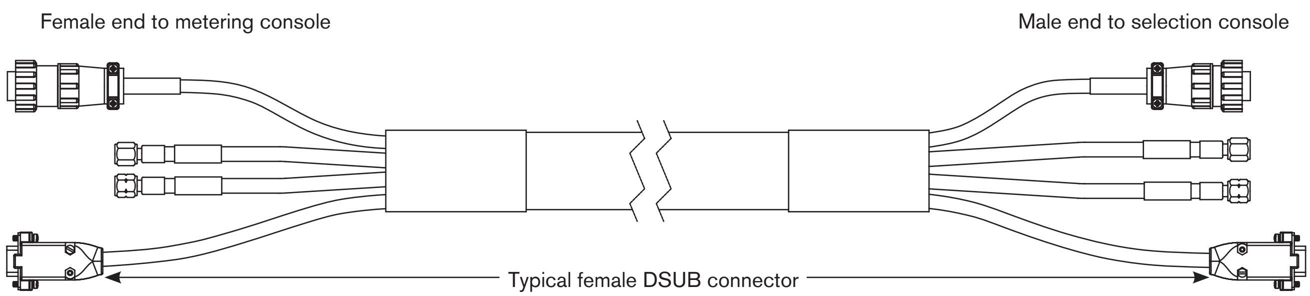

8
3X1
3X2
INLET AIR
125 PSI/9 ATM MAX
3X3
3X4
7
INLET GAS
125 PSI/9 ATM MAX
O2
N2
F5
H35
H5
Ar

Selection console to metering console connections

❾ Cable and gas hose assembly

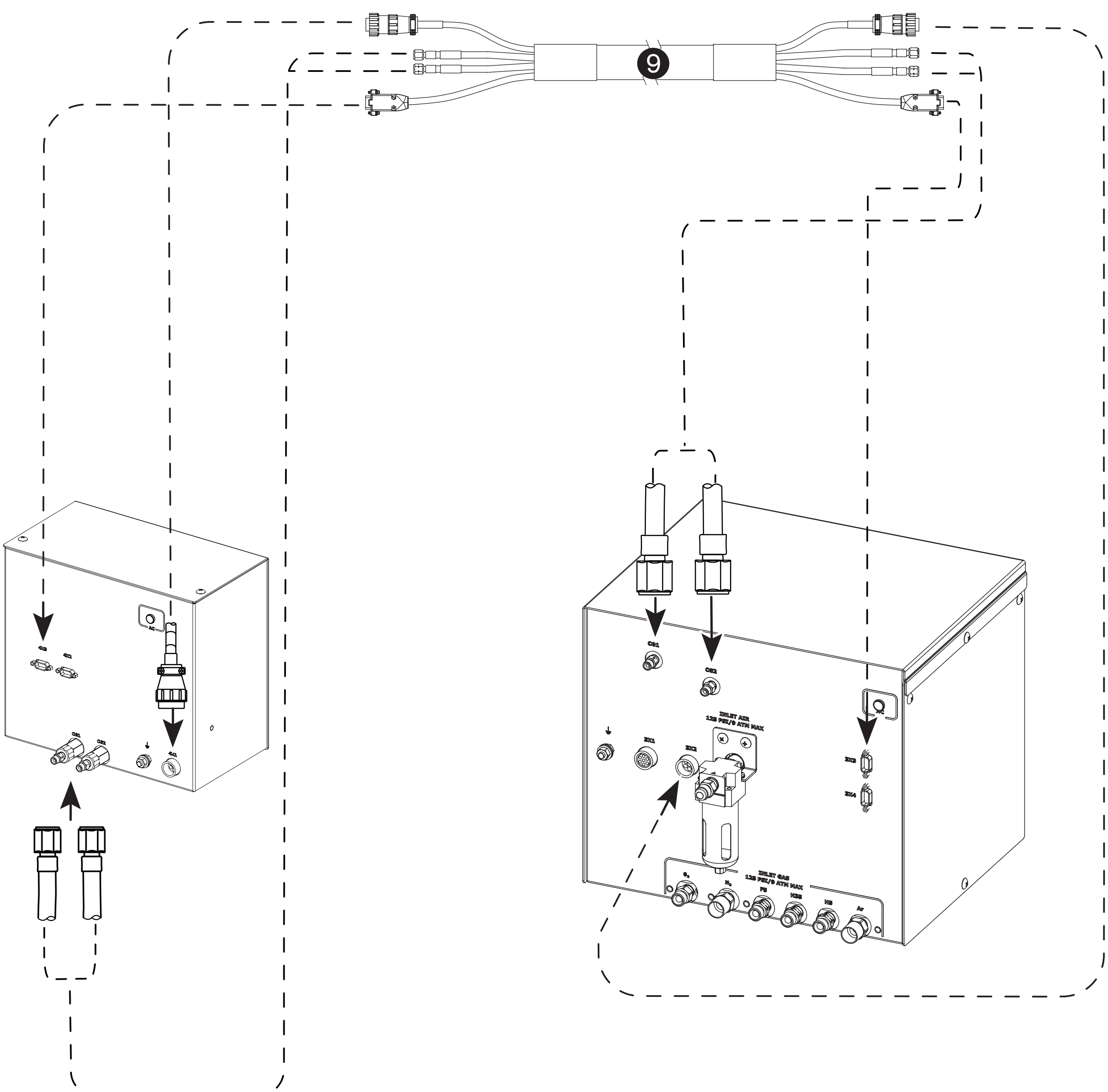
Part no.	Length
128992	3 m (10 ft)
128993	4.5 m (15 ft)
228338	6 m (20 ft)
128952	7.5 m (25 ft)
128994	10 m (35 ft)
128930	15 m (50 ft)
128995	20 m (65 ft)

Power cable signal list – 9-pin connectors					
Metering console end			**Selection console end**		
Pin No.	Input/Output	Description	Pin No.	Input/Output	Function
1	Input	120 VAC power	1	Output	AC in, return
2	Input	120 VAC power	2	Output	AC in, hot
3	Input	Chassis ground	3	Output	Chassis ground
4		Not used	4		Not used
5		Not used	5		Not used
6		Not used	6		Not used
7		Not used	7		Not used

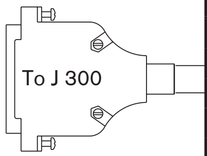


Communication cable signal list – 9-pin DSUB connectors					
Metering console end			**Selection console end**		
Pin No.	Input/Output	Description	Pin No.	Input/Output	Function
2	Input/Output	CAN L	2	Input/Output	CAN communication
3	Input	CAN ground	3	Output	Power ground
7	Input/Output	CAN H	7	Input/Output	CAN communication
9	Input	Not used	9	Output	Not used

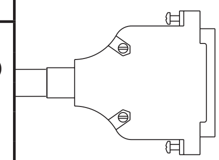
Caution: Never use PTFE tape on any joint preparation.



⑩ Power supply to CNC interface cable

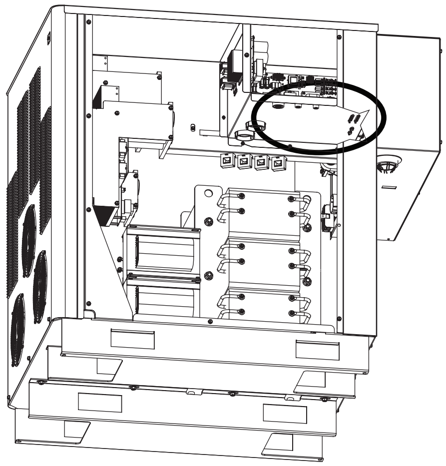


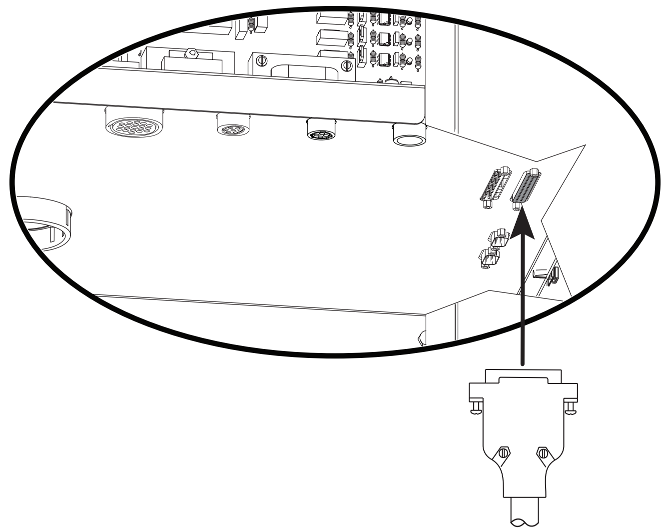
Part no.	Length	Part no.	Length	Part no.	Length
123210	3 m (10 ft)	123216	13.5 m (45 ft)	123742	35 m (115 ft)
123211	4.5 m (15 ft)	123023	15 m (50 ft)	123219	37.5 m (125 ft)
123212	6 m (20 ft)	123494	16.5 m (55 ft)	123220	45 m (150 ft)
123022	7.5 m (25 ft)	123851	20 m (65 ft)	123852	60 m (200 ft)
123213	9 m (30 ft)	123217	22.5 m (75 ft)	123853	75 m (250 ft)
123214	10 m (35 ft)	123741	25 m (82 ft)		
123215	12 m (40 ft)	123218	30 m (100 ft)		



⑪ Optional multi-system CNC interface cable (see schematics for installation information)

Wire color	Pin no.	Power supply end Input/ Output	Signal name	Function	CNC end Input/ Output	Notes
Black Red	1 20	Input Input	Rx – Rx +	RS-422 serial receiver RS-422 serial receiver	Output Output	
Black Green	2 21	Output Output	Tx – Tx +	RS-422 serial transmitter RS-422 serial transmitter	Input Input	
Black Blue	3 22		RS-422 ground None	RS-422 serial ground Not used		
Black Yellow	4 23	Output Output	Motion 1 E (–) Motion 1 C (+)	Notifies the CNC that an arc transfer has occurred and to begin machine motion once the CNC's pierce delay has timed out	Input Input	2 & 3
Black Brown	5 24	Output Output	Error E (–) Error C (+)	Notifies the CNC that an error has occurred	Input Input	2
Black Orange	6 25	Output Output	Rampdown error E (–) Rampdown error C (+)	Notifies the CNC that a rampdown error has occurred	Input	2
Red White	7 26	Output Output	Not ready E (–) Not ready C (+)	Notifies the CNC that the plasma system is not ready to fire an arc	Input	2
Red Green	8 27	Output Output	Motion 2 E (–) Motion 2 C (+)	Notifies the CNC that an arc transfer has occurred and to begin machine motion once the CNC's pierce delay has timed out	Input Input	2 & 3
Red Blue	9 28	Output Output	Motion 3 E (–) Motion 3 C (+)	Notifies the CNC that an arc transfer has occurred and to begin machine motion once the CNC's pierce delay has timed out	Input Input	2 & 3
Red Yellow	10 29	Output Output	Motion 4 E (–) Motion 4 C (+)	Notifies the CNC that an arc transfer has occurred and to begin machine motion once the CNC's pierce delay has timed out	Input Input	2 & 3
Red Brown	11 30		None None	Not used Not used		
Red Orange	12 31	Input Input	Corner (–) Corner (+)	The CNC Notifies the plasma system that a corner is approaching and to reduce cut current (Cut current is CNC selectable or defaults to 50% of cut current)	Output Output	1
Green White	13 32	Input Input	Pierce (–) Pierce (+)	The CNC Notifies the plasma system to maintain the shield preflow until the CNC releases the signal	Output	1
Green Blue	14 33	Input Input	Hold (–) Hold (+)	Not required without CommandTHC. CommandTHC requires a signal to preflow gases during IHS	Output	1
Green Yellow	15 34	Input Input	Start (–) Start (+)	The CNC initiates the plasma arc	Output Output	1
Green Brown	16 35		None None	Not used Not used		
Green Orange	17 36		None Power ground	Not used Ground		
White Black	18 37		Power ground CNC +24 VDC	Ground Available 24 VDC (200 milliamps maximum) see notes		4
	19		CNC +24 VDC	Not connected		





Notes to CNC interface cable run list

Note 1. Inputs are optically isolated. They require 24 VDC at 7.3 mA, or dry-contact closure. The external relay's life may be improved by adding a metallized-polyester capacitor (0.022µF 100V or higher) in parallel with the relay contacts

Note 2. Outputs are optically isolated, open collector, transistors. The maximum rating is 24 VDC at 10 mA.

Note 3. Machine motion is selectable and is used for configurations with multiple plasma systems.

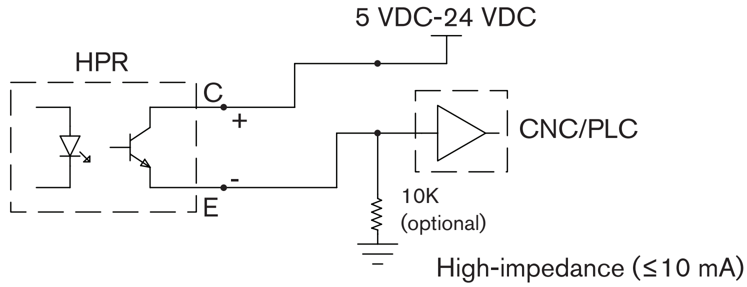
Note 4.* CNC +24 VDC provides 24 VDC at 200 mA maximum. A jumper is required on J301 to use 24 V power.

Caution: The CNC cable must be constructed using cable with 360 degree shielding and metal housing connectors at each end. The shielding must be terminated to the metal housings at each end to ensure proper grounding and to provide the best shielding.

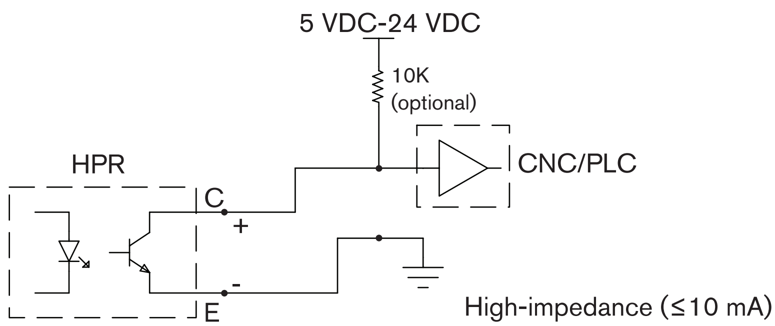
* See example 1 on page 3-33

Examples of output circuits

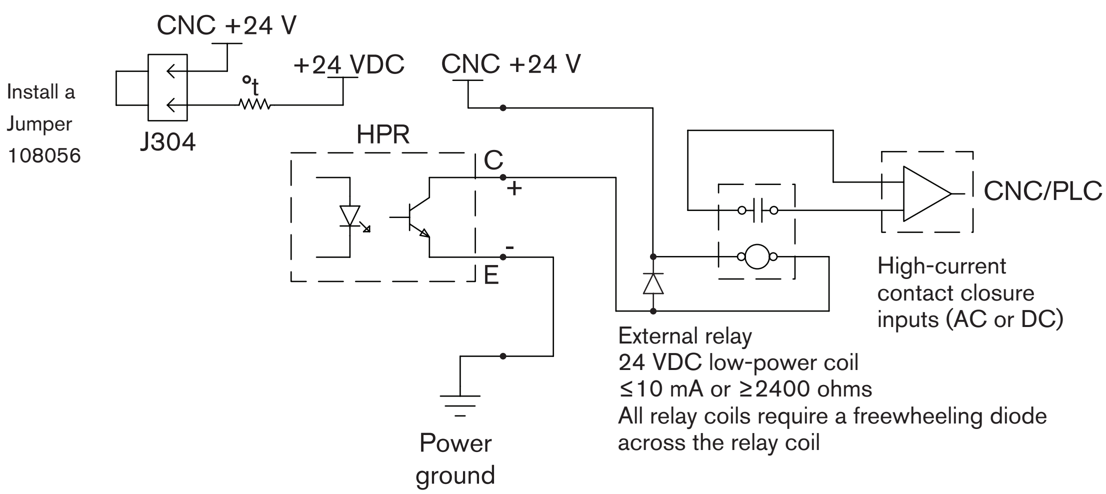
1. Logic interface, active-high



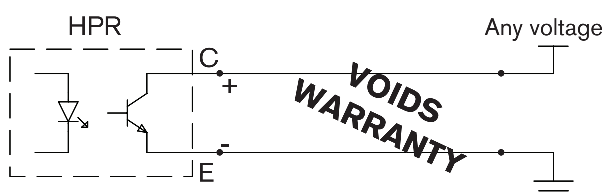
2. Logic interface, active-low



3. Relay interface

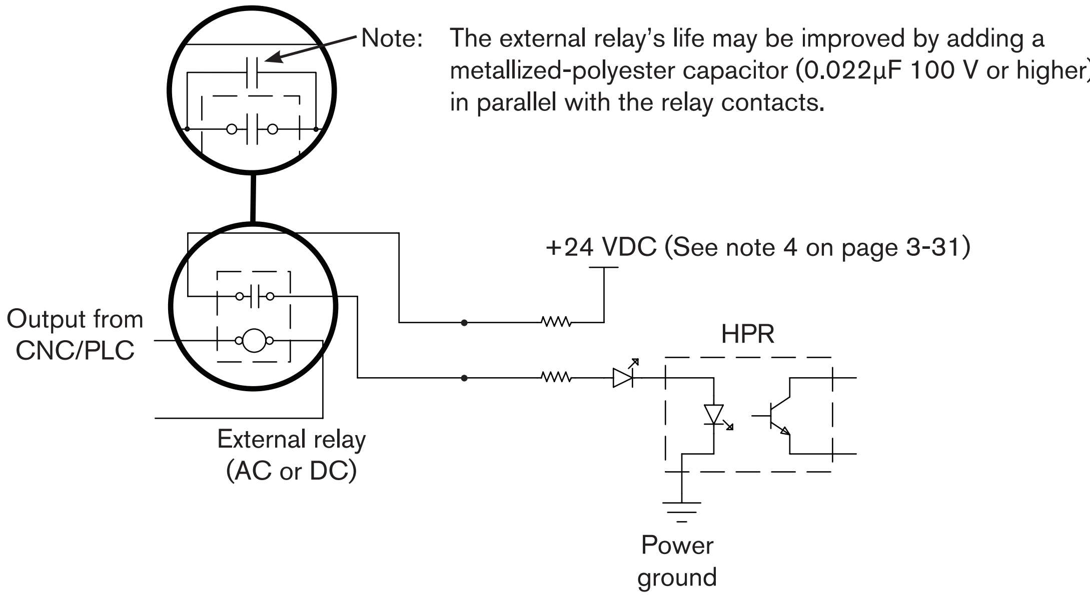


4. Do not use this configuration. Warranty will be void.

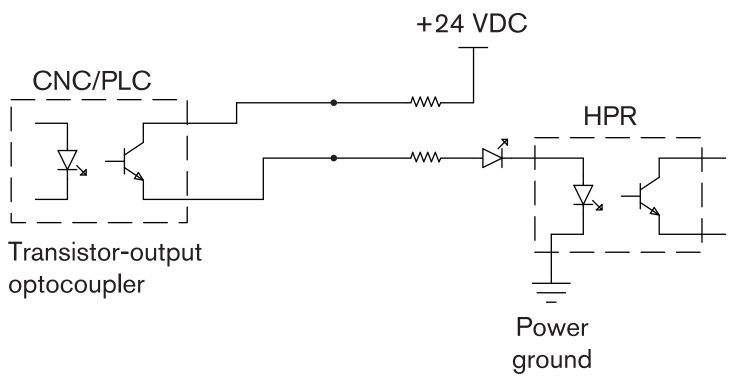


Examples of input circuits

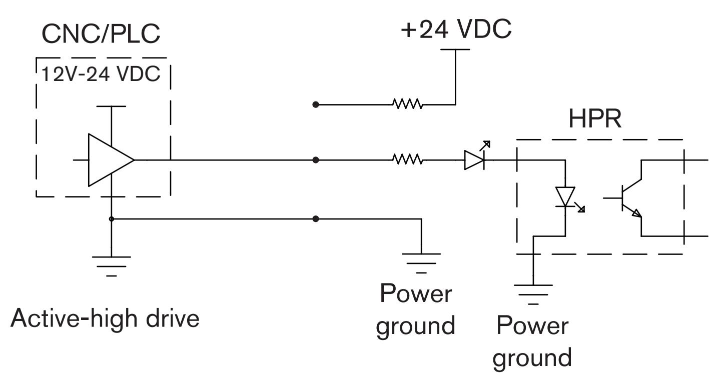
1. Relay interface



2. Optocoupler interface



3. Amplified-output interface



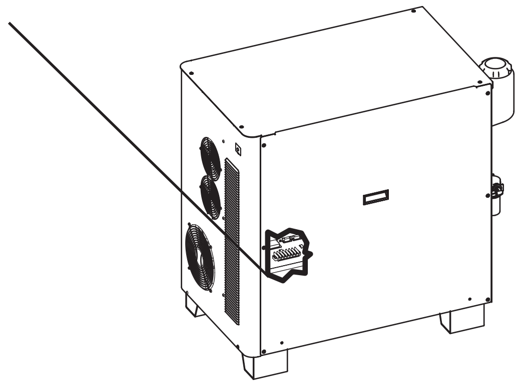
Remote ON/OFF switch (provided by customer)

DANGER

ELECTRIC SHOCK CAN KILL

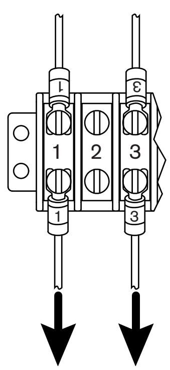
Disconnect electrical power before performing any maintenance.
See the *Safety Section* in this Manual for more safety precautions.

1. Locate terminal block 2 (TB2) in the power supply.

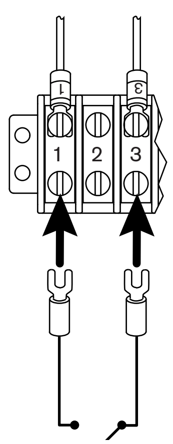


TB2 location

2. Remove wire 1 and wire 3 as shown. These wires do not need to be reconnected.



3. Connect switch to terminals 1 and 3 as shown.

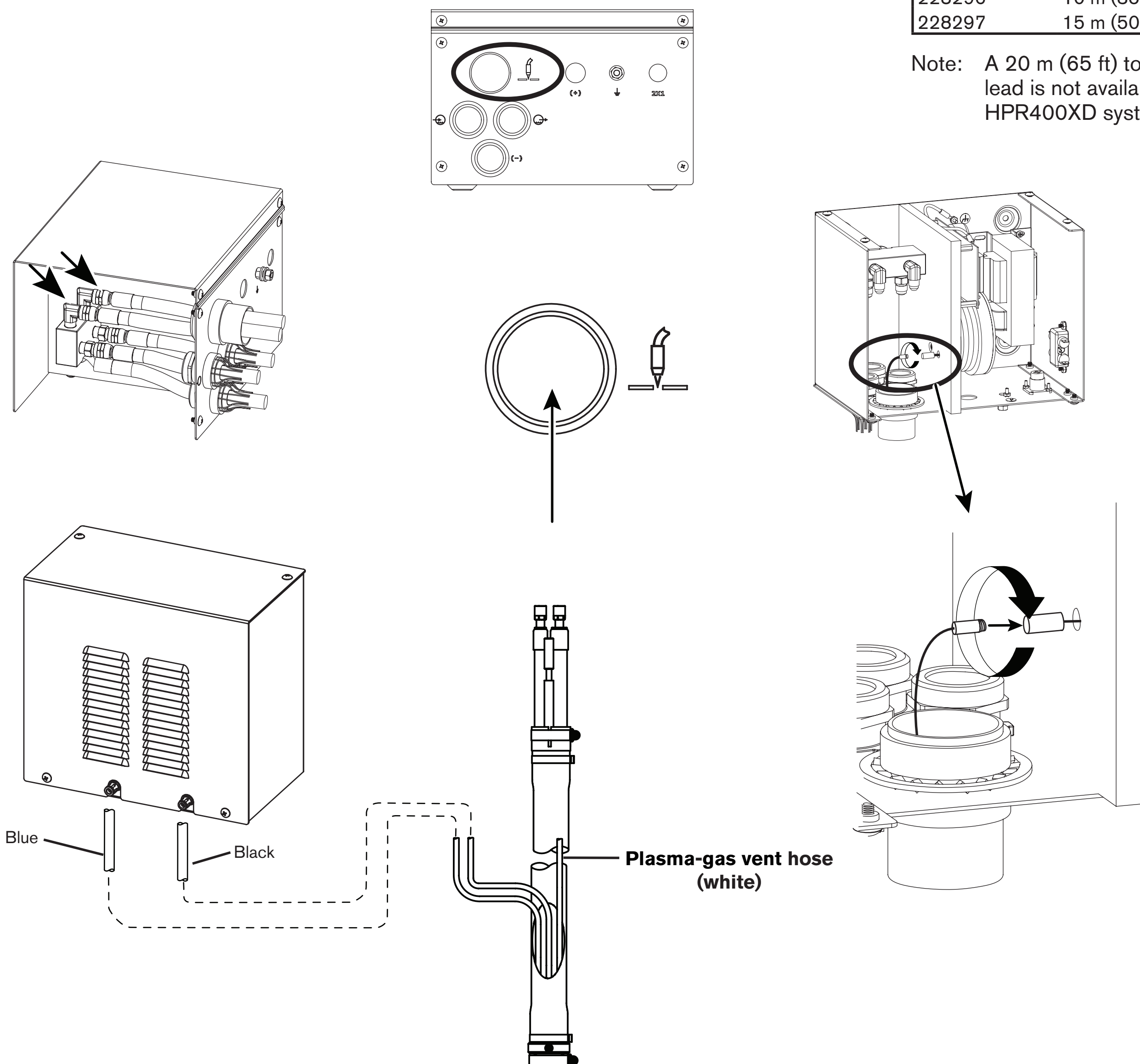


Note: Use a switch, relay or solid-state relay that is compatible with 24 VAC @ 100 mA. It must be a maintained contact switch, not a momentary contact switch.

⓬ Torch lead assembly

Part no.	Length
228291	2 m (6 ft)
228292	3 m (10 ft)
228293	4.5 m (15 ft)
228294	6 m (20 ft)
228295	7.5 m (25 ft)
228296	10 m (35 ft)
228297	15 m (50 ft)

Note: A 20 m (65 ft) torch lead is not available for HPR400XD systems



Caution: **The length of the hoses from the torch to the metering console are critical to cut quality and consumable life.**

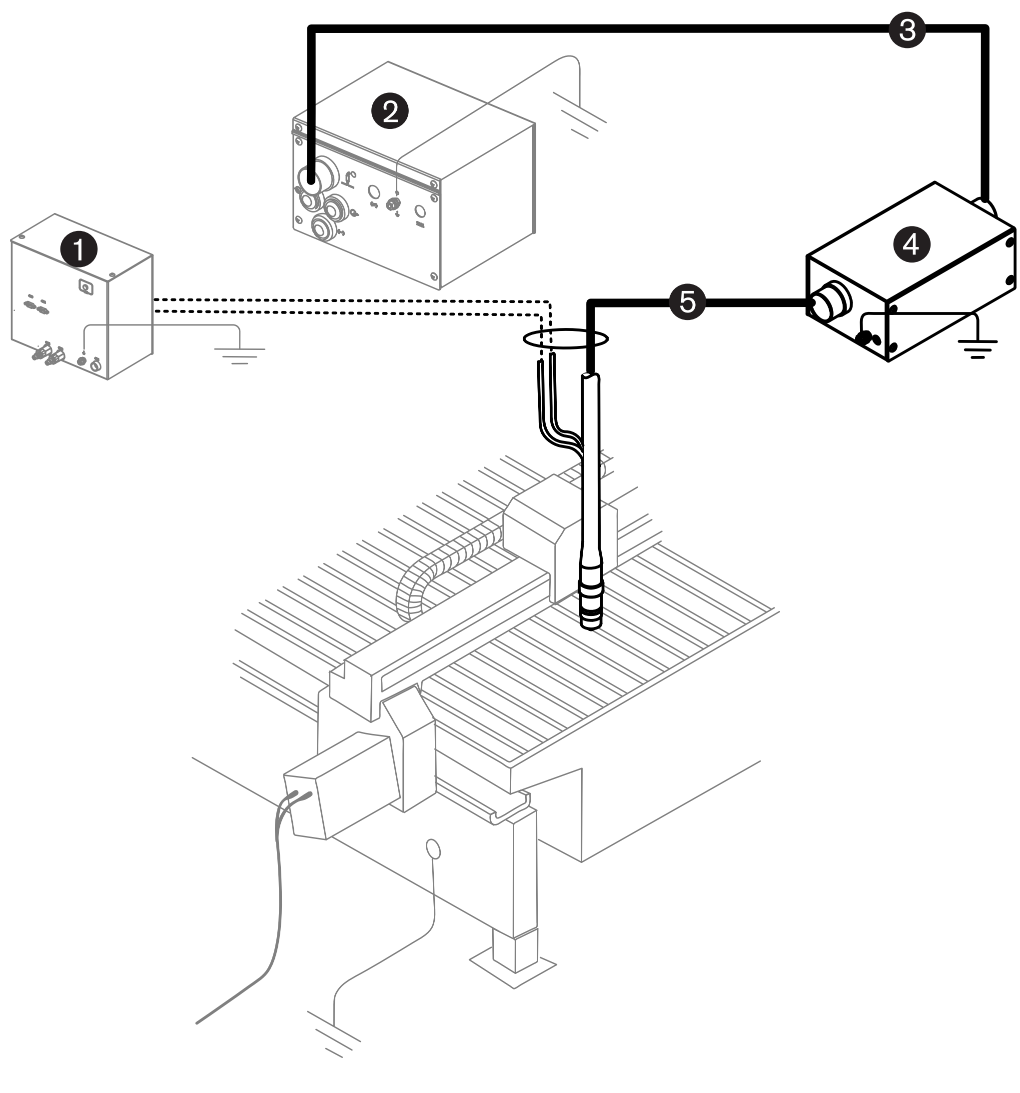
<u>Do not alter the length of the hoses.</u>

Caution: **Locate the exposed end of the plasma-gas vent hose away from sparks caused by piercing to avoid ignition and possible damage to the torch leads.**

Torch lead junction box (Optional)

Note: See the *Parts list for part numbers*

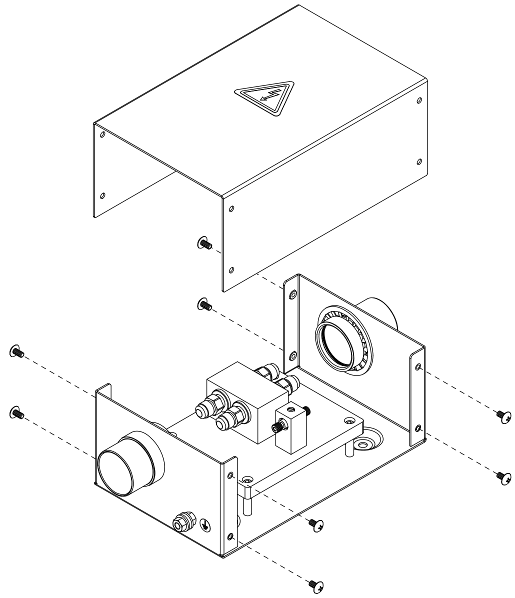
Caution: **Total lead length from the ignition console to the torch must be less than or equal to:**
20 m (65 feet) for HPR130XD / HPR260XD
15 m (50 feet) for HPR400XD / HPR800XD



1. Metering console
2. Ignition console
3. Junction box lead
4. Junction box
5. Junction box to torch lead

Install the junction box

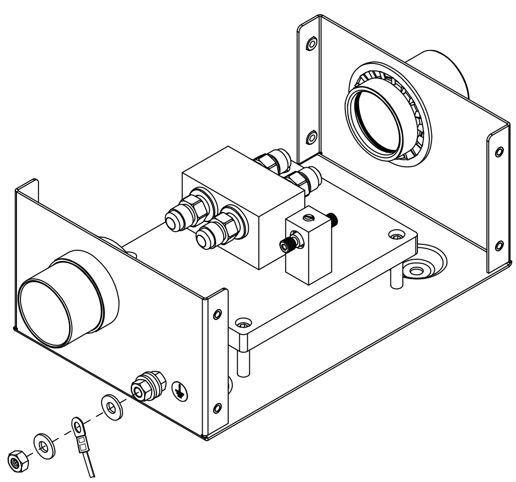
1. Remove the cover fom the junction box



2. Mount the junction box near the cutting location. (See *Specification* – for Junction box mounting dimensions)

Note: Allow space to install and remove the cover of the box for servicing.

3. Ground the junction box to the bus bar on the cutting table or equivalent. See *Recommended grounding and shielding* in the *Installation* section in your system's instruction manual for more information.



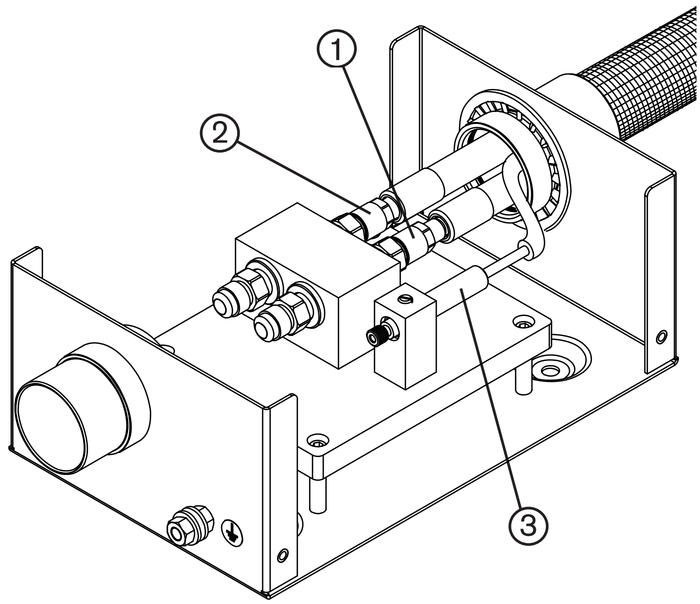
Connect the leads

Note: Do not overtighten the connections

Junction box to the ignition console

1. Connect one end of the junction box lead to the junction box.

Note: The lead can go in either end of the junction box.

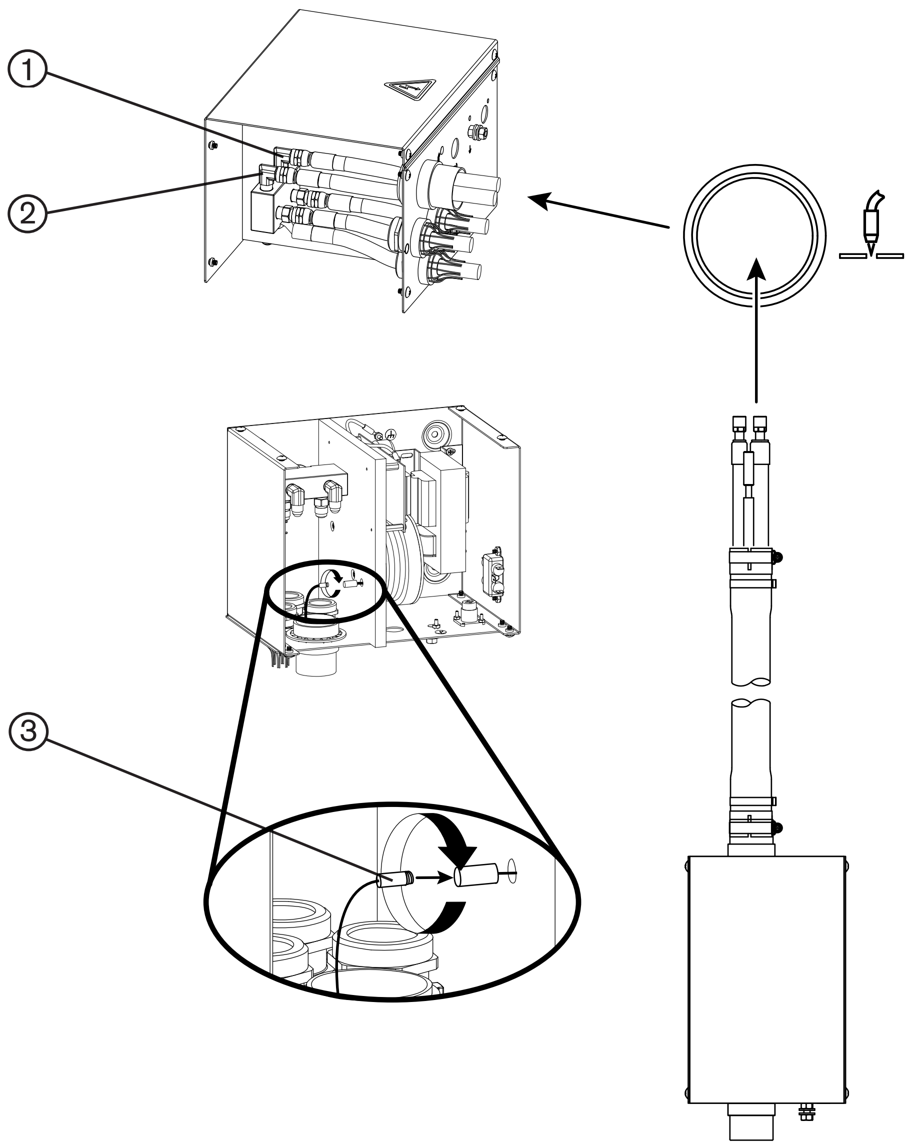


1 Coolant supply hose (green)

2 Coolant return hose (red)

3 Pilot arc lead (yellow)

2. Connect the other end of the junction box lead to the ignition console.



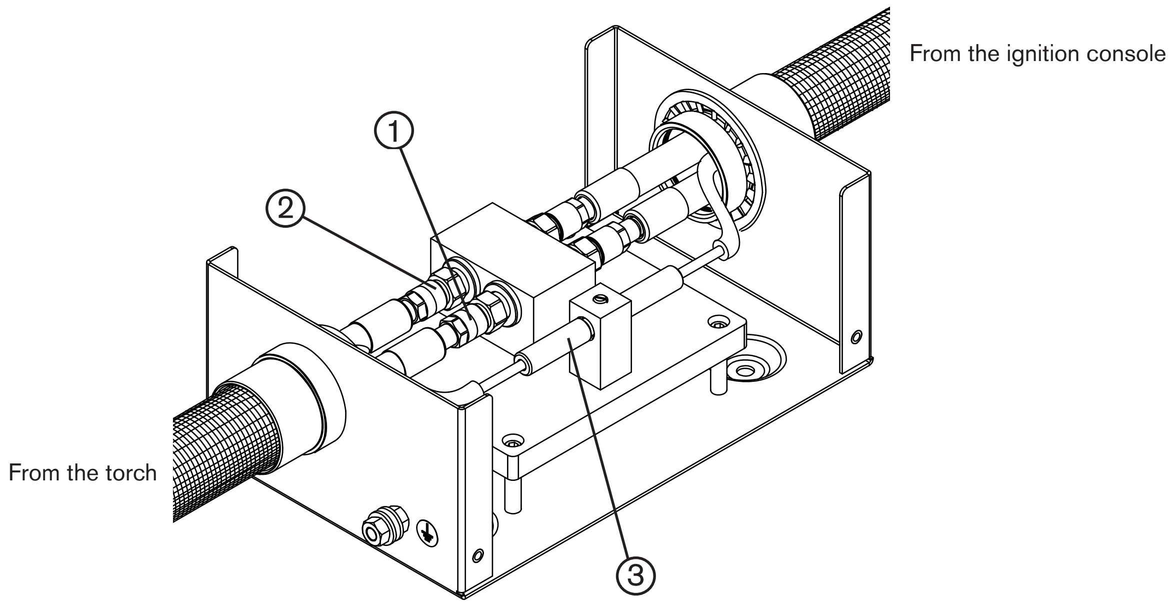
1 Coolant supply hose (green)

2 Coolant return hose (red)

3 Pilot arc lead (yellow)

Lead from the torch to the junction box

1. Connect the lead from the torch to the junction box.

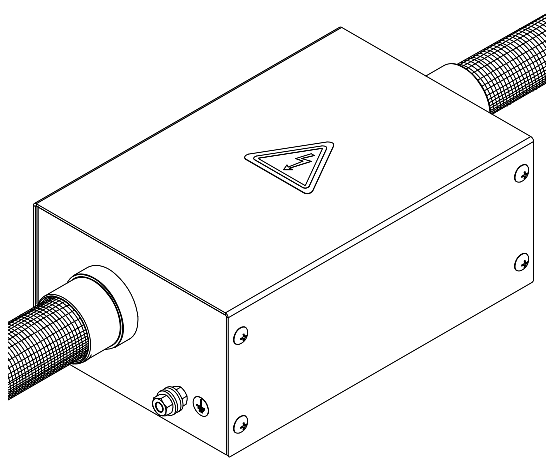


1 Coolant supply hose (green)

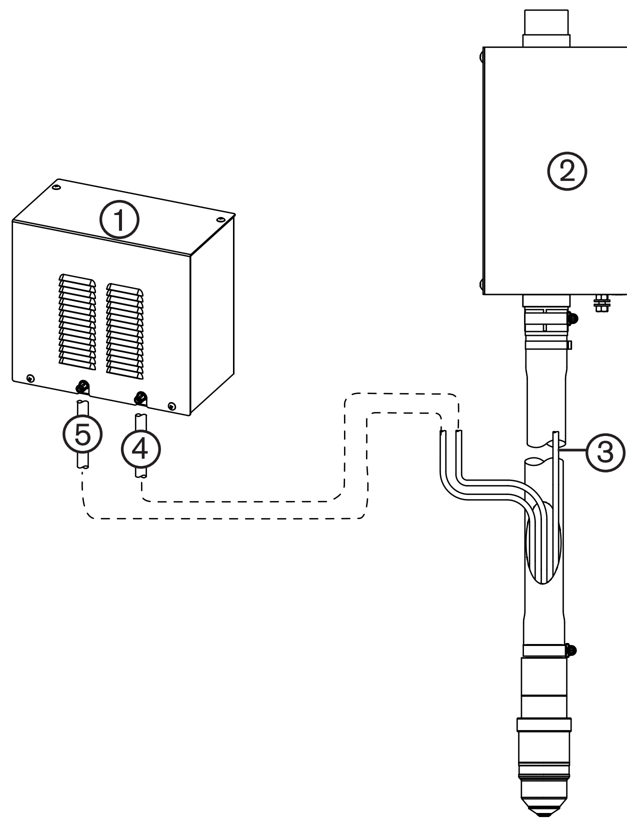
2 Coolant return hose (red)

3 Pilot arc lead (yellow)

2. Install the junction box cover.



3. Connect the torch hoses to the metering console.



1 Metering console

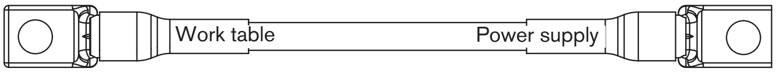
2 Junction box

3 Plasma gas vent hose (white)

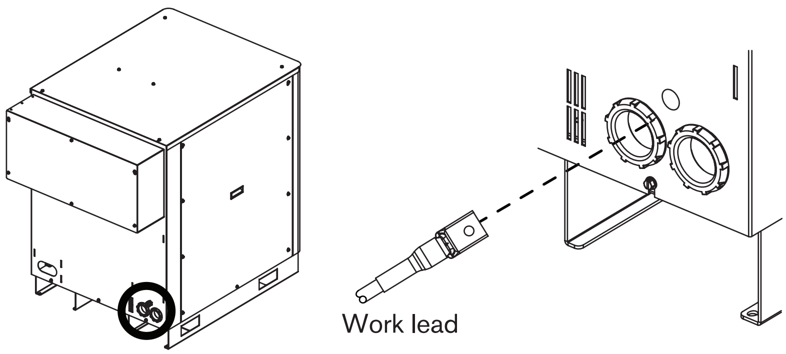
4 Plasma gas hose (black)

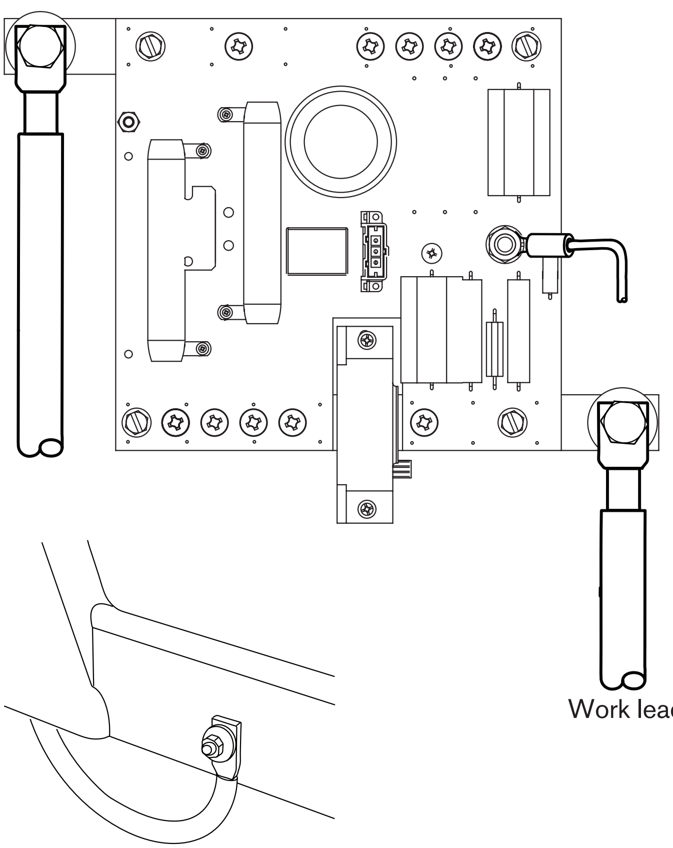
5 Shield hose (blue)

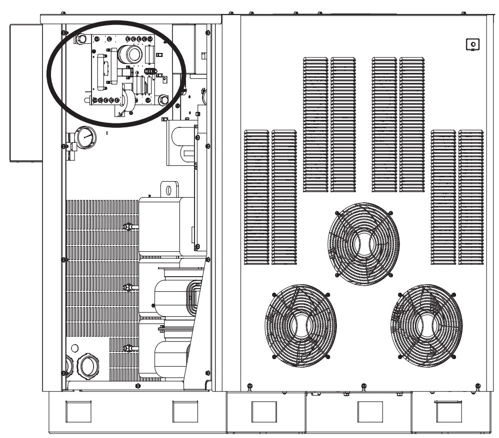
⓭ Work lead



Part no.	Length	Part no.	Length
123418	3 m (10 ft)	123996	25 m (82 ft)
023382	4.5 m (15 ft)	123997	35 m (115 ft)
023078	7.5 m (25 ft)	023081	45 m (150 ft)
123994	10 m (35 ft)	023188	60 m (200 ft)
023079	15 m (50 ft)	023815	75 m (250 ft)
123995	20 m (65 ft)		





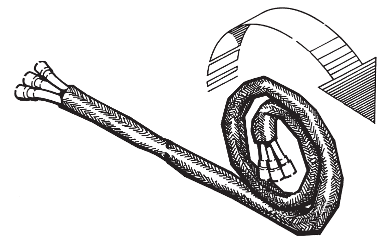


Lower frame of work table (typical).

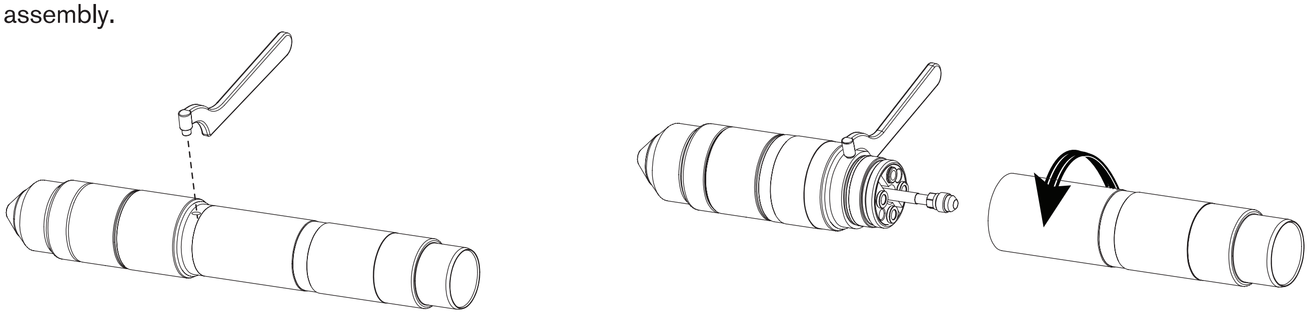
F Torch connections

Connect the torch to the torch lead assembly

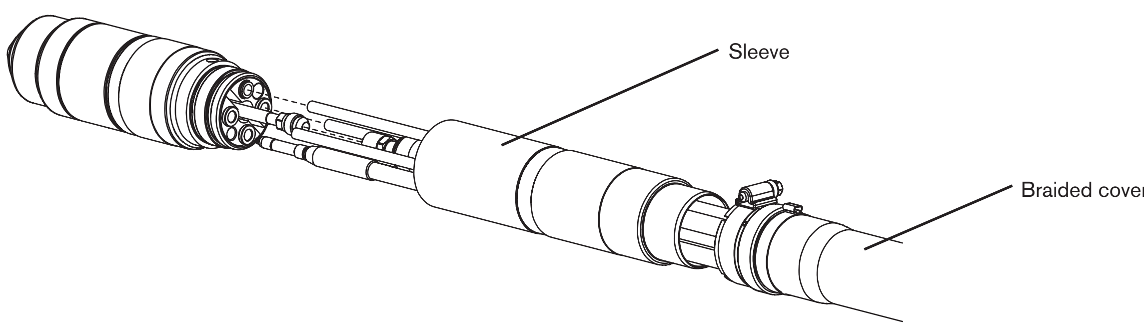
1. Uncoil the first 2 meters (6.5 ft) of the leads on a flat surface.



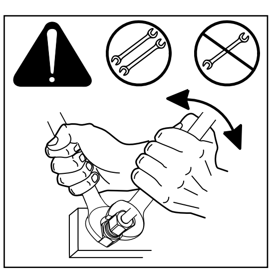
2. Hold the torch assembly in place with the spanner wrench (104269) and remove the mounting sleeve from the torch assembly.

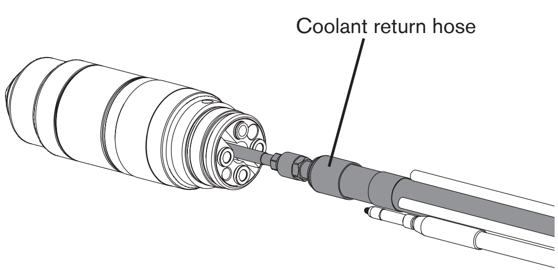


3. Push back the braided cover and slide the sleeve over the leads. Align the torch with the hoses in the lead assembly. The hoses must not be twisted. They are taped together to help prevent twisting.



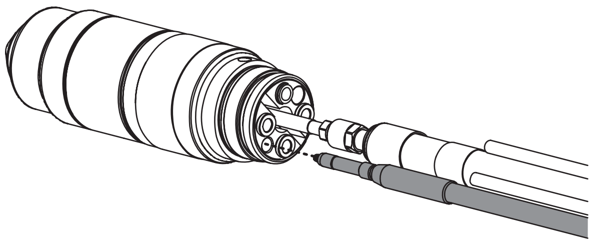
4. Connect the coolant return hose (red).

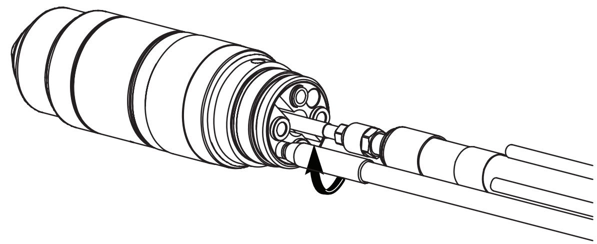




Caution: Never use PTFE tape on any joint preparation.

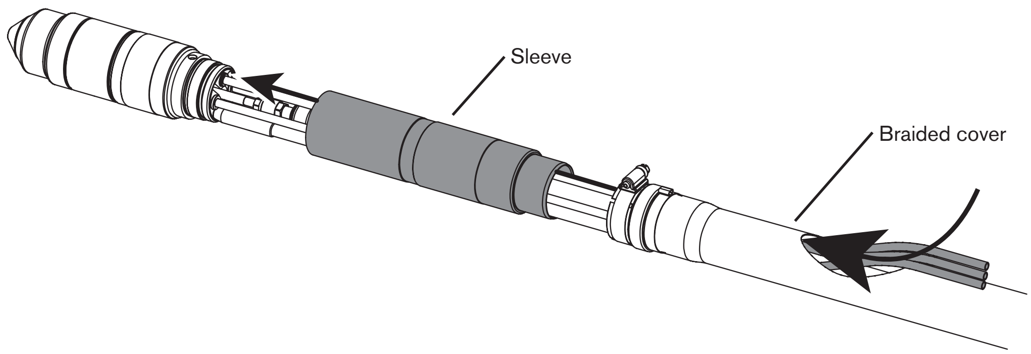
5. Connect the pilot arc lead (yellow). Insert the connector into the torch receptacle and turn it by hand until it is tight.



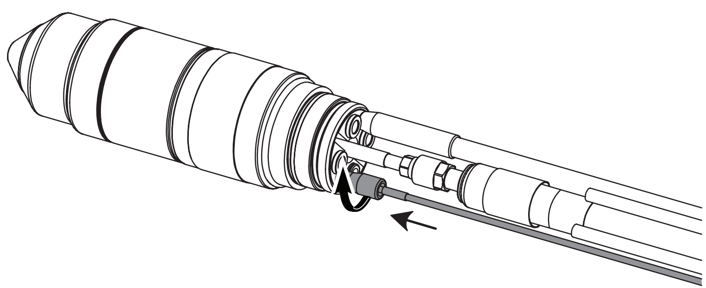


6. Connect the optional ohmic contact wire.

   6a. Route the ohmic contact wire through the opening in the braided cover and the torch sleeve.

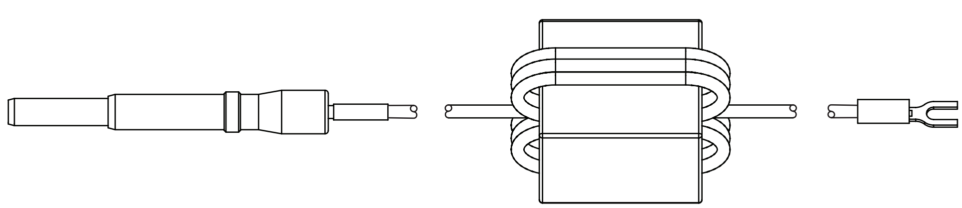


   6b. Insert the connector into the torch receptacle and turn it by hand until it is tight.

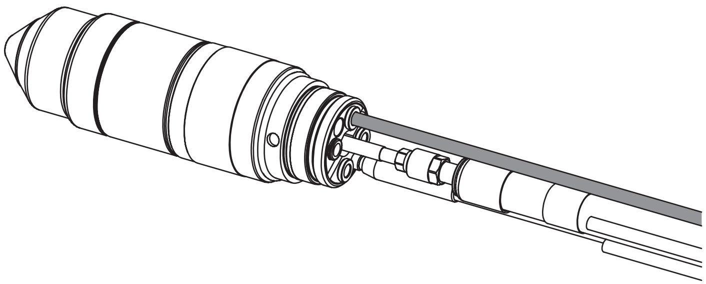


Ohmic contact wire part numbers (Not part of the HPR400XD system. Shown for reference only)

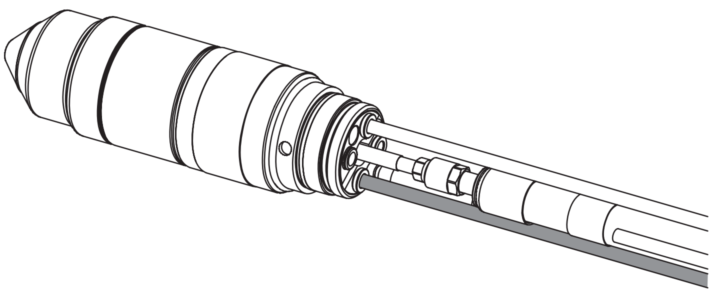
Part no.	Length
123983	3 m (10 ft)
123984	6 m (20 ft)
123985	7.5 m (25 ft)
123986	9 m (30 ft)
123987	12 m (40 ft)
123988	15 m (50 ft)
123989	23 m (75 ft)
123990	30 m (100 ft)
123991	45 m (150 ft)



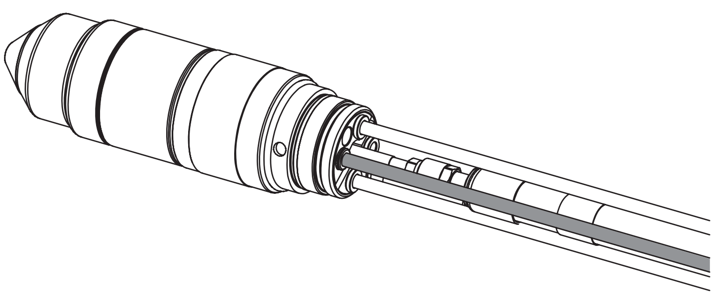
7. Connect the plasma-gas vent hose (white).



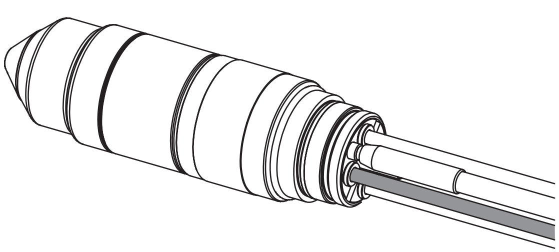
8. Connect the coolant supply hose (green).



9. Connect the plasma gas hose (black).

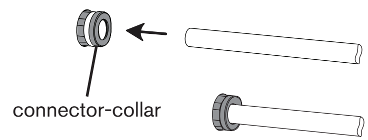


10. Connect the shield gas hose (blue).

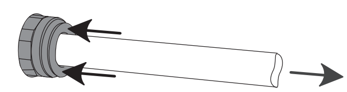


Note: The connectors in steps 7–10 are push-to-connect fittings.

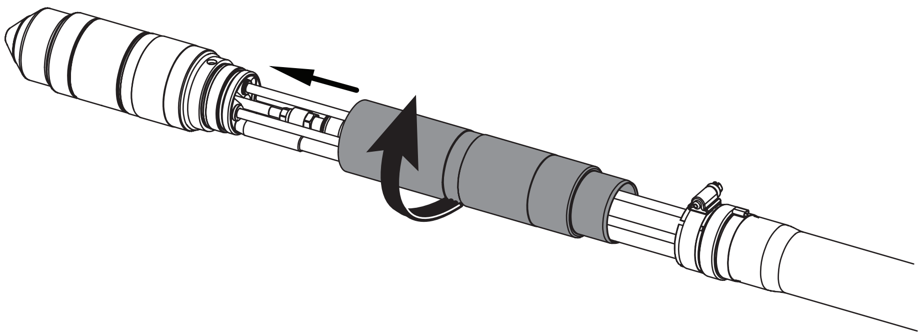
To make a connection, push the hose fitting into the appropriate connector until it stops, 13 mm (0.5 in.).



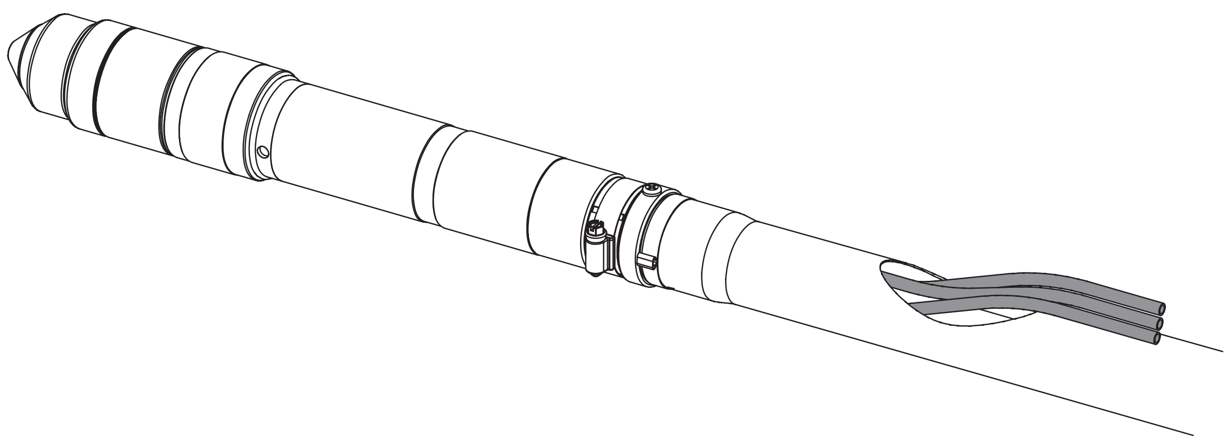
To disconnect a fitting, push the connector-collar toward the torch, and pull the hose away from the torch.



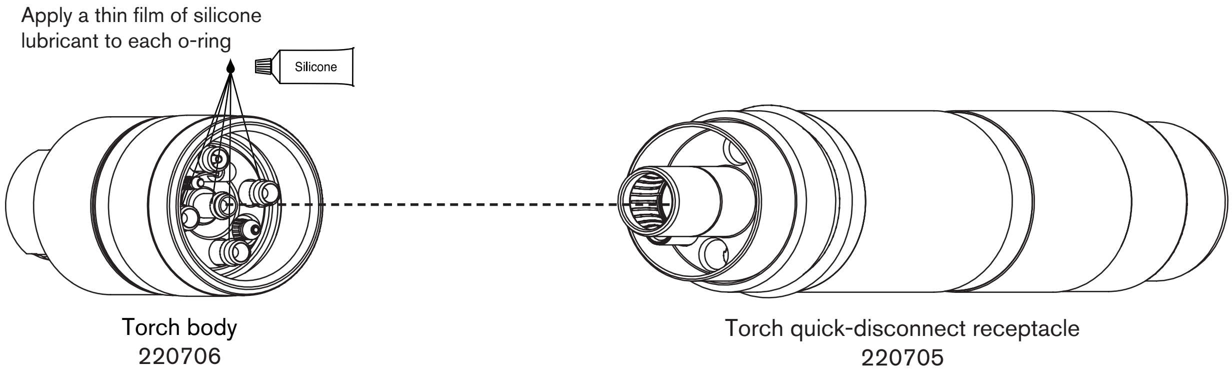
11. Slide the torch sleeve over the connections and screw it onto the torch assembly.



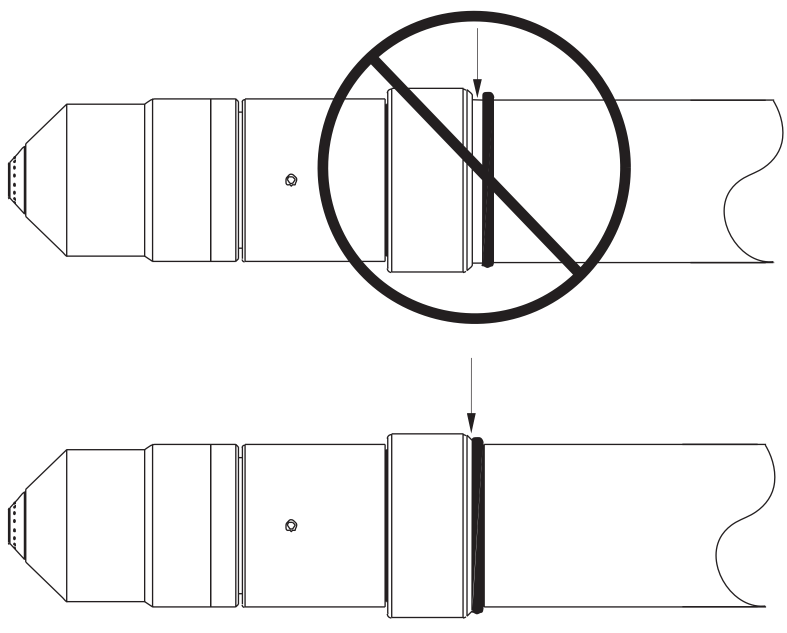
12. Slide the braided cover up to the torch sleeve. Make sure that the plasma, shield and vent hoses are routed through the hole in the braided cover. Loosen the hose clamp on the braided cover, slide the braided cover and clamp over the sleeve and tighten the clamp.



Connect the torch to the quick-disconnect

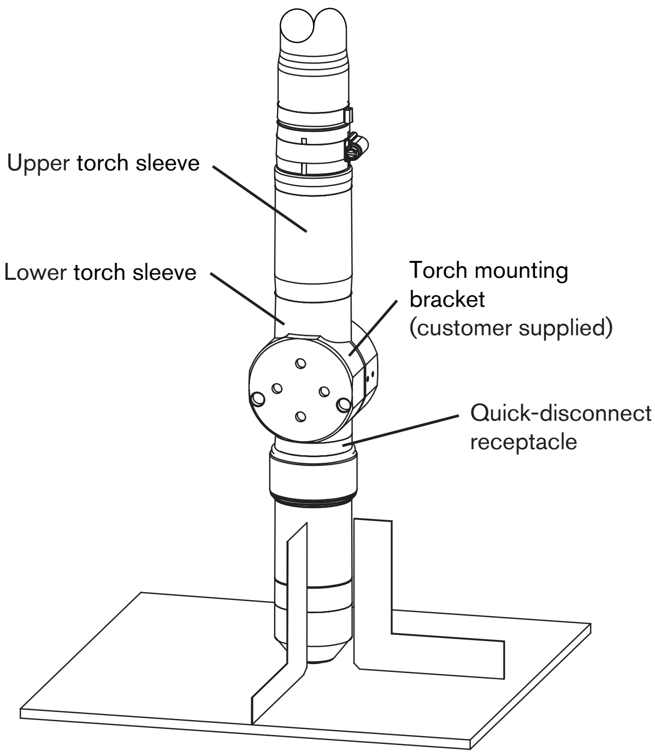


Installation note
Align the torch body to the torch leads and secure by screwing completely together. Be certain that there is no space between the torch body and the o-ring on the torch leads. See also *Torch connections* earlier in this section for torch lead connections to ignition console.



Torch mounting and alignment

Mounting the torch



Installation

1. Install the torch (with torch leads attached) in the torch mounting bracket.
2. Position the torch below the mounting bracket, so that the bracket is around the lower portion of the torch sleeve but not touching the torch quick-disconnect.
3. Tighten the securing screws.

Note: The bracket should be as low on the torch sleeve as possible to minimize vibration at the tip of the torch.

Torch alignment

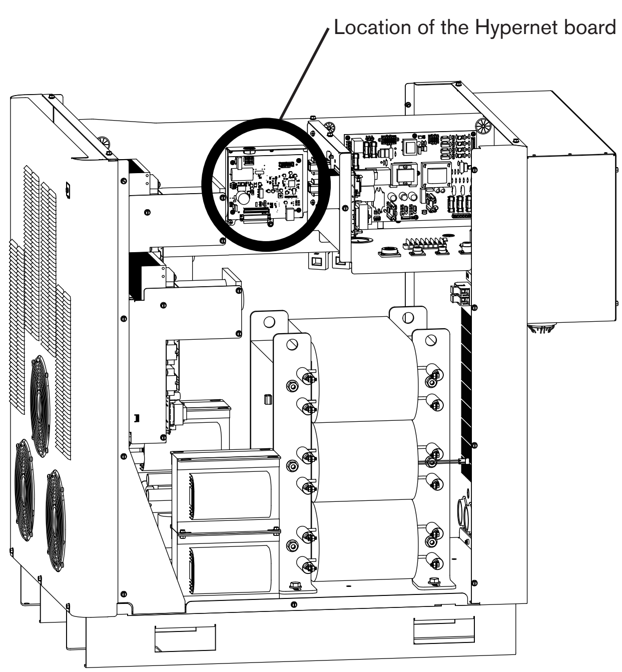
To align the torch at right angles to the workpiece, use a square. See figure above.

Torch lifter requirement

The system requires a high-quality, motorized torch lifter with sufficient travel to cover all cutting thickness requirements. The lifter must provide 203 mm (8 in) of vertical travel. The unit should have the capability of maintaining a constant speed of up to 5080 mm/min (200 ipm) with positive braking. A unit which drifts through the stop point is not acceptable.

HyperNet

HyperNet is only used to connect certain Hypertherm components to each other. An HPRXD system can be connected to the ArcGlide® torch height control, and an EDGE® Pro or MicroEDGE® Pro CNC using an ethernet hub and cable. The HyperNet PCB provides communication between components and is the source for the arc voltage needed for the torch height control. See the ArcGlide instruction manual (806450), the EDGE Pro instruction manual (806360) or the MicroEDGE Pro CNC instruction manual (807290) for more information.



Power requirements

General

All switches, slow-blow fuses and power cables are customer-supplied and must be chosen as outlined by applicable national and local electrical codes. Installation must be performed by a licensed electrician. Use a separate, primary, line disconnect switch for the power supply. Recommendations on fuse and circuit breaker sizing are listed below, however actual sizes required will vary based on individual site electrical line conditions (including but not limited to: source impedance, line impedance, and line voltage fluctuation), product inrush characteristics, and regulatory requirements.

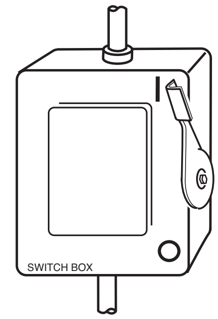
The main feed protection device (circuit breaker or fuse) must be sized to handle all branch-feed loads for both inrush and steady-state current. The power supply must be wired into one of the branch-feed circuits. The power supply has a steady-state current listed in the table below.

Use a motor-start circuit breaker or equivalent if time delay high inrush fuses are not permitted by local and national codes. Time delay fuses and circuit breakers must be capable of withstanding inrush current that is up to 30 times the rated input current (FLA) for 0.01 seconds and up to 12 times the rated input current (FLA) for 0.1 seconds.

Input voltage	Phase	Rated input current (FLA) @ 80 kW output	Recommended time delay, high inrush fuse size	Recommended cable size for 15 m (50 ft) maximum length
				Rated for 90°C (194°F)
200/208 VAC	3	262/252 amps	325 amps	235 mm^2 (350 MCM)
220 VAC	3	238 amps	300 amps	201.1 mm^2 (300 MCM)
240 VAC	3	219 amps	275 amps	167.5 mm^2 (250 MCM)
380 VAC	3	138 amps	175 amps	67.5 mm^2 (2/0 AWG)
400 VAC	3	131 amps	175 amps	67.5 mm^2 (2/0 AWG)
440 VAC	3	120 amps	150 amps	53.5 mm^2 (1 AWG)
480 VAC	3	110 amps	150 amps	53.5 mm^2 (1 AWG)
600 VAC	3	88 amps	110 amps	26.7 mm^2 (3 AWG)

Note: Cable AWG recommendations taken from table 310-16 of the National Electric Code handbook (USA).

Line disconnect switch



The line disconnect switch serves as the supply-voltage disconnecting (isolating) device. Install this switch near the power supply for easy access by the operator.

Installation must be performed by a licensed electrician and according to applicable national and local codes.

The switch should:

- Isolate the electrical equipment and disconnect all live conductors from the supply voltage when in the “OFF” position
- Have one “OFF” and one “ON” position clearly marked with “O” (OFF) and “I” (ON)
- Have an external operating handle capable of being locked in the “OFF” position
- Contain a power-operated mechanism that serves as an emergency stop
- Have slow-blow fuses installed for the proper breaking capacity (see table above).

18 Main power cable

Wire sizes vary based on the distance of the receptacle from the main box. The wire sizes listed in the table above were taken from the National Electric Code 1990 handbook, table 310.16 (USA). Use a 4-conductor Type SO input power cable with a conductor temperature rating of 90° C (194° F). Installation must be performed by a licensed electrician.

Connect the power

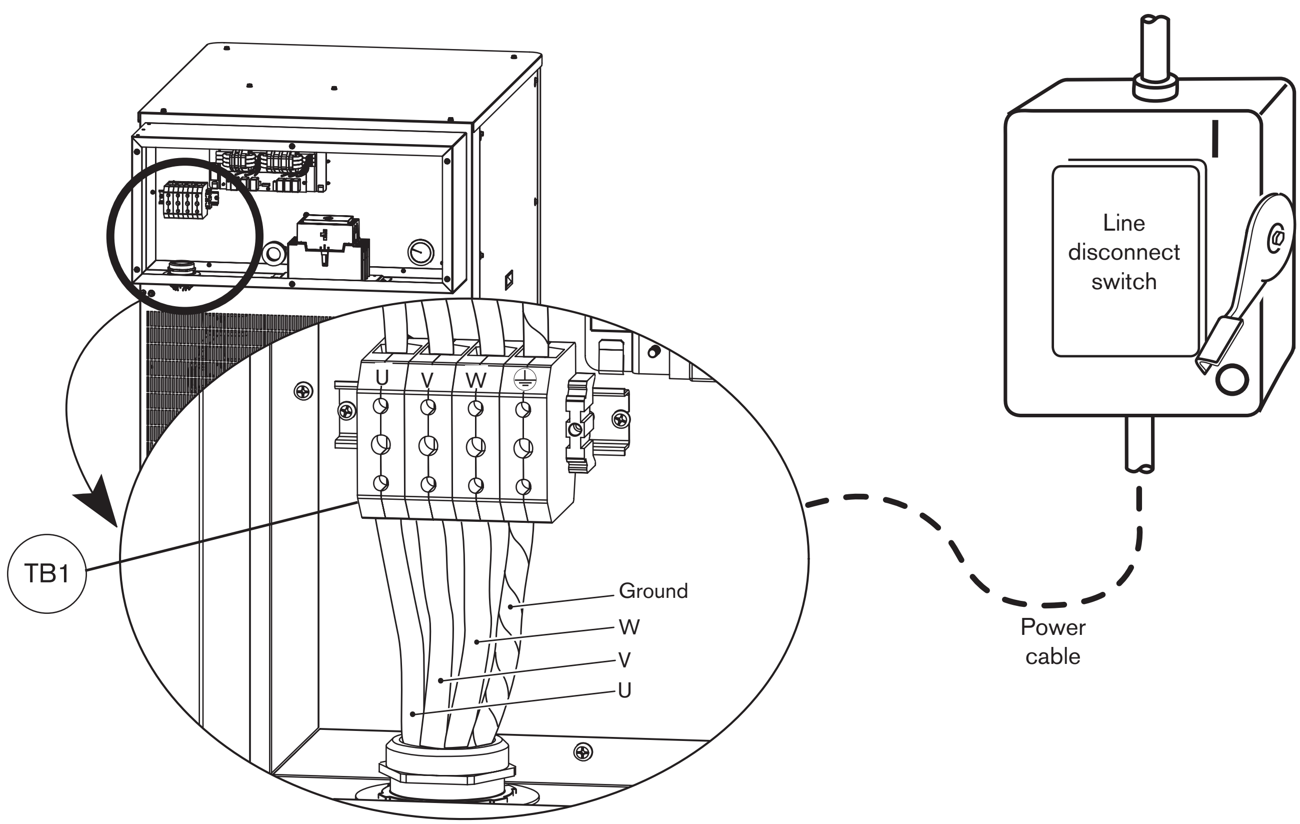
DANGER
ELECTRIC SHOCK CAN KILL

The line disconnect switch must be in the OFF position before making the power cable connections. In the U.S., use a "lock-out/tag-out" procedure until installation is complete. In other countries, follow appropriate national and local safety procedures.

1. Insert the power cable through the strain relief at the rear of the power supply.
2. Connect the ground lead (PE) to the GROUND terminal (⏚) of TB1 as shown below.
3. Connect the power leads to the terminals of TB1 as shown below.
4. Verify that the line disconnect switch is in the OFF position and remains in the OFF position for the remainder of the installation of the system.
5. Connect the power cord leads to the line disconnect switch following national and local electrical codes.

North American wire colors
U = Black
V = White
W = Red
(PE) Earth ground = Green/Yellow

European wire colors
U = Black
V = Blue
W = Brown
(PE) Earth ground = Green/Yellow



Torch coolant requirements

The system is shipped without any coolant in the tank. Before filling the coolant system, determine what coolant mix is correct for your operating conditions.

Observe the warning and cautions below. Refer to the *Material Safety Data Sheets* appendix for data on safety, handling, and storage of propylene glycol and benzotriazole.

DANGER
COOLANT CAN BE IRRITATING TO SKIN AND EYES AND HARMFUL OR FATAL IF SWALLOWED

Propylene glycol and benzotriazole are irritating to skin and eyes, and harmful or fatal if swallowed. Upon contact, flush skin or eyes with water. If swallowed, seek immediate medical attention.

CAUTION

Never use automotive anti-freeze in place of propylene glycol. Antifreeze contains corrosion inhibitors that will damage the torch coolant system.

Always use purified water in the coolant mixture in order to prevent damage to the pump and corrosion in the torch coolant system.

Definitions

Ambient temperature – The temperature of the room in which the chiller is being used.

Premixed coolant for standard operating temperatures

Use Hypertherm premixed coolant (028872) when operating in an ambient temperature range of -12° C to 40° C (10° F to 104° F). Refer to the custom coolant mix recommendations, if temperatures during operation are ever outside of this range.

Hypertherm premixed coolant consists of 69.8% water, 30% propylene glycol, and 0.2% benzotriazole.

Custom Coolant mix for cold operating temperatures (below -12° C / 10° F)

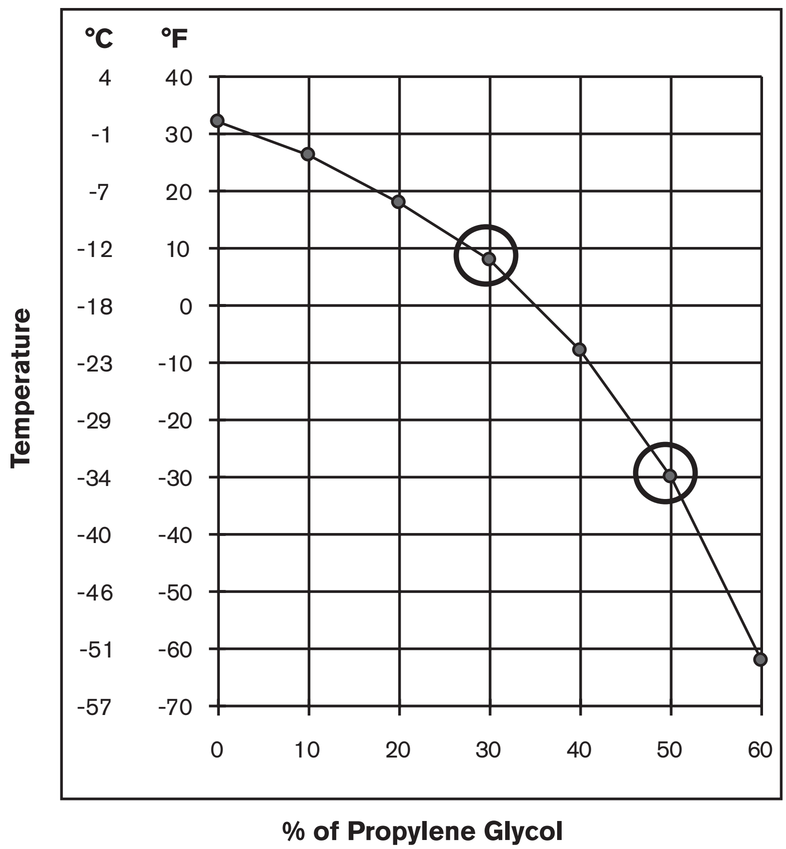
CAUTION

For operating temperatures colder than the temperature stated above, the percentage of propylene glycol must be increased. Failure to do so could result in a cracked torch head, hoses, or other damage to the torch coolant system due to freezing.

Use the chart below to determine what percentage of propylene glycol to use in the mixture.

Mix 100% glycol (028873) with the premixed Hypertherm coolant (028872) to increase the percentage of glycol. The 100% glycol solution can also be mixed with purified water (see next page for water purity requirements) to achieve the required protection from freezing.

Note: The maximum percentage of glycol should never exceed 50%.



Freezing Point of Propylene Glycol Solution

10/16/08

Custom Coolant mix for hot operating temperatures (above 38° C / 100° F)

Treated water (with no propylene glycol) can only be used as coolant when ambient temperatures are **never** below 0° C (32° F). For operations in very warm temperatures, treated water will provide the best cooling properties.

Treated water refers to a mixture of purified water, that meets the specifications below, and 1 part benzotriazole (BZT) to 300 parts of water. BZT (128020) acts as a corrosion inhibitor for the copper based coolant system contained in the plasma system.

Water purity requirements

It is critical to maintain a low level of calcium carbonate in the coolant to avoid reduced performance of the torch or cooling system.

Always use water that meets the minimum and maximum specifications in the table below when using a custom coolant mix.

Water that does not meet the minimum purity specifications below can cause excessive deposits on the nozzle that will alter the water flow and produce an unstable arc.

Water that does not meet the maximum purity specifications below can also cause problems. Deionized water that is too pure will cause leaching problems with the coolant system plumbing.

Use water purified by any method (deionization, reverse osmosis, sand filters, water softeners, etc.) as long as the water purity meets the specifications in the table below. Contact a water specialist for advice in choosing a water filtration system.

	Water purity measurement method			
Water purity	Conductivity μS/cm at 25° C (77° F)	Resistivity mΩ-cm at 25° C (77° F)	Dissolved solids (ppm of NaCl)	Grains per gallon (gpg of $CaCO_2$)
Pure water (for reference only)	0.055	18.3	0	0
Maximum purity	0.5	2	0.206	0.010
Minimum purity	18	0.054	8.5	0.43
Maximum potable water (for reference only)	1000	0.001	495	25

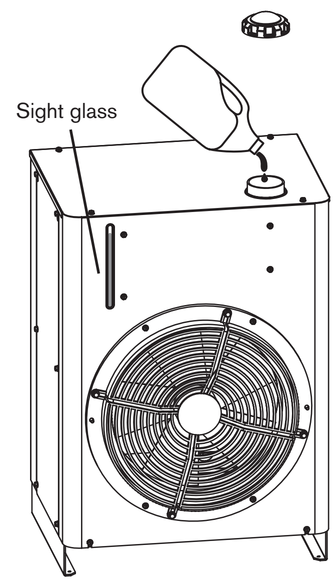
10/16/08

Fill the cooler with coolant

The cooling system's capacity is 15.5 to 34.5 liters (4 to 9 gallons) of coolant, depending on the length of the torch leads and coolant hoses.

> **Caution:** **Using the wrong coolant can cause damage to the system. Refer to *Torch Coolant Requirements* in this section for more information.**
>
> **Do not over fill the coolant tank.**

1. Remove the filler cap and add coolant until the level in the sight glass reaches full.
2. Turn ON the power supply using the remote ON/OFF switch or the CNC. The coolant level in the tank will drop as the coolant circulates through the system, and an error code (060 or 093) may occur.
3. Turn OFF the power.
4. Add coolant to the cooler until the level in the sight glass reaches full, and turn ON the power.
5. Repeat this process as many times as necessary, until the pump can be run continuously. This will allow coolant to completely fill the coolant loop and purge any air from the system.
6. Replace the filler cap.



Gas requirements

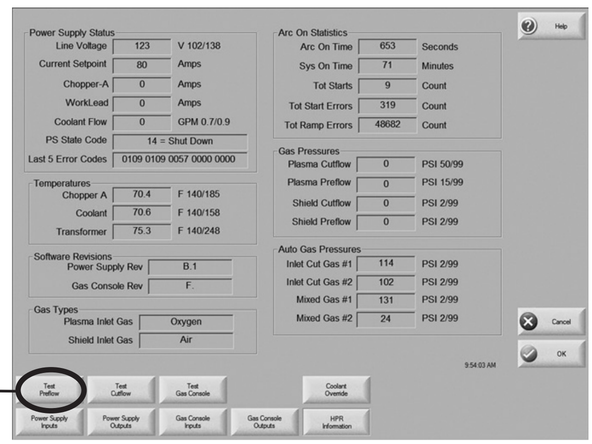
The customer must furnish all gases and gas-supply regulators for the system. Use a high-quality, 2-stage pressure regulator located within 3 m (10 ft) of the selection console. See *gas regulators* in this section for recommendations. See the *Specification* section for gas and flow specifications. See *Supply gas hoses* at the end of this section for recommendations.

Caution: **Gas supply pressures not within the specifications in Section 2 can cause poor cut quality, poor consumable life and operational problems.**

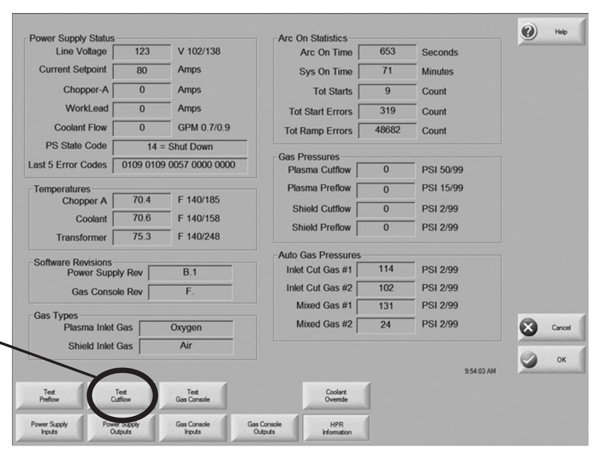
If the purity level of the gas is too low or if there are leaks in the supply hoses or connections,

- **Cut speeds can decrease**
- **Cut quality can deteriorate**
- **Cutting thickness capability can decrease**
- **Parts life can shorten**

Setting the supply regulators



1. Turn OFF the power to the system. Set all gas regulator pressures to 8 bar (115 psi).
2. Turn ON the power to the system using the remote ON/OFF switch or the CNC.
3. Set to Test Preflow.
4. While gas is flowing adjust the supply regulator for the shield gas to 8 bar (115 psi).
5. Turn OFF Test Preflow.
6. Set system to Test Cutflow.
7. While gas is flowing adjust the supply regulator for the plasma gas to 8 bar (115 psi).
8. Turn OFF Test Cutflow.



Gas regulators

Low-quality gas regulators do not provide consistent supply pressures and can result in poor cut quality and system operation problems. Use a high-quality, 1-stage, gas regulator to maintain consistent gas supply pressure, if using liquid cryogenic or bulk storage. Use a high-quality, 2-stage, gas regulator to maintain consistent gas supply pressure from high pressure gas cylinders.

The high-quality gas regulators listed below are available from Hypertherm and meet U.S. Compressed Gas Association (CGA) specifications. In other countries, select gas regulators that conform to national and local codes.

2-stage regulator

Single stage regulator

Part Number	Description	Qty.
128544	**Kit: Oxygen, 2-stage ***	**1**
128545	**Kit: Inert Gas, 2-stage**	**1**
128546	**Kit: Hydrogen (H5, H35 and methane) 2-stage**	**1**
128547	**Kit: Air, 2-stage**	**1**
128548	**Kit: 1-stage (for use with cryogenic liquid nitrogen or oxygen)**	**1**
022037	Oxygen, 2-stage	1
022038	Inert gas, 2-stage	1
022039	Hydrogen/methane, 2-stage	3
022040	Air, 2-stage	1
022041	Line regulator, 1-stage	1

***** Kits include appropriate fittings

Supply gas plumbing

Rigid copper plumbing or suitable flexible hose may be used for all gas supplies. Do not use steel or aluminum pipe. After installation, pressurize the entire system and check for leaks.
Recommended hose diameters are 9.5 mm (3/8 in) for lengths < 23 m (75 ft) and 12.5 mm (1/2 in) for lengths > 23 m (75 ft).

For flexible-hose systems, use a hose designed for inert gas to carry air, nitrogen or argon-hydrogen. See the last page of this section for hose part numbers.

Caution: Never use PTFE tape on any joint preparation.

Caution: When connecting the selection console to the supply gases, make sure that all hoses, hose connections and fittings are acceptable for use with oxygen and argon-hydrogen. Installation must be made in accordance with national and local codes.

Note: When cutting with oxygen as the plasma gas, air must also be connected to the selection console to achieve the proper mixtures in the preflow and cutflow modes.

WARNING
CUTTING WITH OXYGEN CAN CAUSE FIRE OR EXPLOSION

Cutting with oxygen as the plasma gas can cause a potential fire hazard due to the oxygen-enriched atmosphere that it creates. As a precaution, Hypertherm recommends that an exhaust ventilation system be installed when cutting with oxygen.

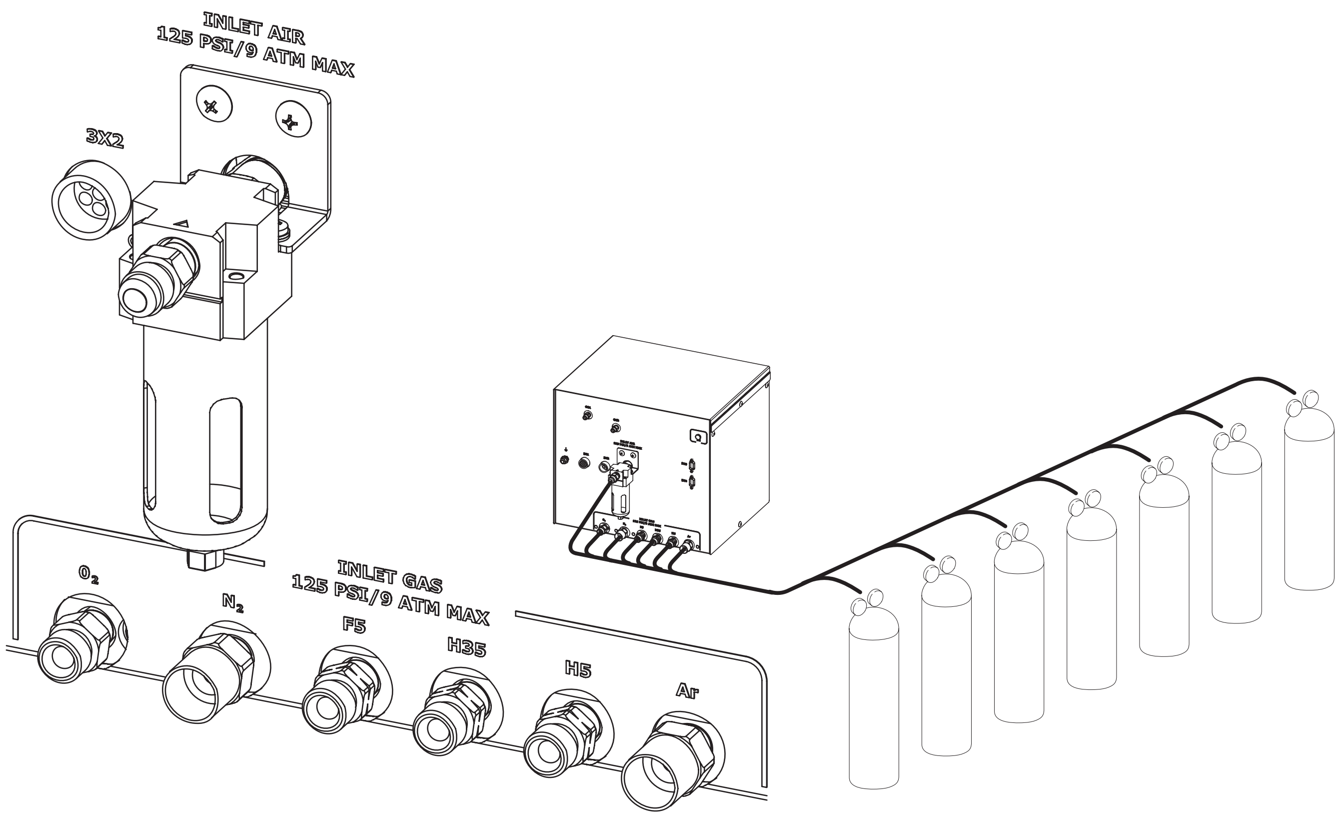
Flashback arrestors are required (unless not available for specific gases or required pressures) to prevent fire from propagating back to supply gas.

Connect the supply gases

Connect the supply gases to the selection console. Torch leads must be purged between gas changes.

