KE-USBMX20
Matrix Keypad Interface
User Manual

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Thank you for purchasing the

HAGSTROM ELECTRONICS, INC.

KE-USBMX20. This product is configurable in a variety of ways to meet your specific requirements. Please take a few minutes to read this manual before using your KE-USBMX20.

Introduction to the KE-USBMX20

Our KE-USBMX20 Keyboard Encoder is a product designed to interface Matrix Keypads, Membrane Switches, and/or other contact closures to the computer's USB port. Devices connected to the KE-USBMX20 input header produce keystrokes that appear to the computer as if they were entered from a standard USB keyboard. The KE-USBMX20 can scan any matrix up to a 5 x 4 arrangement.

The KE-USBMX20 is programmable by the user. This programmability feature allows for the configuration of the matrix row and column pins as well as the selection of the keystrokes that will be sent to the computer for each matrix position. The user's configuration is stored in non-volatile memory so that the information is retained on the unit until it is changed at a later time by the user. Responses to each key can be programmed as a single keystroke or a macro sequence of keystrokes.

The KE-USBMX20 Input Header

The 9 pin header provides 9 signals that can be programmed to scan any size matrix up to 5 x 4. Any of the input header pins may be designated as either a Column or a Row. The KE-USBMX20 configures its scanning to the keypad, allowing the direct 1:1 connection to the header of many "off the shelf" keypads without any cabling.

Power Requirements and Hardware

The KE-USBMX20 requires no external power source. It is powered directly from the USB port on the computer. One micro-B to A Type USB cable is provided with the unit.

Supported Devices

All devices with a standard USB port will work with the KE-USBMX20. The KE-USBMX20.EXE configuration program is for Windows based systems, but once programmed, the KE-USBMX20 may be moved to another platform that supports a standard USB keyboard.

Default Settings

The KE-USBMX20 is programmed and shipped with a default 5x4 matrix configuration. This default configuration can be changed or modified at any time by the user with the KE-USBMX20.exe program.

Computer Connection

There is a micro B type USB connector located on the side of the KE-USBMX20. Connection to this port can be made with power on as the KE-USBMX20 supports "Hot Plug" operation as a USB device as well as a boot keyboard device.

Plug the USB Micro Type B side of the USB cable to the KE-USBMX20 port. Plug the Type A side of the USB cable to the computer's USB port or to a USB Hub port.

Up to four KE-USBMX20 units may be used on the same computer and programmed independently through the supplied load program.

Micro Type B to KE-USBMX20

Type A USB to KE-USBMX20

Interfacing to the KE-USBMX20 Header

The header on the KE-USBMX20 consists of 9 configurable pins. The pins are designated as "1" through "9".

Use the supplied KE-USBMX20.EXE program to configure the header pins as either Rows or Columns. Keystrokes are initiated by shorting a Row pin to a Column pin through a contact closure. The pins that are defined as Columns will sink current while scanning the matrix. The Rows are used to read the status of the inputs when a Column is active.
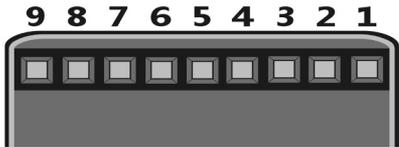
Keypads with male headers can be directly plugged onto the KE-USBMX20 connector. KE-USBMX20 pins can be configured to be either Rows or Columns to allow for this direct attachment.

The KE-USBMX20 header connects directly to the keypad header. Secure with the adhesive pad included or with your own fastening system.

View of the 9 pin female header pin designations as seen from the bottom of the KE-USBMX20

9 8 7 6 5 4 3 2 1

*__*Note:__ Keypads with male pins may be connected directly. For membrane keypads with female headers, adapters may be used to directly connect from the pigtail to the KE-USBMX20 header. (See Accessories on page 20)*

Status Feedback LED

Status LED

The KE-USBMX20 features a status LED on the side for user feedback. When this light is Red, the unit has power but has not been initialized by the system. Once initialized and scanning, the LED will be Blue. When a key is detected as active, the LED will light Green momentarily.

The KE-USBMX20.EXE Program

The KE-USBMX20 unit is shipped with a CD ROM containing the KE-USBMX20.EXE utility program which is used for configuring the unit. Configuration parameters include the defining of the pins used as Rows and Columns, and the keystroke or keystrokes generated by the activation of a key within the matrix.

Getting Started
To begin using the KE-USBMX20, follow the steps listed below.

1. Attach the KE-USBMX20 to the computer as described on page 2 under the section "Computer Connections".

2. Insert the CD and save the contents to its own folder on the computer's drive. The CD may now be removed and stored for future use.

