INDUS Scientific Pvt. Ltd.

Automotive Exhaust Monitor for
Diesel Engine

OMS - 104

USER MANUAL

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1. INTRODUCTION

Automotive Exhaust Monitor OMS 104 is designed and manufactured by INDUS *Scientific* for measuring the opacity of the exhaust from diesel vehicles. The opacity is proportional to the attenuation of light between a light source and a detector. A unique feature of OMS 104 is that it is very compact and light.

The OMS 104 system consists of three units. One is a smoke chamber which contains the smoke column through which the smoke from the tail pipe of a vehicle is passed and smoke density is measured. The measuring electronics is clamped on at one end. Second unit is the RPM adapter which measures the oil temperature, RPM by a piezo sensor or Vibration Based Sensor. The other unit is a hand-held device for user interface.

The exhaust gas to be measured is fed into the smoke chamber. The gas enters the smoke column at its center. The smoke column is a tube, which has a light source and a detector placed at one end. The light beam traverses the smoke column twice making the effective length as 430mm, though physically it is only half that long.

The system has a built-in heating facility and the temperature at the time of measurement will be around 80°C. This equipment can be used to check and measure emissions of all kinds of diesel vehicles and measures the opacity and absorption coefficient of the exhaust from the vehicle being tested.

OMS 104 has facilities for measuring engine oil temperature and engine RPM, and can be operated according to the revised free acceleration test procedure specified in MORTH/CMVR/TAP-115/116, Issue No.2, Part VIII. This smoke meter meets the requirements of the provisions of Rule 116(3) of Central Motor Vehicle Rules 1989, as amended up to date.

OMS104 is provided with a Vibration Based Sensor so that RPM can be measured without accessing the diesel tubes. Even the engine hood need not be opened as the sensor can be placed on engine hood.

2. TECHNICAL DATA

Principle of Operation	Attenuation of light beam
Geometry	Folded Hartridge Geometry
Measurement	Smoke density in Hartridge smoke units (HSU) & K
Range	0 to 100% opacity in HSU; 0 to ∞ in K (m^{-1})
Resolution	0.1 % in HSU, 0.01 m^{-1} in K
Light Source	LED, Green Spectrum (567 nm)
Detector	Photocell
Display	Backlit LCD display, 16 chars x 2 line a) Smoke density in Hartridge units b) Light absorption co-efficient K in m^{-1} c) Temperature in ° C d) Backlight is provided for daylight operation
Keyboard	Membrane keypad with 12 keys
Operation	Highly user friendly during operations, prompt messages are introduced during acceleration and data acquisition. Software interlocks during Smoke measurement with RPM and Oil temperature, satisfying new CMVR specification.
Time Constant	Physical: 0.4 second: Electrical: 1 m second
Temperature Sensor	RTD (PT100) or Thermocouple
RPM Sensor	Piezo Sensor or Vibration Based Sensor
Printer (optional)	24 column dot matrix, paper width of 56mm
Printer Output	Opacity in both Hartridge units & K, Temperature in °C with time stamp
Probe	A steel probe with synthetic rubber connecting hose (4m)
Warm-up Time	20 Minutes
Operating Temperature	5 to 50° C
Measuring Chamber Temp	80° C
Power Supply	190 – 250V AC, 50Hz / 11 – 12 V DC
Smoke Chamber (lxbxw)	450 mm x 140 mm x 200 mm
Weight	6 Kgs

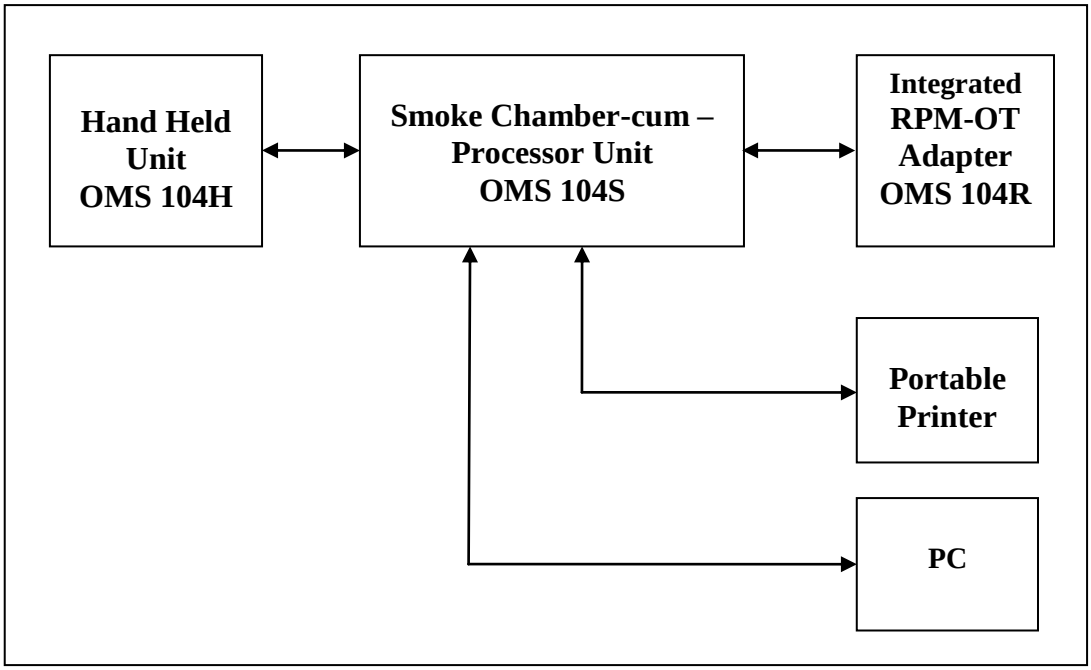
3. SYSTEM DESCRIPTION

The overall mechanical as well as electrical details of OMS 104 Smoke Meter are described here.

General Block Diagram

INDUS Smoke Meter OMS 104 consists of 3 processor units:

1. OMS 104S – Smoke Chamber-cum-Processor Unit
2. OMS 104R – Integrated RPM - OT Adapter
3. OMS 104H – Hand held Unit



OMS 104S

OMS 104S measures smoke and chamber temperature and inter communicates with RPM – OT adapter, Hand Held Unit, PC and Printer by RS232 communication.