Caution: **Synthetic lubricants containing esters that are used in some air compressors will damage polycarbonates used in the air regulator bowl.**

Fitting	Size
N_2 / Ar	5/8 – 18, RH, internal (inert gas) "B"
Air	9/16 – 18, JIC, #6
H35 / F5 / H5	9/16 – 18, LH, (fuel gas) "B"
O_2	9/16 – 18, RH, (oxygen) "B"

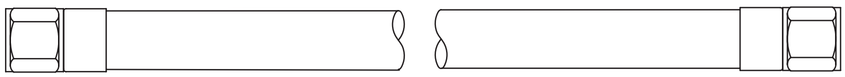


Caution: **Replacing the fittings on the selection console may cause the internal valves to malfunction, because particulates can migrate into the valves.**

Supply gas hoses

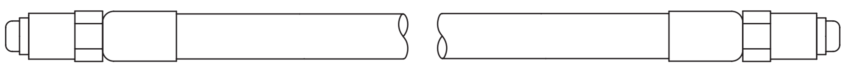
⓮ Oxygen hose

Caution: Never use PTFE tape on any joint preparation.



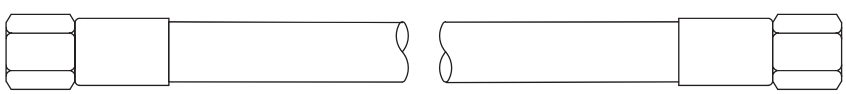
Part no.	Length	Part no.	Length
024607	3 m (10 ft)	024738	25 m (82 ft)
024204	4.5 m (15 ft)	024450	35 m (115 ft)
024205	7.5 m (25 ft)	024159	45 m (150 ft)
024760	10 m (35 ft)	024333	60 m (200 ft)
024155	15 m (50 ft)	024762	75 m (250 ft)
024761	20 m (65 ft)		

⓯ Nitrogen or argon hose



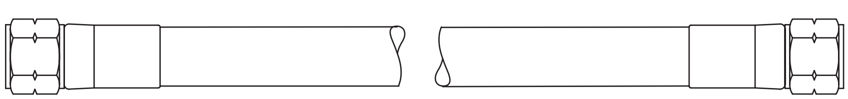
Part no.	Length	Part no.	Length
024210	3 m (10 ft)	024739	25 m (82 ft)
024203	4.5 m (15 ft)	024451	35 m (115 ft)
024134	7.5 m (25 ft)	024120	45 m (150 ft)
024211	10 m (35 ft)	024124	60 m (200 ft)
024112	15 m (50 ft)	024764	75 m (250 ft)
024763	20 m (65 ft)		

⓰ Air hose



Part no.	Length	Part no.	Length
024671	3 m (10 ft)	024740	25 m (82 ft)
024658	4.5 m (15 ft)	024744	35 m (115 ft)
024659	7.5 m (25 ft)	024678	45 m (150 ft)
024765	10 m (35 ft)	024680	60 m (200 ft)
024660	15 m (50 ft)	024767	75 m (250 ft)
024766	20 m (65 ft)		

⓱ Argon-hydrogen (H35) or nitrogen-hydrogen (F5)



Part no.	Length	Part no.	Length
024768	3 m (10 ft)	024741	25 m (82 ft)
024655	4.5 m (15 ft)	024742	35 m (115 ft)
024384	7.5 m (25 ft)	024743	45 m (150 ft)
024769	10 m (35 ft)	024771	60 m (200 ft)
024656	15 m (50 ft)	024772	75 m (250 ft)
024770	20 m (65 ft)		

Section 4

OPERATION

In this section:

Daily start-up

Prior to start-up, ensure that your cutting environment and that your clothing meet the safety requirements outlined in the *Safety* section of this manual.

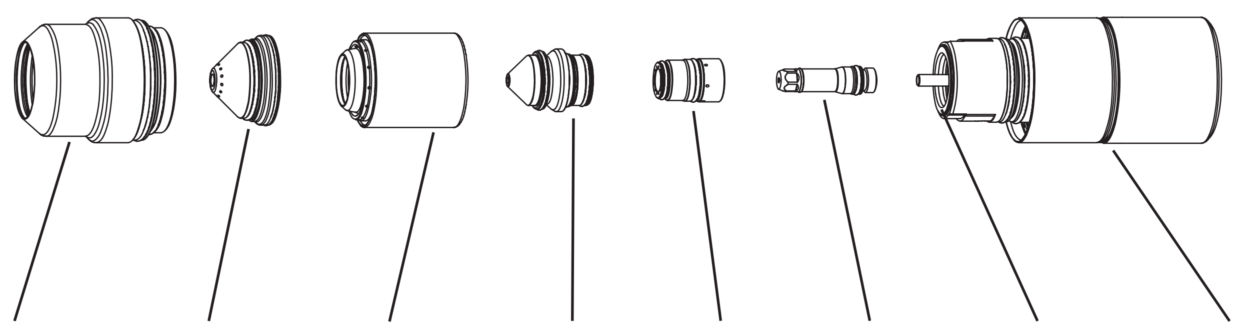
Check torch

DANGER

ELECTRIC SHOCK CAN KILL

Before operating this system, you must read the *Safety* section thoroughly. Turn OFF the power supply's main disconnect switch before proceeding with the following steps.

1. Turn main disconnect switch to the power supply OFF.
2. Remove the consumables from the torch and check for worn or damaged parts. **Always place the consumables on a clean, dry, oil-free surface after removing. Dirty consumables can cause the torch to malfunction.**
    - Refer to *Install and inspect consumables* later in this section for details and for parts inspection tables.
    - Refer to the *Cut charts* to choose the correct consumables for your cutting needs.
3. Replace consumable parts. Refer to *Install and inspect consumables* later in this section for details.
4. Ensure that the torch is perpendicular to the workpiece.

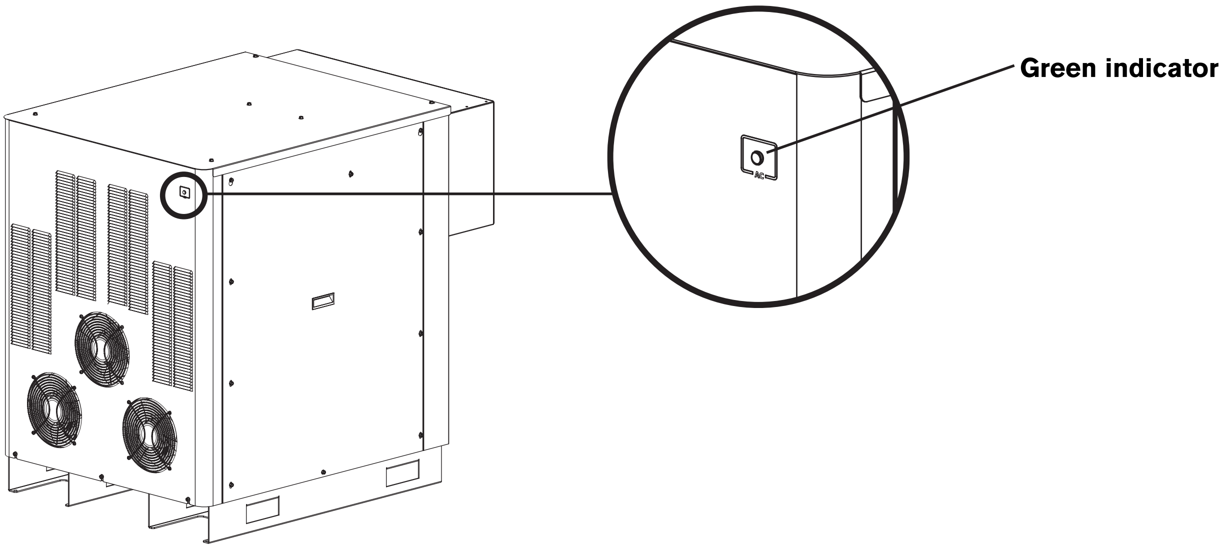


Power indicators

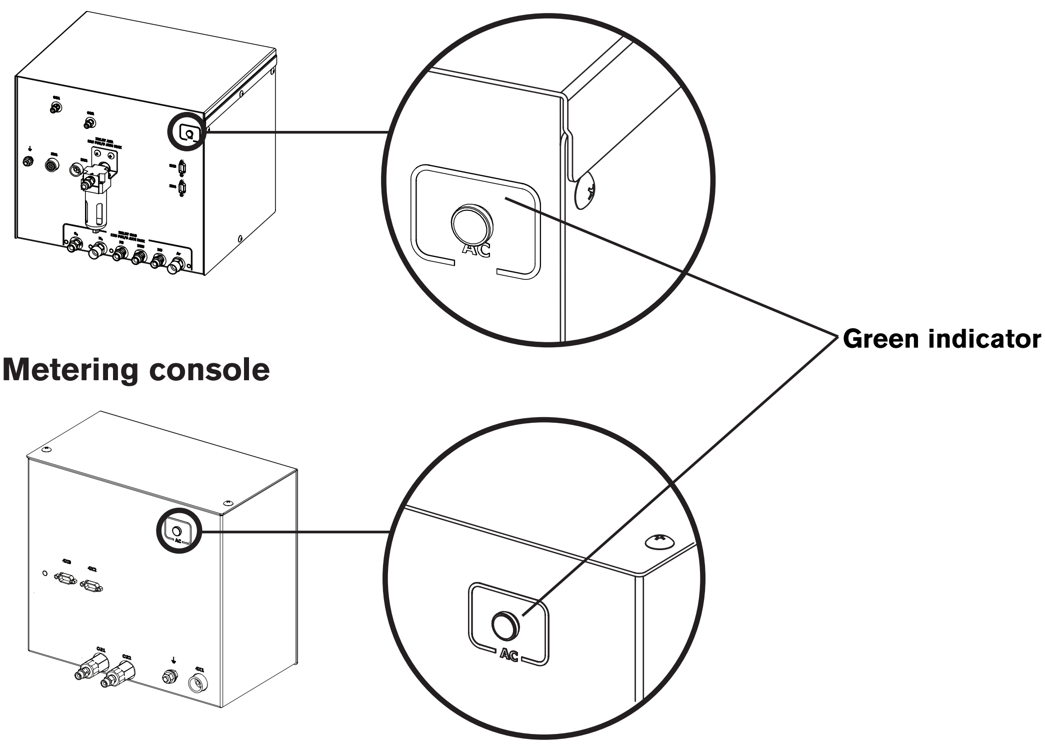
General

Power for the system is controlled by the CNC. The power supply, selection console and metering console each have an LED lamp that illuminates when power is supplied to the component.

Power supply



Selection console



Metering console

CNC controller requirements

Note: See appendix B, *CNC interface protocol,* for more detailed information.

Base required elements

The following elements should be able to be displayed and adjusted on the CNC for setup and basic system information. The plasma system needs this group for basic setup and operation capability.

1. Remote ON/OFF
2. Ability to display and adjust the basic plasma process set-points (command ID No. 95)
   a. Current set point
   b. Plasma preflow
   c. Plasma cutflow
   d. Shield preflow
   e. Shield cutflow
   f. Plasma gas type
   g. Shield gas type
   h. Gas mixing set-points
3. Display basic system information
   a. System error code
   b. Gas and PS firmware version
4. Manual pump control

Required real time elements

The following elements should be able to be displayed in real time while cutting. This is necessary for troubleshooting and diagnostic purposes.

5. Display line voltage
6. Display chopper current
7. Display work lead current
8. Display system status code
9. Display chopper temperature
10. Display transformer temperature
11. Display coolant temperature
12. Display coolant flow
13. Display pressure transducers

Required diagnostic elements

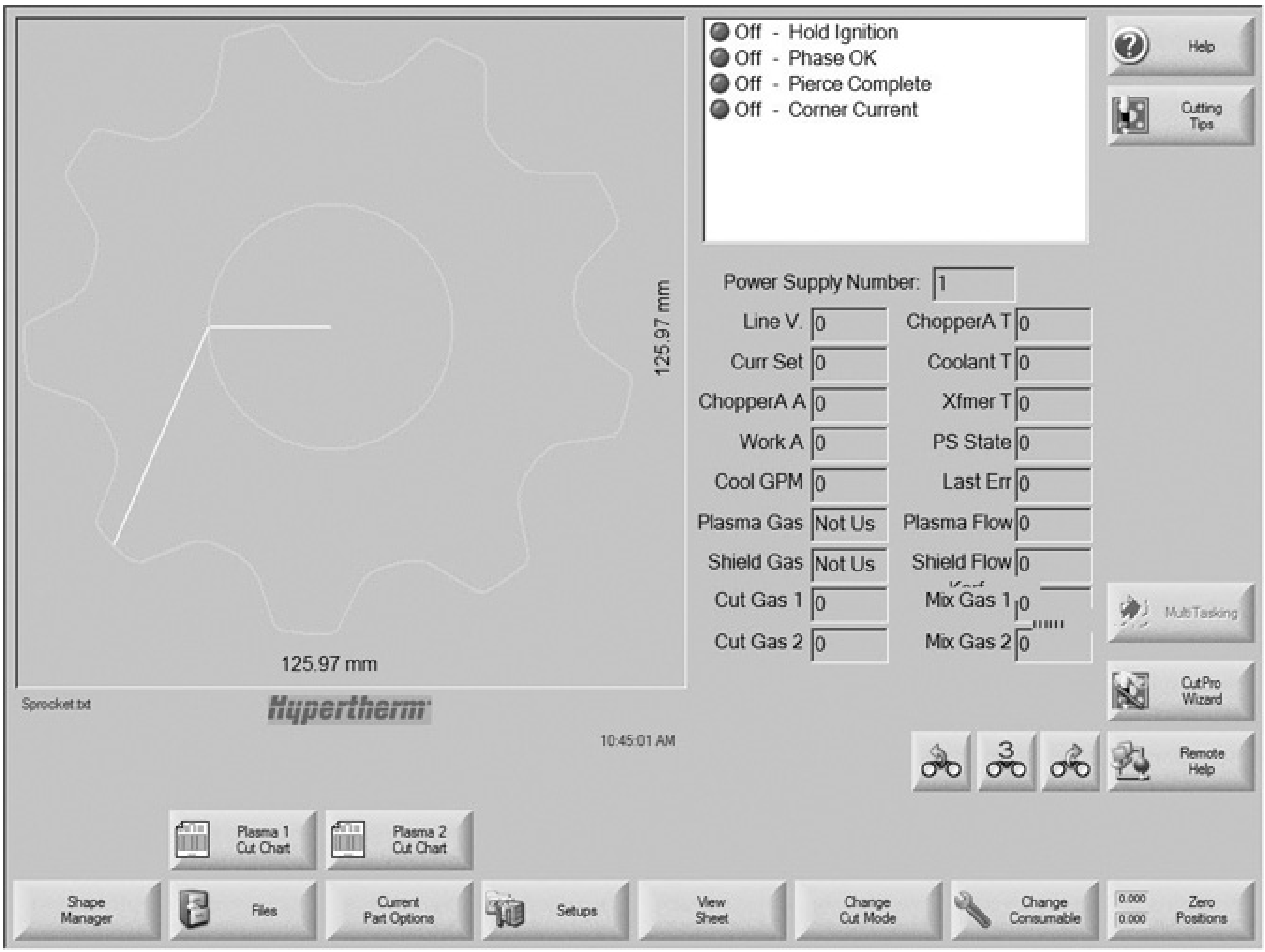
These elements provide additional diagnostic capability to the system for troubleshooting gas-delivery problems. The CNC should be capable of executing these commands and displaying the relevant information for the respective test according to the serial protocol guidelines.

14. Test preflow gases
15. Test cutflow gases
16. Inlet leak test
17. System leak test
18. System flow test

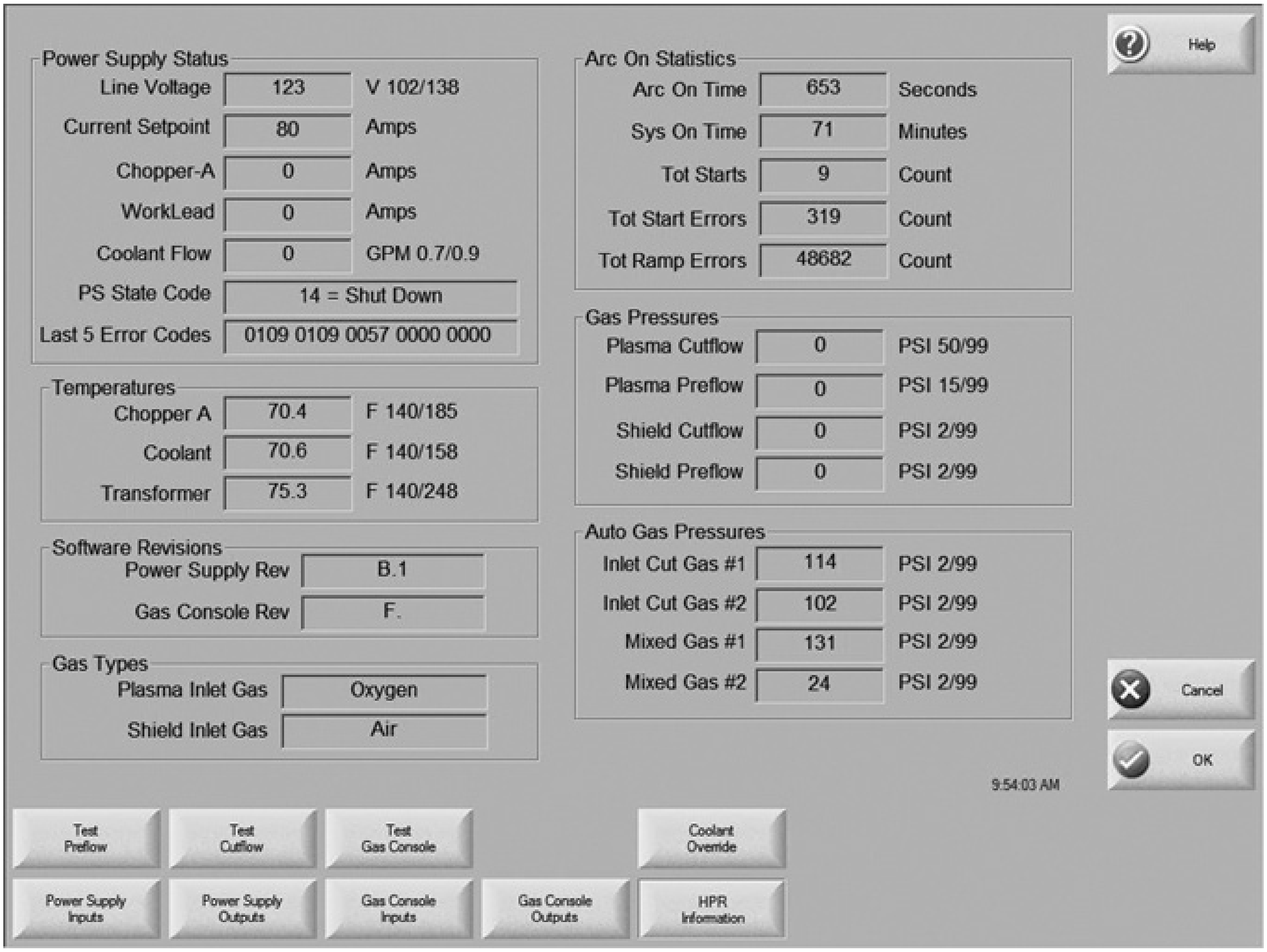
CNC screen examples

The screens shown are for reference. The screens you work with may be different, but should include the functions listed on the previous page.

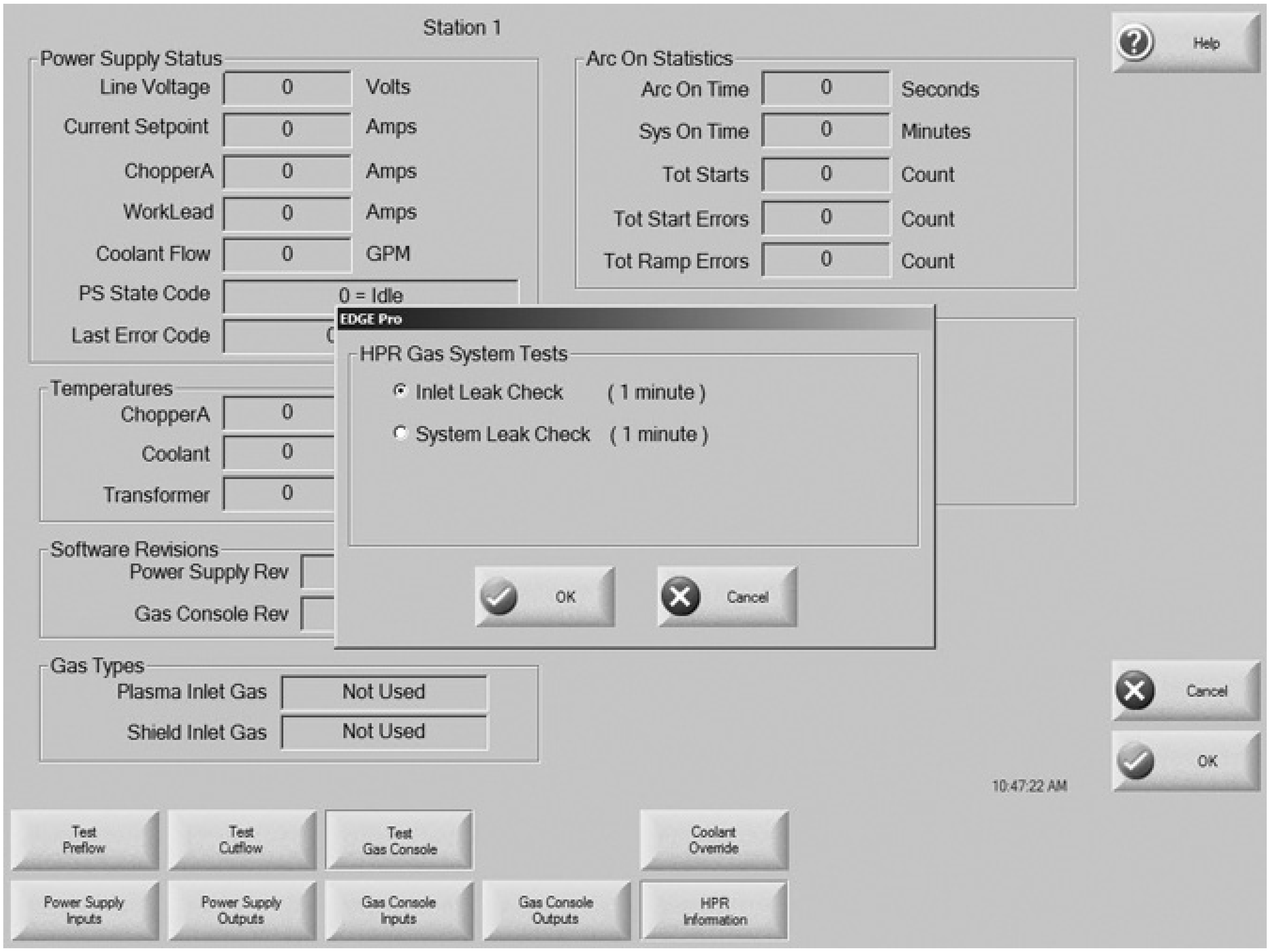
Main (control) screen



Diagnostic screen



Test screen


Station 1
Power Supply Status
Line Voltage 0 Volts
Current Setpoint 0 Amps
ChopperA 0 Amps
WorkLead 0 Amps
Coolant Flow 0 GPM
PS State Code 0 = Idle
Last Error Code
Arc On Statistics
Arc On Time 0 Seconds
Sys On Time 0 Minutes
Tot Starts 0 Count
Tot Start Errors 0 Count
Tot Ramp Errors 0 Count
Help
Temperatures
ChopperA 0
Coolant 0
Transformer 0
Software Revisions
Power Supply Rev
Gas Console Rev
EDGE Pro
HPR Gas System Tests
Inlet Leak Check (1 minute)
System Leak Check (1 minute)
OK
Cancel
Gas Types
Plasma Inlet Gas Not Used
Shield Inlet Gas Not Used
Cancel
OK
10:47:22 AM
Test Preflow
Test Cutflow
Test Gas Console
Coolant Override
Power Supply Inputs
Power Supply Outputs
Gas Console Inputs
Gas Console Outputs
HPR Information

Cut chart screen

Consumable selection

Standard cutting (0°)

Most of the consumables on the following pages are designed for standard (straight) cutting, when the torch is perpendicular to the workpiece.

Bevel cutting (0° to 45°)

Consumables for 130 amp and 260 amp bevel cutting are specifically designed for bevel cutting. 400 amp consumables can be used for standard cutting and bevel cutting, but bevel-specific, 400 amp cut charts are provided for convenience.

Marking

Any of the consumable sets can also be used for marking with argon or nitrogen. Marking parameters are shown at the bottom of each cut chart. The quality of the marks will vary depending on the marking process, cut process, material type, material thickness, and material surface finish. For best mark quality, use the argon marking process settings. For all marking processes the depth of the mark can be increased by reducing the marking speed, or the depth can be decreased by increasing the marking speed. Argon marking currents can be increased by up to 30% to increase the depth of the mark. When marking with an argon process at 25 amps or greater, the process will start with air before changing to argon, and a thicker, darker mark will be seen at the start of the mark. When using the argon marking processes, mark and cut individual parts. Marking the entire nest prior to cutting may lead to reduced consumable life. For better results intersperse cuts and marks. Poor quality marking or burn-through may occur with material less than 1.5 mm (0.06 in. or 16 gauge).

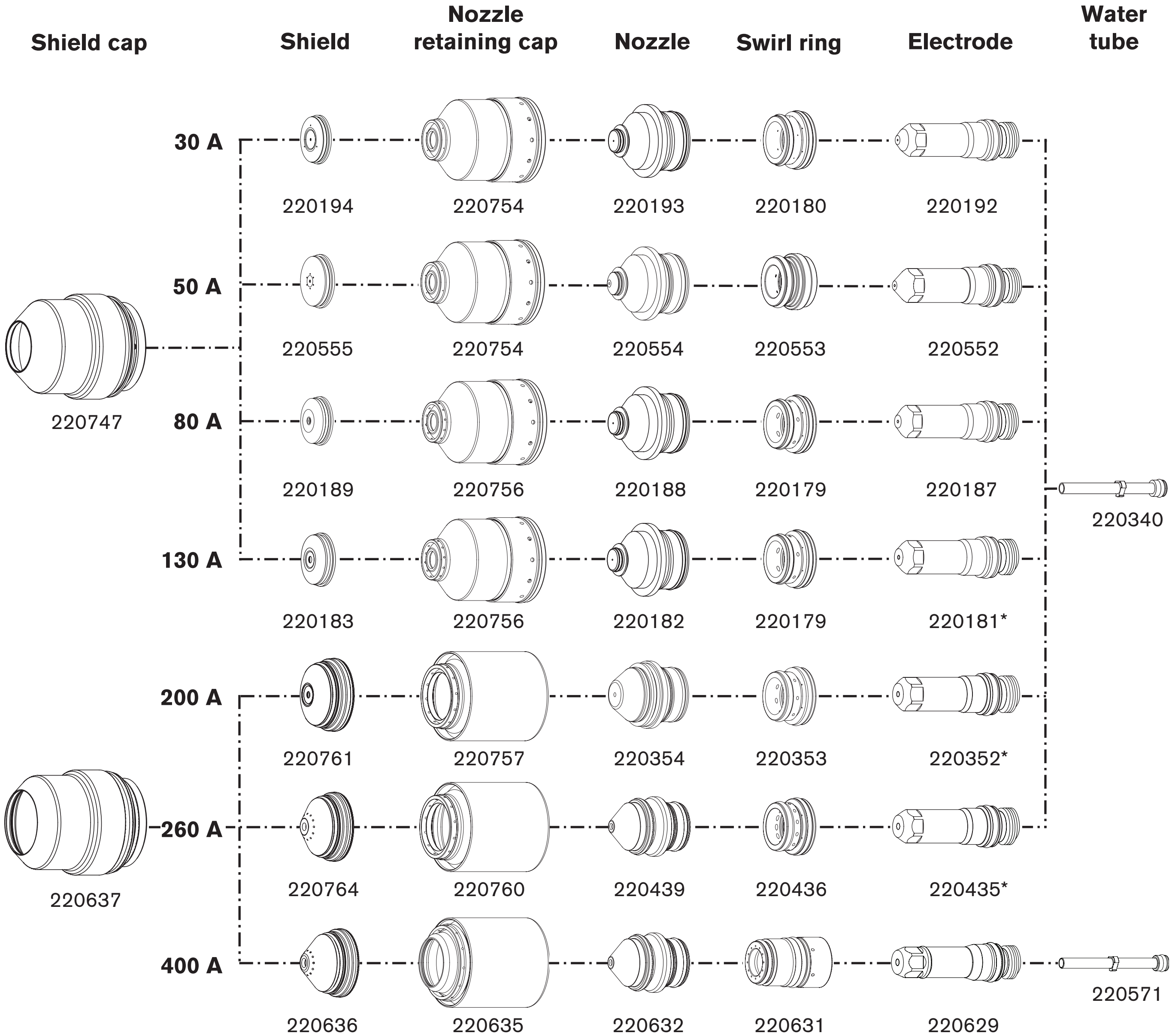
Consumables for mirror-image cutting

See the *Parts List* section in this manual for part numbers.

SilverPlus electrodes

SilverPlus electrodes provide increased life when the average cut duration is short (< 60 seconds), and cut quality is not the most critical requirement. SilverPlus electrodes are available for 130 amp, 200 amp, and 260 amp mild steel O_2 / Air cutting. Part numbers can be found on the following page.

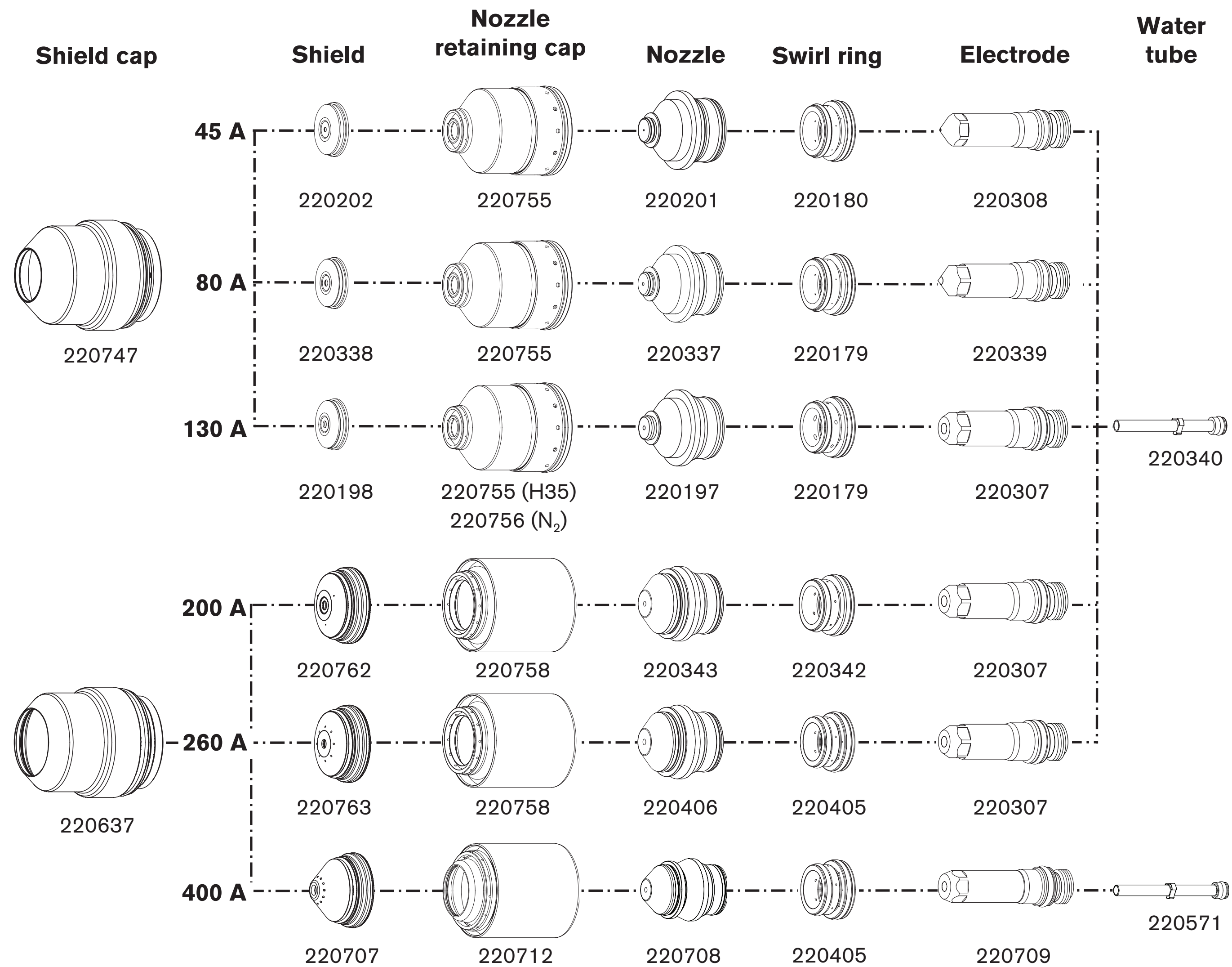
Mild steel



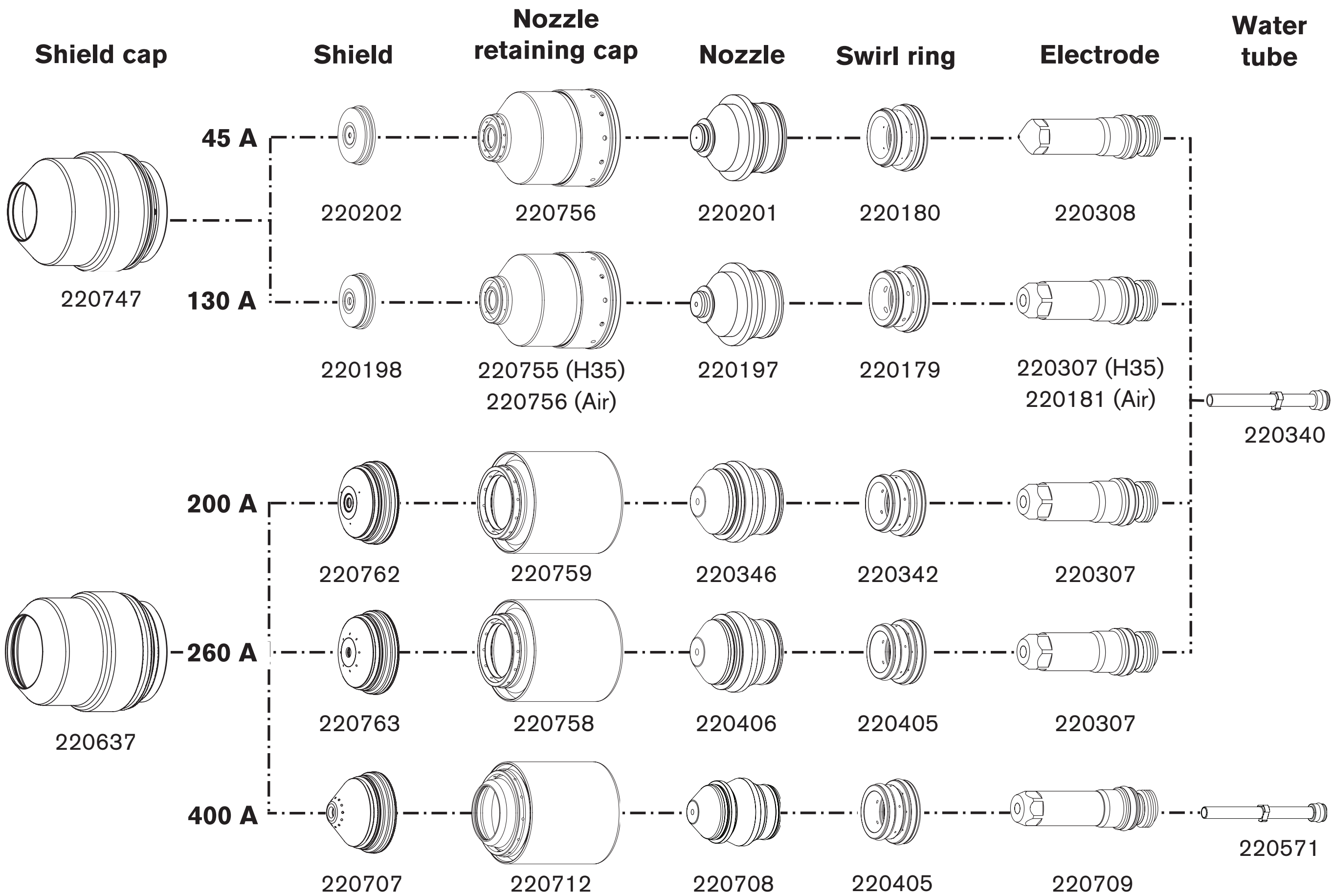
* SilverPlus electrodes are available for these processes.

Mild steel, 130 amp, O_2 / Air – 220665
Mild steel, 200 amp, O_2 / Air – 220666
Mild steel, 260 amp, O_2 / Air – 220668

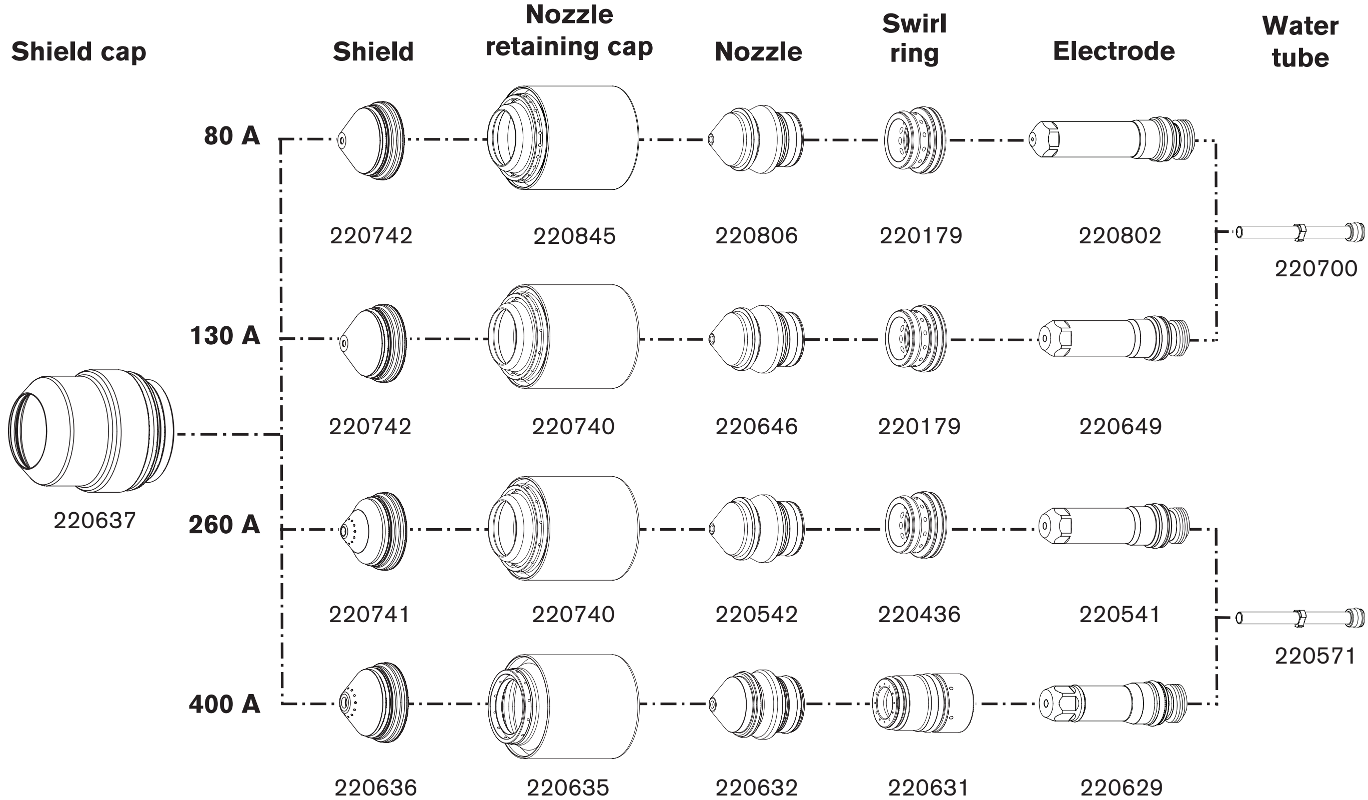
Stainless steel



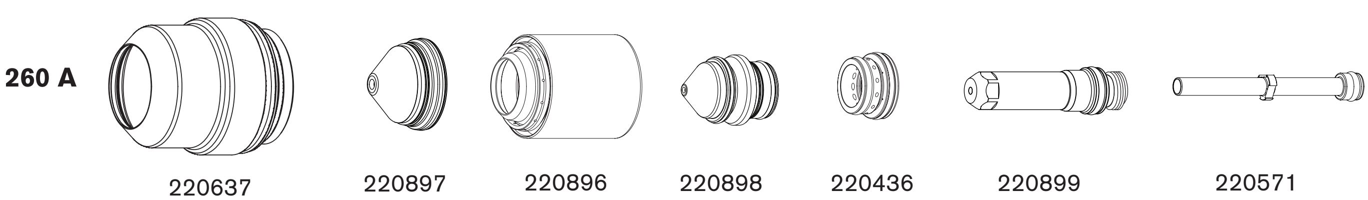
Aluminum


Shield cap
Shield
Nozzle retaining cap
Nozzle
Swirl ring
Electrode
Water tube
45 A
130 A
200 A
260 A
400 A
220747
220637
220202
220756
220201
220180
220308
220198
220755 (H35)
220756 (Air)
220197
220179
220307 (H35)
220181 (Air)
220340
220762
220759
220346
220342
220307
220763
220758
220406
220405
220307
220707
220712
220708
220405
220709
220571

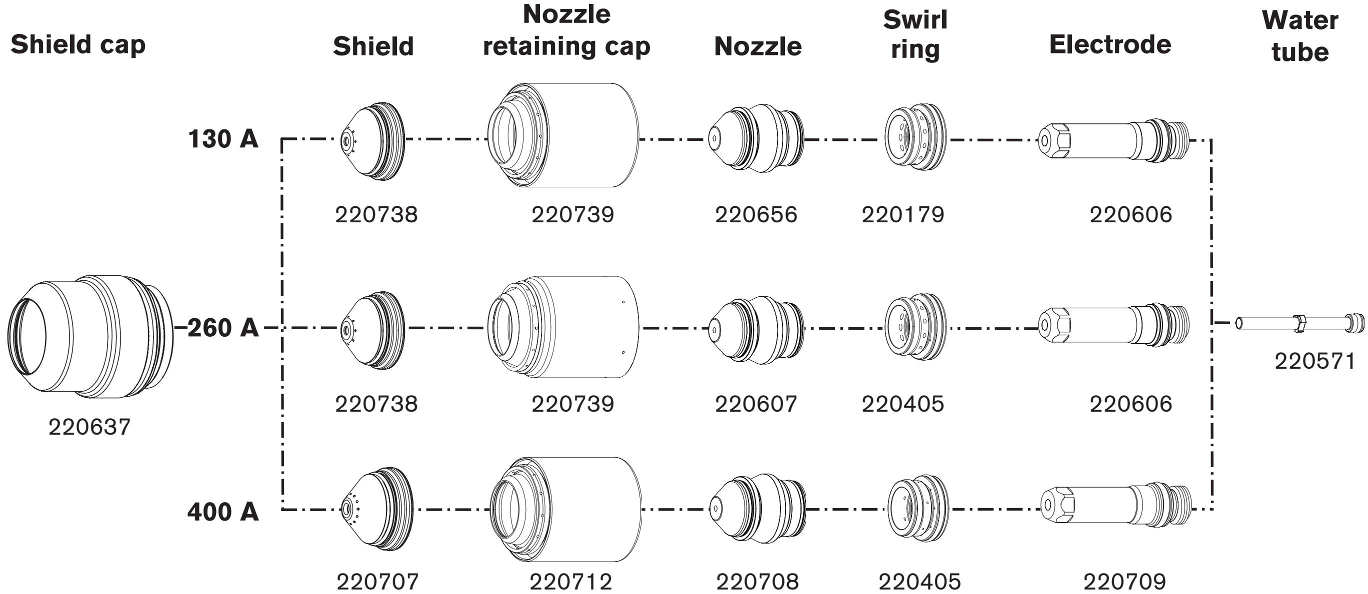
Mild steel bevel cutting



Mild steel, thick piercing, bevel cutting



Stainless steel bevel cutting



Install and Inspect consumables

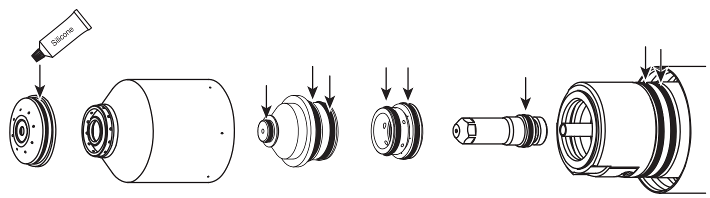
WARNING

The system is designed to go into an idle mode if the retaining cap is removed. However, DO NOT CHANGE CONSUMABLE PARTS WHILE IN THE IDLE MODE. Always disconnect power to the power supply before inspecting or changing torch consumable parts. Use gloves when removing consumables. The torch might be hot.

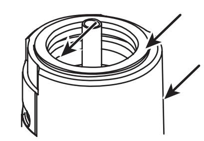
Install consumables

Check the consumable parts daily for wear before cutting. Before removing consumables, bring the torch to the edge of the cutting table, with the torch lifter raised to its highest point to prevent the consumables from dropping into the water of the water table.

Note: Do not overtighten parts! Only tighten until mating parts are seated.

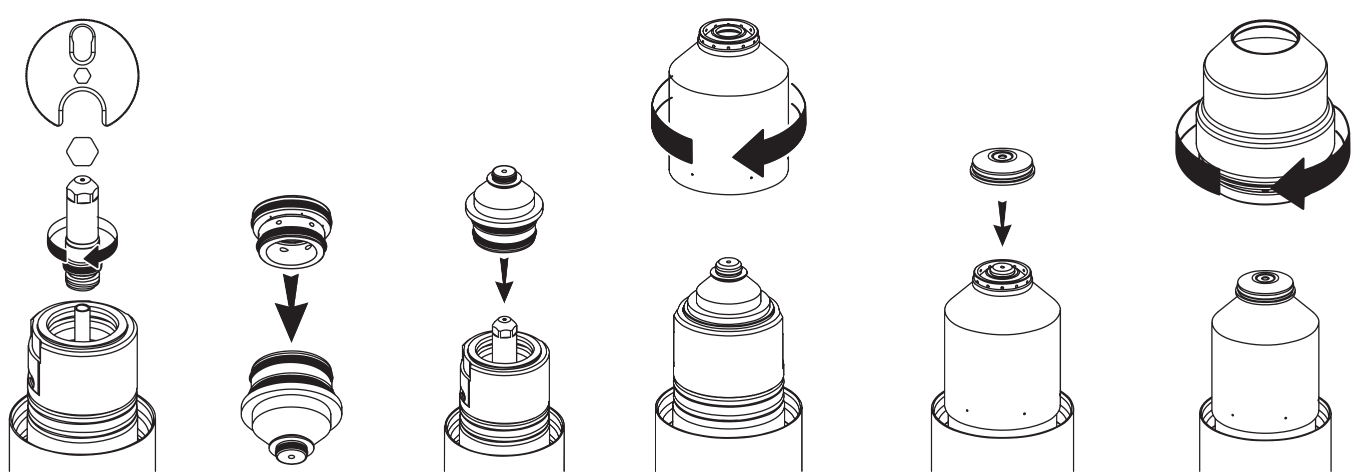


Apply a thin film of silicone lubricant on each o-ring. The o-ring should look shiny, but there should not be any excess or built-up grease.



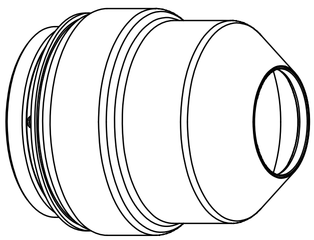
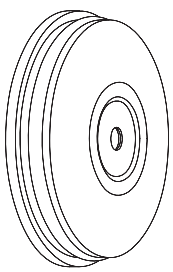
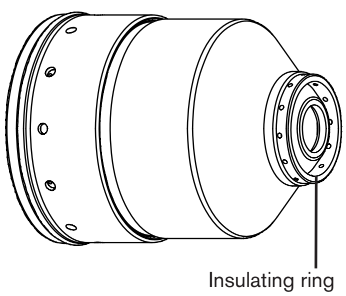
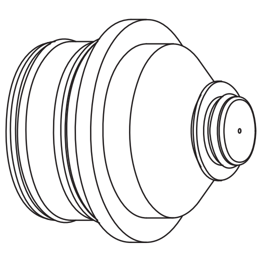
Wipe the internal and external surfaces of the torch with a clean cloth or paper towel.

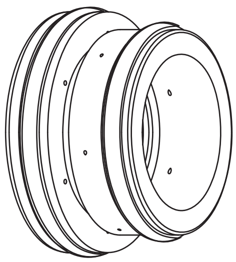
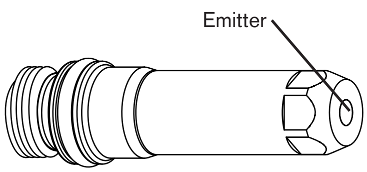
Tool: 104119

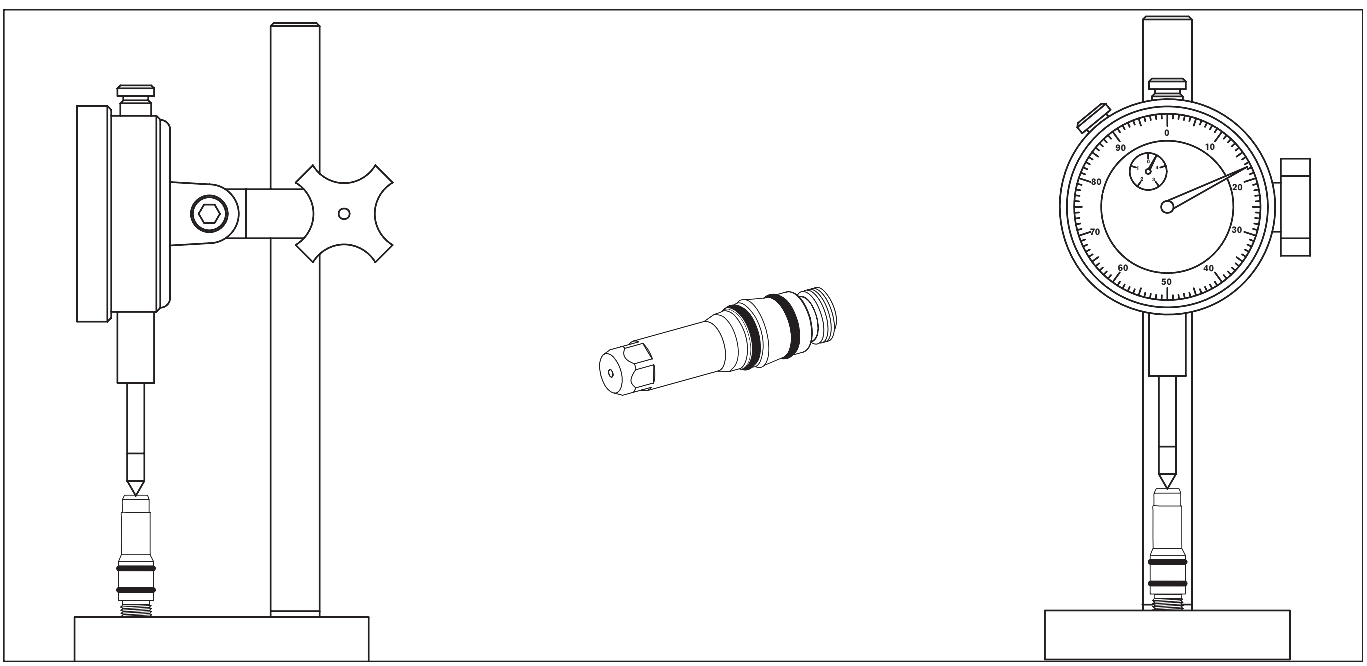


1. Install the electrode
2. Install the swirl ring
3. Install the nozzle and swirl ring
4. Install the nozzle retaining cap
5. Install the shield
6. Install the shield cap

Inspect consumables

Inspect	Look for	Action
Shield cap 	Erosion, missing material Cracks Burned surface	Replace shield cap Replace shield cap Replace shield cap
Shield 	**General:** Erosion or missing material Molten material attached Blocked gas holes **Center hole:** Must be round **O-rings:** Damage Lubricant	 Replace shield Replace shield Replace shield Replace the shield when the hole is no longer round Replace shield Apply a thin film of silicone lubricant if the o-rings are dry
Nozzle retaining cap 	**General:** Damage to insulating ring Poor cut quality after replacing other consumables	 Replace nozzle retaining cap Replace nozzle retaining cap
Nozzle Always replace the nozzle and electrode as a set. 	**General:** Erosion or missing material Blocked gas holes **Center hole:** Must be round Signs of arcing **O-rings:** Damage Lubricant	 Replace nozzle Replace nozzle Replace the nozzle when the hole is no longer round Replace nozzle Replace nozzle Apply a thin film of silicone lubricant if the o-rings are dry

Inspect	Look for	Action
Swirl ring 	**General:** Chips or cracks Blocked gas holes Dirt or debris **O-rings:** Damage Lubricant	 Replace swirl ring Replace swirl ring Clean and check for damage; replace when damaged Replace swirl ring Apply a thin film of silicone lubricant if the o-rings are dry
Electrode Always replace the nozzle and electrode as a set. 	**Center surface:** Emitter wear – a pit forms as the emitter wears. **O-rings:** Damage Lubricant	 In general, replace the electrode when the pit depth is 1 mm (0.04 in.) or greater. For the 400 amp mild steel electrode and all SilverPlus electrodes, replace the electrode when the pit depth is 1.5 mm (0.06 in.) or greater. See Electrode pit depth gage below. Replace electrode Apply a thin film of silicone lubricant if the o-rings are dry



Electrode pit depth gage (004147)

Torch maintenance

Poor cut quality and premature failure may occur if the HPR torch is not maintained properly.

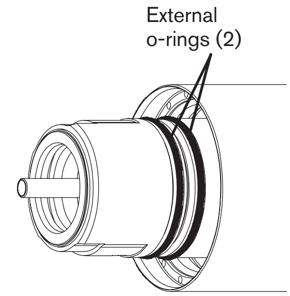
The torch is manufactured to very tight tolerances to maximize cut quality. The torch should not be subjected to hard impacts that can cause critical features to become misaligned.

The torch should be stored in a clean location when not in use, to avoid contamination of critical surfaces and passages.

Routine maintenance

The following steps should be completed each time consumables are changed:

1. Use a clean cloth to wipe off the torch inside and outside. A cotton swab can be used to access hard-to-reach internal surfaces.
2. Use compressed air to blow away any remaining dirt and debris from internal and external surfaces.
3. Apply a thin film of silicone lubricant on each external o-ring. The o-rings should look shiny, but there should not be any excess or built-up grease.
4. If consumables will be reused, use a clean cloth to wipe them off, and use compressed air to blow them off before they are installed again. This is especially critical for the nozzle retaining cap.

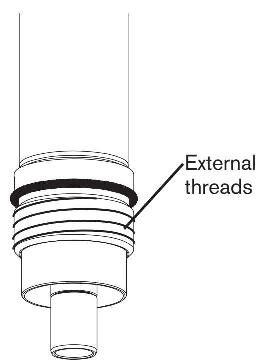


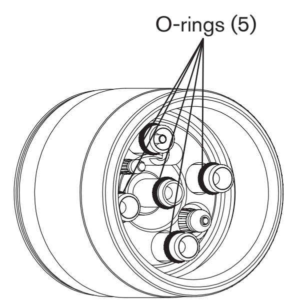
Front view of the torch

Quick-disconnect maintenance

The following steps should be completed every 5-10 times consumables are changed:

1. Remove the torch from the quick-disconnect assembly.
2. Use compressed air to blow off all internal surfaces and the external threads.
3. Use compressed air to blow off all internal surfaces at the rear of the torch.
4. Inspect each of the 5 o-rings at the rear of the torch for nicks or cuts. Replace any damaged o-rings. If they are not damaged, apply a thin film of silicone lubricant on each o-ring. The o-rings should look shiny, but there should not be any excess or built-up grease.



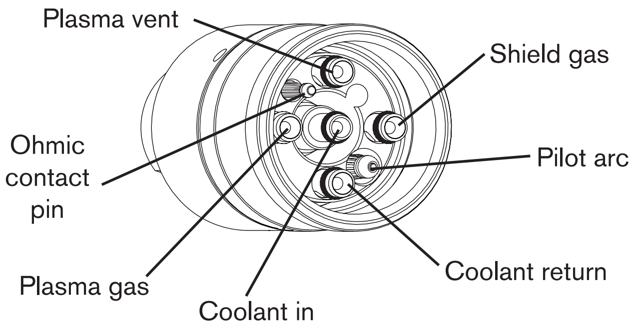


Rear view of the torch

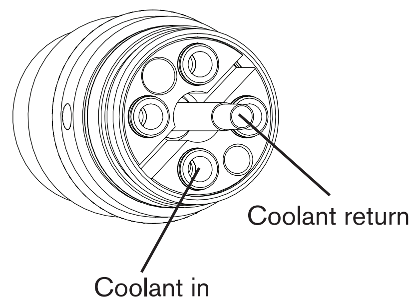
Maintenance kit

Even with proper care, the o-rings at the rear of the torch will need to be replaced periodically. Hypertherm provides a kit (128879) of replacement parts. Kits should be kept in stock and be used as part of your routine maintenance schedule.

Torch connections



Torch



Torch quick-disconnect receptacle

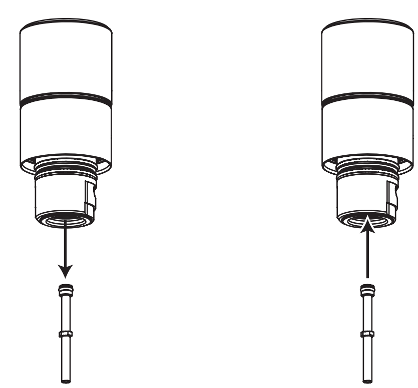
Replace torch water tube

	WARNING

The system is designed to go into an idle mode if the retaining cap is removed. However, DO NOT CHANGE CONSUMABLE PARTS WHILE IN THE IDLE MODE. Always disconnect power to the power supply before inspecting or changing torch consumable parts. Use gloves when removing consumables. The torch might be hot.

Note: The water tube may seem loose when correctly inserted, but any side-to-side looseness will disappear after the electrode is installed.

1. Turn OFF all power to the system.
2. Remove consumables from torch. See *Install and inspect consumables* in this section.
3. Remove the old water tube.
4. Apply a thin film of silicone lubricant on the o-ring, and install a new water tube. The o-ring should look shiny, but there should not be any excess or built-up grease.
5. Replace consumables. See *Install and inspect consumables* in this section.



Common cutting faults

- Torch pilot arc will initiate, but will not transfer. Causes can be:

  1. Work cable connection on the cutting table is not making good contact.
  2. Malfunction in the system. See Section 5.
  3. Torch-to-work distance is too high.

- The workpiece is not totally penetrated, and there is excessive sparking on top of the workpiece. Causes can be:

  1. Current is set too low (check *Cut chart* information).
  2. Cut speed is too high (check *Cut chart* information).
  3. Torch parts are worn (see *Install and inspect consumables*).
  4. Metal being cut is too thick.

- Dross forms on the bottom of the cut. Causes can be:

  1. Cutting speed is not correct (check *Cut chart* information).
  2. Arc current is set too low (check *Cut chart* information).
  3. Torch parts are worn (see *Install and inspect consumables*).

- Cut angle is not square. Causes can be:

  1. Wrong direction of machine travel.
     High-quality side is on the right with respect to the forward motion of the torch.
  2. Torch-to-work distance is not correct (check *Cut chart* information).
  3. Cutting speed is not correct (check *Cut chart* information).
  4. Arc current is not correct (check *Cut chart* information).
  5. Damaged consumable parts (see *Install and inspect consumables*).

- Short consumable life. Causes can be:

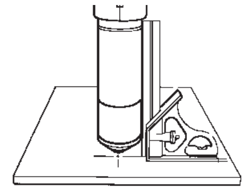
  1. Arc current, arc voltage, travel speed, motion delay, gas flow rates, or initial torch height not set as specified in the *Cut charts*.
  2. Attempting to cut highly magnetic metal plate, such as armor plate with a high nickel content, will shorten consumable life. Long consumable life is difficult to achieve when cutting plate that is magnetized or becomes magnetized easily.
  3. Beginning or ending the cut off the plate surface. **To achieve consumable long life, all cuts must begin and end on the plate surface**.

How to optimize cut quality

The following tips and procedures will help produce square, straight, smooth and dross-free cuts.

Tips for table and torch

- Use a square to align the torch at right angles to the workpiece.



- The torch may travel more smoothly if you clean, check and "tune" the rails and drive system on the cutting table. Unsteady machine motion can cause a regular, wavy pattern on the cut surface.

- The torch must not touch the workpiece during cutting. Contact can damage the shield and nozzle, and affect the cut surface.

Plasma set-up tips

Follow carefully each step in the *Daily start-up* procedure described earlier in this section.

Purge the gas lines before cutting.

Maximize the life of consumable parts

Hypertherm's LongLife® process automatically "ramps up" the gas and current flows at the start and ramps them down at the end of each cut, to minimize erosion of the electrode's center surface. The LongLife process also requires that cuts start and stop on the workpiece.

- The torch should never fire into the air.
  - Starting the cut at the edge of the workpiece is acceptable, as long as the arc is not fired in the air.
  - To start with a pierce, use a pierce height that is 1.5 to 2 times the torch-to-work distance. See *Cut charts.*

- Each cut should end with the arc still attached to the workpiece, to avoid arc blow-outs (ramp-down errors).
  - When cutting drop parts (small parts that drop down after being cut from the workpiece), check that the arc stays attached to the edge of the workpiece, for proper ramp-down.

- If arc blow-outs occur, try one or more of the following:
  - Reduce the cutting speed during the final part of the cut.
  - Stop the arc before the part is completely cut, to allow completion of the cut during the ramp-down.
  - Program the path of the torch into the scrap area for ramp-down.

    Note: Use a "chain cut" if possible, so the path of the torch can lead directly from one cut part into the next, without stopping and starting the arc. However, do not allow the path to lead off the workpiece and back on, and remember that a chain cut of long duration will cause electrode wear.

    Note: It may be difficult to achieve the full benefits of the LongLife process in some conditions.

Additional factors of cut quality

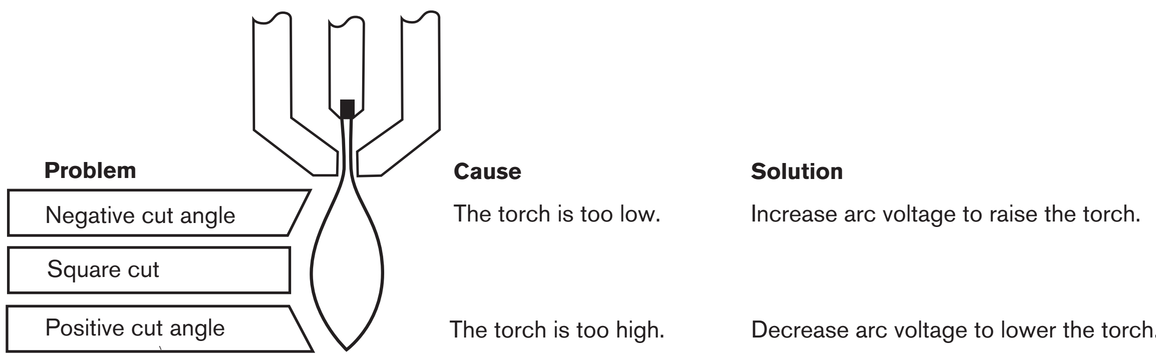
Cut angle

Note: The squarest cut angle will be on the right side with respect to the forward motion of the torch.

Note: To determine whether a cut-angle problem is being caused by the plasma system or the drive system, make a test cut and measure the angle of each side. Next, rotate the torch 90° in its holder and repeat the process. If the angles are the same in both tests, the problem is in the drive system.

If a cut-angle problem persists after “mechanical causes” have been eliminated (see *Tips for table and torch,* previous page), check the torch-to-work distance, especially if cut angles are all positive or all negative.

- A positive cut angle results when more material is removed from the top of the cut than from the bottom.
- A negative cut angle results when more material is removed from the bottom of the cut.



Dross

Low-speed dross forms when the torch's cutting speed is too slow and the arc shoots ahead. It forms as a heavy, bubbly deposit at the bottom of the cut and can be removed easily. Increase the speed to reduce the dross.

High-speed dross forms when the cutting speed is too fast and the arc lags behind. It forms as a thin, linear bead of solid metal attached very close to the cut. It is welded to the bottom of the cut and is difficult to remove. To reduce high-speed dross:

- Decrease the cutting speed.
- Decrease arc voltage, to decrease the torch-to-work distance.

Notes: Dross is more likely to form on warm or hot metal than on cool metal. For example, the first cut in a series of cuts will likely produce the least dross. As the workpiece heats up, more dross may form on subsequent cuts.

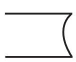
Dross is more likely to form on mild steel than on stainless steel or aluminum.

Worn or damaged consumables may produce intermittent dross.

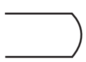
Straightness of the cut surface

A typical plasma cut surface is slightly concave.

The cut surface may become more concave, or convex. Correct torch height is required to keep the cut surface acceptably close to straight.



A strongly concave cut surface occurs when the torch-to-work distance is too low. Increase the arc voltage to increase the torch-to-work distance and straighten the cut surface.



A convex cut surface occurs when the torch-to-work distance is too great or the cutting current is too high. First, reduce the arc voltage, then reduce the cutting current. If there is overlap between different cutting currents for that thickness, try the consumables designed for the lower current.

Additional improvements

Some of these improvements involve trade-offs, as described.

Piercing

The pierce delay should allow sufficient time to penetrate the full thickness of the material, but not so long that it allows the arc to "wander" while trying to find the edge of a large pierce hole. As consumables wear, this delay time may need to be increased. Pierce delay times given in the cut charts are based on average delay times throughout the life of the consumables.

Using the "pierce complete" signal during piercing maintains the shield-gas pressure at the higher preflow pressure, which provides additional protection for the consumables (for example: 30 amp O_2/O_2 and 50 amp O_2/O_2 processes). The pierce complete signal must be turned off for processes with shield gas preflow pressures that are lower than the cutflow pressures (for example: 600 amp and 800 amp processes).

When piercing materials close to the maximum thickness for a specific process, there are several important factors to consider:

- Allow a lead-in distance that is about the same as the thickness of the material being pierced. 50 mm (2 in) material requires a 50 mm lead-in.
- To avoid damage to the shield from the build up of molten material created by the pierce, do not allow the torch to descend to cut height until it has cleared the puddle of molten material.
- When pre-piercing with the 400 amp O_2/air process, the arc should be on for a minimum of 4 seconds or the electrode may experience rapid wear. This 4 seconds allows the current to properly ramp-up and ramp-down which is required for the long life process. A small torch movement may be necessary if the peirce time is less than 4 seconds to keep the arc transferred to the plate.
- Different material chemistries can have an adverse effect on the pierce capability of the system. In particular, high-strength steel and steel with a high manganese or silicon content can reduce the maximum pierce capability. Hypertherm calculates mild steel pierce parameters with certified A-36 plate.
- If the system has difficulty piercing a specific material or thickness, increasing the shield preflow pressure can help in some cases.
  Trade-off: This may reduce starting reliability.
- Using a "moving pierce" or "flying pierce" (starting torch motion immediately after transfer and during the pierce process) can extend the piercing capability of the system in some cases. Because this can be a complex process that can damage the torch, lifter, or other components, an edge start is recommended unless the operator is experienced with this technique.

How to increase cutting speed

- Decrease the torch-to-work distance.
  Trade-off: This will increase the negative cut angle.

  Note: The torch must not touch the workpiece while piercing or cutting.

Cut charts

The following *Cut charts* show the consumable parts, cutting speeds and the gas and torch settings required for each process.

The numbers shown in the *Cut charts* are recommended to provide high-quality cuts with minimal dross. Because of differences between installations and material composition, adjustments may be required to obtain desired results.

Thin stainless steel with HDi technology

Overview

The HPRXD family of plasma cutting systems offers a HyDefinition inox (HDi) 60 A cutting process for thin stainless steel that produces high quality cuts with minimal dross. Specifically, it enables operators to achieve:

- A sharp, top edge of the cut
- A shiny surface finish
- Good cut-edge angularity

You can use these 60 A stainless steel settings with your existing HPRXD system along with the following three new consumables:

- 220814 (nozzle retaining cap)
- 220815 (shield)
- 220847 (nozzle)

The cut charts and consumables for the 60 A stainless steel process can be used with both automatic and manual gas consoles.

Recommendations

Hypertherm develops stainless steel processes using SAE grade 304L. When cutting other grades of stainless steel, you may need to adjust the cut chart parameters to obtain optimal cut quality. In order to reduce the amount of dross, the first recommended adjustment is to adjust the cut speed. Dross can also be reduced by increasing the shield cut flow setting. Both of these adjustments may change the angle of the cut edge.

Cut charts

The HDi charts are listed by amperage with the other stainless steel cut charts.

Thick stainless steel piercing technique

Overview

Hypertherm has developed a technique for extending the stainless steel piercing capability of the HPR400XD and HPR800XD systems:

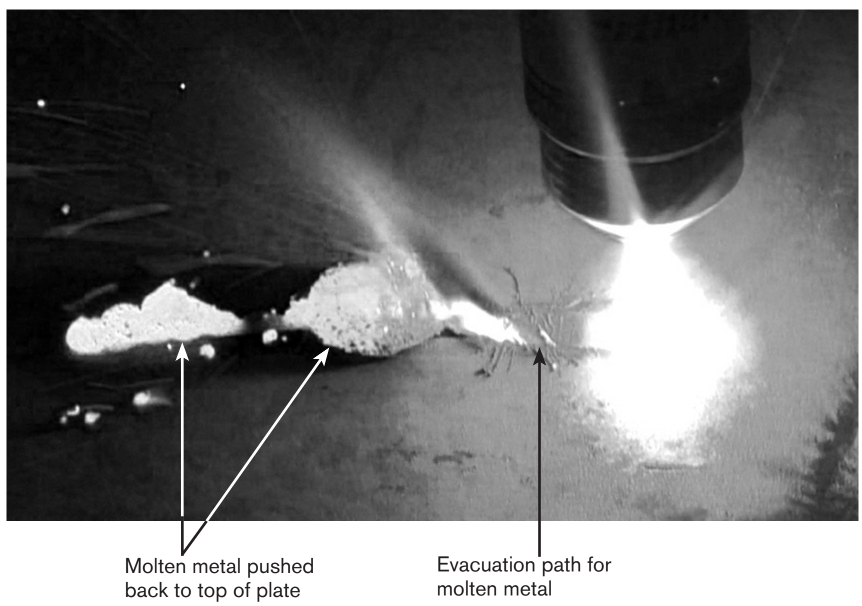
- The HPR400XD can now perform a moving pierce on stainless steel workpieces 75 mm (3 inches) thick.
- The HPR800XD can now perform a moving pierce on stainless steel workpieces 100 mm (4 inches) thick.

The moving pierce technique (sometimes referred to as a "flying pierce" or "running pierce") enables operators to cut through thick plates using their plasma systems, without having to resort to other methods such as drilling. It starts torch motion immediately after transfer and during the pierce process.

While the parameters for this moving pierce process are built into Hypertherm's CNC software and nesting software, the information is available to all HPRXD customers and can be used with other compatible CNCs and nesting software programs.

How moving pierce works

The moving pierce method uses a combination of torch height control, table motion, and plasma current adjustments to form a path in the plate through which the molten metal can flow safely away from the torch. This is accomplished through a series of defined segment lengths and speeds that are synchronized with torch lifter motion. In this way, the molten material can be kept as far from the torch as possible while also maintaining a sustainable arc voltage.



Operators should plan the direction of the moving pierce in their part geometry so that this "rooster tail" of molten metal and hot gases does not get directed at themselves or at the gantry, torch lifter, controller, other torches, or other sensitive equipment. As the molten metal is fed to the side of the torch in the opposite direction of the table motion, most of it gets deposited on top of the plate. Once the arc penetrates the plate, operators can use the standard settings for cutting.

Note: Different material chemistries can have an adverse effect on the pierce capability of the system. The moving pierce settings detailed in this document were developed using 304L stainless steel.

For details on the sequencing involved in coordinating the torch height and table motion in order to perform this type of moving pierce, refer to the *Moving Pierce Technique* white paper (part number 807840), which can be found in the "Downloads library" on the Hypertherm website at www.hypertherm.com. There you can also find a *Thick Metal Cutting Techniques* white paper (part number 807850), which contains technical details on other techniques for cutting thick metal, including the dogleg lead-out technique, that Hypertherm offers as enhancements to its HPRXD systems.

WARNING

The "rooster tail" of molten material and hot gases produced by this moving pierce technique can result in injury, fire, and damage to equipment if appropriate precautions are not taken.

You may be required to use guards to protect operators and to prevent the molten metal from reaching any flammable materials.

Requirements

- This stainless steel moving pierce technique is specific to the HPR400XD and HPR800XD systems.
- Using this technique with the HPR400XD requires an automatic gas console.
- The "pierce complete" (or "pierce control") signal must be turned off for these processes when the shield gas preflow pressure is lower than the shield gas cutflow pressure.
- This moving pierce technique requires a torch height control (THC) system that is controllable through the CNC.

Moving pierce cut charts

The moving pierce cut charts are listed by amperage with the other stainless steel cut charts. They show the consumable parts, the segment lengths and speeds, and the torch, motion, and plasma current settings that are used to perform the moving pierce for each process.

Once the pierce is complete, cutting can continue with the standard cut chart settings for the 400 A or 800 A stainless steel process as defined in the *Operation* section of your *HPR400XD Instruction Manual* or *HPR800XD Instruction Manual.*

Fine Feature cutting

Overview

Hypertherm has developed the following processes specifically for cutting mild steel in the 3 mm to 25 mm (0.135 to 1 inch) range of thicknesses. These cut chart settings offer a set of optimal parameters for each thickness and are designed to achieve:

- Minimum angle deviation
- A sharp top edge
- A visibly smooth, low-gloss finish

Note: All of these Fine Feature cut chart processes were developed for the automatic gas console.

Benefits and trade-offs

These Fine Feature processes are ideally suited for jobs in which the greatest importance is placed on achieving the best possible finish on the cut surface, a sharp top edge, and tighter control on angle deviation.

When these Factors are not critical, refer to the standard quality cut charts in your HPRXD Instruction Manual, which provide the greatest balance between cut quality and productivity.

In a few cases, two processes are given for a single thickness when performance trade-offs should be considered, such as between the top-edge quality and the angle of the cut. In general, use the lower amperage process for the best edge quality and the higher amperage process for the best dross-free cutting performance.

The Fine Feature processes use standard (straight) cutting consumables designed to work best when the torch is perpendicular to the workpiece. Operators can expect to achieve the same consumable life they currently get using comparable amperage processes with the standard quality cut charts.

Note: The “pierce complete” (or “pierce control”) signal must be turned off when the shield gas preflow pressure is lower than the shield gas cutflow pressure (for example, the 80 A processes in the following cut chart).

Recommendations

- Looping corners can be helpful in achieving sharper corners and in some cases minimizing or eliminating low-speed dross.
- In most cases, these Fine Feature processes employ lower torch-to-work distances than those in the standard quality cut charts, so a flat and properly leveled workpiece will produce optimal results. Pre-piercing and subsequent cleaning of the pierce puddles is recommended, whenever possible.

Cut charts

The Fine Feature cut chart is listed at the beginning of the mild steel cut charts because it has a range of 30 A to 260 A. It is displayed in two separate tables and is sorted by material thickness: the first table lists the consumable part numbers to use for each process (metric and English); the second table shows the cutting speeds and the gas and torch settings required for each process (metric and English).

Note: The marking parameters for the Fine Feature processes covered in this section will be the same as those detailed in the standard quality mild steel cut charts, which are found in the *Operation* section of your HPRXD Instruction Manual.

Bevel cutting

Cut charts

The bevel cut charts are slightly different from the standard cut charts. The torch-to-work distance is a range rather than a single value, material thickness is given as an equivalent value, a column for minimum clearance has been added, and there is no column for arc voltage.

Equivalent thicknesses and the arc voltages will vary depending on the angle of the cut. The angle for bevel cutting can range from 0° to 45°.

Consumables

Bevel cutting processes use separate sets of consumables that are specially designed for bevel applications. These consumables have been optimized for PowerPierce™, which uses the tapered design to increase pierce capabilities.

See the *Parts list* for mirror-image consumable part numbers.

Bevel compensation tables

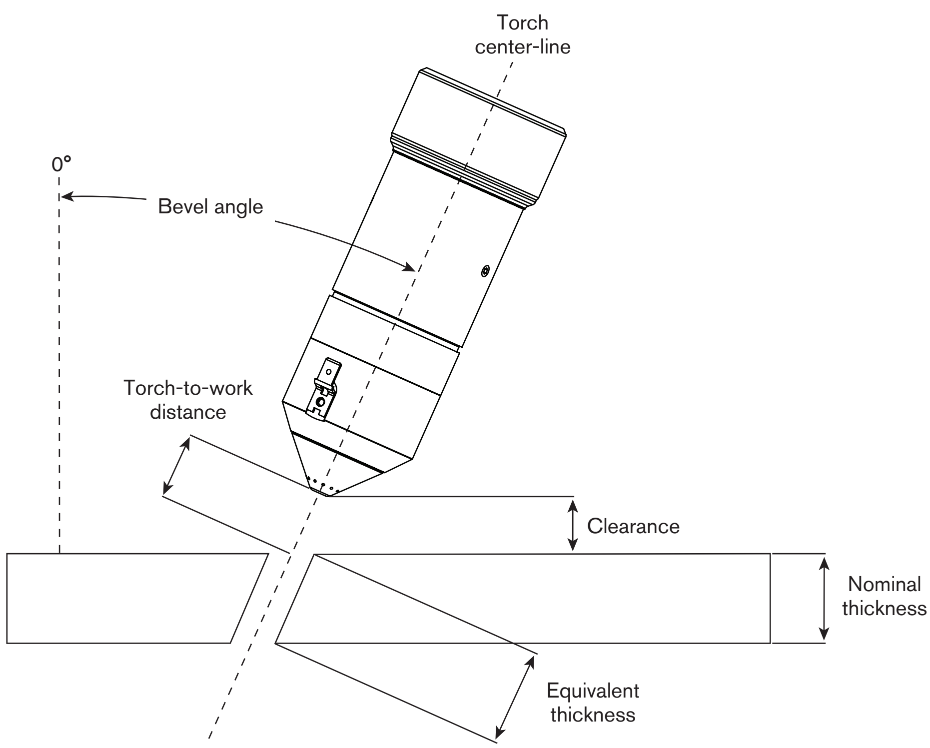
Customers using bevel heads with an HPRXD plasma-cutting system are now able to use dynamic cut charts (or compensation tables) with compatible CNC and nesting software to achieve more accurate bevel cutting results with mild steel. These specialized cut charts enable operators to retrieve bevel cut settings that are specially tailored for making V cuts, A cuts, and Y Top cuts.

The bevel compensation tables require an HPRXD plasma-cutting system and are intended to be used for cutting mild steel. While these tables are built into Hypertherm's CNC software and nesting software, the information is available to all HPRXD customers and can be used with other compatible CNCs and nesting software programs. For technical details on how to use these compensation tables for mild steel bevel cutting, refer to the HPRXD *Bevel Compensation Cut Charts* white paper (part number 807830), which can be found in the "Downloads library" on the Hypertherm website at www.hypertherm.com.

See *Bevel cutting definitions* on the next page for more detailed information.

Bevel cutting definitions

Bevel angle	The angle between the center line of the torch and a line that is perpendicular to the workpiece. If the torch is perpendicular to the workpiece, the bevel angle is zero. The maximum bevel angle is 45°.
Nominal thickness	The vertical thickness of the workpiece.
Equivalent thickness	The length of the cut edge, or the distance the arc travels through the material while cutting. Equivalent thickness is equal to the nominal thickness divided by the cosine of the bevel angle. Equivalent thicknesses are listed in the cut chart.
Clearance	The vertical distance from the lowest point of the torch to the surface of the workpiece.
Torch-to-work distance	The linear distance from the center of the torch outlet to the workpiece surface along the torch center-line. A range of torch-to-work distances are listed in the cut chart. The smallest number is for a straight cut (bevel angle = 0°). The largest number is for a 45° bevel cut with a clearance of 3 mm (0.120 in).
Arc voltage	The arc voltage setting is dependent on the bevel angle and the setup of the cutting system. The arc voltage setting on one system may be different from a second system even if the workpiece is the same thickness. The arc voltages for bevel cutting are not supplied in the bevel cut charts.



Underwater cut charts

Overview

Hypertherm has developed underwater cut charts for 80 A, 130 A, 200 A, 260 A, and 400 A mild steel processes. These underwater cut charts are designed to produce optimal results for cutting mild steel up to 75 mm (3 inches) below the surface of the water.

Benefits and trade-offs

Underwater cutting can significantly reduce the level of noise and smoke generated by normal plasma cutting, as well as the glare of the plasma arc. Underwater operation provides the maximum possible noise suppression over the widest possible range of current levels. For example, you can expect noise levels to stay below 70 decibels for many processes when cutting up to 75 mm (3 inches) below the surface of the water. Operators can expect exact noise levels to vary depending on the table design and the cutting application being used.

However, underwater cutting can limit the visual and auditory signals that experienced operators may use while cutting to ensure they are getting a high quality cut and the cutting process is proceeding as it should. Underwater cutting can also affect the cut edge quality, resulting in a rougher surface finish with increased dross levels.

WARNING!

Explosion hazard – underwater cutting with fuel gases or aluminum

Do not cut under water with fuel gases containing hydrogen. Do not cut aluminum alloys underwater or on a water table unless you can prevent the accumulation of hydrogen gas.

Doing so can result in an explosive condition that can detonate during plasma cutting operations.

All underwater processes (80–400 A) use consumables that are designed for standard (straight) cutting, when the torch is perpendicular to the workpiece.

Requirements and restrictions

- These processes are specifically designed for cutting mild steel up to 75 mm (3 inches) below the surface of the water. Do not attempt to cut in water if the surface of the workpiece is deeper than 75 mm (3 inches).
- The True Hole™ process is not compatible with underwater cutting. If you are using a water table with the True Hole process, the water level should be at least 25 mm (1 inch) below the bottom surface of the workpiece.
- Preflow must be on during initial height sense (IHS) for all underwater cutting.
- Ohmic contact cannot be used for underwater cutting.

Operators should disable ohmic contact from the CNC. For example, if you are using a Hypertherm CNC and torch height control (THC) system, you can disable ohmic contact sensing by switching the Nozzle Contact IHS setting to OFF. The system then defaults to stall force sensing as a backup for torch height control.

The use of stall force sensing is not as accurate as ohmic contact sensing, so operators may need to optimize the stall force setting and/or the cut height setting (or torch-to-work distance) to compensate for possible workpiece deflection. That is, the stall force value should be set high enough to avoid false stall detection but not so high that the excess force causes a deflection of the workpiece and inaccurate IHS operation. In this example, the cut height value can be adjusted from the cut chart, while the stall force value can be adjusted from the THC setup parameters.

Refer to the instruction manuals for your Hypertherm CNC and THC systems for more details on setting the stall force threshold or on disabling ohmic contact. Alternative CNCs and THC systems can also be set up for underwater cutting.

Cut charts

The underwater cut charts are listed by amperage with the other mild steel cut charts.

Estimated kerf-width compensation

The widths in the chart below are for reference. Differences between installations and material composition may cause actual results to vary from those shown in the table. N/A = data not available.

Metric

Process	Thickness (mm)																	
	1.5	3	5	6	8	10	12	15	20	25	30	32	38	40	50	60	70	80
Mild steel																		
400A O_2 / Air	N/A	N/A	N/A	N/A	N/A	N/A	3.40	3.50	3.68	3.76	4.06	N/A	N/A	4.88	5.94	6.60	7.80	9.10
260A O_2 / Air	N/A	N/A	N/A	2.54	2.54	2.54	2.79	3.43	3.56	3.91	N/A	4.32	4.45	N/A	5.72	N/A	N/A	N/A
200A O_2 / Air	N/A	N/A	1.93	1.98	2.09	2.20	2.26	2.61	2.95	3.16	N/A	4.19	4.87	N/A	5.45	N/A	N/A	N/A
130A O_2 / Air	N/A	1.64	1.77	1.81	1.92	2.04	2.11	2.22	2.65	3.43	N/A	4.26	4.59	N/A	N/A	N/A	N/A	N/A
80A O_2 / Air	N/A	1.37	1.53	1.73	1.79	1.91	2.00	2.11	2.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
50A O_2 / O_2	1.52	1.74	1.86	1.86	2.09	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30A O_2 / O_2	1.35	1.45	1.54	1.56	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stainless steel																		
400A N_2 / Air	N/A	N/A	N/A	N/A	N/A	N/A	3.00	2.90	2.80	3.10	3.30	N/A	N/A	5.00	N/A	N/A	N/A	N/A
400A H35 / N_2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	5.10	5.30	5.45	N/A	N/A	5.50	5.80	6.35	N/A	N/A
400A H35 and N_2 / N_2	N/A	N/A	N/A	N/A	N/A	N/A	3.90	4.00	4.20	4.45	4.65	N/A	N/A	5.15	5.65	5.90	6.35	6.95
260A H35 and N_2/ N_2	N/A	N/A	N/A	2.34	3.02	3.71	3.80	3.82	4.32	4.34	N/A	4.58	4.77	N/A	5.63	N/A	N/A	N/A
260A N_2 / Air	N/A	N/A	N/A	2.31	2.39	2.46	2.54	2.76	3.08	3.30	N/A	3.64	4.43	N/A	4.16	N/A	N/A	N/A
260A H35 / N_2	N/A	N/A	N/A	N/A	3.84	3.83	3.81	3.81	4.06	4.32	N/A	4.53	4.70	N/A	7.46	N/A	N/A	N/A
200A N_2 / N_2	N/A	N/A	N/A	N/A	2.10	2.16	2.29	2.47	2.92	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
200A H35 / N_2	N/A	N/A	N/A	N/A	3.66	3.68	3.81	3.68	3.94	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
200A H35 and N_2/ N_2	N/A	N/A	N/A	N/A	3.05	3.05	3.05	2.88	3.30	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130A H35 / N_2	N/A	N/A	N/A	N/A	2.69	2.72	2.77	3.03	2.90	3.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130A N_2 / N_2	N/A	N/A	N/A	1.83	1.89	1.88	2.42	2.51	3.00	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130A H35 and N_2/ N_2	N/A	N/A	N/A	1.78	2.25	2.73	2.76	3.03	2.90	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
80A F5 / N_2	N/A	N/A	1.02	1.20	1.05	0.96	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
45A F5 / N_2	0.59	0.38	0.52	0.54	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
45A N_2 / N_2	0.49	0.23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Metric

Process	Thickness (mm)																	
	1.5	3	5	6	8	10	12	15	20	25	30	32	38	40	50	60	70	80
Aluminum																		
400A N_2 / Air	N/A	N/A	N/A	N/A	N/A	N/A	3.50	3.60	3.70	3.90	4.00	N/A	N/A	4.00	7.60	N/A	N/A	N/A
400A H35 / N_2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	4.20	4.30	4.30	N/A	N/A	4.45	5.40	7.05	8.00	8.15
400A H35 and N_2 / N_2	N/A	N/A	N/A	N/A	N/A	N/A	3.55	3.65	3.80	3.80	4.20	N/A	N/A	4.45	4.55	6.15	6.85	7.10
260A N_2 / Air	N/A	N/A	N/A	2.49	2.73	2.97	3.05	2.91	3.05	3.30	N/A	2.87	3.99	N/A	5.66	N/A	N/A	N/A
260A H35 / N_2	N/A	N/A	N/A	2.64	2.64	2.62	2.79	3.09	3.30	3.56	N/A	3.29	3.60	N/A	5.37	N/A	N/A	N/A
200A N_2 / N_2	N/A	N/A	N/A	N/A	1.78	2.03	2.58	2.54	3.01	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
200A H35 / N_2	N/A	N/A	N/A	N/A	2.44	2.67	2.92	3.18	3.30	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
200A H35 and N_2/ N_2	N/A	N/A	N/A	N/A	2.79	2.92	3.05	3.30	3.81	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130A H35 / N_2	N/A	N/A	N/A	N/A	2.70	2.72	2.77	2.36	2.90	1.72	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130A Air / Air	N/A	N/A	N/A	2.09	2.09	2.10	2.19	1.91	1.87	2.23	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130A H35 and N_2/ N_2	N/A	N/A	N/A	2.06	2.39	2.73	2.76	2.00	2.90	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
45A Air / Air	1.07	1.10	1.25	1.25	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

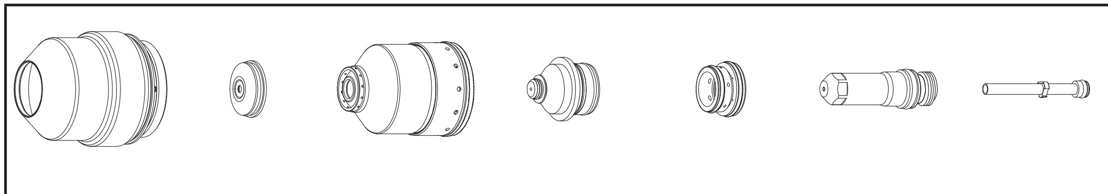
English

Process	Thickness (in)															
	0.060	0.135	1/4	5/16	3/8	1/2	5/8	3/4	1.0	1-1/4	1-1/2	1-3/4	2.0	2-1/4	2-1/2	3.0
Mild steel																
400A O_2 / Air	N/A	N/A	N/A	N/A	N/A	0.135	0.140	0.145	0.148	0.164	0.183	0.215	0.237	0.250	0.275	0.340
260A O_2 / Air	N/A	N/A	0.100	0.100	0.100	0.110	0.115	0.135	0.150	0.170	0.175	0.220	0.225	0.240	0.260	N/A
200A O_2 / Air	N/A	N/A	0.078	0.082	0.086	0.089	0.108	0.116	0.125	0.164	0.192	N/A	0.216	N/A	N/A	N/A
130A O_2 / Air	N/A	0.066	0.071	0.076	0.080	0.083	0.089	0.104	0.135	0.167	0.181	N/A	N/A	N/A	N/A	N/A
80A O_2 / Air	N/A	0.054	0.068	0.070	0.075	0.080	0.084	0.102	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
50A O_2 / O_2	0.060	0.063	0.073	0.082	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
30A O_2 / O_2	0.053	0.057	0.067	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Stainless steel																
400A N_2 / Air	N/A	N/A	N/A	N/A	N/A	0.118	0.116	0.112	0.122	0.132	0.198	0.235	N/A	N/A	N/A	N/A
400A H35 / N_2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.200	0.210	0.215	0.218	0.220	0.230	0.245	0.255	N/A
400A H35& N_2 / N_2	N/A	N/A	N/A	N/A	N/A	0.135	0.160	0.165	0.175	0.185	0.200	0.210	0.225	0.230	0.235	0.265
260A H35 and N_2/ N_2	N/A	N/A	0.092	0.119	0.145	0.151	0.151	0.170	0.171	0.180	0.188	0.197	0.225	N/A	N/A	N/A
260A N_2 / Air	N/A	N/A	0.091	0.094	0.100	0.100	0.120	0.120	0.130	0.142	0.175	0.223	0.155	N/A	N/A	N/A
260A H35 / N_2	N/A	N/A	N/A	0.150	0.151	0.165	0.170	0.177	0.182	0.184	0.185	0.202	0.307	N/A	N/A	N/A
200A N_2 / N_2	N/A	N/A	N/A	0.083	0.085	0.090	0.100	0.115	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
200A H35 / N_2	N/A	N/A	N/A	0.144	0.145	0.150	0.152	0.155	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
200A H35 and N_2/ N_2	N/A	N/A	N/A	0.120	0.120	0.120	0.111	0.130	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130A H35 / N_2	N/A	N/A	N/A	0.115	0.121	0.123	0.124	0.125	0.129	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130A N_2 / N_2	N/A	N/A	0.072	0.074	0.083	0.095	0.100	0.118	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130A H35 and N_2/ N_2	N/A	N/A	0.070	0.089	0.107	0.109	0.123	0.114	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
80A F5 / N_2	N/A	0.032	0.047	0.050	0.052	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
45A F5 / N_2	0.023	0.015	0.021	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
45A N_2 / N_2	0.019	0.009	0.006	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Aluminum																
400A N_2 / Air	N/A	N/A	N/A	N/A	N/A	0.140	0.143	0.145	0.155	0.160	0.160	0.230	0.300	N/A	N/A	N/A
400A H35 / N_2	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0.164	0.170	0.170	0.170	0.190	0.215	0.250	0.310	0.318
400A H35& N_2 / N_2	N/A	N/A	N/A	N/A	N/A	0.140	0.145	0.150	0.150	0.170	0.175	0.175	0.180	0.225	0.263	0.276
260A N_2 / Air	N/A	N/A	0.098	0.107	0.120	0.120	0.120	0.120	0.130	0.145	0.158	0.193	0.227	N/A	N/A	N/A
260A H35 / N_2	N/A	N/A	0.104	0.104	0.105	0.110	0.126	0.130	0.140	0.141	0.142	0.222	0.210	N/A	N/A	N/A
200A N_2 / N_2	N/A	N/A	N/A	0.070	0.080	0.090	0.100	0.105	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
200A H35 / N_2	N/A	N/A	N/A	0.096	0.105	0.115	0.125	0.130	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
200A H35 and N_2/ N_2	N/A	N/A	N/A	N/A	0.115	0.120	0.130	0.150	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130A H35 / N_2	N/A	N/A	N/A	0.106	0.107	0.109	0.112	0.114	0.120	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130A Air / Air	N/A	N/A	0.082	0.082	0.082	0.086	0.071	0.071	0.089	N/A	N/A	N/A	N/A	N/A	N/A	N/A
130A H35 and N_2/ N_2	N/A	N/A	0.081	0.094	0.107	0.109	0.067	0.114	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
45A Air / Air	0.042	0.043	0.049	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

Mild steel Fine Feature Consumables

30 A to 260 A

Metric



Material Thickness	Current	Select Gases		Shield Cap	Shield	Nozzle Retaining Cap	Nozzle	Swirl Ring	Electrode	Water Tube
mm	Amps	Plasma gas	Shield gas	Part Number						
3 4 5 6	30	O_2	O_2	220747	220194	220754	220193	220180	220192	220340
5 6	50	O_2	O_2	220747	220555	220754	220554	220553	220552	220340
7 8 9 10	80	O_2	Air	220747	220189	220756	220188	220179	220187	220340
10 12	130	O_2	Air	220747	220183	220756	220182	220179	220181	220340
15 16 20	200	O_2	Air	220637	220761	220757	220354	220353	220352	220340
20 22 25	260	O_2	Air	220637	220764	220760	220439	220436	220435	220340

Mild steel Fine Feature Cutting

30 A to 260 A

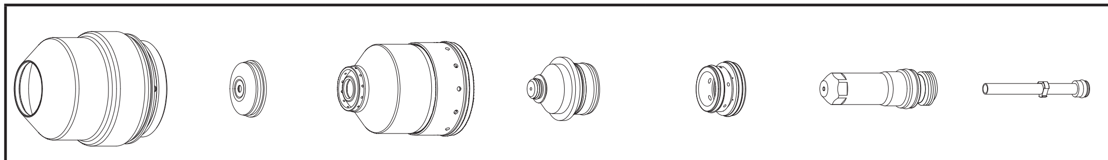
Metric

Material Thickness	Current	Select Gases		Set Preflow		Set Cutflow		Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pirece Height		Pierce Delay Time
mm	**Amps**	Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Volts	mm	mm/m	mm	Factor %	Seconds
3	**30**	O_2	O_2	78	75	94	7	119	1.5	1160	2.7	180	0.5
4								124		905			0.7
5								125		744			0.9
6								128		665			1.0
5	**50**	O_2	O_2	70	30	81	14	123	1.5	1200	3.0	200	0.4
6								128	2.0	950	4.0		0.5
7	**80***	O_2	Air	48	23	78	25	119	1.5	2286	4.1	267	0.4
8										2240			
9								121		1987			0.5
10								122		1733			
10	**130**	O_2	Air	32	32	84	27	129	2.3	2437	6.1	267	0.3
12							25	132	2.5	1935	6.6	260	0.5
15	**200**	O_2	Air	23	42	74	15	130	2.0	1778	8.1	400	0.6
16													
20								132	2.3	1678		356	0.8
20	**260**	O_2	Air	22	49	80	47	157	2.3	2032	8.9	389	0.6
22							49	162	3.6	1905		250	0.7
25						84		168		1651			0.8

Note: *The pierce complete signal must be turned off for the 80 A processes.

Mild steel Fine Feature Consumables

30 A to 260 A



English

Material Thickness	Current	Select Gases		Shield Cap	Shield	Nozzle Retaining Cap	Nozzle	Swirl Ring	Electrode	Water Tube
in	Amps	Plasma gas	Shield gas	Part Number						
0.135 3/16	**30**	O_2	O_2	220747	220194	220754	220193	220180	220192	220340
1/4	**50**	O_2	O_2	220747	220555	220754	220554	220553	220552	220340
5/16 3/8	**80**	O_2	Air	220747	220189	220756	220188	220179	220187	220340
3/8 1/2	**130**	O_2	Air	220747	220183	220756	220182	220179	220181	220340
5/8 3/4	**200**	O_2	Air	220637	220761	220757	220354	220353	220352	220340
3/4 7/8 1	**260**	O_2	Air	220637	220764	220760	220439	220436	220435	220340

Mild steel Fine Feature Cutting

30 A to 260 A

English

Material Thickness	Current	Select Gases		Set Preflow		Set Cutflow		Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pirece Height		Pierce Delay Time
in	**Amps**	Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Volts	in	ipm	in	Factor %	Seconds
0.135	**30**	O_2	O_2	78	75	94	7	123	0.06	40	0.11	180	0.5
3/16								128		30			0.7
1/4	**50**	O_2	O_2	70	30	81	14	125	0.08	35	0.16	200	0.5
5/16	**80***	O_2	Air	48	23	78	25	119	0.06	90	0.16	267	0.4
3/8								121		70			0.5
3/8	**130**	O_2	Air	32	32	84	27	128	0.09	98	0.24	267	0.3
1/2							25	132	0.10	70	0.26	260	0.5
5/8	**200**	O_2	Air	23	42	74	14	130	0.08	70	0.32	400	0.6
3/4							15		0.09			356	0.8
3/4	**260**	O_2	Air	22	49	80	47	158	0.09	80	0.35	389	0.6
7/8							49	166	0.14	75		250	0.7
1						84		171		65			0.8

Note: *The pierce complete signal must be turned off for the 80 A processes.

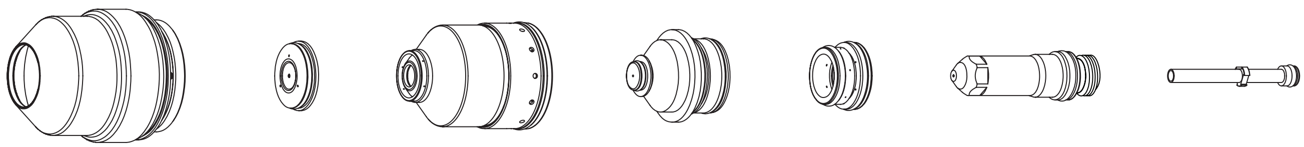
Mild steel

O_2 Plasma / O_2 Shield

30 A

Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	43 / 90
Cutflow	25 / 52	0 / 0

Note: Air must be connected to use this process. It is used as the preflow gas.



220747 220194 220754 220193 220180 220192 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
O_2	O_2	78	17	94	17	**0.5**	114	1.3	5355	2.3	180	0.1
						0.8	115		4225			0.2
						1	116		3615			0.3
						1.2	117		2865			
						1.5	119		2210			
			35		7	**2**	120	1.5	1490	2.7		0.4
						2.5	122		1325			
			75			**3***	123		1160			0.5
						4*	125		905			0.7
						6*	128		665			1.0

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
O_2	O_2	78	17	94	17	**0.018**	114	0.05	215	0.09	180	0.1
						0.024			200			
						0.030	115		170			0.2
						0.036	116		155			0.3
						0.048	117		110			
						0.060	119		85			
			35		7	**0.075**	120	0.06	60	0.11		0.4
						0.105	122		50			
			75			**0.135***	123		40			0.5
						3/16*	128		30			0.7
						1/4*			25			1.0

Marking

Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**15**	2.5	0.10	6350	250	105
Ar	Air	90	10	90	10	**9**	2.5	0.10	2540	100	80

* Pierce complete is recommended for these thicknesses.

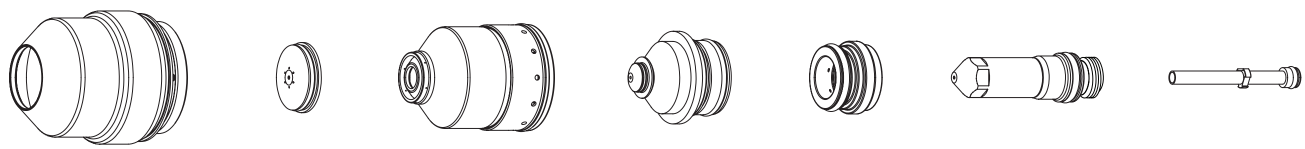
Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	43 / 90
Cutflow	25 / 52	0 / 0

Mild steel

O_2 Plasma / O_2 Shield

50 A

Note: Air must be connected to use this process. It is used as the preflow gas.



220747 220555 220754 220554 220553 220552 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
						0.8	110		6500			
						1	111	1.0	5000	2.0		
						1.2	112		4150			0.0
						1.5	114		3200			
						2	115	1.3	2700	2.6		
						2.5	117		2200			0.1
O_2	O_2	70	30	81	14	**3**	119		1800		200	0.2
						4	121	1.5	1400	3.0		0.3
						5	122		1200			0.4
						6	126		950			
						7	128	2.0	780	4.0		0.5
						8	130		630			

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
						0.030	110		270			
						0.036		0.04	210	0.08		
						0.048	112		160			0.0
						0.060	114		125			
O_2	O_2	70	30	81	14	**0.075**	115	0.05	110	0.10	200	
						0.105	118		80			0.1
						0.135	120	0.06	60	0.12		0.2
						3/16	121		50			0.3
						1/4	125	0.08	35	0.16		0.5
						5/16	130		25			

Marking

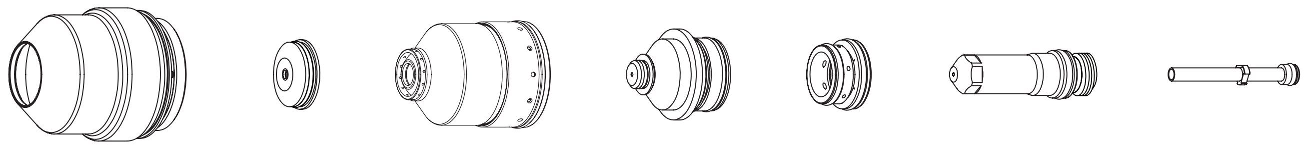
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**15**	2.5	0.10	6350	250	118
Ar	Air	90	10	90	10	**9**	2.5	0.10	2540	100	77

Mild steel

O_2 Plasma / Air Shield

80 A

Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	76 / 161
Cutflow	23 / 48	41 / 87



220747 220189 220756 220188 220179 220187 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	factor %	seconds
O_2	Air	48	23	78	23	**2**	112	2.5	9810	3.8	150	0.1
						2.5	115		7980			
						3	117		6145			0.2
						4	120	2.0	4300	4.0	200	
						5	121		3670			0.3
						6	123		3045			
						8	125		2430			0.4
						10	127		1810			0.5
					10	**12**	130		1410	5.0	250	0.7
						15	133		1030			0.8
						20	135	2.5	545	6.3		0.9

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	factor %	seconds
O_2	Air	48	23	78	23	**0.075**	112	0.10	400	0.15	150	0.1
						0.105	115		290			
						0.135	117		180			0.2
						3/16	120	0.08	155	0.16	200	
						1/4	123		110			0.3
						5/16	125		96			0.4
						3/8	127		75			0.5
					10	**1/2**	130		50	0.20	250	0.7
						5/8	133		37			0.8
						3/4	135	0.10	25	0.25		0.9

Marking

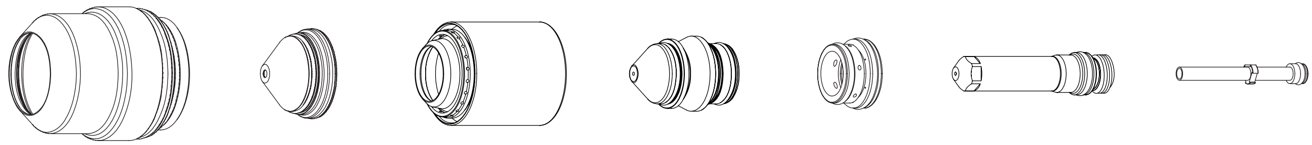
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**15**	2.5	0.10	6350	250	130
Ar	Air	50	10	50	10	**15**	3.0	0.12	2540	100	78

Mild steel bevel cutting

O_2 Plasma / Air Shield

80 A

Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	47 / 100
Cutflow	23 / 48	47 / 100



220637 220742 220845 220806 220179 220802 220700

Metric

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	mm	**mm**	Range (mm)	mm/m	mm	factor %	seconds
O_2	Air	48	39	78	39	2.0	**2**	2.5 – 8.6	9810	3.8	150	0.1
							2.5		7980			
							3		6145			0.2
							4	2.0 – 8.6	4300	4.0	200	
							5		3670			0.3
							6		3045			
							8		2430			0.4
							10		1810			0.5
					17		**12**		1410	5.0	250	0.7
							15		1030			0.8
							20	2.5 – 8.6	545	6.3		0.9

English

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	in	**in**	Range (in)	ipm	in	factor %	seconds
O_2	Air	48	39	78	39	0.08	**0.075**	0.1 – 0.34	400	0.15	150	0.1
							0.105		290			
							0.135		180			0.2
							3/16	0.08 – 0.34	155	0.16	200	
							1/4		110			0.3
							5/16		96			0.4
							3/8		75			0.5
					17		**1/2**		50	0.20	250	0.7
							5/8		37			0.8
							3/4	0.1 – 0.34	25	0.25		0.9

Marking

Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**15**	2.5	0.10	6350	250	130
Ar	Air	50	10	50	10	**15**	3.0	0.12	2540	100	78

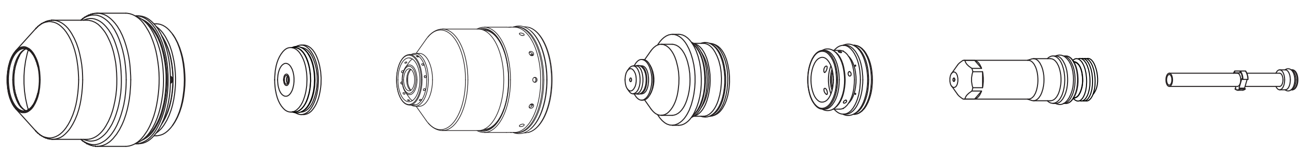
Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	76 / 161
Cutflow	23 / 48	41 / 87

Mild steel underwater cutting

No more than 75 mm (3 in) below the surface of the water

O_2 Plasma / Air Shield

80 A



220747 220189 220756 220188 220179 220187 220340

Metric

<table>
<tr><th colspan="2">Select Gases</th><th colspan="2">Set Preflow</th><th colspan="2">Set Cutflow</th><th>Material Thickness</th><th>Arc Voltage</th><th>Torch-to-Work Distance</th><th>Cutting Speed</th><th colspan="2">Initial Pierce Height</th><th>Pierce Delay Time</th></tr>
<tr><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>mm</th><th>Volts</th><th>mm</th><th>mm/m</th><th>mm</th><th>factor %</th><th>seconds</th></tr>
<tr><td rowspan="7">O_2</td><td rowspan="7">Air</td><td rowspan="7">48</td><td rowspan="7">23</td><td rowspan="7">78</td><td rowspan="5">23</td><td>4</td><td>116</td><td rowspan="7">2.0</td><td>3877</td><td rowspan="5">4.0</td><td rowspan="5">200</td><td>0.2</td></tr>
<tr><td>5</td><td>118</td><td>3407</td><td rowspan="4">0.3</td></tr>
<tr><td>6</td><td>122</td><td>2746</td></tr>
<tr><td>8</td><td>125</td><td>2162</td></tr>
<tr><td>10</td><td>129</td><td>1639</td></tr>
<tr><td rowspan="2">10</td><td>12</td><td>132</td><td>1271</td><td rowspan="2">5.0</td><td rowspan="2">250</td><td>0.5</td></tr>
<tr><td>15</td><td>136</td><td>922</td><td>0.7</td></tr>
</table>

English

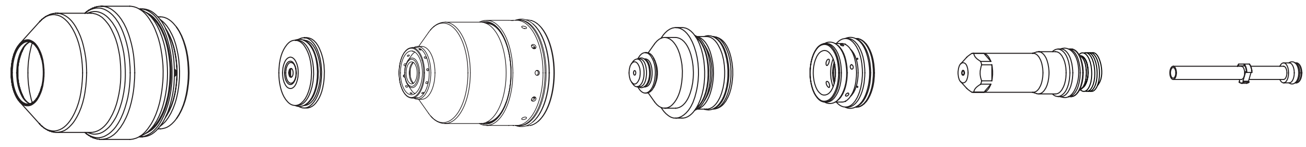
<table>
<tr><th colspan="2">Select Gases</th><th colspan="2">Set Preflow</th><th colspan="2">Set Cutflow</th><th>Material Thickness</th><th>Arc Voltage</th><th>Torch-to-Work Distance</th><th>Cutting Speed</th><th colspan="2">Initial Pierce Height</th><th>Pierce Delay Time</th></tr>
<tr><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>inches</th><th>Volts</th><th>inches</th><th>ipm</th><th>inches</th><th>factor %</th><th>seconds</th></tr>
<tr><td rowspan="7">O_2</td><td rowspan="7">Air</td><td rowspan="7">48</td><td rowspan="7">23</td><td rowspan="7">78</td><td rowspan="5">23</td><td>0.135</td><td>115</td><td>0.10</td><td>162</td><td>0.150</td><td>150</td><td rowspan="2">0.2</td></tr>
<tr><td>3/16</td><td>117</td><td rowspan="6">0.08</td><td>140</td><td rowspan="4">0.16</td><td rowspan="4">200</td></tr>
<tr><td>1/4</td><td>123</td><td>99</td><td>0.3</td></tr>
<tr><td>5/16</td><td>125</td><td>86</td><td>0.4</td></tr>
<tr><td>3/8</td><td>128</td><td>68</td><td>0.5</td></tr>
<tr><td rowspan="2">10</td><td>1/2</td><td>133</td><td>45</td><td rowspan="2">0.20</td><td rowspan="2">250</td><td>0.7</td></tr>
<tr><td>5/8</td><td>137</td><td>33</td><td>0.8</td></tr>
</table>

Mild steel

O_2 Plasma / Air Shield

130 A

Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	102 / 215
Cutflow	33 / 70	45 / 96



220747 220183 220756 220182 220179 220181 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	factor %	seconds
O_2	Air	32	32	84	28	**3**	124	2.5	6505	5.0	200	0.1
						4	126	2.8	5550	5.6		0.2
						5			4795			0.3
						6	127		4035			
					22	**8**	129	3.0	3360	6.0		
						10	130		2680			
						12	132	3.3	2200	6.6		0.5
						15	135	3.8	1665	7.6		0.7
			52			**20**	138		1050			1.0
						25	141	4.0	550		190	1.8
						32	160	4.5	375	Edge start		
						38	167		255			

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	factor %	seconds
O_2	Air	32	32	84	28	**0.135**	124	0.10	240	0.20	200	0.1
						3/16	126	0.11	190	0.22		0.2
						1/4	127		150			0.3
					22	**5/16**	129	0.12	132	0.24		
						3/8	130		110			
						1/2	132	0.13	80	0.26		0.5
						5/8	135	0.15	60	0.30		0.7
			52			**3/4**	138		45			1.0
						1	141	0.16	20		190	1.8
						1-1/4	160	0.18	15	Edge start		
						1-1/2	167		10			

Marking

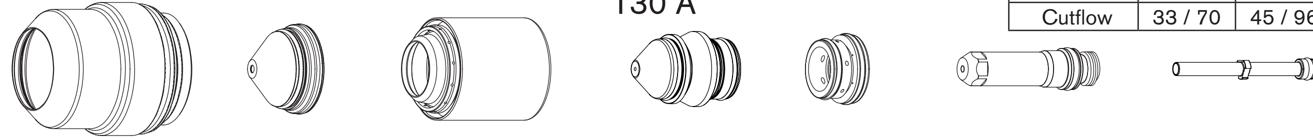
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**15**	2.5	0.10	6350	250	130
Ar	Air	50	10	50	10	**15**	3.0	0.12	2540	100	75

Mild steel bevel cutting

O_2 Plasma / Air Shield

130 A

Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	64 / 135
Cutflow	33 / 70	45 / 96



220637 220742 220740 220646 220179 220649 220700

Note: Bevel angle range is 0° to 45°.

Metric

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	mm	**mm**	Range (mm)	mm/m	mm	factor %	seconds
O_2	Air	15	23	84	21	2.0	**3**	2.5 – 8.6	6505	5.0	200	0.1
							4	2.8 – 8.6	5550	5.6		0.2
							5		4795			0.3
							6		4035			
					15		**8**	3.0 – 8.6	3360	6.0		
							10		2680			
							12	3.3 – 8.6	2200	6.6		0.5
							15	3.8 – 8.6	1665	7.6		0.7
							20		1050			1.0
							25	4.0 – 8.6	550		190	1.8
			33				**32***	4.5 – 8.6	375	10.2	220	4.0
							38		255	Edge start		

English

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	in	**in**	Range (in)	ipm	in	factor %	seconds
O_2	Air	15	23	84	21	0.08	**0.135**	0.10 – 0.34	240	0.20	200	0.1
							3/16	0.11 – 0.34	190	0.22		0.2
							1/4		150			0.3
					15		**5/16**	0.12 – 0.34	132	0.24		
							3/8		110			
							1/2	0.13 – 0.34	80	0.26		0.5
							5/8	0.15 – 0.34	60	0.30		0.7
							3/4		45			1.0
							1	0.16 – 0.34	20		190	1.8
			33				**1-1/4***	0.18 – 0.34	15	0.40	220	4.0
							1-1/2		10	Edge start		

Marking

Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**15**	2.5	0.10	6350	250	130
Ar	Air	50	10	50	10	**15**	3.0	0.12	2540	100	75

* Suggestions for piercing 32 mm (1-1/4 in) mild steel: 1. Turn preflow on during IHS, 2. Use ohmic contact during IHS, 3. Use pierce complete when piercing.

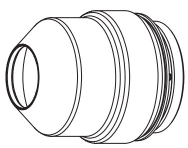
Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	102 / 215
Cutflow	33 / 70	45 / 96

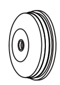
Mild steel underwater cutting

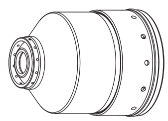
No more than 75 mm (3 in) below the surface of the water

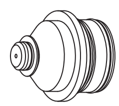
O_2 Plasma / Air Shield

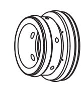
130 A

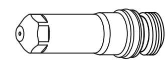

220747

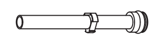

220183


220756


220182


220179


220181


220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	factor %	seconds
O_2	Air	32	32	84	28	**5**	127	2.8	4212	5.6	200	0.3
					22	**8**	129	3.0	2998	6.0		
						10	131		2412			
						12	133	3.3	1980	6.6		0.5
						15	138	3.8	1497	7.6		0.7

English

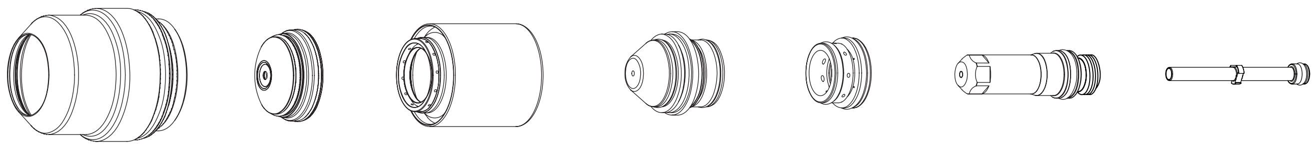
Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**inches**	Volts	inches	ipm	inches	factor %	seconds
O_2	Air	32	32	84	28	**3/16**	127	0.11	171	0.22	200	0.2
						1/4	126		135			0.3
					22	**5/16**	129	0.12	119	0.24		
						3/8	130		99			
						1/2	134	0.13	72	0.26		0.5
						5/8	140	0.15	54	0.30		0.7
			52			**3/4**	144		41			1.0

Mild steel

O_2 Plasma / Air Shield

200 A

Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	128 / 270
Cutflow	39 / 82	48 / 101



220637 220761 220757 220354 220353 220352 220340

Metric

Select Gases: Plasma gas	Select Gases: Shield gas	Set Preflow: Plasma gas	Set Preflow: Shield gas	Set Cutflow: Plasma gas	Set Cutflow: Shield gas	**Material Thickness** **mm**	Arc Voltage Volts	Torch-to-Work Distance mm	Cutting Speed mm/m	Initial Pierce Height mm	Initial Pierce Height factor %	Pierce Delay Time seconds
O_2	Air	23	42	74	18	**5**	123	3.3	5700	6.6	200	0.2
						6	124		5250			
						8	125		4355			0.3
						10	126		3460			
						12	128		3060			0.5
						15	131	4.1	2275	8.2		0.6
						20	133		1575			0.8
						25	143	5.1	1165	10.2		1.0
						32	145		750			Edge start
						38	152		510			
						50	163		255			

English

Select Gases: Plasma gas	Select Gases: Shield gas	Set Preflow: Plasma gas	Set Preflow: Shield gas	Set Cutflow: Plasma gas	Set Cutflow: Shield gas	**Material Thickness** **in**	Arc Voltage Volts	Torch-to-Work Distance in	Cutting Speed ipm	Initial Pierce Height in	Initial Pierce Height factor %	Pierce Delay Time seconds
O_2	Air	23	42	74	18	**3/16**	124	0.13	230	0.26	200	0.2
						1/4			200			
						5/16	125		171			0.3
						3/8	126		140			
						1/2	128		115			0.5
						5/8	131	0.16	80	0.32		0.6
						3/4	133		65			0.8
						1	143	0.20	45	0.40		1.0
						1-1/4	145		30			Edge start
						1-1/2	152		20			
						2	163		10			

Marking

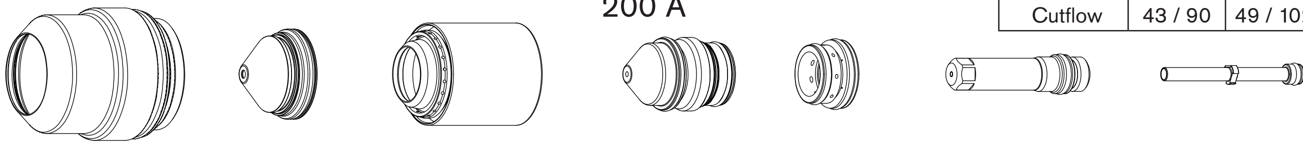
Select Gases		Set Preflow		Set Cutflow		**Amperage** **Amps**	Torch-to-Work Distance mm	Torch-to-Work Distance in	Marking Speed mm/m	Marking Speed ipm	Arc Voltage Volts
N_2	N_2	10	10	10	10	**15**	2.5	0.10	6350	250	130
Ar	Air	30	10	30	10	**20**	3.0	0.12	2540	100	63

Mild steel bevel cutting

O_2 Plasma / Air Shield

200 A

Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	114 / 240
Cutflow	43 / 90	49 / 102



220637 220658 220845 220659 220353 220662 220700

Note: For mirror-image cutting, use 220996 (nozzle retaining cap) and 220350 (swirl ring) instead.

Metric

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	mm	**mm**	Range (mm)	mm/m	mm	Factor %	Seconds
O_2	Air	23	83	69	42	2.0	**5**	3.3 – 8.4	5700	6.6	200	0.2
							6		5250			
							8		4355			0.3
							10		3460			
							12		3060			0.5
							15	4.1 – 8.4	2275	8.2		0.6
							20		1575			0.8
							25	5.1 – 8.4	1165	10.2		1.0
							32		750			2.7
							38		510	Edge start		
							50		255			

English

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	in	**in**	Range (in)	ipm	in	Factor %	Seconds
O_2	Air	23	83	69	42	0.08	**3/16**	0.13 – 0.33	230	0.26	200	0.2
							1/4		200			
							5/16		171			0.3
							3/8		140			
							1/2		115			0.5
							5/8	0.16 – 0.33	80	0.32		0.6
							3/4		65			0.8
							1	0.20 – 0.33	45	0.40		1.0
							1-1/4		30			2.7
							1-1/2		20	Edge start		
							2		10			

Marking

Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**15**	2.5	0.10	6350	250	124
Ar	Air	30	10	30	10	**20**	3.0	0.12	2540	100	61

Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	128 / 270
Cutflow	39 / 82	48 / 101

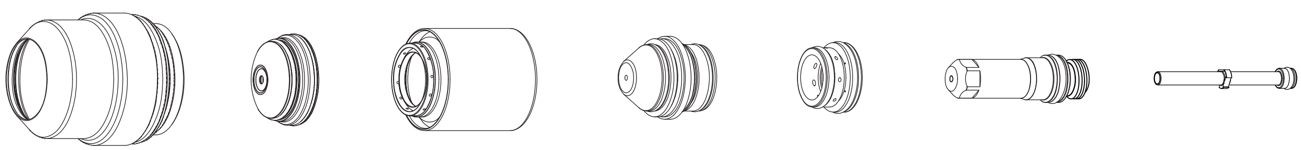
Mild steel underwater cutting

No more than 75 mm (3 in) below the surface of the water

O_2 Plasma / Air Shield

200 A

Note: Preflow must be on during IHS.



220637 220761 220757 220354 220353 220352 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
O_2	Air	23	42	74	18	**8**	126	3.3	3878	6.6	200	0.3
						10	127		3116			
						12	129		2764			0.5
						15	133	4.1	2052	8.2		0.6

English

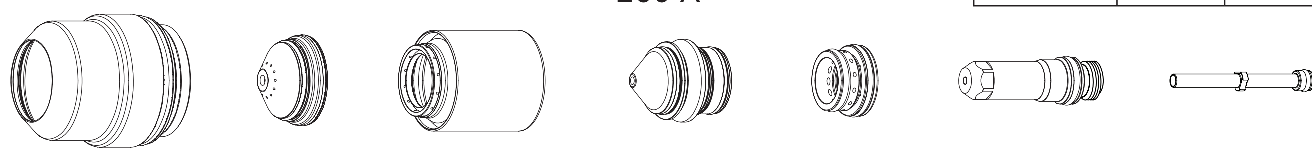
Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**inches**	Volts	inches	ipm	inches	Factor %	Seconds
O_2	Air	23	42	74	18	**1/4**	125	0.13	180	0.26	200	0.2
						5/16	126		154			0.3
						3/8	127		126			
						1/2	129		104			0.5
						5/8	135	0.16	72	0.32		0.6
						3/4	137		59			0.8

Mild steel

O_2 Plasma / Air Shield

260 A

Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	130 / 275
Cutflow	42 / 88	104 / 220



220637 220764 220760 220439 220436 220435 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	factor %	seconds
O_2	Air	22	49	76	46	**6**	150	2.8	6500	8.5	300	0.3
						8			5470			
						10			4440			
						12			3850			0.4
				80	49	**15**	155	3.6	3130	9.0	250	0.5
						20	159		2170			0.6
						22	166		1930			0.7
				84		**25**	171		1685			0.8
						28	170	4.8	1445	9.5	200	0.9
						32	172		1135			1.0
						38	174		895	Edge start		
						44	185		580			
						50	188		405			
						58	193		290			
						64	202		195			

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	factor %	seconds
O_2	Air	22	49	76	46	**1/4**	150	0.11	245	0.33	300	0.3
						5/16			215			
						3/8			180			
						1/2			145			0.4
				80	49	**5/8**	155	0.14	115	0.35	250	0.5
						3/4	159		90			0.6
						7/8	166		75			0.7
				84		**1**	171		65			0.8
						1-1/8	170	0.19	55	0.38	200	0.9
						1-1/4	172		45			1.0
						1-1/2	174		35	Edge start		
						1-3/4	185		22			
						2	188		15			
						2-1/4	193		12			
						2-1/2	202		8			

Marking

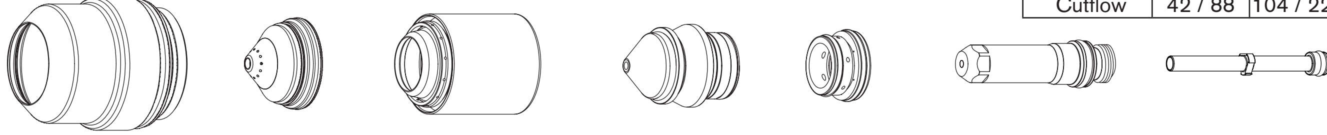
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	135
Ar	Air	30	20	30	20	**24**	3.0	0.12	2540	100	68

Mild steel bevel cutting (standard)

O_2 Plasma / Air Shield

260 A

Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	130 / 275
Cutflow	42 / 88	104 / 220



220637 220741 220740 220542 220436 220541 220571

Metric

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	mm	**mm**	Range (mm)	mm/m	mm	factor %	seconds
O2	Air	22	49	76	46	2.0	**6**	2.8 – 7.6	6500	8.5	300	0.3
							8		5470			
							10		4440			
							12		3850			0.4
				80	49		**15**	3.6 – 7.6	3130	9.0	250	0.5
							20		2170			0.6
							22		1930			0.7
				84			**25**		1685			0.8
							28	4.8 – 7.6	1445	9.5	200	0.9
							32		1135			1.0
							38*		895			2.0
							44		580	Edge start		
							50		405			
							58		290			
							64		195			

English

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	in	**in**	Range (in)	ipm	in	factor %	seconds
O_2	Air	22	49	76	46	0.08	**1/4**	0.11 – 0.30	245	0.33	300	0.3
							5/16		215			
							3/8		180			
							1/2		145			0.4
				80	49		**5/8**	0.14 – 0.30	115	0.35	250	0.5
							3/4		90			0.6
							7/8		75			0.7
				84			**1**		65			0.8
							1-1/8	0.19 – 0.30	55	0.38	200	0.9
							1-1/4		45			1.0
							1-1/2*		35			2.0
							1-3/4		22	Edge start		
							2		15			
							2-1/4		12			
							2-1/2		8			

Marking

Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	135
Ar	Air	30	20	30	20	**24**	3.0	0.12	2540	100	68

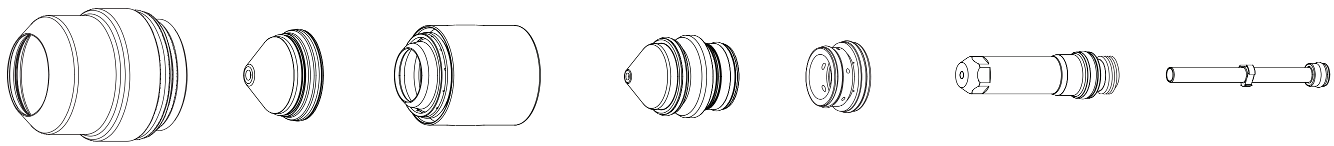
***** See the alternate, thick metal piercing, cut chart if you have a problem with excessive slag on the shield or problems with the torch misfiring.

Mild steel bevel cutting (alternate) thick metal piercing

O_2 Plasma / Air Shield

260 A

Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	85 / 180
Cutflow	47 / 99	54 / 115



220637 220897 220896 220898 220436 220899 220571

Metric

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	mm	**mm**	Range (mm)	mm/m	mm	factor %	seconds
O_2	Air	22	20	74	19	2.0	**25**	3.6 – 7.6	1685	9.0	250	0.8
							28	4.8 – 7.6	1445	9.5	200	1.0
							32		1135			1.2
							38*		895			3.0
							44		580	Edge start		
							50		405			
							58		290			
							64		195			

English

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	in	**in**	Range (in)	ipm	in	factor %	seconds
O_2	Air	22	20	74	19	0.08	**1**	0.14 – 0.30	65	0.35	250	0.8
							1-1/8	0.19 – 0.30	55	0.38	200	1.0
							1-1/4		45			1.2
							1-1/2*		35			3.0
							1-3/4		22	Edge start		
							2		15			
							2-1/4		12			
							2-1/2		8			

Marking

Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	122
Ar	Air	30	10	30	10	**24**	3.0	0.12	2540	100	62

The consumables on this page are designed for thick metal piercing. They are only recommended for use if you have a problem with excessive slag on the shield, or problems with the torch misfiring, when using the standard bevel consumables.

Using the thick metal piercing process may result in a 20% decrease in the life of the consumables.

* Suggestions for piercing 38 mm (1-1/2 in) mild steel:

1. Turn preflow on during IHS
2. Use stall force during IHS
3. Use pierce complete when piercing

Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	130 / 275
Cutflow	42 / 88	104 / 220

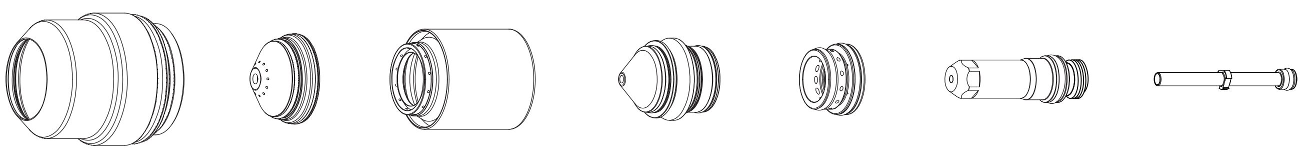
Mild steel underwater cutting

No more than 75 mm (3 in) below the surface of the water

O_2 Plasma / Air Shield

260 A

Note: Preflow must be on during IHS.



220637 220764 220760 220439 220436 220435 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
O_2	Air	22	49	76	49	**8**	150	2.8	4889	8.4	300	0.3
						10			3997			
						12	152		3501			0.4
				80	49	**15**	156	3.6	2830	9.0	250	0.5
						20	160		1958			0.6
						22	162		1750			0.7
				84		**25**	165		1527			0.8
						28	170	4.8	1311	9.6	200	0.9

English

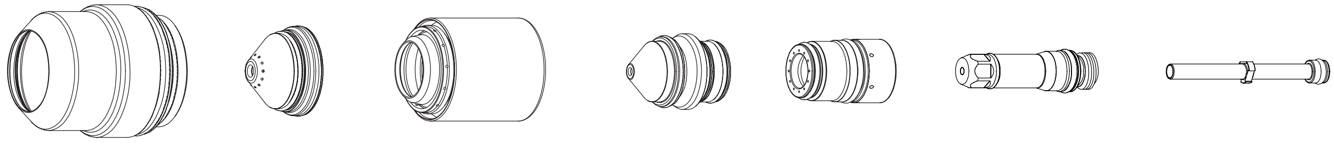
Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**inches**	Volts	inches	ipm	inches	Factor %	Seconds
O_2	Air	22	49	76	46	**5/16**	150	0.11	194	0.33	300	0.3
						3/8			162			
						1/2	153		131			0.4
				80	49	**5/8**	157	0.14	104	0.35	250	0.5
						3/4	159		81			0.6
						7/8	162		68			0.7
				84		**1**	165		59			0.8
						1-1/8	171	0.19	50	0.38	200	0.9

Mild steel

O_2 Plasma / Air Shield

400 A

Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	190 / 400
Cutflow	66 / 140	137 / 290



220637 220636 220635 220632 220631 220629 220571

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
O_2	Air	24	50	60	50	**12**	139	3.6	4430	7.2	200	0.4
						15	142		3950			0.5
						20	146		2805			0.7
						22	148	3.8	2540	7.6		0.8
						25	150	4.0	2210	8.0		0.9
						30	153	4.6	1790	9.2		1.1
						40	158		1160	11.5	250	1.9
						50	167	5.3	795	19.1	360	5.2
						60	173	6.4	580	Edge start		
						70	183		380			
						80	197	7.9	180			

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
O_2	Air	24	50	60	50	**1/2**	140	0.14	170	0.28	200	0.4
						5/8	143		150			0.5
						3/4	145		115			0.6
						7/8	148	0.15	100	0.30		0.8
						1	151	0.16	85	0.32		0.9
						1-1/4	153	0.18	65	0.36		1.2
						1-1/2	157		48	0.45	250	1.6
						1-3/4	160		40			2.5
						2	168	0.21	30	0.75	360	5.5
						2-1/4	171	0.25	25	Edge start		
						2-1/2	175		20			
						3	193	0.31	10			

Marking

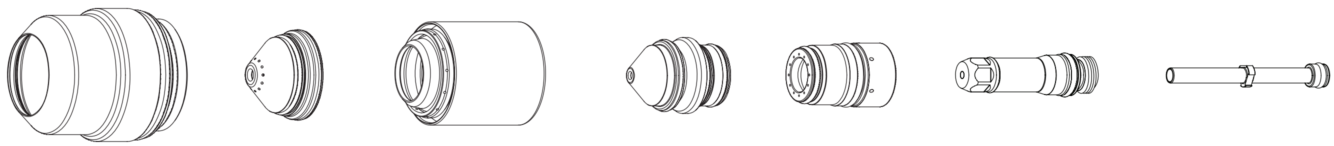
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**22**	2.5	0.10	1270	50	123
Ar	Air	20	10	30	10	**25**	3.0	0.12	1270	50	55

Mild steel bevel cutting

O_2 Plasma / Air Shield

400 A

Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	190 / 400
Cutflow	66 / 140	137 / 290



220637 220636 220635 220632 220631 220629 220571

Note: Bevel angle range is 0° to 45°.

Metric

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	mm	**mm**	Range (mm)	mm/m	mm	Factor %	Seconds
O_2	Air	24	50	60	50	2.0	**12**	3.6 – 9.4	4430	7.2	200	0.4
							15		3950			0.5
							20		2805			0.7
							22	3.8 – 9.4	2540	7.6		0.8
							25	4.0 – 9.4	2210	8.0		0.9
							30	4.6 – 9.4	1790	9.2		1.1
							40		1160	11.5	250	1.9
							50	5.3 – 9.4	795	19.1	360	5.2
							60	6.4 – 9.4	580	Edge start		
							70		380			
							80	7.9 – 9.4	180			

English

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	in	**in**	Range (in)	ipm	in	Factor %	Seconds
O_2	Air	24	50	60	50	0.08	**1/2**	0.14 – 0.37	170	0.28	200	0.4
							5/8		150			0.5
							3/4		115			0.6
							7/8	0.15 – 0.37	100	0.30		0.8
							1	0.16 – 0.37	85	0.32		0.9
							1-1/4	0.18 – 0.37	65	0.36		1.2
							1-1/2		48	0.45	250	1.6
							1-3/4		40			2.5
							2	0.21 – 0.37	30	0.75	360	5.5
							2-1/4	0.25 – 0.37	25	Edge start		
							2-1/2		20			
							3	0.31 – 0.37	10			

Marking

Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**22**	2.5	0.10	1270	50	123
Ar	Air	20	10	30	10	**25**	3.0	0.12	1270	50	55

Flow rates – lpm/scfh		
	O_2	Air
Preflow	0 / 0	190 / 400
Cutflow	66 / 140	137 / 290

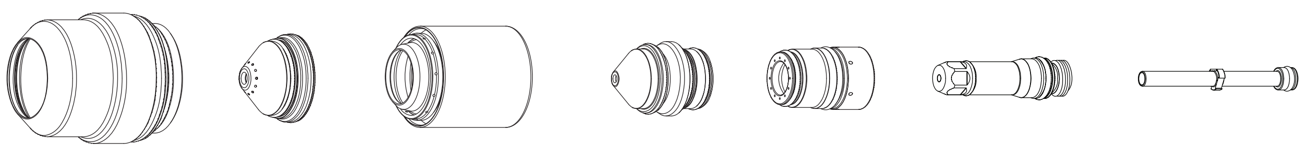
Mild steel underwater cutting

No more than 75 mm (3 in) below the surface of the water

O_2 Plasma / Air Shield

400 A

Note: Preflow must be on during IHS.



220637 220636 220635 220632 220631 220629 220571

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
O_2	Air	24	50	60	50	**16**	144	3.6	3398	7.2	200	0.5
						20	147		2535			0.7
						22	150	3.8	2311	7.6		0.8
						25	153	4.0	1997	8.0		0.9
						30	155	4.6	1624	9.2		1.1
						40	160		1039	11.5	250	1.9

English

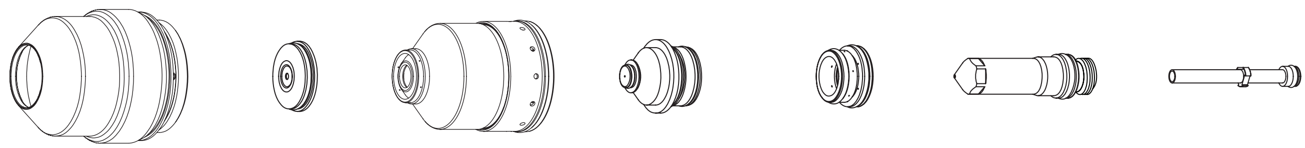
Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**inches**	Volts	inches	ipm	inches	Factor %	Seconds
O_2	Air	24	50	60	50	**5/8**	144	0.14	135	0.28	200	0.5
						3/4	146		104			0.6
						7/8	150	0.15	90	0.30		0.8
						1	154	0.16	77	0.32		0.9
						1-1/4	156	0.18	59	0.36		1.2
						1-1/2	159		43	0.45	250	1.6
						1-3/4	162		36			2.5

Stainless steel

N_2 Plasma / N_2 Shield

45 A

Flow rates – lpm/scfh	
	N_2
Preflow	24 / 51
Cutflow	75 / 159



220747 220202 220755 220201 220180 220308 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
N_2	N_2	35	5	62	49	**0.8**	94	2.5	6380	3.8	150	0.0
						1			5880			0.1
						1.2			5380			0.2
						1.5	95		4630			
						2	97		3935			
						2.5	101		3270			
						3	103		2550			0.3
						4			1580			

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
N_2	N_2	35	5	62	49	**0.036**	94	0.10	240	0.15	150	0.0
						0.048			210			0.1
						0.060	95		180			0.2
						0.075	97		160			
						0.105	101		120			
						0.135	103		75			0.3

Marking

Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**15**	2.5	0.10	6350	250	85
Ar	N_2	90	10	90	10	**12**	2.5	0.10	2540	100	65

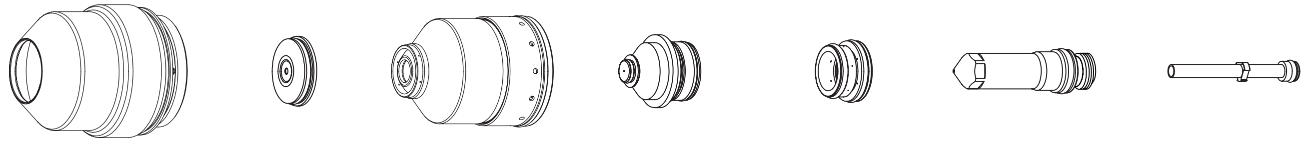
Note: This process produces a darker cut edge than the 45 A, F5/N_2 stainless steel process.

Stainless steel

F5 Plasma / N_2 Shield

45 A

Flow rates – lpm/scfh		
	F5	N_2
Preflow	0 / 0	43 / 91
Cutflow	8 / 17	65 / 138



220747 220202 220755 220201 220180 220308 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
F5	N_2	35	18	62	49	**0.8**	99	2.5	6570	3.8	150	0.2
						1			5740			
						1.2			4905			
						1.5			3890			
						2	101		3175			
						2.5	102		2510			
						3	103		2010			0.3
						4	104		1435			
					11	**6**	110	2.0	845		190	0.5

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
F5	N_2	35	18	62	49	**0.036**	99	0.10	240	0.15	150	0.2
						0.048			190			
						0.060			150			
						0.075	100		130			
						0.105	102		90			
						0.135	104		65			0.3
					11	**3/16**	108	0.08	45		190	0.4
						1/4	110		30			0.5

Marking

Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**15**	2.5	0.10	6350	250	85
Ar	N_2	90	10	90	10	**12**	2.5	0.10	2540	100	65

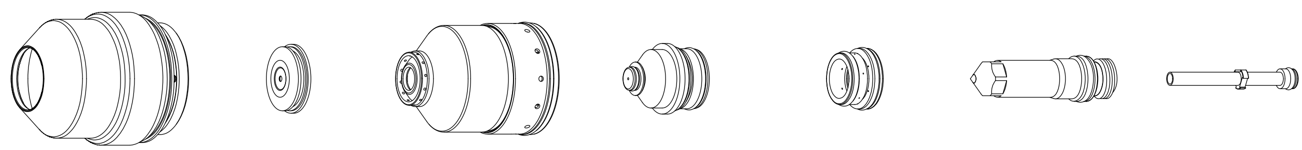
Note: This process produces a shinier cut edge than the 45 A, N_2/N_2 stainless steel process.

Stainless steel HDi

F5 Plasma / N_2 Shield

60 A

Flow rates – lpm/scfh		
	F5	N_2
Preflow	0 / 0	76 / 160
Cutflow	20 / 42	58 / 122



220747 220815 220814 220847 220180 220339 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
F5	N_2	70	40	90	35	**3**	114	2.0	2770	4.0	200	0.3
						4	117		2250			
						5	118		1955			
					45	**6**	120		1635			0.5

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
F5	N_2	70	40	90	35	**0.105**	113	0.08	120	0.16	200	0.3
						0.135	116		95			
						3/16	118		80			
					45	**1/4**	120		60			0.5

Marking

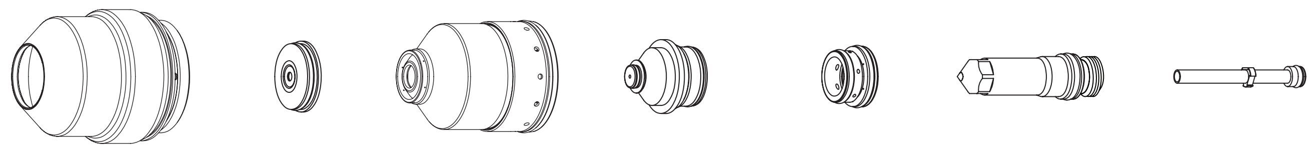
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**15**	2.5	0.1	6350	250	95
Ar	N_2	90	10	90	10	**8**	2.5	0.1	2540	100	82

Flow rates – lpm/scfh		
	F5	N_2
Preflow	0 / 0	67 / 142
Cutflow	31 / 65	87 / 185

Stainless steel

F5 Plasma / N_2 Shield

80 A



220747 220338 220755 220337 220179 220339 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	factor %	seconds
F5	N_2	33	23	65	60	**4**	108	3.0	2180	4.5	150	0.2
						5	110	2.7	1700	4.1		0.3
						6	112	2.5	1225	3.8		
						8	116	3.0	895	4.5		0.4
						10	120		560			0.5

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	factor %	seconds
F5	N_2	33	23	65	60	**0.135**	108	0.12	105	0.18	150	0.2
						3/16	110	0.11	60	0.17		0.3
						1/4	112	0.10	45	0.15		
						5/16	116	0.12	35	0.18		0.4
						3/8	120		25			0.5

Marking

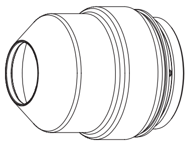
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**15**	2.5	0.10	6350	250	95
Ar	N_2	50	10	50	10	**12**	3.0	0.12	2540	100	60

Stainless steel

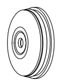
N_2 Plasma / N_2 Shield

130 A

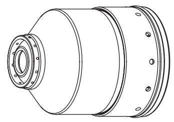
Flow rates – lpm/scfh	
	N_2
Preflow	97 / 205
Cutflow	79 / 168



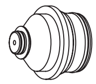
220747



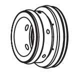
220198



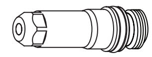
220756



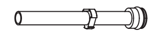
220197



220179



220307



220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	factor %	seconds
N_2	N_2	19	51	75	23	**6**	153	3.0	1960	6.0	200	0.3
						8	155		1630			0.4
						10	156		1300			0.5
						12	162	3.5	900	7.0		0.8
						15	167	3.8	670	Edge start		
						20	176	4.3	305			

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	factor %	seconds
N_2	N_2	19	51	75	23	**1/4**	153	0.12	75	0.24	200	0.3
						5/16	155		64			0.4
						3/8	156		55			0.5
						1/2	162	0.14	30	0.28		0.8
						5/8	167	0.15	25	Edge start		
						3/4	176	0.17	15			

Marking

Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	140
Ar	N_2	50	10	50	10	**15**	3.0	0.12	2540	100	75

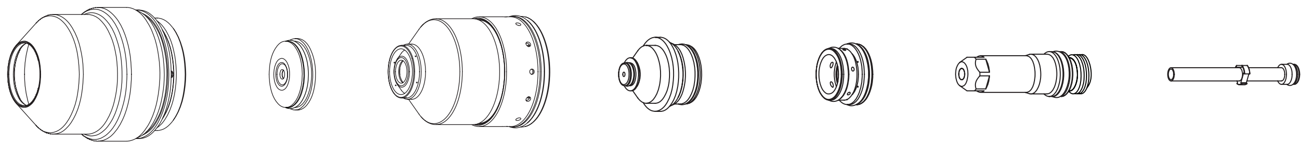
Note: This process produces a rougher, darker cut edge with more dross, and the cut edges are closer to perpendicular than the 130 A, $H35/N_2$ process.

Stainless steel

H35 Plasma / N_2 Shield

130 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	76 / 160
Cutflow	26 / 54	68 / 144



220747 220198 220755 220197 220179 220307 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield	**mm**	Volts	mm	mm/m	mm	factor %	seconds
H35	N_2	19	32	75	49	**8**	150	4.5	1140	7.7	170	0.3
						10	154		980			
					37	**12**	158		820			0.5
					24	**15**	162		580			0.8
						20	165		360			1.3
					16	**25**	172		260	Edge start		

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	factor %	seconds
H35	N_2	19	32	75	49	**5/16**	150	0.18	45	0.31	170	0.3
						3/8	154		40			
					37	**1/2**	158		30			0.5
					24	**5/8**	162		20			0.8
						3/4	165		15			1.3
					16	**1**	172		10	Edge start		

Marking

Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	130
Ar	N_2	50	10	50	10	**15**	3.0	0.12	2540	100	75

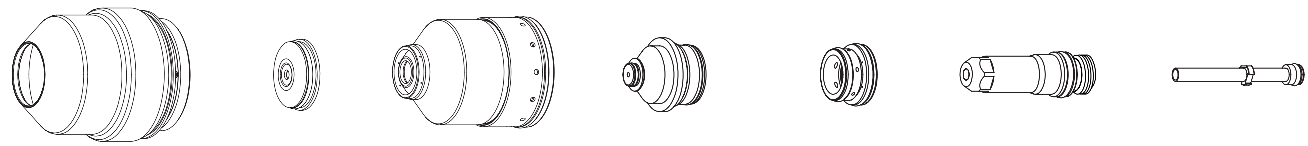
Note: This process produces a smoother, shinier cut edge with less dross, and the cut edges are less perpendicular than the 130 A, N_2/N_2 process.

Stainless steel

H35 and N_2 Plasma / N_2 Shield

130 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	97 / 205
Cutflow	13 / 28	71 / 150



220747 220198 220755 220197 220179 220307 220340

Metric

Select Gases		Set Preflow		Set Cutflow				**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Mix Gas 1	Mix Gas 2	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
H35	N_2	19	51	75	38	32	18	**6**	150	3.0	1835	6.0	200	0.3
								8	152		1515			
								10	153		1195			
					27			**12**	160	3.5	875	7.0		0.5
								15	168	3.8	670	7.6		0.8
								20	176	4.3	305	7.7	180	1.3

English

Select Gases		Set Preflow		Set Cutflow				**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Mix Gas 1	Mix Gas 2	**in**	Volts	in	ipm	in	Factor %	Seconds
H35	N_2	19	51	75	38	32	18	**1/4**	150	0.12	70	0.24	200	0.3
								5/16	152		60			
								3/8	153		50			
					27			**1/2**	160	0.14	30	0.28		0.5
								5/8	168	0.15	25	0.30		0.8
								3/4	176	0.17	15	0.31	180	1.3

Marking

Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	130
Ar	N_2	50	10	50	10	**15**	3.0	0.12	2540	100	75

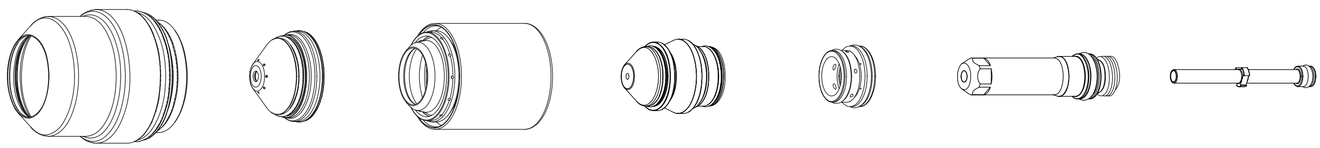
Note: This process produces a smoother, shinier cut edge with less dross, and the cut edges are less perpendicular than the 130 A, N_2/N_2 process. Edge color is more silver than the H35/N_2 process.

Stainless steel bevel cutting

N_2 Plasma / N_2 Shield

130 A

Flow rates – lpm/scfh	
	N_2
Preflow	97 / 205
Cutflow	125 / 260



220637 220738 220739 220656 220179 220606 220571

Note: Bevel angle range is 0° to 45°.

Metric

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	mm	**mm**	Range (mm)	mm/m	mm	factor %	seconds
N_2	N_2	19	51	75	63	2.0	**6**	3.0 – 10.0	1960	6.0	200	0.3
							8		1630			0.4
							10		1300			0.5
							12	3.5 – 10.0	900	7.0		0.8
							15	3.8 – 10.0	670	Edge start		
							20	4.3 – 10.0	305			

English

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	in	**in**	Range (in)	ipm	in	factor %	seconds
N_2	N_2	19	51	75	63	0.08	**1/4**	0.12 – 0.40	75	0.24	200	0.3
							5/16		64			0.4
							3/8		55			0.5
							1/2	0.14 – 0.40	30	0.28		0.8
							5/8	0.15 – 0.40	25	Edge start		
							3/4	0.17 – 0.40	15			

Marking

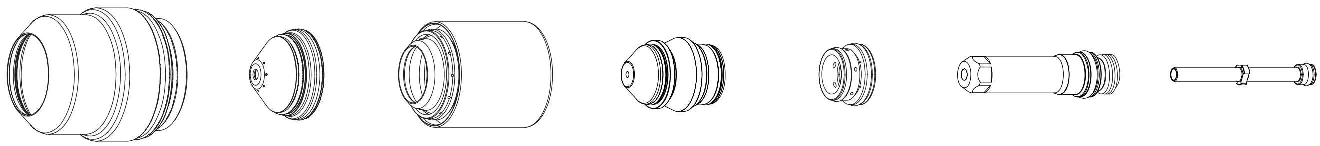
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	140
Ar	N_2	50	10	50	10	**15**	3.0	0.12	2540	100	75

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	90 / 190
Cutflow	26 / 54	114 / 240

Stainless steel bevel cutting

H35 Plasma / N_2 Shield

130 A



220637 220738 220739 220656 220179 220606 220571

Note: Bevel angle range is 0° to 45°.

Metric

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	mm	**mm**	Range (mm)	mm/m	mm	factor %	seconds
H35	N_2	19	32	75	63	2.0	**8**	4.5 – 10.0	1140	7.7	170	0.3
							10		980			
							12		820			0.5
							15		580			0.8
							20		360			1.3
							25		260	Edge start		

English

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	in	**in**	Range (in)	ipm	in	factor %	seconds
H35	N_2	19	32	75	63	0.08	**5/16**	0.18 – 0.40	45	0.31	170	0.3
							3/8		40			
							1/2		30			0.5
							5/8		20			0.8
							3/4		15			1.3
							1		10	Edge start		

Marking

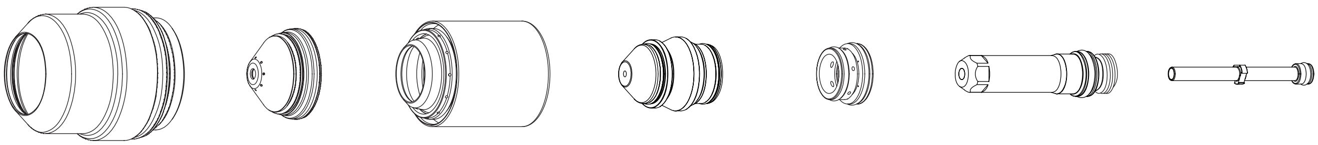
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	130
Ar	N_2	50	10	50	10	**15**	3.0	0.12	2540	100	75

Stainless steel bevel cutting

H35 and N_2 Plasma / N_2 Shield

130 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	97 / 205
Cutflow	13 / 28	120 / 250



220637 220738 220739 220656 220179 220606 220571

Note: Bevel angle range is 0° to 45°.

Metric

Select Gases		Set Preflow		Set Cutflow				Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Mix Gas 1	Mix Gas 2	mm	**mm**	Range (mm)	mm/m	mm	Factor %	Seconds
H35	N_2	19	51	75	80	32	18	2.0	**6**	3.0 – 10.0	1835	6.0	200	0.3
									8		1515			
									10		1195			
									12	3.5 – 10.0	875	7.0		0.5
									15	3.8 – 10.0	670	7.6		0.8
									20	3.0 – 10.0	305	7.7	180	1.3

English

Select Gases		Set Preflow		Set Cutflow				Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Mix Gas 1	Mix Gas 2	in	**in**	Range (in)	ipm	in	Factor %	Seconds
H35	N_2	19	51	75	80	32	18	0.080	**1/4**	0.12 – 0.40	70	0.24	200	0.3
									5/16		60			
									3/8		50			
									1/2	0.14 – 0.40	30	0.28		0.5
									5/8	0.15 – 0.40	25	0.30		0.8
									3/4	0.17 – 0.40	15	0.31	180	1.3

Marking

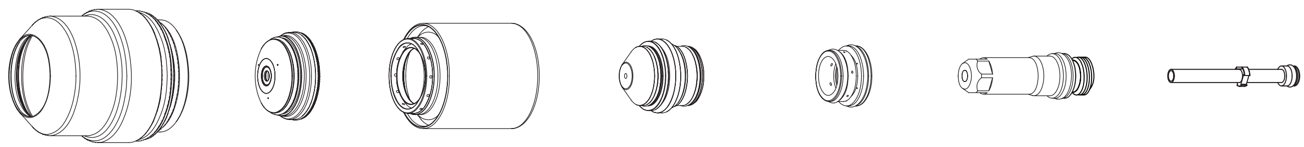
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	130
Ar	N_2	50	10	50	10	**15**	3.0	0.12	2540	100	75

Stainless steel

N_2 Plasma / N_2 Shield

200 A

Flow rates – lpm/scfh	
	N_2
Preflow	111 / 235
Cutflow	137 / 290



220637 220762 220758 220343 220342 220307 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	factor %	seconds
N_2	N_2	17	42	84	42	**8**	159	3.8	3000	7.6	200	0.4
						10	160		2700			0.5
						12	161		2400			0.6
						15	163		1800			0.8
						20	167		1000			1.0

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	factor %	seconds
N_2	N_2	17	42	84	42	**5/16**	159	0.15	118	0.3	200	0.4
						3/8	160		110			0.5
						1/2	161		90			0.6
						5/8	163		65			0.8
						3/4	167		45			1.0

Marking

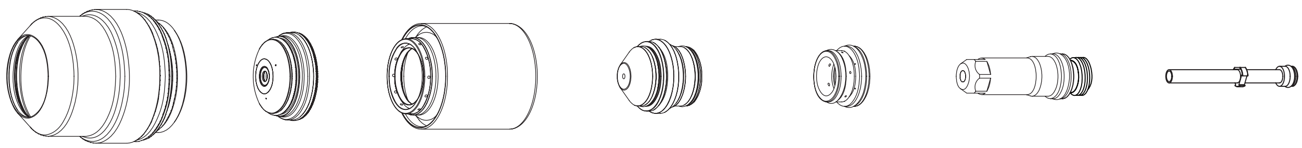
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	140
Ar	N_2	30	10	30	10	**20**	3.0	0.12	2540	100	66

Stainless steel

H35 Plasma / N_2 Shield

200 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	116 / 245
Cutflow	30 / 63	104 / 220



220637 220762 220758 220343 220342 220307 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
H35	N_2	17	43	88	52	**8**	175	9.0	1790	9.0	100	0.4
						10			1620			0.5
						12	170	7.5	1450	7.5		0.6
						15	173		1200			0.7
						20	177		820			0.8

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
H35	N_2	17	43	88	52	**5/16**	175	0.35	70	0.35	100	0.4
						3/8			65			0.5
						1/2	170	0.30	55	0.30		0.6
						5/8	173		45			0.7
						3/4	177		35			0.8

Marking

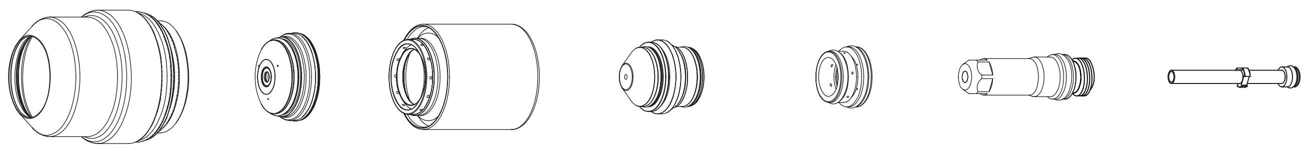
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	140
Ar	N_2	30	10	30	10	**20**	3.0	0.12	2540	100	66

Stainless steel

H35 and N_2 Plasma / N_2 Shield

200 A

<table>
<tr><th colspan="3">Flow rates – lpm/scfh</th></tr>
<tr><th></th><th>H35</th><th>N_2</th></tr>
<tr><td>Preflow</td><td>0 / 0</td><td>116 / 245</td></tr>
<tr><td>Cutflow</td><td>11 / 24</td><td>118 / 250</td></tr>
</table>



220637 220762 220758 220343 220342 220307 220340

Metric

<table>
<tr><th colspan="2">Select Gases</th><th colspan="2">Set Preflow</th><th colspan="4">Set Cutflow</th><th>Material Thickness</th><th>Arc Voltage</th><th>Torch-to-Work Distance</th><th>Cutting Speed</th><th colspan="2">Initial Pierce Height</th><th>Pierce Delay Time</th></tr>
<tr><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>Mix Gas 1</th><th>Mix Gas 2</th><th>mm</th><th>Volts</th><th>mm</th><th>mm/m</th><th>mm</th><th>Factor %</th><th>Seconds</th></tr>
<tr><td rowspan="5">H35</td><td rowspan="5">N_2</td><td rowspan="5">17</td><td rowspan="5">41</td><td rowspan="5">87</td><td rowspan="5">41</td><td rowspan="5">42</td><td rowspan="5">20</td><td>8</td><td>160</td><td rowspan="3">4.0</td><td>2000</td><td rowspan="3">8.0</td><td rowspan="3">200</td><td>0.4</td></tr>
<tr><td>10</td><td>161</td><td>1900</td><td>0.5</td></tr>
<tr><td>12</td><td>162</td><td>1800</td><td>0.6</td></tr>
<tr><td>15</td><td>167</td><td>4.6</td><td>1600</td><td>7.0</td><td rowspan="2">150</td><td>0.8</td></tr>
<tr><td>20</td><td>171</td><td>5.1</td><td>1000</td><td>7.5</td><td>1.0</td></tr>
</table>

English

<table>
<tr><th colspan="2">Select Gases</th><th colspan="2">Set Preflow</th><th colspan="4">Set Cutflow</th><th>Material Thickness</th><th>Arc Voltage</th><th>Torch-to-Work Distance</th><th>Cutting Speed</th><th colspan="2">Initial Pierce Height</th><th>Pierce Delay Time</th></tr>
<tr><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>Mix Gas 1</th><th>Mix Gas 2</th><th>in</th><th>Volts</th><th>in</th><th>ipm</th><th>in</th><th>Factor %</th><th>Seconds</th></tr>
<tr><td rowspan="5">H35</td><td rowspan="5">N_2</td><td rowspan="5">17</td><td rowspan="5">41</td><td rowspan="5">87</td><td rowspan="5">41</td><td rowspan="5">42</td><td rowspan="5">20</td><td>5/16</td><td>160</td><td rowspan="3">0.16</td><td>79</td><td rowspan="3">0.320</td><td rowspan="3">200</td><td>0.4</td></tr>
<tr><td>3/8</td><td>161</td><td>75</td><td>0.5</td></tr>
<tr><td>1/2</td><td>162</td><td>70</td><td>0.6</td></tr>
<tr><td>5/8</td><td>167</td><td>0.18</td><td>60</td><td>0.270</td><td rowspan="2">150</td><td>0.8</td></tr>
<tr><td>3/4</td><td>171</td><td>0.20</td><td>45</td><td>0.300</td><td>1.0</td></tr>
</table>

Marking

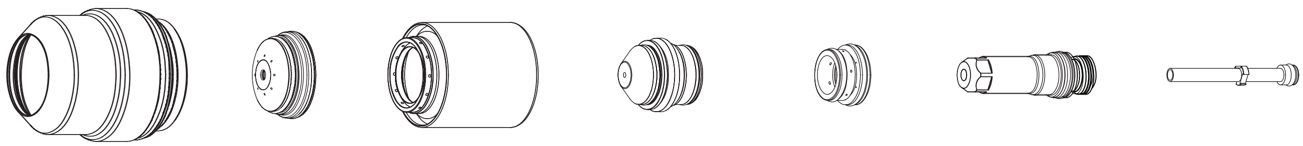
<table>
<tr><th colspan="2" rowspan="2">Select Gases</th><th colspan="2" rowspan="2">Set Preflow</th><th colspan="2" rowspan="2">Set Cutflow</th><th>Amperage</th><th colspan="2">Torch-to-Work Distance</th><th colspan="2">Marking Speed</th><th>Arc Voltage</th></tr>
<tr><th>Amps</th><th>mm</th><th>in</th><th>mm/m</th><th>ipm</th><th>Volts</th></tr>
<tr><td>N_2</td><td>N_2</td><td>10</td><td>10</td><td>10</td><td>10</td><td>18</td><td>2.5</td><td>0.10</td><td>6350</td><td>250</td><td>140</td></tr>
<tr><td>Ar</td><td>N_2</td><td>30</td><td>10</td><td>30</td><td>10</td><td>20</td><td>3.0</td><td>0.12</td><td>2540</td><td>100</td><td>66</td></tr>
</table>

Stainless steel

N_2 Plasma / Air Shield

260 A

Flow rates – lpm/scfh		
	N_2	Air
Preflow	127 / 270	0 / 0
Cutflow	54 / 114	116 / 245



220637 220763 220758 220406 220405 220307 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	factor %	seconds
						6	160		6375			
						8	158		4910			0.3
						10	157		3440			
						12	161		2960	7.5	200	0.4
						15	163		2520			0.5
N_2	Air	12	47	79	56	**20**	164	3.8	1590			0.6
						25	168		1300			0.8
						32	171		875			1.0
						38	179		515			
						44	190		365	Edge start		
						50	195		180			

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	factor %	seconds
						1/4	160		240			
						5/16	158		193			0.3
						3/8	157		140			
						1/2	161		110	0.3	200	0.4
						5/8	163		95			0.5
N_2	Air	12	47	79	56	**3/4**	164	0.15	70			0.6
						1	168		50			0.8
						1-1/4	171		35			1.0
						1-1/2	179		20			
						1-3/4	190		14	Edge start		
						2	200		6			

Marking

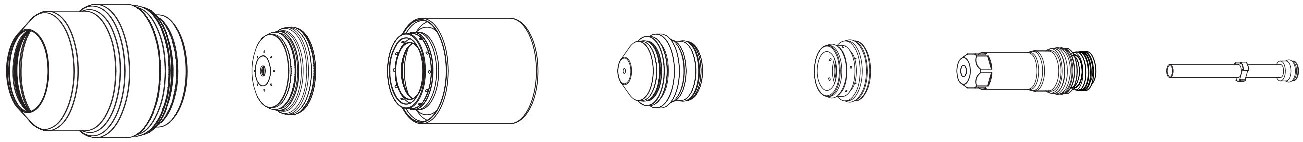
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	120
Ar	N_2	30	10	30	10	**20**	3.0	0.12	2540	100	63

Stainless steel

H35 Plasma / N_2 Shield

260 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	127 / 270
Cutflow	40 / 84	122 / 260



220637 220763 220758 220406 220405 220307 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	factor %	seconds
H35	N_2	12	49	85	60	**8**	188	11.0	2030	11.0	100	0.3
						10			1870			
						12	173	9.0	1710	9.0		0.4
						15	171	7.5	1465		120	0.5
						20	175		1085			0.6
						25	180		785			0.7
						32	185		630			1.0
						38	186		510	Edge start		
						44	189		390			
						50	200		270			

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	factor %	seconds
H35	N_2	12	49	85	60	**5/16**	188	0.45	80	0.45	100	0.3
						3/8			75			
						1/2	173	0.35	65	0.35		0.4
						5/8	171	0.30	55	0.36	120	0.5
						3/4	175		45			0.6
						1	180		30			0.7
						1-1/4	185		25			1.0
						1-1/2	186		20	Edge start		
						1-3/4	189		15			
						2	200		10			

Marking

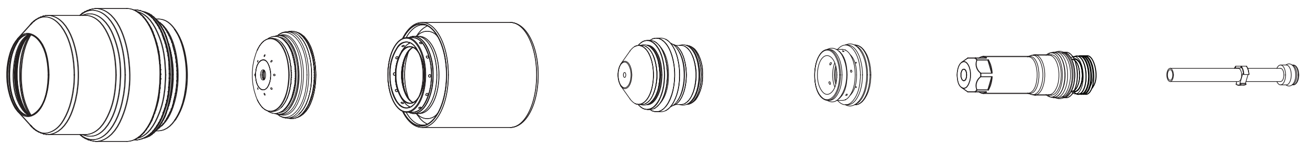
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	120
Ar	N_2	30	10	30	10	**20**	3.0	0.12	2540	100	63

Stainless steel

H35 and N_2 Plasma / N_2 Shield

260 A

<table>
<tr><th colspan="3">Flow rates – lpm/scfh</th></tr>
<tr><td></td><td>H35</td><td>N_2</td></tr>
<tr><td>Preflow</td><td>0 / 0</td><td>132 / 280</td></tr>
<tr><td>Cutflow</td><td>13 / 27</td><td>163 / 345</td></tr>
</table>



220637 220763 220758 220406 220405 220307 220340

Metric

<table>
<tr><th colspan="2">Select Gases</th><th colspan="2">Set Preflow</th><th colspan="4">Set Cutflow</th><th>Material Thickness</th><th>Arc Voltage</th><th>Torch-to-Work Distance</th><th>Cutting Speed</th><th colspan="2">Initial Pierce Height</th><th>Pierce Delay Time</th></tr>
<tr><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>Mix Gas 1</th><th>Mix Gas 2</th><th>mm</th><th>Volts</th><th>mm</th><th>mm/m</th><th>mm</th><th>Factor %</th><th>Seconds</th></tr>
<tr><td rowspan="11">H35</td><td rowspan="11">N_2</td><td rowspan="11">12</td><td rowspan="11">49</td><td rowspan="11">87</td><td rowspan="11">60</td><td rowspan="6">60</td><td rowspan="6">21</td><td>**6**</td><td>170</td><td rowspan="11">4.0</td><td>3980</td><td rowspan="8">8.0</td><td rowspan="8">200</td><td rowspan="3">0.3</td></tr>
<tr><td>**8**</td><td>173</td><td>3085</td></tr>
<tr><td>**10**</td><td>175</td><td>2190</td></tr>
<tr><td>**12**</td><td>176</td><td>1790</td><td>0.5</td></tr>
<tr><td>**15**</td><td>177</td><td>1650</td><td>0.7</td></tr>
<tr><td>**20**</td><td>179</td><td>1320</td><td>0.8</td></tr>
<tr><td rowspan="5">40</td><td rowspan="5">26</td><td>**25**</td><td>182</td><td>920</td><td>1.0</td></tr>
<tr><td>**32**</td><td>186</td><td>755</td><td>1.2</td></tr>
<tr><td>**38**</td><td>189</td><td>510</td><td colspan="3" rowspan="3">Edge start</td></tr>
<tr><td>**44**</td><td>195</td><td>390</td></tr>
<tr><td>**50**</td><td>202</td><td>270</td></tr>
</table>

English

<table>
<tr><th colspan="2">Select Gases</th><th colspan="2">Set Preflow</th><th colspan="4">Set Cutflow</th><th>Material Thickness</th><th>Arc Voltage</th><th>Torch-to-Work Distance</th><th>Cutting Speed</th><th colspan="2">Initial Pierce Height</th><th>Pierce Delay Time</th></tr>
<tr><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>Mix Gas 1</th><th>Mix Gas 2</th><th>in</th><th>Volts</th><th>in</th><th>ipm</th><th>in</th><th>Factor %</th><th>Seconds</th></tr>
<tr><td rowspan="11">H35</td><td rowspan="11">N_2</td><td rowspan="11">12</td><td rowspan="11">49</td><td rowspan="11">87</td><td rowspan="11">60</td><td rowspan="6">60</td><td rowspan="6">21</td><td>**1/4**</td><td>170</td><td rowspan="11">0.16</td><td>150</td><td rowspan="8">0.32</td><td rowspan="8">200</td><td rowspan="3">0.3</td></tr>
<tr><td>**5/16**</td><td>173</td><td>121</td></tr>
<tr><td>**3/8**</td><td>175</td><td>90</td></tr>
<tr><td>**1/2**</td><td>176</td><td rowspan="2">65</td><td>0.5</td></tr>
<tr><td>**5/8**</td><td>177</td><td>0.7</td></tr>
<tr><td>**3/4**</td><td>179</td><td>55</td><td>0.8</td></tr>
<tr><td rowspan="5">40</td><td rowspan="5">26</td><td>**1**</td><td>182</td><td>35</td><td>1.0</td></tr>
<tr><td>**1-1/4**</td><td>186</td><td>30</td><td>1.2</td></tr>
<tr><td>**1-1/2**</td><td>189</td><td>20</td><td colspan="3" rowspan="3">Edge start</td></tr>
<tr><td>**1-3/4**</td><td>187</td><td>15</td></tr>
<tr><td>**2**</td><td>202</td><td>10</td></tr>
</table>

Marking

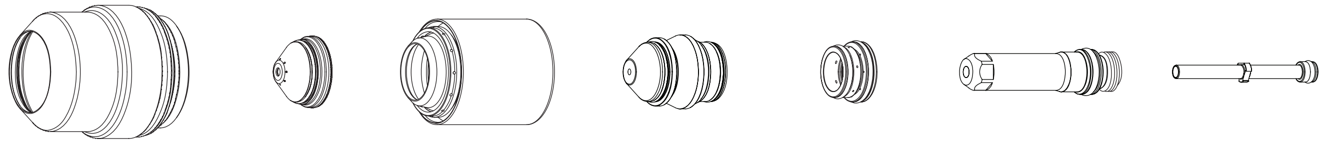
<table>
<tr><th colspan="2" rowspan="2">Select Gases</th><th colspan="2" rowspan="2">Set Preflow</th><th colspan="2" rowspan="2">Set Cutflow</th><th>Amperage</th><th colspan="2">Torch-to-Work Distance</th><th colspan="2">Marking Speed</th><th>Arc Voltage</th></tr>
<tr><th>Amps</th><th>mm</th><th>in</th><th>mm/m</th><th>ipm</th><th>Volts</th></tr>
<tr><td>N_2</td><td>N_2</td><td>10</td><td>10</td><td>10</td><td>10</td><td>**18**</td><td>2.5</td><td>0.10</td><td>6350</td><td>250</td><td>120</td></tr>
<tr><td>Ar</td><td>N_2</td><td>30</td><td>10</td><td>30</td><td>10</td><td>**20**</td><td>3.0</td><td>0.12</td><td>2540</td><td>100</td><td>63</td></tr>
</table>

Stainless steel bevel cutting

H35 Plasma / N_2 Shield

260 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	127 / 270
Cutflow	40 / 84	122 / 260



220637 220738 220739 220607 220405 220606 220571

Notes: Bevel angle range is 0° to 45°.

Metric

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	mm	**mm**	Range (mm)	mm/m	mm	factor %	seconds
H35	N_2	12	49	85	60	2.0	**8**	11.0	2030	11.0	100	0.3
							10		1870			
							12	9.0 – 10.0	1710	9.0		0.4
							15	7.5 – 10.0	1465		120	0.5
							20		1085			0.6
							25		785			0.7
							32		630			1.0
							38		510	Edge start		
							44		390			
							50		270			

English

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	in	**in**	Range (in)	ipm	in	factor %	seconds
H35	N_2	12	49	85	60	0.08	**5/16**	0.45 – 0.40	80	0.45	100	0.3
							3/8		75			
							1/2	0.35 – 0.40	65	0.35		0.4
							5/8	0.30 – 0.40	55	0.36	120	0.5
							3/4		45			0.6
							1		30			0.7
							1-1/4		25			1.0
							1-1/2		20	Edge start		
							1-3/4		15			
							2		10			

Marking

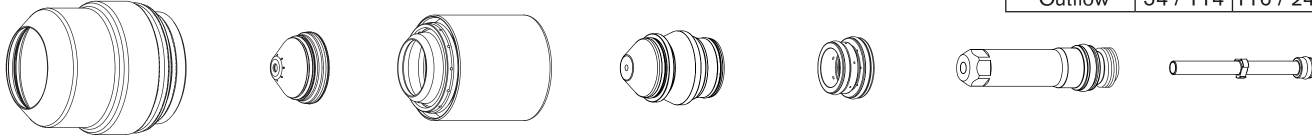
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	120
Ar	N_2	30	10	30	10	**20**	3.0	0.12	2540	100	63

Stainless steel bevel cutting

N_2 Plasma / Air Shield

260 A

Flow rates – lpm/scfh		
	N_2	Air
Preflow	127 / 270	0 / 0
Cutflow	54 / 114	116 / 245



220637 220738 220739 220607 220405 220606 220571

Note: Bevel angle range is 0° to 45°.

Metric

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	mm	**mm**	Range (mm)	mm/m	mm	factor %	seconds
							6		6375			
							8		4910			0.3
							10		3440			
							12		2960	7.5	200	0.4
							15		2520			0.5
N_2	Air	12	47	79	56	2.0	**20**	3.8 – 10.0	1590			0.6
							25		1300			0.8
							32		875			1.0
							38		515			
							44		365	Edge start		
							50		180			

English

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	in	**in**	Range (in)	ipm	in	factor %	seconds
							1/4		240			
							5/16		193			0.3
							3/8		140			
							1/2		110	0.3	200	0.4
							5/8		95			0.5
N_2	Air	12	47	79	56	0.08	**3/4**	0.15 – 0.40	70			0.6
							1		50			0.8
							1-1/4		35			1.0
							1-1/2		20			
							1-3/4		14	Edge start		
							2		6			

Marking

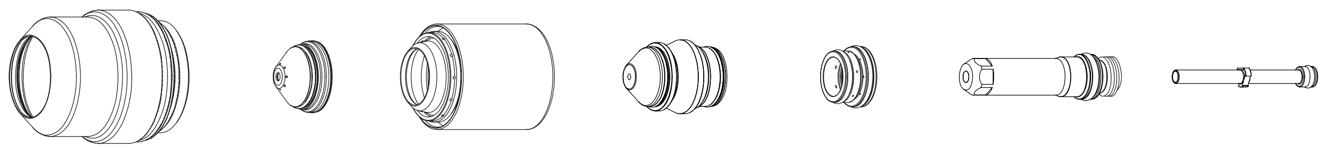
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	120
Ar	N_2	30	10	30	10	**20**	3.0	0.12	2540	100	63

Stainless steel bevel cutting

H35 and N_2 Plasma / N_2 Shield

260 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	132 / 280
Cutflow	13 / 27	163 / 345



220637 220738 220739 220607 220405 220606 220571

Note: Bevel angle range is 0° to 45°.

Metric

Select Gases		Set Preflow		Set Cutflow				Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Mix Gas 1	Mix Gas 2	mm	**mm**	Range (mm)	mm/m	mm	Factor %	Seconds
H35	N_2	12	49	87	60	60	21	2.0	**6**	4.0 – 10.0	3980	8.0	200	0.3
									8		3085			
									10		2190			
									12		1790			0.5
									15		1650			0.7
									20		1320			0.8
						40	26		**25**		920			1.0
									32		755			1.2
									38		510	Edge start		
									44		390			
									50		270			

English

Select Gases		Set Preflow		Set Cutflow				Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Mix Gas 1	Mix Gas 2	in	**in**	Range (in)	ipm	in	Factor %	Seconds
H35	N_2	12	49	87	60	60	21	0.08	**1/4**	0.16 – 0.40	150	0.32	200	0.3
									5/16		121			
									3/8		90			
									1/2		65			0.5
									5/8					0.7
									3/4		55			0.8
						40	26		**1**		35			1.0
									1-1/4		30			1.2
									1-1/2		20	Edge start		
									1-3/4		15			
									2		10			

Marking

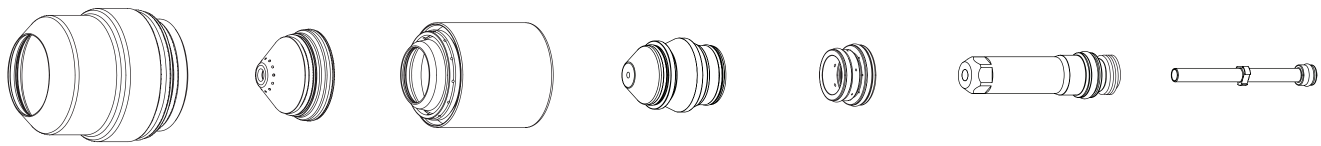
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	120
Ar	N_2	30	10	30	10	**20**	3.0	0.12	2540	100	63

Stainless steel

N_2 Plasma / Air Shield

400 A

Flow rates – lpm/scfh		
	N_2	Air
Preflow	42 / 90	146 / 310
Cutflow	86 / 182	102 / 217



220637 220707 220712 220708 220405 220709 220571

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
N_2	Air	30	50	85	31	**12**	158	3.8	3300	9.9	260	0.3
						15	159		2800			0.4
						20	162	4.6	2340	13.8	300	0.5
						25	164		1940			0.6
						30	176	6.4	1450	19.2		0.8
						40	177	4.6	570	Edge start		
						45	187		430			

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
N_2	Air	30	50	85	31	**1/2**	158	0.15	125	0.39	260	0.3
						5/8	159		105			0.4
						3/4	162	0.18	95	0.54	300	0.5
						1	164		75			0.6
						1-1/4	176	0.25	50	0.75		0.8
						1-1/2	177	0.18	25	Edge start		
						1-3/4	187		17			

Marking

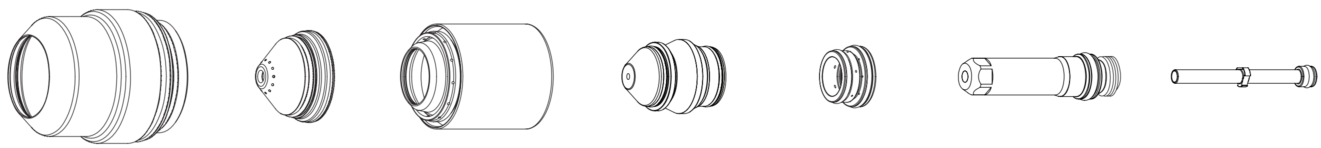
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**22**	2.5	0.10	1270	50	94
Ar	N_2	30	10	30	10	**24**	3.0	0.12	2540	100	50

Stainless steel

H35 Plasma / N_2 Shield

400 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	189 / 400
Cutflow	86 / 182	123 / 260



220637 220707 220712 220708 220405 220709 220571

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
H35	N_2	30	45	86	45	**20**	180	9.0	1100	14.5	150	0.7
						25	181		905	19.0	210	1.0
						30	184		800			1.5
						40	186		600			2.0
						50	192		400	Edge start		
						60	198		280			

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
H35	N_2	30	45	86	45	**3/4**	180	0.35	45	0.53	150	0.7
						1	181		35	0.75	210	1.0
						1-1/4	184		30			1.5
						1-1/2	186		25			2.0
						1-3/4	189		20	Edge start		
						2	192		15			
						2-1/4	198		12			
						2-1/2	202		10			

Marking

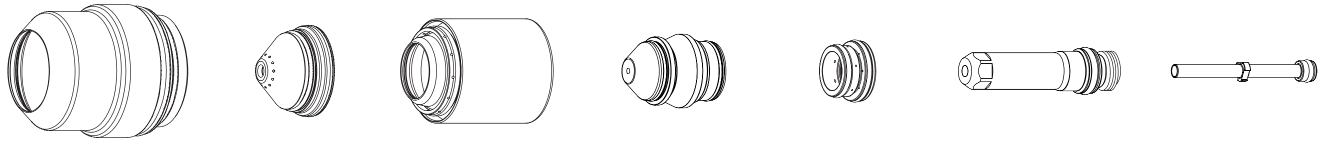
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**22**	2.5	0.10	1270	50	94
Ar	N_2	30	10	30	10	**24**	3.0	0.12	2540	100	50

Stainless steel

H35 and N_2 Plasma / N_2 Shield

400 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	194 / 410
Cutflow	36 / 77	194 / 410



220637 220707 220712 220708 220405 220709 220571

Metric

Select Gases		Set Preflow		Set Cutflow				**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Mix Gas 1	Mix Gas 2	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
H35	N_2	30	45	88	45	60	40	**12**	157	4.6	2750	14	300	0.4
								15	159		2390			0.5
								20	166		1810			0.7
								25	172		1310			1.0
							60	**30**	186	5.3	1080	16		2.0
								40	187	6.4	720	19		3.0
								45			635			
								50	190		520	Edge start		
								60	192		410			
								70	194		310			
								80	210		180			

English

Select Gases		Set Preflow		Set Cutflow				**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Mix Gas 1	Mix Gas 2	**in**	Volts	in	ipm	in	Factor %	Seconds
H35	N_2	30	45	88	45	60	40	**1/2**	157	0.18	105	0.5	300	0.4
								5/8	159		90			0.5
								3/4	166		75			0.7
								1	172		50			1.0
							60	**1-1/4**	182	0.21	40	0.6		1.5
								1-1/2	186	0.25	30	0.8		2.0
								1-3/4	187		25			3.0
								2	190		20	Edge start		
								2-1/4	192		17			
								2-1/2	194		15			
								3	202		10			

Marking

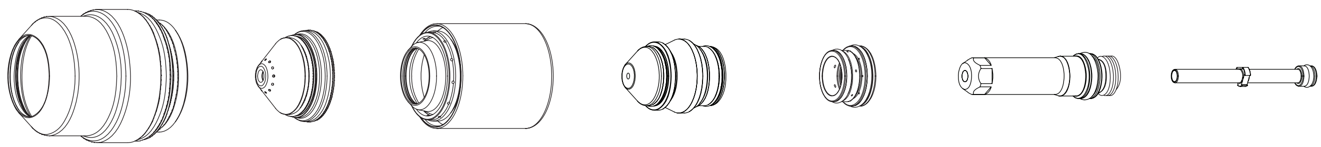
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**22**	2.5	0.10	1270	50	94
Ar	N_2	30	10	30	10	**24**	3.0	0.12	2540	100	50

Flow rates – lpm/scfh		
	N_2	Air
Preflow	42 / 90	146 / 310
Cutflow	86 / 182	102 / 217

Stainless steel bevel cutting

N_2 Plasma / Air Shield

400 A



220637 220707 220712 220708 220405 220709 220571

Note: Bevel angle range is 0° to 45°.