OMS 104R

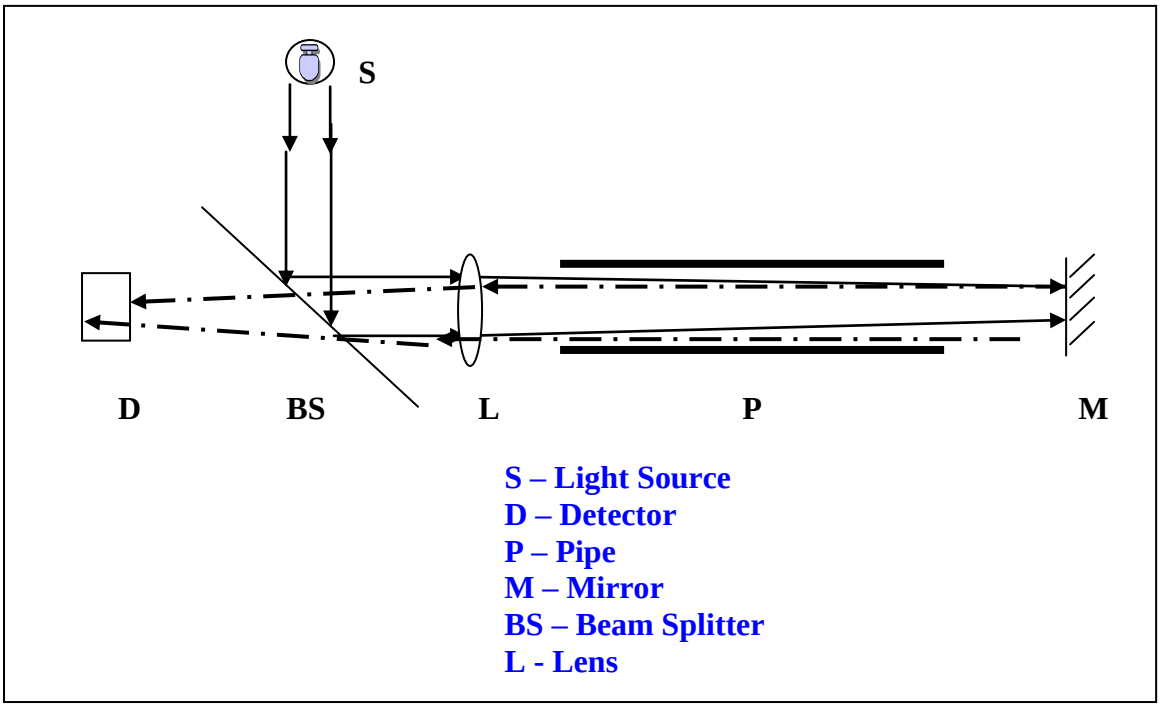
An OMS 104R measure RPM and Oil Temperature by detecting diesel pressure signals and Vibration Based signals from engine and inter communicates with OMS 104S.

OMS 104H

OMS 104H is a hand held device consisting of keyboard, LCD display for user interface and inter communicates with OMS 104S

Optics

The optics of OMS 104 is based on the principle of folded geometry, which is responsible for its compactness. This is illustrated below.



The light source is a green LED, marked as **'S'.** The light beam from **'S'** falls on a beam splitter **'BS',** gets reflected to the right and passes through the smoke column in the pipe **'P'.** The beam hits a mirror **'M'** located at the end of the smoke column and gets reflected in the opposite direction. The beam passes through the lens **'L'** for the second time to get focused on the detector **'D'** after transiting the beam splitter. The net result of this beam folding is that the beam travels through the smoke column twice, thus making the traversed length twice the length of the smoke column. Thus the Hartridge geometry of 430 mm is achieved by a smoke column half the size.

A heater is placed around the smoke pipe in order to raise the temperature of the smoke. This will prevent condensation of smoke inside the smoke column. A centrifugal fan is mounted on either the end of smoke column to drive out the smoke after measurement.

4. ASSEMBLY & INSTALLATION

OMS104 will work in either 1) wired or 2) wireless mode

For Wired mode

1. Connect OMS104S to OMS104R using D-Type 9-pin connector.
2. Connect OMS104S to OMS104H using D-Type 9-pin connector.
3. Connect OMS104S to PC using D-Type 9-pin connector (optional).
4. Keep the mode selection switch to wired position in OMS104R.
5. Ensure that the AC main switch is in the OFF position, before connecting OMS104S power cable to AC mains.
6. Keep the Plain glass filters in their positions.
7. Place the sampling hose at an ascending gradient from the probe to the smoke chamber.
8. The equipment should be placed on an even surface.
9. Position the equipment in such a way that it is not affected by strong vibrations, dust or soiling.

For Wireless mode:

1. In wireless mode, no need of DB9 cables.
2. Connect OMS104S to PC using D-Type 9-pin connector (optional).
3. Make sure OMS104R; OMS104H is fully charged/not in battery low condition.
4. Keep the mode selection switch to wireless position in OMS104R.
5. And follow the above said points from 5 onwards.
6. After switch on the smoke chamber, gently press the switch to ON the Handheld remote (OMS104H) & OMS104R unit.(Min switch press validation time 1Sec)
7. System takes approximately 1 – 2min to pair in network. (Max distance with in 10mts with each other unit).
8. Wireless status LED blinks ever 1 sec basis in OMS104R on successful paired with OMS104R.
9. Until point 7 Handheld remote (OMS104H) shows OMS104R Failed ,Accept / decline
10. On successful parried with (OMS104H), Remote comes to measurement screen.
11. Battery low indication (LED & Buzzer) is provided on oms104R and oms104H.

Operating Voltage

The equipment OMS 104 is designed for both AC & DC operation. Before plugging the equipment into the mains socket, ensure that the AC voltage is 190 – 270 V AC. DC operating voltage is 11 – 12V DC from battery.

Smoke Sampling Probes

Three sampling probes are provided along with OMS 104. Any one of these three probes can be used at a time.

These three probes listed below together with the sampling hose of Ø 25 mm (inner) and 4.0 meter length form part of the standard equipment.

Probe diameter 10 mm (ID) straight
Probe diameter 18 mm (ID) straight
Probe diameter 22.5 mm (ID) straight.