Metric

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	mm	**mm**	Range (mm)	mm/m	mm	Factor %	Seconds
N_2	Air	30	50	85	31	2.0	**12**	3.8 – 11.6	3300	9.9	260	0.3
							15		2800			0.4
							20	4.6 – 11.6	2340	13.8	300	0.5
							25		1940			0.6
							30	6.4 – 11.6	1450	19.2		0.8
							40	4.6 – 11.6	570	Edge start		
							45		430			

English

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	in	**in**	Range (in)	ipm	in	Factor %	Seconds
N_2	Air	30	50	85	31	0.08	**1/2**	0.15 – 0.46	125	0.39	260	0.3
							5/8		105			0.4
							3/4	0.18 – 0.46	95	0.54	300	0.5
							1		75			0.6
							1-1/4	0.25 – 0.46	50	0.75		0.8
							1-1/2	0.18 – 0.46	25	Edge start		
							1-3/4		17			

Marking

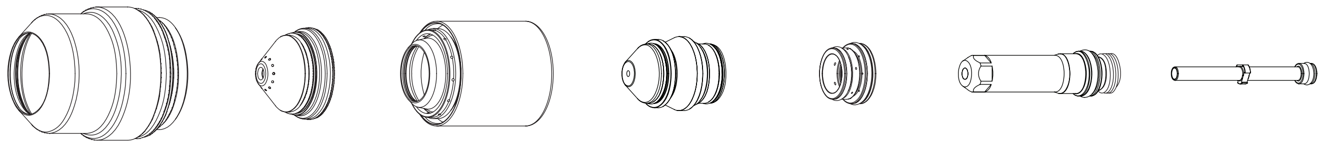
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**22**	2.5	0.10	1270	50	94
Ar	N_2	30	10	30	10	**24**	3.0	0.12	2540	100	50

Stainless steel bevel cutting

H35 Plasma / N_2 Shield

400 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	189 / 400
Cutflow	86 / 182	123 / 260



220637 220707 220712 220708 220405 220709 220571

Note: Bevel angle range is 0° to 45°.

Metric

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	mm	**mm**	Range (mm)	mm/m	mm	Factor %	Seconds
H35	N_2	30	45	86	45	2.0	**20**	9.0 – 11.6	1100	14.5	150	0.7
							25		905	19.0	210	1.0
							30		800			1.5
							40		600			2.0
							50		400	Edge start		
							60		280			

English

Select Gases		Set Preflow		Set Cutflow		Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	in	**in**	Range (in)	ipm	in	Factor %	Seconds
H35	N_2	30	45	86	45	0.08	**3/4**	0.35 – 0.46	45	0.53	150	0.7
							1		35	0.75	210	1.0
							1-1/4		30			1.5
							1-1/2		25			2.0
							1-3/4		20	Edge start		
							2		15			
							2-1/4		12			
							2-1/2		10			

Marking

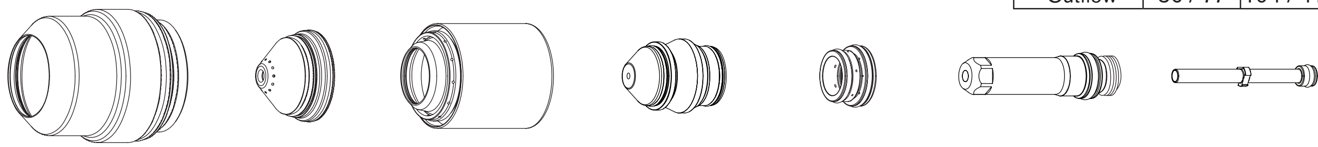
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**22**	2.5	0.10	1270	50	94
Ar	N_2	30	10	30	10	**24**	3.0	0.12	2540	100	50

Stainless steel bevel cutting

H35 and N_2 Plasma / N_2 Shield

400 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	194 / 410
Cutflow	36 / 77	194 / 410



220637 220707 220712 220708 220405 220709 220571

Note: Bevel angle range is 0° to 45°.

Metric

Select Gases		Set Preflow		Set Cutflow				Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Mix Gas 1	Mix Gas 2	mm	**mm**	Range (mm)	mm/m	mm	Factor %	Seconds
H35	N_2	30	45	88	45	60	40	2.0	**12**	4.6 – 11.6	2750	14	300	0.4
									15		2390			0.5
									20		1810			0.7
									25		1310			1.0
							60		**30**	5.3 – 11.6	1080	16		2.0
									40	6.4 – 11.6	720	19		3.0
									50		520	Edge start		
									60		410			
									70		310			
									80		180			

English

Select Gases		Set Preflow		Set Cutflow				Minimum Clearance	**Equivalent Material Thickness**	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Mix Gas 1	Mix Gas 2	in	**in**	Range (in)	ipm	in	Factor %	Seconds
H35	N_2	30	45	88	45	60	40	0.08	**1/2**	0.18 – 0.46	105	0.5	300	0.4
									5/8		90			0.5
									3/4		75			0.7
									1		50			1.0
							60		**1-1/4**	0.21 – 0.46	40	0.6		1.5
									1-1/2	0.25 – 0.46	30	0.8		2.0
									1-3/4		25			3.0
									2		20	Edge start		
									2-1/4		17			
									2-1/2		15			
									3		10			

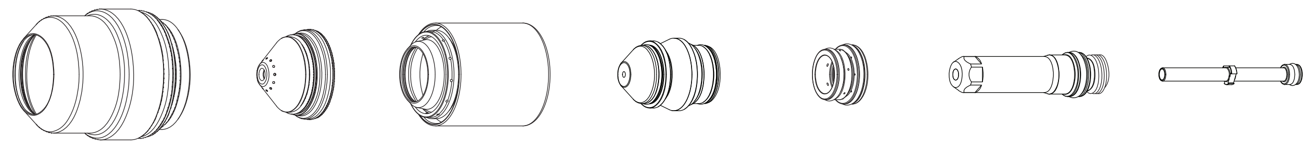
Marking

Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**22**	2.5	0.10	1270	50	94
Ar	N_2	30	10	30	10	**24**	3.0	0.12	2540	100	50

Stainless steel – Moving pierce

H35 and N_2 Plasma / N_2 Shield

400 A



220637 220707 220712 220708 220405 220709 220571

Moving pierce (MP) parameters – metric

Material Thickness	First Segment	First Speed	Second Segment	Second Speed	Third Segment	Third Speed	Pierce Delay Time	Transfer Height Factor	Moving Delay Factor	Pierce Height Factor	End Height Factor	Torch-to-Work Distance*	Cut Height Delay	MP AVC Delay
mm	mm	mm/m	mm	mm/m	mm	mm/m	Seconds	% Cut Height	% Pierce Delay	% Cut Height	% Cut Height	mm	Seconds	Seconds
50	19.1	1143	10.6	381	38.1	508	4.8	300	50	500	250	6.4	0.5	5.7
75	25.3			508	63.5	254	8.0						3.0	4.0

Moving pierce (MP) parameters – English

Material Thickness	First Segment	First Speed	Second Segment	Second Speed	Third Segment	Third Speed	Pierce Delay Time	Transfer Height Factor	Moving Delay Factor	Pierce Height Factor	End Height Factor	Torch-to-Work Distance*	Cut Height Delay	MP AVC Delay
inch	in	ipm	in	ipm	in	ipm	Seconds	% Cut Height	% Pierce Delay	% Cut Height	% Cut Height	in	Seconds	Seconds
2.0	0.75	45	0.42	15	1.5	20	4.8	300	50	500	250	0.25	0.5	5.7
3.0	1.00			20	2.5	10	8.0						3.0	4.0

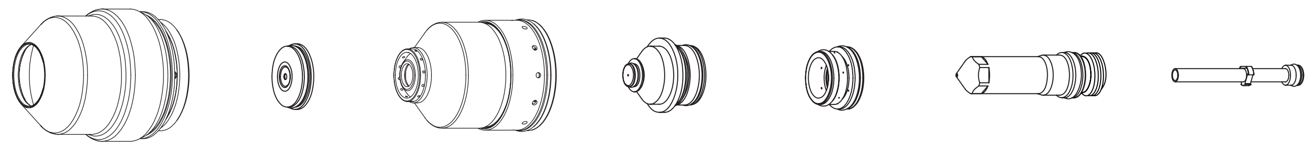
Note: *Torch-to-work distance is equivalent to cut height

Aluminum

Air Plasma / Air Shield

45 A

Flow rates – lpm/scfh	
	Air
Preflow	45 / 95
Cutflow	78 / 165



220747 220202 220756 220201 220180 220308 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
Air	Air	35	19	62	49	**1.2**	130	2.5	4750	3.8	150	0.2
						1.5	115		4160			
						2	113		3865			
						2.5	110		3675			
						3	107		2850			
					33	**4**	102	1.8	2660	2.7		0.3
						6	117	3.0	1695	4.5		0.6

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
Air	Air	35	19	62	49	**0.040**	130	0.10	220	0.15	150	0.2
						0.051	115		170			
						0.064	113		160			
						0.102	110		140			
					33	**0.125**	102	0.07	110	0.11		0.3
						3/16	114	0.12	90	0.18		0.4
						1/4	117		60			0.6

Marking

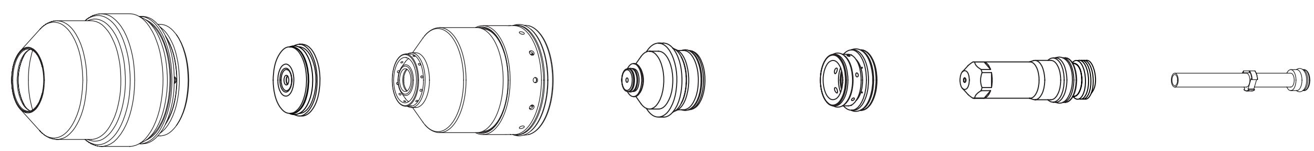
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**15**	2.5	0.10	6350	250	85
Ar	Air	90	10	90	10	**12**	2.5	0.10	2540	100	75

Aluminum

Air Plasma / Air Shield

130 A

<table>
<tr><th colspan="2">Flow rates – lpm/scfh</th></tr>
<tr><td></td><td>Air</td></tr>
<tr><td>Preflow</td><td>73 / 154</td></tr>
<tr><td>Cutflow</td><td>78 / 165</td></tr>
</table>



220747 220198 220756 220197 220179 220181 220340

Metric

<table>
<tr><th colspan="2">Select Gases</th><th colspan="2">Set Preflow</th><th colspan="2">Set Cutflow</th><th>Material Thickness</th><th>Arc Voltage</th><th>Torch-to-Work Distance</th><th>Cutting Speed</th><th colspan="2">Initial Pierce Height</th><th>Pierce Delay Time</th></tr>
<tr><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>mm</th><th>Volts</th><th>mm</th><th>mm/m</th><th>mm</th><th>Factor %</th><th>Seconds</th></tr>
<tr><td rowspan="7">Air</td><td rowspan="7">Air</td><td rowspan="7">19</td><td rowspan="7">31</td><td rowspan="7">75</td><td rowspan="7">23</td><td>6</td><td>153</td><td>2.8</td><td>2370</td><td>5.6</td><td rowspan="6">200</td><td>0.2</td></tr>
<tr><td>8</td><td rowspan="2">154</td><td rowspan="3">3.0</td><td>1920</td><td rowspan="3">6.0</td><td rowspan="2">0.3</td></tr>
<tr><td>10</td><td>1465</td></tr>
<tr><td>12</td><td>156</td><td>1225</td><td>0.5</td></tr>
<tr><td>15</td><td>158</td><td>3.3</td><td>1050</td><td>6.6</td><td>0.8</td></tr>
<tr><td>20</td><td>162</td><td>3.5</td><td>725</td><td>7.0</td><td>1.3</td></tr>
<tr><td>25</td><td>172</td><td>4.0</td><td>525</td><td colspan="3">Edge start</td></tr>
</table>

English

<table>
<tr><th colspan="2">Select Gases</th><th colspan="2">Set Preflow</th><th colspan="2">Set Cutflow</th><th>Material Thickness</th><th>Arc Voltage</th><th>Torch-to-Work Distance</th><th>Cutting Speed</th><th colspan="2">Initial Pierce Height</th><th>Pierce Delay Time</th></tr>
<tr><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>Plasma gas</th><th>Shield gas</th><th>in</th><th>Volts</th><th>in</th><th>ipm</th><th>in</th><th>Factor %</th><th>Seconds</th></tr>
<tr><td rowspan="7">Air</td><td rowspan="7">Air</td><td rowspan="7">19</td><td rowspan="7">31</td><td rowspan="7">75</td><td rowspan="7">23</td><td>1/4</td><td>153</td><td>0.11</td><td>90</td><td>0.22</td><td rowspan="6">200</td><td>0.2</td></tr>
<tr><td>5/16</td><td rowspan="2">154</td><td rowspan="3">0.12</td><td>76</td><td rowspan="3">0.24</td><td rowspan="2">0.3</td></tr>
<tr><td>3/8</td><td>60</td></tr>
<tr><td>1/2</td><td>156</td><td>45</td><td>0.5</td></tr>
<tr><td>5/8</td><td>158</td><td>0.13</td><td>40</td><td>0.26</td><td>0.8</td></tr>
<tr><td>3/4</td><td>162</td><td>0.14</td><td>30</td><td>0.28</td><td>1.3</td></tr>
<tr><td>1</td><td>172</td><td>0.16</td><td>20</td><td colspan="3">Edge start</td></tr>
</table>

Marking

<table>
<tr><th colspan="2" rowspan="2">Select Gases</th><th colspan="2" rowspan="2">Set Preflow</th><th colspan="2" rowspan="2">Set Cutflow</th><th>Amperage</th><th colspan="2">Torch-to-Work Distance</th><th colspan="2">Marking Speed</th><th>Arc Voltage</th></tr>
<tr><th>Amps</th><th>mm</th><th>in</th><th>mm/m</th><th>ipm</th><th>Volts</th></tr>
<tr><td>N_2</td><td>N_2</td><td>10</td><td>10</td><td>10</td><td>10</td><td>18</td><td>2.5</td><td>0.10</td><td>6350</td><td>250</td><td>120</td></tr>
<tr><td>Ar</td><td>Air</td><td>50</td><td>10</td><td>50</td><td>10</td><td>15</td><td>3.0</td><td>0.12</td><td>2540</td><td>100</td><td>82</td></tr>
</table>

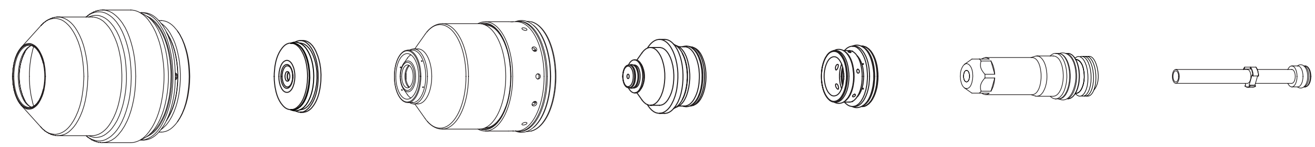
Note: This process produces a rougher cut edge that is less perpendicular than the 130 A, H35/N_2 process.

Aluminum

H35 Plasma / N_2 Shield

130 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	76 / 160
Cutflow	26 / 54	68 / 144



220747 220198 220755 220197 220179 220307 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
H35	N_2	19	32	75	49	**8**	158	5.0	1775	6.5	130	0.3
						10			1615			
					37	**12**	156	4.5	1455	7.7	170	0.5
					24	**15**			1305			0.8
						20	157		940			1.3
					16	**25**	176		540	Edge start		

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
H35	N_2	19	32	75	49	**5/16**	158	0.20	70	0.26	130	0.3
						3/8			65			
					37	**1/2**	156	0.18	55	0.31	170	0.5
					24	**5/8**			50			0.8
						3/4	157		40			1.3
					16	**1**	176		20	Edge start		

Marking

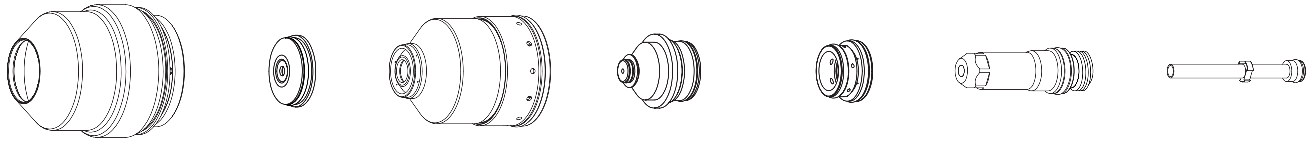
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	130
Ar	N_2	50	10	50	10	**15**	3.0	0.12	2540	100	75

Aluminum

H35 and N_2 Plasma / N_2 Shield

130 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	97 / 205
Cutflow	13 / 28	71 / 150



220747 220198 220755 220197 220179 220307 220340

Metric

Select Gases		Set Preflow		Set Cutflow				**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Mix Gas 1	Mix Gas 2	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
H35	N_2	19	51	75	27	32	18	**6**	156	3.5	2215	7.0	200	0.3
								8	157		1915			
								10	158		1615			
								12	159	3.0	1455	6.0		0.5
								15	160		1215			0.8
								20	163		815			1.3

English

Select Gases		Set Preflow		Set Cutflow				**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Mix Gas 1	Mix Gas 2	**in**	Volts	in	ipm	in	Factor %	Seconds
H35	N_2	19	51	75	27	32	18	**1/4**	156	0.14	85	0.28	200	0.3
								5/16	157		75			
								3/8	158		65			
								1/2	159	0.12	55	0.24		0.5
								5/8	160		45			0.8
								3/4	163		35			1.3

Marking

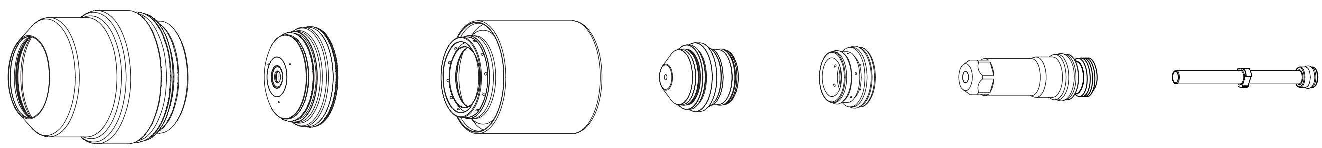
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	130
Ar	N_2	50	10	50	10	**15**	3.0	0.12	2540	100	75

Aluminum

N_2 Plasma / N_2 Shield

200 A

Flow rates – lpm/scfh	
	N_2
Preflow	113 / 240
Cutflow	135 / 287



220637 220762 220759 220346 220342 220307 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
						8			6000			0.3
						10	158		4750			0.4
N_2	N_2	17	43	73	43	**12**		6.4	3500	9.0	140	0.5
						15	166		2350			0.6
						20	165		1000			0.8

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
						5/16			236			0.3
						3/8	158		200			0.4
N_2	N_2	17	43	73	43	**1/2**		0.25	120	0.35	140	0.5
						5/8	166		80			0.6
						3/4	165		50			0.8

Marking

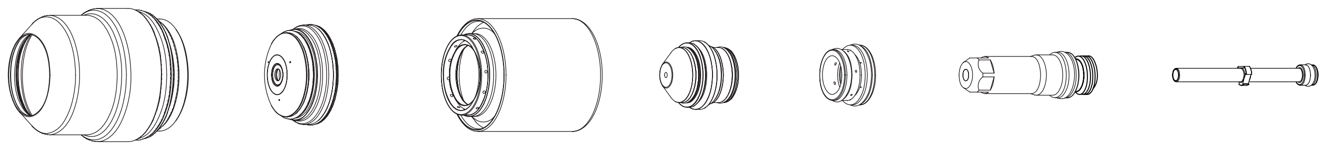
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	140
Ar	N_2	30	10	30	10	**20**	3.0	0.12	2540	100	66

Aluminum

H35 Plasma / N_2 Shield

200 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	113 / 240
Cutflow	34 / 72	90 / 190



220637 220762 220759 220346 220342 220307 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
H35	N_2	17	43	73	43	**8**	152	6.4	5000	9.0	140	0.3
						10			4400			
						12	150		3800			0.4
						15			3000			0.5
						20	159		1450			0.6

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
H35	N_2	17	43	73	43	**5/16**	152	0.25	197	0.35	140	0.3
						3/8			180			
						1/2	150		140			0.4
						5/8			110			0.5
						3/4	159		70			0.6

Marking

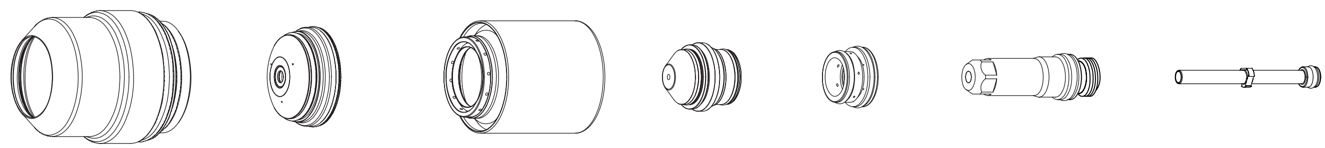
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	140
Ar	N_2	30	10	30	10	**20**	3.0	0.12	2540	100	66

Aluminum

H35 and N_2 Plasma / N_2 Shield

200 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	121 / 256
Cutflow	13 / 27	126 / 267



220637 220762 220759 220346 220342 220307 220340

Metric

Select Gases		Set Preflow		Set Cutflow				**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Mix Gas 1	Mix Gas 2	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
H35	N_2	17	44	73	44	42	20	**8**	158	6.4	4350	9.0	140	0.3
								10			4000			
								12			3650			0.4
								15	162		2450			0.5
								20	170		1050			0.6

English

Select Gases		Set Preflow		Set Cutflow				**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	Mix Gas 1	Mix Gas 2	**in**	Volts	in	ipm	in	Factor %	Seconds
H35	N_2	17	44	73	44	42	20	**5/16**	158	0.25	171	0.35	140	0.3
								3/8			160			
								1/2			140			0.4
								5/8	162		80			0.5
								3/4	170		50			0.6

Marking

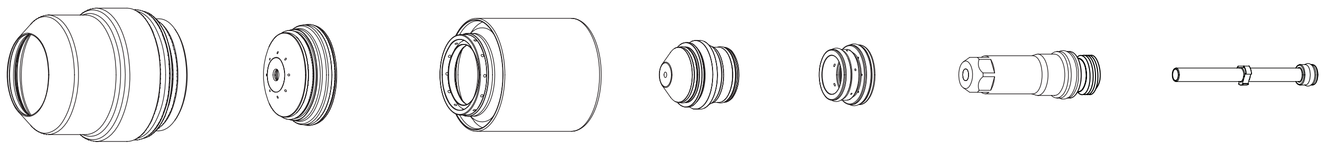
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	140
Ar	N_2	30	10	30	10	**20**	3.0	0.12	2540	100	66

Aluminum

N_2 Plasma / Air Shield

260 A

Flow rates – lpm/scfh		
	N_2	Air
Preflow	125 / 265	0 / 0
Cutflow	50 / 105	113 / 240



220637 220763 220758 220406 220405 220307 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
N_2	Air	12	49	74	56	**6**	172	6.4	7900	9.0	140	0.2
						8			6415			0.3
						10	171		4930			0.4
						12	164	4.0	4290	8.0	200	0.5
						15	165		3330			0.6
						20	171		1940			
						25	177		1440	11.0	260	0.8
						32	191		940	Edge start		
						38	195		520			
						44	202		320			
						50	205		215			

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
N_2	Air	12	49	74	56	**1/4**	172	0.25	300	0.35	140	0.2
						5/16			253			0.3
						3/8	171		200			0.4
						1/2	164	0.16	160	0.32	200	0.5
						5/8	165		120			0.6
						3/4	171		80			
						1	177		55	0.42	260	0.8
						1-1/4	190		40	Edge start		
						1-1/2	195		20			
						1-3/4	202		12			
						2	205		8			

Marking

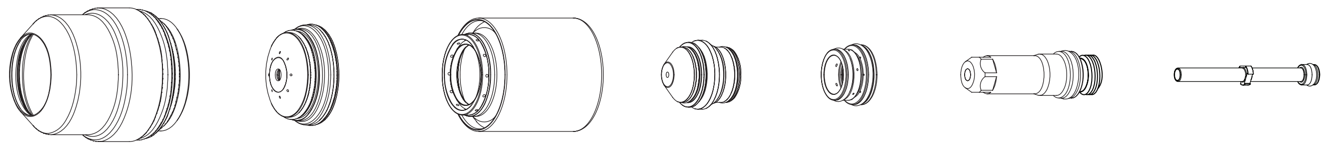
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	120
Ar	N_2	30	10	30	10	**20**	3.0	0.12	2540	100	63

Aluminum

H35 Plasma / N_2 Shield

260 A

Flow rates – lpm/scfh		
	H35	N_2
Preflow	0 / 0	127 / 270
Cutflow	33 / 70	118 / 250



220637 220763 220758 220406 220405 220307 220340

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
H35	N_2	12	49	76	58	**6**	170	11.0	7200	11.0	100	0.2
						8			6660			0.3
						10		10.0	6120	10.0		0.4
						12	162	7.6	5160	8.5	110	0.5
						15	163		3720			0.6
						20	166		2230			
						25	174		1930	11.0	150	0.8
						32	175		1510	Edge start		
						38	176		1150			
						44	183		670			
						50	190		390			

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
H35	N_2	12	49	76	58	**1/4**	170	0.45	280	0.45	100	0.2
						5/16			262			0.3
						3/8		0.40	250	0.40		0.4
						1/2	162	0.30	190	0.33	110	0.5
						5/8	163		130			0.6
						3/4	166		90			
						1	174		75	0.45	150	0.8
						1-1/4	175		60	Edge start		
						1-1/2	176		45			
						1-3/4	183		25			
						2	190		14			

Marking

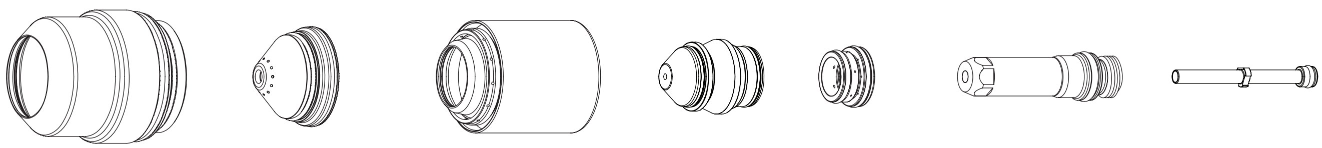
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**18**	2.5	0.10	6350	250	120
Ar	N_2	30	10	30	10	**20**	3.0	0.12	2540	100	63

Aluminum

N_2 Plasma / Air Shield

400 A

Flow rates – lpm/scfh		
	N_2	Air
Preflow	42 / 90	146 / 310
Cutflow	68 / 144	103 / 219



220637 220707 220712 220708 220405 220709 220571

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
N_2	Air	30	50	70	31	**12**	155	3.8	4480	12.5	330	0.4
						15	159		3770			0.5
						20	163	4.1	2740	18.0	440	0.6
						25	169		1850			0.7
						30	175		1410	Edge start		
						40	188		810			
						50	206		410			

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
N_2	Air	30	50	70	31	**1/2**	155	0.15	170	0.5	330	0.4
						5/8	159		140			0.5
						3/4	163	0.16	115	0.7	440	0.6
						1	169		70			0.7
						1-1/4	177		50	Edge start		
						1-1/2	178		35			
						1-3/4	198		25			
						2	206		16			

Marking

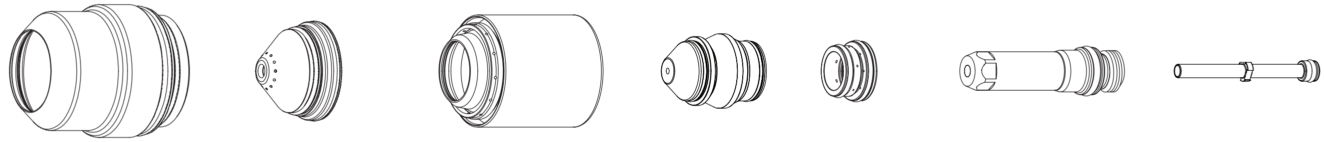
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**22**	2.5	0.10	1270	50	94
Ar	N_2	30	10	30	10	**24**	3.0	0.12	2540	100	50

Aluminum

H35 Plasma / N_2 Shield

400 A

Flow rates – lpm/scfh		
	N_2	Air
Preflow	0 / 0	189 / 400
Cutflow	86 / 182	123 / 260



220637 220707 220712 220708 220405 220709 220571

Metric

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**mm**	Volts	mm	mm/m	mm	Factor %	Seconds
H35	N_2	30	45	86	45	**20**	170	9.0	2420	13.5	150	0.7
						25	175		1820	18.9	210	1.0
						30	177		1590			1.5
						40	180		1190			2.0
						50	188		790	Edge start		
						60	200		450			
						70	208		310			
						80	210		210			

English

Select Gases		Set Preflow		Set Cutflow		**Material Thickness**	Arc Voltage	Torch-to-Work Distance	Cutting Speed	Initial Pierce Height		Pierce Delay Time
Plasma gas	Shield gas	Plasma gas	Shield gas	Plasma gas	Shield gas	**in**	Volts	in	ipm	in	Factor %	Seconds
H35	N_2	30	45	86	45	**3/4**	170	0.35	100	0.53	150	0.7
						1	175		70	0.74	210	1.0
						1-1/4	177		60			1.5
						1-1/2	180		50			2.0
						1-3/4	184		40	Edge start		
						2	188		30			
						2-1/4	200		20			
						2-1/2	208		15			
						3	210		10			

Marking

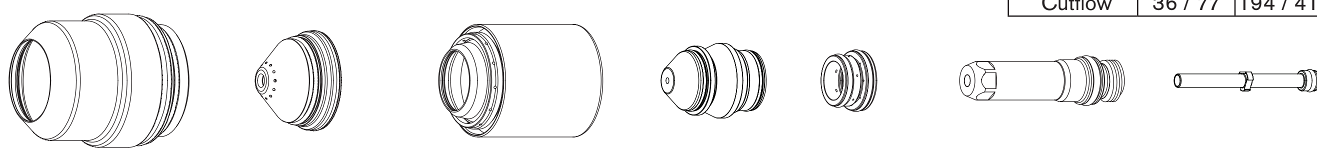
Select Gases		Set Preflow		Set Cutflow		**Amperage**	Torch-to-Work Distance		Marking Speed		Arc Voltage
						Amps	mm	in	mm/m	ipm	Volts
N_2	N_2	10	10	10	10	**22**	2.5	0.10	1270	50	94
Ar	N_2	30	10	30	10	**24**	3.0	0.12	2540	100	50

Aluminum

H35 and N_2 Plasma / N_2 Shield

400 A

<table>
<tr><th colspan="3">Flow rates – lpm/scfh</th></tr>
<tr><td></td><td>H35</td><td>N_2</td></tr>
<tr><td>Preflow</td><td>0 / 0</td><td>194 / 410</td></tr>
<tr><td>Cutflow</td><td>36 / 77</td><td>194 / 410</td></tr>
</table>



220637 220707 220712 220708 220405 220709 220571

Metric

<table>
<tr><th colspan="2">Select Gases</th><th colspan="2">Set Preflow</th><th colspan="4">Set Cutflow</th><th>Material Thickness</th><th>Arc Voltage</th><th>Torch-to-Work Distance</th><th>Cutting Speed</th><th colspan="2">Initial Pierce Height</th><th>Pierce Delay Time</th></tr>
<tr><td>Plasma gas</td><td>Shield gas</td><td>Plasma gas</td><td>Shield gas</td><td>Plasma gas</td><td>Shield gas</td><td>Mix Gas 1</td><td>Mix Gas 2</td><td>mm</td><td>Volts</td><td>mm</td><td>mm/m</td><td>mm</td><td>Factor %</td><td>Seconds</td></tr>
<tr><td rowspan="10">H35</td><td rowspan="10">N_2</td><td rowspan="10">30</td><td rowspan="10">45</td><td rowspan="10">88</td><td rowspan="10">45</td><td rowspan="10">60</td><td rowspan="4">40</td><td>12</td><td>155</td><td rowspan="4">4.6</td><td>5190</td><td rowspan="4">14</td><td rowspan="6">300</td><td>0.4</td></tr>
<tr><td>15</td><td>157</td><td>4710</td><td>0.5</td></tr>
<tr><td>20</td><td>159</td><td>3620</td><td>0.7</td></tr>
<tr><td>25</td><td>166</td><td>2620</td><td>1.0</td></tr>
<tr><td rowspan="6">60</td><td>30</td><td>171</td><td>5.3</td><td>2170</td><td>16</td><td>1.5</td></tr>
<tr><td>40</td><td>175</td><td rowspan="5">6.4</td><td>1440</td><td>19</td><td>2.0</td></tr>
<tr><td>50</td><td>185</td><td>1000</td><td colspan="3" rowspan="4">Edge start</td></tr>
<tr><td>60</td><td>195</td><td>450</td></tr>
<tr><td>70</td><td>200</td><td>310</td></tr>
<tr><td>80</td><td>208</td><td>210</td></tr>
</table>

English

<table>
<tr><th colspan="2">Select Gases</th><th colspan="2">Set Preflow</th><th colspan="4">Set Cutflow</th><th>Material Thickness</th><th>Arc Voltage</th><th>Torch-to-Work Distance</th><th>Cutting Speed</th><th colspan="2">Initial Pierce Height</th><th>Pierce Delay Time</th></tr>
<tr><td>Plasma gas</td><td>Shield gas</td><td>Plasma gas</td><td>Shield gas</td><td>Plasma gas</td><td>Shield gas</td><td>Mix Gas 1</td><td>Mix Gas 2</td><td>in</td><td>Volts</td><td>in</td><td>ipm</td><td>in</td><td>Factor %</td><td>Seconds</td></tr>
<tr><td rowspan="12">H35</td><td rowspan="12">N_2</td><td rowspan="12">30</td><td rowspan="12">45</td><td rowspan="12">88</td><td rowspan="12">45</td><td rowspan="12">60</td><td rowspan="4">40</td><td>1/2</td><td>155</td><td rowspan="4">0.18</td><td>200</td><td rowspan="4">0.5</td><td rowspan="6">300</td><td>0.4</td></tr>
<tr><td>5/8</td><td>157</td><td>180</td><td>0.5</td></tr>
<tr><td>3/4</td><td>159</td><td>150</td><td>0.7</td></tr>
<tr><td>1</td><td>166</td><td>100</td><td>1.0</td></tr>
<tr><td rowspan="8">60</td><td>1-1/4</td><td>171</td><td>0.21</td><td>80</td><td>0.6</td><td>1.5</td></tr>
<tr><td>1-1/2</td><td>175</td><td rowspan="7">0.25</td><td>60</td><td>0.8</td><td>2.0</td></tr>
<tr><td>1-3/4</td><td>180</td><td>50</td><td colspan="3" rowspan="6">Edge start</td></tr>
<tr><td>2</td><td>185</td><td>40</td></tr>
<tr><td>2-1/4</td><td>195</td><td>20</td></tr>
<tr><td>2-1/2</td><td>200</td><td>15</td></tr>
<tr><td>3</td><td>208</td><td>10</td></tr>
</table>

Marking

<table>
<tr><th colspan="2" rowspan="2">Select Gases</th><th colspan="2" rowspan="2">Set Preflow</th><th colspan="2" rowspan="2">Set Cutflow</th><th>Amperage</th><th colspan="2">Torch-to-Work Distance</th><th colspan="2">Marking Speed</th><th>Arc Voltage</th></tr>
<tr><td>Amps</td><td>mm</td><td>in</td><td>mm/m</td><td>ipm</td><td>Volts</td></tr>
<tr><td>N_2</td><td>N_2</td><td>10</td><td>10</td><td>10</td><td>10</td><td>22</td><td>2.5</td><td>0.10</td><td>1270</td><td>50</td><td>94</td></tr>
<tr><td>Ar</td><td>N_2</td><td>30</td><td>10</td><td>30</td><td>10</td><td>24</td><td>3.0</td><td>0.12</td><td>2540</td><td>100</td><td>50</td></tr>
</table>

Section 5

MAINTENANCE

In this section:

Introduction

Hypertherm assumes that the service personnel performing the troubleshooting testing are high-level electronic service technicians who have worked with high-voltage electro-mechanical systems. Knowledge of final isolation troubleshooting techniques is also assumed.

In addition to being technically qualified, maintenance personnel must perform all testing with safety in mind. Refer to the *Safety* section for operating precautions and warning formats.

WARNING
SHOCK HAZARD

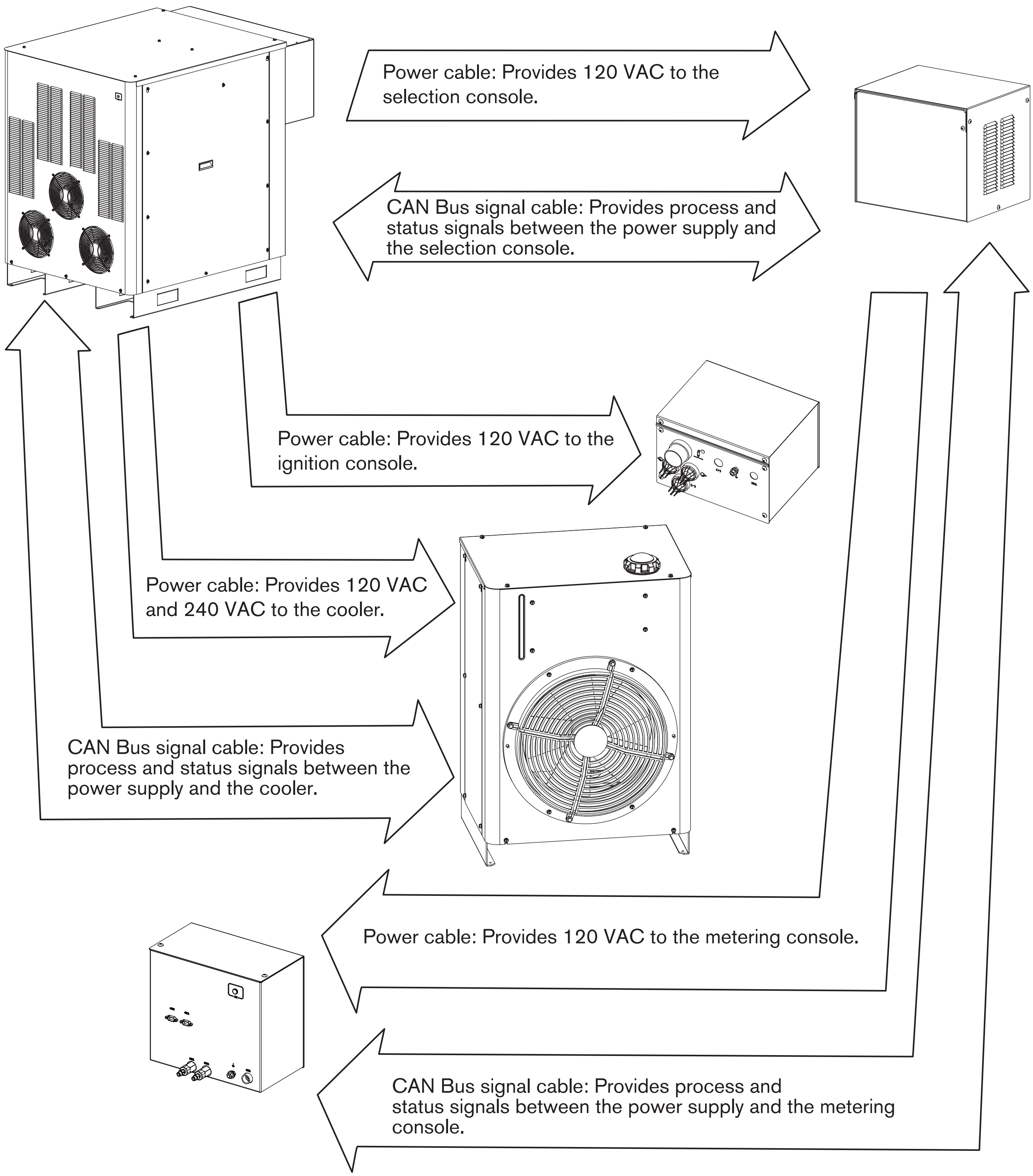
Use extreme care when working near the chopper modules. Each large electrolytic capacitor (blue-cased cylinder) stores large amounts of energy in the form of electric voltage. Even if the power is off, dangerous voltages exist at the capacitor terminals, on the chopper, and the diode heatsinks. Never discharge any capacitor with a screwdriver or other implement… explosion, property damage and/or personal injury will result.

Routine maintenance

See *Preventive Maintenance,* located at the end of this section, for maintenance information. Contact the Technical Services department listed at the front of this manual with any questions regarding maintenance procedures.

System description

Power and signal cables



Sequence of operation

1. Power-up – The system verifies that all of these signals are off at power-up
   Coolant flow off
   Chopper current off
   Transfer off
   Phase-loss off
   Chopper 1 overtemp off
   Magnetics overtemp off
   Coolant overtemp off
   Plasma start off

2. Purge – Air or N_2 gas flows through torch for 20 seconds
   Contactor closes and the chopper performs a chopper test and a current sensor test
   Plasma start off
   Contactor remains closed when the purge cycle ends

3. Idle
   Gas pressure ok
   Coolant flow on
   Chopper current off
   Line voltage ok

4. Preflow – 2-second flow of gas

5. Pilot arc – Current flows between electrode and nozzle
   Chopper, main contactor and pilot arc relay are on
   High frequency present
   Chopper current sensor = pilot arc current

6. Transfer – Pilot arc current sensed on the worklead

7. Ramp-up – Chopper current increases to its setpoint and gas changes to cutflow
   Coolant flow on
   Gas pressure ok
   Phase-loss on
   Line voltage ok

8. Steady state – normal operating parameters
   Coolant flow on
   Gas pressure ok
   Phase loss on
   Chopper 1 overtemp off
   Magnetics overtemp off
   Coolant overtemp off

9. Ramp-down – Current and gas flow decrease after plasma start has been removed
   Cutflow gas off

10. Auto Off – 10-second postflow
    Main contactors off
    Choppers off

Gas system purge cycle

When the system is turned on, or the operator changes from one cut process to another, the system automatically goes through a purge cycle. The purge cycle has 2 stages; a preflow purge and a cutflow purge.

The preflow purge gas flows for 8 seconds with an auto gas console, or 12 seconds with a manual gas console.

The cutflow purge gas flows for 8 seconds with an auto gas console, or 12 seconds with a manual gas console.

There are 2 exceptions to the cycle described above.

Exception 1 – if the operator changes from a non-fuel gas process (O_2/Air, Air/Air, or N_2/Air) to a fuel gas process (H35/N_2, or F5/N_2) or the reverse, there will be 3 stages to the purge process. Nitrogen will purge the gas system first, for 12 seconds. The preflow and cutflow purges will follow the nitrogen purge.

Note: Error code 42 (low nitrogen gas pressure) will be displayed, if nitrogen is not connected to the gas system. If error code 42 is not resolved in 3 minutes, it will be replaced by error code 139 (purge time-out error).

Exception 2 – no purge cycle will occur if the operator changes from any cut process to a nitrogen or argon marking process.

Gas system valve usage

The following tables show which valves are active for each cutting process.

O_2/O_2 process	Metering console control board				Selection console control board															
LED number	38	39	28	37	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Preflow	B4		B2		SV1		SV3					SV8		SV10						
Cutflow		B3		B1	SV1		SV3					SV8		SV10						

O_2/Air process	Metering console control board				Selection console control board															
LED number	38	39	28	37	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Preflow	B4		B2		SV1		SV3					SV8		SV10						
Cutflow		B3	B2		SV1		SV3					SV8		SV10						

N_2/N_2 process	Metering console control board				Selection console control board															
LED number	38	39	28	37	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Preflow	B4			B1									SV9		SV11					
Cutflow	B4			B1									SV9		SV11					

$F5/N_2$ process	Metering console control board				Selection console control board															
LED number	38	39	28	37	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Preflow		B3		B1						SV6			SV9							
Cutflow	B4			B1						SV6			SV9					SV14		

$H35/N_2$ process	Metering console control board				Selection console control board															
LED number	38	39	28	37	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Preflow		B3		B1					SV5				SV9							
Cutflow	B4			B1					SV5				SV9					SV14		

H35 & N_2/N_2 process	Metering console control board				Selection console control board															
LED number	38	39	28	37	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Preflow		B3		B1					SV5				SV9							
Cutflow	B4			B1					SV5				SV9			SV12	SV13			

N_2/Air process	Metering console control board				Selection console control board															
LED number	38	39	28	37	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Preflow		B3	B2				SV3						SV9	SV10						
Cutflow		B3	B2				SV3						SV9	SV10						

Air/Air process	Metering console control board				Selection console control board															
LED number	38	39	28	37	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Preflow		B3	B2			SV2	SV3					SV8		SV10						
Cutflow		B3	B2			SV2	SV3					SV8		SV10						

Marking process

The valves that are active when marking are represented by the tables below. The active valves in the metering console will differ depending on what process was used before marking.

Valves active when changing from a process that **does not** use a fuel gas

N_2/N_2	Metering console control board				Selection console control board															
LED number	38	39	28	37	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Preflow	B4		B2												SV11					
Cutflow	B4		B2												SV11					

Valves active when changing from a process that **does** use a fuel gas

N_2/N_2	Metering console control board				Selection console control board															
LED number	38	39	28	37	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Preflow		B3		B1									SV9							
Cutflow		B3		B1									SV9							

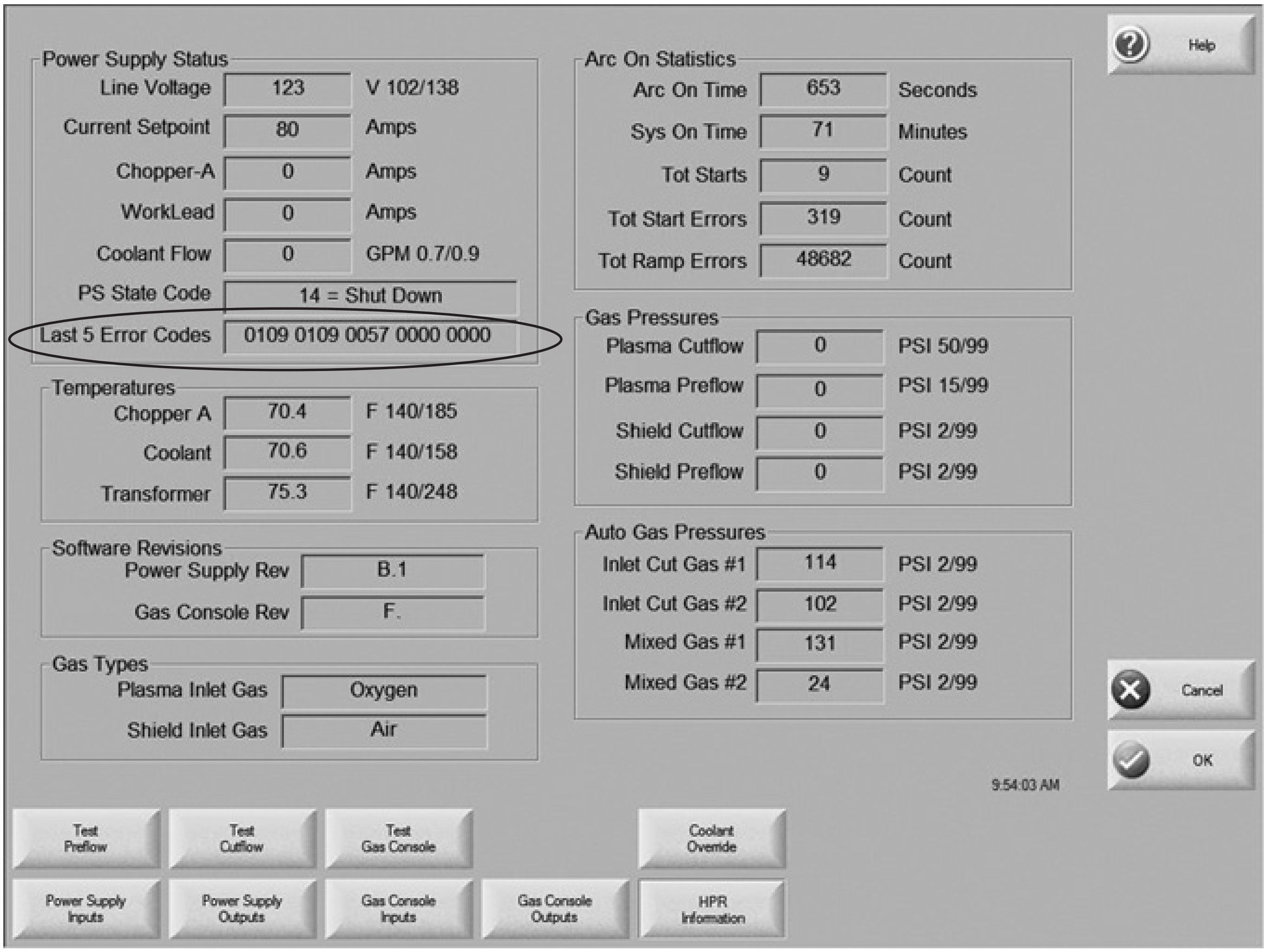
Ar/N_2	Metering console control board				Selection console control board															
LED number	38	39	28	37	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Preflow	B4			B1									SV9						SV15	
Cutflow	B4			B1									SV9						SV15	

Ar/Air 25 to 35 amps	Metering console control board				Selection console control board															
LED number	38	39	28	37	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Preflow	B4		B2				SV3				SV7			SV10						
Cutflow	B4		B2				SV3				SV7			SV10						

Ar/Air < 25 or > 35 amps	Metering console control board				Selection console control board															
LED number	38	39	28	37	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Preflow		B3	B2				SV3				SV7			SV10						
Cutflow		B3	B2				SV3				SV7			SV10						

Error codes

Error codes are displayed on the CNC screen. The diagnostic screen shown below is for reference. The screens you work with may be different, but should include the functions described in the Operation section of this manual.



Error code troubleshooting – error codes 000 to 018

Error code number	Name	Description	Corrective action
000	No error	System is ready to run.	None needed.
009	Flow switch test	The flow switch is tested when the pump restarts after a pump timeout (30 minutes without a start signal). The test ensures that the coolant flow is correct before firing the torch.	Wait 10 seconds for the flow rate to stabilize.
011	No active processs **HPR400XD HPR800XD Only**	The current setting is greater than the capability of the selected process. When this error code occurs, the power supply will ignore the start signal until a correct process is chosen.	1. Verify that the secondary power supply is turned ON. 2. Verify that the current for the selected process is within the range of the power supply capability (up to 400A for 400XD, and up to 800A for 800XD).
012	Test in progress	One of the gas test modes is running.	Wait for the test to finish.
013	Test passed	The test was successful.	No action required.
014	Cut gas channel 1 fail	The gas pressure in channel 1 is decreasing, which indicates a leak.	Look for leaks and loose connections between the selection console and the metering console.
015	Cut gas channel 2 fail	The gas pressure in channel 2 is decreasing, which indicates a leak.	Look for leaks and loose connections between the selection console and the metering console.
016	Plasma rampdown fail	Plasma pressure did not decrease in the time allowed.	Verify that there is no obstruction in the plasma vent hose.
017	Shield rampdown fail	Shield pressure did not decrease in the time allowed.	Inspect the holes in the shield for obstructions. Replace the shield if the holes are blocked.

Error code troubleshooting – error codes 020 to 028, 224 to 228

Error code number	Name	Description	Corrective action
020	No pilot arc	No current detected from chopper at ignition and before 1-second timeout.	1. Verify that the consumable parts are in good condition. 2. Verify proper preflow and cut-flow settings. 3. Perform gas leak tests (see *Maintenance* section). 4. Verify spark across spark gap. 5. Inspect CON1 and pilot arc relay for excessive wear. 6. Perform gas flow test (see *Maintenance* section). 7. Perform torch lead test (see *Maintenance* section). 8. Perform start circuit test (see *Maintenance* section).
021	No arc transfer	No current detected on work lead 500 milli-seconds after pilot arc current was established.	1. Verify proper pierce height. 2. Verify proper preflow and cut-flow settings. 3. Inspect work lead for damage or loose connections.
024 Primary 224 Secondary	Lost current Chopper 1	Lost the current signal from Chopper 1 after transfer.	1. Verify that the consumable parts are in good condition. 2. Verify proper cut-flow gas settings. 3. Verify pierce delay time. 4. Verify arc did not lose contact with plate while cutting (hole cutting, scrap cutting, etc).
025 Primary 225 Secondary	Lost current Chopper 2 **HPR260XD HPR400XD Only**	Lost the current signal from Chopper 2 after transfer.	1. Verify that the consumable parts are in good condition. 2. Verify proper cut-flow gas settings. 3. Verify pierce delay time. 4. Verify arc did not lose contact with plate while cutting (hole cutting, scrap cutting, etc).
026 Primary 226 Secondary	Lost transfer	Lost the transfer signal after transfer completed.	1. Verify that the consumable parts are in good condition. 2. Verify proper cut-flow gas settings. 3. Verify pierce delay time. 4. Verify arc did not loose contact with plate while cutting (hole cutting, scrap cutting, etc). 5. Inspect work lead for damage or loose connections. 6. Try connecting work lead directly to the plate.
027 Primary 227 Secondary	Lost phase	Phase imbalance to chopper after contactor engaged or while cutting.	1. Verify phase-to-phase voltage to power supply. 2. Disconnect power to power supply, remove cover on contactor and inspect contacts for excessive wear. 3. Inspect power cord, contactor, and input to chopper for loose connections. 4. Inspect phase loss fuses on Power Distribution board. Replace board if fuses are blown. 5. Perform phase loss test (see *Maintenance* section).
028 Primary 228 Secondary	Lost current Chopper 3 **HPR400XD Only**	Lost the current signal from Chopper 3 after transfer.	1. Verify that the consumable parts are in good condition. 2. Verify proper cut-flow gas settings. 3. Verify pierce delay time. 4. Verify arc did not lose contact with plate while cutting (hole cutting, scrap cutting, etc).

Error code troubleshooting – error codes 030 to 042, 231 to 234

Error code number	Name	Description	Corrective action
030	Gas system error **Auto Gas Only**	A failure has occurred in the gas system.	1. Verify that cable number 5 (power supply-to-gas console control cable) is not damaged and is properly connected to PCB3 and to the rear of the gas console. 2. Verify that cable number 6 (power supply-to-gas console power cable) is not damaged and is properly connected inside the power supply and to the rear of the gas console. 3. Verify that D1 (+5 VDC) and D2 (+3.3 VDC) are illuminated on PCB2 inside the gas console. These LEDs indicate power to PCB2. 4. If power is present at PCB2 and PCB3 and both gas console cables are good, then PCB2 or PCB3 has failed. Use the CAN tester to verify which board needs to be replaced.
031 Primary 231 Secondary	Start lost	Start signal was received and then lost before an arc was established.	1. If a mechanical relay is being used to provide the HPR with a start signal, this relay is either bouncing when activated or the contacts are faulty. Replace the relay. 2. Inspect interface cable for damage; faulty crimps, or poor electrical connections. 3. If interface cable is good and a relay is not driving the start input, the CNC is dropping the start signal before a steady state arc has been established.
032	Hold timeout	Hold signal was active for longer than 60 seconds.	1. Check the interface cable for damage. The hold wires may be short-circuiting inside. 2. The CNC is maintaining this input, it could be waiting for an IHS complete input from another torch. 3. If CNC interface cable is good and it is a 1-torch system, change PCB3.
033	Precharge time-out **Auto Gas Only**	Selection console was not able to charge the lines to the correct value.	This is a warning for a possible gas restriction in the leads. Verify that there are no restrictions in the plasma and shield hoses, or low inlet-gas pressure.
034 Primary 234 Secondary	Lost current Chopper 4 **HPR400XD Only**	Lost the current signal from Chopper 4 after transfer.	1. Verify that the consumable parts are in good condition. 2. Verify proper cut-flow gas settings. 3. Verify pierce delay time. 4. Verify arc did not lose contact with plate while cutting (hole cutting, scrap cutting, etc).
042	Low nitrogen (N_2) gas pressure	Nitrogen gas pressure under lower limit of: 2.07 bar (30 psi) – cutting 0.34 bar (5 psi) – marking During N_2 purge, when changing between a fuel gas process and an oxidizer process.	1.Verify that the nitrogen supply is turned on and inspect gas supply pressure and volume of gas remaining in supply tanks. 2. Verify that the gas regulator is set to 8.27 bar (120 psi). See *Setting the supply regulators* (*Installation* section).

Error code troubleshooting – error codes 044 to 046

Error code number	Name	Description	Corrective action
044	Low plasma gas pressure	Plasma gas pressure under lower limit of 0.34 bar (5 psi) – preflow 3.45 bar (50 psi) – cutflow (cutting) 0.34 bar (5 psi) – cutflow (marking)	1. Inspect gas supply pressure and volume of gas remaining in supply tanks. 2. Verify the gas regulator settings on gas console with the parameters in the cut charts. 3. See *Setting the supply regulators* (*Installation* section). 4. Perform gas leak tests (*Maintenance* section).
045	High plasma gas pressure	Plasma gas pressure over upper limit of: 7.58 bar (110 psi) – manual 9.65 bar (140 psi) – auto	1. Verify gas supply pressure settings. 2. Verify gas regulator settings on gas console with cut chart. 3. See *Setting the supply regulators* (*Installation* section). 4. Solenoid at off-valve is not opening. Verify power to valves, disconnect plasma and shield hoses exiting off-valve. If pressures decrease a valve is not functioning or no power to the valve.
046	Low line voltage	Line voltage is close to or less than the lower limit of 102 VAC (120 VAC -15%). The normal lower limit for operation is 108 VAC (120 VAC -10%).	1. Verify input-line voltage at PCB2 in the power supply (also PCB1 in the cooler for HPR400XD systems). Voltage needs to be within 10% of nominal (120 VAC). 2. Verify fuses on PCB2 in the power supply. 3. Verify 120 VAC voltage on plug J2.4, pins 3 and 4 on PCB2 in the power supply. 4. For HPR400XD systems, verify the voltage on PCB1 in the cooler with a DC volt meter. It should be about 0.415 VDC between TP23 and TP2 on PCB1. 5. If AC voltage on PCB2, J2.4, pins 3 and 4, is greater than 108 VAC and DC voltage between TP23 and TP2 on PCB1 is less than 0.38 VDC, verify minimum 108 VAC voltage on plug J4, pins 1 and 2 on PCB1. Verify the wiring between PCB2 in the power supply and J4 on PCB1. If the voltage on plug J4 is greater than 108 VAC, but the DC voltage on TP23 and TP2 is less than 0.38, replace PCB1. 6. If the AC voltage on PCB2 in the power supply at J2.4, pins 3 and 4, is greater than 108 VAC and the DC voltage between TP23 and TP2 on PCB1 in the cooler (HPR400XD only) is also greater than 0.38 VDC, verify the CAN link between PCB3 in the power supply and PCB1 in the cooler.

Error code troubleshooting – error codes 047 to 053, 248 to 250

Error code number	Name	Description	Corrective action
047	High line voltage	Line voltage is close to or greater than the upper limit of 138 VAC (120 VAC +15%). The normal upper limit for operation is 132 VAC (120 VAC +10%).	1. Verify input–line voltage at PCB2 in the power supply and PCB1 in the cooler (HPR400XD only). Voltage needs to be within 10% of nominal (120 VAC). 2. Verify fuses on PCB2 in the power supply. 3. Verify 120 VAC voltage on plug J2.4, pins 3 and 4 on PCB2 in the power supply. 4. Verify the voltage on PCB1 in the cooler (HPR400XD only) with a DC volt meter. It should be about 0.415 VDC between TP23 and TP2 on PCB1. 5. If AC voltage on PCB2, J2.4, pins 3 and 4, is less than 132 VAC and DC voltage between TP23 and TP2 on PCB1 is greater than 0.44 VDC, verify maximum 132 VAC voltage on plug J4, pins 1 and 2 on PCB1. Verify wiring between PCB2 in the power supply and J4 on PCB1. If the voltage on plug J4 is less than 132 VAC, but the DC voltage on TP23 and TP2 is greater than 0.44, replace PCB1. 6. If the AC voltage on PCB2 in the power supply on plug J2.4, pins 3 and 4, is less than 132 VAC and the DC voltage between TP23 and TP2 on PCB1 in the cooler (HPR400XD only) is also less than 0.44 VDC, verify the CAN link between PCB3 in the power supply and PCB1 in the cooler.
048 Primary 248 Secondary	CAN error	An error occurred with the CAN communications between the power supply and the gas console.	1. Verify that cable number 5 (power supply-to-gas console control cable) is not damaged and is properly connected to PCB3 and to the rear of the gas console. 2. Verify that cable number 6 (power supply-to-gas console power cable) is not damaged and is properly connected inside the power supply and to the rear of the gas console. 3. Verify that D1 (+5 VDC) and D2 (+3.3 VDC) are illuminated on PCB2 inside the gas console. These LEDs indicate power to PCB2. 4. If power is present at PCB2 and PCB3 and both gas console cables are good, then PCB2 or PCB3 has failed. Use the CAN tester to verify which board needs to be replaced.
050 Primary 250 Secondary	Start signal is on at power-up	Plasma start signal input is active during power-up of power supply.	1. Stop or clear the cutting program. The plasma start signal to the plasma was not dropped after the last cut. 2. Verify that the CNC interface cable is not damaged. 3. Remove CNC interface cable from PCB3 and look for an open circuit between pins 15 and 34. 4. If the circuit is closed either the CNC is issuing a plasma start or the CNC interface cable is damaged. 5. If circuit is open, and LEDN300J is illuminated with CNC Interface cable removed from PCB3, replace PCB3.
053	Low shield gas pressure	Shield pressure is below lower limit of 0.14 bar (2 psi).	1. Verify gas supply pressure and that a sufficient volume of gas remains in your supply. 2. Verify gas regulator settings on gas console with cut chart. 3. See *Setting the supply regulators* (*Installation* section). 4. Perform gas leak tests (*Maintenance* section).

Error code troubleshooting – error codes 054 to 061

Error code number	Name	Description	Corrective action
054	High shield gas pressure	Shield gas pressure is over upper limit of: 7.58 bar (110 psi) – manual 9.65 bar (140 psi) – auto	1. Verify gas supply regulator settings. See *Setting the supply regulators* (Installation section). 2. Verify pressure settings on gas console with cut chart. 3. Solenoid at off-valve is not opening. Verify power to valves, disconnect plasma and shield hoses exiting off-valve. If pressures decrease, a valve is not functioning or no power to the valve.
055	MV1 inlet pressure **Auto Gas Only**	Motor valve 1 inlet pressure is less than 3.45 bar (50 psi) or greater than 9.65 bar (140 psi).	1. Verify that gas pressure transducer P1 is between 3.45 bar (50 psi) and 9.65 bar (140 psi). Increase or decrease the inlet gas pressure to correct the problem.
056	MV2 inlet pressure **Auto Gas Only**	Motor valve 2 inlet pressure is less than 3.45 bar (50 psi) or greater than 9.65 bar (140 psi).	1. Verify that gas pressure transducer P2 is between 3.45 bar (50 psi) and 9.65 bar (140 psi). Increase or decrease the inlet gas pressure to correct the problem.
057	Cut gas 1 pressure **Auto Gas Only**	Cut gas 1 outlet pressure is less than 3.45 bar (50 psi) or greater than 9.65 bar (140 psi) in the selection console.	1. Verify that gas pressure transducer P3 is between 3.45 bar (50 psi) and 9.65 bar (140 psi). Increase or decrease the inlet gas pressure to correct the problem.
058	Cut gas 2 pressure **Auto Gas Only**	Cut gas 2 outlet pressure is less than 3.45 bar (50 psi) for non-mixing, or less than 1.38 bar (20 psi) when mixing or greater than 9.65 bar (140 psi) for non-mixing and mixing.	1. Verify that gas pressure transducer P4 is between 3.45 bar (50 psi) and 9.65 bar (140 psi). Increase or decrease the inlet gas pressure to correct the problem.
060	Low coolant flow	Coolant flow is less than the required 2.3 lpm (0.6 gpm).	1. Verify that the correct consumables are properly installed. 2. Perform the coolant flow test procedure in the Maintenance section of the manual.
061	No plasma gas type	Manual gas - The gas console control board is not receiving signals from the gas selector knob. Auto gas - The selection console is not receiving the plasma gas type signal.	1. Auto gas - the process parameters may not have been downloaded. Verify that the process information can be viewed on the CNC screen. 2. Manual gas - the selector knob (2) may be set between positions. Reset the knob. 3. Verify that there is power to the console by looking to see if any LED on any board in the selection console (auto) or gas console (manual) is illuminated. If no LED is illuminated, verify that the fuse on the power distribution PCB is in proper working condition. 4. If the problem still exists, replace the control board.

Error code troubleshooting – error codes 062 to 067, 265 to 267

Error code number	Name	Description	Corrective action
062	No shield gas type	Manual gas – The gas console control board is not receiving signals from the gas selector knob. Auto gas – The selection console is not receiving the shield gas type signal.	1. Auto gas – The process parameters may not have been downloaded. Verify that the process information can be viewed on the CNC screen. 2. Manual gas – The selector knob (2) may be set between positions. Reset the knob. 3. Verify that there is power to the console by looking to see if any LED on any board in the selection console (auto) or gas console (manual) is illuminated. If no LEDs are illuminated, verify that the fuse on the power distribution PCB is in proper working condition. 4. If the problem still exists, replace the control board.
065 Primary 265 Secondary	Chopper 1 overtemp	Chopper 1 has overheated.	1. Verify that all chopper fans are operating properly. Spinning fan blades should be difficult to see. 2. Blow dust out of system, especially from fans and heat sink of chopper. 3. Verify that the voltage on rear side of J3.202, pins 2 and 3 on PCB3, is less than or equal to 2.9 VDC. 4. If the voltage is low, verify correct wiring between chopper temperature sensor and J3.202 pins 1 and 2. 5. If wiring is good and overtemp error does not clear after 30 minutes of the power supply idling with the fans running, replace the chopper.
066 Primary 266 Secondary	Chopper 2 overtemp **HPR260XD HPR400XD Only**	Chopper 2 has overheated.	1. Verify that all chopper fans are operating properly. Spinning fan blades should be difficult to see. 2. Blow dust out of system, especially from fans and heat sink of chopper. 3. Verify that the voltage on rear side of J3.202, pins 5 and 6 on PCB3, is less than or equal to 2.9 VDC. 4. If the voltage is low, verify correct wiring between chopper temperature sensor and J3.202 pins 4 and 5. 5. If wiring is good and overtemp error does not clear after 30 minutes of the power supply idling with the fans running, replace the chopper.
067 Primary 267 Secondary	Magnetics overtemp	Power transformer has overheated.	1. Verify that all the large fans are operating properly. Spinning fan blades should be difficult to see. 2. Blow dust out of system especially from fans and large power transformer. 3. Verify that the voltage on the rear side of J3.202 pins 14 and 15, is equal to or less than 3.2 VDC. 4. If voltage is low or near 0 VDC, inspect wiring between the transformer's temperature sensor and J3.202 pins 13 and 14. Look for shorts between wires or to ground. 5. If wiring is good, the transformer has overheated. Allow the power supply to idle with the fans running for a minimum of 30 minutes to cool the large power transformer. 6. Replace the transformer's temperature sensor if it is open or shorted. Replacement kit part number is 228309.

Error code troubleshooting – error codes 071 to 075, 273 to 275

Error code number	Name	Description	Corrective action
071	Coolant overtemp	Torch coolant has overheated.	1. Verify that the large fan in the cooler (HPR400XD only) is running. 2. Blow dust out of the coolerr (HPR400XD only), especially from the heat exchanger. 3. Verify that the voltage on the rear side of J1.5 pins 6 and 8, is equal to or lower than 2.8 VDC. 4. If voltage is low, inspect wiring between coolant temperature sensor and J1.5, pins 5 and 6, for shorts to wires or ground. 5. If wiring is good, the coolant has overheated; let system idle with the fans running for 30 minutes to cool. 6. Replace the coolant temperature sensor if it is open or shorted. Sensor part number is 229224.
072	Auto gas, control board overtemp **Auto Gas Only**	Control board has exceeded 90° C (194° F).	Verify that the airflow to the gas console is not restricted.
073 Primary 273 Secondary	Chopper 3 overtemp **HPR400XD Only**	Chopper 3 has overheated.	1. Verify that all chopper fans are operating properly. Spinning fan blades should be difficult to see. 2. Blow dust out of system, especially from fans and heat sink of chopper. 3. Verify that the voltage on rear side of J3.202, pins 8 and 9 on PCB3, is less than or equal to 2.9 VDC. 4. If the voltage is low, verify correct wiring between chopper temperature sensor and J3.202 pins 7 and 8. 5. If wiring is good and overtemp error does not clear after 30 minutes of the power supply idling with the fans running, replace the chopper.
074 Primary 274 Secondaryy	Chopper 4 overtemp **HPR400XD Only**	Chopper 4 has overheated.	1. Verify that all chopper fans are operating properly. Spinning fan blades should be difficult to see. 2. Blow dust out of system, especially from fans and heat sink of chopper. 3. Verify that the voltage on rear side of J3.202, pins 11 and 12 on PCB3, is less than or equal to 2.9 VDC. 4. If the voltage is low, verify correct wiring between chopper temperature sensor and J3.202 pins 10 and 11. 5. If wiring is good and overtemp error does not clear after 30 minutes of the power supply idling with the fans running, replace the chopper.
075 Primary 275 Secondary	Low current on CS3 **HPR400XD Only**	A current less than 10 amps has been detected by current sensor 3.	See the chopper test later in this section.

Error code troubleshooting – error codes 076 to 101, 276 to 301

Error code number	Name	Description	Corrective action
076 Primary 276 Secondary	Low current on CS4 **HPR400XD Only**	A current less than 10 amps has been detected by current sensor 4.	See the chopper test later in this section.
093	No coolant flow	Coolant flow signal was lost or never was satisfied.	1. If this is a new system, follow start procedure. 2. Verify that the coolant filter is in good condition. 3. Perform coolant flow tests (*Maintenance* section). 4. Verify that the CNC drives the plasma start signal for at least 10 seconds to allow the timed-out pump to turn on again.
095 Primary 295 Secondary	High current on CS4 **HPR400XD Only**	A current greater than 35 amps has been detected by current sensor 4.	See the chopper test later in this section.
098	Phase loss at initialization **HPR400XD HPR800XD Only**	The system detected incoming line voltage during power-up, before the contactor was energized.	1. Verify phase-to-phase voltage to power supply. 2. Disconnect power to power supply, remove cover on contactor and inspect contacts for excessive wear. 3. Inspect power cord, contactor, and input to chopper for loose connections. 4. Inspect phase loss fuses on Power Distribution board. Replace board if fuses are blown. 5. Perform phase loss test (see *Maintenance* section).
099 Primary 299 Secondary	Chopper 1 overtemp at power-up	Chopper 1 is indicating an overtemp at power-up.	1. Verify that the temperature sensor for the chopper has not been bypassed or that the wires to the temperature switch are shorted out in the harness, or that the sensor is open. 2. If no jumper is present, the chopper is overheated and needs time to cool to 83° C (181.4° F).
100 Primary 300 Secondary	Chopper 2 overtemp at power-up **HPR260XD HPR400XD Only**	Chopper 2 is indicating an overtemp at power-up.	1. Verify that the temperature sensor for the chopper has not been bypassed or that the wires to the temperature switch are shorted out in the harness, or that the sensor is open. 2. If no jumper is present, the chopper is overheated and needs time to cool to 83° C (181.4° F).
101 Primary 301 Secondary	Magnetics overtemp at power-up	Main transformer is indicating an overtemp at power-up.	1. Verify that the transformer temperature sensor has not been bypassed or the wires to the temperature sensor are not shorted out in the harness. 2. Verify that the sensor is not open or shorted, if it is not open or shorted, the main transformer is overheated and needs time to cool to 150° C (302° F).

Error code troubleshooting – error codes 102 to 111, 302 to 308

Error code number	Name	Description	Corrective action
102 Primary 302 Secondary	Chopper 1 current at power-up	Chopper 1 current signal is active at power-up.	See wiring diagrams in section 7 1. Verify that the voltage at CS1 is correct. 2. Verify that the wiring between CS1 and PCB3 is correct and not damaged. 3. Swap CS1 with CS2. If the error code changes to 156, replace the original CS1.
103 Primary 303 Secondary	High current on CS1	A current greater than 35 Amps has been detected by current sensor 1.	See the chopper test later in this section.
104 Primary 304 Secondary	High current on CS2 **HPR260XD HPR400XD Only**	A current greater than 35 amps has been detected by current sensor 2.	See the chopper test later in this section.
105 Primary 305 Secondary	Low current on CS1	A current less than 10 amps has been detected by current sensor 1.	See the chopper test later in this section.
106 Primary 306 Secondary	Low current on CS2 **HPR260XD HPR400XD Only**	A current less than 10 amps has been detected by current sensor 2.	See the chopper test later in this section.
107 Primary 307 Secondary	High current on CS3 **HPR400XD Only**	A current greater than 35 amps has been detected by current sensor 3.	See the chopper test later in this section.
108 Primary 308 Secondary	Transfer at power-up	The system has detected current on the work lead during power-up.	1. Verify that the electrical connections to current sensors CS1 and CS3 are correct and not damaged. 2. Replace PCB3 if connections are correct and not damaged. 3. Verify that the main contactor (CON1) is not welded closed, or closing at power-up.
109	Coolant flow at power-up	"Coolant flow OK" signal is active during power-up and before pump motor is activated.	Either the coolant flow sensor was bypassed or it is faulty. 1. Verify that there is power at the sensor. 2. Verify that all the connectors have good connections.
111	Coolant overtemp at power-up	Coolant is indicating an overtemp at power-up.	1. Verify that the coolant temperature sensor has not been bypassed or the wires to the sensor are not shorted out in the harness. 2. If not, the coolant temperature is over the set point and needs time to cool to 70° C (158° F).

Error code troubleshooting – error codes 116 to 133, 316

Error code number	Name	Description	Corrective action
116 Primary 316 Secondary	Watchdog interlock	An error occurred with the CAN communication system.	1. Verify that cable number 5 (power supply-to-gas console control cable) is not damaged and is properly connected to PCB3 and the rear of the gas console. 2. Verify that cable number 6 (power supply-to-gas console power cable) is not damaged and is properly connected inside the power supply and to the rear of the gas console. 3a. **(Manual gas console)** Verify that D1 (+5 VDC) and D2 (+3.3 VDC) are illuminated on PCB2 inside the gas console. These LEDs indicate power to PCB2. 3b. **(Auto gas console)** Verify that D17 (+5 VDC) and D18 (+3.3 VDC) are illuminated on PCB2 inside the gas console. These LEDs indicate power to PCB2. 4. If power is present at PCB2 and PCB3 and both gas console cables are good, then PCB2 or PCB3 has failed. Use the CAN tester to verify which board needs to be replaced. 5. Verify that the gas console control PCB and power distribution PCBs are securely mounted to the chassis at all four corners.
123	MV1 error **Auto Gas Only**	Motor valve 1 did not move into position within 60 seconds.	Verify that LED D17 or D18 illuminates on the AC valve driver PCB in the selection console. If either illuminates, replace the motor valve. If they do not illuminate, replace PCB3.
124	MV2 error **Auto Gas Only**	Motor valve 2 did not move into position within 60 seconds.	Verify that LED D19 or D20 is illuminating on the AC valve driver PCB in the selection console. If either illuminates, replace the motor valve. If they do not illuminate, replace PCB3.
133	Unknown gas console type	The power supply control board does not recognize the gas console that is installed or has not received a CAN message.	1. Verify that the part numbers of PCB2 and PCB3 are correct. 2. Verify that the power supply-to-gas console control cable is not damaged and is properly connected to PCB3 and the rear of the gas console. 3. Verify that the power supply-to-gas console power cable is not damaged and is properly connected inside the power supply and to the rear of the gas console. 4. Verify that D1 (+5 VDC) and D2 (+3.3 VDC) are illuminated on PCB2 inside the gas console. These LEDs indicate power to PCB2. 5. If power is present at PCB2 and PCB3 and both gas console cables are good, then PCB2 or PCB3 has failed. Use the CAN tester to verify which board needs to be replaced.

Error code troubleshooting – error codes 134 to 140, 334 and 338

Error code number	Name	Description	Corrective action
134 Primary 334 Secondary	Chopper 1 overcurrent	Chopper 1 current feedback has exceeded 160 amps.	1. Verify that the wiring between CS1 and PCB3 is correct and not damaged. 2. Measure voltage across current sensor. a) Red to black = +15 VDC, Green to black = -15 VDC, white to black = 0 VDC at idle and varies with current output (4 VDC = 100 amps). b) If possible, take a voltage reading on current sensor while trying to cut. Ratio is 4 VDC = 100 amps. c) If the current sensor voltage is approximately 6.4 VDC or greater at idle, replace the current sensor. 3. Remove connector JA.1 from the chopper and verify that LED1 is extinguished. a) If LED1 is extinguished with the connector removed, then reconnect JA.1 and try to fire the torch. If the chopper still goes into overcurrent, replace the chopper. b) If the chopper does not go into overcurrent, replace PCB3.
138 Primary 338 Secondary	Chopper 2 overcurrent **HPR260XD HPR400XD Only**	Chopper 2 current feedback has exceeded 160 amps.	1. Verify that the wiring between CS2 and PCB3 is correct and not damaged. 2. Measure voltage across current sensor. a) Red to black = +15 VDC, Green to black = -15 VDC, white to black = 0 VDC at idle and varies with current output (4 VDC = 100 amps). b) If possible, take a voltage reading on current sensor while trying to cut. Ratio is 4 VDC = 100 amps. c) If the current sensor voltage is approximately 6.4 VDC or greater at idle, replace the current sensor. 3. Remove connector JB.1 from the chopper and verify that LED1 is extinguished. a) If LED1 is extinguished with the connector removed, then reconnect JB.1 and try to fire the torch. If the chopper still goes into overcurrent, replace the chopper. b) If the chopper does not go into overcurrent, replace PCB3.
139	Purge time-out error	The purge cycle did not complete within 3 minutes.	This is a warning for a possible gas restriction in the leads. 1. Verify that there are no restrictions in the plasma and shield hoses. 2. Verify that the inlet gas pressures are set to the proper levels.
140	Pressure transducer 1or 8 error **Auto Gas Only**	Faulty transducer or control board in the metering console or the selection console.	1. Verify that transducer P1 in the selection console is working properly. Replace if necessary. 2. Verify that transducer P8 in the metering console is working properly. Replace if necessary. 3. Verify that the control boards in the metering and selection consoles are working properly. Replace if necessary.

Error code troubleshooting – error codes 141 to 152, 346 to 351

Error code number	Name	Description	Corrective action
141	Pressure transducer 2 or 7 error **Auto Gas Only**	Faulty transducer or control board in the metering console or the selection console.	1. Verify that transducer P2 in the selection console is working properly. Replace if necessary. 2. Verify that transducer P7 in the metering console is working properly. Replace if necessary. 3. Verify that the control boards in the metering and selection consoles are working properly. Replace if necessary.
142	Pressure transducer 3 or 5 error **Auto Gas Only**	Faulty transducer or control board in the metering console or the selection console.	1. Verify that transducer P3 in the selection console is working properly. Replace if necessary. 2. Verify that transducer P5 in the metering console is working properly. Replace if necessary. 3. Verify that the control boards in the metering and selection consoles are working properly. Replace if necessary.
143	Pressure transducer 4 or 6 error **Auto Gas Only**	Faulty transducer or control board in the metering console or the selection console.	1. Verify that transducer P4 in the selection console is working properly. Replace if necessary. 2. Verify that transducer P6 in the metering console is working properly. Replace if necessary. 3. Verify that the control boards in the metering and selection consoles are working properly. Replace if necessary.
144	Internal flash error **Manual Gas Only**	Communication problem to the flash chip on the gas console control board.	Replace the control board.
145	Internal flash error **Auto Gas Only**	Communication problem to the flash chip on the selection console control board.	Replace the control board.
146 Primary 346 Secondary	Chopper 3 overtemp at power-up **HPR400XD Only**	Chopper 3 is indicating an overtemp at power-up.	1. Verify that the temperature sensor for the chopper has not been bypassed or that the wires to the temperature switch are shorted out in the harness, or that the sensor is open. 2. If no jumper is present, the chopper is overheated and needs time to cool to 83° C (181.4° F).
147 Primary 347 Secondary	Chopper 4 overtemp at power-up **HPR400XD Only**	Chopper 4 is indicating an overtemp at power-up.	1. Verify that the temperature sensor for the chopper has not been bypassed or that the wires to the temperature switch are shorted out in the harness, or that the sensor is open. 2. If no jumper is present, the chopper is overheated and needs time to cool to 83° C (181.4° F).
151 Primary 351 Secondary	Software fail	Software has detected an incorrect state or condition.	Replace power supply control board.
152	Internal flash error	Communication problem to the flash chip on the power supply control board.	Replace the control board.

Error code troubleshooting – error codes 153 to 156, 354 to 356

Error code number	Name	Description	Corrective action
153	PS EEPROM error	EEPROM memory on power supply control board not working.	Replace the control board.
154 Primary 354 Secondary	Chopper 3 overcurrent **HPR400XD Only**	Chopper 3 current feedback has exceeded 160 amps.	1. Verify that the wiring between CS3 and PCB3 is correct and not damaged. 2. Measure voltage across current sensor. a) Red to black = +15 VDC, Green to black = -15 VDC, white to black = 0 VDC at idle and varies with current output (4 VDC = 100 amps). b) If possible, take a voltage reading on current sensor while trying to cut. Ratio is 4 VDC = 100 amps. c) If the current sensor voltage is approximately 6.4 VDC or greater at idle, replace the current sensor. 3. Remove connector JC.1 from the chopper and verify that LED1 is extinguished. a) If LED1 is extinguished with the connector removed, then reconnect JC.1 and try to fire the torch. If the chopper still goes into overcurrent, replace the chopper. b) If the chopper does not go into overcurrent, replace PCB3..
155 Primary 355 Secondary	Chopper 4 overcurrent **HPR400XD Only**	Chopper 4 current feedback has exceeded 160 amps.	1. Verify that the wiring between CS4 and PCB3 is correct and not damaged. 2. Measure voltage across current sensor. a) Red to black = +15 VDC, Green to black = -15 VDC, white to black = 0 VDC at idle and varies with current output (4 VDC = 100 amps). b) If possible, take a voltage reading on current sensor while trying to cut. Ratio is 4 VDC = 100 amps. c) If the current sensor voltage is approximately 6.4 VDC or greater at idle, replace the current sensor. 3. Remove connector JD.1 from the chopper and verify that LED1 is extinguished. a) If LED1 is extinguished with the connector removed, then reconnect JD.1 and try to fire the torch. If the chopper still goes into overcurrent, replace the chopper. b) If the chopper does not go into overcurrent, replace PCB3.
156 Primary 356 Secondary	Chopper 2 current at power-up **HPR260XD HPR400XD Only**	Chopper 2 current signal is active at power-up.	See wiring diagrams in section 7 1. Verify that the voltage at CS2 is correct. 2. Verify that the wiring between CS2 and PCB3 is correct and not damaged. 3. Swap CS2 with CS3. If the error code changes to 157, replace the original CS2.

Error code troubleshooting – error codes 157 to 159, 357 to 359

Error code number	Name	Description	Corrective action
157 Primary 357 Secondary	Chopper 3 current at power-up **HPR400XD Only**	Chopper 3 current signal is active at power-up.	See wiring diagrams in section 7 1. Verify that the voltage at CS3 is correct. 2. Verify that the wiring between CS3 and PCB3 is correct and not damaged. 3. Swap CS3 with CS2. If the error code changes to 156, replace the original CS3.
158 Primary 358 Secondary	Chopper 4 current at power-up **HPR400XD Only**	Chopper 4 current signal is active at power-up.	See wiring diagrams in section 7 1. Verify that the voltage at CS4 is correct. 2. Verify that the wiring between CS4 and PCB3 is correct and not damaged. 3. Swap CS4 with CS2. If the error code changes to 156, replace the original CS4.
159 Primary 359 Secondary	Motor-drive fault **HPR400XD and HPR800XD**	The pump-motor-drive board (PCB7) is indicating a drive fault. Note: The secondary error code (359) may display if the secondary power supply is turned off individually, or when the entire system is turned off. Customers with a manual gas console will not see this error code when the entire system is turned off.	1. Verify that the circuit breaker on PCB7 has not tripped. If it has tripped, reset the breaker by pressing the button until it is even with the top of the circuit breaker. If the circuit breaker is not tripped and there is no power to PCB7, verify that the fuse on PCB2 in the power supply is good. 2. If D32 on PCB7 illuminates, the solenoid valve and motor are drawing too much current. D32 will only illuminate for a short time, and extinguishes after the outputs from the pump-motor-drive turn-off in response to the fault condition. Verify the wiring to the solenoid valve and the motor. Verify that the pump spins freely and is properly mounted to the motor. Look for obstructions in the torch, consumables, coolant lines, and in-line filter. Verify that the solenoid valve is operating. Any of these can cause the motor or solenoid valve to draw excessive current. Test for low coolant flow by using the coolant flow test in this section. 3. If D32 on PCB7 illuminates immediately at power-up, and all the items above have been verified, replace PCB7. 4. If D30 on PCB7 illuminates, the IGBT drive has encountered an over current condition. D30 will only illuminate for a short time, and extinguishes after the outputs from the pump motor-drive turn off. Follow the same steps for D32 above. 5. If D31 on PCB7 illuminates, the heatsink thermistor is indicating that the heatsink is too hot. Wait 10 minutes for it to cool. If the error remains, verify that the wires from heatsink on PCB7 are properly connected to the J6 connector on PCB7. If the error still remains, turn OFF all power to the system and measure the resistance on the J6 connector between pins 1 and 2. At 25° C (77° F) the resistance should be 10k.

Error code troubleshooting – error codes 160 to 180

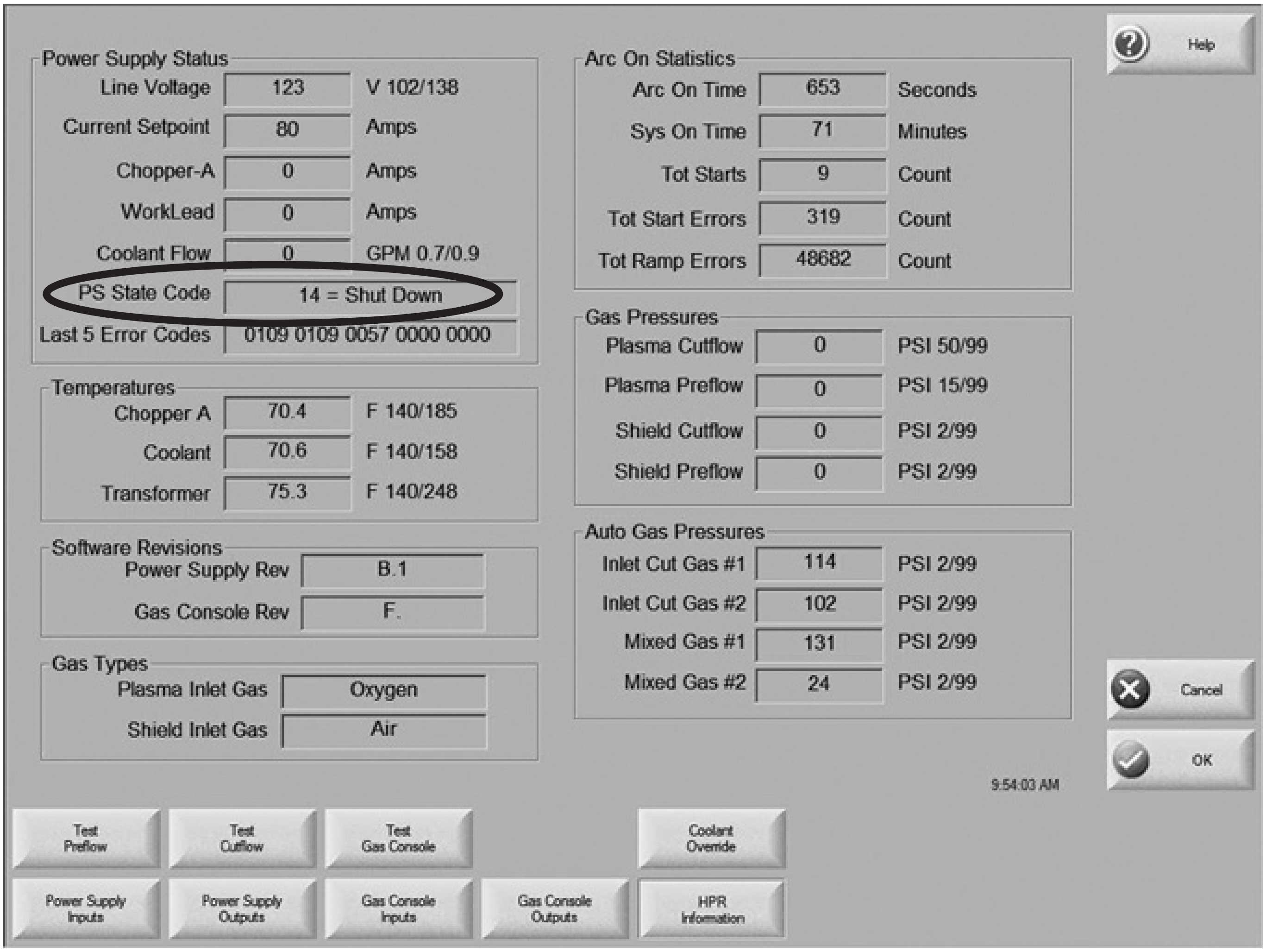
Error code number	Name	Description	Corrective action
160	HPR cooler's CAN fault **HPR400XD Only**	Communication between the control board (PCB3 in the power supply) and the cooler sensor board (PCB1 in the cooler) was interrupted for more than 1 second.	1. Verify that the cable connections from the power supply to the cooler are good. 2. Verify that D1 (+ 5 VDC) and D2 (+3.3 VDC) are illuminated on PCB1 inside the cooler. 3. Verify that the CAN bus LEDs, D7 and D8 are blinking.
161	Maximum coolant flow has been exceeded	Coolant flow has exceeded 6.8 lpm (1.8 gpm) for a cooler, 8.52 lpm (2.25 gpm) for a chiller.	1. Verify proper coolant flow. 2. Look for air bubbles in the coolant. 3. Verify that the coolant is mixed in the proper proportions.
180	Selection console CAN time-out **Auto Gas Only**	The power supply did not receive a CAN message from the selection console within 1 second.	1. Verify that the power supply-to-selection console CONTROL and POWER cables are not damaged and are properly connected to PCB3, and the rear of the selection console. 2. Verify that D17 (+5 VDC) and D18 (+3.3 VDC) are illuminated on PCB2 inside the selection console. These LEDs indicate power to PCB2. Also verify that D26 (CAN – RX) and D27 (CAN – TX) are illuminated on PCB2 inside the selection console. These LEDs indicate communication between the selection console and the power supply. 3. If power is present at PCB2 and PCB3 and both selection console cables are good, then PCB2 or PCB3 has failed. Use the CAN tester to verify which board needs to be replaced. 4. Verify that the gas console control PCB and power distribution PCBs are securely mounted to the chassis at all four corners.