Selection of Sampling Probe

The ratio of the cross-sectional area of the probe to that of the exhaust pipe must not be less than 0.05. Hence the probe size has to be selected considering the inside diameter of the vehicle exhaust pipe. The open construction of the smoke column ensures that pressure difference between the measuring chambers and ambient does not exceed 75 mm (water gauge).

The probe is a tube with its open end facing forward in the axis of exhaust pipe or of the extension pipe, if such an extension is necessary. It should be situated in a section where the distribution of smoke is approximately uniform. To achieve this, the probe shall be placed as far down stream in the exhaust pipe as possible or if necessary in an extension pipe so that, if D is the diameter of exhaust pipe at the opening, the end of the probe is situated in the direction of flow before the sampling point and 3D or 200 mm after that point. If an extension pipe is used, the joint must have an airtight seal.

The flexible sampling hose with the selected probe should be connected to the smoke chamber at an ascending gradient and fixed to the exhaust pipe.

The table shows the standard probe and exhaust pipe relationships:

Probes (ID)	**Exhaust Pipe inner diameter**
Probe 1 (Ø 10 mm)	Less than 44 mm
Probe 2 (Ø 18 mm)	44 mm to 80 mm
Probe 3 (Ø 22.5 mm)	Above 80 mm

5. OPERATIONAL PROCEDURES

The operating instructions for OMS 104 Smoke Meter are provided in this section. Follow each and every instruction for proper functioning of the equipment.

On power ON, the display shows "**INDUS Scientific**" and "**Bangalore**" on the LCD, the heater element attached to the smoke chamber begins to heat up. A temperature of 60 °C is reached within 30 minutes. The equipment is now ready to use.

Preparation of the vehicle

- The engine of the vehicle should be warmed up and oil temperature must reach 60°C.
- The vehicle must be run in to achieve reproducible results.
- The combustion chamber should not be cooled or fouled by a prolonged period of idling preceding the test.

Start-up Display

When the instrument is switched ON, the following displays will appear one by one on the LCD screen:

i) Name of the Manufacturer

After Power ON, display shows the name of the manufacturer for 10 seconds

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	I	N	D	U	S		S	c	i	e	n	t	i	f	i	c
0xC					B	a	n	g	a	l	o	r	e			

ii) Name of the Instrument and Version (Hardware and Software)

Next display shows the name of the instrument and version for 10 seconds

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8					O	M	S		1	0	4					
0xC			V	:	X	X	X	X	-	X	X	X	X			

iii) Initialization Process

Next display shows the Initialization process for 2 seconds

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8			I	n	i	t	i	a	l	i	z	i	n	g		
0xC																

Stand-by Mode

In stand by mode, the instrument displays the smoke value as follows

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	H	U	:		X	X	X	.	X		%					
0xC	K		:		X	X	.	X	X		/	m				

Main Menu

Enter into main menu from stand-by mode by using **MENU** key and scroll the menus by using **UP** or **DOWN** keys. Select the menu by using **YES** key.

A. Display Parameter Menu

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	1	.	D	i	s	p	.		P	a	r	a	m	t	r	s
0xC																

B. Edit Parameter Menu

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	2	.	E	d	i	t		P	a	r	a	m	t	r	s	
0xC																

C. Diagnostics Menu

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	3	.	D	i	a	g	n	o	s	t	i	c	s			
0xC																

D. System Settings Menu

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	4	.	S	y	s	t	e	m		S	e	t	t	n	g	s
0xC																

A. Display Parameter Menu

Scroll the parameter menu by using **UP** or **DOWN** keys.

i) Smoke in HU and K

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	H	U	:		X	X	X	.	X		%					
0xC	K		:		X	X	.	X	X		/	m				

ii) Smoke in K and SD

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	K		:		X	X	.	X	X		/	m				
0xC	S	D	:		X	X	X	X	.	X		m	g	/	m	3

iii) RPM and Oil Temperature

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	R	P	M	:		X	X	X	X							
0xC	O	T		:		X	X	X	.	X	X		°	C		

iv) Thermocouple and Ambient Temperature

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	T	C	:		X	X	X	.	X	X		°	C			
0xC	A	T	:		X	X	X	.	X	X		°	C			

v) Chamber Temperature and Pressure

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	C	T	:		X	X	X		°	C						
0xC	P	R	:		X	X	X	.	X	X		K	p	a		

vi) Date and Time

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	D	a	t	e	:		X	X	/	X	X	/	X	X	X	X
0xC	T	i	m	e	:		X	X	:	X	X	:	X	X		

B. Edit Parameter Menu

Edit parameter menu is for editing certain parameter value. Scroll the Edit Parameter menu by using **UP** or **DOWN** scroll keys and select parameter by using **YES** key. Edit the parameter by using the **UP** or **DOWN** and **LEFT or RIGHT** keys. Save the parameter by using the **SAVE** key.

i) Edit Date

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	1	.	S	e	t		D	a	t	e						
0xC																

After Pressing **YES** Key

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	1	.	S	e	t		D	a	t	e						
0xC	0	X	/	X	X	/	2	0	X	X						

After pressing **SAVE** key

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8																
0xC	S	a	v	i	n	g										

ii) Edit Time

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	2	.	S	e	t		T	i	m	e						
0xC																

After Pressing **YES** Key

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	2	.	S	e	t		T	i	m	e						
0xC	0	X	:	X	X	:	X	X								

After pressing **SAVE** key

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8																
0xC	S	a	v	i	n	g										

iii) Edit Customer Name (For Printout)

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	2	.	S	e	t		N	a	m	e						
0xC																

After Pressing **YES** Key

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	N	a	m	e			:		-	-	-	-	-	-	-	-
0xC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

After pressing **SAVE** key

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8																
0xC	S	a	v	i	n	g										

iii) Edit Customer Address line-1 (For Printout)

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	2	.	S	e	t		A	d	d	r	1					
0xC																

After Pressing **YES** Key

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	A	d	d	r	1		:		-	-	-	-	-	-	-	-
0xC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

After pressing **SAVE** key

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8																
0xC	S	a	v	i	n	g										

iv) Edit Customer Address line-2 (For Printout)

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	2	.	S	e	t		A	d	d	r	2					
0xC																

After Pressing **YES** Key

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	A	d	d	r	2		:		-	-	-	-	-	-	-	-
0xC	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

After pressing **SAVE** key

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8																
0xC	S	a	v	i	n	g										

C. Diagnostics Menu

Diagnostics menu is for trouble shooting the equipment. Scroll the Diagnostics menu by using **UP** or **DOWN** scroll keys and select each menu by using **YES** key.

i) Print Diagnostic Report

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	1	.	P	r	i	n	t		D	i	a	g		R	e	p
0xC																

After Pressing **YES**,

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	1	.	P	r	i	n	t		D	i	a	g		R	e	p
0xC	Y	e	s												N	o

After Pressing **YES**,

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	P	r	i	n	t	i	n	g								
0xC	D	i	a	g	n	o	s	t	i	c		R	e	p	.	

ii) Transmit Diagnostic report to PC

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	2	.	T	x	m	t	.		D	i	a	g		R	e	p
0xC																

After Pressing **YES**,

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	2	.	T	x	m	t	.		D	i	a	g		R	e	p
0xC	Y	e	s												N	o

After Pressing **YES**,

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	T	r	a	n	s	m	i	t	t	i	n	g				
0xC	D	i	a	g	n	o	s	t	i	c		R	e	p	.	

D. System Settings Menu

System Settings menu is meant for configuring the equipment and is protected by password. Only Authorized persons will perform this menu operation.

6. SPAN CALIBRATION

INDUS Smoke Meter OMS 104 is provided with an instrument specific calibration filter. The opacity value of this Filter glass is 49.3 % in HU and light absorption co-efficient K is 1.58/m (these values may change as per the availability of the filter). Please refer to the calibration certificate attached.

For ensuring the linearity of measurements, the instrument should be calibrated with this Filter glass after power ON.

Note:

Before Vehicle test ensure the Filter glass is not in the slot.

Zero Calibration

Switch OFF the mains, clean both the Plain Glasses by pulling them out one at a time. Clean the Plain Glasses with lint-free cloth. Insert each Plain Glass back into its position.

With pure air in the smoke chamber, Press **ZERO** Key for Zero Calibration.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	Z	e	r	o		S	e	t		?						
0xC	Y	e	s												N	o

Use **YES** key for Zero point calibration.

If the smoke value is less than 10 % the display shows

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	Z	e	r	o		S	e	t	t	i	n	g				
0xC																

If the smoke value is greater than 10 % and Less than 50 % the display shows,

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	Z	e	r	o		S	e	t	t	i	n	g				
0xC	W	a	r	n	i	n	g	!								

After zero set, the display shows

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	H	U	:	0	0	0	.	0		%						
0xC	K		:	0	0	.	0	0		/	m					

Note:

Even in clean air, sometimes some smoke density readings may come due to soiling of plain glasses. This can be avoided by cleaning the plain glasses. However, measurement can be made with slightly soiled plain glasses, after the Zero calibration.

If the smoke value is greater than 50 % (plain glass not cleaned properly) the display shows

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	E	r	r	o	r											
0xC	C	l	e	a	n		G	l	a	s	s	/	W	i	n	s

7A. MEASUREMENT (With RPM-OT)

Press **MSR** key for measurement. The Display prompts for RPM Sensor (RPM-OT Method) Selection

A) Sensor Type

Two Types of Sensors are available. Scroll the Sensor type by using **UP** or **DOWN** keys.

i) Piezo Sensor

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	S	e	t		S	e	n	s	o	r						
0xC	1	.	P	i	e	z	o		S	e	n	s	o	r		

Set the Sensor by using **YES** key.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	S	e	t	t	i	n	g									
0xC	P	i	e	z	o		S	e	n	s	o	r				

ii) Vibration Based Sensor

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	S	e	t		S	e	n	s	o	r						
0xC	2	.	V	i	b	r	a	t	i	o	n	B	a	s	e	d

Set the Sensor by using **YES** key.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	S	e	t	t	i	n	g									
0xC	V	i	b	r	a	t	i	o	n		B	a	s	e	d	

Scroll the cylinder (1, 2, 3, 4, 5, 6, 8, 10 and 12) by using **UP** or **DOWN** keys and

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	S	e	t		C	y	l	i	n	d	e	r				
0xC	0	4														

Set cylinder by using the **YES** key

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	S	e	t	t	i	n	g									
0xC	0	4		C	y	l	i	n	d	e	r					

B) Vehicle Type

Scroll the vehicle type by using **UP** or **DOWN** keys.

i) Non Three Wheeler

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	S	e	t		V	e	h	i	c	l	e					
0xC	1	.	N	o	n		3	-	W	h	e	e	l	e	r	

Set the vehicle type by using **YES** key.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	S	e	t	t	i	n	g									
0xC	N	o	n		3	-	W	h	e	e	l	e	r			

ii) Three Wheeler

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	S	e	t		V	e	h	i	c	l	e					
0xC	2	.	3	-	W	h	e	e	l	e	r					

Set the vehicle type by using **YES** key.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	S	e	t	t	i	n	g									
0xC	3	-	W	h	e	e	l	e	r							

C) Vehicle Number

Enter the vehicle number by using **UP** or **DOWN** and **LEFT** or **RIGHT** keys

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	S	e	t		V	e	h	i	c	l	e		N	o		
0xC	-	-	-	-	-	-	-	-	-	-	-	-	-	-		

Set vehicle number by using **SAVE** key or quit from the vehicle number entry by using **CANCEL** key

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	S	e	t	t	i	n	g									
0xC	V	e	h	i	c	l	e		N	u	m	b	e	r		

Note:

Vehicle number entry menu is available only in equipments configured as with printer.

D) Oil Temperature Test

Check the oil temperature. The system will proceed without oil temperature if necessary or temperature is low, keep engine running till the desired temperature is reached.