Error code troubleshooting – error code 181, 182, 298, and 383

Error code number	Name	Description	Corrective action
181	Metering console CAN time-out **Auto Gas Only**	The power supply did not receive a CAN message from the metering console within 1 second.	1. Verify that the power supply-to-metering console CONTROL and POWER cables are not damaged and are properly connected to PCB3, and the rear of the metering console. 2. Verify that D17 (+5 VDC) and D18 (+3.3 VDC) are illuminated on PCB2 inside the metering console. These LEDs indicate power to PCB2. Also verify that D26 (CAN – RX) and D27 (CAN – TX) are illuminated on PCB2 inside the metering console. These LEDs indicate communication between the metering console and the power supply. 3. If power is present at PCB2 and PCB3 and both metering console cables are good, then PCB2 or PCB3 has failed. Use the CAN tester to verify which board needs to be replaced. 4. Verify that the gas console control PCB and power distribution PCBs are securely mounted to the chassis at all four corners.
182	Secondary power supply time-out **HPR800XD Only**	The secondary power supply fails before transmitting the error to the primary power supply.	1. The primary power supply to secondary power supply CAN communication cable was disconnected after power-up. 2. The cable has electrical interference (noise) or the cable shielding has been compromised.
298	Secondary power supply phase loss at initialization **HPR800XD Only**	The system detected incoming line voltage during power-up, before the contactor was energized.	1. Verify phase-to-phase voltage to power supply. 2. Disconnect power to power supply, remove cover on contactor and inspect contacts for excessive wear. 3. Inspect power cord, contactor, and input to chopper for loose connections. 4. Inspect phase loss fuses on Power Distribution board. Replace board if fuses are blown. 5. Perform phase loss test (see *Maintenance* section).
383	No ramp-up message **HPR800XD Only**	The secondary power supply is ready to provide current output but does not receive the control signal from the primary power supply.	1 Turn off the power to the system and then turn on the power again. 2. The cable has electrical interference (noise) or the cable shielding has been compromised.

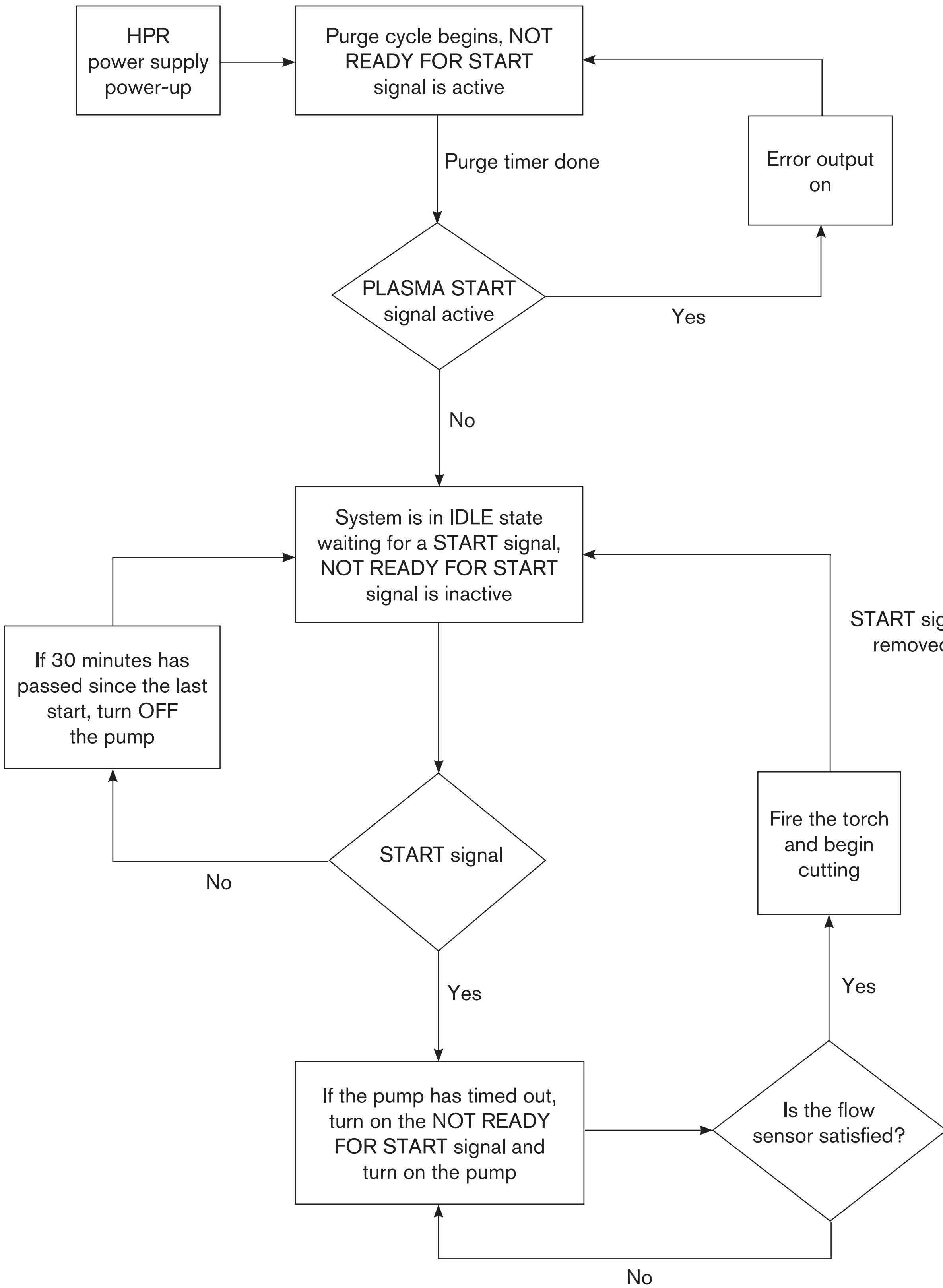
Power supply states

Power supply states are displayed on the CNC screen. The diagnostic screen shown below is for reference.

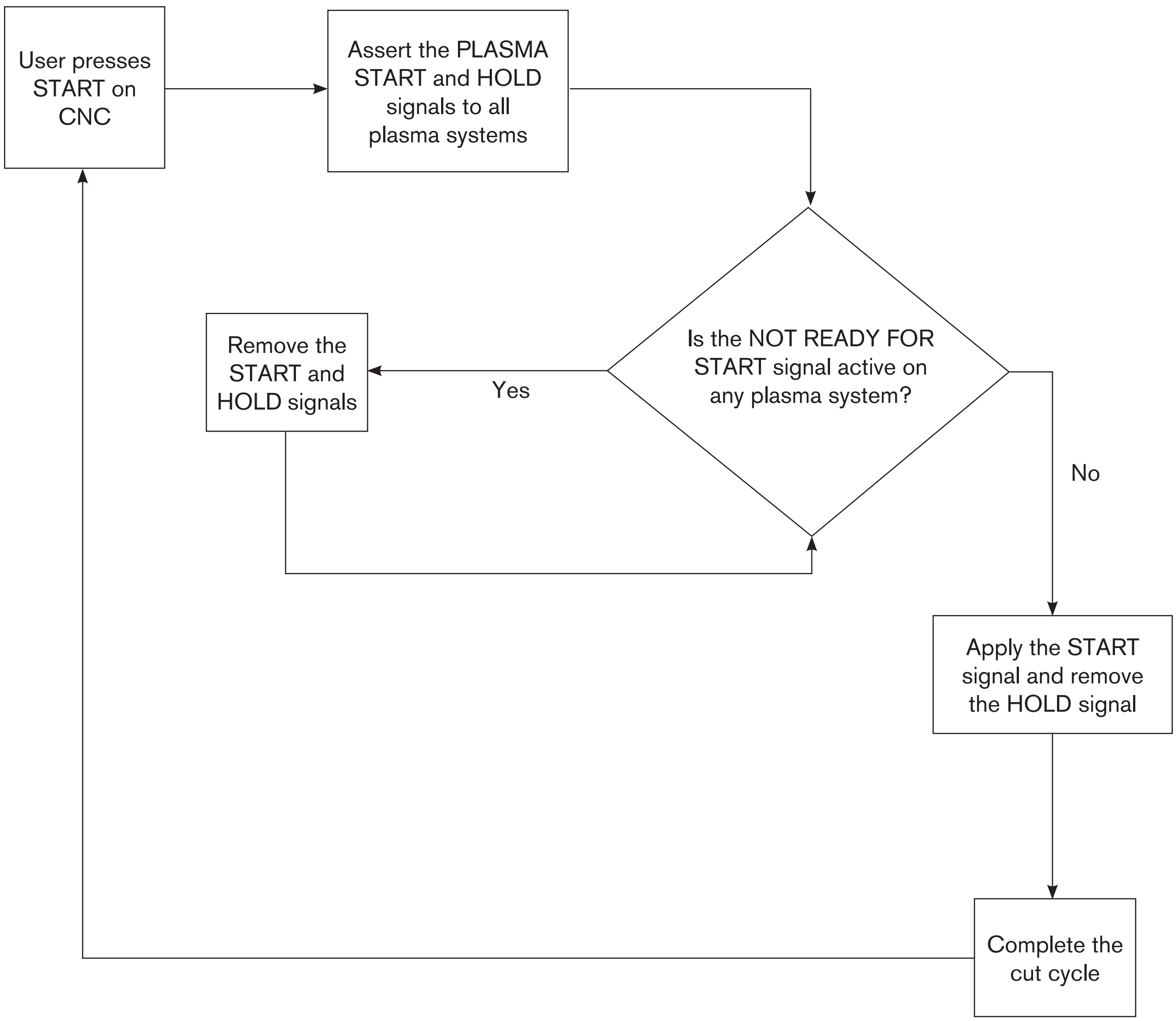


State code	Name	State code	Name
00	Power-up (idle)	11	Cycle complete (auto off)
02	Purge	12	Test cutflow
03	Ready for start (idle2)	14	Shutdown
04	Preflow	15	Reset
05	Pilot arc	16	Maintenance
06	Transfer	20	Test preflow
07	Ramp-up	22	Manual pump control
08	Steady state	23	Inlet leak check
09	Ramp-down	24	System leak check
10	Final ramp-down	25	Burkert valve flow check

Plasma system operation with pump time-out



CNC operation with pump time-out



Initial checks

Before trouble-shooting, do a visual check and verify that proper voltages are present at the power source, transformers and power distribution board.

DANGER

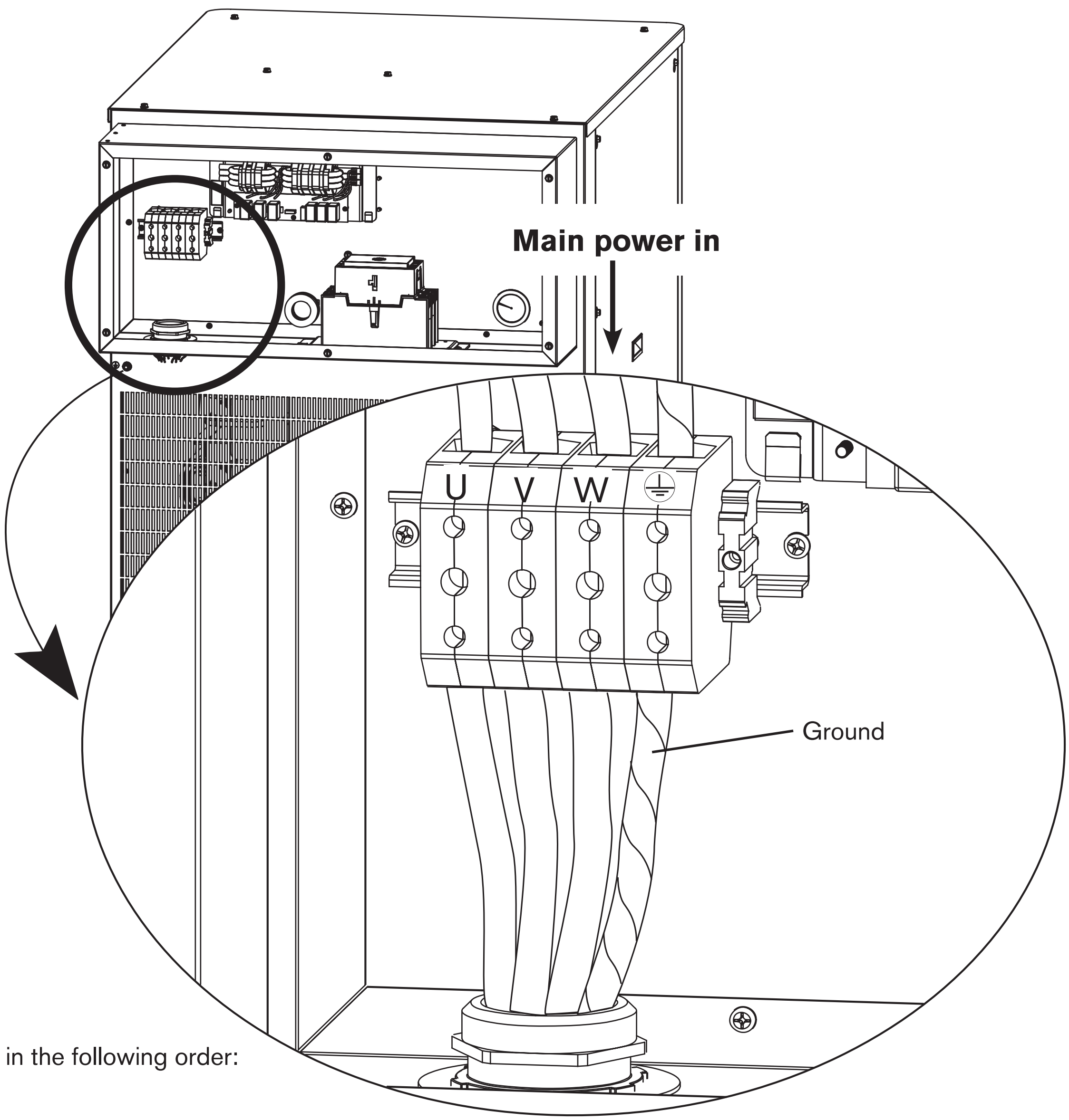
SHOCK HAZARD: Always use caution when servicing a power supply when plugged in and the covers are removed. Dangerous voltages exist within the power supply which could cause injury or death.

1. Disconnect line power by turning OFF the main disconnect switch.
2. Remove the power supply's top panel and 2 side panels.
3. Inspect interior of power supply for discoloration on PC boards, or other apparent damage. If a component or module is obviously defective, replace it before doing any testing. Refer to the *Parts List* section to identify parts and part numbers.
4. If no damage is apparent, connect power to the power supply, and turn ON the main disconnect switch.
5. Measure the voltage between the W, V and U terminals of TB1 located on the right side of the power supply. See figure on next page. Also refer to the wiring diagram in Section 7, if required. The voltage between any 2 of the 3 terminals should be equal to the supply voltage. If there is a problem at this point, disconnect main power and check connections, power cable, and fuses at line disconnect switch. Repair or replace any defective component.

Power measurement

		DANGER **SHOCK HAZARD**

There is line voltage at the contactor and the power distribution board (PCB2) when the line disconnect switch is on. Use extreme care when measuring primary power in these areas. Voltages present at the terminal block and contactors can cause injury or death.



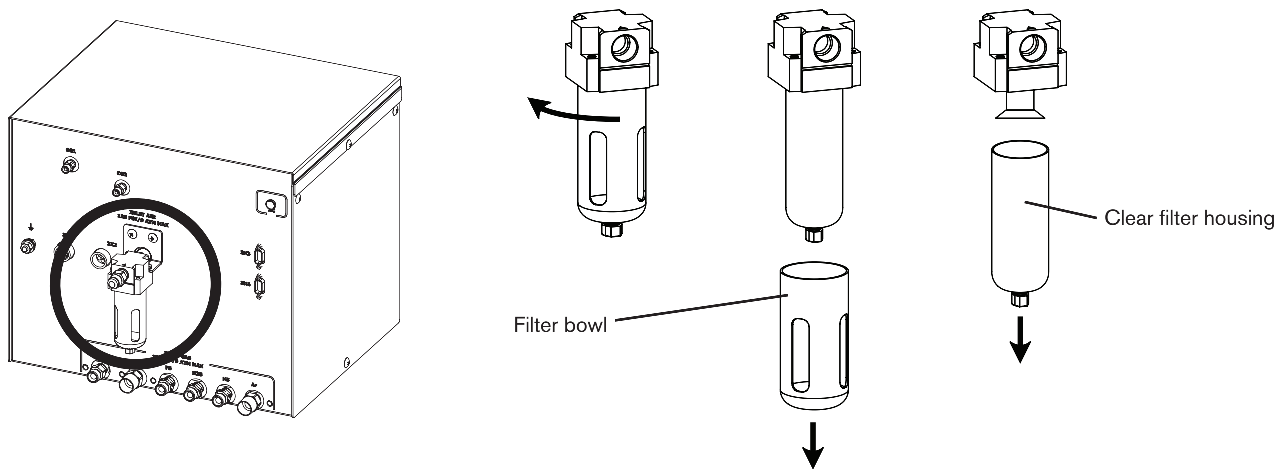
Note: Check lines in the following order:
U to V
U to W
V to W
Check each line to ground. If one line is 10% greater, or more, than the other 2, put that leg on U.

Air filter element replacement

1. Turn OFF all electrical power and disconnect the air hose from the filter.

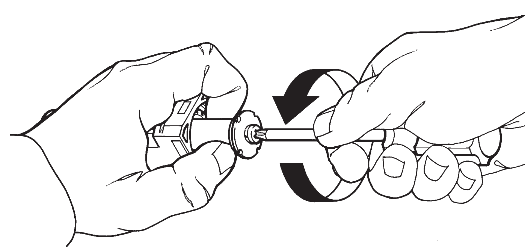
2. Remove the filter bowl by turning it counter clockwise until it releases.

3. Pull the clear filter housing down firmly to remove it. The filter housing has an o-ring around the top. Apply a thin film of silicone lubricant on the o-ring to extend it’s life. The o-ring should look shiny, but there should not be any excess or built-up grease.



4. Use a screwdriver to remove the filter element from the filter housing. Then install the new filter element.

   Note: Do not allow the filter element to turn when loosening the screw.



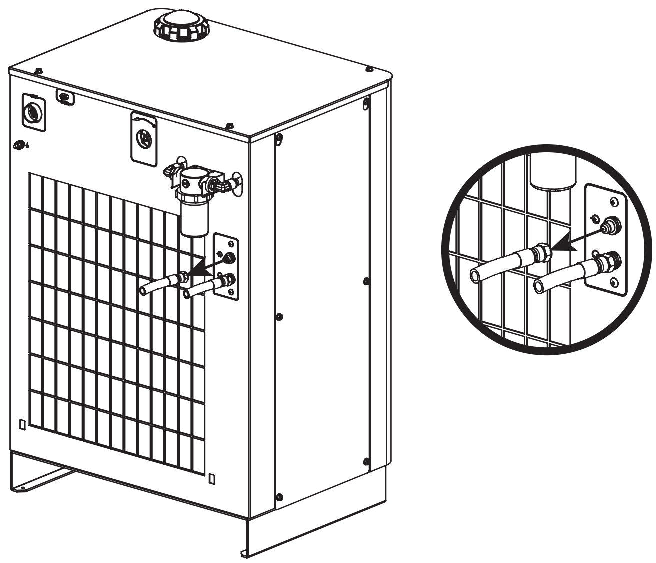
5. Reinstall the clear filter housing and the filter bowl.

Coolant system servicing

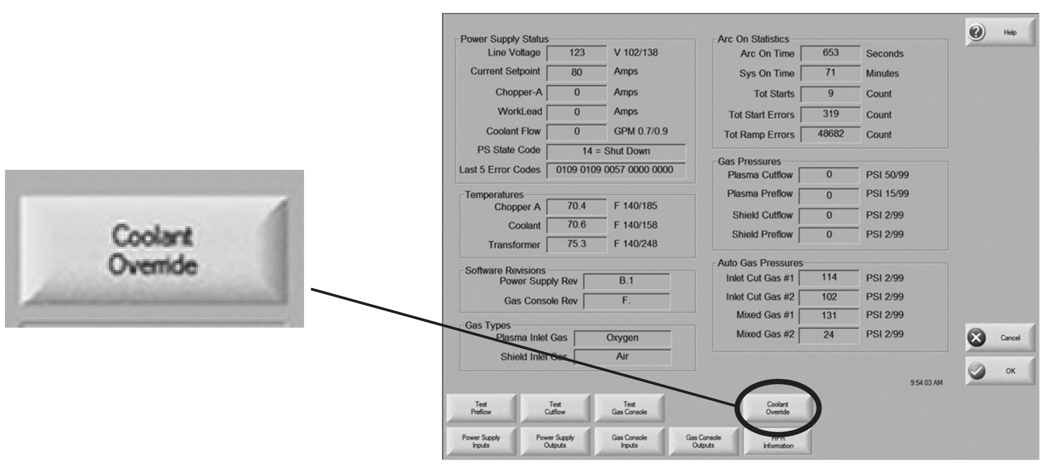
Draining the coolant system

1. Turn OFF all power to the system.

2. Remove the return coolant hose (red washer on the cooler fitting) from the rear of the cooler and put it in a 20 liter (5 gallon) container.



3. Turn ON the pump manually, using the manual pump control button on your CNC screen.



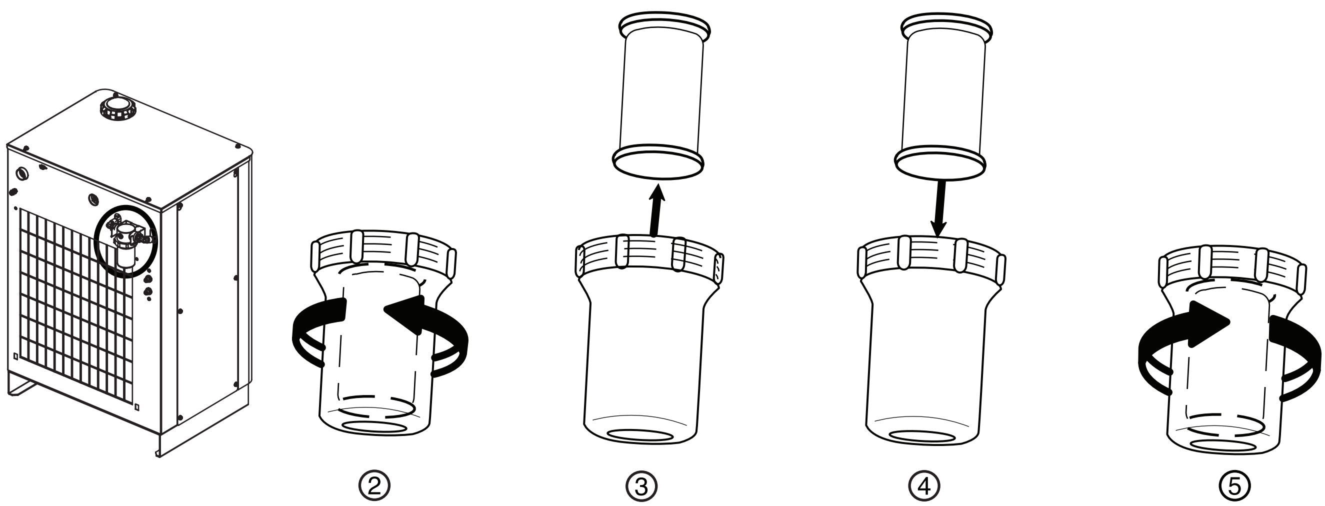
4. Turn OFF the pump when the coolant stops flowing.

Caution: **Coolant will flow from the filter when its housing is removed. Drain coolant before servicing the filter.**

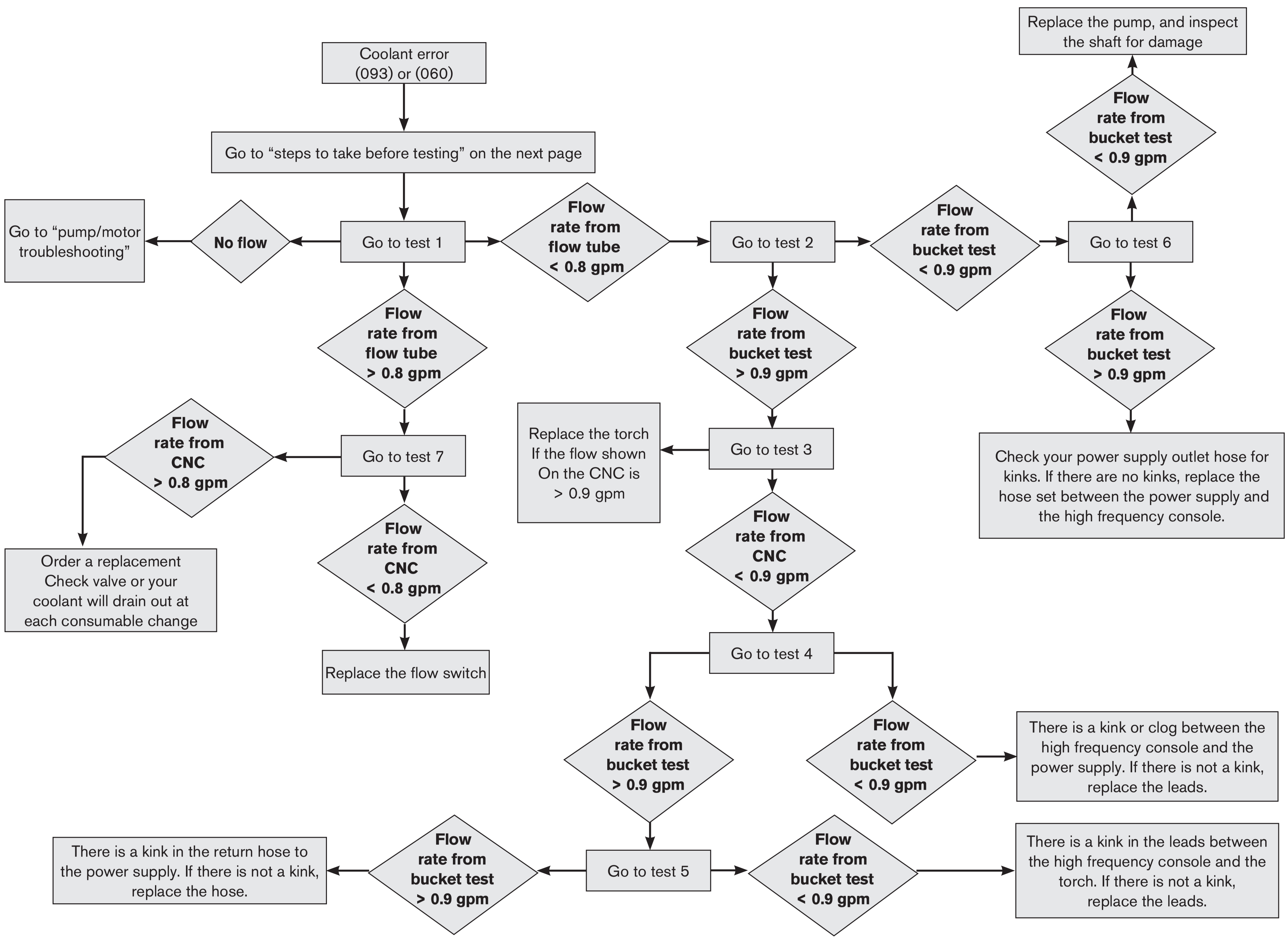
Coolant system filter

Filter replacement

1. Turn OFF all power to the system.
2. Remove housing.
3. Remove and discard filter element.
4. Install new filter element 027664.
5. Re-install housing.
6. Refill with new coolant.



Coolant flow troubleshooting chart



Coolant flow tests

If the CNC screen shows a coolant flow error (093 or 060), turn OFF the system and then ON again to clear the error. Then perform the following tests to find the cause of the problem.

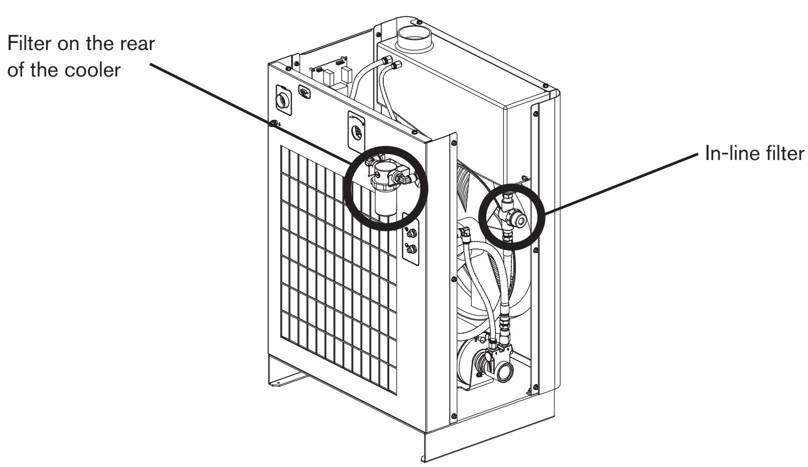
An in-line flow meter is the most accurate way to measure the flow rate, but can not be used with all the tests described without custom fittings. An in-line flow meter (part number 128933) is available from Hypertherm. The following “bucket” tests give a good idea of the flow rate.

Note: The CNC screens shown here are for reference. The screens you work with may look different, but should have the same functions shown here.

Before testing

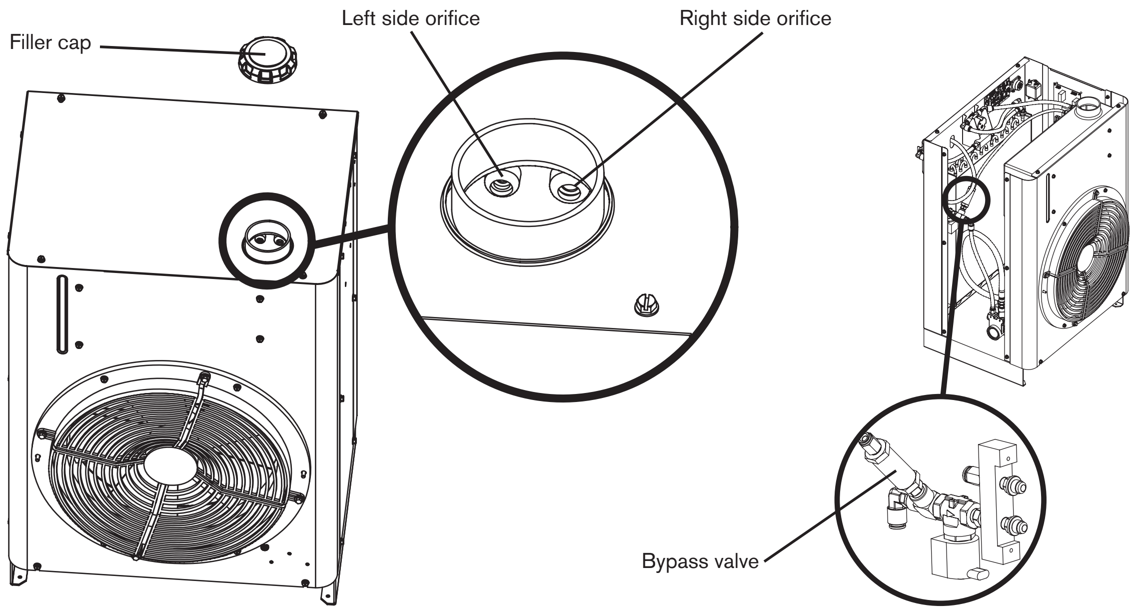
Notes: It is important to follow the troubleshooting steps in the order in which they are shown in the flow chart on the previous page.
Coolant must be drained from the system before the in-line filter is cleaned (step 1 below). The coolant in the system will drain out as soon as the in-line filter is removed.

1. Clean the in-line filter.
2. Replace the filter element on the rear of the cooler.
3. Verify that the system has the correct level of coolant when refilling the system after completing steps 1 and 2. See fill the cooler with coolant in the *Installation* section.



Bypass valve verification

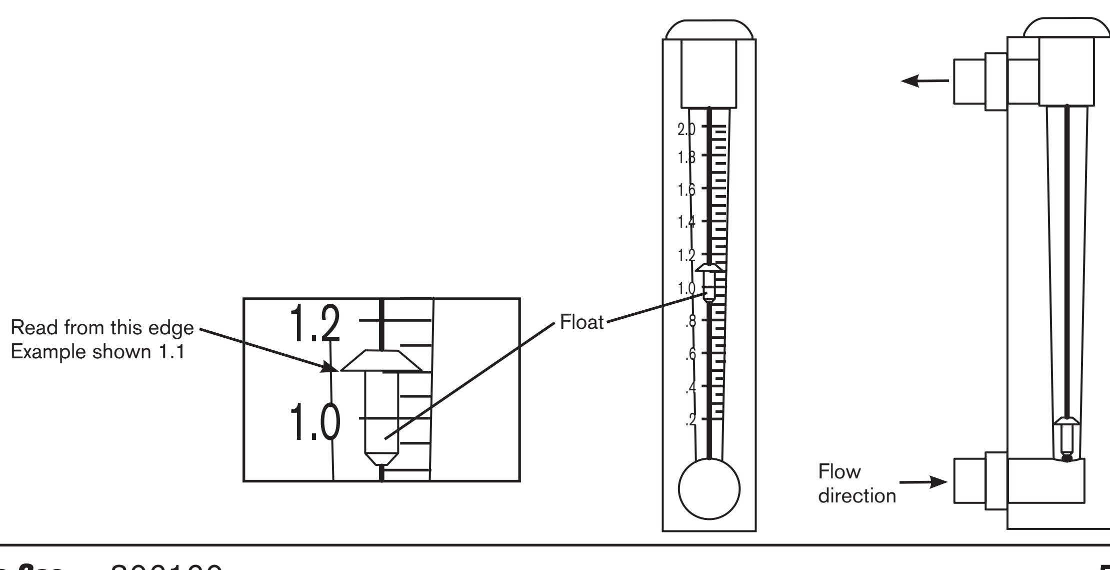
1. Remove the cooler's filler cap.
2. Stand in front of the cooler with the pump running, and look inside the coolant tank.
3. Coolant should be flowing from the orifice on the right. If coolant is flowing from the orifice on the left, look for a restriction in the coolant path. Install a new bypass valve if there is no obstruction.



Using the Hypertherm flow meter (128933)

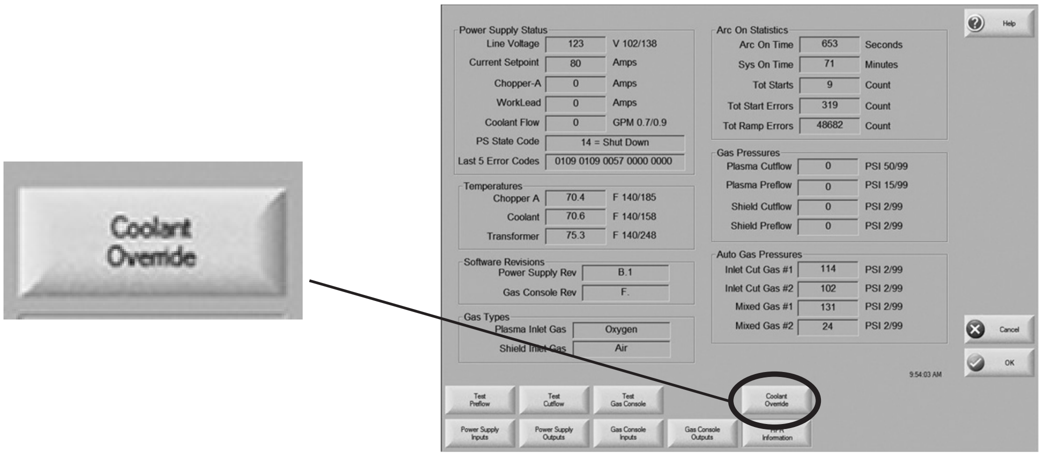
Use the steps below to get an accurate reading from the flow meter.

1. Hold the flow meter upright. Square in both axis.
2. Take your reading from the edge shown below.

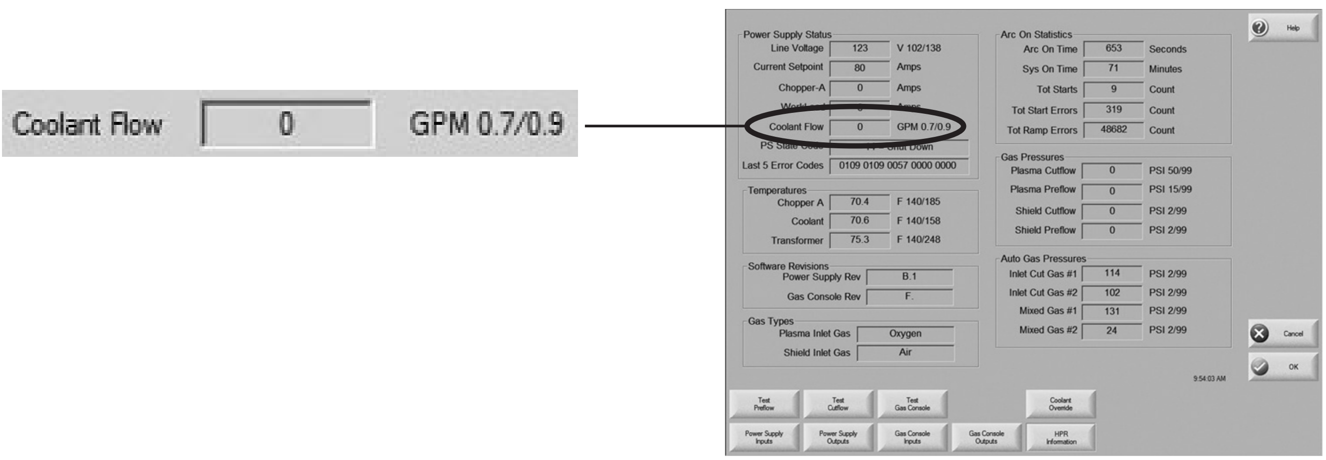


Manual pump operation

1. Go to the CNC screen that turns on the pump manually (refer to the operation instructions for the CNC being used). If the selection console shows coolant flow error 093, the pump must be turned on manually within 8 seconds of turning on the power supply, or the power will have to be turned off and then on again.
2. Turn ON the power. Turn ON the pump manually, and allow the coolant to flow for 60 seconds.



3. Write down the coolant flow rate on the CNC screen. The recorded flow rate will be used for comparison during some of the tests. Coolant flow must be greater than 2.3 lpm (0.6 gpm) for the system to operate.

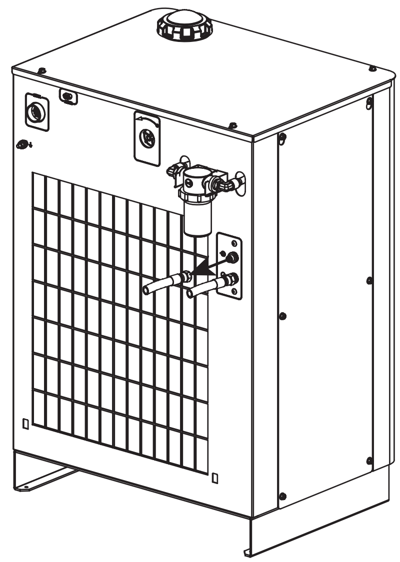


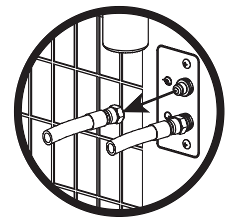
Note: A flow diagram can be found on schematic 013374, sheet 19 of 24

Test 1 – return line

Note: An in-line flow meter is required to complete this test.

1. Turn OFF the power. Remove the return coolant line (red washer on the cooler fitting), and connect the flow meter to measure the flow rate.
2. Measure the flow rate on the flow meter. Turn ON the power. Turn ON the pump manually using the manual pump control button on your CNC screen (see step 1 under “Manual pump operation”). Write down the flow rate from the flow meter.
3. Reconnect the return coolant line (red washer on the cooler fitting).





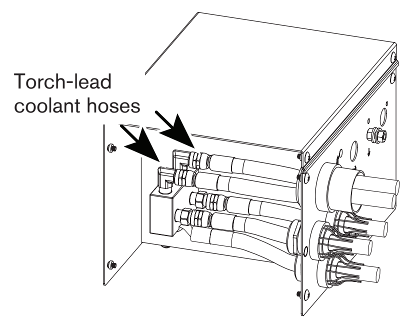
If the flow rate is 0.8 gpm or more, replace the flow switch.

If the flow rate is less than 0.8 gpm, Go to test 2.

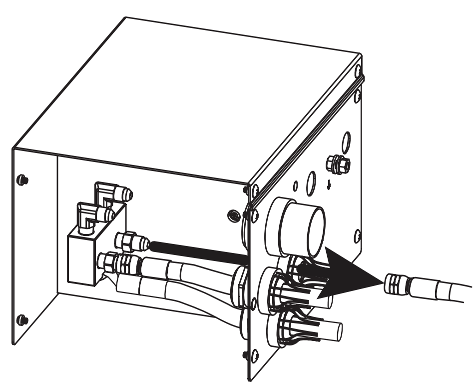
If there is no flow, go to pump and motor troubleshooting.

Test 2 – supply line at ignition console

Note: Remove the torch-lead coolant hoses to access the supply line.



1. Turn OFF the power. Remove the supply coolant line (blue hose with green tape) from the RHF/LHF console, and place it in a 3.8 liter (1 gallon) container. A Hypertherm coolant container works well.
2. Measure how long it takes to fill the container. Turn ON the power. Turn ON the pump manually using the manual pump control button on your CNC screen (see step 1 under “Manual pump operation”). Write down how long it takes to fill the container.
3. Reconnect the coolant lines.



If the container is full in 65 seconds or less, go to test 3.

If it takes more than 65 seconds to fill the container, go to test 6.

Test 3 – change the torch

1. Replace the torch and consumables with a new torch and new consumables.
2. Turn ON the pump manually using the manual pump control button on your CNC screen (see step 1 under “Manual pump operation”), let it run for 60 seconds, and look at the flow rate on the CNC screen.

If the flow rate on the CNC screen is 0.9 gpm or more, the torch is clogged.

If the flow rate is still less than 0.9 gpm, go to test 4.

Test 4 – supply line to the torch receptacle

1. Turn OFF the power. Remove the coolant supply line at the torch receptacle, and place it in a 3.8 liter (1 gallon) container. A Hypertherm coolant container works well.

Caution: Coolant will flow from the hose very quickly.

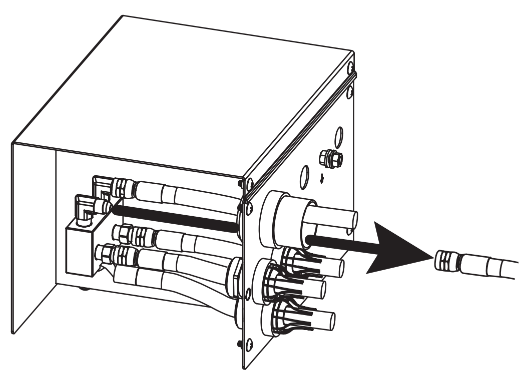
2. Measure how long it takes to fill the container. Turn ON the power. Turn ON the pump manually using the manual pump control button on your CNC screen (see step 1 under “Manual pump operation”). Write down how long it takes to fill the container.
3. Reconnect the coolant supply line to the torch receptacle.

If it takes more than 65 seconds to fill the container, look for an obstruction or kink in the coolant hose between the torch and the LHF/RHF console. If there is no obstruction or kink, replace the torch leads.

If the container is full in 65 seconds or less, go to test 5.

Test 5 – return line from the torch receptacle (remove at the ignition console)

1. Turn OFF the power. Remove the return coolant line (blue hose with red tape) from the RHF/LHF console, and place it in a 3.8 liter (1 gallon) container. A Hypertherm coolant container works well.
2. Measure how long it takes to fill the container. Turn ON the power. Turn ON the pump manually using the manual pump control button on your CNC screen (see step 1 under “Manual pump operation”). Write down how long it takes to fill the container.
3. Reconnect the return coolant line.



If it takes more than 65 seconds to fill the container, there is an obstruction in the torch receptacle. Replace the torch receptacle.

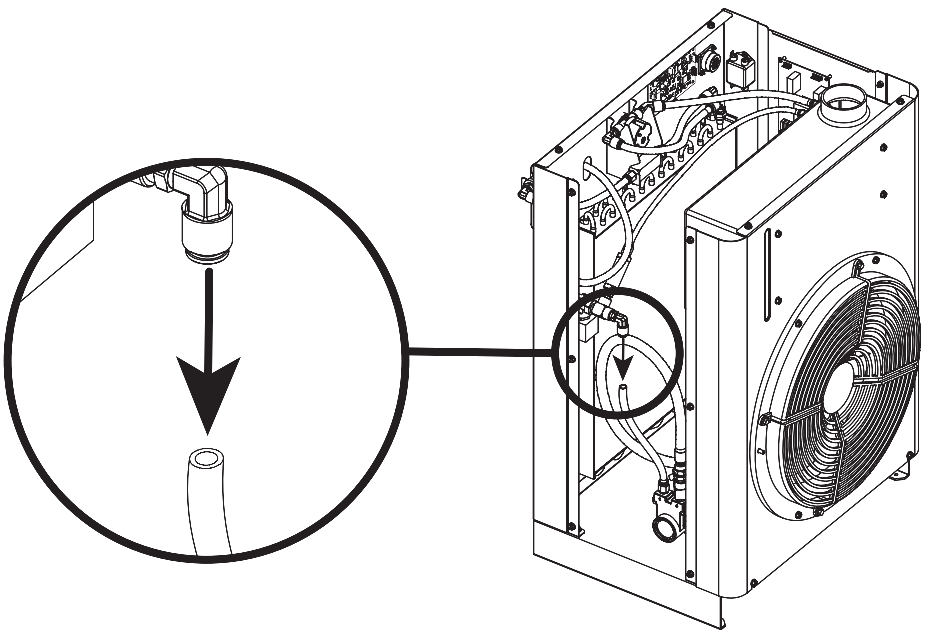
If the container is full in 65 seconds or less, there is an obstruction in the return coolant line (from the RHF/LHF console to the power supply). Replace the return coolant line.

Test 6 – bucket test at the pump

1. Turn OFF the power. Remove the pump outlet, coolant line, and place it in a 3.8 liter (1 gallon) container. A Hypertherm coolant container works well.
2. Measure how long it takes to fill the container. Turn ON the power. Turn ON the pump manually using the manual pump control button on your CNC screen (see step 1 under “Manual pump operation”). Write down how long it takes to fill the container.

If it takes more than 65 seconds to fill the container, replace the pump and check the motor shaft for damage.

If it takes less than 65 seconds to fill the container, check the coolant supply line (from the power supply to the RHF/ LHF console) for kinks. If no kinks are found, replace the by-pass valve and perform this test again. If it still takes more than 65 seconds to fill the container, replace the hoses between the power supply and RHF/LHF console.



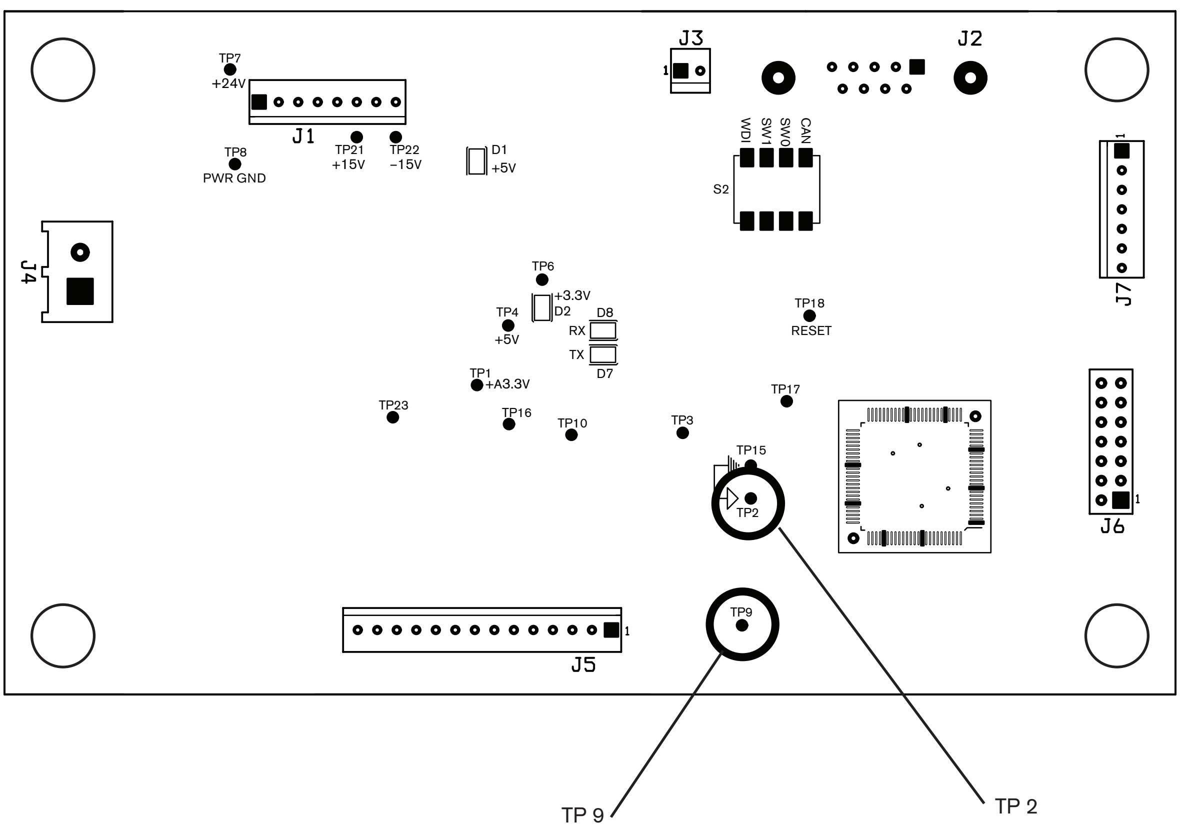
Pump and motor troubleshooting

Is the motor LED illuminated on the control board?
Is the motor on?
If the LED is illuminated, but the pump is not running, turn the pump on manually.
If the motor will not turn on, verify that the fuse is OK, and make sure there is power to the motor.

If you are still not getting flow from the pump, verify that the solenoid valve and relief valve are working correctly.

Testing the flow sensor

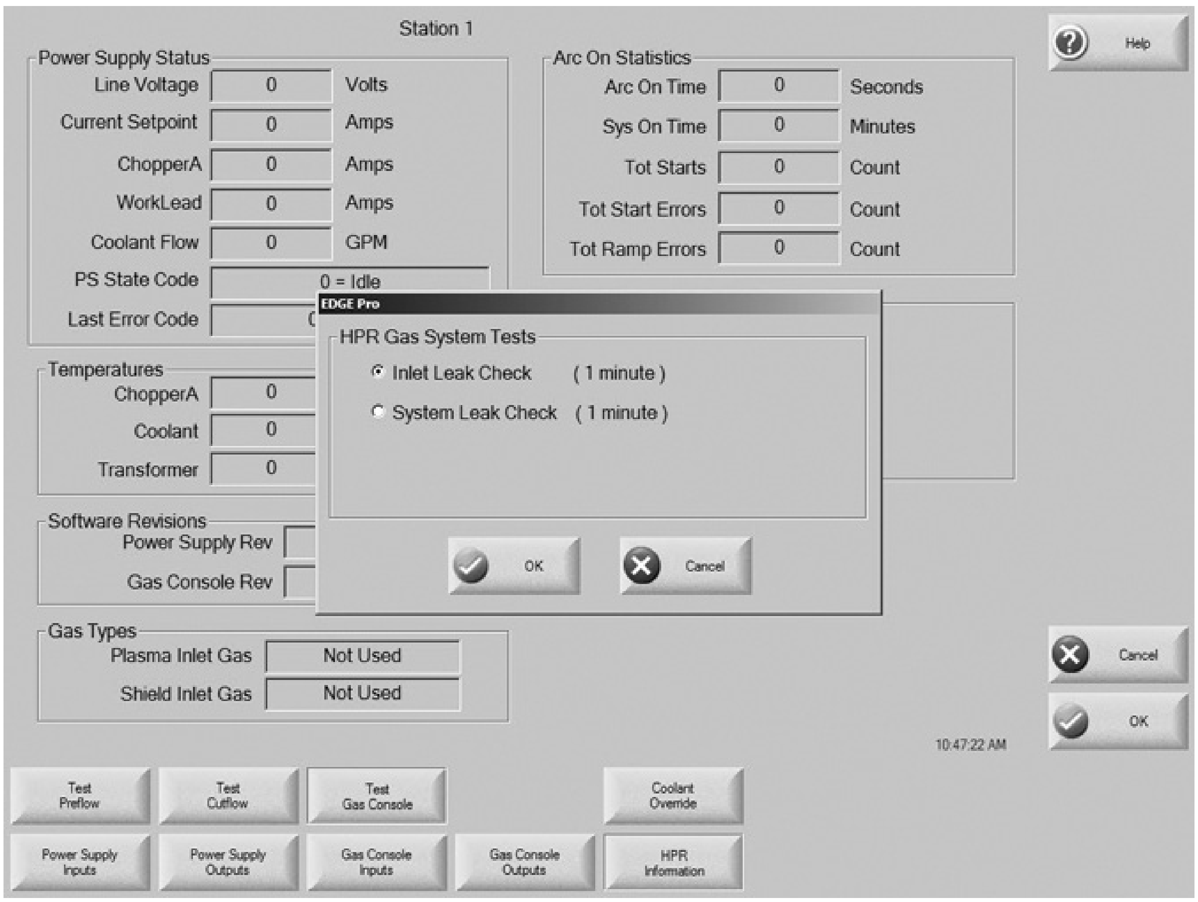
1. Turn ON the power.
2. Measure the VDC between TP2 and TP9.
   TP9 is 67% scaled voltage from the flow sensor. Normal flow is 3.8 lpm (1.0 gpm), which will equal 0.67 VDC at TP9.



Gas leak tests

Notes: The CNC screen shown below is from a Hypertherm Automation controller, using version 6 software, and is for reference only. Other controllers should have a test screen similar to the one shown. Contact the original equipment manufacturer for instructions on how to access the test screen needed.

See sheet 20 of 24 on schematic 013374, in this manual, for more details on the gas delivery system.



Leak test 1 (inlet leak test)

Purpose: Tests the inlet-valve solenoids in the selection console for leaks.

Test description: The valves in the metering console (B1-B4) open to release all gas pressure to the atmosphere, then the valves close and pressure is monitored by P3 and P4 in the selection console. The pressure will increase if an inlet valve is leaking. Code number 14 (cut gas channel number 1 failed) or 15 (cut gas channel number 2 failed) will be displayed if there is a leak. Code number 13 (test passed) will be displayed if no leak is detected.

Procedure:

1. Turn ON power to the plasma system.
2. Perform Inlet Leak Check on the CNC controller.
3. Turn OFF power and then turn ON power. This will purge gases from the system.

Leak test 2 (system leak test)

Purpose: Tests for leaks to the atmosphere from the gas system.

Test description: The gas for the process selected is purged through the gas system. The metering console valves (B1-B4), and the inlet valves (for the selected process) in the selection console are closed. Gas pressure is now trapped in the system. The trapped pressure is monitored. Code number 14 (cut gas channel number 1 failed) or 15 (cut gas channel number 2 failed) will be displayed if the pressure drops faster than 0.14 bar/minute (2 psi/minute). Code number 13 will be displayed if the pressure decreases within the acceptable limit of 0.14 bar/minute (2 psi/minute).

Procedure:

1. Perform System Leak Check on the CNC controller.
2. Turn OFF power and then turn ON power. This will purge gases from the system.

Leak test 3 (proportional valve test in the metering console)

Purpose: Tests the Burkert valves (B1 and B3) in the metering console to ensure that they are working within the correct parameters.

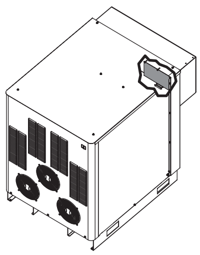
Test description: 130-amp mild steel consumables, and the 30-amp O_2/O_2 mild steel process are used for this test, because there is a known flow rate.
Gas flows from the torch, and the Burkert valve that controls the plasma gas channel (B3) attempts to maintain the set plasma gas pressure (monitored by P7 and P8) by adjusting the valve dynamically. The signal percentage to the valve is measured (example – 65% on), and the value is checked against the expected range (55% – 75%). The test is successful if the signal percentage is within the expected range. Code number 14 (shield gas channel failed) or 15 (plasma gas channel failed) will be displayed if the test fails. The same test is repeated for the Burkert valve that controls the shield gas channel (B1).

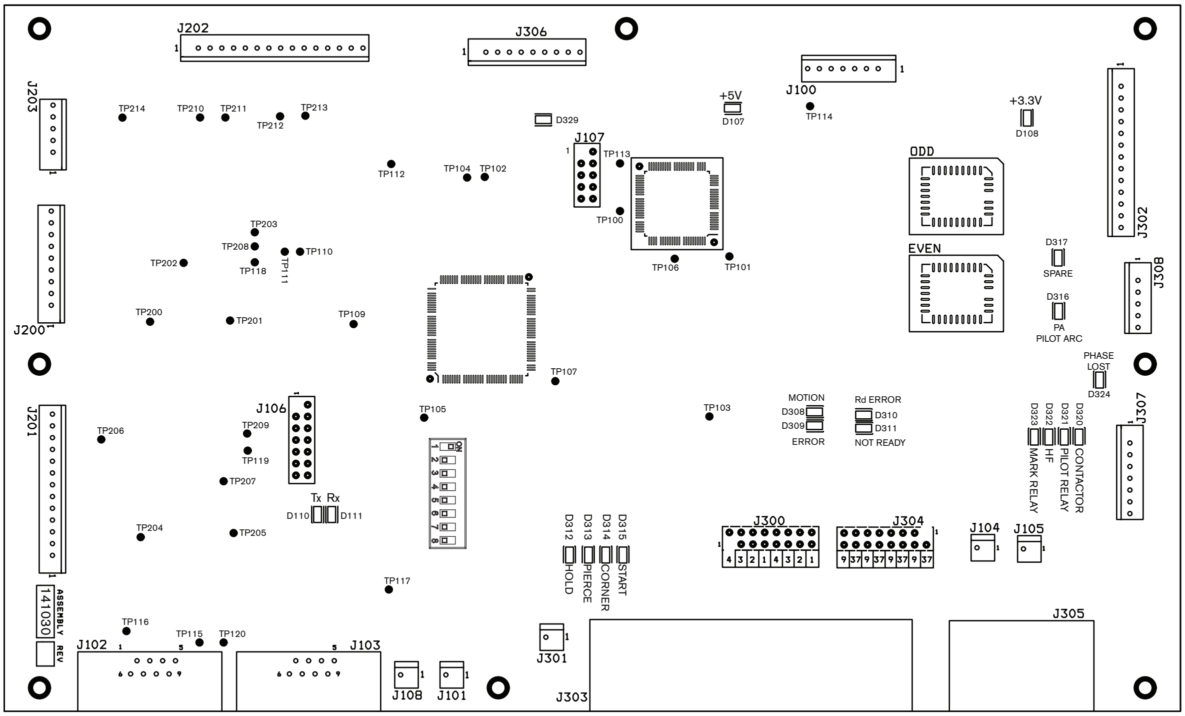
For the next part of the test, the Burkert valve that controls the plasma gas channel (B3) is closed, and the pressure is measured milliseconds later (pressure should decrease). The test is successful if the pressure is below a given limit (0.69 bar [10 psi]). The same test is repeated on the shield gas channel (B1).
Code number 16 (plasma ramp-down test failed) or 17 (shield rampdown test failed) will be displayed if the signal percentage is out of the expected range. Code number 13 (test passed) will be displayed if the signal percentage is within the expected range.

Procedure:

1. Install 130-amp mild steel consumables in the torch and select the 30-amp O_2/O_2 mild steel process.
2. Perform Metering Valve Flow Check on the CNC controller (test 3).
3. Turn OFF the power and then turn ON the power. This will purge gases from the system.

Power supply control board PCB3



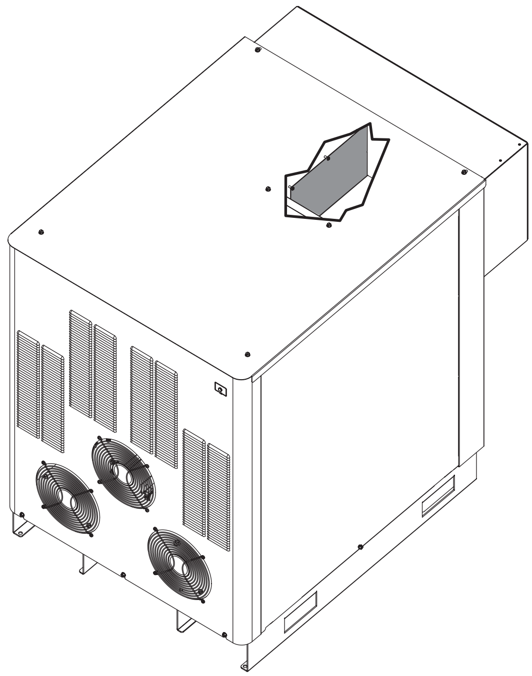


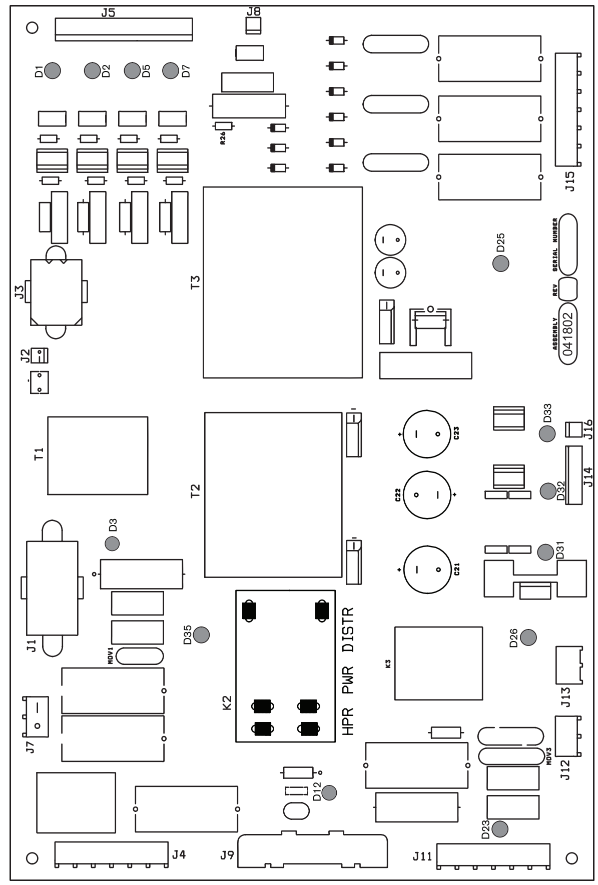
Control PCB LED list					
LED	Description	Status	LED	Description	Status
D107	+ 5 V OK	Steady	D312	Hold	
D108	+ 3.3 V OK	Steady	D313	Pierce	
D110	CAN transmit LED	Blinking	D314	Corner	
D111	CAN receive LED	Blinking	D315	Start redundant	
D308	Motion		D316	Pilot arc enable	
D309	Error		D317	Spare	
D310	Ramp-down error		D324	Phase loss	
D311	Not ready		D329	Pump motor-drive OK	Steady when OK

Firmware	
Item	Part number
U110	081135 EVEN
U109	081135 ODD

Control PCB test points					
Test point number	Description	Test point number	Description	Test point number	Description
TP105	WDI	TP117	CAN ground	TP206	Chopper 4 analog input
TP108	Reset	TP118	CCA+	TP207	Chopper control D
TP109	Reset	TP119	CCC+	TP208	DAC output A
TP110	Digital ground	TP120	CRXD (CANL)	TP209	DAC output B
TP111	Analog ground	TP200	Chopper 1 analog input	TP210	Chopper A temperature sensor
TP112	A + 3.3 V	TP201	Chopper control A	TP211	Chopper B temperature sensor
TP113	+ 3.3 V	TP202	Chopper 2 analog input	TP212	Chopper C temperature sensor
TP114	+ 5 V	TP203	Chopper control B	TP213	Chopper D temperature sensor
TP115	CANH	TP204	Chopper 3 analog input	TP214	Work lead analog input
TP116	CANL	TP205	Chopper control C		

Power supply power distribution board PCB2





Power distribution PC board LED list		
LED	Output	Color
D1	Contactor	Red
D2	Pilot arc relay	Red
D3	120 VAC (switched)	Green
D5	HF ignition	Red
D7	Surge select	Red
D12	24 VAC (switched)	Green
D23	240 VAC (switched)	Green
D25	+ 24 VDC	Red
D26	Pump motor	Green
D31	+ 5 VDC	Red
D32	− 15 VDC	Red
D33	+ 15 VDC	Red
D35	24 VAC	Green

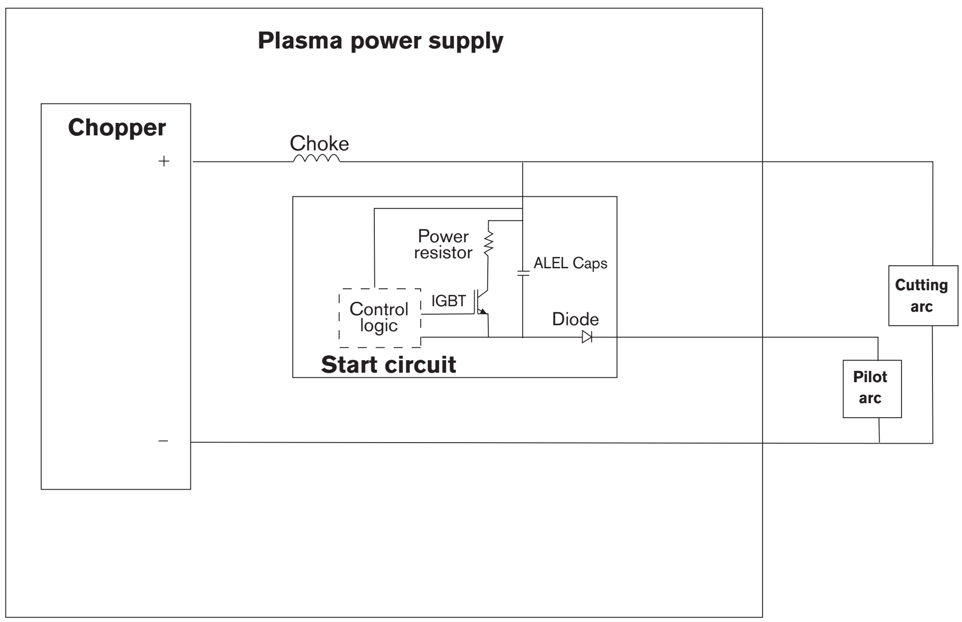
Start-circuit PCB1

Operation

The start circuit is a high-speed switch that quickly transfers the pilot arc current from the pilot arc lead to the work lead. The start circuit performs 2 functions:

1. It allows the initial pilot arc current to flow through the pilot arc lead quickly, with little impedance.
2. After initial pilot arc current is established, the start circuit introduces impedance to the pilot arc lead to aid in transferring the arc to the workpiece. See schematic below.

Start circuit functional schematic



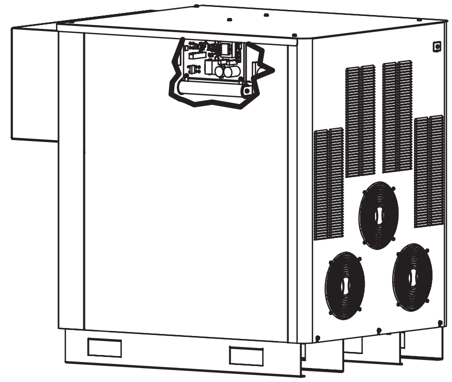
Start circuit troubleshooting

DANGER
SHOCK HAZARD

Always use caution when servicing a power supply when plugged in and the covers are removed. Dangerous voltages exist within the power supply which could cause injury or death.

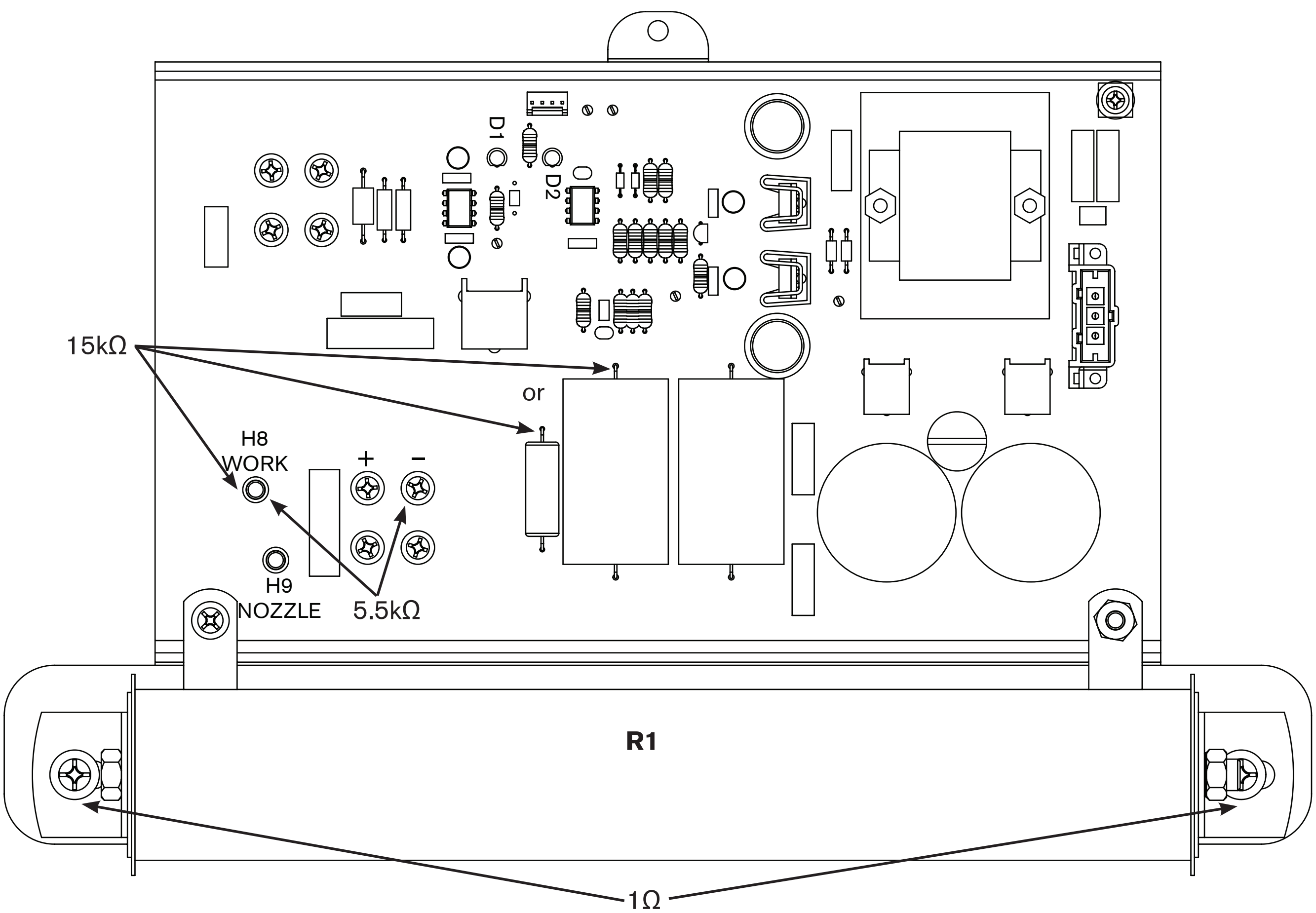
D2 should always be illuminated.

D1 illuminates as soon as the torch fires and will extinguish as soon as the arc transfers to the workpiece. If arc transfer is immediate, the LED will not illuminate.



If there is no arc at the torch or if the arc will not transfer:

1. Turn OFF all power to the system.
2. Remove wires from H8 (WORK) and H9 (NOZZLE) studs on the board.
3. Verify a resistance of about (≈) 5.5 kΩ between H8 and D50 (–). If the resistance value is not correct, replace the board.
   Note: Resistance value may slowly increase to the correct value due to the capacitance in the circuit.
4. Verify a resistance of about (≈) 15 kΩ between snubber and H8.
   - The work lead should not have any cuts or breaks. Verify a resistance of 1Ω or less. The work lead connection to the cutting table should be clean and have good contact to the table.
   - Verify that LED-D2 is illuminated. If it is not illuminated, the board may need to be replaced or the board may not be receiving power.
   - Fire the torch in the air and verify that D1 is illuminated. If it is not illuminated, but a pilot arc is established, the board may need to be replaced.
   - Verify a resistance of about (≈) 1 Ω across the R1 resistor.



Pilot arc current levels

The pilot arc current level will vary according to the arc current selected, and the process. See table below.

Pilot arc current

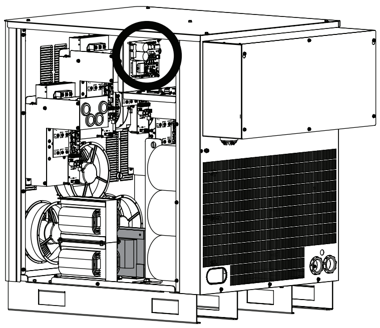
Plasma gas	30-amps	45-amps	50-amps	80-amps	130-amps	200-amps	260-amps	400-amps
O_2	25	30	30	30	30	40	40	60
N_2	25	30	30	30	35	40	40	60
H35	25	30	30	30	35	40	40	60
F5	25	30	30	30	35	40	40	60
Air	25	30	30	30	35	40	40	60

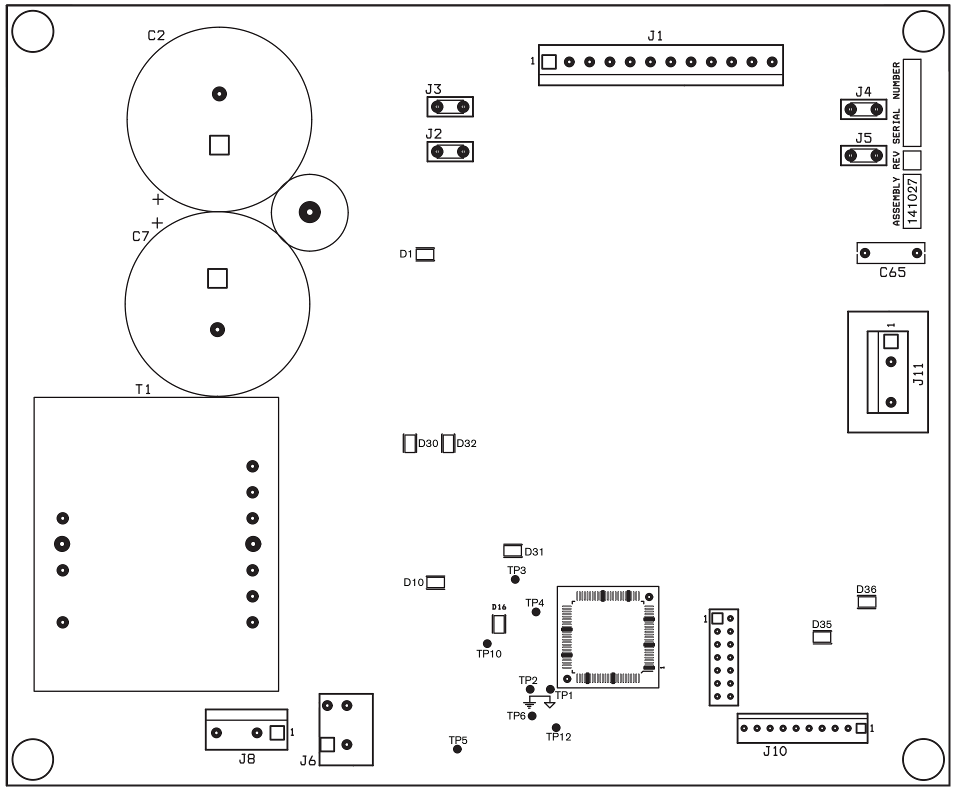
Transfer current

Plasma gas	30-amps	45-amps	50-amps	80-amps	130-amps	200-amps	260-amps	400-amps
O_2	10	10	10	10	15	20	20	30
N_2	10	10	10	10	15	20	20	30
H35	10	10	10	10	15	20	20	30
F5	10	10	10	10	15	20	20	30
Air	10	10	10	10	15	20	20	30

Pump motor drive board PCB7

Note: The inductor on the pump motor-drive board makes a noise during operation that has been described as a "hum", "sing", and "click". This is normal and can be disregarded.

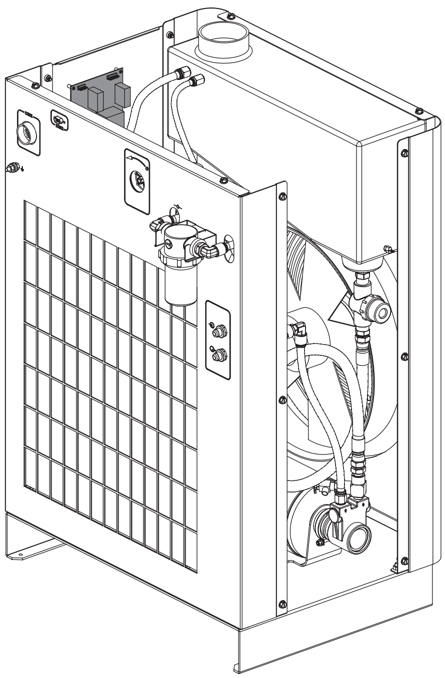


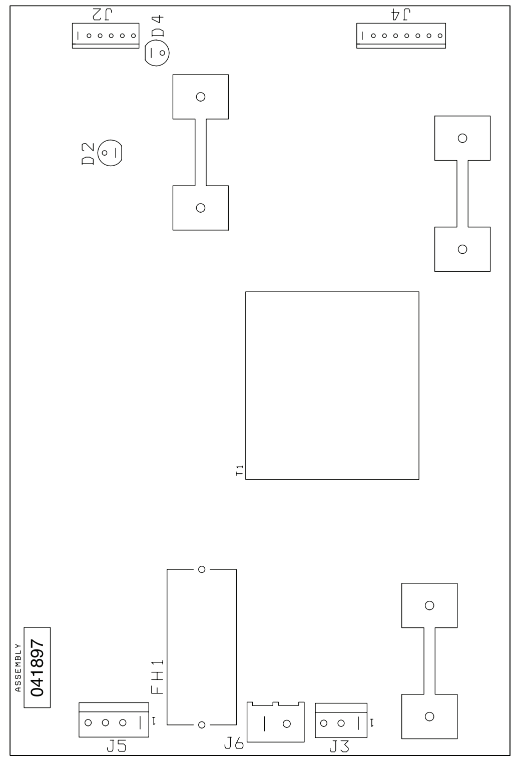


Control PCB LED list		
LED	Description	Status
D1	+ 15 V OK	On when +15 voltage is OK
D10	+ 5 V OK	On when +5 voltage is OK
D16	+ 3.3 V OK	On when +3.3 voltage is OK
D30	IPM temperature alarm output	Off when OK. On when there is a sustained over-current condition
D31	Temperature	Off when OK. On when there is a temperature fault
D32	IPM alarm output	Off when OK. On when there is an internal overtemp, over-current, or bad gate supply-drive voltage
D35	Pump motor drive OK	On when pump-motor-drive is OK
D36	Pump motor drive enable	On when enabled

Control PCB test points					
Test point number	Description	Test point number	Description	Test point number	Description
TP1	Analog ground	TP5	+ 5 V	TP9	Digital ground
TP2	Digital ground	TP6	A + 3.3 V	TP10	+ 3.3 V
TP3	Reset\	TP7	+ 3.3 V	TP11	SCIRXD
TP4	Reset	TP8	SCITXD	TP12	LINEFB +

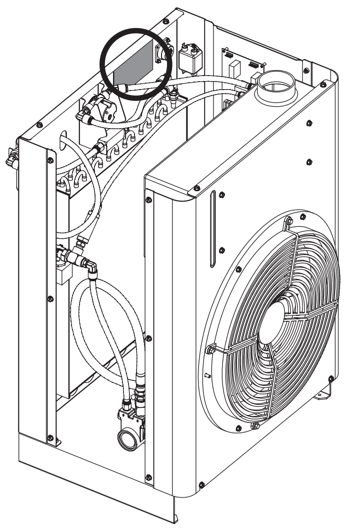
Cooler power distribution board PCB1

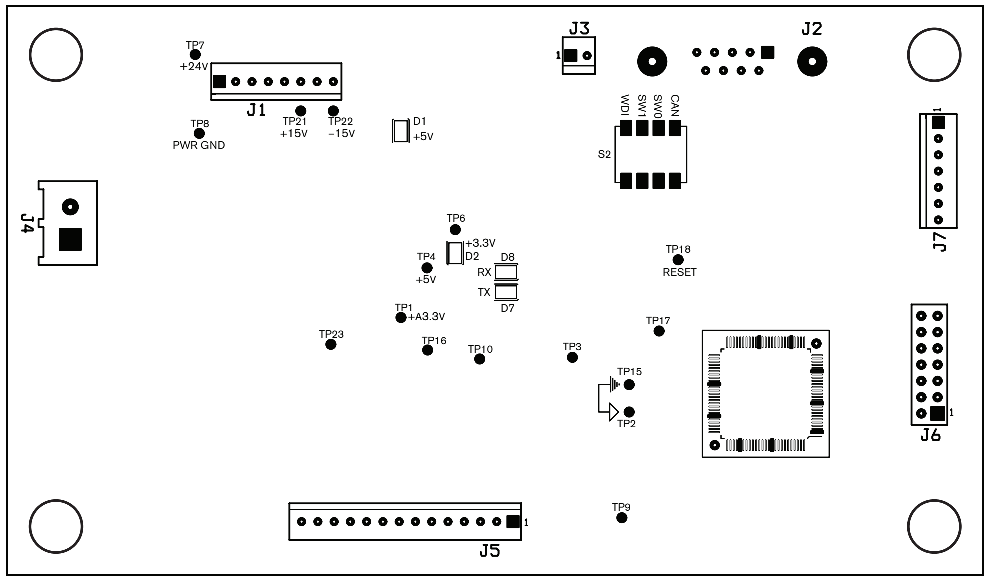




Gas console control board LED list		
LED	Signal name	Color
D2	SV16	Red
D4	+ 5 VDC	Green

Cooler sensor board PCB2

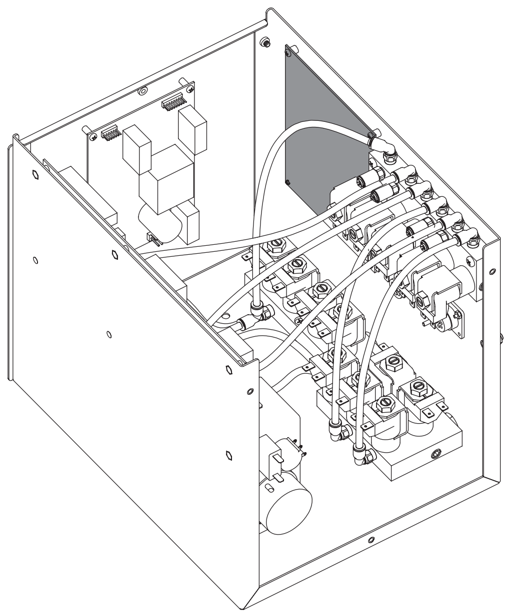


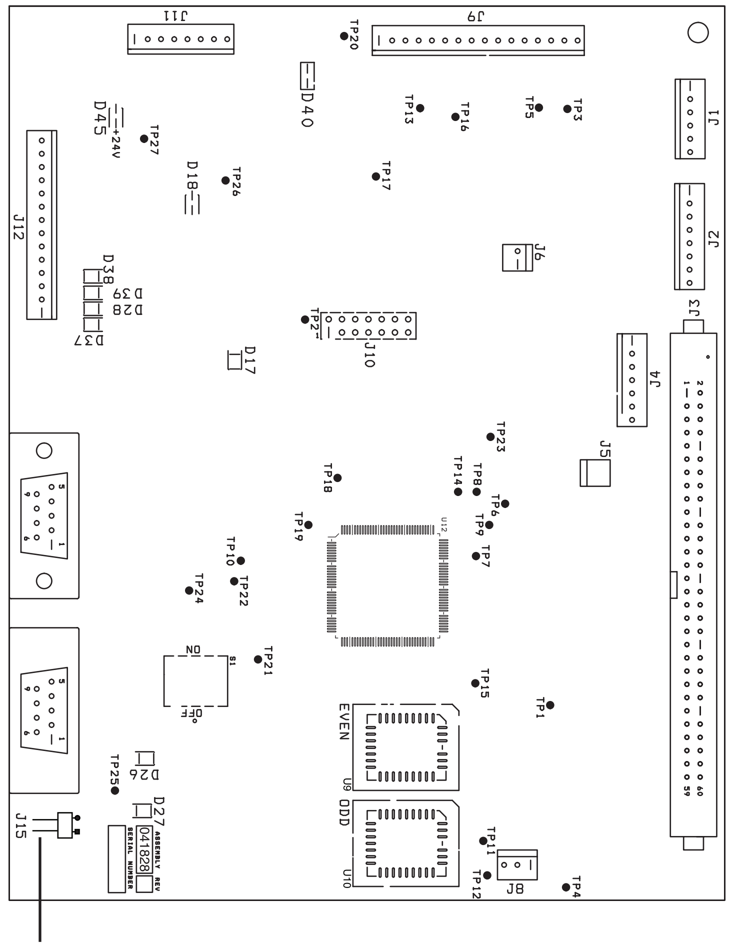


Gas console control board LED list		
LED	Signal name	Color
D1	+ 5 VDC	red
D2	+ 3.3 VDC	Green
D7	CAN TX	
D8	CAN RX	

Control PCB test points			
Test point number	Description	Test point number	Description
TP1	A + 3.3 V	TP12	Digital ground
TP2	Analog ground	TP13	+ 3.3 V
TP3	Pressure sensor (for use in the future)	TP14	SCIRXD (RS422 transmit)
TP4	+ 5 V	TP15	Digital ground
TP6	+ 3.3 V	TP16	Analog ground
TP7	+ 24 V	TP17	Reset\
TP8	Power ground	TP18	Reset
TP9	Coolant flow sensor input	TP21	+ 15 V
TP10	Chiller flow input (for use in the future)	TP22	– 15 V
TP11	SCIRXD (RS422 receive)	TP23	Line voltage input

Selection console control board PCB2



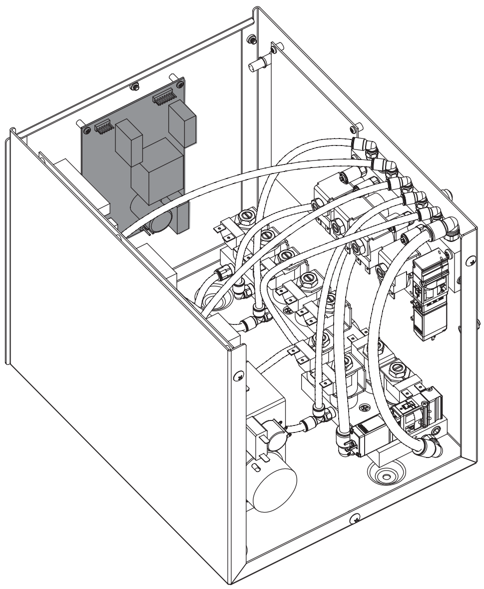


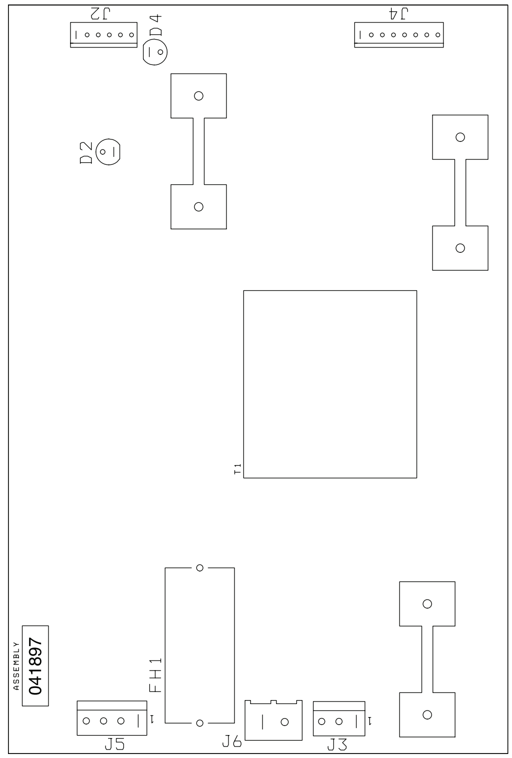
Note: CAN termination resistor. The jumper must be removed.