Sensor placing time

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8																
0xC		P	l	a	c	e		h	o	l	d	e	r			

E) Flush Acceleration Test

The system enters into Flush Acceleration test and the displays shows,

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	R	e	a	d	y		f	o	r							
0xC	F	l	u	s	h		A	c	c	.		T	e	s	t	

Next display shows as follows and waits for **MSR** key Press.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	R	P	M	:	X	X	X	X						M	S	R
0xC	O	T		:	X	X	X	.	X	X			F	X	X	R

Press **MSR** key and depress the accelerator pedal rapidly and completely (but not violently) and hold (i.e. Engine will be accelerated from low idle to high idle). Keep the engine at high idle for about 4 seconds, display shows **"Acc"** at the top Right corner

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	R	P	M	:	X	X	X	X						A	c	c
0xC	O	T		:	X	X	X	.	X	X			F	X	X	M

Release the accelerator pedal when display shows **"Idle"** at the top Right corner

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	r	:	X	X	X	X							I	d	l	e
0xC	R	:	X	X	X	X							F	X	X	V

Repeat the above steps for 2 more times. Immediately after completion of 3rd test, the instrument will automatically produce a Report of Flush Test (For with Printer model a Printed report as shown below and with PC mode report will be logged to the PC).

If vehicle is old or structural vibration is more RPM linearity may differ, to avid this sensors can be refreshed by first pressing **down key** (yellow LED blinks in OMS104R) and after 1 sec pressing **right key** will switch off yellow led. Wait for 6 to 8 sec to get idle RPM, while Refreshing do not accelerate vehicle.

Flush acceleration test result print out format as follows

```
**********************************
        INDUS Scientific Pvt Ltd
            Bangalore – 43

Date : DD/MM/YYYY
Time : HR:MN:SC

Sensor     : Vibration Based Sensor
Cylinder   : XX
Veh. Type  : Non 3 Wheeler
Veh. No.   : -------------------------

            Flush Acc. Test Result
==================================================
Min.RPM        Max. RPM        OT C
--------------------------------------------------
XXXX           XXXX            XXX.XX
XXXX           XXXX            XXX.XX
XXXX           XXXX            XXX.XX
--------------------------------------------------
Mean Values
XXXX           XXXX            XXX.XX
```

Now the equipment will be ready for performing free acceleration tests.

F) Free Acceleration Test

For Free Acceleration test, the prescribed procedure requires that the engine, which is at idle to start with, is accelerated to the max. RPM measured in the flushing step within 300 RPM in the case of Non 3-wheelers or 500 RPM in the case of 3-wheelers.

The procedure detailed below guides the operator through the free acceleration measurement. The instrument records the idle and max. RPM and the corresponding smoke density values. The measurement process is considered successful if 3 smoke density values (in units of K) come within 25 % of the mean. Otherwise the measurement is declared as failed. The procedural steps are given below.

Immediately after the completion of flush acceleration test, the display shows

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	R	e	a	d	y		f	o	r							
0xC	F	r	e	e		A	c	c	.		T	e	s	t		

Connect the sampling hose to the Smoke Chamber. Insert the Probe into the tail pipe and fix it firmly using the clamp provided on the probe.

Release the accelerator pedal and keep the engine at low idle when display shows **"Idle"** at the top right corner.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	R	P	M	:	X	X	X	X					I	d	l	e
0xC	O	T		:	X	X	X	.	X	X			A	X	X	R

Wait and keep the engine at low idle when display shows **"Wait"** at the top right corner.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	R	P	M	:	X	X	X	X					W	a	i	t
0xC	O	T		:	X	X	X	.	X	X			A	X	X	R

Depress the accelerator pedal rapidly and completely (but not violently) to maximum governed RPM (i.e. the engine will be accelerated from idle to max. RPM) when display shows **"Acc"** at the top right corner.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	R	P	M	:	X	X	X	X					A	c	c	
0xC	O	T		:	X	X	X	.	X	X			A	X	X	M

Release the accelerator pedal and maintain the engine at maximum governed RPM when display shows **"DAcc"** at the top right corner.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	R	P	M	:	X	X	X	X					D	A	c	c
0xC	O	T		:	X	X	X	.	X	X			A	X	X	M

Keep the engine at max. RPM when display shows **"Hold"** at the top right corner.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	R	P	M	:	X	X	X	X					H	o	l	d
0xC	O	T		:	X	X	X	.	X	X			A	X	X	M

Release the accelerator pedal & keep the engine at low idle when display shows **"Idle"** at the top right corner.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	r	:	X	X	X	X							I	d	l	e
0xC	R	:	X	X	X	X							A	X	X	V

Next, the display shows the Peak Smoke value in HU and K

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	H	U	:	X	X	.	X						I	d	l	e
0xC	K		:	X	X	.	X	X					A	X	X	V

readings or within a bandwidth of 0.25 K whichever is higher and do not form a decreasing sequence. The mean of these three valid readings is taken as the above absorption co-efficient.

In case valid readings are not obtained within the 10 free accelerations, the testing will be discontinued. Finally, a printed result of the test will automatically be produced by the instrument if the result is OK. If the vehicle opacity readings are not valid a printout will be produced after 10 successive trials.

Failure of measurement sequence may be due to any of the following reasons:

1. High and varying smoke density from the vehicle.
2. Uneven acceleration.

Free acceleration test result print out format as follows

Free Acc. Test Result

HU %	K /m	RPM	OT C
XX.X	XX.XX	XXXX	XXX.XX
XX.X	XX.XX	XXXX	XXX.XX
XX.X	XX.XX	XXXX	XXX.XX
Mean Values			
XX.X	XX.XX	XXXX	XXX.XX

Chamber Temp. : XXX C
Dif.Pressure: XXX.XX Kpa

RESULT : PASS or FAIL

Max. Permissible Limit
Mean HU = 65 %
Mean K = 2.44 /m

Sign:……
****

Repeat above steps till get 3 consecutive stabilized readings are obtained. The value can be treated as stable when three of them consecutively are situated within a bandwidth of 25 % of the arithmetic mean (in /m units) of these

7B. MEASUREMENT (Without RPM-OT)

Press **MSR** key for measurement. The Display prompts for Vehicle Number Entry

A) Vehicle Number

Enter the vehicle number by using **UP** or **DOWN** and **LEFT** or **RIGHT** keys

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	S	e	t		V	e	h	i	c	l	e		N	o		
0xC	-	-	-	-	-	-	-	-	-	-	-	-	-	-		

Set vehicle number by using **SAVE** key or quit from the vehicle number entry by using **CANCEL** key

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	S	e	t	t	i	n	g									
0xC	V	e	h	i	c	l	e		N	u	m	b	e	r		

Note:

Vehicle number entry menu is available only in equipments configured as with printer.