Control PCB2 firmware list	
Item	Part number
U9	081110 EVEN
U10	081110 ODD

Gas console control board LED list		
LED	Signal name	Color
D17	+ 3.3 VDC	Green
D18	+ 5 VDC	Green
D26	CAN – RX	Green
D27	CAN – TX	Green
D28	Not used	Red
D37	Not used	Red
D38	Not used	Red
D39	Not used	Red
D40	+ 15 VDC	Green
D45	+ 24 VDC	Green

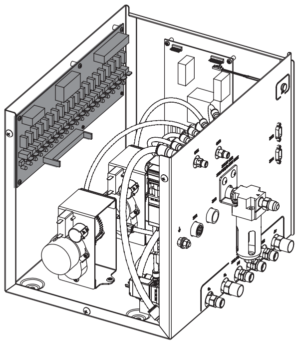
Selection console power distribution board PCB1

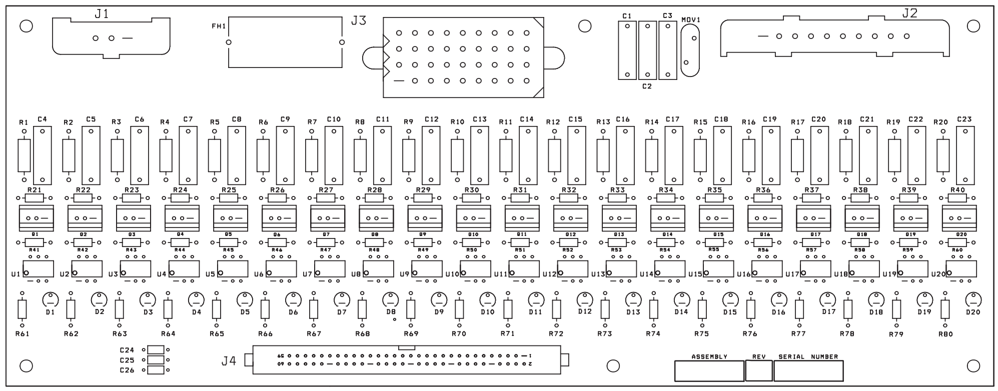




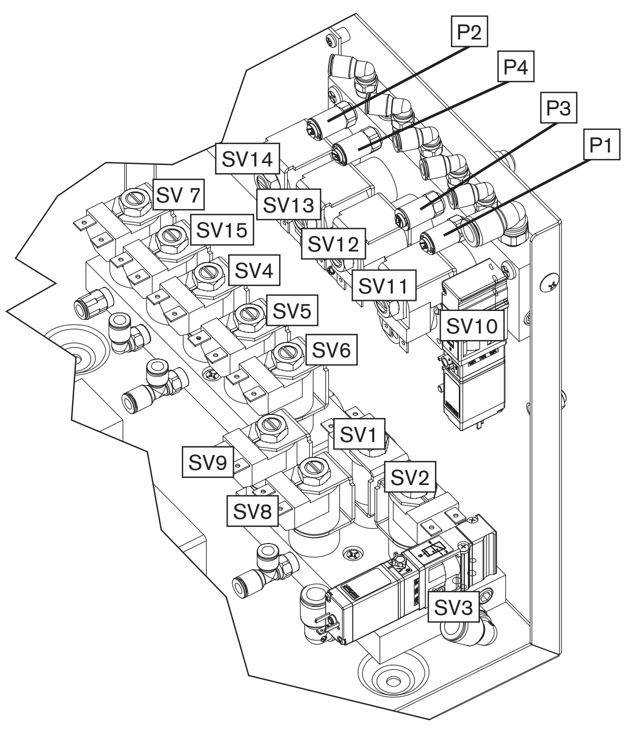
Gas console control board LED list		
LED	Signal name	Color
D2	SV16	Red
D4	+ 5 VDC	Green

Selection console, AC valve-driver board PCB3

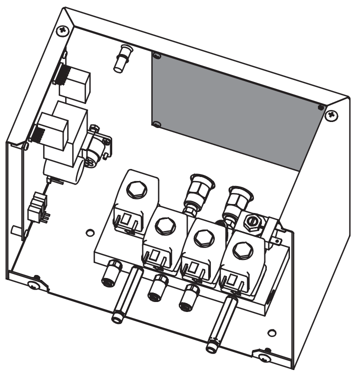


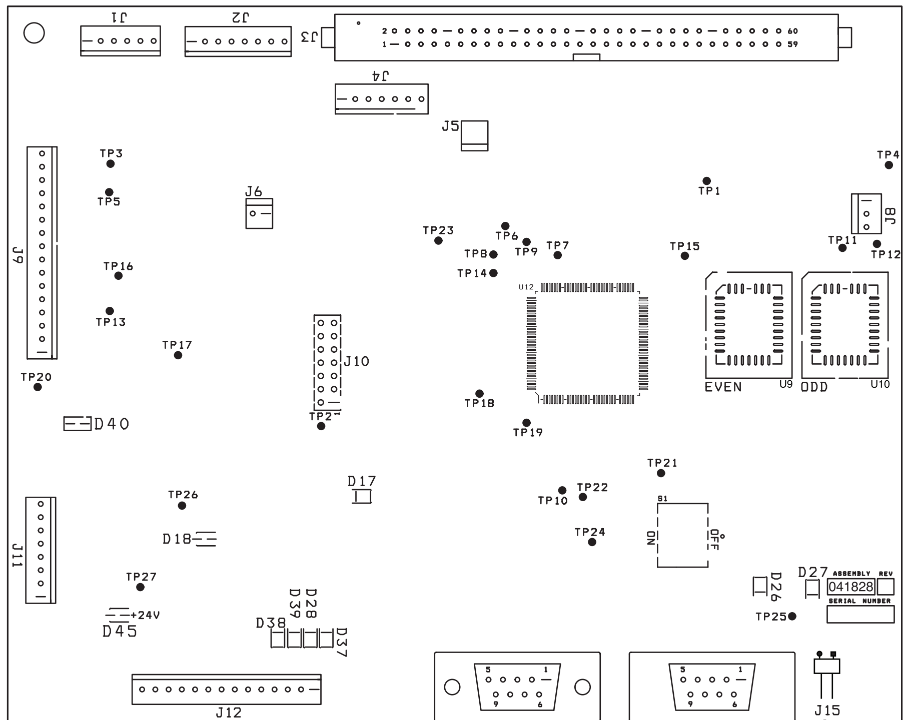


LED	Signal name	Color	LED	Signal name	Color
D1	SV1	Red	D11	SV11	Red
D2	SV2	Red	D12	SV12	Red
D3	SV3	Red	D13	SV13	Red
D4	SV4	Red	D14	SV14	Red
D5	SV5	Red	D15	(not used)	Red
D6	SV6	Red	D16	Metering console vent solenoid	Red
D7	SV7	Red	D17	MV1 close	Red
D8	SV8	Red	D18	MV1 open	Red
D9	SV9	Red	D19	MV2 close	Red
D10	SV10	Red	D20	MV2 open	Red



Metering console control board PCB2

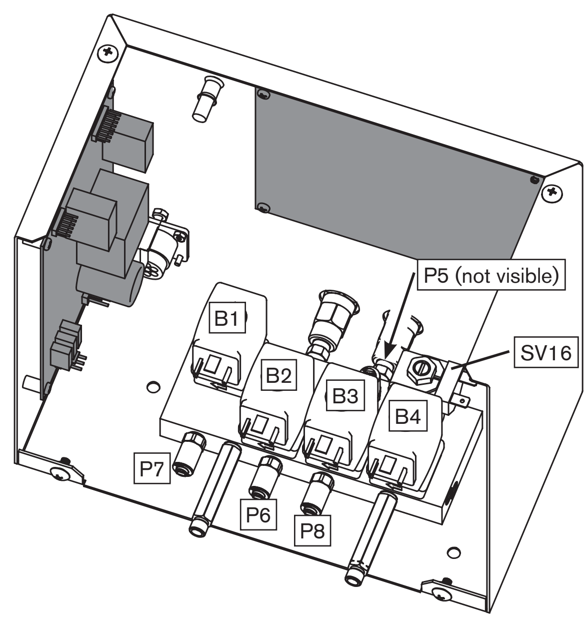




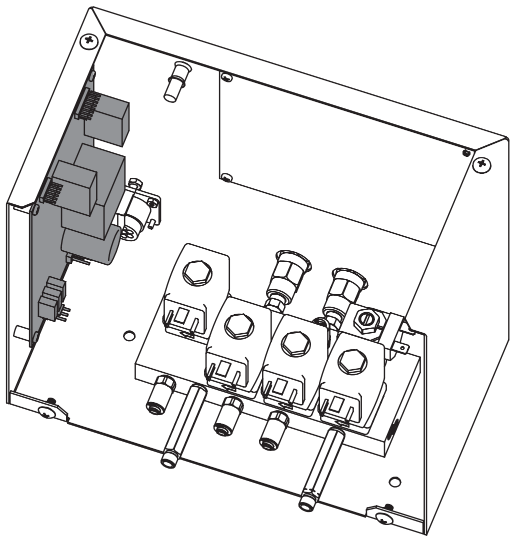
Note: CAN termination resistor. The jumper must be installed.

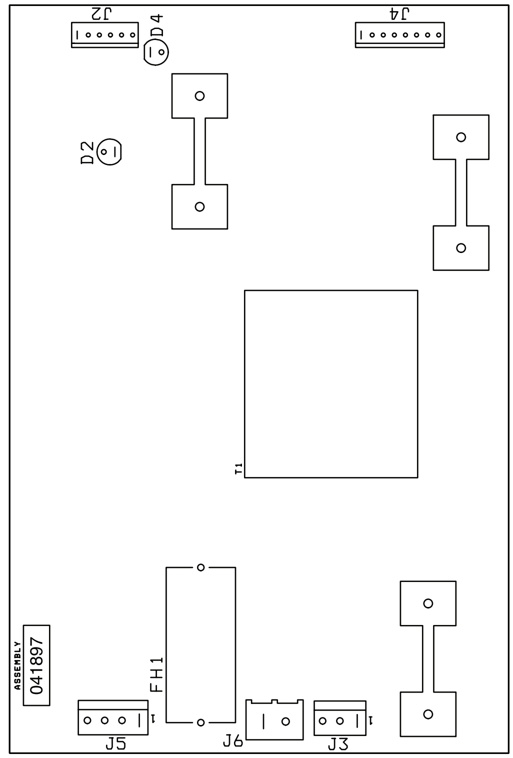
Control PCB2 firmware list	
Item	Part number
U9	081110 EVEN
U10	081110 ODD

Gas console control board LED list		
LED	Signal name	Color
D17	+ 3.3 VDC	Green
D18	+ 5 VDC	Green
D26	CAN – RX	Green
D27	CAN – TX	Green
D28	Burkert valve 2	Red
D37	Burkert valve 1	Red
D38	Burkert valve 4	Red
D39	Burkert valve 3	Red
D40	+ 15 VDC	Green
D45	+ 24 VDC	Green



Metering console power distribution board PCB1





Gas console control board LED list		
LED	Signal name	Color
D2	SV16	Red
D4	+ 5 VDC	Green

Chopper tests

WARNING
SHOCK HAZARD

Use extreme care when working near the chopper modules. Each large electrolytic capacitor (blue-cased cylinder) stores large amounts of energy in the form of electric voltage. Even if the power is off, dangerous voltages exist at the capacitor terminals, on the chopper, and the diode heatsinks. Never discharge any capacitor with a screwdriver or other implement… explosion, property damage and/or personal injury will result.

Automatic chopper tests during power-up

When the power is turned ON, the contactor will close and each chopper will automatically test in sequence (1, 3, 2, and 4). If the status changes to 3, all choppers passed the test. After the tests are complete the unit will advance to the purge cycle unless an error is detected on one of the choppers.

As each chopper is turned on, the current flows into the surge circuit and is measured for high and low limits. If the chopper passes the test, the next chopper is tested.

If chopper 1 passes the test and one of the other choppers fails, you can assume that the main contactor, the input power, and the surge circuit are OK.

Error codes:

Chopper 1 – low-current error code 105
Chopper 1 – high-current error code 103

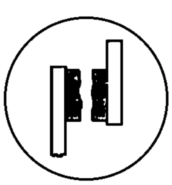
Chopper 3 – low-current error code 075
Chopper 3 – high-current error code 107

Chopper 2 – low-current error code 106
Chopper 2 – high-current error code 104

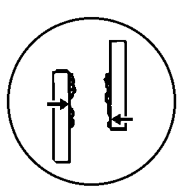
Chopper 4 – low-current error code 076
Chopper 4 – high-current error code 095

Chopper 1 failure

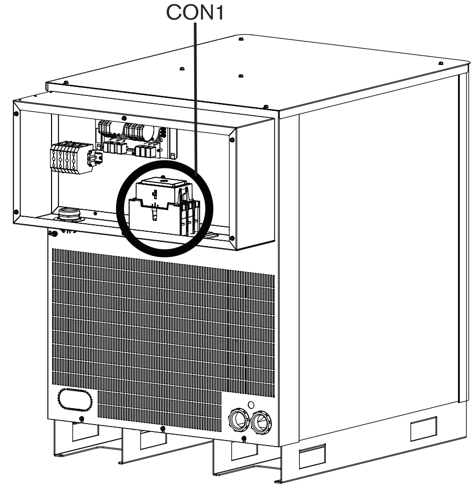
1. Turn OFF all power to the system.
2. Remove the cover over the main contactor (CON1) and inspect the contacts for arcing or damage.
   - If the contacts are damaged, replace the contactor.
   - If the contacts are OK, replace the cover, turn ON the power, and continue to step 3.



OK



Excessive wear



3. Locate dipswitch S301 on the control board (PCB3) and move switch 5 to the ON position. The switch must be returned to its original position before cutting.

4. Measure the open circuit voltage (OCV)
   Attach the test leads of a DC volt meter to the NEG terminal and the WORK terminal on the I/O board. Turn ON the power to start the chopper test. After the contactor (CON1) closes, read the OCV which should be about 360 VDC.
   - If the OCV is 0, the chopper is probably faulty. Swap chopper 1 with chopper 2 for verification. If chopper 1 is faulty, the error code should change to 106. Replace chopper 1.
   - If OCV is about 360 VDC, continue to step 5.

5. Swap current sensor 1 (CS1) with current sensor 2 (CS2). Move the sensor, but leave the power cable and the control wiring in place.
   - If the error remains on chopper 1, replace the I/O PCB.
   - If the error changes to chopper 2, replace CS1.

Chopper 2, 3, or 4 failure

1. Swap the current sensor for the chopper that failed with the current sensor for the next chopper in sequence.
   - If the error moves to the next chopper in sequence, replace the current sensor for the chopper that failed.
   - If the error remains on the original chopper, continue to step 2.

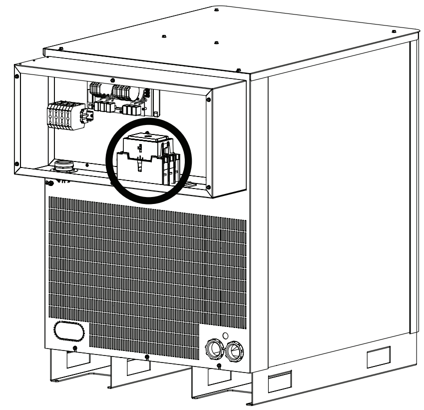
2. Measure the OCV
   - The chopper outputs are connected in parallel at the I/O board, and the choppers are tested in sequence (1, 3, 2, and 4). This means that if you measure the OCV at the NEG and WORK terminals on a fully functional HPR400XD, the voltage will be 0 until the contactor (CON1) closes. Chopper 1 will turn on and you will measure 360 VDC. Chopper 1 will turn off and the voltage will decrease to 0. Chopper 3 (1, 3, 2, and 4) will turn on next, and the voltage will increase to 360 VDC and then decrease to 0 when chopper 3 turns off. This sequence repeats until all 4 choppers are tested.

   Example:
   If you get error 075 or 107, you know chopper 3 failed the test. Because chopper 1 and chopper 2 passed the test, you know the incoming power and the I/O board are OK. If you measure the OCV at the NEG terminal and the WORK terminal on the I/O board, you will see the voltage cycle from 0 to 360, back to 0, and then to 360 again, because chopper 1 and chopper 2 are OK. If you do not get the third reading of 360 VDC from chopper 3, that means chopper 3 is faulty. You can swap chopper 3 with chopper 2 for verification. The error code will move to chopper 2, if chopper 3 is faulty. If the error does not move, or you measure an OCV of about 360 VDC for chopper 3, contact Hypertherm Technical Service at 800-643-9878.

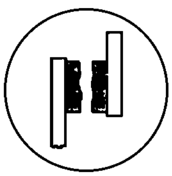
Note: Return switch 5 on S301 to the OFF position before returning to normal cutting operations.

Phase-loss detection test

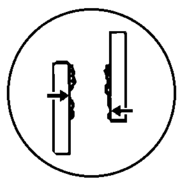
1. Turn OFF all power to the system and remove the cover from CON1.



2. Inspect the condition of the 3 contacts for excessive wear. If one or more of the contacts are worn excessively, replace CON1 and restart the system. If the error remains, perform the following steps.

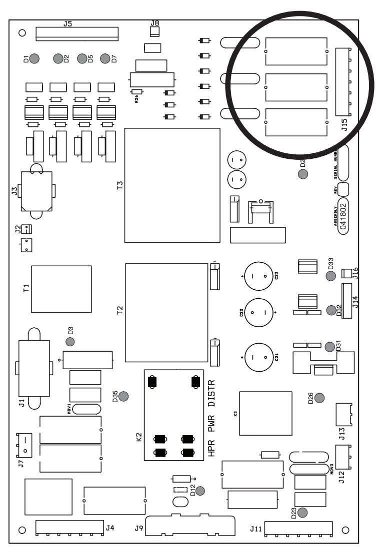


OK



Excessive wear

3. Test the fuses F5, F6, and F7 on the power distribution board (PCB2). If any of the fuses are blown, replace PCB2.



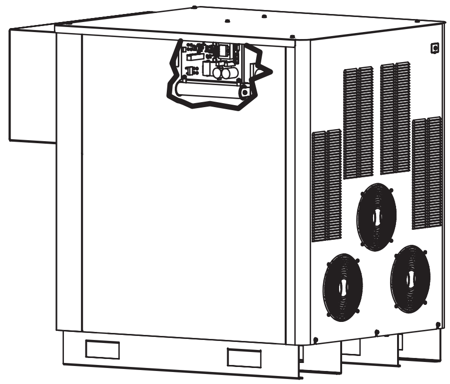
4. Remove J2.8 from PCB2 and place a jumper between pins 1 and 2 on the cable connector.
   a. Make a test cut. If the phase-loss error continues, verify wiring between J2.8 on PCB2 and J3.302 on PCB3 by verifying the continuity between
      – J2.8 pin1 to J3.302 pin14
      – J2.8 pin2 to J3.302 pin15.
   b. If the wiring is OK, replace PCB3. If any wiring is damaged, repair or replace any damaged wires.
   c. If the phase-loss error goes away while the jumper is on J2.8, make another cut and measure the phase-to-phase voltage across the fuses F5, F6, and F7. The voltage should be 220 VAC +/-15%. If 1 of the 3 voltage readings is less than 187 VAC, check the contacts to the contactor, and check for loose connections between the power cord, contactor, power transformer, and the chopper.

WARNING
SHOCK HAZARD

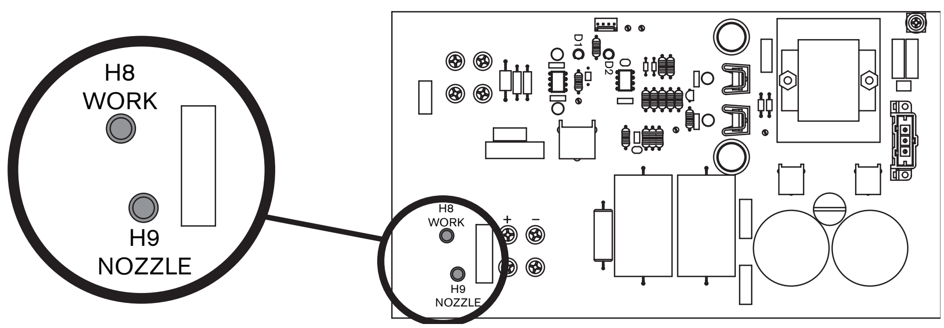
Always use caution when servicing a power supply when plugged in and the covers are removed. Dangerous voltages exist within the power supply which could cause injury or death.

Torch lead test

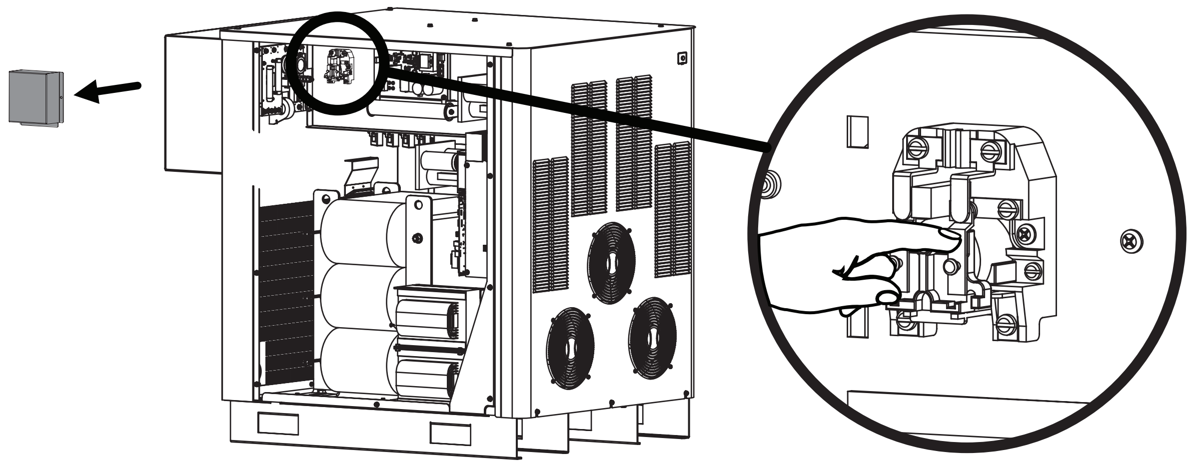
1. Turn OFF all power to the system.
2. Locate the start-circuit assembly.



3. Install a temporary jumper wire between H8 (work) and H9 (nozzle) on the start circuit PCB1.



4. Locate the pilot arc relay (CR1) and remove the dust cover. Have a second person close the contact.



5. Measure the ohm value between the nozzle and the plate. The reading should be less than 3 ohms. A measurement of greater than 3 ohms indicates a faulty connection between the torch and ignition console or between the ignition console and the power supply.
6. Verify that the pilot arc wire on the torch lead is not damaged. If it is damaged replace the lead. If it is not damaged, replace the torch head.

Preventive maintenance

Hypertherm created a Preventive Maintenance Program (PMP) specifically for your plasma system. The PMP has two parts: a cleaning and inspection schedule and a component replacement schedule.

See the *HPR400XD Auto Gas Preventive Maintenance Program Instruction Manual (808660)* for part numbers.

If you have questions about how to maintain your plasma system, contact your OEM or regional Hypertherm Technical Service team. You can find contact information for each regional office at www.hypertherm.com/global on the "Contact us" page after choosing your language.

This document refers to your system's instruction manual. If you do not have your instruction manual, you can find it in the Hypertherm downloads library:

1. Go to www.hypertherm.com/global
2. Choose your language.
3. Click Downloads library.
4. Enter your instruction manual's part number in the Part number field.
    - HPR400XD Auto Gas Instruction Manual: 806160

Section 6

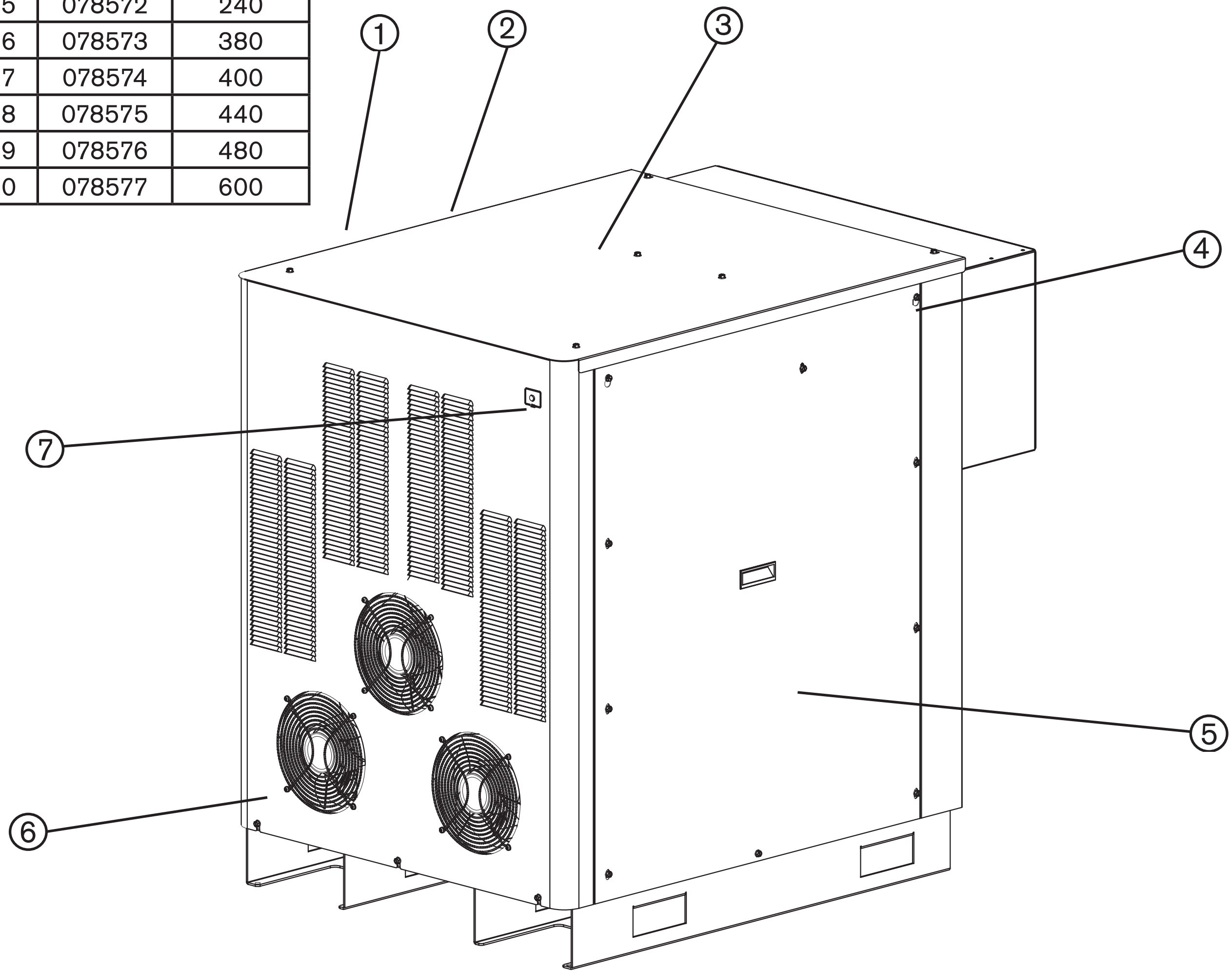
PARTS LIST

In this section:

Power supply

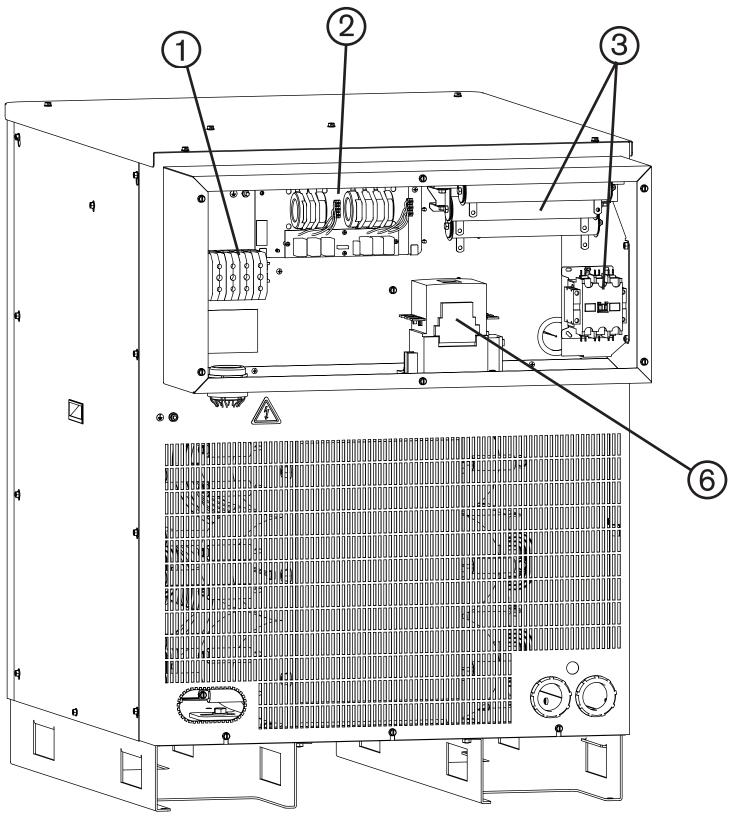
Power supplies		
Without Hypernet	**With Hypernet**	**Voltage (AC)**
078523	078570	200/208
078524	078571	220
078525	078572	240
078526	078573	380
078527	078574	400
078528	078575	440
078529	078576	480
078530	078577	600

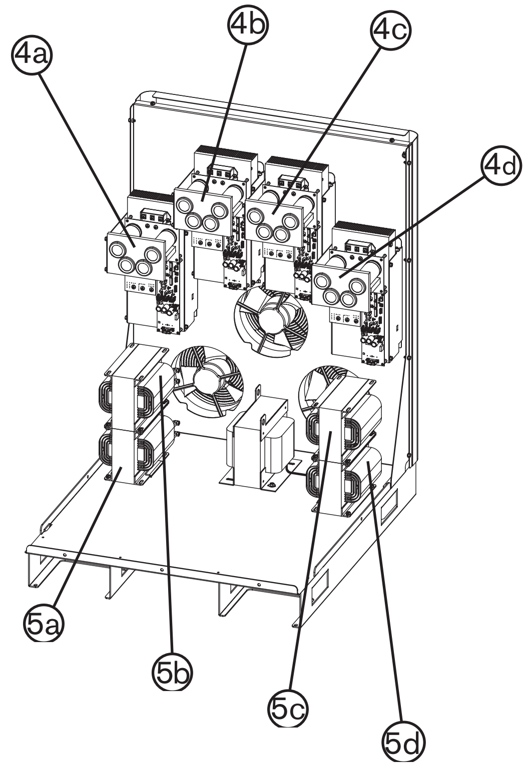
Note: The Hypernet option is currently used with the ArcGlide® torch height control. See the ArcGlide instruction manual (806450) for more information.



Item	Part Number	Description	Designator	Qty.
1	See table above	Power supply		
2	228363	Panel: Left side, with labels and handles (not shown)		1
3	228362	Panel: Top, with labels		1
4	075241	Sheet metal screws		1
5	228395	Panel: Right side, with labels and handles		1
6	228361	Panel: Front, with labels		1
7	129633	Green power lamp assembly		
8	228604	Kit: Hypernet upgrade (not shown)		1

Power supply

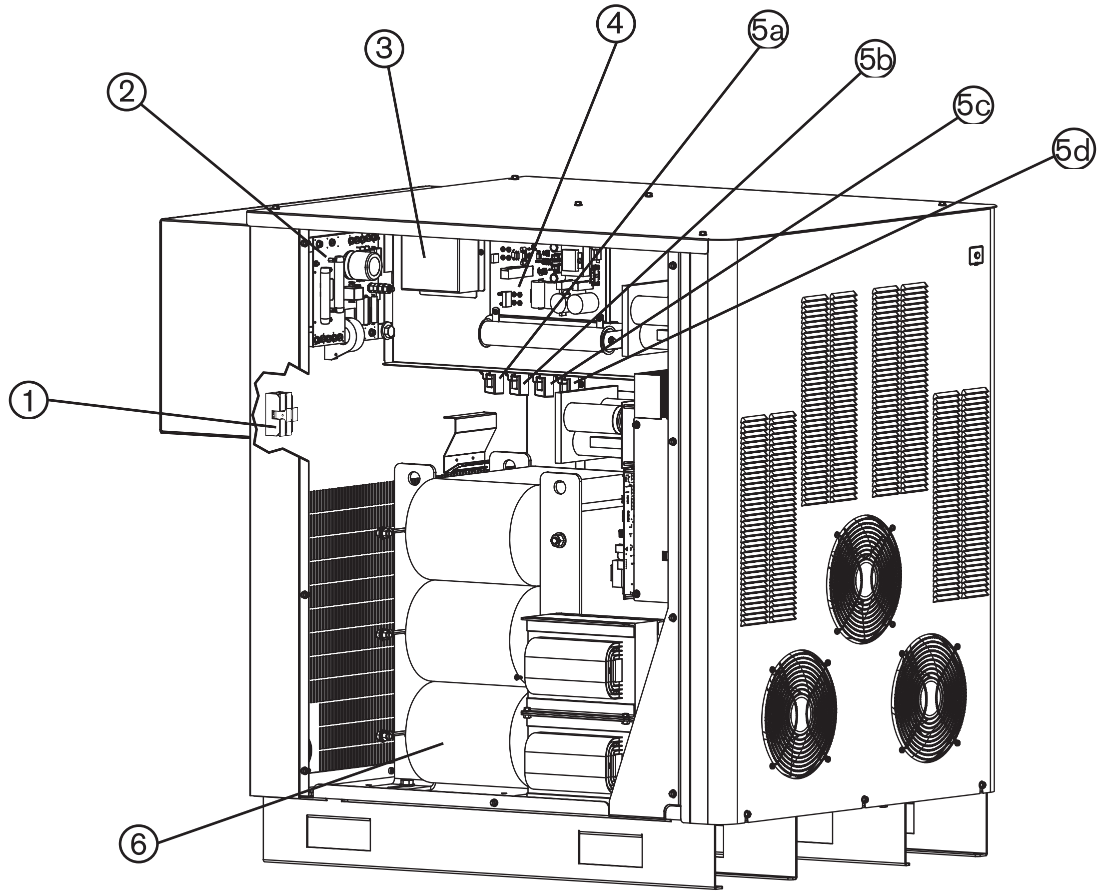




Item	Part Number	Description	Designator	Qty.
1	229214*	Terminal block: Input power	TB1	1
	229033**	Terminal block: Input power	TB1	1
2	229195	EMI filter (400 volt power supply only)		1
3	428064	Kit: HPR400/800 inrush circuit		1
4a	129792	Chopper assembly	CHA	1
4b	129792	Chopper assembly	CHB	1
4c	129792	Chopper assembly	CHC	1
4d	129792	Chopper assembly	CHD	1
	127039	6” fan: 230 CFM, 115 VAC 50-60 HZ		8
5a	014080	Inductor: 100 amp, 4 mH	L1	1
5b	014080	Inductor: 100 amp, 4 mH	L2	1
5c	014080	Inductor: 100 amp, 4 mH	L3	1
5d	014080	Inductor: 100 amp, 4 mH	L4	1
6	003218*	Contactor	CON1	1
	003233**	Contactor	CON1	1

* 200, 220, and 240 volt power supplies
** 380, 400, 440, 480, and 600 volt power supplies

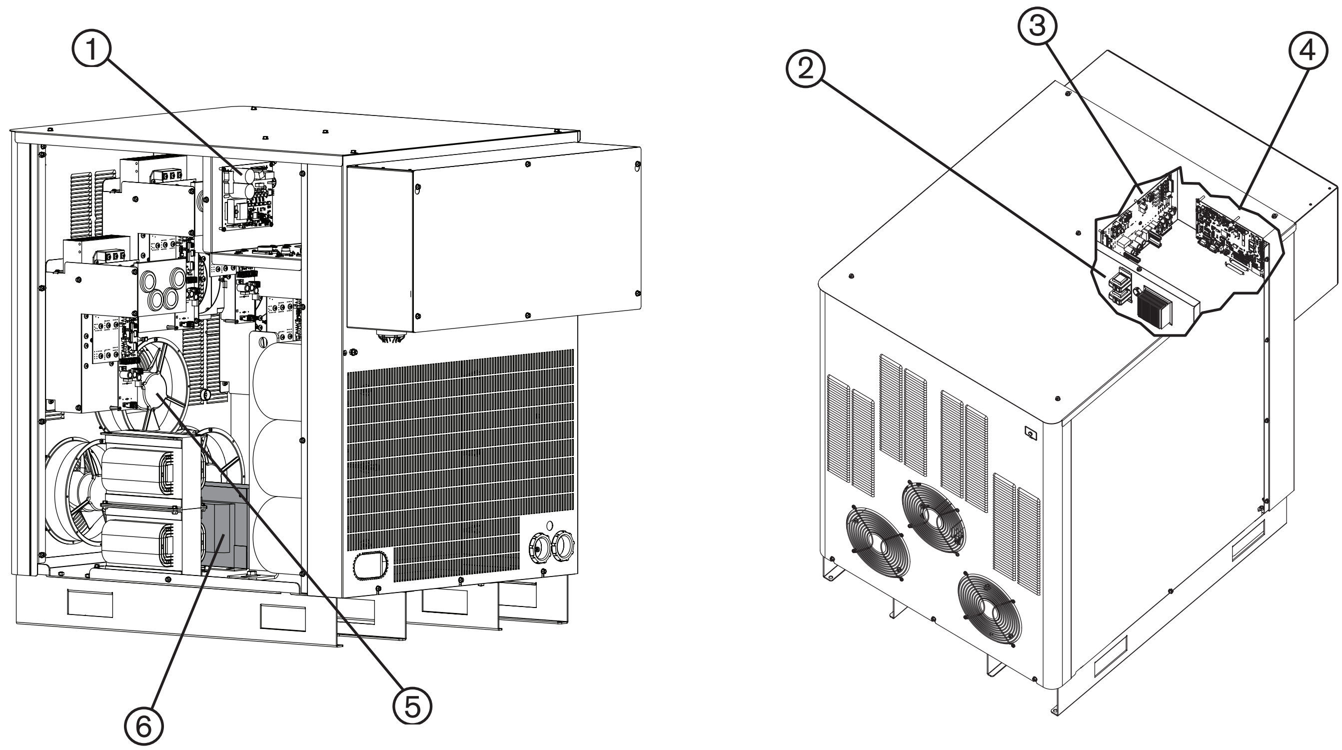
Power supply



Item	Part Number	Description	Designator	Qty.
1	108847*	Fuse: 7.5 amp, 600 volt, high surge	F1, F2	2
	008709**	Fuse: 20 amp, 500 volt, slow blow	F1, F2	2
2	229213	PCB: I/O		1
3	003149***	Relay: Pilot arc, 120 VAC	CR1	1
4	229238	Start circuit assembly	PCB1	1
5a	109004	Current sensor: Hall 100 amp, 4 volt	CS1	1
5b	109004	Current sensor: Hall 100 amp, 4 volt	CS2	1
5c	109004	Current sensor: Hall 100 amp, 4 volt	CS3	1
5d	109004	Current sensor: Hall 100 amp, 4 volt	CS4	1
6	014321	200 volt main transformer: 80KW, 3 ph, 50 HZ	T2	1
	014322	220 volt main transformer: 80KW, 3 ph, 50 HZ		1
	014323	240 volt main transformer: 80KW, 3 ph, 60 HZ		1
	014324	380 volt main transformer: 80KW, 3 ph, 50 HZ		1
	014325	400 volt main transformer: 80KW, 3 ph, 50 HZ		1
	014326	440 volt main transformer: 80KW, 3 ph, 50 HZ		1
	014327	480 volt main transformer: 80KW, 3 ph, 60 HZ		1
	014328	600 volt main transformer: 80KW, 3 ph, 60 HZ		1
	228309	Kit: Thermistor replacement for main transformer		1

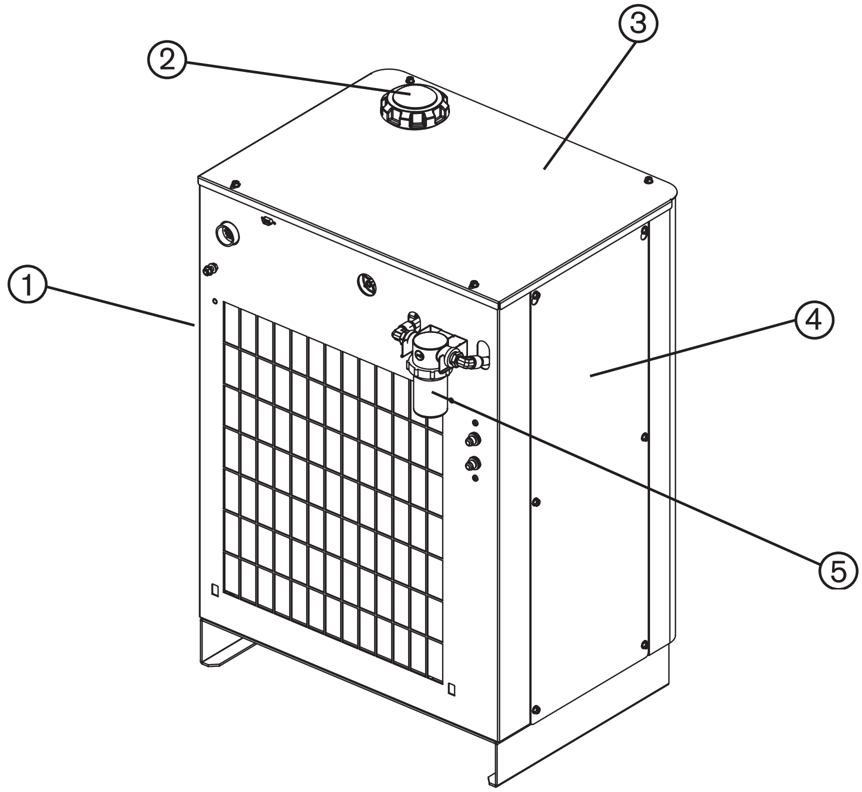
* 380, 400, 440, 480, and 600 volt power supplies
** 200, 220, and 240 volt power supplies
*** CR1 is located under the cover

Power supply



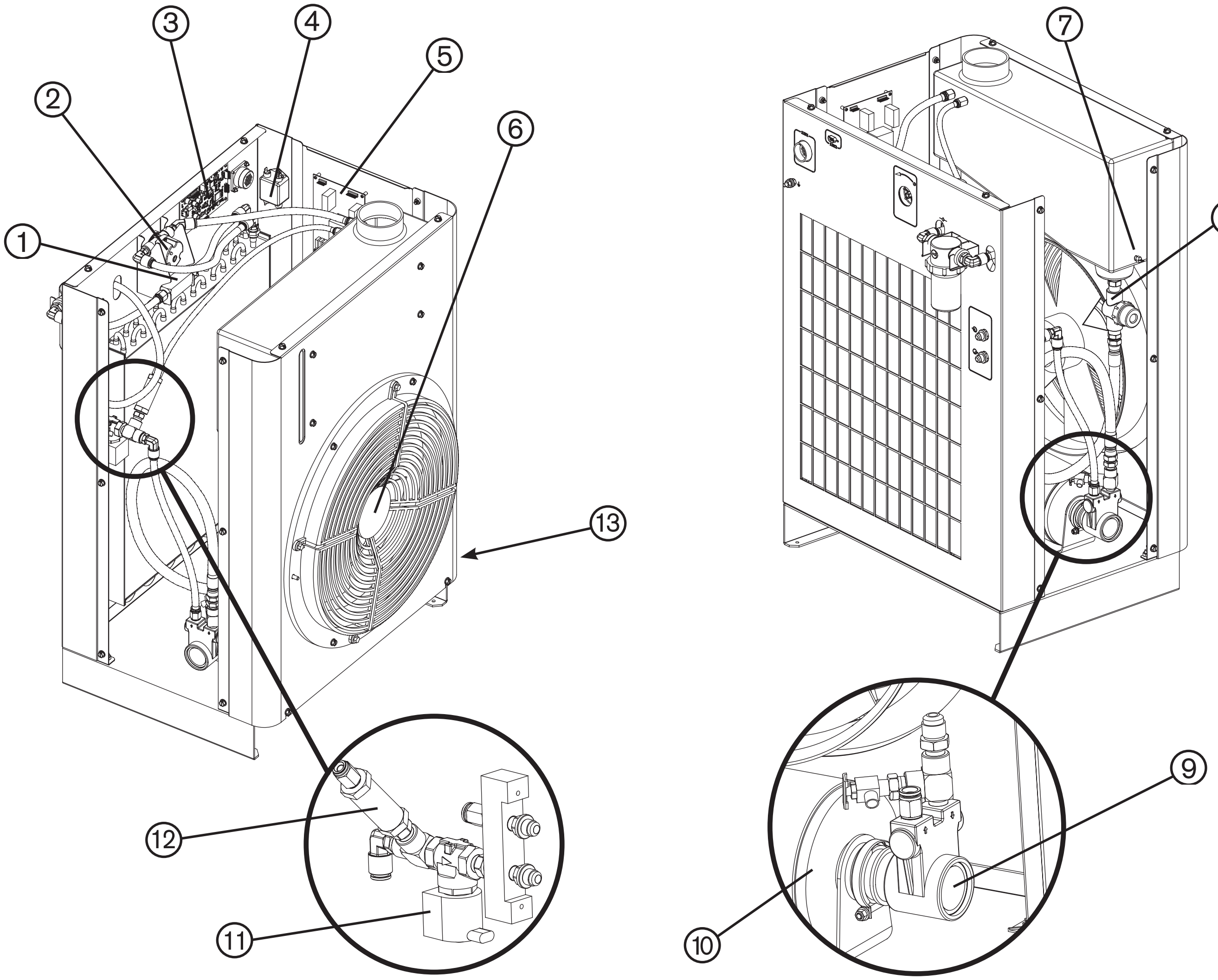
Item	Part Number	Description	Designator	Qty.
1	141027	PCB: Pump motor drive	PCB7	1
2	229212	Inductor: 5 amp, 1.4 mH		2
3	041802	PCB: Power distribution	PCB2	1
	108028	Fuse: 3 amp, 250 volt	F5, F6, F7	3
	108075	Fuse: 6.3 amp, 250 volt (slow-blow)	F1, F2, F3	3
	108709	Fuse: 10 amp, 250 volt	F4	1
4	141030	PCB: Control	PCB3	1
5	027079	10” fan: 450-550 CFM, 120 VAC 50-60 HZ		3
6	229225	Control transformer: 400 volt, 50-60 HZ	T2	1
	229226	Control transformer: 380 volt, 50-60 HZ		1
	229227	Control transformer: 480 volt, 60 HZ		1
	229228	Control transformer: 600 volt, 60 HZ		1
	229230	Control transformer: 240 volt, 60 HZ		1
	229231	Control transformer: 200 and 208 volt, 50-60 HZ		1
	229232	Control transformer: 440 volt, 50-60 HZ		1
	229233	Control transformer: 220 volt, 50-60 HZ		1

Cooler



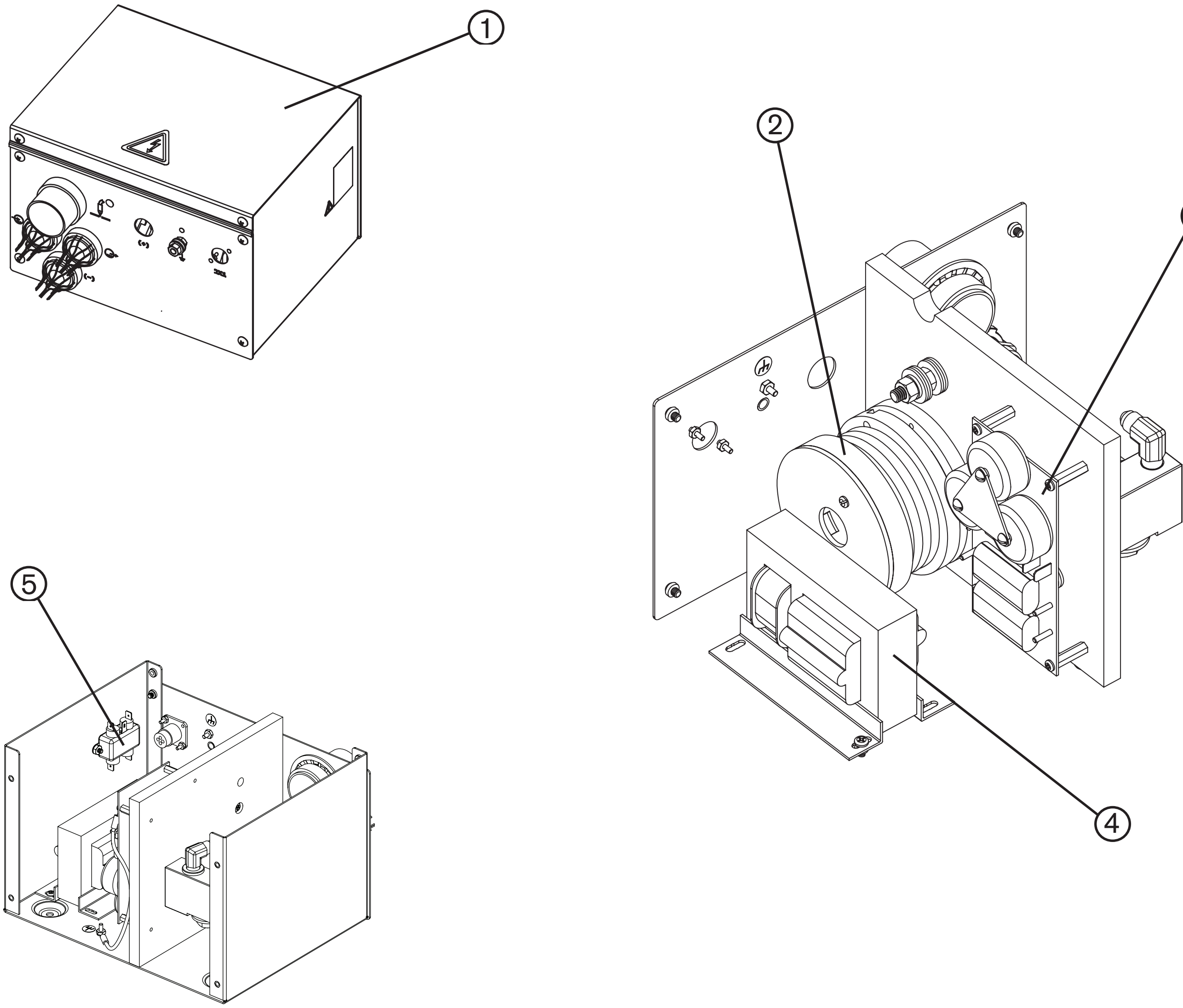
Item	Part Number	Description	Designator	Qty.
	078531	**Cooler**		
1	101022	Panel: Right side		1
2	127014	Filler cap		1
3	228366	Panel: Top, with labels		1
4	110507	Panel: Left side		1
5	027634	Filter housing		1
	027664	Filter element		1

Cooler



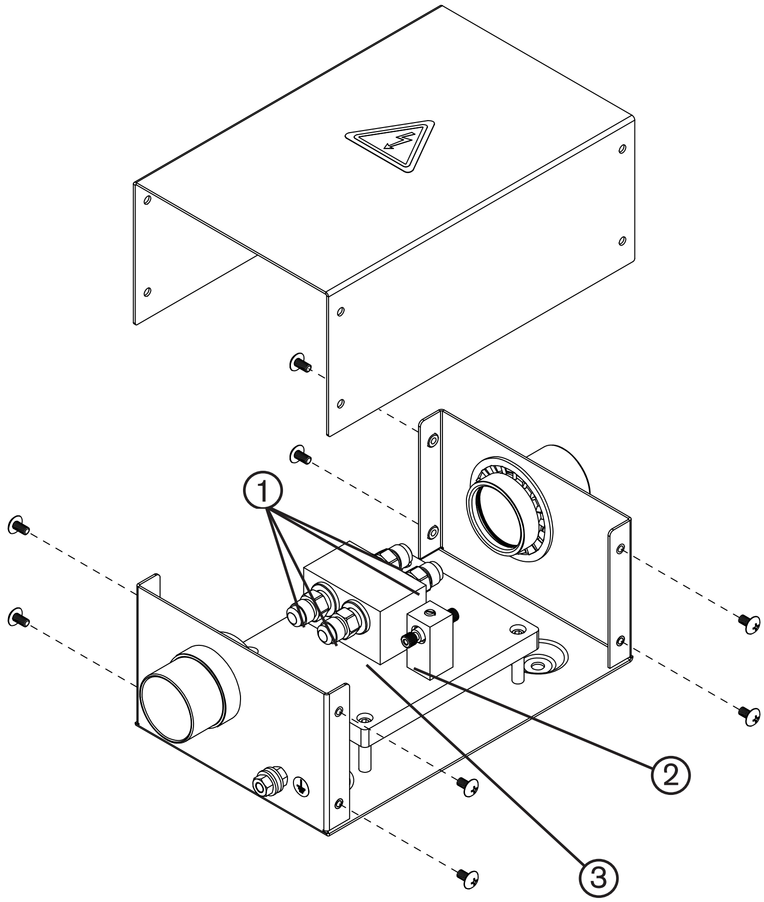
Item	Part Number	Description	Designator	Qty.
1	006113	Check valve		1
2	229235	Flow sensor: 23 lpm (6 gpm)	FS1	1
3	141033	PCB: Cooler sensor		1
4	009040	EMI filter: 250 VAC, 2 amp, 1 phase		1
5	041897	PCB: Console power distribution		1
	008756	Fuse: 5 amp, 250 volt (slow-blow)	F1	1
6	027658	Fan: 240 volt, 240 watt, 2910 cfm		1
7	229224	Temperature sensor	TS1	1
8	027926	Filter assembly: 1/2”, NPT, low profile		1
9	228171	Kit: Pump with clamp		1
10	228230	Kit: Motor with clamp, 1/3 hp		1
11	229229	Solenoid valve		1
12	006132	Check valve (bypass valve): 1/4” NPT, 200 psi		1
13	109207	Capacitor (not visible)		1
	031122	Pump to motor shaft coupler (not shown)		1

Ignition console



Item	Part Number	Description	Designator	Qty.
1	**078172**	**Ignition Console**		
2	129831	Coil assembly	T2	1
3	041817	HF/HV Ignition PCB	PCB IGN	1
4	129854	Transformer	T1	1
5	009045	EMI filter		1

Torch lead junction box (Optional)



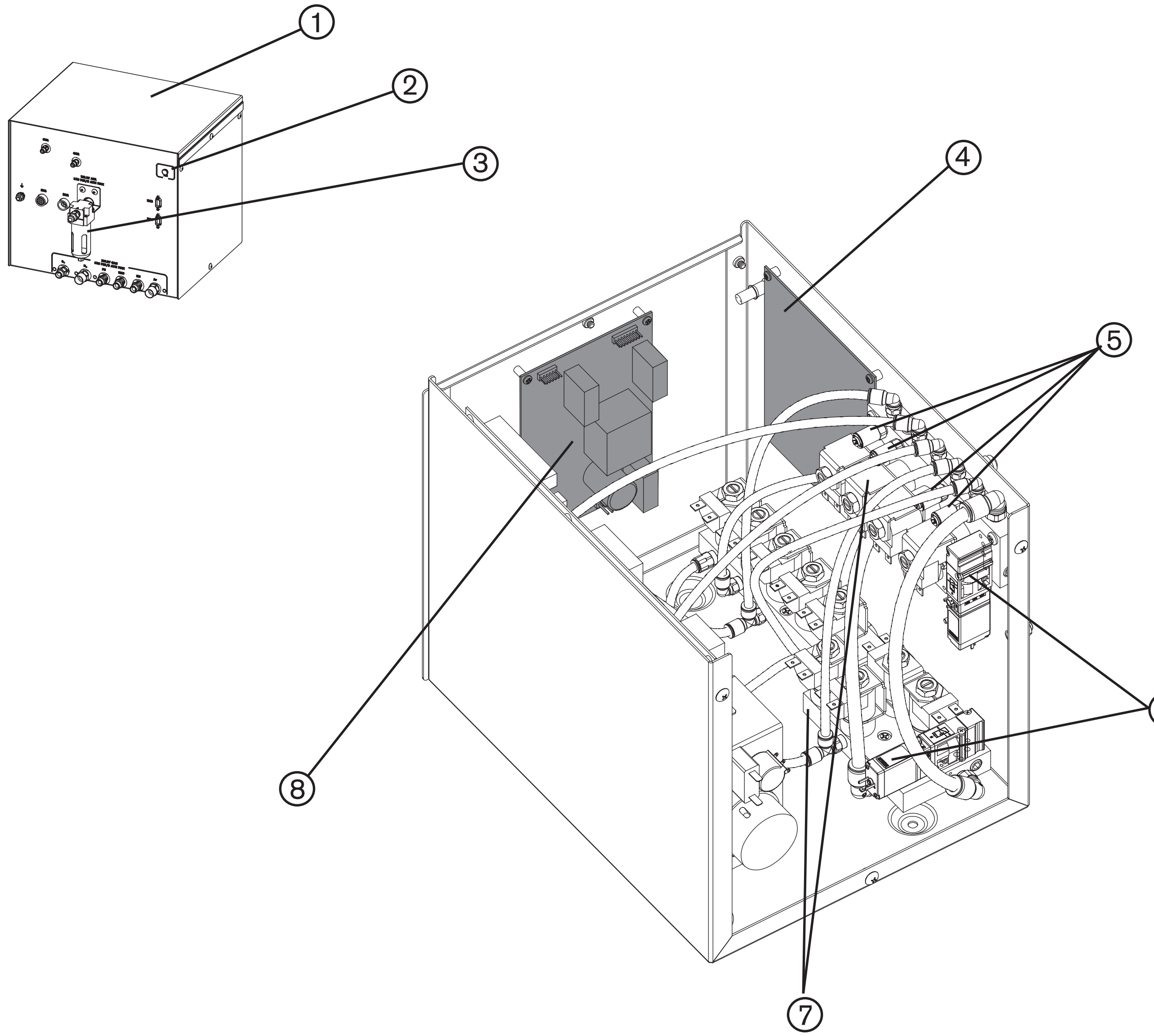
Item	Part Number	Description	Qty.
	078619	**HPRXD junction box**	1
1	015007	Coolant fitting	4
2	104763	Pilot arc fitting	1
3	104762	Coolant block	1

Ignition console to junction box leads

Caution: **Total lead length from the ignition console to the torch must be less than or equal to:**
20 m (65 feet) for HPR130XD / HPR260XD
15 m (50 feet) for HPR400XD / HPR800XD

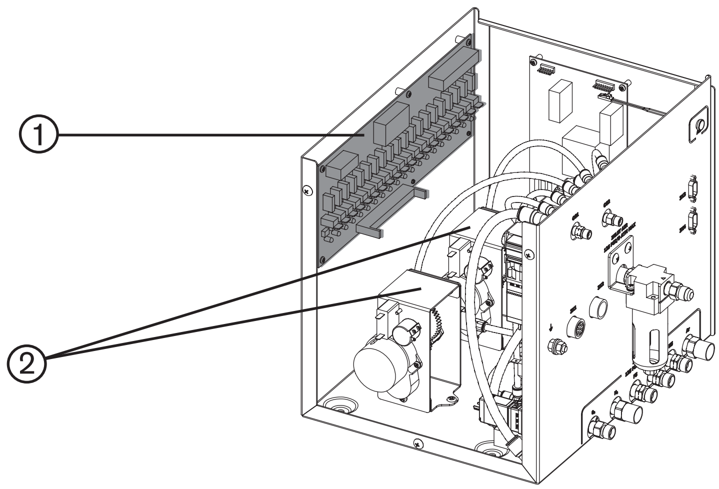
Part no.	Description	Part no.	Description
428420	3 m (10 ft)	428425	10 m (35 ft)
428421	4.5 m (15 ft)	428426	12.2 m (40 ft)
428339	5.5 m (18 ft)	428427	13.7 m (45 ft)
428422	6 m (20 ft)	428428	15 m (50 ft)
428423	7.5 m (25 ft)	428429	16.8 m (55 ft)
428424	9.1 m (30 ft)		

Selection console



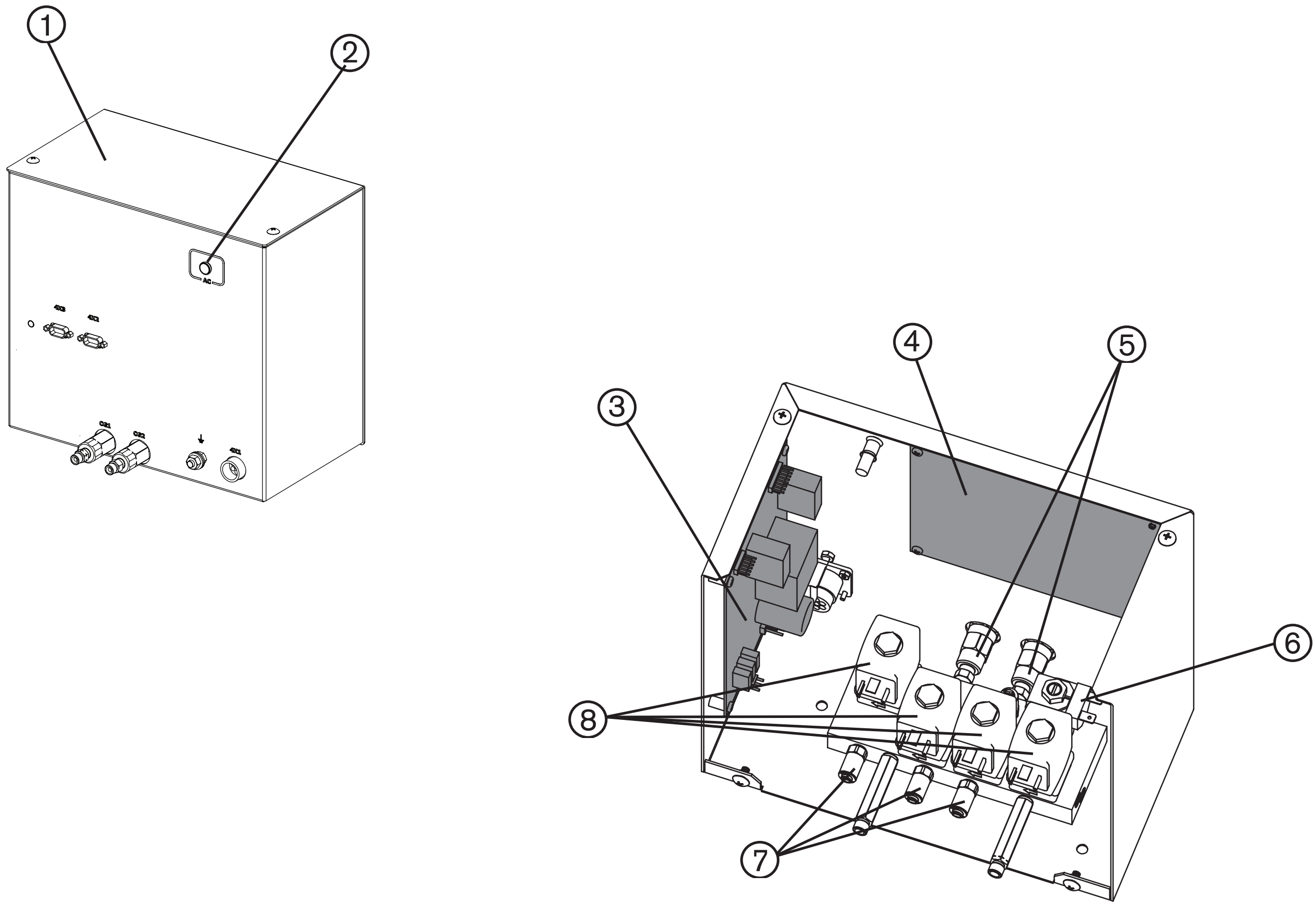
Item	Part Number	Description	Designator	Qty.
1	**078533**	**Selection console**		
2	129633	Green power lamp		1
3	011109	Filter assembly		1
	011110	Filter element		1
4	228069	Kit: Control PCB	PCB2	1
5	005263	Pressure sensor	P1 – P4	4
	123780	Pressure sensor wire harness	P1 – P4	1
6	228984	Solenoid valve	SV3 and SV10	2
7	006109	Solenoid valve	SV1 and SV2, SV4–SV9, SV11–SV15	13
	006112	Replacement solenoid coil		
8	041897	Power distribution PCB	PCB1	1
	008756	Fuse: 5A, 250V, slow blow	F1	1

Selection console



Item	Part Number	Description	Designator	Qty.
1	041822	Valve driver PCB	PCB3	1
	008756	Fuse: 5 A, 250V, slow-blow	F1	1
2	129999	Motor valve assembly	MV1, MV2	2
	229217	Selection console wire harness		1
	228347	Hose kit		1

Metering console

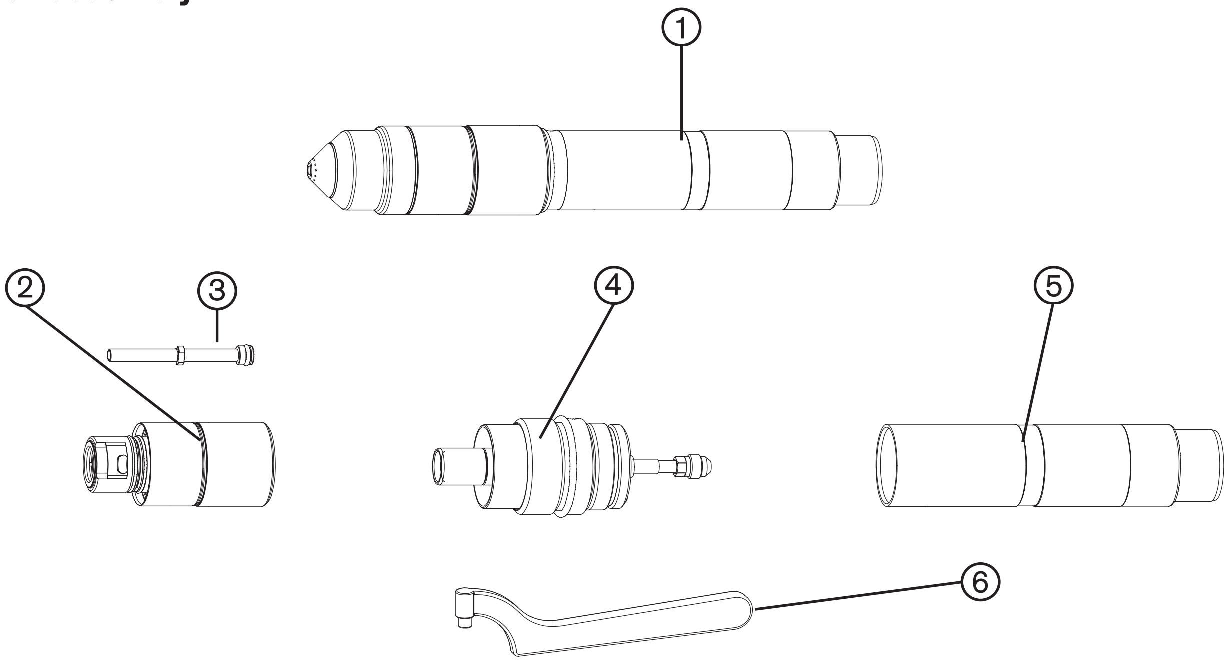


Item	Part Number	Description	Designator	Qty.
1	**078535**	**Metering console**		**1**
2	129633	Green power lamp		1
3	041897	Power distribution PCB	PCB1	1
	008756	Fuse: 5 amp, 250 volt (slow-blow)	F1	1
4	228069	Kit: Control PCB	PCB2	1
5	006077	Check valves		2
6	006109	Solenoid valve	SV16	1
	006112	Replacement solenoid coil		
7	005263	Pressure transducer (3 of 4 shown)	P5-P8	4
	123802	Pressure transducer wire harness		1
8	006128*	Proportional valve	B1-B4	4
	228023**	Kit: HPR gas metering manifold upgrade		1
	229032	Metering console wire harness		1

* Gas consoles with a serial number of 500134 or later take this part number
** Gas consoles with a serial number of 500133 or earlier must order this kit

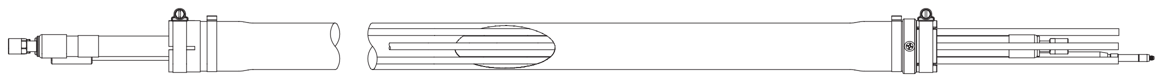
HyPerformance torch

Torch assembly



Item	Part Number	Description
1	228354	**HPR400XD machine torch assembly**
2	220706	Quick-disconnect torch
3	220571	Water tube
4	220705	Quick-disconnect receptacle
5	220789	Torch mounting sleeve assembly: Standard, 181 mm (7 in)
	220788	Torch mounting sleeve assembly: Short, 114 mm (4.5 in)
	220790	Torch mounting sleeve assembly: Long, 248 mm (9.75 in)
6	104269	2” spanner wrench
	128879	Torch kit: O-rings, water tube and seal
	128880	Quick disconnect kit: O-ring and connector

Torch leads

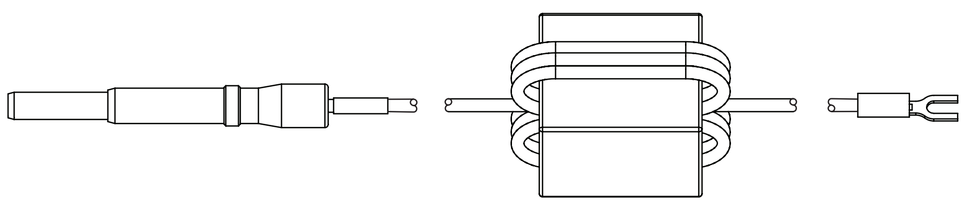


Part no.	Description
228291	2 m (6 ft)
228292	3 m (10 ft)
228293	4.5 m (15 ft)
228294	6 m (20 ft)
228295	7.5 m (25 ft)
228296	10 m (35 ft)
228297	15 m (50 ft)

Note: A 20 m (65 ft) torch lead is not available for HPR400XD systems

Ohmic contact wire (Not part of the HPR400XD system. Shown for reference only.)

Note: The ohmic contact wire is not part of the HPR260XD system. Shown for reference only



Part no.	Length
123983	3 m (10 ft)
123984	6 m (20 ft)
123985	7.5 m (25 ft)
123986	9 m (30 ft)
123987	12 m (40 ft)
123988	15 m (50 ft)
123989	23 m (75 ft)
123990	30 m (100 ft)
123991	45 m (150 ft)

Consumable parts kits

Note: See *Consumable selection* or *Cut charts* in section 4 for specific applications

Mild steel parts kit – 228367

Part Number	Description	Qty.
026009	O-ring: 0.208” X 0.070”	5
027055	Lubricant: Silicone 1/4-oz tube	1
044028	O-ring: 1.364” X 0.070”	2
104119	Tool: Consumable removal / replacement	1
104269	Wrench: Spanner	1
220179	Swirl ring: 80 A/130 A	1
220180	Swirl ring: 30 A	1
220181	Electrode: 130 A	2
220182	Nozzle: 130 A	3
220183	Shield: 130 A	2
220187	Electrode: 80 A	2
220188	Nozzle: 130 A	2
220189	Shield: 80 A	1
220192	Electrode: 30 A	2
220193	Nozzle: 30 A	2
220194	Shield: 30 A	1
220340	Water tube with o-ring	1
220352	Electrode: 200 A	2
220353	Swirl ring: 200 A	1
220354	Nozzle: 200 A	3
220435	Electrode: 260 A	2
220436	Swirl ring: 260 A	1
220439	Nozzle: 260 A	3
220552	Electrode: 50 A	2
220553	Swirl ring: 50 A	1
220554	Nozzle: 50 A	2
220555	Shield: 50 A	1
220571	Water tube with o-ring (bevel)	1
220629	Electrode: 400 A	3
220631	Swirl ring: 400 A	1
220632	Nozzle: 400 A	3
220635	Nozzle retaining cap: 400 A	1
220636	Shield: 400 A	2
220637	Shield cap: 400 A	1
220665	SilverPlus electrode: 130 A	1
220666	SilverPlus electrode: 200 A	1
220668	SilverPlus electrode: 260 A	1
220747	Shield cap: 130 A	1
220754	Nozzle retaining cap: 30 A	1
220756	Nozzle retaining cap: 130 A	1
220757	Nozzle retaining cap: 200 A	1
220760	Nozzle retaining cap: 260 A	1
220761	Shield: 200 A	2
220764	Shield: 260 A	2

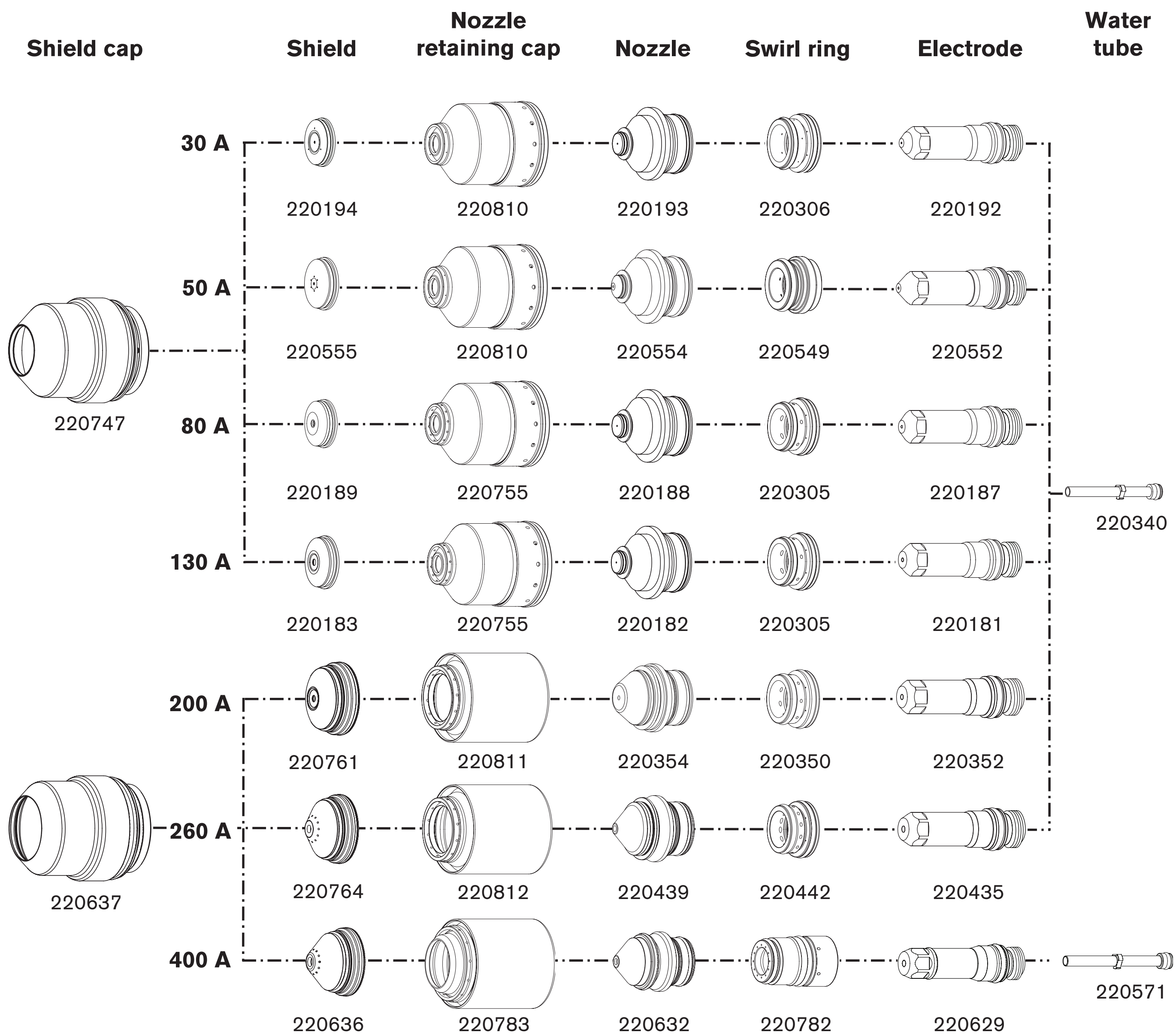
Stainless steel and aluminum parts kit – 228368

Part Number	Description	Qty.
026009	O-ring: 0.208” X 0.070”	5
027055	Lubricant: Silicone 1/4-oz tube	1
044028	O-ring: 1.364” X 0.070”	2
104119	Tool: Consumable removal / replacement	1
104269	Wrench: Spanner	1
220179	Swirl ring: 80 A/130 A mild steel	1
220180	Swirl ring: 30 A mild steel	2
220181	Electrode: 130 A mild steel	1
220197	Nozzle: 130 A stainless steel	2
220198	Shield: 130 A stainless steel	1
220307	Electrode: 130 A stainless steel	4
220337	Nozzle: 80 A stainless steel	2
220338	Shield: 80 A stainless steel	1
220339	Electrode: 80 A stainless steel	4
220340	Water tube with o-ring	1
220342	Swirl ring: 200 A stainless steel	1
220343	Nozzle: 200 A stainless steel	2
220346	Nozzle: 200 A aluminum	1
220405	Swirl ring: 260 A stainless steel/aluminum	1
220406	Nozzle: 260 A stainless steel/aluminum	2
220571	Water tube with o-ring (bevel)	1
220637	Shield cap: 400 A	1
220707	Shield: 400 A stainless steel	2
220708	Nozzle: 400 A stainless steel	3
220709	Electrode: 400 A stainless steel	3
220712	Nozzle retaining cap: 400 A stainless steel	1
220747	Shield cap: 130 A	1
220755	Nozzle retaining cap: 130 A CCW	1
220756	Nozzle retaining cap: 130 A mild steel, CW	1
220758	Nozzle retaining cap: 260 A stainless steel	1
220759	Nozzle retaining cap: 200 A aluminum	1
220762	Shield: 200 A stainless steel	1
220763	Shield: 260 A stainless steel/aluminum	1
220814	Nozzle retaining cap: 60 A HDi	1
220815	Shield: 60 A HDi, stainless steel	1
220847	Nozzle: 60 A HDi, stainless steel	2

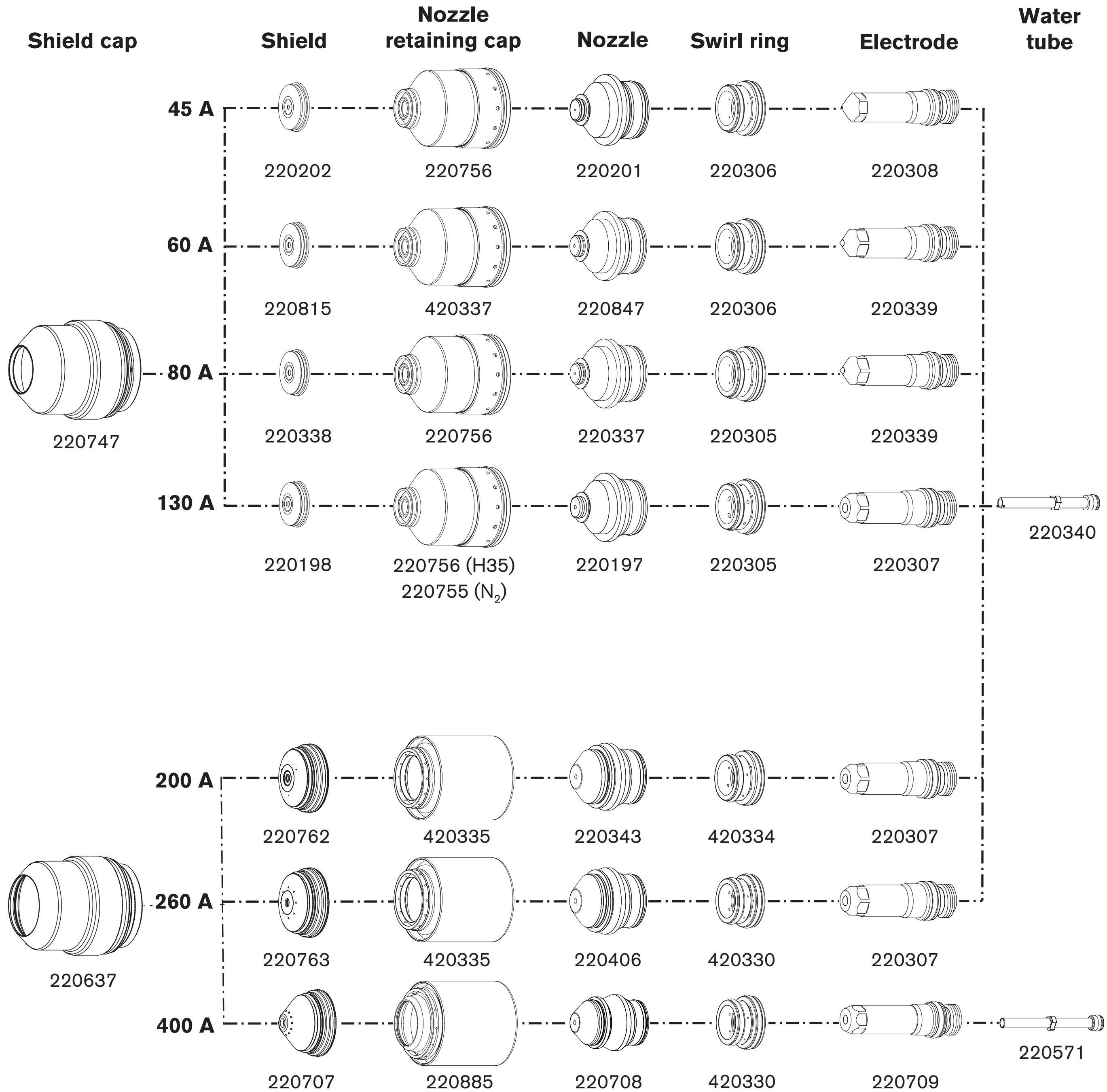
Consumables for mirror-image cutting

Straight cutting

Mild steel

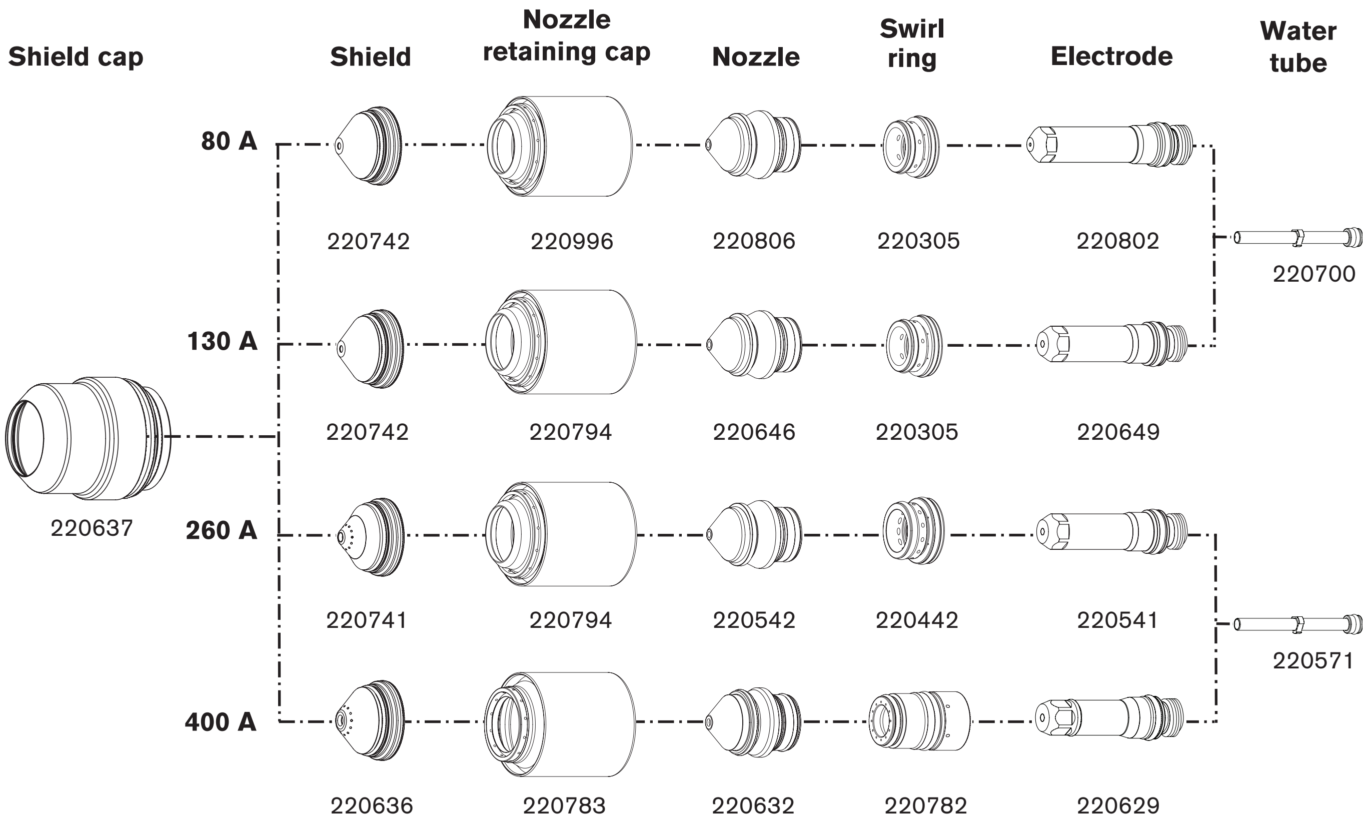


Stainless steel

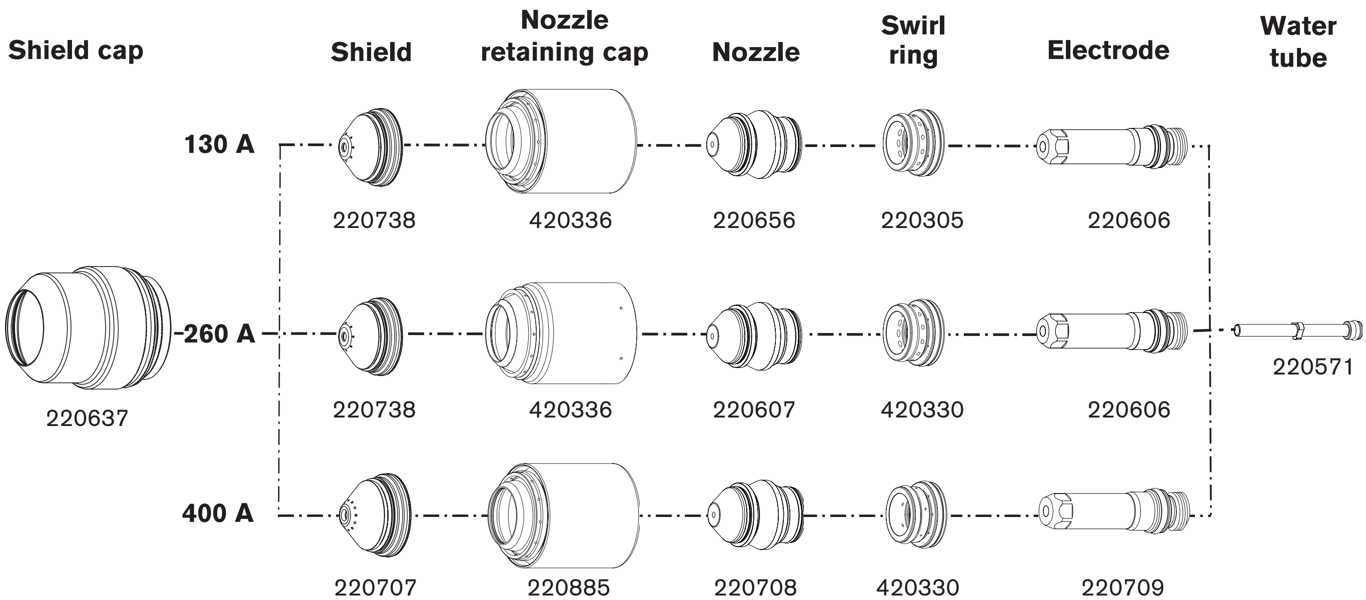


Bevel cutting

Mild steel



Stainless steel



Recommended spare parts

Power supply

Part Number	Description	Designator	Qty.
129633	Green power lamp assembly		1
129792	Chopper assembly	CH1, CH2, CH3, CH4	1
127039	6” fan: 230 CFM, 115 VAC 50-60 HZ		1
027079	10” fan: 450-550 CFM, 120 VAC 50-60 HZ		1
003149	Relay: Pilot arc, 120 VAC	CR1	1
229213	PCB: I/O		1
003232*	Contactor	CON1	1
003228**	Contactor	CON1	1
109004	Current sensor: Hall 100 amp, 4 volt	CS1, CS2, CS3, CS4	1
229238	Start circuit assembly	PCB1	1
008551	Fuse: 7.5 amp, 600 volt	F1, F2	2
141030	PCB: Control	PCB3	1
041802	PCB: Power distribution	PCB2	1
108028	Fuse: 3 amp, 250 volt	F5, F6, F7	3
108075	Fuse: 6.3 amp, 250 volt (slow-blow)	F1, F2, F3	3
108709	Fuse: 10 amp, 250 volt	F4	1
228171	Kit: Pump with clamp		1
228230	Kit: Motor with clamp		1
141027	PCB: Pump motor drive	PCB7	1

* 200/208, 220 and 240 volt power supplies
** 380, 400, 440, 480 and 600 volt power supplies

Cooler

Part Number	Description	Designator	Qty.
041897	PCB: Console power distribution		1
008756	Fuse: 5 amp, 250 volt (slow-blow)	F1	1
027634	Filter housing (on the rear panel of the cooler)		1
027664	Filter element		1
027926	Filter housing (under the coolant tank)		1
229235	Flow sensor	FS1	1
006113	Check valve: 3/8” FPT		1
229229	Solenoid valve		1
141033	PCB: Cooler sensor		1

Ignition console

Part Number	Description	Designator	Qty.
041817	HFHV Ignition PCB		1
129854	Transformer	T1	1

Selection and metering consoles

Part Number	Description	Designator	Qty.
228069	Kit: Control PCB	PCB2	1
041897	Power distribution PCB	PCB1	1
008756	Fuse: 5 amp, 250 volt (slow-blow)	F1	1
041822	Valve driver PCB	PCB3	1
008756	Fuse: 5 amp, 250 volt (slow-blow)	F1	1
228984	Solenoid valve	SV3 and SV10	2
006109	Solenoid valve	SV1, SV2, SV4-SV9, SV11-SV15	13
005263	Pressure sensor		1
011109	Air filter housing (on the rear panel of the selection console)		1
011110	Air filter element		1

Warning Label – 110647

This warning label is affixed to some power supplies. It is important that the operator and maintenance technician understand the intent of these warning symbols as described. The numbered text corresponds to the numbered boxes on the label.

1. Cutting sparks can cause explosion or fire.

1.1 Do not cut near flammables.

1.2 Have a fire extinguisher nearby and ready to use.

1.3 Do not use a drum or other closed container as a cutting table.

2. Plasma arc can injure and burn; point the nozzle away from yourself. Arc starts instantly when triggered.

2.1 Turn off power before disassembling torch.

2.2 Do not grip the workpiece near the cutting path.

2.3 Wear complete body protection.

3. Hazardous voltage. Risk of electric shock or burn.

3.1 Wear insulating gloves. Replace gloves when wet or damaged.

3.2 Protect from shock by insulating yourself from work and ground.

3.3 Disconnect power before servicing. Do not touch live parts.

4. Plasma fumes can be hazardous.

4.1 Do not inhale fumes.

4.2 Use forced ventilation or local exhaust to remove the fumes.

4.3 Do not operate in closed spaces. Remove fumes with ventilation.

5. Arc rays can burn eyes and injure skin.

5.1 Wear correct and appropriate protective equipment to protect head, eyes, ears, hands, and body. Button shirt collar. Protect ears from noise. Use welding helmet with the correct shade of filter.

6. Become trained. Only qualified personnel should operate this equipment. Use torches specified in the manual. Keep non-qualified personnel and children away.

7. Do not remove, destroy, or cover this label. Replace if it is missing, damaged, or worn.

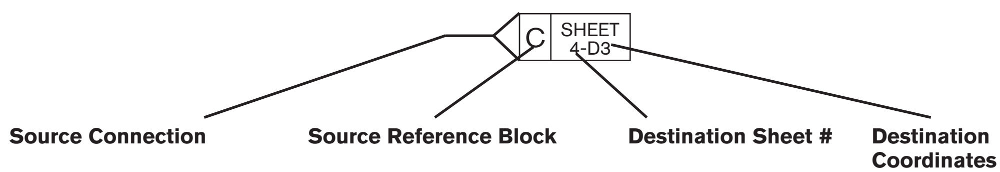
Section 7

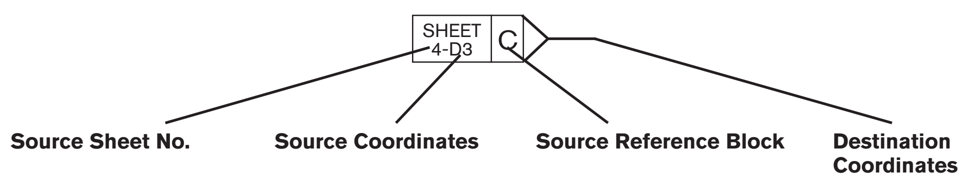
WIRING DIAGRAMS

Introduction

This section contains the wiring diagrams for the system. When tracing a signal path or referencing with the *Parts List* or **Troubleshooting** sections, please be aware of the following format to assist you in understanding the wiring diagrams' organization:

- Sheet numbers are located in the lower right-hand corner.
- Page-to-page referencing is done in the following manner:

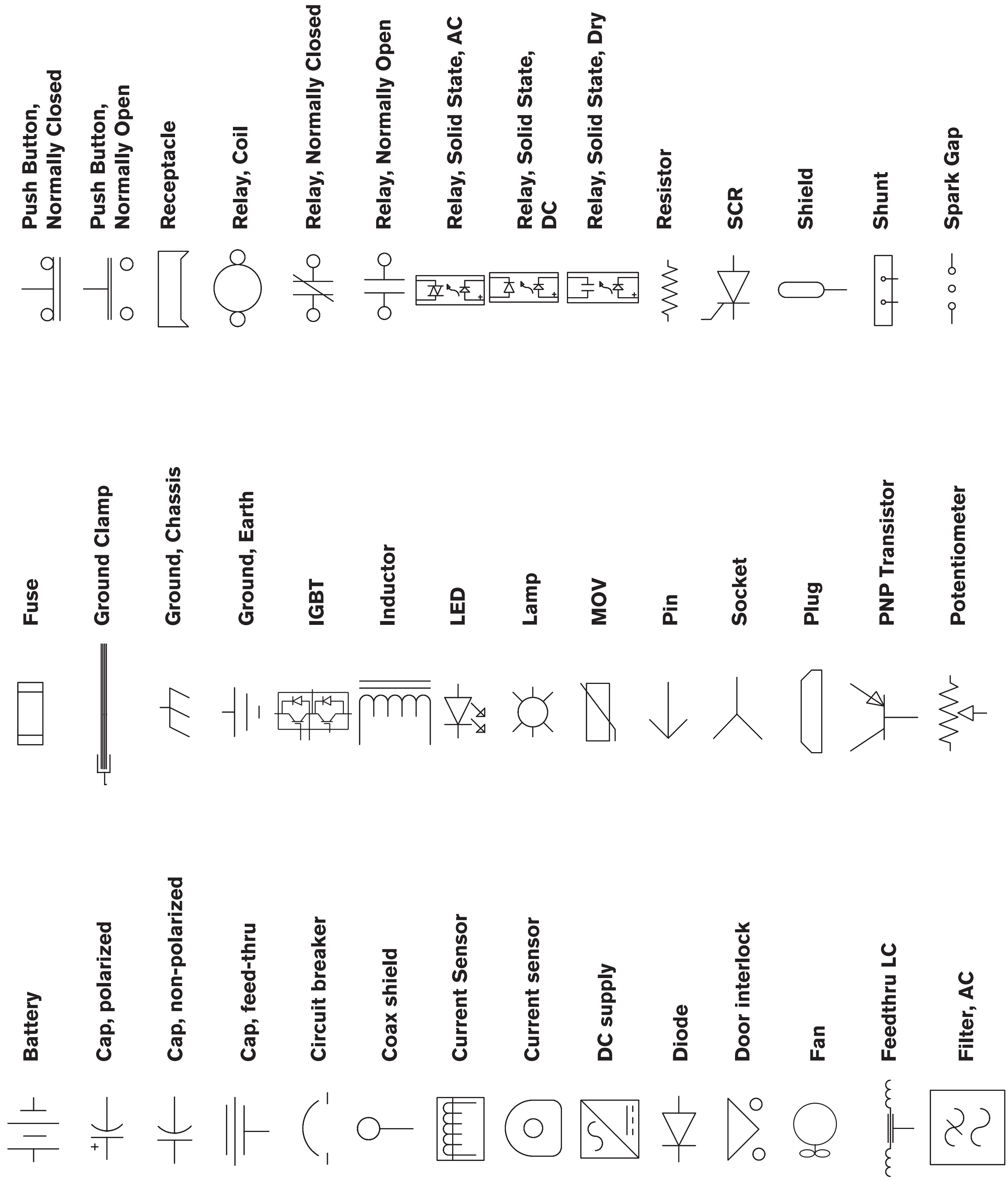


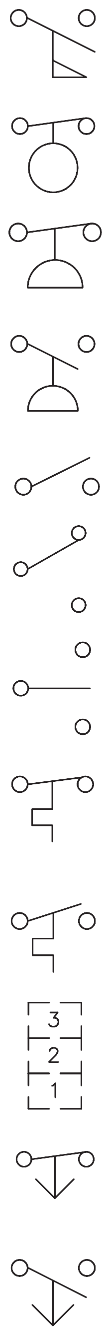


Destination and **Source Coordinates** refer to letters A-D on the Y-axis of each sheet and numbers 1-4 on the X-axis of each sheet. Lining up the coordinates will bring you to the source or destination blocks (similar to a road map).

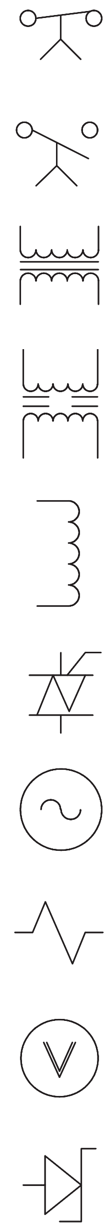
Wiring diagram symbols

Wiring diagram symbols and their identification precede the system wiring diagrams in this section.


Push Button, Normally Closed
Push Button, Normally Open
Receptacle
Relay, Coil
Relay, Normally Closed
Relay, Normally Open
Relay, Solid State, AC
Relay, Solid State, DC
Relay, Solid State, Dry
Resistor
SCR
Shield
Shunt
Spark Gap
Fuse
Ground Clamp
Ground, Chassis
Ground, Earth
IGBT
Inductor
LED
Lamp
MOV
Pin
Socket
Plug
PNP Transistor
Potentiometer
Battery
Cap, polarized
+
Cap, non-polarized
Cap, feed-thru
Circuit breaker
Coax shield
Current Sensor
Current sensor
DC supply
Diode
Door interlock
Fan
Feedthru LC
Filter, AC

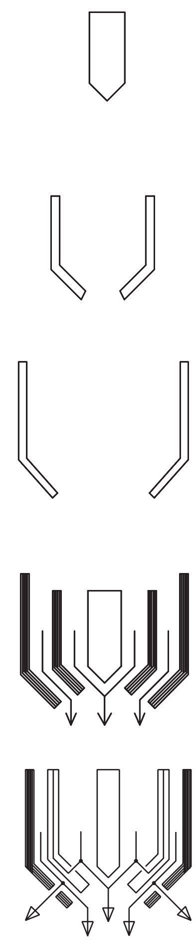


- Switch, Flow
- Switch, Level, Normally Closed
- Switch, Pressure, Normally Closed
- Switch, Pressure, Normally Open
- Switch, 1 Pole, 1 Throw
- Switch, 1 Pole, 2 Throw
- Switch, 1 Pole, 1 Throw, Center Off
- Switch, Temperature, Normally Closed
- Switch, Temperature, Normally Open
- Terminal Block
- Time Delay Closed, NC/Off
- Time Delay Open, NO/Off



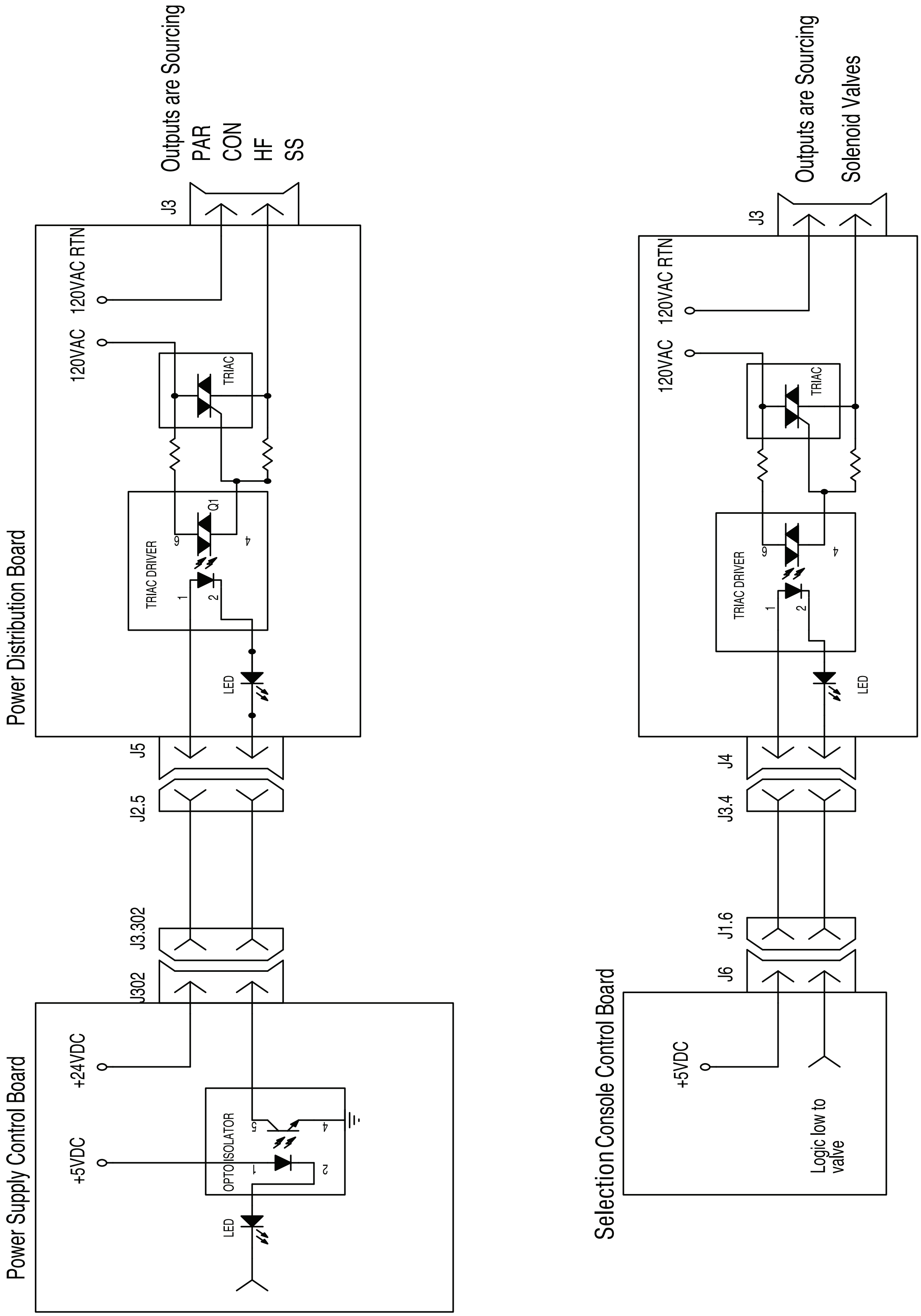
- Time Delay Open, NC/On
- Time Delay Closed, NO/Off
- Transformer
- Transformer, Air Core
- Transformer Coil
- Triac
- VAC Source
- Valve, Solenoid
- Voltage Source
- Zener Diode

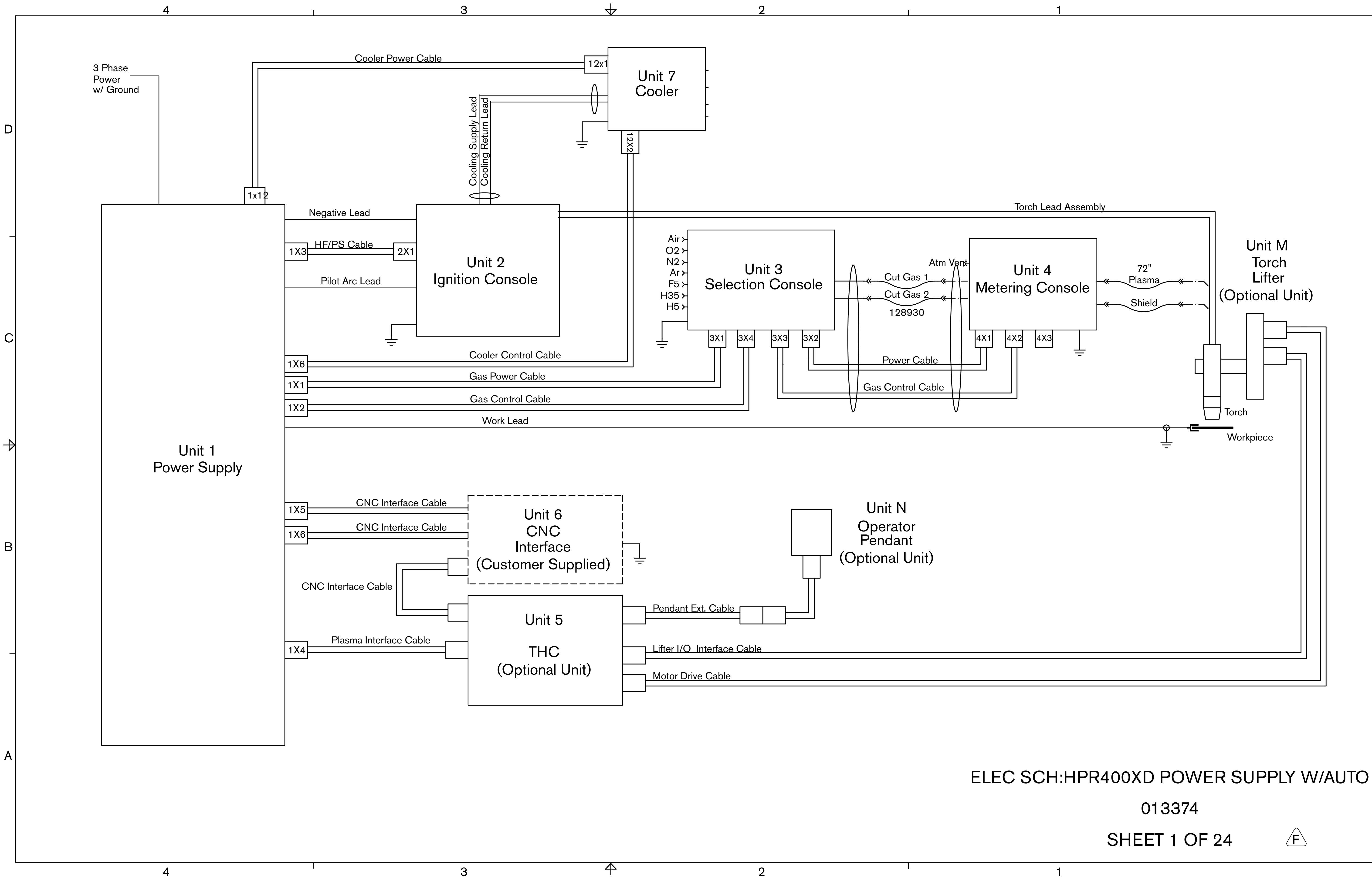
Torch Symbols



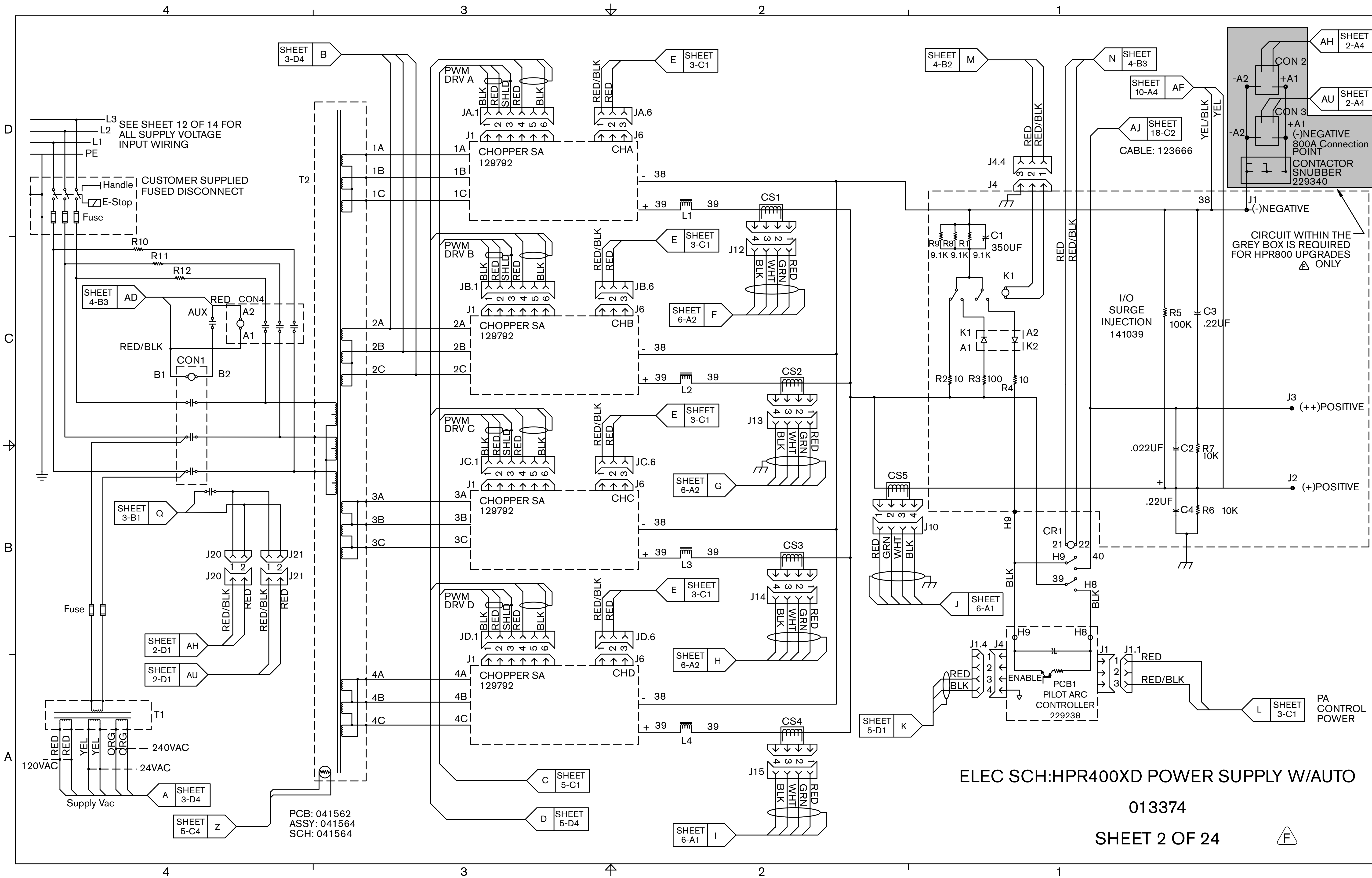
- Electrode
- Nozzle
- Shield
- Torch
- Torch, HyDefinition™

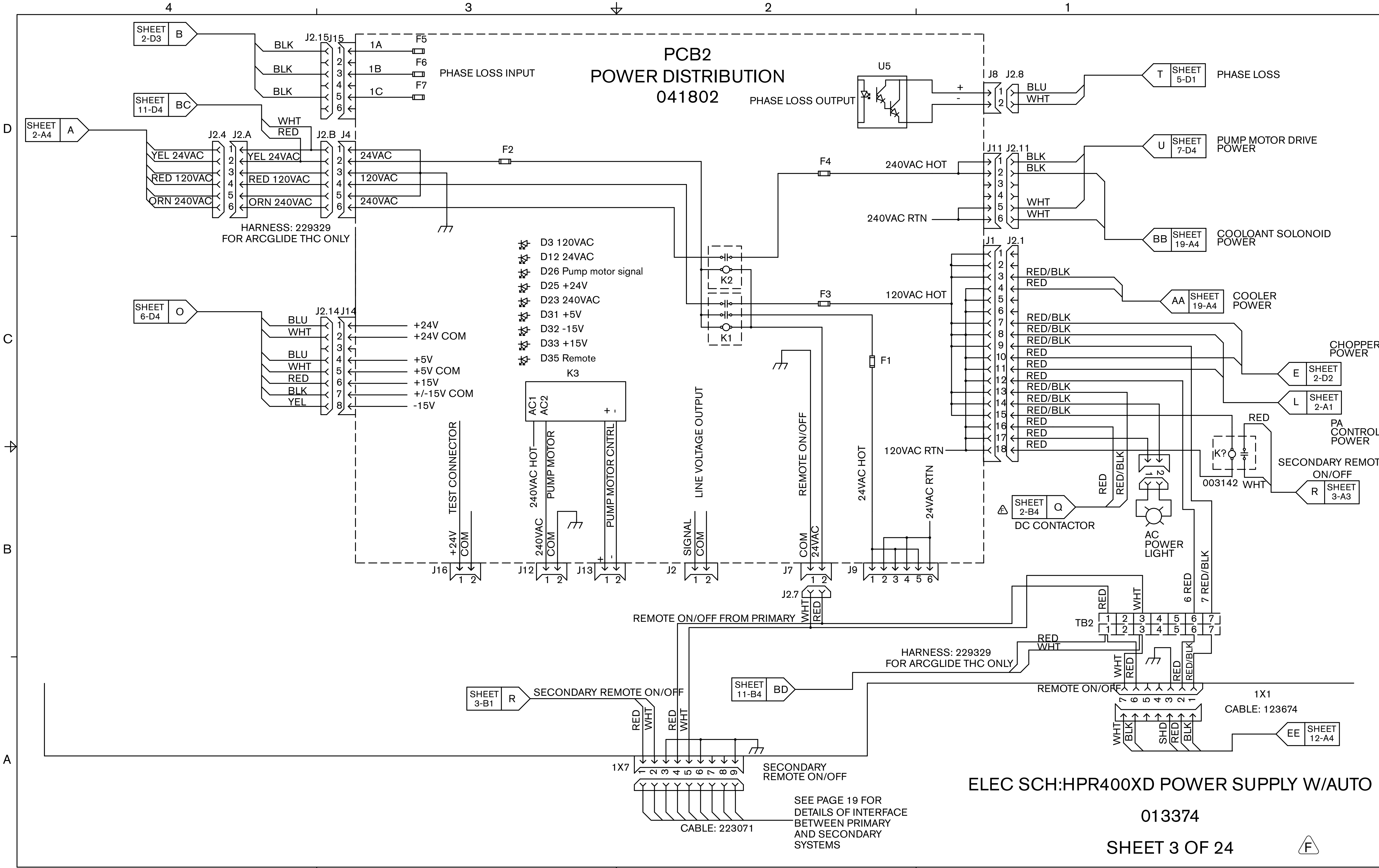
Discrete output functionality





3 Phase Power w/ Ground
Cooler Power Cable
12x1
Unit 7 Cooler
Cooling Supply Lead
Cooling Return Lead
12X2
1x12
Negative Lead
Torch Lead Assembly
1X3
HF/PS Cable
2X1
Unit 2 Ignition Console
Pilot Arc Lead
Air
O2
N2
Ar
F5
H35
H5
Unit 3 Selection Console
Atm Vent
Cut Gas 1
Cut Gas 2
128930
Unit 4 Metering Console
72" Plasma
Shield
Unit M Torch Lifter (Optional Unit)
3X1
3X4
3X3
3X2
4X1
4X2
4X3
1X6
Cooler Control Cable
1X1
Gas Power Cable
1X2
Gas Control Cable
Power Cable
Gas Control Cable
Torch
Work Lead
Workpiece
Unit 1 Power Supply
1X5
CNC Interface Cable
1X6
CNC Interface Cable
Unit 6 CNC Interface (Customer Supplied)
CNC Interface Cable
Unit N Operator Pendant (Optional Unit)
Unit 5
THC (Optional Unit)
Pendant Ext. Cable
1X4
Plasma Interface Cable
Lifter I/O Interface Cable
Motor Drive Cable
ELEC SCH:HPR400XD POWER SUPPLY W/AUTO
013374
SHEET 1 OF 24
F

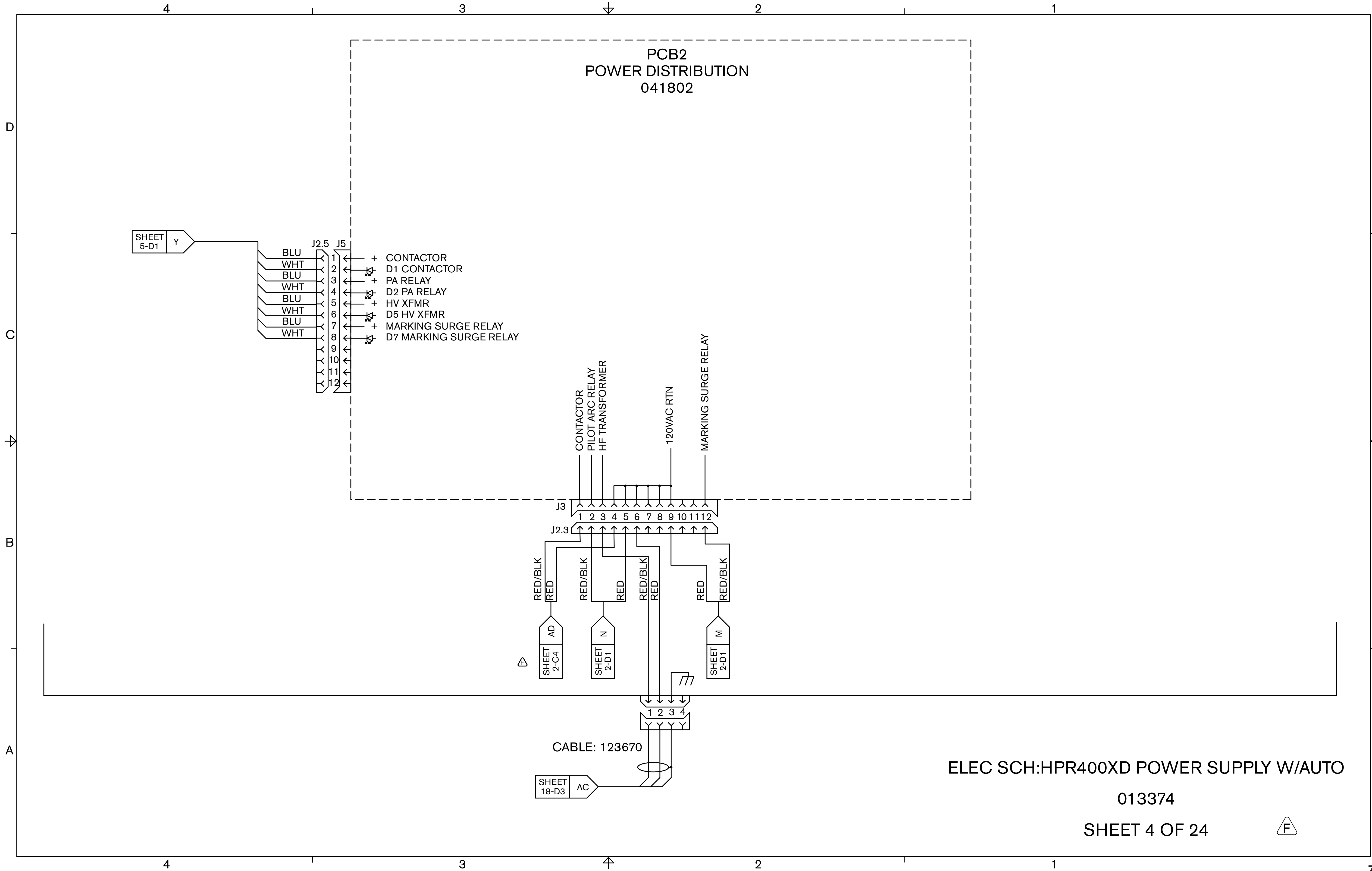

SEE SHEET 12 OF 14 FOR ALL SUPPLY VOLTAGE INPUT WIRING
L3
L2
L1
PE
CUSTOMER SUPPLIED FUSED DISCONNECT
Handle
E-Stop
Fuse
R10
R11
R12
SHEET 4-B3 AD
RED
CON4
AUX
A2
A1
RED/BLK
CON1
B1
B2
T2
SHEET 3-D4 B
PWM DRV A
BLK RED SHLD RED BLK
JA.1
J1
RED/BLK RED
JA.6
J6
SHEET 3-C1 E
CHOPPER SA 129792
CHA
1A
1B
1C
38
39
L1
CS1
J12
BLK WHT GRN RED
SHEET 6-A2 F
PWM DRV B
JB.1
JB.6
CHB
2A
2B
2C
L2
CS2
J13
SHEET 6-A2 G
PWM DRV C
JC.1
JC.6
CHC
3A
3B
3C
L3
CS3
J14
SHEET 6-A2 H
PWM DRV D
JD.1
JD.6
CHD
4A
4B
4C
L4
CS4
J15
SHEET 6-A1 I
SHEET 5-C1 C
SHEET 5-D4 D
SHEET 3-B1 Q
J20
J21
SHEET 2-D1 AH
SHEET 2-D1 AU
Fuse
T1
120VAC
RED RED YEL YEL ORG ORG
240VAC
24VAC
Supply Vac
SHEET 3-D4 A
SHEET 5-C4 Z
PCB: 041562
ASSY: 041564
SCH: 041564
SHEET 4-B2 M
RED RED/BLK
J4.4
J4
SHEET 4-B3 N
SHEET 10-A4 AF
YEL/BLK YEL
SHEET 18-C2 AJ
CABLE: 123666
SHEET 2-A4 AH
CON 2
-A2
+A1
SHEET 2-A4 AU
CON 3
(-)NEGATIVE 800A Connection POINT
CONTACTOR SNUBBER 229340
J1
(-)NEGATIVE
CIRCUIT WITHIN THE GREY BOX IS REQUIRED FOR HPR800 UPGRADES ONLY
R9 R8 R1
9.1K 9.1K 9.1K
C1 350UF
K1
K2
A2
A1
R2 10 R3 100 R4 10
I/O SURGE INJECTION 141039
R5 100K
C3 .22UF
J3 (++)POSITIVE
.022UF C2 R7 10K
J2 (+)POSITIVE
.22UF C4 R6 10K
CS5
J10
RED GRN WHT BLK
SHEET 6-A1 J
H9
CR1
21 22
40
H8
BLK
J1.4
J4
ENABLE
PCB1 PILOT ARC CONTROLLER 229238
J1
J1.1
RED
RED/BLK
SHEET 3-C1 L
PA CONTROL POWER
SHEET 5-D1 K
ELEC SCH:HPR400XD POWER SUPPLY W/AUTO
013374
SHEET 2 OF 24
F



ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

SHEET 3 OF 24

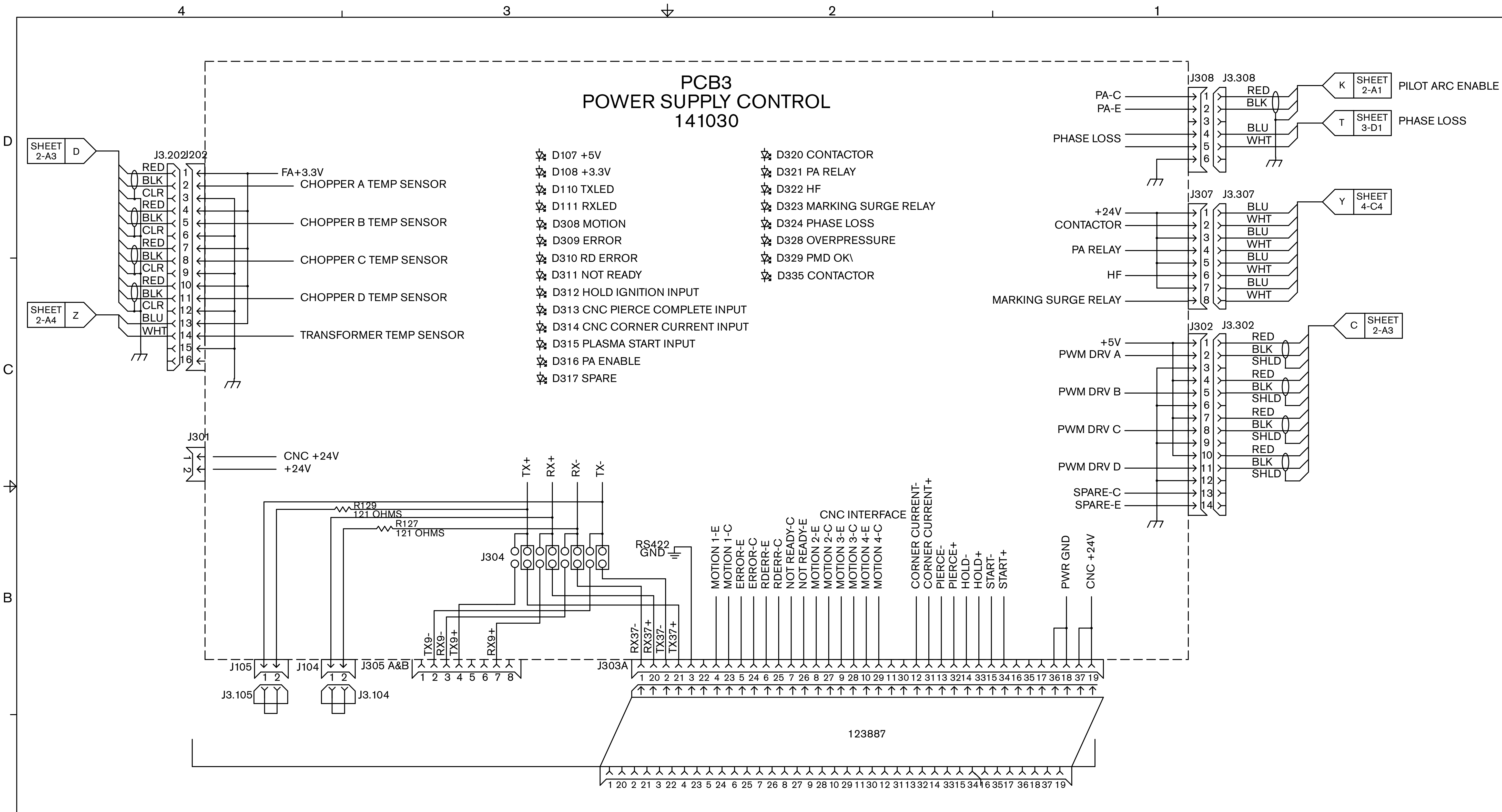


ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

SHEET 4 OF 24

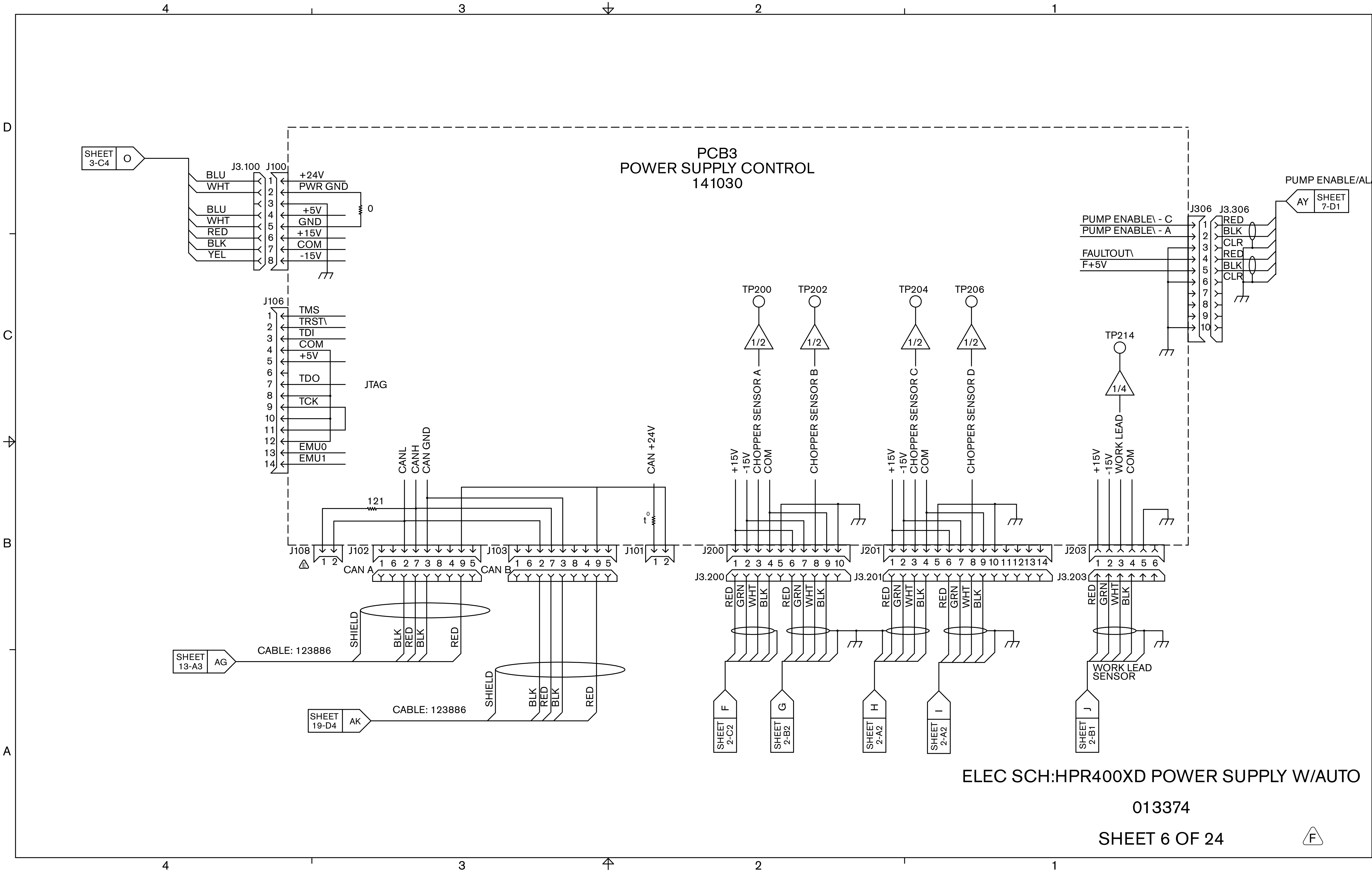
F



ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

SHEET 5 OF 24 F

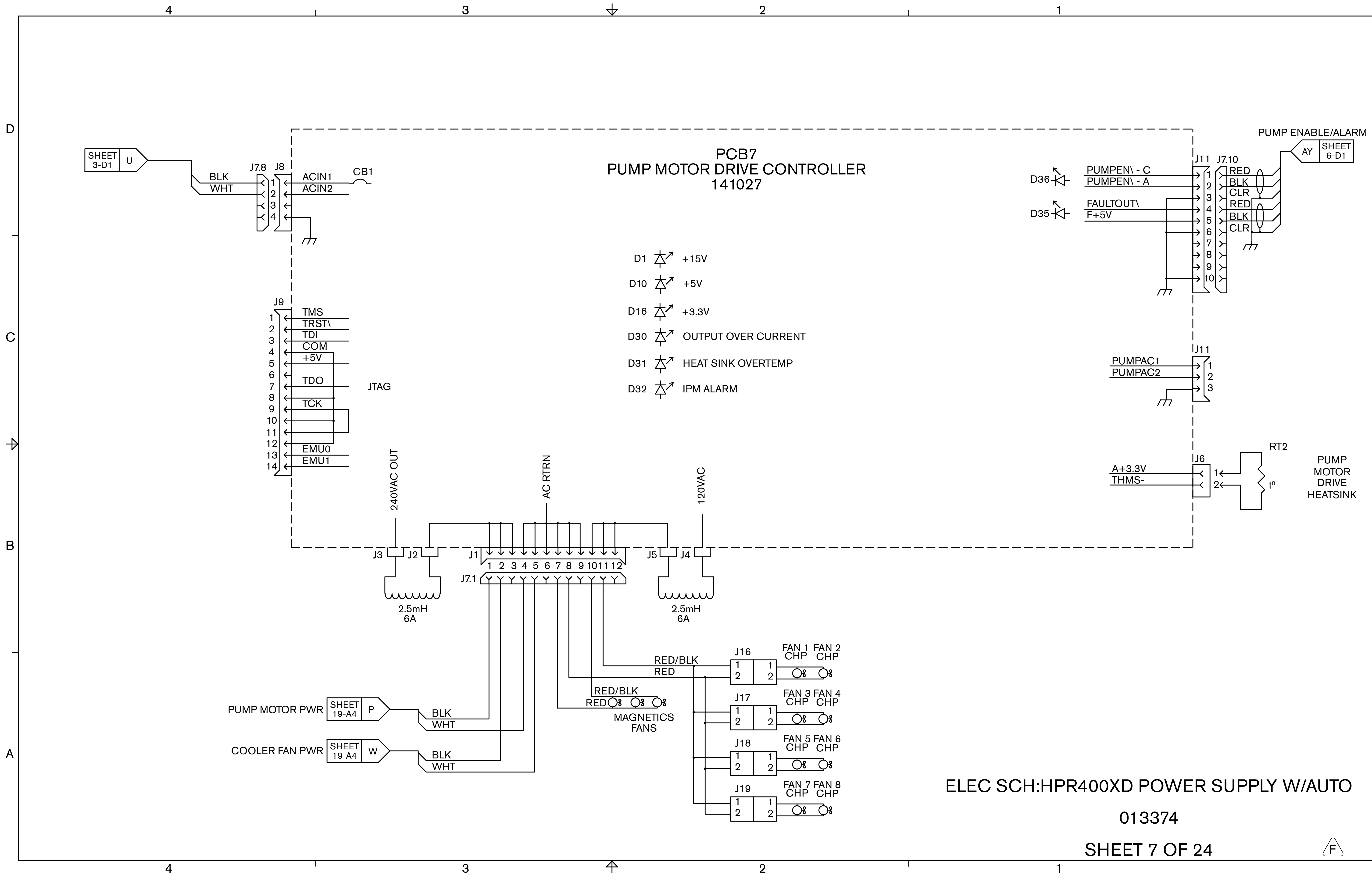


ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

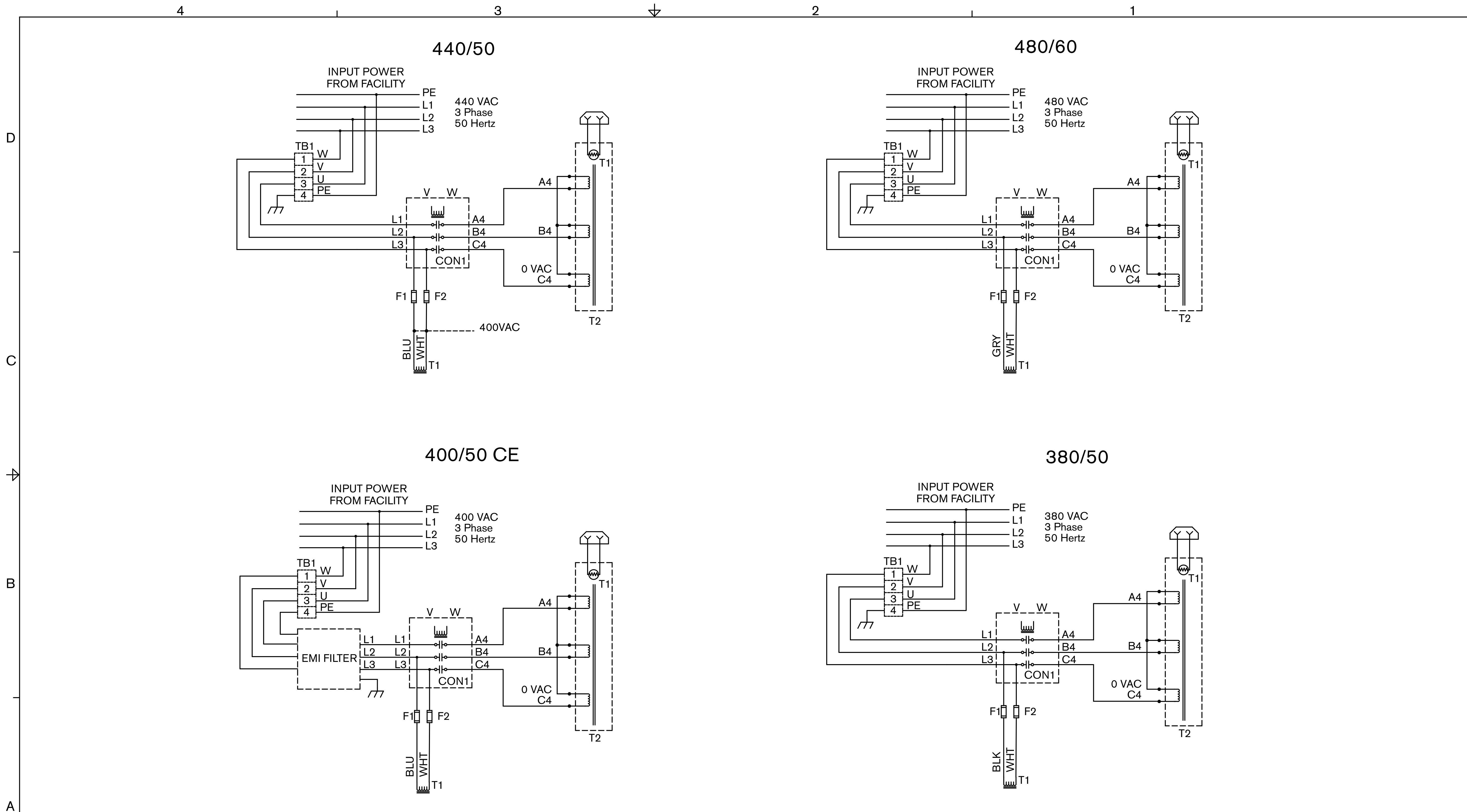
013374

SHEET 6 OF 24

F



PCB7
PUMP MOTOR DRIVE CONTROLLER
141027
SHEET 3-D1
U
BLK
WHT
J7.8
J8
ACIN1
ACIN2
CB1
J9
TMS
TRST\
TDI
COM
+5V
TDO
TCK
EMU0
EMU1
JTAG
D1 +15V
D10 +5V
D16 +3.3V
D30 OUTPUT OVER CURRENT
D31 HEAT SINK OVERTEMP
D32 IPM ALARM
D36
D35
PUMPEN\ - C
PUMPEN\ - A
FAULTOUT\
F+5V
J11
J7.10
RED
BLK
CLR
PUMP ENABLE/ALARM
AY
SHEET 6-D1
PUMPAC1
PUMPAC2
J6
A+3.3V
THMS-
RT2
PUMP MOTOR DRIVE HEATSINK
240VAC OUT
AC RTRN
120VAC
J3
J2
J1
J5
J4
J7.1
2.5mH 6A
PUMP MOTOR PWR
SHEET 19-A4
P
COOLER FAN PWR
W
RED/BLK
RED
MAGNETICS FANS
J16
J17
J18
J19
FAN 1 CHP
FAN 2 CHP
FAN 3 CHP
FAN 4 CHP
FAN 5 CHP
FAN 6 CHP
FAN 7 CHP
FAN 8 CHP
ELEC SCH:HPR400XD POWER SUPPLY W/AUTO
013374
SHEET 7 OF 24
F



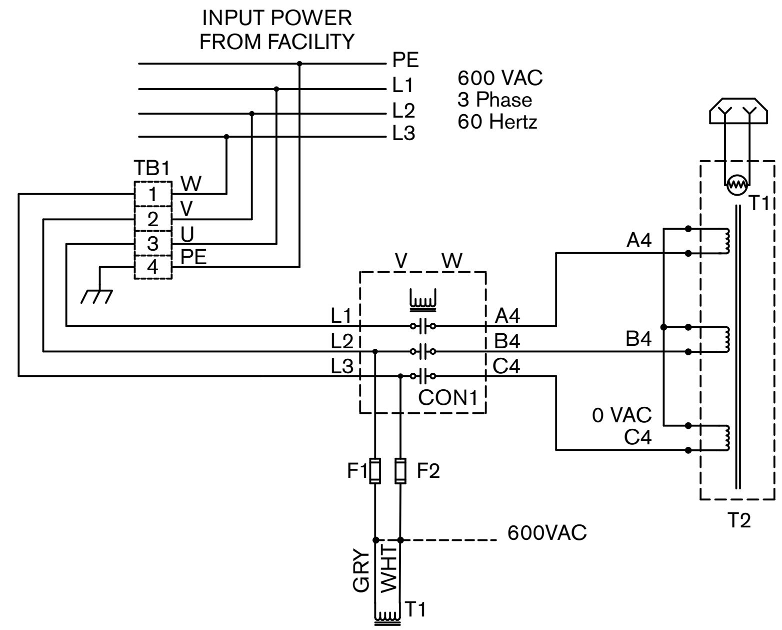
ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

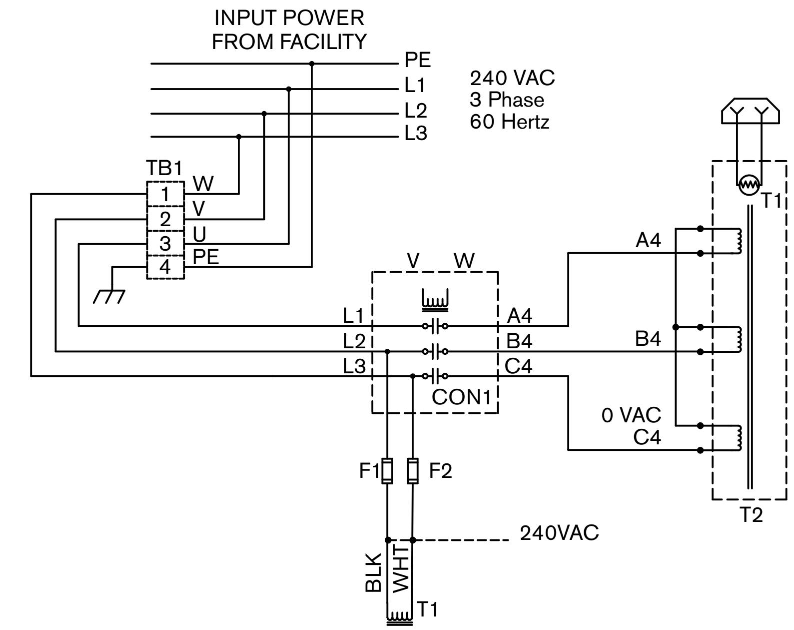
SHEET 8 OF 24

F

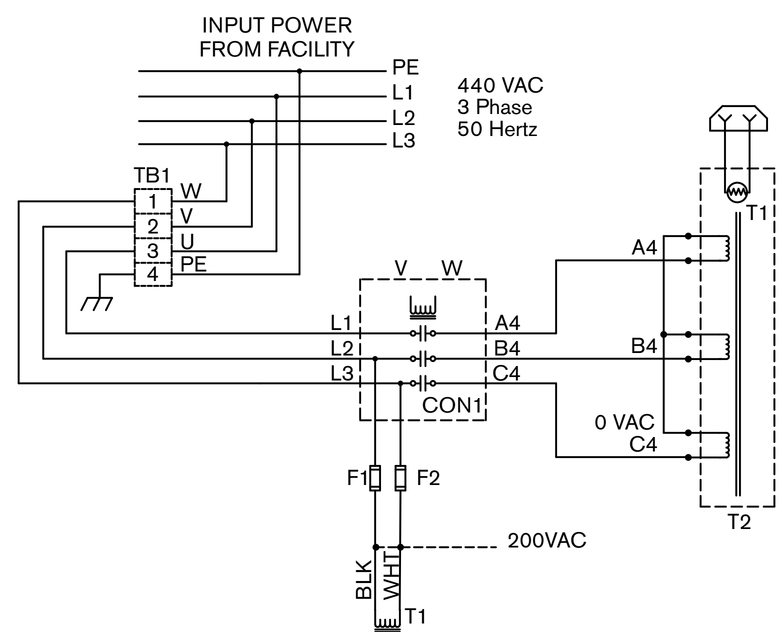
600/60



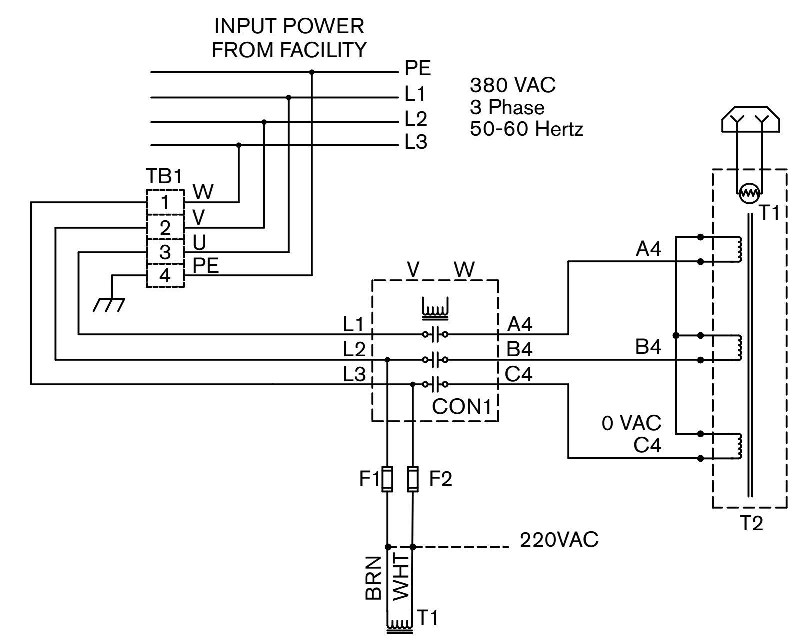
240/60



200/50-60



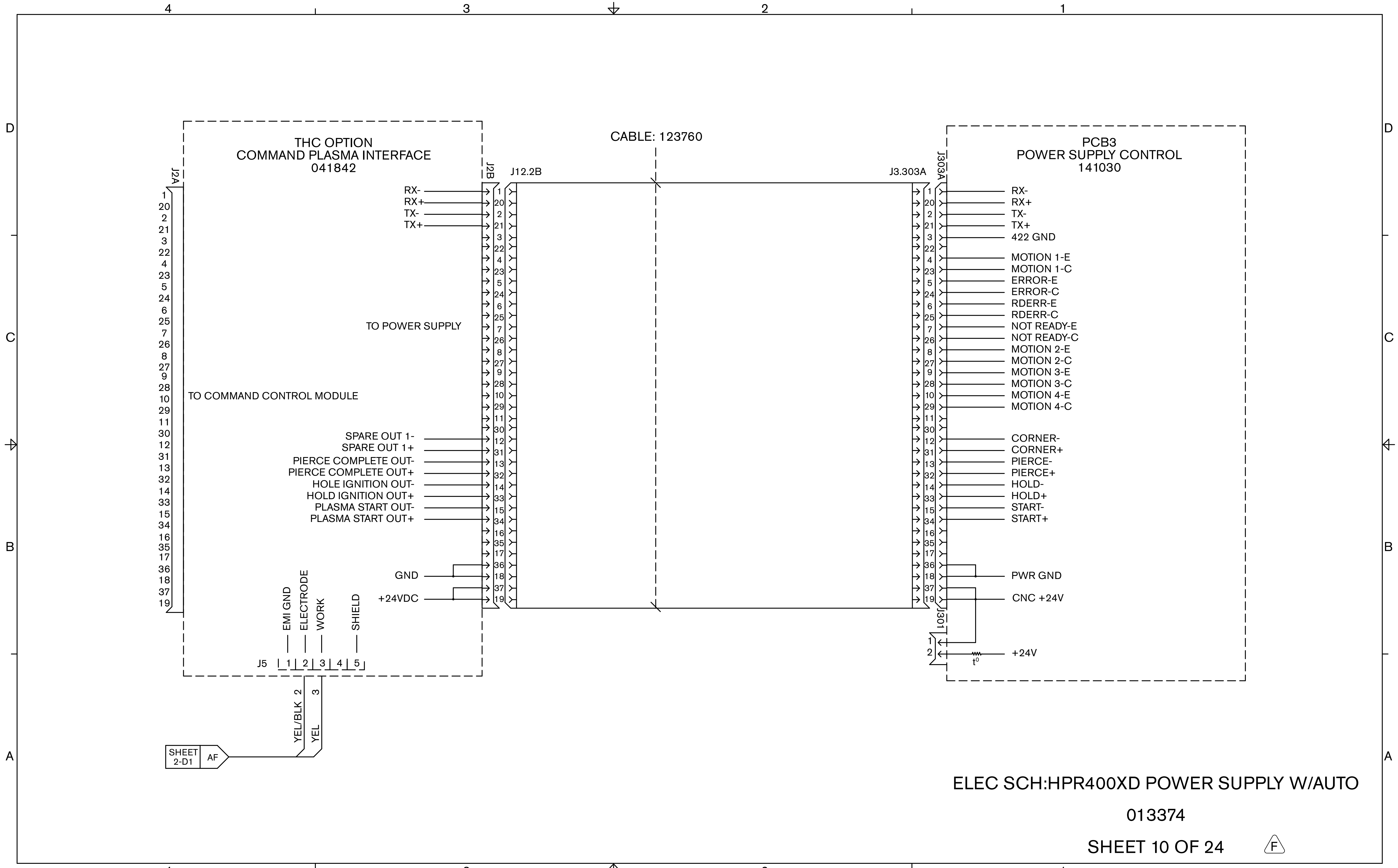
220/50-60



ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

SHEET 9 OF 24 F

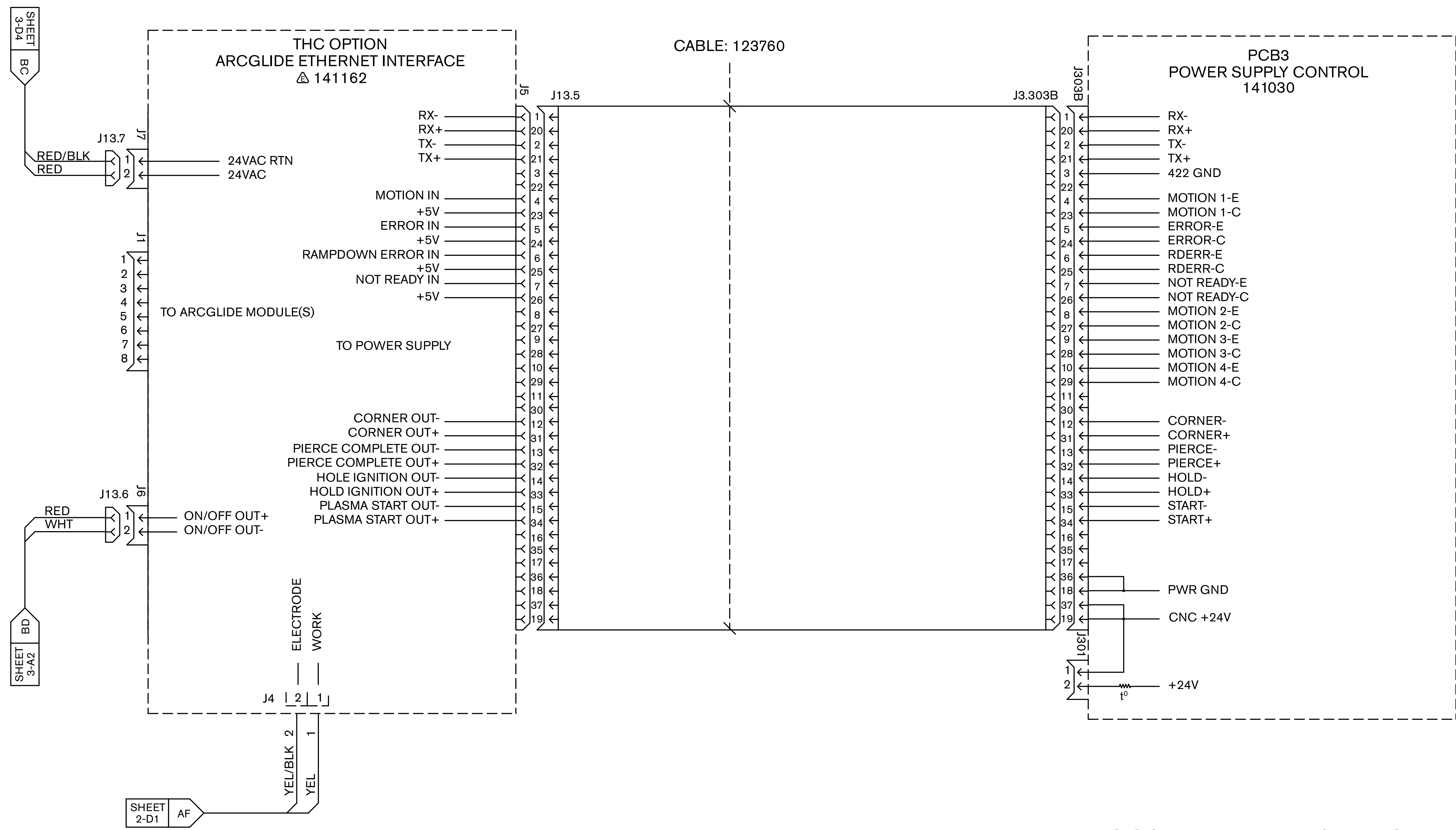


ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

SHEET 10 OF 24

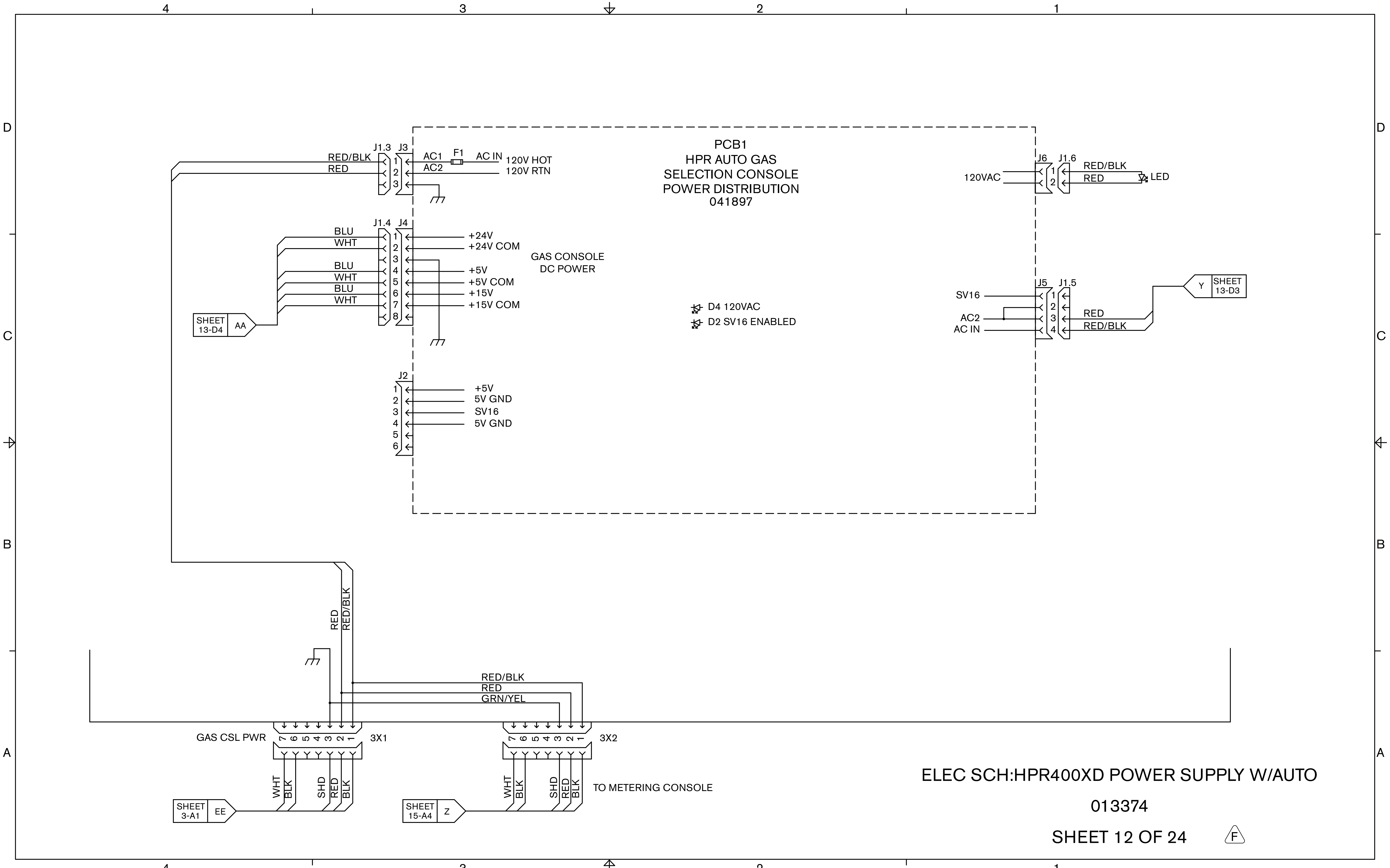
F



ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

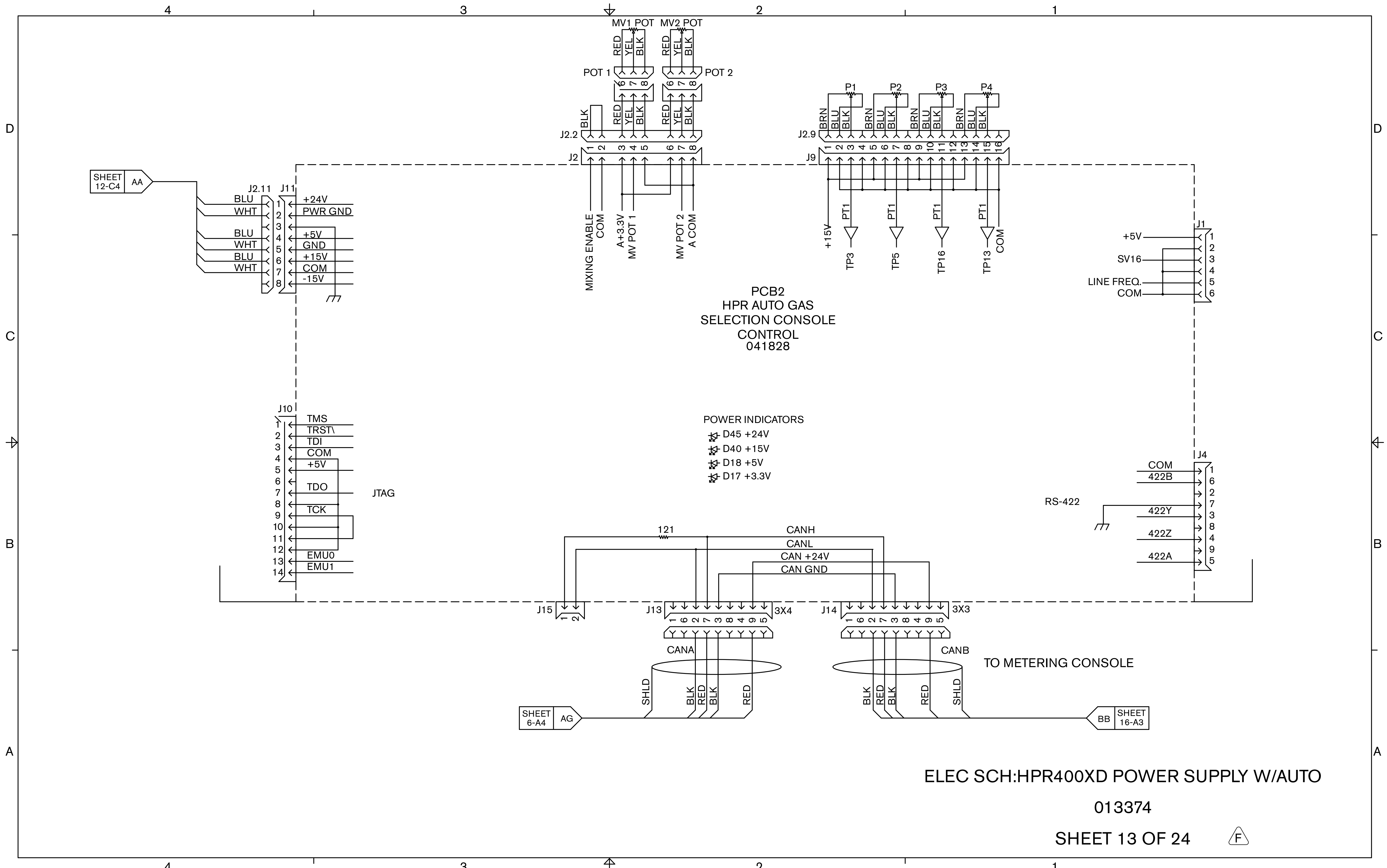
SHEET 11 OF 24



ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

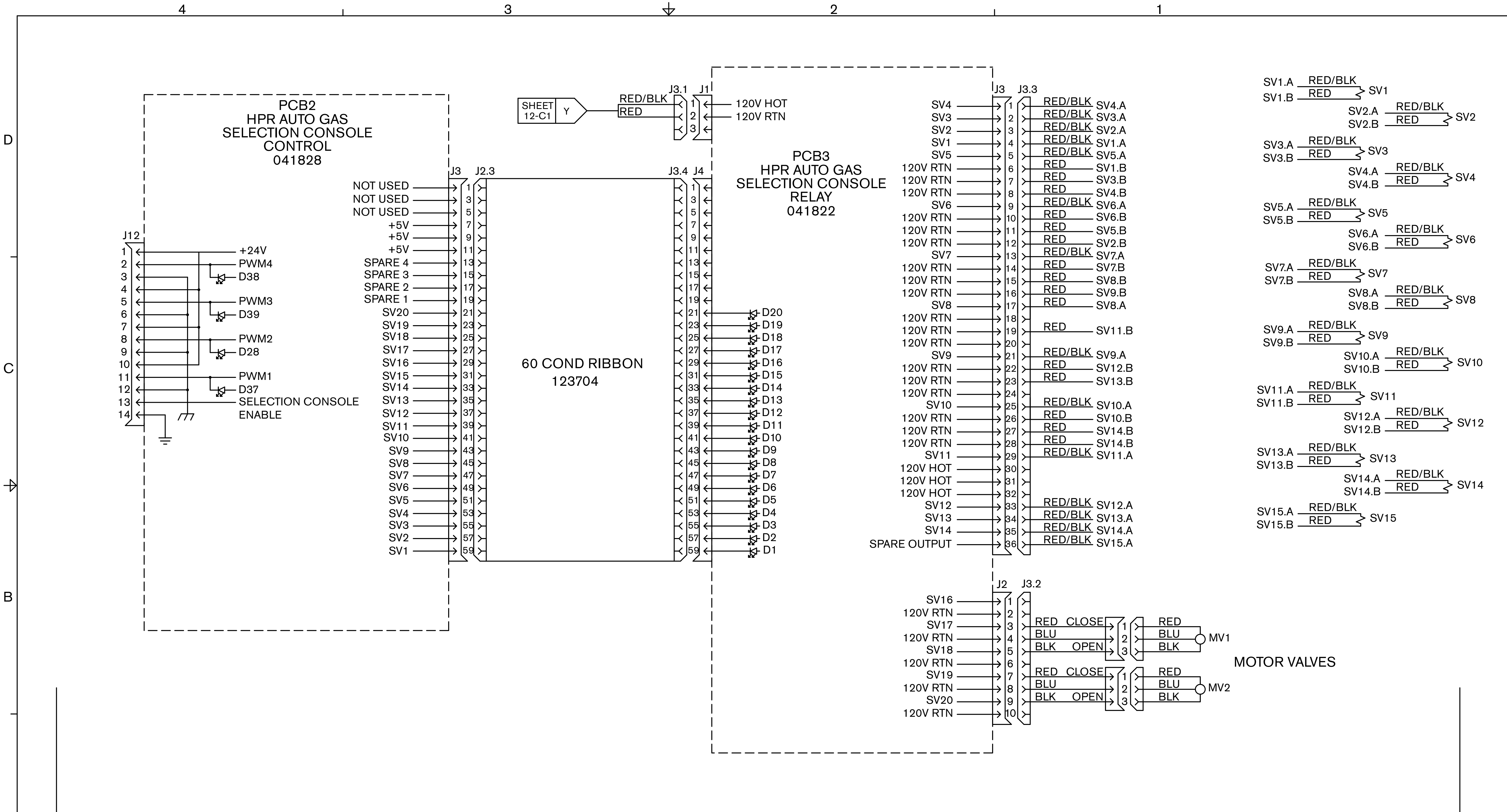
SHEET 12 OF 24 F



ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

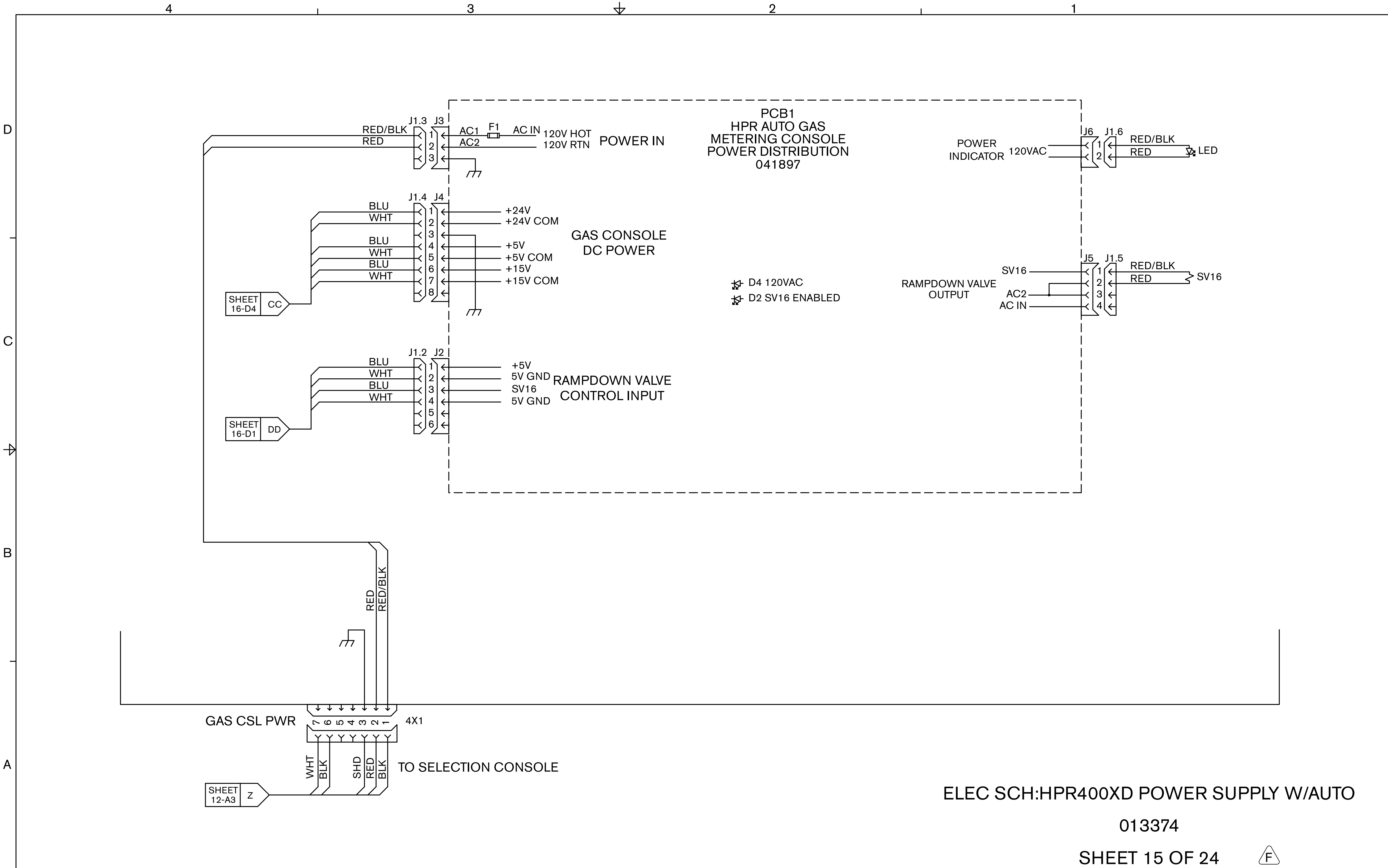
SHEET 13 OF 24



ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

SHEET 14 OF 24 F

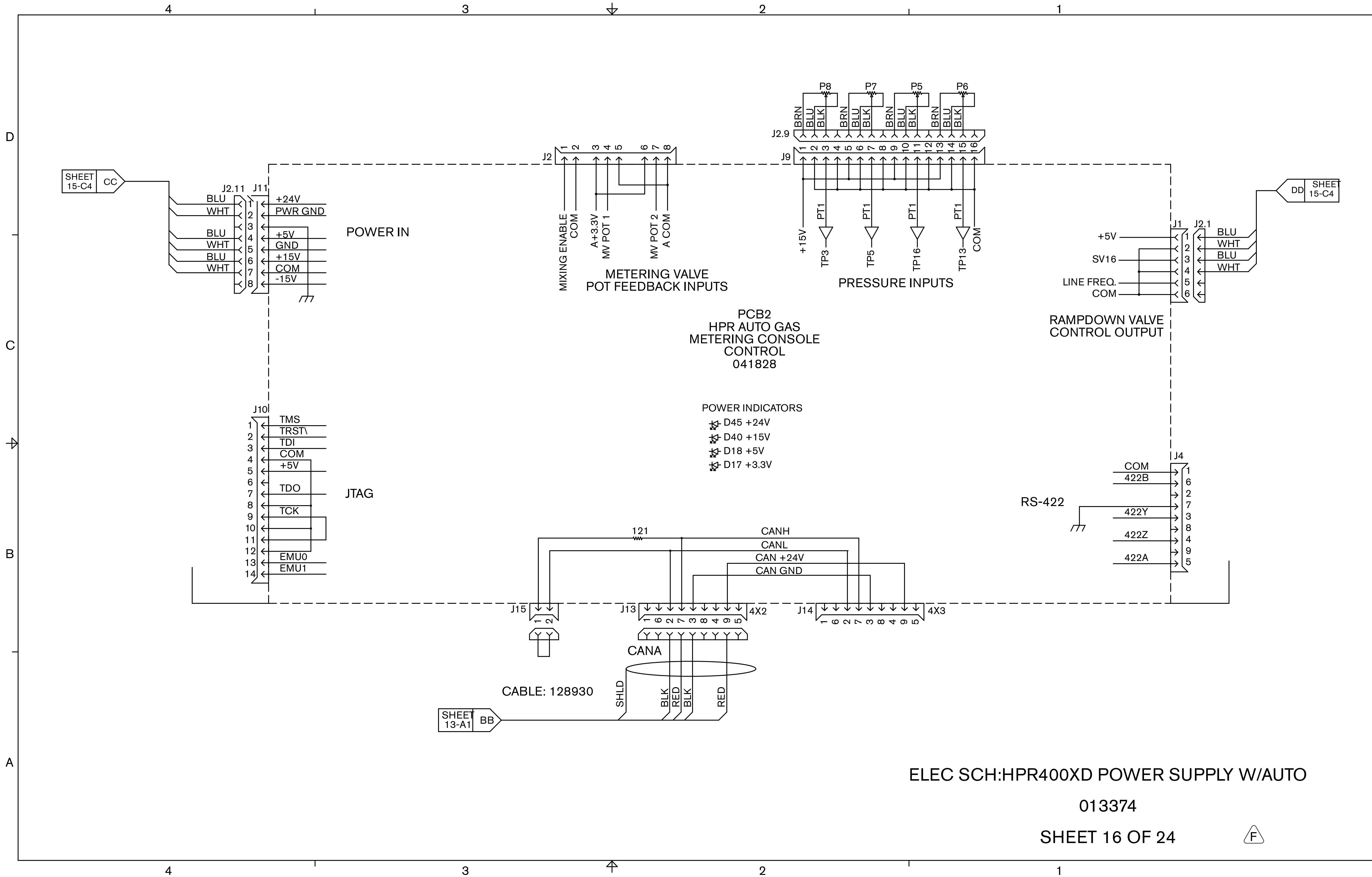


ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

SHEET 15 OF 24

F

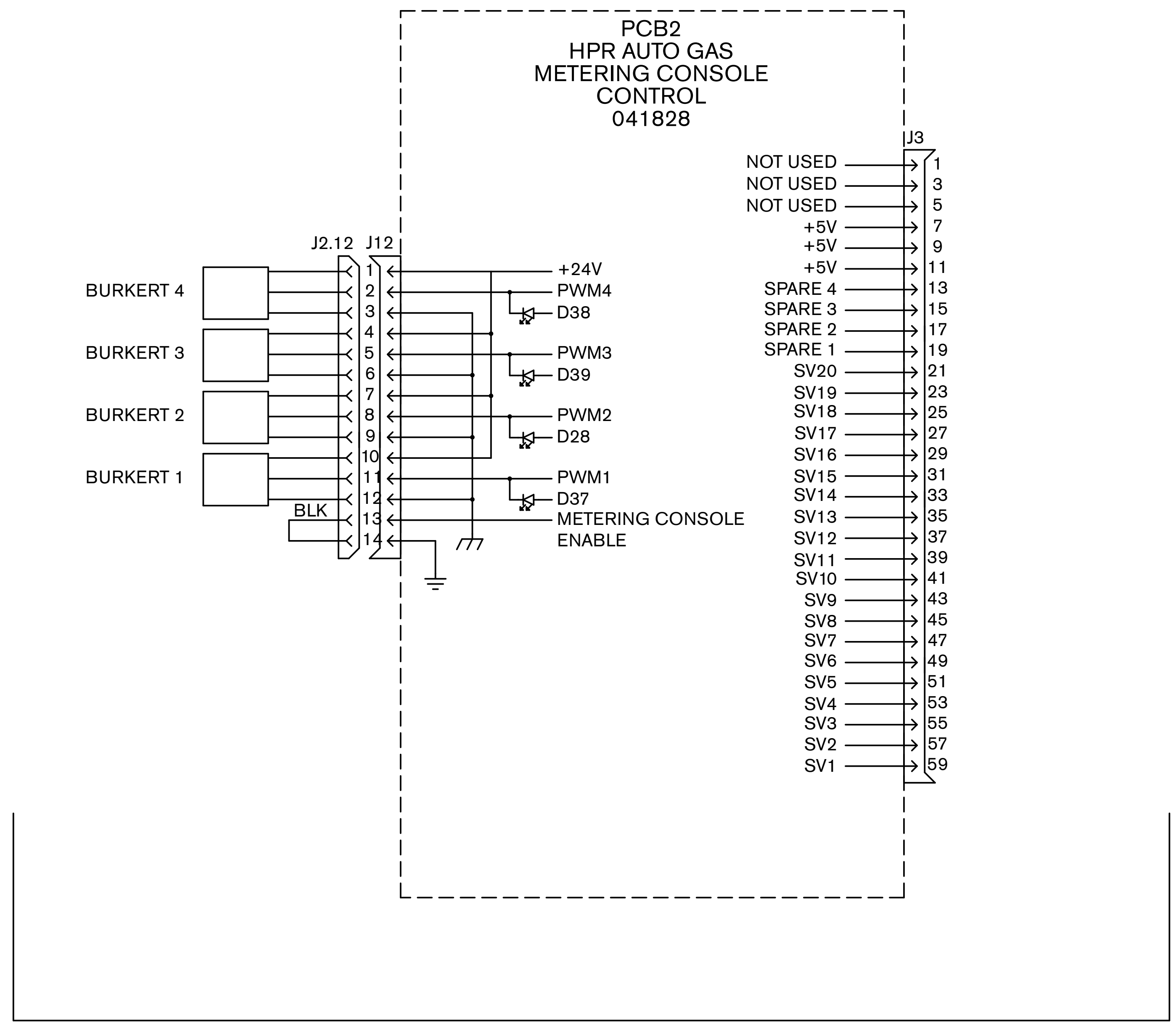


ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

SHEET 16 OF 24

F

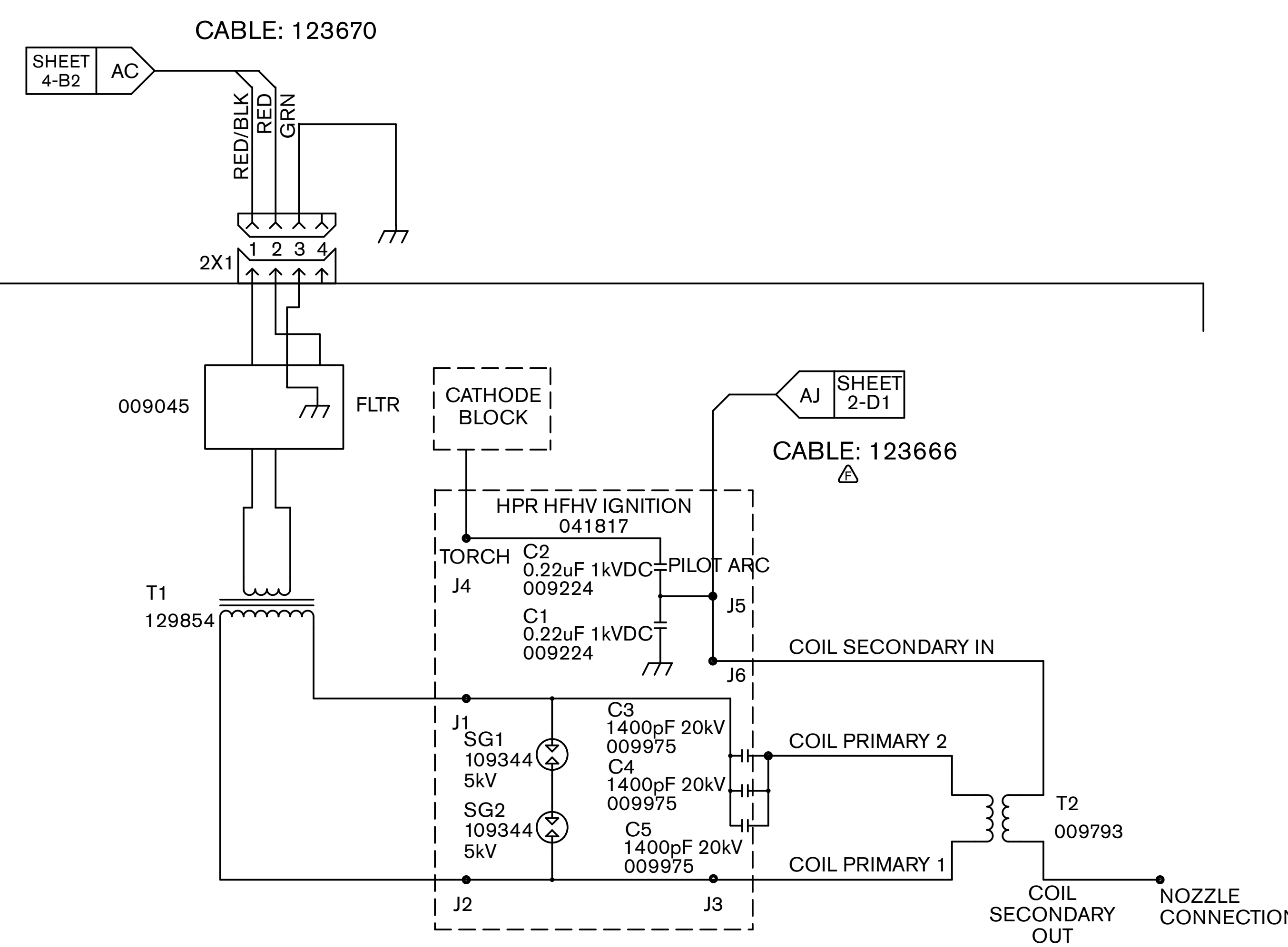


ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

SHEET 17 OF 24

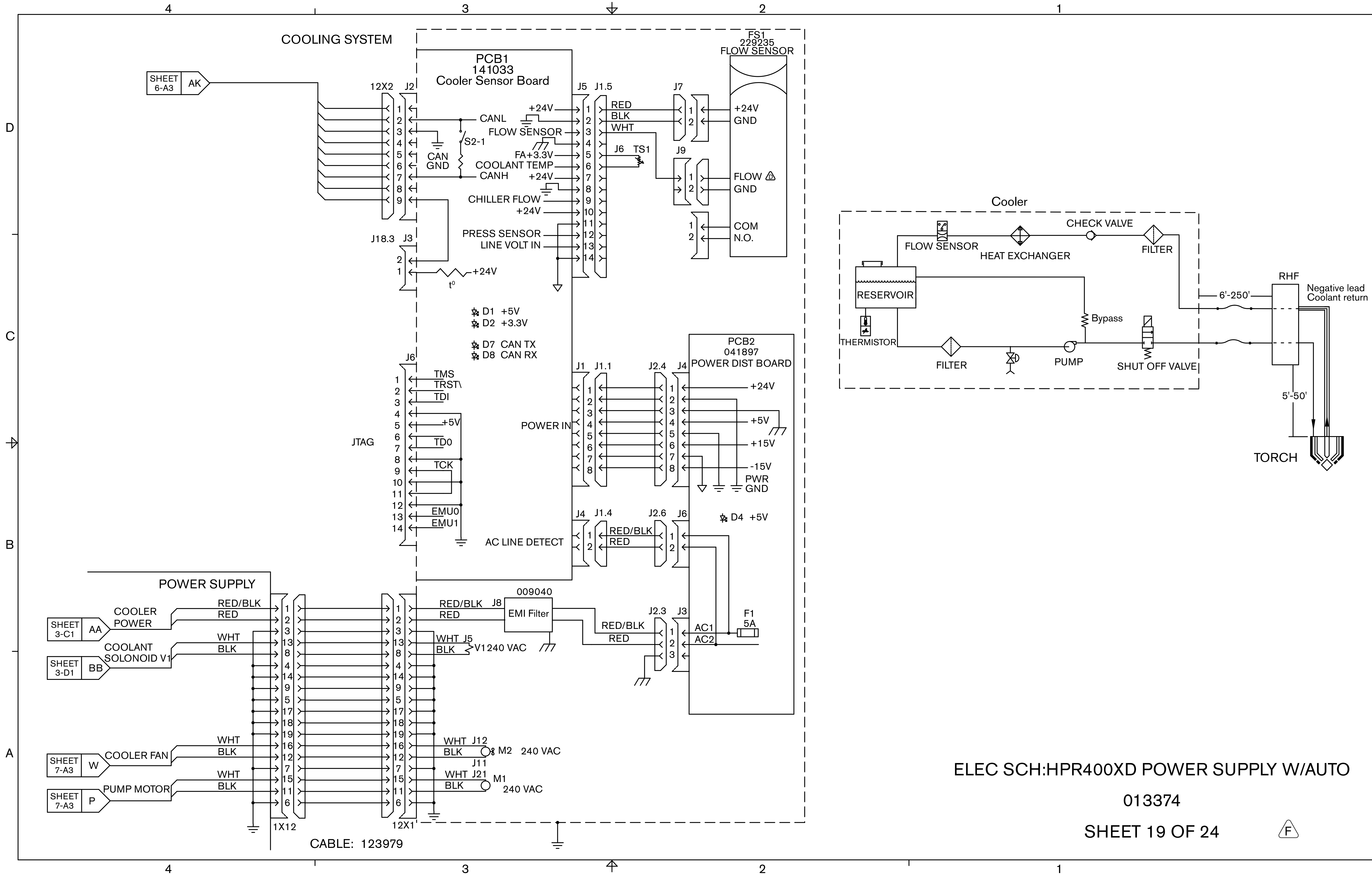
F

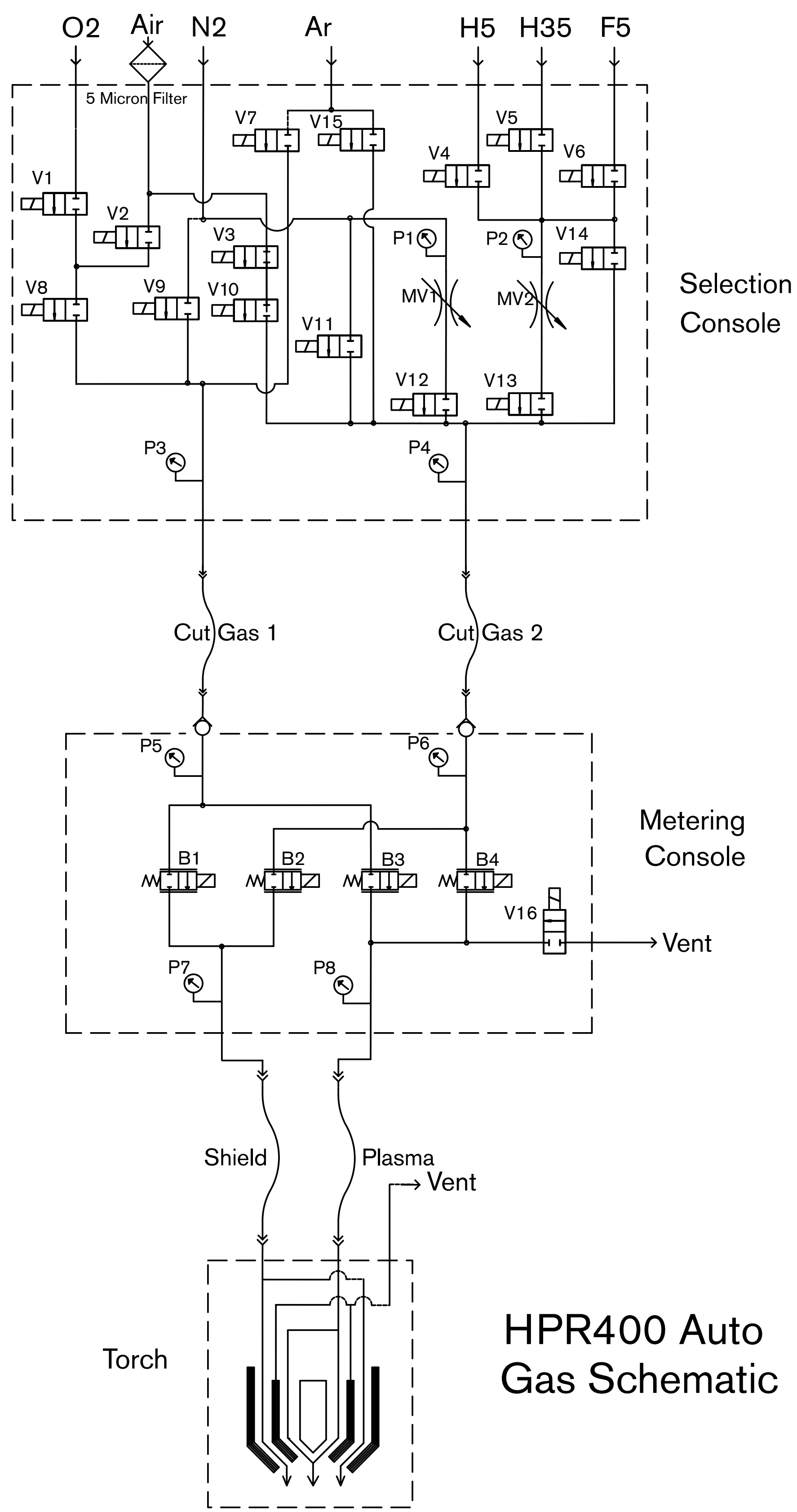


ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

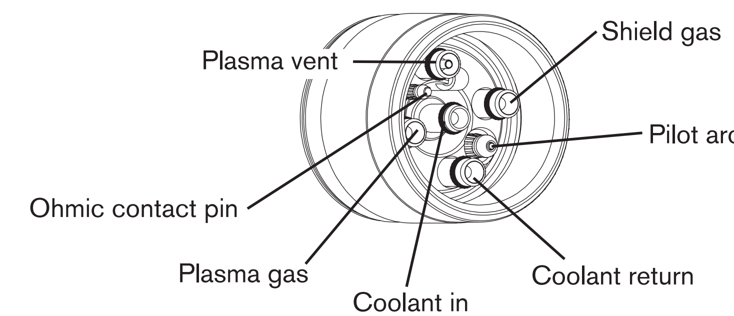
SHEET 18 OF 24


COOLING SYSTEM
SHEET 6-A3
AK
12X2
J2
PCB1
141033
Cooler Sensor Board
CANL
CAN GND
S2-1
CANH
+24V
FLOW SENSOR
FA+3.3V
COOLANT TEMP
CHILLER FLOW
PRESS SENSOR
LINE VOLT IN
J18.3
J3
+24V
J5
J1.5
RED
BLK
WHT
J6
TS1
J7
J9
FS1
229235
FLOW SENSOR
+24V
GND
FLOW
GND
COM
N.O.
D1 +5V
D2 +3.3V
D7 CAN TX
D8 CAN RX
J6
TMS
TRST\
TDI
+5V
TD0
TCK
EMU0
EMU1
JTAG
POWER IN
AC LINE DETECT
J1
J1.1
J2.4
J4
PCB2
041897
POWER DIST BOARD
+24V
+5V
+15V
-15V
PWR GND
J4
J1.4
J2.6
J6
RED/BLK
RED
D4 +5V
POWER SUPPLY
SHEET 3-C1
AA
COOLER POWER
SHEET 3-D1
BB
COOLANT SOLONOID V1
SHEET 7-A3
W
COOLER FAN
SHEET 7-A3
P
PUMP MOTOR
RED/BLK
RED
WHT
BLK
1X12
12X1
CABLE: 123979
009040
EMI Filter
J8
WHT J5
BLK
V1 240 VAC
J2.3
J3
AC1
AC2
F1
5A
WHT J12
BLK
M2 240 VAC
J11
WHT J21
BLK
M1
240 VAC
Cooler
FLOW SENSOR
HEAT EXCHANGER
CHECK VALVE
FILTER
RESERVOIR
THERMISTOR
Bypass
FILTER
PUMP
SHUT OFF VALVE
6'-250'
RHF
Negative lead
Coolant return
5'-50'
TORCH
ELEC SCH:HPR400XD POWER SUPPLY W/AUTO
013374
SHEET 19 OF 24
F



HPR400 Auto Gas Schematic

Torch connections



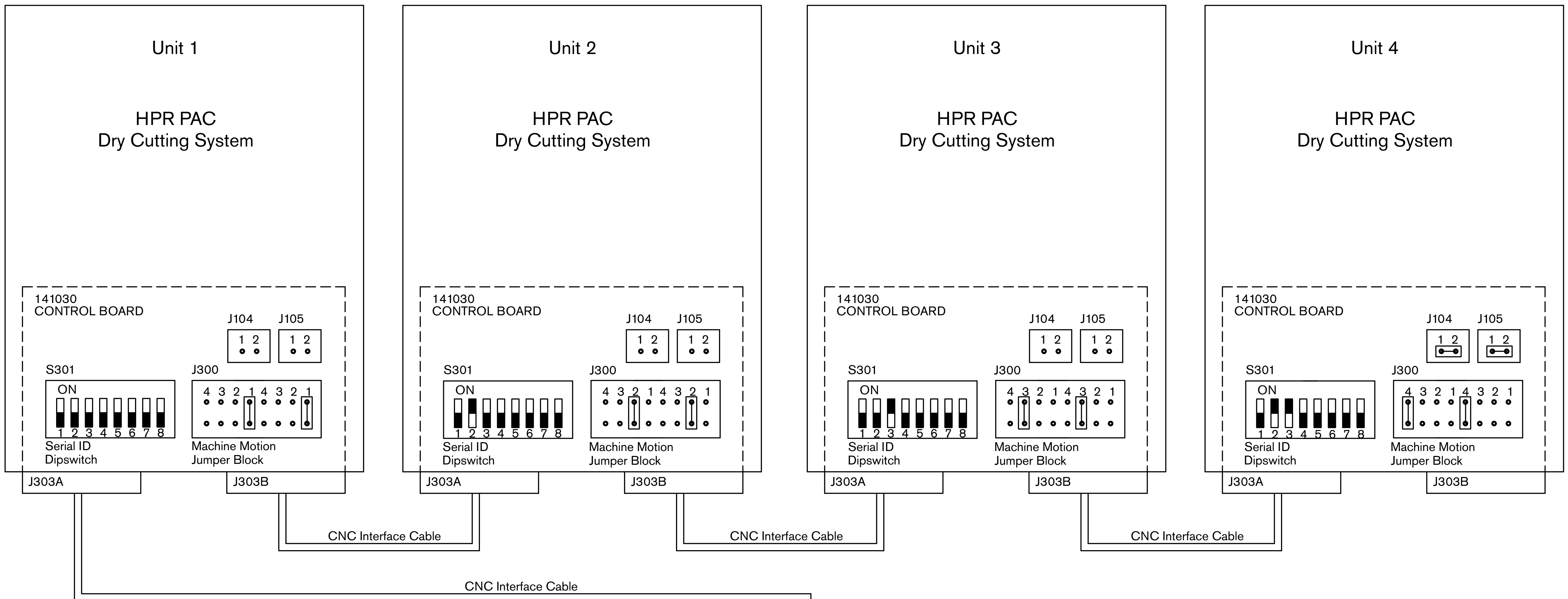
ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

SHEET 20 OF 24

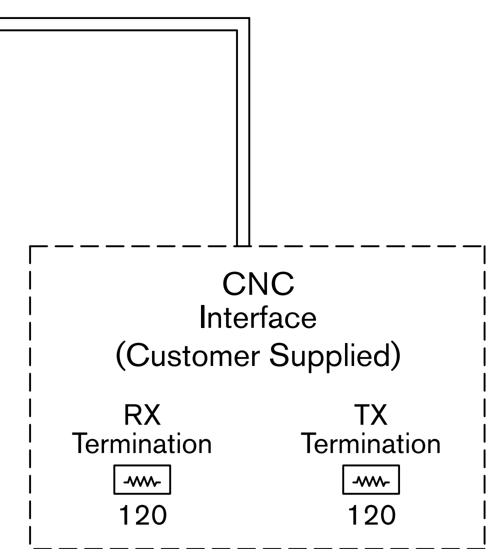
F

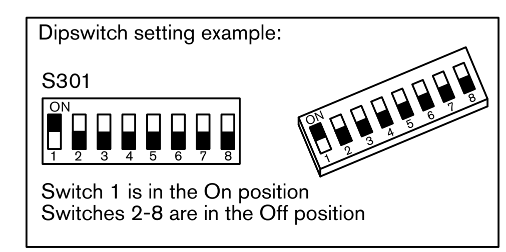
Optional Multi-System Interface



Notes:

1) For single system installations set Serial ID (S301), and Machine Motion (J300) as shown in Unit 1, jumpers J104 and J105 must be closed.
2) On multi-system installations refer to the illustration. Jumpers J104 and J105 are left open on all systems except for the very last system where they are in the closed position. Termination resistors (120-ohm) or termination jumpers must be installed/set at the CNC for each of the RS-422 RX and TX signal pairs.
3) If a Hypertherm Automation Controller is being used, and there are intermittent communication failures (PS Link Failure), try removing the jumpers on J104 and J105 on the control board, and the termination jumper (J6 or J8) on the serial isolation board in the controler. Only remove the termination jumper on the serial isolation board that is connected to the HPR power supply. See sheet 19 for more details.