B) Smoke Test

Now the equipment is ready for Smoke Test. The display shows,

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	H	U	:	X	X	.	X						M	S	R	
0xC		K	:	X	X	.	X	X					A	X	X	M

Or

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	P	r	e	s	s		M	S	R		K	e	y			
0xC	A	c	c	.		t	h	e		V	e	h	i	c	l	e

Note:

Ensure the Plan glasses are in positions provided in Smoke Chamber (OMS104S).

Connect the sampling hose to the Smoke Chamber. Insert the Probe into the tail pipe of the vehicle to be test and fix it firmly using the clamp provided on the probe.

Release the accelerator pedal and keep the engine at ideal.

Press **MSR** Key. The Display Shows,

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	H	U	:	X	X	.	X						A	c	c	
0xC		K	:	X	X	.	X	X					A	X	X	M

Depress the accelerator pedal rapidly and completely (but not violently) as the display shows **"Acc"** at the top right corner. Keep the engine at max. RPM

Release the accelerator pedal & keep the engine at low idle when display shows **"Idle"** at the top right corner.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	H	U	:	X	X	.	X						I	d	l	e
0xC	K		:	X	X	.	X	X					A	X	X	V

Next, the display shows the Peak Smoke value in HU and K

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	H	U	:	3	1	.	1						I	d	l	e
0xC	K		:	0	0	.	8	6					A	X	X	V

Repeat above steps till get 3 consecutive stabilized readings are obtained. The value can be treated as stable when three of them consecutively are situated within a bandwidth of 25 % of the arithmetic mean (in /m units) of these three readings or within a bandwidth of 0.25 K whichever is higher and do not form a decreasing sequence. The mean of these three valid readings is taken as the above absorption co-efficient.

In case valid readings are not obtained (the vehicle opacity readings are not valid) within the 10 successive trials, the testing will be discontinued.

Finally, the Result of the vehicle test will be Printed (In Case of Equipment with Printer) or will be logged to a PC (in case of equipment configured with PC) of the test will automatically be produced by the instrument.

Failure of measurement sequence may be due to any of the following reasons:

1. High and varying smoke density from the vehicle.
2. Uneven acceleration.

Smoke test result print out format as follows

****
INDUS Scientific Pvt Ltd
Bangalore – 43

Date : DD/MM/YYYY
Time : HR:MN:SC

Veh. No. : ----------

Smoke Test Result

HU %	K /m
XX.X	XX.XX
XX.X	XX.XX
XX.X	XX.XX
XX.X	XX.XX
Mean Value	
XX.X	XX.XX

Chamber Temp. : XXX C

RESULT : PASS or FAIL

Max. Permissible Limit
Mean HU = 65 %
Mean K = 2.44 /m

Sign:……

8. Table of Symbols and Prompt Messages

Table of Symbols

Sl. No.	Symbol	Description
1	HU	Smoke in HU in %
2	K	Smoke in K in /m
3	SD	Smoke Density in mg/m^3
4	RPM	Engine speed in RPM
5	R	Maximum RPM of engine
6	r	Minimum RPM of engine
7	OT	Oil Temperature in °C
8	TC	Thermocouple Temperature in °C
9	AT	Ambient Temperature in °C
10	CT	Chamber Temperature in °C
11	PR	Pressure in KPa

Prompt Messages (Measurement Mode)

Sl. No.	Prompt Message	Description
1	MSR	Press MSR key
2	Acc	Depress the accelerator pedal rapidly and completely (but not violently) to maximum governed RPM
3	Idle	Release the accelerator pedal and keep the engine at low idle RPM
4	Wait	Maintain the engine at low idle RPM until WAIT prompt disappear
5	DAcc	Release the accelerator and maintain the engine at maximum governed RPM
6	Hold	Hold the engine at maximum governed RPM
7	OT	Denote the oil temperature test
8	FXXR	Denote the rest state of flush acc. test (XX = 01 to 03)
9	FXXM	Denote the measurement state of flush acc. test (XX = 01 to 03)
10	FXXV	Denote the validation state of flush test (XX = 01 to 03)
11	AXXR	Denote the rest state of free acc. test (XX = 01 to 10)
12	AXXM	Denote the measurement state of free acc. test (XX = 01 to 10)
13	AXXV	Denote the validation state of free acc. test (XX = 01 to 10)

9. Key Functionality

Key	Function
SAVE/YES	Save the data or select the menu/parameter
⇧	Up scroll for scrolling menus or increment the data
CANCEL/NO	Cancel the data or Exit from menu
⇦	Left scroll for selecting digit or character
MENU	Enter into the main menu
⇨	Right scroll for selecting digit or character
ZERO	Zero Calibration
⇩	Down scroll for scrolling menus or decrement the data
MSR	Enter into the Measurement mode
EXIT	Exit from the main menu
LF	Paper feed for printer
PRN	Print the Calibration Page

Note:

LF *and* **PRN** *Key functions are available only with equipments configured as with printer.*

10. MAINTENANCE

Causes of Error and Remedy

Error	Causes	Remedy
Power LED not ON in OMS104H	1. AC power chord may not be connected 2. OMS104S is not connected with mains 3. OMS104H is not connected with OMS104S	1. Check the AC socket voltage 2. Check the power cable of OMS104S 3. Check the cable between OMS104H and OMS104S 4. Check if both are in range
COM LED is not blinking	1. OMS104S communication failure	1. Check the connection between OMS104S and OMS104H 2. Check the connection between OMS104S and OMS104R 3. Check if both are in range
LCD is active with back light but no display	1. The system has crashed	1. Switch OFF the system immediately and ON again after a few minutes
ERROR appears on the display	1. The plain glass filters may be soiled 2. LED is defective	1. Switch OFF the system, pull out the plain glass one by one. Clean them with glass cleaner using soft cloth 2. If LED is not glowing, replace the LED
Display remains at K = ∞ /m	1. The plain glass filters may be soiled 2. LED may be defective	1. Switch OFF the system, pull out the plain glass one by one. Clean them with glass cleaner using soft cloth 2. If LED is not glowing, replace the LED
Display remains at K = 00.00 /m	1. Smoke is not entering the smoke chamber 2. The detector has failed	1. Smoke sampling probe is not connected to the tail pipe of the vehicle 2. Call INDUS Service
Opacity values are very irregular	3. Sampling hose bent too much 4. Built-up of gases at outlet from the instrument	3. Straighten the hose 4. Ensure that gas outlet is free.
Chamber Temperature below operating temperature	5. Heater elements are not powered ON.	5. Call INDUS Service
Filter calibration value is not in the specified range	1. The plain glass filters near the light source might be soiled 2. LED may be defective 3. Calibration filter is not placed in proper position	1. Switch OFF the system, pull out the plain glass one by one. Clean them with glass cleaner using soft cloth 2. Replace the LED 3. Push the filter holder inside into its place