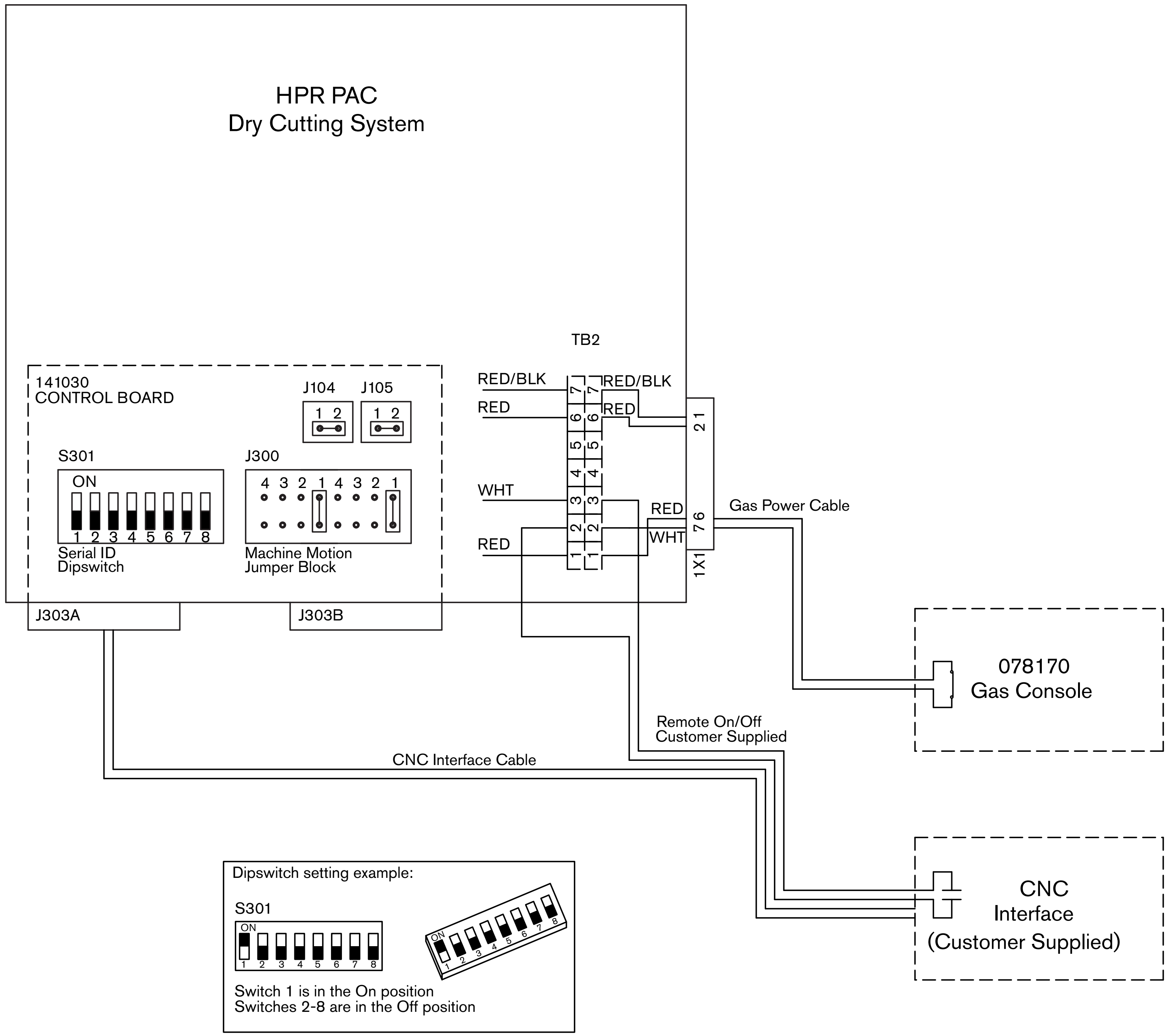
ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

SHEET 21 OF 24

F

Optional Remote On/Off



Notes:

1) For single system installation set Serial ID (S301), Machine Motion (J300), J104 & J105 as shown.

Relocate the white wire on TB2 from position #3 to position #2. Connect customer supplied Remote On/Off cable in series with the power supply and the gas console power switch. Connect one terminal of the Remote On/Off cable to position #2 on TB2 and the other terminal to position #3.

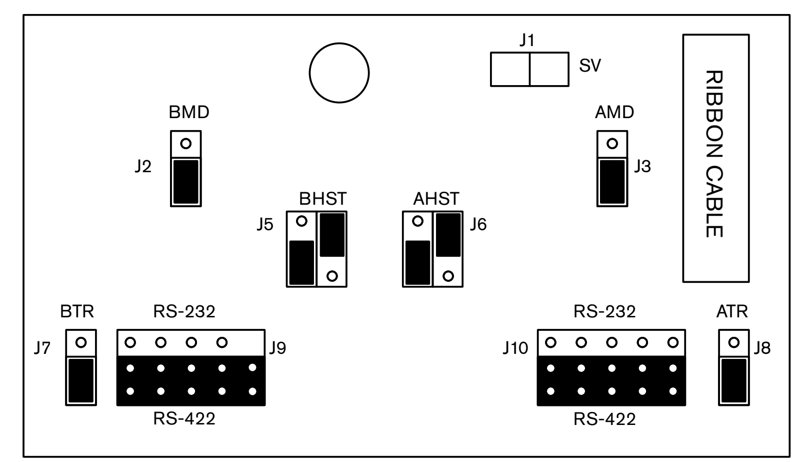
Refer to page 3 of the wiring diagram

Depress the Gas Console Power switch to the closed position (on position).

2) For a multi-system installation set up as described above, set jumpers as shown on the multi-system interface page

3) The CNC will need a dedicated I/O for each system using the Remote On/Off feature (contact should be rated for min. 24Vac, 0.5 Amp)

* If a Hypertherm Automation controller is being used, and there are intermittent communication failures (PS Link Failure), try removing the jumnpers on J104 and J105 on the control board, and the termination jumper (J6 or J8) on the serial isolation board in the controler. Only remove the termination jumper on the serial isolation board that is connected to the HPR power supply. See figure below for details.



Serial isolation board in a Hypertherm Automation controller

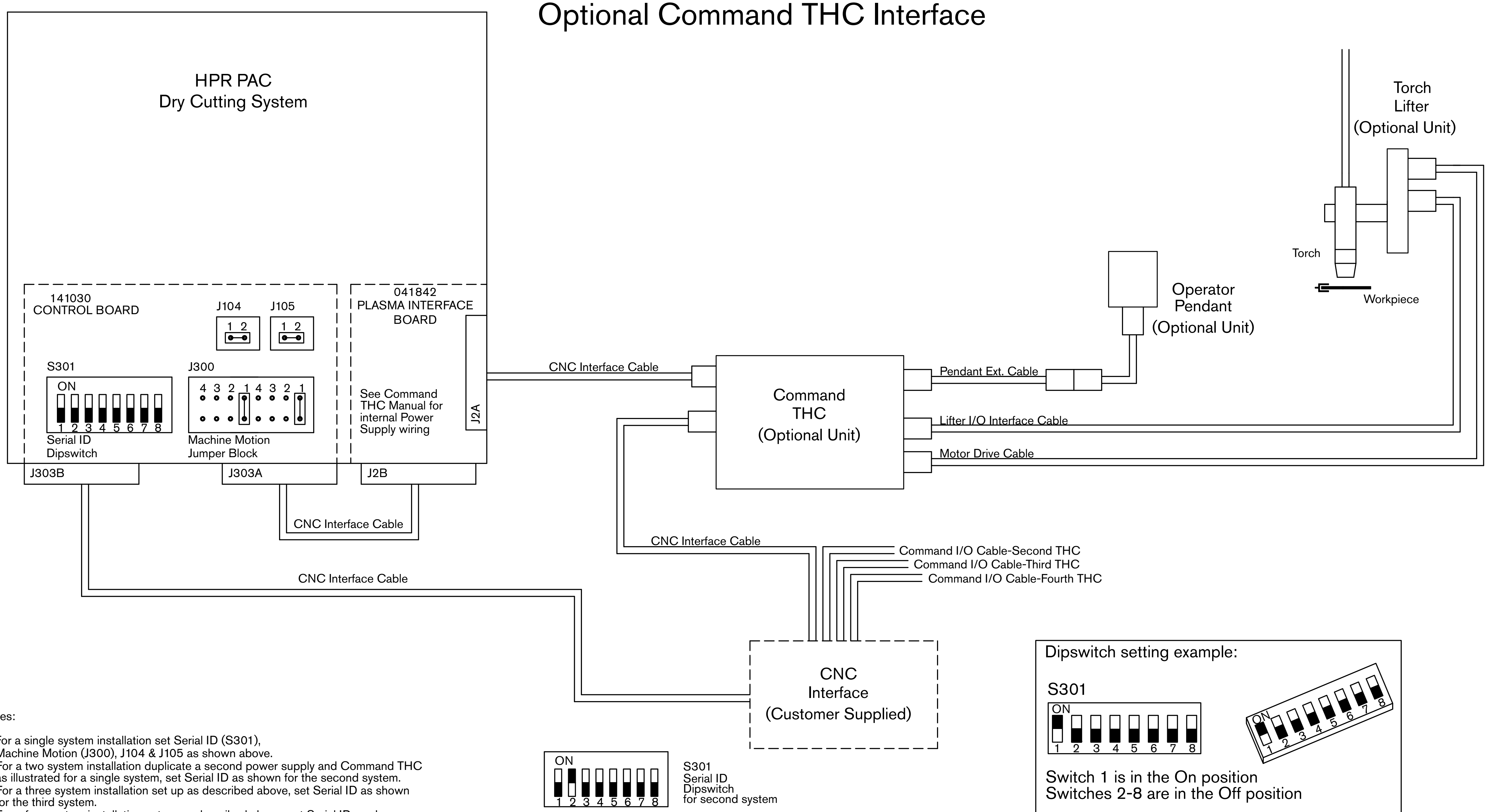
ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

SHEET 22 OF 24

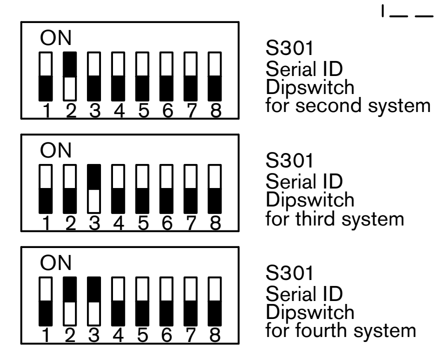
F

Optional Command THC Interface



Notes:

1) For a single system installation set Serial ID (S301), Machine Motion (J300), J104 & J105 as shown above.
2) For a two system installation duplicate a second power supply and Command THC as illustrated for a single system, set Serial ID as shown for the second system.
3) For a three system installation set up as described above, set Serial ID as shown for the third system.
4) For a four system installation set up as described above, set Serial ID as shown for the fourth system.
5) All machine interface cables (Pwr. supply-CNC) used for serial communication between Pwr. supply-CNC will have a common connection node with the CNC.
6) The CNC will need a dedicated I/O port for each Command THC.
7) If a Hypertherm Automation controller is being used, and there are intermittent communication failures (PS Link Failure), try removing the jumpers on J104 and J105 on the control board, and the termination jumper (J6 or J8) on the serial isolation board in the controler. Only remove the termination jumper on the serial isolation board that is connected to the HPR power supply. See figure on Sheet 19 for details.



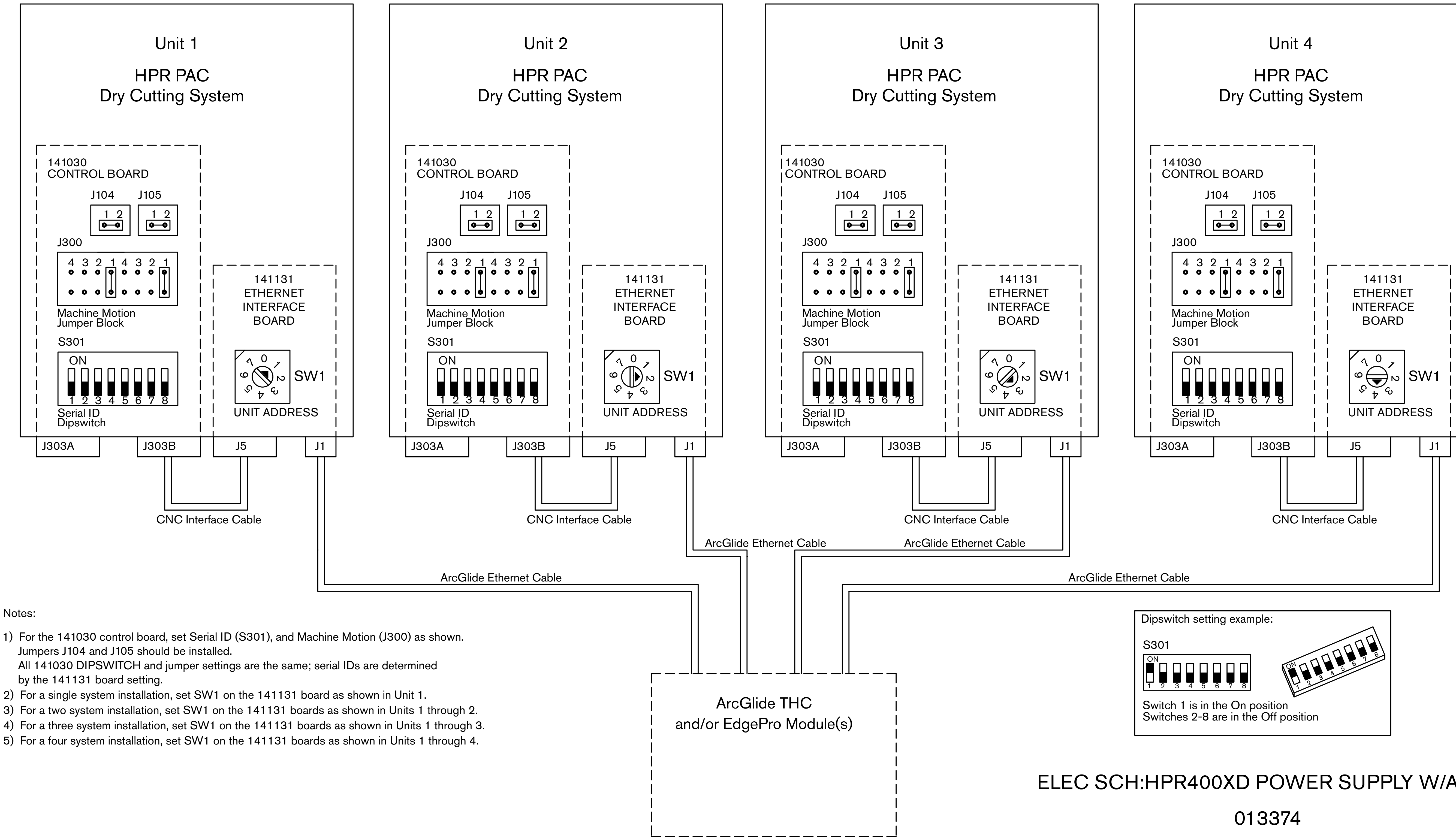
ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

SHEET 23 OF 24

F

Optional ArcGlide/EdgePro Multi-System Interface



Notes:

1) For the 141030 control board, set Serial ID (S301), and Machine Motion (J300) as shown.
Jumpers J104 and J105 should be installed.
All 141030 DIPSWITCH and jumper settings are the same; serial IDs are determined by the 141131 board setting.
2) For a single system installation, set SW1 on the 141131 board as shown in Unit 1.
3) For a two system installation, set SW1 on the 141131 boards as shown in Units 1 through 2.
4) For a three system installation, set SW1 on the 141131 boards as shown in Units 1 through 3.
5) For a four system installation, set SW1 on the 141131 boards as shown in Units 1 through 4.

Dipswitch setting example:

S301

Switch 1 is in the On position
Switches 2-8 are in the Off position

ELEC SCH:HPR400XD POWER SUPPLY W/AUTO

013374

SHEET 24 OF 24 F

Appendix A

HYPERTHERM TORCH COOLANT SAFETY DATA

In this section:

1 – IDENTIFICATION OF THE SUBSTANCE/MIXTURE AND OF THE COMPANY UNDERTAKING

Product identifier – Torch Coolant 30% PG Mixture

GHS Product Identifier – **Not applicable**.

Chemical Name – **Not applicable**.

Trade name – **Torch Coolant 30% PG Mixture**

CAS No. – **Not applicable**.

EINECS No. – **Not applicable**.

REACH Registration No. – **Not available**.

Relevant identified uses of the substance or mixture and uses advised against

Identified use(s) – **Industrial use only**.

Uses advised against – **Not available**.

Details of the supplier of the safety data sheet

Company Identification – **Hypertherm**

Telephone – **+1 (603) 643-5638 (USA), +31 (0) 165 596 907 (Europe)**

E-Mail (competent person) – **technical.service@Hypertherm.com**

Address – **P.O. Box 5010, Hanover, NH 03755 USA (USA),**
Vaartveld 9, 4704 SE Roosendaal, Nederlands (Europe)

Emergency telephone number – (800) 255-3924 (USA), +1 (813) 248-0585 (International)

2 – HAZARDS IDENTIFICATION

EC Classification	NONE	GHS Classification Signal word(s)	NONE
NONE	NONE	NONE	NONE

According to Regulation (EC) No. 1272/2008 (CLP) – NONE
According to Directive 67/548/EEC & Directive 1999/45/EC – NONE
Preparation is not classified as hazardous in the sense of directive 1999/45/EC and 2006/121/EC.

Risk Phrases – NONE

Safety Phrases – NONE

Hazard statement(s) – NONE

Precautionary statement(s) – NONE

3 – COMPOSITION/INFORMATION ON INGREDIENTS

HAZARDOUS INGREDIENT 1	**% W/W**	**CAS No.**	**EC No.**	**EC Classification**
Propylene Glycol	30-50	57-55-6	200-338-0	**NONE**
GHS Classification				
Not classified				**NONE**
HAZARDOUS INGREDIENT 2	**% W/W**	**CAS No.**	**EC No.**	**EC Classification**
Benzotriazole	<1.0	95-14-7	202-394-1	**Xn, F**
GHS Classification				
WARNING	**Acute Tox. 4 (Oral, Dermal, Inhalation)** **Eye Irrit. 2, Aquatic Chronic 3**			**H302, 312, 319, 332, 412**

For full text of R phrases see section 16. For full text of H/P phrases see section 16. Non-hazardous components are not listed.

4 – FIRST AID MEASURES

Inhalation	Unlikely to be hazardous by inhalation unless present as an aerosol. Remove patient from exposure.
Skin Contact	Wash skin with water.
Eye Contact	If substance has gotten into the eyes, immediately wash out with plenty of water for several minutes.
Ingestion	Laxative. Do not induce vomiting. If swallowed, seek medical advice immediately and show this container or label.
Further Medical Treatment	Unlikely to be required but if necessary treat symptomatically.

5 – FIRE-FIGHTING MEASURES

Combustible but not readily ignited.

Extinguishing media	Extinguish preferably with dry chemical, foam or water spray
Unsuitable Extinguishing Media	None known
Fire Fighting Protective Equipment	A self contained breathing apparatus and suitable protective clothing should be worn in fire conditions

6 – ACCIDENTAL RELEASE MEASURES

Personal Precautions	Put on protective clothing
Environmental Exposure Controls	Absorb spillages onto sand, earth or any suitable adsorbent material
Other	None

7 – HANDLING AND STORAGE

Handling	Unlikely to cause harmful effects under normal conditions of handling and use.
Storage	Keep container tightly closed and dry. Keep away from heat. Keep out of the reach of children. Keep away from oxidizing agents.
Storage Temperature:	Ambient.
Storage Life:	Stable at ambient temperatures.
Specific Use:	Industrial use only.

8 – EXPOSURE CONTROLS/PERSONAL PROTECTION

	Respirators	Normally no personal respiratory protection is necessary. Wear suitable respiratory protective equipment if exposure to levels above the occupational exposure limit is likely. A suitable dust mask or dust respirator with filter type A/P may be appropriate.
	**Eye Protection**	Safety spectacles.
	Gloves	Wearing of chemical protective gloves is not necessary.
	Body protection	None.
	Engineering Controls	Ensure adequate ventilation to remove vapors, fumes, dust etc.
	Other	None.

OCCUPATIONAL EXPOSURE LIMITS

SUBSTANCE	CAS No.	LTEL (8 hr TWA ppm)	LTEL (8 hr TWA mg/m^3)	STEL (ppm)	STEL (mg/m^3)	**Note:**
Propylene Glycol	**57-55-6**	**NE**	**10***	**NE**	**NE**	**AIHA WEEL in the USA**
Benzotriazole	**95-14-7**	**NE**	**NE**	**NE**	**NE**	**None**

9 – PHYSICAL AND CHEMICAL PROPERTIES

Information on basic physical and chemical properties

Appearance – **Liquid**	Vapor Pressure (mm Hg) – **Not available**
Color – **Pinkish – Reddish**	Vapor Density (Air=1) – **Not available**
Odor – **Slight**	Density (g/ml) – **1.0 ± 0.1 g/ml**
Odor Threshold (ppm) – **Not available**	Solubility (Water) – **Soluble**
pH (Value) – **5.5-7.0** (Concentrated)	Solubility (Other) – **Not established**
Melting Point (°C) / Freezing Point (°C) – **< -0°C / (< 32°F)**	Partition Coefficient (n-Octanol/water) – **Not available**
Boiling point/boiling range (°C): **>100°C (>212°F)**	Auto Ignition Temperature (°C) – **Not available**
Flash Point (°C) – **>95°C (>203°F)**	Decomposition Temperature (°C) – **Not available**
Evaporation rate – **Not available**	Viscosity (mPa.s) – **Not available**
Flammability (solid, gas) – **Non-flammable**	Explosive properties – **Not explosive**
Explosive limit ranges – **Not available**	Oxidizing properties – **Not oxidizing**
Other information – **None**	

10 – STABILITY AND REACTIVITY

Reactivity	None
Chemical stability	Stable under normal conditions
Possibility of hazardous reactions	None
Conditions to avoid	None anticipated
Incompatible materials	Keep away from oxidizing agents
Hazardous Decomposition Product(s)	Carbon monoxide, Carbon dioxide, Nitrogen oxides

11 – TOXICOLOGICAL INFORMATION

11.1.1 – Substances

Acute toxicity	
Ingestion	Low oral toxicity, but ingestion may cause irritation of the gastrointestinal tract
Inhalation	Unlikely to be hazardous by inhalation
Skin Contact	Mild irritant to rabbit skin
Eye Contact	Mild irritant to the eye
Hazard label(s)	None
Serious eye damage/irritation	Mild irritant to the eye
Respiratory or skin sensitization	Mild irritant to rabbit skin
Mutagenicity	Not known
Carcinogenicity	IARC, NTP, OSHA, ACGIH do not list this product or any components thereof as known or suspected carcinogen
Reproductive toxicity	Not known
STOT-single exposure	Not known
STOT-repeated exposure	Not known
Aspiration hazard	Not known

12 – ECOLOGICAL INFORMATION

Toxicity	Do not let this chemical/product enter the environment.
Persistence and degradability	Biodegradable
Bioaccumulative potential	None anticipated
Mobility in soil	The product is predicted to have moderate mobility in soil
Results of PBT and vPvB assessment	None assigned
Other adverse effects	None anticipated

13 – DISPOSAL CONSIDERATIONS

Waste treatment methods – Disposal should be in accordance with local, state or national legislation. No special measures are required. No specific waste water pretreatment required.

Additional Information – None

14 – TRANSPORT INFORMATION

Not classified as dangerous for transport.
Transport in bulk according to Annex II of MARPOL73/78 and the IBC Code.

15 – REGULATORY INFORMATION

USA
TSCA (Toxic Substance Control Act) – **Listed.**
SARA 302 – Extremely Hazardous Substances – **Not applicable.**
SARA 313 – Toxic Chemicals – **Not applicable.**
SARA 311/312 – Hazard Categories – **None.**
CERCLA (Comprehensive Environmental Response Compensation and Liability Act) – **Not applicable.**
CWA (Clean Water Act) – CWA 307 – Priority Pollutants – **None.**
CAA (Clean Air Act 1990) CAA 112 – Hazardous Air Pollutants (HAP) – **None.**
Proposition 65 (California) – **Not applicable.**
State Right to Know Lists – **CAS No. 95-14-7 Listed in MA, NJ, PA.**

Canada
WHMIS Classification (Canada) – **Not classified.**
CANADA INGREDIENT DISCLOSURE LIST – **Not applicable.**
Canada (DSL/NDSL) – **Listed.**

EU
EINECS (Europe) – **Listed.**
Wassergefährdungsklasse (Germany) – **None.**

16 – OTHER INFORMATION

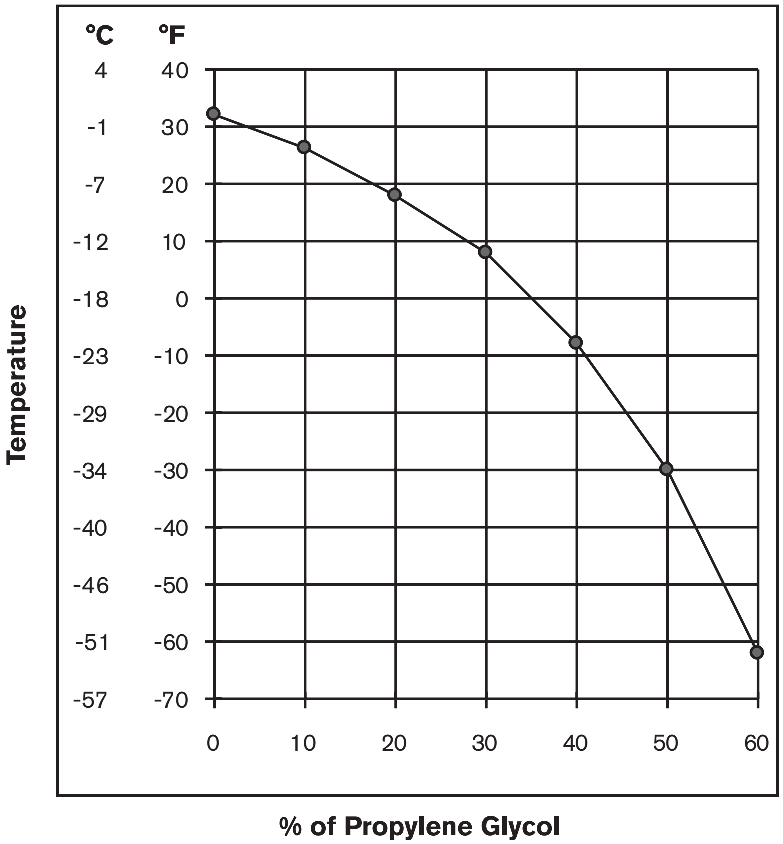
The following sections contain revisions or new statements: 1–16.

Legend

LTEL	Long Term Exposure Limit
STEL	Short Term Exposure Limit
STOT	Specific Target Organ Toxicity
DNEL	Derived No Effect Level
PNEL	Predicted No Effect Concentration

References:

Risk Phrases and Safety Phrases None. Preparation is not classified as hazardous in the sense of directive 1999/45/EC and 2006/121/EC.
Hazard statement(s) and Precautionary statement(s). None. Preparation is not classified as hazardous in the sense of directive 1999/45/EC and 2006/121/EC.
Training advice – None.
Additional Information USA – NFPA (National Fire Protection Association) – NFPA Rating: **Flammability – 1, Health – 0, Instability/Reactivity – 0.**
Information contained in this publication or as otherwise supplied to Users is believed to be accurate and is given in good faith, but it is for the Users to satisfy themselves of the suitability of the product for their own particular purpose. Hypertherm gives no warranty as to the fitness of the product for any particular purpose and any implied warranty or condition (statutory or otherwise) is excluded except to the extent that exclusion is prevented by law. Hypertherm accepts no liability for loss or damage (other than that arising from death or personal injury caused by defective product, if proved), resulting from reliance on this information. Freedom under Patents, Copyright and Designs cannot be assumed. **Note:** Original safety data sheet authored in English



Freezing Point of Propylene Glycol Solution

Appendix B

CNC INTERFACE PROTOCOL

In this section

Interface hardware

- The interface will use a combination of discrete signals (5 inputs, 3 outputs, and 24 VDC active low) and an addressable RS422 interface.
- The hardware will provide 4 unique addresses, which allows 4 systems to be connected to one serial port on the CNC. The addressing mechanism will be inside the power supply, on a PC board (Note: A total of 32 I/O points [20 Inputs, 12 Outputs] will be required for 4 systems).
- The RS422 hardware will have tri-stateable transmitter to disconnect itself from the line when not communicating.
- Mounting holes for footprint of CommandTHC plasma interface board.
- Must have an interface compatible with the CommandTHC/HD4070.

Signal list

Signals

Signal name	Type	Description
Plasma Start	Input	When active, the plasma system will fire an arc.
Machine Motion 1	Output	Indicates the arc has transferred to the plate. This signal is selected using jumper on power supply control board. Only 1 motion signal is needed per system. The remaining motion signals can be used to wire multiple systems in a daisy chain configuration.
Machine Motion 2	Output	Indicates the arc has transferred to the plate. This signal is selected using jumper on power supply control board. Only 1 motion signal is needed per system. The remaining motion signals can be used to wire multiple systems in a daisy chain configuration.
Machine Motion 3	Output	Indicates the arc has transferred to the plate. This signal is selected using jumper on power supply control board. Only 1 motion signal is needed per system. The remaining motion signals can be used to wire multiple systems in a daisy chain configuration.
Machine Motion 4	Output	Indicates the arc has transferred to the plate. This signal is selected using jumper on power supply control board. Only 1 motion signal is needed per system. The remaining motion signals can be used to wire multiple systems in a daisy chain configuration.
Hold Ignition	Input	When active, the system will stay in preflow and delay torch ignition. The signal should be applied at the same time the start signal is applied.
System Error	Output	Indicates that an error has occurred in the plasma system. Use the serial interface to query for the specific error code number.

Signal list (continued)

Signal name	Type	Description
Pierce Complete	Input	When active, the system will use shield preflow gases during piercing. When the signal is removed, the system will switch to shield cutflow gases. The signal should be applied at the same time the start signal is applied.
Corner Current	Input	When active, the system will switch to user specified corner current.
Remote Power	Input	Used to turn the power on or off
Not Ready for Start	Output	When on, this signal indicates that the plasma system is not ready for a plasma start signal. This could be because the system is purging or in test gas mode.
Ramp-down Error	Output	Indicates the arc did not ramp-down properly. Consumable life is shortened.
TX+	Serial	Transmitting from the system **Connect to CNC RX+**
TX–	Serial	Transmitting from the system **Connect to CNC RX–**
RX+	Serial	Receiving by the system **Connect to CNC TX+**
RX–	Serial	Receiving by the system **Connect to CNC TX–**

Hardware

Inputs – active low, dry contact, opto-isolated

Inactive: 24 V or open circuit, 0 mA

Active: 0 V or closed contact (0 ohm min, 6.5 mA; 200K ohm max, 0.1 mA)

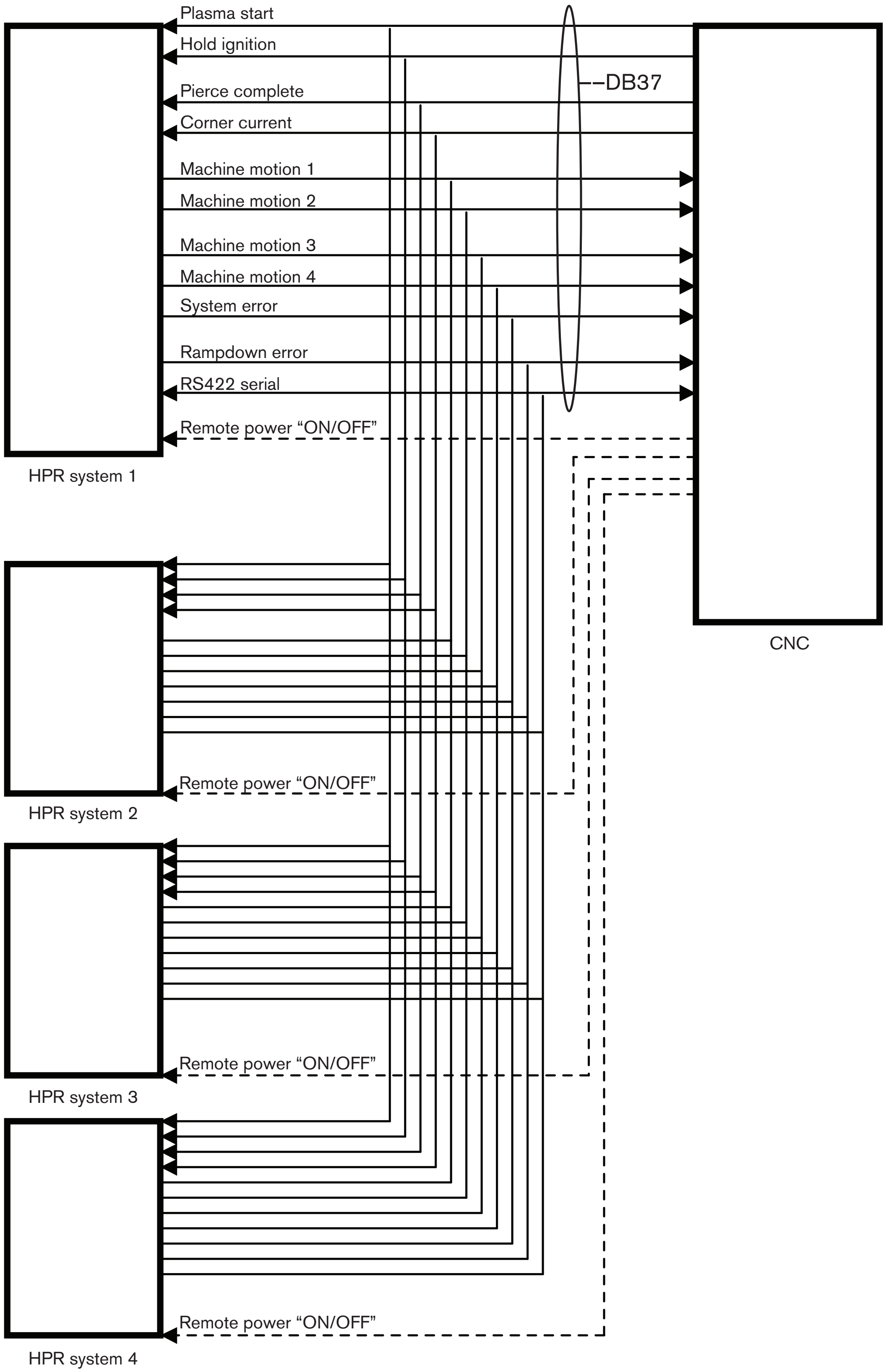
Outputs – active low, open collector, opto-isolated

Inactive: Up to 40 V open circuit/open collector, 0 mA
Recommended 24 V pull-up into high impedance load

Active: 0.3 V max output into high impedance load, sinking capacitor up to 5 mA
Or 2k ohm minimum load resistance

Serial – RS422 serial communications

Multi-drop wiring



Multi-drop addressing

The power supply control has DIP switches to set the power supply ID.
DIP switches 2, 3, 4 are used to set the ID.

2	3	4	ID
Off	Off	Off	0
On	Off	Off	1
Off	On	Off	2
On	On	Off	3
Off	Off	On	Reserved
On	Off	On	Reserved
Off	On	On	Reserved
On	On	On	Reserved

Systems with ID 0 power-up with the serial interface enabled. Systems with any other ID power-up with the serial interface disabled.

To implement the multi-drop interface, the CNC must send the SLEEP command (086) which will put all systems on the line into sleep mode. The WAKE command (085) with specific system ID will wake the system that the CNC wants to communicate with. Any command can now be sent to that power supply, while all other systems will ignore the communications. When the CNC is finished communicating with that power supply the SLEEP command must be sent, then the WAKE command is used to communicate with the next system.

Serial commands

Format

ASCII-based protocol
Baud 19200
8 Data bits
1 Stop bit
No parity
No flow control

Framing

> = Start of message
3 byte command ID
Data
2 byte checksum
< = End of message

Sample: >0011C2<

Commands

Responses will echo the ID of the command, unless there is an error in the command.

Command table (1 of 14)

ID	Command	System	Description
000	HELLO	Manual gas system Auto gas system	Establish communications with the plasma system. Use this command to determine if the system is configured as an 800XD or 400XD. This command will return “HPR800XD” in place of “HPR400XD” when the secondary power supply is connected and the power is on. **Data:** None **Return value:** String identifying the system **Sample:** >00090< >000HYPERFORMANCE130MANUALB5< or >000HYPERFORMANCE130AUTO30< or >000HYPERFORMANCE130AUTOMIX1E<
001	VERSION	Manual gas system Auto gas system	Get the version of the power supply firmware. **Data:** None **Return value:** Power supply firmware then Gas console firmware, space-delimited **Sample:** >00191< >001A.0 A.25< (power supply rev A, gas rev A)
002	GET_STATE	Manual gas system Auto gas system	Get the current state of the plasma system. **Data:** None **Return value:** Status code (see table V) **Sample:** >00292< >002000052< (status code 0)
003	LAST_ERROR	Manual gas system Auto gas system	Get the last error that occurred at the system. **Data:** None **Return value:** Error code (see table IV) **Sample:** >00393< >00301165B< (error code 116)
004	REMOTE_MODE	Manual gas system Auto gas system	Switch system into remote mode, to allow remote control of the plasma system. **Data:** None **Return value:** 1 = accepted, 0 = not accepted **Sample:** >00494< >0041C5<

Command table (2 of 14)

ID	Command	System	Description
028	READ_PLASMA_AMPS	Manual gas system Auto gas system	Read actual power supply current. **Data:** None **Return value:** Power supply current in amps **Sample:** >0289A< >02801305E< (130 amps)
058	SET_NOMINAL_AMPS	Auto gas system	Set the power supply current in amps. **Data:** 5-260 Amps (Limited to 130 amps on the HPR130) **Return value:** Actual current value set **Sample:** >05813031< >058013061< (set 130 amps)
064	GAS_PREFLOW_TEST_START	Manual gas system Auto gas system	Turn on the preflow gases. Not allowed when cutting. **Data:** None **Return value:** 1 = accepted, 0 = not accepted **Sample:** >0649A< >0641CB<
065	GAS_PREFLOW_TEST_STOP	Manual gas system Auto gas system	Turn off the preflow gases. Not allowed when cutting. **Data:** None **Return value:** 1 = accepted, 0 = not accepted **Sample:** >0659B< >0651CC<
066	GAS_CUTFLOW_TEST_START	Manual gas system Auto gas system	Turn on the cutflow gases. Not allowed when cutting. **Data:** None **Return value:** 1 = accepted, 0 = not accepted **Sample:** >0669C< >0661CD<
067	GAS_CUTFLOW_TEST_STOP	Manual gas system Auto gas system	Turn off the cutflow gases. Not allowed when cutting. **Data:** None **Return value:** 1 = accepted, 0 = not accepted **Sample:** >0679D< >0671CE<)

Command table (3 of 14)

ID	Command	System	Description
068	SYSTEM_RESET	Manual gas system Auto gas system	Clear error conditions and resume operation. Only accepted if system is in a shutdown error condition (Error code > 79 and State = 14). **Data:** None **Return value:** 1 = accepted, 0 = not accepted **Sample:** >0689E< >0681CF<
070	SET_CORNER_CURRENT	Manual gas system Auto gas system	When CORNER CURRENT input is activated the power supply will switch to the current percentage specified. **Data:** % of cutting current (50-100%) 50=50% **Return value:** % achieved **Sample:** >0707503< >070007563< (set 75%)<
071	MANUAL_PUMP_CONTROL	Manual gas system Auto gas system	Used to override software control of the coolant pump. If the system has a fatal error, the pump cannot be overridden. **Data:** 1 = override software to force pump on, 0 = system software controls the pump, override off **Return value:** 1 = accepted, 0 = not accepted **Sample:** >0711C9< >0711C9<
072	GET_CONTROL_VOLTAGE	Manual gas system Auto gas system	Returns the internal control voltage of the power supply **Data:** None **Return value:** Voltage (1/10 V) 1200 = 120.0 V **Sample:** >07299< >07212005C< (120.0 volts)

Command table (4 of 14)

ID	Command	System	Description
074	GET_IO_STATUS	Manual gas system Auto gas system	Read the status of the I/O ports of the DSP. Refer to I/O listing for description of each bit in Ports A-F. **Data:** None **Return value:** PA00000000 PB00000000 PC00000000 PD00000000 PE00000000 PF00000000 Ports A-F are returned space-delimited. The numbers are the decimal representation of the binary value of the port. 1 = on, 0 = off. **Sample:** >0749B< >074PA00000100 PB00000000 PC00010101 PD00100000 PE00010000 PF10000000B7<
078	SET_ALL_GAS_FLOWS	Auto gas system	Set all gas flow rates. N_2 mix setpoint and Gas 2 mix setpoint are only applicable when using a mixed plasma gas such as H35 – N_2. Otherwise, these 2 values should be set to 0. A value of 0 for N_2 mix setpoint will cause the system to close SV12, the solenoid valve for N_2 mixing. A value of 0 for Gas 2 Mix Setpoint will cause the system to close SV13 and open SV14. This will cause the inlet gas to bypass motor valve 2 and pass directly to the outlet of the mixing console. **Data:** Space-delimited: Plasma cutflow (0 –99 psi), Plasma preflow (0 – 99 psi), Shield cutflow (0 – 99 psi), Shield preflow (0 – 99 psi), N_2 mix setpoint (0 – 100 psi), Gas2 mix setpoint (0 – 100 psi). **Return value:** 1 = accepted, 0 = not accepted **Sample:** >07855 45 35 25 50 50AB< >0781D0<

Command table (5 of 14)

ID	Command	System	Description
079	GET_PS_INFO	Manual gas system Auto gas system	Returns pressures, system state, and system error, space-delimited **Data:** None **Return value:** Plasma cutflow pressure (0044 = 44 psi) Plasma preflow pressure (0044 = 44 psi) Shield cutflow pressure (0044 = 44 psi) Shield preflow pressure (0044 = 44 psi) Current setpoint (amps) System state (see table V) (0003 = state 3) System error (see table IV) (0000 = error 0) Cut gas 1 pressure (0044 = 44 psi) Cut gas 2 pressure (0044 = 44 psi) N_2 Mix inlet pressure (0044 = 44 psi) Gas2 Mix inlet pressure (0044 = 44 psi) **Note:** Cut gas 1, Cut gas 2, N_2 mix inlet, and Gas 2 mix inlet are not measured in the manual gas console configuration. **Sample:** >079A0< >079PC0044 PP0042 SC0034 SP0035 CS0040 ST0003 ER0000 CG0000 CG0000 MV0000 MV0000DE<
084	DOWNLOAD_SOFTWARE Not currently implemented on the HD4070 or the HPR systems	TBD	Download new firmware to the plasma system. **Data:** TBD **Return value:** 1 = packet accepted, 0 = not accepted **Sample:** TBD
085	WAKE	Manual gas system Auto gas system	This command is used to wake a system and enable its transmitter to communicate on a multi drop line. **Data:** System ID, which is set by dipswitches on PC board. **Return value:** Echo of the command **Sample:** >0850CD< >0850CD<
086	SLEEP	Manual gas system Auto gas system	Tell all systems on the line to disconnect their transmitters **Data:** None **Return value:** None **Sample:** >0869E< No response

Command table (6 of 14)

ID	Command	System	Description
087	BROADCAST MODE	Manual gas system Auto gas system	Tell all systems to listen but not respond. **Data:** None **Return value:** None **Sample:** >0879F< no response
094	READ_GAS_PRESSURES	Manual gas system Auto gas system	Read the gas pressures. **Data:** None **Return value:** Plasma cutflow pressure (psi), Plasma preflow pressure (psi), Shield cutflow pressure (psi), Shield preflow pressure (psi), Cut gas 1 pressure (psi), Cut gas 2 pressure (psi), N_2 Mix inlet pressure (psi), Gas2 Mix inlet pressure (psi) space-delimited Values are in psi (0007 = 7 psi) **Sample:** >0949D< >094PC0007 PP0036 SC0016 SP0003 CG0000 CG0000 MV0000 MV00005D<
095	SET_ALL_PARAMETERS	Auto gas system	Set all variables to run the plasma system. **If inlet gases change power supply will enter the purge state. Gas type changes are not allowed when the system is cutting (state 4 – state 10).** N_2 mix setpoint and Gas 2 mix setpoint are only applicable when using a mixed plasma gas such as H35 – N_2 otherwise these 2 values should be set to 0. A value of 0 for N_2 Mix setpoint will cause the system to close SV12, the solenoid valve for N_2 mixing. A value of 0 for Gas 2 Mix Setpoint will cause the system to close SV13 and open SV14. This will cause the inlet gas to bypass motor valve 2 and pass directly to the outlet of the mixing console. **Data:** Current setpoint (5 – 130/260/400 amps), Corner current percent (50 - 100%), Plasma gas type code (use table VI), Shield gas type code (use table VI), Plasma cutflow setpoint (0 – 99 psi), Plasma preflow setpoint (0 – 99 psi), Shield cutflow setpoint (0 – 99 psi), Shield preflow setpoint (0 – 99 psi), N_2 mix setpoint (0 – 100 psi), Gas 2 mix setpoint (0 – 100 psi), space-delimited. **Return value:** 1= accepted, 0 = not accepted **Sample:** >095100 75 1 6 55 45 35 25 00 0084< >0951CF<

Command table (7 of 14)

ID	Command	System	Description
096	SET_INLET_GASES	Auto gas system	Set inlet gases for auto console. **If inlet gases change, the power supply will enter the purge state. Gas type changes are not allowed when the system is cutting (state 4 – state 10).** **Data:** Plasma gas type code (See table VI), Shield gas type code (See table VI), space-delimited. **Return value:** 1= accepted, 0 = not accepted **Sample:** >0961 626< (Set plasma gas = O_2 and set shield gas = N_2) >0961D0<
097	READ_CORNER_CURRENT	Manual gas system Auto gas system	Read the corner-current percentage **Data:** None **Return value:** Percentage **Sample:** >097A0< >09700756C< (75%)
098	GET_INLET_GASES	Manual gas system Auto gas system	Read the inlet gas types **Data:** None **Return value:** Plasma gas type code (See table VI), Shield gas type code (See table VI), space-delimited **Sample:** >098A1< >0980001 000648< (Plasma gas = O_2 and shield gas = N_2)
099	GET_GAS_FLOWS	Auto gas system	Read the gas setpoints **Data:** None **Return value:** Plasma cutflow setpoint (psi), Plasma preflow setpoint (psi), Shield cutflow setpoint (psi), Shield preflow setpoint (psi), N_2 Mix setpoint (psi), Gas 2 mix setpoint (psi) space-delimited. (55 = 55 psi) **Sample:** >099A2< >0990055 0045 0035 0025 0050 0050EE<

Command table (8 of 14)

ID	Command	System	Description
100	GET_CONTROL_DATA	Manual gas system Auto gas system	Read internal control data: Chopper A used in HPR130/HPR260 Chopper B used in HPR260 Return string is the same whether the system is an HPR130 or HPR260. Chopper B data can be ignored for HPR130. Chopper A temp (raw A/D, 0 - 1023), Chopper B temp (raw A/D, 0 - 1023), Line voltage (1/10 volts, 0 - 2400), 240.0 vac Coolant flow (1/100 gpm, 0 - 440), 4.40 gpm Coolant temp (raw A/D, 0 - 1023), Transformer temp (raw A/D, 0 - 1023), Chopper A current (0 – 130 amps), Chopper B current (0 – 130 amps), Work lead current (0 – 130/260 amps), Chopper A setpoint (5 – 130 amps), Chopper B setpoint (5 – 130 amps), PWM chopper A (100% = 1070), PWM chopper B (100% = 1070). **Data:** None **Return value:** Above info is space-delimited. **Sample:** >10091< >100CAT0482 CBT0021 LVO0118 CFL0009 CTP0481 TTP0481 CAC0001 CBC0014 WLC0005 CAS0000 CBS0534 PWMA0000 PWMB00000B<
101	SET_IO_STATUS	Manual gas system Auto gas system	This command will allow the user to turn on or off each output of the processor. After sending this command, the SYSTEM_RESET command must be issued to restore the processor state. The I/O are in the following order: **Data:** 1 = On, 0 = Off for each I/O point **Return value:** 1 = accepted, 0 = not accepted **Power Supply** Pilot arc Relay Marking surge relay Pilot arc enable Coolant pump motor Soft-start enable CNC error CNC ramp-down error Igniter Contactor CNC machine motion CNC spare output Spare output **Sample:** >101111111111111DD< = All outputs on >1011C3<

Command table (9 of 14)

ID	Command	System	Description
102	SET_GAS_IO_FROM_PS	Manual gas system Auto gas system	This command will allow the user to turn on or off each output of the processor. After sending this command, the SYSTEM_ RESET command must be issued to restore the processor state. The I/O are in the following order: **Note: Use caution when selecting gas valves to make sure fuel and oxidizers are not mixed together resulting in a combustible mixture.** **Data:** 1 = On, 0 = Off for each I/O point **Return value:** 1 = accepted, 0 = not accepted **Manual Gas Console** Shield cutflow (SV16) Calibrate bypass (SV13) Plasma cutflow 1 (SV14) Ramp-down valve (SV20) Shield preflow (SV17) Plasma preflow (SV18) Plasma cutflow 2 (SV19) H35 plasma cutflow 2 (SV12) Spare valve (SV15) O_2 shield cutflow (SV4) Air shield cutflow (SV5) N_2 shield cutflow (SV6) Air preflow (SV7) N_2 preflow (SV8) Air plasma cutflow 2 (SV9) Air plasma cutflow 1 (SV1) O_2 plasma cutflow 1 (SV2) H35 plasma cutflow 1 (SV3) O_2 plasma cutflow 2 (SV10) N_2 plasma cutflow (SV11) **Auto Gas Console** O_2 inlet (SV1) Air inlet (SV2) Air inlet 2 (SV3) H5 inlet (SV4) H35 inlet (SV5) F5 inlet (SV6) Spare out 1 (Spare) Ramp-down valve (SV16) Non-XD = Spare out 2, XD = Ar inlet2 (SV15) Gas 2 no mix (SV14) Gas 2 mix (SV13) N_2 mix (SV12) N_2 inlet 2 (SV11) Air inlet 3 (SV10) N_2 inlet (SV9) O_2 air inlet (SV8) Non-XD = CH4 inlet, XD = Ar inlet1 (SV7) **Sample:** >1021111111111111111111111167< >1021C4<

Command table (10 of 14)

ID	Command	System	Description
114	READ_INPUTS	Manual gas system Auto gas system	This command will return the status of inputs to the PC board. **Data:** None **Return value:** 1 = on, 0 = off **Power Supply** Serial program Plasma start Hold ignition Phase OK Arc detect Pierce complete Corner current Redundant start Serial ID0 Serial ID1 Serial ID2 Dipswitch #1 Dipswitch #5 Dipswitch #6 Dipswitch #7 Dipswitch #8 Chopper A overcurrent Chopper B overcurrent **Sample:** >11496< >11400000000000000000F6<
117	READ_GAS_INPUTS_FROM_PS	Manual gas system Auto gas system	This command will allow the CNC to query the gas console I/O by sending the command to the serial port on the power supply control board. **Data:** None **Return value:** 1 = on, 0 = off **Manual Gas Console** Error select Status select Test preflow Test cutflow Serial ID bit 0 Serial ID bit 1 Serial ID bit 2 **Auto Gas Console** Metering dipswitch 2 Metering dipswitch 3 Metering dipswitch 4 Select dipswitch 1 Select dipswitch 2 Select dipswitch 3 Select dipswitch 4 Metering dipswitch 1 **Sample:** >11799< >1170000000E9<

Command table (11 of 14)

ID	Command	System	Description
121	LEAK_CHECK_MODE	Manual gas system Auto gas system	This command will put the system into leak mode. There are 3 modes, mode #1 is the inlet leak check mode. This is used to see if the inlet solenoids are allowing gas to pass through the valve even when they are closed. Mode #2 is the system leak check mode which will test for leaks to atmosphere within the system. Mode #3 is the Burkert valve flow test. For automatic gas consoles only. For the inlet leak test, the system should have 0 psi on all gas channels, and hold at this pressure. For the system leak test, the system should charge all gas lines, then hold the pressure. The Burkert flow test checks for an expected PWM value for a set pressure and does a gas ramp-down test. **NOTE: This test is preformed using 130 amp O_2 / Air consumables and setting the 30 amp O_2 / O_2 process** Each test takes about 40 seconds to complete. This command will only be accepted when the power supply is in the state IDLE2 (03). After leak checking is complete the system must be set to mode 0. An error code will reflect the state of the test. Using the GET_LAST_ERROR command, you can get the result of the test. 12 = Test in progress 13 = Test passed 14 = Cut gas channel #1 failed 15 = Cut gas channel #2 failed 16 = Plasma ramp-down test failed (Burkert test only) 17 = Shield ramp-down test failed (Burkert test only) **Data:** Mode 0 = run 1 = Inlet leak check 2 = System leak check 3 = Burkert flow check **Return value:** Time for the test to run in seconds, 0 = not accepted **Sample:** >1211C5< >12140F8< “40 second test”

Command table (12 of 14)

ID	Command	System	Description
122	READ_GAS_SWITCH	Manual gas system	This command will return data that shows the actual position of the rotary switches used to set the inlet gas type. The difference between this command and 098 is that this command returns the values set by the position of the switch. The 098 command returns values that the software decides are acceptable gas combinations. For example, H35 plasma and O_2 shield is not acceptable and is overridden by the software to be H35 plasma and N_2 shield regardless of the position of the shield gas knob. In this case, the 098 command would return H35 N_2. This command will return H35 O_2. **Data:** None **Return value:** Plasma gas type code (See table VI), Shield gas type code (See table VI), space-delimited **Sample:** >12295< >1220001 00063C<
124	INDEX_MOTORVALVES	Auto gas system	Move the motor valve by a fixed number of ADC counts **Data:** Motor Valve number (1 or 2) Open/Clos (0 = Close, 1 = Open) Multiplier (move by x10 counts, 3 = move 30 counts) **Return value:** 1 = accepted **Sample:** Open Motor valve 1 by 30 counts >1241 1 36C< >1241C8<
125	GET_TIMER_COUNTER	Manual gas system Auto gas system	Read Timer/Counter data from the power supply **Data:** None **Return value:** Arc-on time (seconds) System on time (minutes) Total starts (# of arc transfers) Total starting errors (failed to transfer) Total ramp-down errors (failed to ramp-down current) Write counter (# of writes to the present memory block – for diagnostics only) Memory block (current memory location for timer counter data – for diagnostics only) All fields are a fixed width of 7 numbers followed by a space. **Sample:** >12598< >1250000000 0000000 0000000 0000000 0000000 0000000 0000000 58<

Command table (13 of 14)

ID	Command	System	Description
126	GET_INFO2	Auto gas control board only	See 079
127	GET_INFO3	Auto gas control board only	See 079
131	CLEAR WARNINGS	Manual gas system Auto gas system	This command will clear error codes less than #43. Sample: >13195< >1311C6<
132	READ COOLANT PRESSURE	HPR260 ONLY	This command returns the raw A/D value for coolant pressure. 83 counts = 225 psi 73 counts = 200 psi **Sample:** >13296< >13280FE<
133	GET CONTROL DATA3	HPR400XD ONLY	This command provides data for the 3rd and 4th choppers used in the HPR400 system. Chopper C temp (raw A/D) Chopper D temp (raw A/D) Chopper C current (amps) Chopper D current (amps) **Data:** None **Return value:** Above info space-delimited. **Sample:** >13397< >133CCT0482 CDT0021 CCC0000 CDC000050<
134	READ ERROR LOG	ALL HPR SYSTEMS	This command will return the last 4 error codes the system encountered. The log will only record errors (error code values greater than 0). It ignores error code 0, which indicates no error or that an error has been cleared. The error codes are listed space-delimited, most recent error first. **Data:** None **Return value:** Error – most recent (see table IV Error Codes) Error #2 Error #3 Error – oldest error **Sample:** >13498< >134020 020 024 0534A<

Command table (14 of 14)

ID	Command	System	Description
136	SERIAL_RESPONSE_DELAY	All HPR systems	Used when a CNC serial port can only support a half-duplex connection. The HPR power supply will reduce its response speed. **Data:** None **Return value:** 1 if successful **Sample:** Send >1369A<, response >1361CB<
158	GET_SECONDARY_VERSION	HPR800XD ONLY	Get the software version of the secondary power supply **Data:** None **Return value:** The Secondary Power Supply software version ex.”D.0”. “0.0” is returned if no secondary power supply is connected and the power is on. **sample:** >1589E< >158D.040<

Error responses

If there is a problem with the serial command, the module will return an error.

Bad checksum

Return ID: 500
Description: The serial command received does not have the correct checksum.
Sample: >00091< – checksum should be 90, not 91
>50095< – bad checksum

Bad command

Return ID: 501
Description: If the module does not recognize the command ID, it will return ID 501.
Sample >999AB< – unknown ID
>50196< – bad command

Calculating checksums

Checksum is calculated on the command ID and command data only.

HELLO Command: >00090<

0 = 0x30 (ASCII value for number 0)
0 = 0x30
0 = 0x30
—————
Checksum = 0x30 + 0x30 + 0x30 = 90

READ INPUTS power supply response: >107000058<

1 = 0x31
0 = 0x30
7 = 0x37
0 = 0x30
0 = 0x30
0 = 0x30
0 = 0x30
—————
Checksum = 0x31 + 0x30 + 0x37 + 0x30 + 0x30 + 0x30 + 0x30 = 0x158
We only use the 2 least significant digits so the checksum = 58

Error codes

ID	Name	Description
000	NO ERROR	System is ready to run.
009	FLOW SWITCH TEST	When the pump is restarted after a pump timeout (30 minutes without a start signal) the system will test the flow switch to make sure there is sufficient flow before firing the torch.
011	NO_ACTIVE_PROCESS	The power supply receives an invalid current setting from a CNC.
012	TEST IN PROGRESS	One of the gas test modes is running.
013	TEST PASSED	The test completed successfully.
014	CUT GAS CHANNEL #1 FAIL	The gas pressure is dropping on channel #1, indicating a leak.
015	CUT GAS CHANNEL #2 FAIL	The gas pressure is dropping on channel #2, indicating a leak.
016	PLASMA RAMP-DOWN FAIL	Pump output has exceeded 200 psi.
017	SHIELD RAMP-DOWN FAIL	Shield pressure did not decrease in the allotted time.
018	PUMP OVER PRESSURE	Pump output has exceeded 13.79 bar (200 psi.)
020	NO PILOT ARC	No current detected from chopper at ignition and before 1-second timeout.
021	NO ARC TRANSFER	No transfer signal detected before 500-msec timeout.
024 Primary 224 Secondary	LOST CURRENT CH1	After transfer, lost the chopper current signal.
025 Primary 225 Secondary	LOST CURRENT CH2	After transfer, lost the chopper current signal.
026 Primary 226 Secondary	LOST TRANSFER	After transfer, lost the transfer signal.
027 Primary 227 Secondary	LOST PHASE	When main contactor is engaged, no “phase OK” input.
028 Primary 228 Secondary	LOST CURRENT CH3	After transfer, lost the chopper current signal.
030	GAS SYSTEM ERROR	A failure has occurred in the gas system.
031 Primary 231 Secondary	START LOST	Start signal was removed before steady-state operation.
032	HOLD TIMEOUT	Hold signal was applied for longer than 60 seconds.
033	PRE CHARGE TIMEOUT	Gas console was not able to charge the gas lines to the correct pressure.
034 Primary 234 Secondary	PRE CHARGE TIMEOUT	Gas console was not able to charge the gas lines to the correct pressure.
042	LOW NITROGEN PRESSURE	Nitrogen gas pressure under lower limit of 2.07 bar (30 psi) – cutting, 0.34 bar (5 psi) – marking
044	LOW PLASMA GAS PRESSURE	Gas pressure under lower limit of 0.34 bar (5 psi) – pre-flow 3.45 bar (50 psi) – cutflow (cutting) 0.34 bar (5 psi) – cutflow (marking).
045	HIGH PLASMA GAS PRESSURE	Gas pressure over upper limit of 7.58 bar (110 psi).
046	LOW LINE VOLTAGE	Line voltage is under lower limit of 102 VAC (120 VAC -15%).
047	HIGH LINE VOLTAGE	Line voltage is over upper limit of 138 VAC (120 VAC +15%).
048 Primary 248 Secondary	CAN ERROR	An error occurred with the CAN communication system.
050 Primary 250 Secondary	START ON AT INIT	Start signal input is active during power-up.
053	LOW SHIELD GAS PRESSURE	Gas pressure is under lower limit of 0.14 bar (2 psi).

ID	Name	Description
054	HIGH SHIELD GAS PRESSURE	Gas pressure is over upper limit of 7.58 bar (110 psi).
055	MV 1 INLET PRESSURE	Motor valve 1 inlet pressure is less than 3.45 bar (50 psi) or greater than 9.65 bar (140 psi).
056	MV 2 INLET PRESSURE	Motor valve 2 inlet pressure is less than 3.45 bar (50 psi) or greater than 9.65 bar (140 psi).
057	CUT GAS 1 PRESSURE	In the selection console, cut gas 1 outlet pressure is less than 3.45 bar (50 psi) or greater than 9.65 bar (140 psi).
058	CUT GAS 2 PRESSURE	In the selection console, if cut gas 2 outlet pressure is less than 3.45 bar (50 psi) for non-mixing, or less than 1.38 bar (20 psi) when mixing or greater than 9.65 bar (140 psi) for non-mixing and mixing.
060	LOW COOLANT FLOW	Coolant flow is less than the required 2.3 lpm (0.6 gpm).
061	NO PLASMA GAS TYPE	Plasma gas has not been selected.
062	NO SHIELD GAS TYPE	Shield gas has not been selected, or system is in test mode.
065 Primary 265 Secondary	CHOPPER1 OVERTEMP	Chopper #1 overheated.
066 Primary 266 Secondary	CHOPPER2 OVERTEMP	Chopper #2 overheated.
067 Primary 267 Secondary	MAGNETICS OVERTEMP	Transformer has overheated.
071	COOLANT OVERTEMP	Torch coolant has overheated.
072	AUTOMATIC GAS CONTROL BOARD OVERTEMP	Control board has exceeded 90° C (194° F).
073 Primary 273 Secondary	CHOPPER3 OVERTEMP	Chopper #3 overheated
074 Primary 274 Secondary	CHOPPER4 OVERTEMP	Chopper #4 overheated
075 Primary 275 Secondary	CURRENT TOO LOW ON LEM #3	A current less than 10 amps has been detected by current sensor 3.
076 Primary 276 Secondary	CURRENT TOO LOW ON LEM #4	A current less than 10 amps has been detected by current sensor 4.
093	NO COOLANT FLOW	Coolant flow is less than 0.6 gpm.
095	CURRENT TOO HIGH ON LEM #4	Current has exceeded 35 amps during the chopper test
099 Primary 299 Secondary	CHOPPER1 OVERTEMP AT INIT	Chopper #1 is indicating overtemp during power-up.
100 Primary 300 Secondary	CHOPPER2 OVERTEMP AT INIT	Chopper #2 is indicating overtemp during power-up.
101 Primary 301 Secondary	MAGNETICS OVERTEMP AT INIT	Transformer is indicating overtemp during power-up.
102 Primary 302 Secondary	OUTPUT CURRENT AT INIT	Chopper current signal is active on power-up.
103 Primary 303 Secondary	CURRENT TOO HIGH ON LEM #1	A current greater than 35 amps has been detected by current sensor 1.
104 Primary 304 Secondary	CURRENT TOO HIGH ON LEM #2	A current greater than 35 amps has been detected by current sensor 2.
105 Primary 305 Secondary	CURRENT TOO LOW ON LEM #1	A current less than 10 amps has been detected by current sensor 1.

ID	Name	Description
106 Primary 306 Secondary	CURRENT TOO LOW ON LEM #2	A current less than 10 amps has been detected by current sensor 2.
107 Primary 307 Secondary	CURRENT TOO HIGH ON LEM #3	A current greater than 35 amps has been detected by current sensor 3.
108 Primary 308 Secondary	TRANSFER AT INIT	The system has detected current on the work lead during power-up.
109	COOLANT FLOW AT INIT	Coolant flow is greater than 1.14 lpm (0.3 gpm) when pump is off.
111	COOLANT OVERTEMP AT INIT	Coolant is indicating overtemp during power-up.
116 Primary 316 Secondary	WATCHDOG INTERLOCK	CAN communication error.
123	MV 1 ERROR	Motor valve 1 did not move into position within 60 seconds.
124	MV 2 ERROR	Motor valve 2 did not move into position within 60 seconds.
133	UNKNOWN GAS CONSOLE TYPE	The power supply control board does not recognize the gas console installed or has not received a CAN message identifying the type of console installed.
134 Primary 334 Secondary	CHOPPER 1 OVERCURRENT	Chopper 1 current feedback has exceeded 160 amps.
138 Primary 338 Secondary	CHOPPER 2 OVERCURRENT	Chopper 2 current feedback has exceeded 160 amps.
139	PURGE TIMEOUT ERROR	The purge cycle did not complete within 3 minutes.
140	AUTO GAS PRESSURE TRANSDUCER #1 ERROR	Faulty transducer or auto gas control PCB
141	AUTO GAS PRESSURE TRANSDUCER #2 ERROR	Faulty transducer or auto gas control PCB
142	AUTO GAS PRESSURE TRANSDUCER #3 ERROR	Faulty transducer or auto gas control PCB
143	AUTO GAS PRESSURE TRANSDUCER #4 ERROR	Faulty transducer or auto gas control PCB
144	MANUAL GAS CONSOLE INTERNAL FLASH MEMORY ERROR	Replace manual gas console control PCB
145	AUTOMATIC GAS CONSOLE INTERNAL FLASH MEMORY ERROR	Replace auto gas console control PCB
146 Primary 346 Secondary	CHOPPER #3 OVERTEMP AT INIT	Chopper #3 is indicating over temp during power-up
147 Primary 347 Secondary	CHOPPER #4 OVERTEMP AT INIT	Chopper #4 is indicating over temp during power-up
151 Primary 351 Secondary	SOFTWARE FAIL	Software has detected an incorrect state or condition.
152	INTERNAL FLASH ERROR	DSP memory is not working properly.
153	PS EEPROM ERROR	EEPROM memory on power supply board not working.
154 Primary 354 Secondary	CHOPPER 3 OVER CURRENT	Chopper 3 current feedback has exceeded 160 amps
155 Primary 355 Secondary	CHOPPER 4 OVER CURRENT	Chopper 4 current feedback has exceeded 160 amps

ID	Name	Description
156 Primary 356 Secondary	CHOPPER 2 CURRENT AT INIT	Chopper 2 current signal is active on power-up
157 Primary 357 Secondary	CHOPPER 3 CURRENT AT INIT	Chopper 3 current signal is active on power-up
158 Primary 358 Secondary	CHOPPER 4 CURRENT AT INIT	Chopper 4 current signal is active on power-up
159 Primary 359 Secondary	MOTOR DRIVE FAULT	Motor drive board power module is indicating an alarm – this can be comparable to “blowing a fuse” – does not necessarily indicate a problem with the board.
160	HPR COOLER CAN FAULT	Communications between the control board and the pump/motor drive board was interrupted for greater than 1 second.
161	MAXIMUM COOLANT FLOW EXCEEDED	Coolant flow has exceeded 6.8 lpm (1.8 gpm) for a cooler, 8.52 lpm (2.25 gpm) for a chiller.
180	SELECTION CONSOLE CAN TIMEOUT	Power supply has not received a CAN message from the selection console within 1 second
181	METERING CONSOLE CAN TIMEOUT	Power supply has not received a CAN message from the metering console within 1 second
182	SECONDARY POWER SUPPLY TIMEOUT	The secondary power supply fails before transmitting the error to the primary power supply.
383	SECONDARY POWER SUPPLY TIMEOUT	The secondary power supply is ready to provide current output but does not receive the control signal from the primary power supply.

Status codes

ID	Name
00	IDLE
02	PURGE
03	IDLE2
04	PREFLOW
05	PILOT ARC
06	TRANSFER
07	RAMP-UP
08	STEADY STATE
09	RAMP-DOWN
10	FINAL RAMP-DOWN
11	AUTO OFF
12	TEST CUTFLOW
14	SHUTDOWN
15	RESET
16	MAINTENANCE
20	TEST PREFLOW
22	MANUAL PUMP CONTROL
23	INLET LEAK CHECK
24	SYSTEM LEAK CHECK
25	BURKERT FLOW CHECK

Gas type codes

ID	Gas type
0	No gas
1	Oxygen
2	Methane (CH_4) not supported
3	H35 (argon – hydrogen)
4	H5 (not supported)
5	Air
6	Nitrogen
7	Argon
8	F5 (N95)

CNC requirements

Auto gas console

Below is a list of functionality that CNCs must offer for the automatic gas console version of the HPR system. In this system configuration there is no local control of the plasma system. All settings and diagnostic information will be under CNC control.

1. Display and adjust the current setpoint – cutting current, see command ID No. 95
2. Display and adjust the plasma preflow setpoint – pressure setting, see command ID No. 95
3. Display and adjust the plasma cutflow setpoint – pressure setting, see command ID No. 95
4. Display and adjust the shield preflow setpoint – pressure setting, see command ID No. 95
5. Display and adjust the shield cutflow setpoint – pressure setting, see command ID No. 95
6. Display and adjust the plasma gas type – inlet gas selection, see command ID No. 95
7. Display and adjust the shield gas type – inlet gas selection, see command ID No. 95
8. Display and adjust the gas mixing setpoint – pressure setpoint, see command ID No. 95
9. Display the system error code – error code numbers, see command ID No. 3
10. Display the system status code – status code numbers, see command ID No. 2
11. Manual pump control – manually turn on/off the pump, see command ID No. 71
12. Display the firmware version – version of power supply and gas console firmware, see command ID No. 1
13. Test preflow gases – put the system in test gas mode, see command ID No. 64, 65
14. Test cutflow gases – put the system in test gas mode, see command ID No. 66, 67
15. Power on/off – turn on/off the plasma system, not a serial command (active low, dry contact, opto-isolated)
16. Display line voltage – see command ID No. 100
17. Display chopper current(s) – see command ID No. 100
18. Display work lead current – see command ID No. 100
19. Display chopper temperature(s) – see command ID No. 100
20. Display transformer temperature – see command ID No. 100
21. Display gas pressures – see command ID No. 79
22. Display coolant flow rate – see command ID No. 100

Serial interface guidelines

Checksum

The protocol used for the serial interface between the Hypertherm system and the CNC contains a checksum on the message being sent. The checksum should be validated for each message to ensure the information is not corrupted.

Message retries

We recommend retrying a message if the original message was not acknowledged by the system. This is especially important when the high-frequency ignition is active. The high-frequency ignition can be active for up to 1 second and can corrupt serial communications. It is important to space the retries so that the system can handle an interruption in serial communications for up to 1 second.

Another alternative to handling the high frequency ignition is to poll for the power supply state, using the GET_STATE command. If the state is (5 – Pilot arc) then stop serial communications until the state is no longer (5 – Pilot arc).

Cable shielding

We have chosen to use metal shell DB style machine/serial interface cables on some on the newer systems. One of the reasons this type of cable was selected is for their EMI shielding capabilities. It is important that integrity of the shielding of this cable be maintained. The shielding provides protection from the high-frequency ignition system, if the cable shields are not properly terminated then the protection is not as effective. This is best achieved by ensuring the shield has a 360° termination provided on both end of the cables. Using a drain wire will not achieve the proper shielding. The cable should also be as short as possible with no coils.

Appendix C

ROBOTIC APPLICATIONS

In this section:

Components for robotic applications

Torch leads

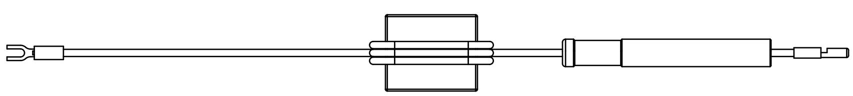
The torch leads listed below have been designed to withstand the added stresses found in robotic, or bevel, applications. They are available with 2 m (6 ft), or 2.5 m (8 ft) gas leads.

Note: Consumable life will be reduced if the 2.5 m (8 ft) gas leads are used.

Overall length	1.8 M (6 feet) gas lead	2.4 M (8 feet) gas lead
2 m (6 ft)	228514	228516
2.5 m (8 ft)	228515	228517
3 m (10 ft)	228475	228482
3.5 m (12 ft)	228476	228483
4.5 m (15 ft)	228477	228484
6 m (20 ft)	228478	228485
7.5 m (25 ft)	228479	228486
10 m (35 ft)	228480	228487
15 m (50 ft)	228481	228488

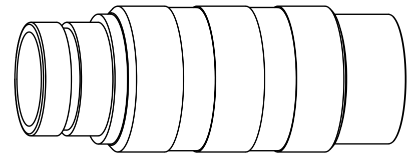
Ohmic contact extension

A 2.5 m (8 ft) Ohmic contact wire is part of the lead set. Extensions can be found in the table below.



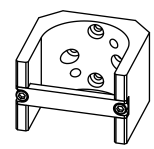
Part number	Length	Part number	Length
223059	1.5 m (5 ft)	223064	12 m (40 ft)
223060	3 m (10 ft)	223065	15 m (50 ft)
223061	4.5 m (15 ft)	223066	22.5 m (75 ft)
223062	6 m (20 ft)	223067	30 m (100 ft)
223063	9 m (30 ft)	223068	45 m (150 ft)

Rotational mounting sleeve (optional) – 220864



The rotational sleeve is designed for use in applications where the torch leads are twisted repeatedly. It is an optional component, and does not need to be used to use the torch leads listed above. The length of the rotational sleeve is 114.3 mm (4.5 in).

Rotational mounting sleeve clamp – 220900

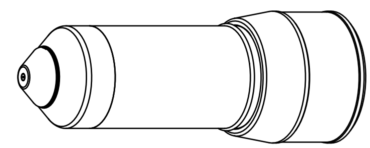


The rotational sleeve has a larger diameter than standard sleeves (57 mm/2.25 in).

Leather overwrap – 024866

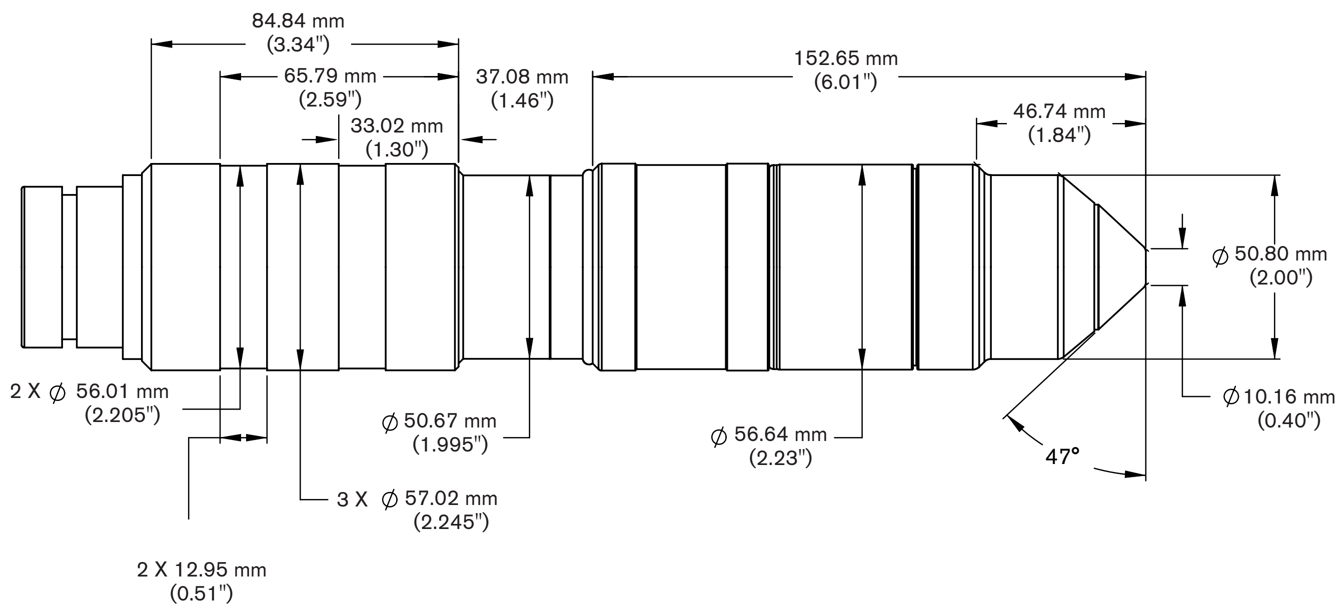
The leather overwrap is 3 m (10 ft) long, and is designed to be installed over the leads from where they attach to the torch. This adds protection in applications where molten metal will splash back on the leads.

Robotic teaching torch (laser pointer) – 228394

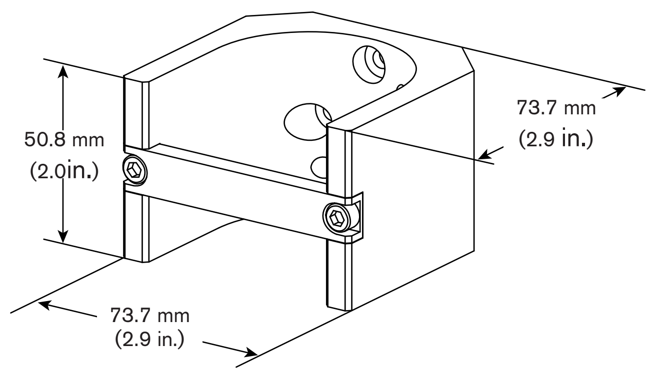


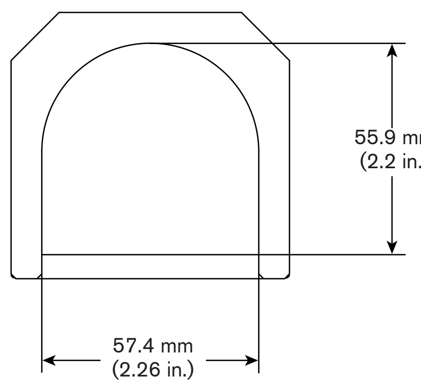
- Mount the laser pointer in the torch sleeve to provide accurate positioning and alignment of the torch.
- Use for online programming/teaching and robotic alignment systems.

Torch and rotational mounting sleeve dimensions



Rotational mounting sleeve clamp dimensions





HPR400XD auto gas instruction manual revision changes (806160)	
Changed Page	**Description of changes for revision 3 (date of revision - 9/2011)**
Global	Inch marks (“) have been replaced by the abbreviation (in).
EMC-1 through W-2	Updated the format and information for both the Electromagnetic compatibility and Warranty sections. Added Certification test marks, Differences in national standards, Higher-level systems, laser and Automation products, and Proper disposal of Hypertherm products information to the Warranty section.
Safety sections	Updated the format and content of the safety information. Added Dry dust collection and Laser radiation information.
2-4	Removed the note under the gas quality and pressure requirements table that said “Oxygen, nitrogen, and air are required for all systems. Nitrogen is used as a purge gas.” The statement was inaccurate. Corrected the kPa pressure values from 827 kPa to 793 kPa.
2-5	Added power supply part numbers with Hypernet. Changed kW to kVA in the last column, “power”.
2-11	Corrected the second bullet point to say “minimum” bend radius not maximum.
2-12	Added IEC symbol graphics and descriptions.
3-3	Updated information about noise levels. A generic statement pointing customers to information on the Hypertherm web site will be added to all Mechanized manuals over time.
3-11	Added a paragraph before the bullet points with some details about moving the power supply with a fork lift. Added “HPR400XD power supplies with serial number HPR400-000560 or later can be upgraded to a HPR800XD primary or secondary power supply.” below the bullet points.
3-17 and 3-18	Added mounting hole call out.
3-23, 29, 37, 53 and 55	Added caution box about not using PTFE tape.
3-26	Corrected the 2 cable signal list tables to say selection console instead of gas console.
3-42 and 3-43	Removed *changing consumables* note under torch alignment. Added a page and moved Torch lifter requirement to next page and added Hypernet information.
3-51	Removed the note “Oxygen, nitrogen, and air are required for all systems. Nitrogen is used as a purge gas.” from under the first paragraph. The statement was inaccurate. Removed the reference to methane because it is not used.
3-53	Added “See *Supply gas hoses* at the end of this section for recommendations” to the first paragraph. Removed the note “Oxygen, nitrogen, and air are required for all systems. Nitrogen is used as a purge gas.” from under the first paragraph. The statement was inaccurate. Removed the reference to methane because it is not used.
4-6 through 4-9	Updated CNC screen examples.
4-10	Added “When using the argon marking processes, mark and cut individual parts. Marking the entire nest prior to cutting may lead to reduced consumable life. For better results intersperse cuts and marks.” under Marking.
4-14	Added Mild steel, thick piercing, bevel cutting consumables.
4-17 and 4-18	Expanded “Inspect consumables” from one page to 2. Increased size of graphics for clarity.

Changed Page	Description of change for revision 2 (date of revision - 9/2011)
4-20	Added Torch quick disconnect receptacle graphic.
4-25	Added "(for example: 30 amp O_2/O_2 and 50 amp O_2/O_2 processes). The pierce complete signal must be turned off for processes with shield gas preflow pressures that are lower than the cutflow pressures (for example: 600 amp and 800 amp processes)." to the second paragraph. Added third bullet point. Added "moving pierce", (800 amp SST piercing can be extended to 100 mm (4 in), and "an edge start is recommended unless the operator is experienced with this technique." to the last bullet point.
4-28 and 4-29	Updated kerf width compensation data. Added mixed gas processes to the table. Added 5 and 8 mm thicknesses. Populated empty boxes with N/A for not available. Added any new values that were available.
4-30	Updated kerf width compensation table data. Added mixed gas processes to the table. Added 5/16 in thickness. Populated empty boxes with N/A for not available. Added any new values that were available.
4-33 through 4-37 and 4-45,	Added 5 mm, 8 mm, and 5/16 in thicknesses to the cut charts.
4-39 and 4-40	Added "on the shield" to the note - They are only recommended for use if you have a problem with excessive slag on the shield, or problems with the torch misfiring, when using the standard bevel consumables.
4-45	Corrected the N_2 cutflow, flow rate.
4-38, 4-39, 4-46 through 4-60, 4-68 through 4-75	Added 8 mm, and 5/16 in thicknesses to the cut charts.
5-4	Changed heading from Control and signal cables to Power and signal cables.
5-5	Corrected the last line under number 2 to read "contactor remains closed" instead of contactor opens.
5-9, 27, 33 34, and 38	Updated the diagnostic screen and the Test Pump button (now the Coolant Override button)
5-10	Added error code number 11. Added XD after HPR130, 260, and 400 in the Name column (all instances). Added error code numbers for HPR800XD secondary power supply. Removed error code number 18. It is for the original HPR260 not the HPR260XD.
5-11, 5-12	Removed the "Perform chopper test" step from error code numbers 020, 024/224, 025/225, 026/226, 028/228, 034/234
5-13, 5-14, and 5-17	Added HPR400XD references to error code numbers 46, 47 steps 1, 4, and 6. Added HPR400XD references to code number 071 steps 1 and 2..
5-18	Added error code number 98 (Phase loss at initialization).
5-24	Added a note to the description of error code number 159/359. Added "on PCB7" after D30, D31, and D32 in the corrective action steps.
5-25	Added error code number 161
5-26	Added error code numbers 182 and 383
5-31	Added "Main power in" with an arrow. Rewrote the note about checking line to ground, for clarity.

Changed Page	Description of change for revision 2 (date of revision - 9/2011)
5-36	Added a second note about following the troubleshooting steps in order.
5-43	Updated the Gas Leak Test screen shot
5-67 and 5-68	Updated the Service Parts Replacement Schedule table. Corrected the part number for the annual preventive maintenance kit (it was 228015 and was changed to 228605). Corrected the part number for the torch main body (it was 220162 and was changed to 220706).
6-2	Added part numbers for power supplies with Hypernet and a note about Hypernet.
6-5	Updated the part numbers for the control transformers.
6-17	Added part numbers to Consumables for mirror image cutting for 80 amp, 130 amp and 260 amp mild steel bevel cutting.
Schematics	All sheets updated from revision C to revision E.
Appendix A	Updated to the latest information and formatting for the Hypertherm torch coolant data (MSDS)
Appendix B	Added the secondary error code ID numbers after the primary error code ID number, for all applicable error codes.
b-6	Added information to the description of the "HELLO" command.
b-19	Added command numbers 136 and 158 to th ecommand table.
b-21	Added error code number 11.
b-24	Added error code numbers 161, 182, and 383.
Appendix C	Updated TOC to include new items.
C-2	Added metric conversions for gas lead lengths. Added graphic of the ohmic contact extension.
C-3	Added graphics for the rotational mounting sleeve, the rotational mounting sleeve clamp, the leather over wrap, and the robotic teaching torch. Also added a dimensional drawing for the torch and rotational mounting sleeve.