Error	Causes	Remedy
RPM not reading	1. OMS104R is not connected with OMS104S 2. RPM sensor not connected with OMS104R in Piezo Sensor method 3. Vibration Based sensor cable connector is not connected with OMS104R in Vibration Based mode.	1. The RPM sensor should be connected very close to the injector. The surface should be smooth, straight and dust free 2. Check the Ground connection in vehicle
Oil Temperature not reading	1. OMS104R is not connected with OMS104S 2. Thermocouple not connected with OMS104R in Vibration Based/Piezo Sensor method	1. Check the insertion RTD into oil bath
Printout is not clear	1. Ribbon cartridge has no ink	1. Replace the cartridge

Error Messages

1.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8			I	n	i	t	.		F	a	i	l	e	d		
0xC																

Cause:

Communication Error between OMS104H and OMS104S

2.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	O	M	S	1	0	4	S		F	a	i	l	e	d		
0xC																

Cause:

Communication error between OMS104S and OMS104H

3.

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8	O	M	S	1	0	4	R		F	a	i	l	e	d		
0xC																

Cause: Communication error between OMS104S and OMS104R or OMS104R is Not Connected to OMS104S.

Field Maintenance

Even though OMS104 requires very little maintenance, the following few points will ensure its proper functioning, thus reducing the down time.

If error appears on the display when doing zero calibration, check the following:

i. The plain glass filters should be clean

ii. The LED should be working

Cleaning the plain glasses

Plain glasses are provided in the smoke column at the Beam splitter '**BS**' and near the mirror '**M**'. These filters will reduce the possibility of detector, light source and mirror being affected by smoke. As a result of smoke entering the chamber, these filters will get coated with smoke over a period of time. So these filters should be cleaned once in a while. Switch off both the units, pull out the filters and clean them with clean cloth. Make sure that you switch ON the system only after putting back the cleaned filters.

- Do not remove both the plain glass filters together. Pull out one by one. At least one filter must be in position all the time to avoid damage to the measuring system.

Checking the LED

Remove the LED chord and check continuity between the two-connector points. If it shows open, the LED might be damaged. In that case, replace the LED as explained earlier.

Maintenance Intervals

The Plain glasses should be cleaned after the end of each and every operating day or whenever ERROR appears on the digital display.

11. STORAGE

When the equipment is to be stored without use for longer periods, the following should be observed:

- Keep OMS104H from direct Sun Light.
- Store OMS104 in a place unaffected by dust, moisture or water spray.
- Storage temperature should not exceed 65° C.
- Sampling hose and probe should be thoroughly cleaned.
- Keep the plain glass filters and the calibration filter separately packed.

12. APPENDIX 1

Version

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8					O	M	S		1	0	4					
0xC			V	:	A	A	B	B	-	X	X	X	X			

AA – Hardware Version

BB – Software Version

XXXX – Equipment Features

Eg:

	0x0	0x1	0x2	0x3	0x4	0x5	0x6	0x7	0x8	0x9	0xA	0xB	0xC	0xD	0xE	0xF
0x8					O	M	S		1	0	4					
0xC			V	:	0	2	0	1	-	0	0	0	F			

13. APPENDIX 2

MOST/CMVR/TAP-115/116	**STANDARDS AND TEST PROCEDURES FOR FREE ACCELERATION**	
ISSUE NO.1		**PART II**

DETAILS OF STANDARDS AND TEST PROCEDURES FOR SMOKE LEVELS BY FREE ACCELERATION FOR IN-SERVICE VEHICLES FITTED WITH NATURALLY ASPIRATED DIESEL ENGINES

1 Scope & Field of application:

1.1 This part applies to the emissions of visible pollutants from compression ignition (diesel) engine vehicles In-service when subjected to a free acceleration test as referred in CMVR-115(2) (c) and for issue of "*Pollution under control certificate"* to be issued by the authorised agencies under CMVR-115(7).

1.2 This part specifies the standards and test procedures for the determination of the smoke emission levels from road vehicles equipped with compression ignition engine. This is based on IS: 8118-1987 - *"Smoke Emission Levels for Diesel Vehicles"* and ECE Regulation no.24 - *"Uniform Provisions concerning the approval of motor vehicles equipped with compression ignition engines with regard to the emission of visible pollutants by the engine"*.

1.3 The free acceleration test procedures mentioned below apply to naturally aspirated automotive compression ignition engines only.

2 Definitions:

2.1 *Compression Ignition Engine:* Means an internal combustion engine that operates on compression ignition principle (Diesel Engines).

2.2 *Smoke Density:* Means the light absorption coefficient of the exhaust gases emitted by the vehicle expressed in terms of m^{-1} or in other units such as Bosch, Hartridge, %opacity etc. Fig.1 chap.1 part 4 shows the relation between light absorption co-efficient, expressed in m^{-1}, %opacity, Hartridge Smoke Units (HSU) and Bosch Smoke number.

2.3 *Opacity Meter:* Means an instrument for continuous measurement of the light absorption coefficient of the exhaust gases emitted by vehicles.

2.4 *Maximum Rated Speed:* Means the maximum speed permitted by governor at full load.

2.5 *Free Acceleration Test:* Means the test conducted by abruptly but not violently, accelerating the vehicle from idle to full speed with the vehicle stationary in neutral gear.

3 ***Specifications:*** The vehicle when subjected to the tests described in 4.0 below shall meet the following limits:

3.1 In the case of naturally aspirated compression ignition engine vehicles, the emissions of visible pollutants in terms of smoke density when expressed as light absorption coefficient, shall not exceed $2.45m^{-1}$ when checked by free acceleration method.

4 ***Test Instrument***

4.1 *Test Instrument*

4.1.1 The opacimeter, the instrument used for the measurement of smoke should be a type approved instrument as given in CMVR-116(3) and meeting the requirements specified in Part VIII.

4.1.2 The instrument should be prepared, used and maintained following the directions given in the instrument manufacturer's operation manual and it should be serviced and calibrated at such intervals as to ensure accuracy.

4.2 Sampling Opacimeter

4.2.1 Installation for tests under Free Acceleration

4.2.1.1 The ratio of cross sectional area of the probe to that of the exhaust pipe shall not be less than 0.05. The back pressure measured in the exhaust pipe at the opening of the probe shall not exceed 75 mm (water gauge).

4.2.1.2 The probe shall be a tube with an end facing forward in the axis of exhaust pipe or of the extension pipe, if one is required. It shall be situated in a section where the distribution of smoke is approximately uniform. To achieve this, the probe shall be placed as far downstream in the exhaust pipe as possible or if necessary in an extension pipe so that, if D is the diameter of exhaust pipe at the opening, the end of probe is situated in a straight portion at least 6D in length upstream of the sampling point and 3D in length downstream. If an extension pipe is used, no air shall be allowed to enter the joint.

4.2.1.3 The sampling system shall be such that at all engine speeds, the pressure of the sample at the opacimeter is within the limits specified. This may be checked by noting the sample pressure at engine idling and maximum no load speeds. Depending on the characteristics of the opacimeter, control of sample pressure can be achieved by a fixed restriction or butterfly valve in the exhaust pipe or extension pipe. Whichever method is used, the back pressure measured in the exhaust pipe at the opening of the probe shall not exceed 75 mm (water gauge).

4.2.1.4 The pipes connecting the opacimeter shall also be as short as possible. The pipe shall be inclined upwards from the sampling point to the opacimeter and sharp bends where soot might

accumulate shall be avoided. A bypass valve may be provided upstream of opacimeter to isolate it from the exhaust gas flow when no measurement is being made.

4.3 Full Flow Opacimeter

The only general precautions to be observed in free acceleration tests are the following:

4.3.1 Joints in the connecting pipes, if any, between the exhaust pipe and the opacimeter shall not allow air to enter from outside.

4.3.2 The pipes connecting the opacimeter shall be short as possible, as prescribed in the case of sampling opacimeters. The pipe system shall be inclined upwards from the exhaust pipe to the opacimeter and sharp bends where soot might accumulate shall be avoided. A by-pass valve may be provided upstream of the opacimeter to isolate it from the exhaust gas flow when no measurement is being made.

4.3.3 A cooling system may also be required upstream of the opacimeter.

4.4 *Vehicle Inspection*

4.4.1 The Exhaust device shall not have any orifice through which the gases emitted by the engine might be diluted.

4.4.2 In cases where an engine has several exhaust outlets, these shall be connected to a single outlet in which opacity measurement shall be made. If it is not possible, to combine all exhaust outlets in one, the smoke shall be measured in each & an arithmetical mean of the values shall be recorded at each outlet. The test shall be taken as valid only if the extreme values measured do not differ by more than 0.15 m^{-1}.

4.4.3 The engine shall be in normal working condition prescribed by the manufacturer. In particular, the cooling water and the oil shall each be at the normal temperature prescribed by the manufacturer, at the time of measurement.

4.5 Measurement Procedure

4.5.1 Free Acceleration Test

4.5.1.1 The test shall be carried out on a vehicle.

4.5.1.2 The engine shall first be brought to normal operating conditions during a road run of about 10 km or on a dynamic run. The test shall be carried out as soon as possible after completion of this warming-up period.

4.5.1.3 The combustion chamber shall not have been cooled or fouled by a prolonged period of idling preceding the test.

4.5.1.4 The vehicle gear change control shall be set in the neutral position and the drive between engine and gear box engaged. With the engine idling, the accelerator control shall be operated quickly, but

not violently, so as to obtain maximum delivery from the injection pump. This position shall be maintained until maximum engine speed is reached and the governor comes into action. As soon as this speed is reached the accelerator shall be released until the engine resumes its idling speed and the opacimeter reverts to the corresponding conditions.

4.5.1.5 The operation described in paragraph 4.5.1.4 above shall be repeated not less than six times in order to clear the exhaust system and to allow for any necessary adjustment of the apparatus. Subsequently, the maximum opacity values read in each successive acceleration shall be taken until stabilized values are obtained, after each acceleration, the engine is
Idling. The values read shall be regarded as stabilized when four of them consecutively are situated within a band-width of 0.25 m^{-1} and do not form a decreasing sequence. The absorption coefficient to be recorded shall be the arithmetical mean of these four values.

4.5.1.6 For the purpose of PUC certification if the smoke is not within limits, the vehicle shall be adjusted as recommended by the vehicle manufacturer to bring the smoke values within limits.

14. ANNEXURE

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CALIBRATION REPORT/ CERTIFICATE

No.: ISPL/CC/ **Date:**

1.0	Component: INDUS Make Smoke Meter Model No. OMS 104 [Sr. No. O] [Upgraded as per revised Test Procedure MORTH/CMVR/TAP/115/116 Issue No. 2 Part VIII]	
2.0	PUC Center: Registration No.:	
3.0	Objective of the test: To carry out Physical and calibration of Smoke Meters as per the test procedure specified in Annexure 1 of CMVR / TAP 115-116 Part-8.	
4.0	Detailed Observations	
4.1	Checking of supply / earthing. **OK**	
4.2	Checking of accessories:	
4.3	Span Calibration Details of Natural Density filters used for mid point calibration filter value [**K=** $^{m-1}$]	
4.4	Electrical Calibration **OK**	
4.5	RPM & Oil Temperature	**OK**
5.0	One no. of Diesel vehicle checked for idling Emission / Free acceleration. Measurement	
6.0	Conclusion:	Filter Value: **K:** $^{m-1}$
7.0	Next Calibration Due Date:	

For **INDUS *Scientific* Private Limited**

Authorized Signature.