3. Open the folder that was created in step 2 and start the configuration program by selecting the program file KE-USBMX20.EXE.

Note: *The programs must be copied to and run from its own folder on the computer's drive. The CD itself should be reserved for back up purposes only.*

The Program Screen

The main program screen displays the configuration settings for the KE-USBMX20. A list of these settings and a description of how they pertain to the KE-USBMX20 setup are listed below.
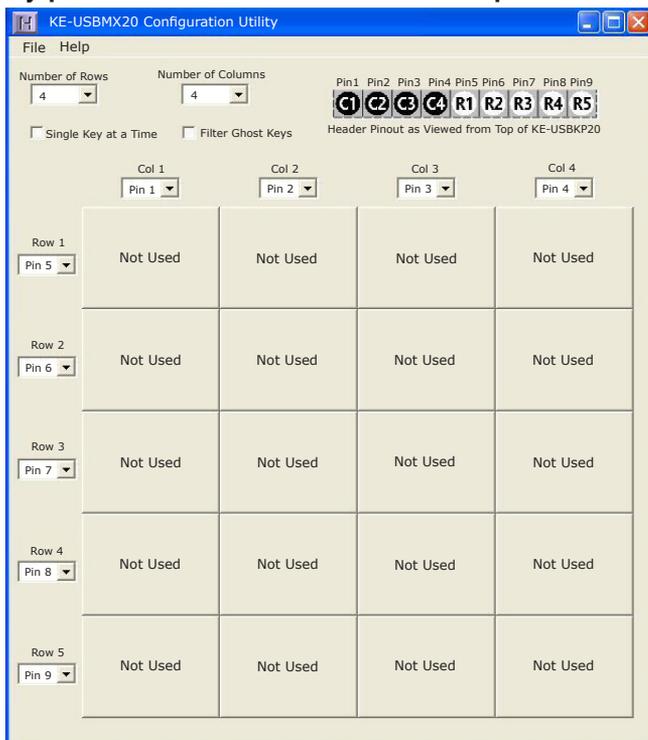
Number of Rows: The number of Rows are selected from the drop down list. This may be any value from 1 to 8.

Number of Columns: The number of Columns are selected from the drop down list. This may be any value from 1 to 8.

Row/Column Pins: The current row and column definitions are shown in the upper right how they are being used on the header. The view is looking down from the top of the KE-USBMX20 box.

Note: The number of Rows plus the number of Columns cannot exceed the total number of 9 pins. For example, 5 Rows + 4 Columns = 9 pins.

Column Pin Assignments: Column pin assignments are selected from the corresponding drop down list across the top of the matrix. Each column must have a header pin assigned to it. Specify any pin "1" through "9" as a column.

Row Pin Assignments: Row pin assignments are selected from the corresponding drop down list. Each row must have a pin assigned to it. Specify any pin "1" through "9" as a row.*

*__*Note:__ A pin cannot be assigned to both a Column and a Row. If a conflict is detected during the matrix definition, it is indicated in the header row/column assignment image in the upper right at the pin position(s) being used for multiple definitions.*

Single Key at a Time: This option will lock out additional key activations once a key has been detected. No new key responses will be generated until all keys have been released if this option is checked in the configuration.

Filter Ghost Keys: Select this option to have the KE-USBMX20 filter out "ghost" conditions within the matrix. Virtually any matrix has the potential for a "ghost" condition. This condition occurs when 3 or more keys are active at the same time and share a row and multiple columns, or a column and multiple rows. The simple way to explain this condition is to look at a 2 column by 2 row matrix. When 3 of any of the keys are held, the result is that all 4 switches appear electrically activated due to feedback of columns through the rows.
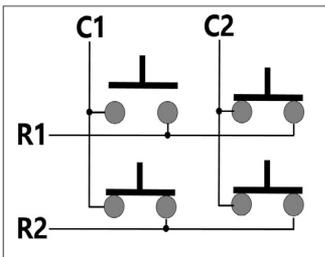

<u>2 Column by 2 Row Matrix</u>
When 3 switches pressed, all 4 electrically appear to be on.

If the user is uncertain of this option, it is recommended that it be selected.

File Menu Selections

These selections are accessed by clicking on "File" in the upper left corner of the main program screen. This list provides several options that include creating and saving file configurations as well as reading and writing the configuration to the KE-USBMX20. A list of these options along with descriptions of how they pertain to the KE-USBMX20 setup are listed below. When a configuration is created on the screen, it must be written to the KE-USBMX20 to become active on the unit.
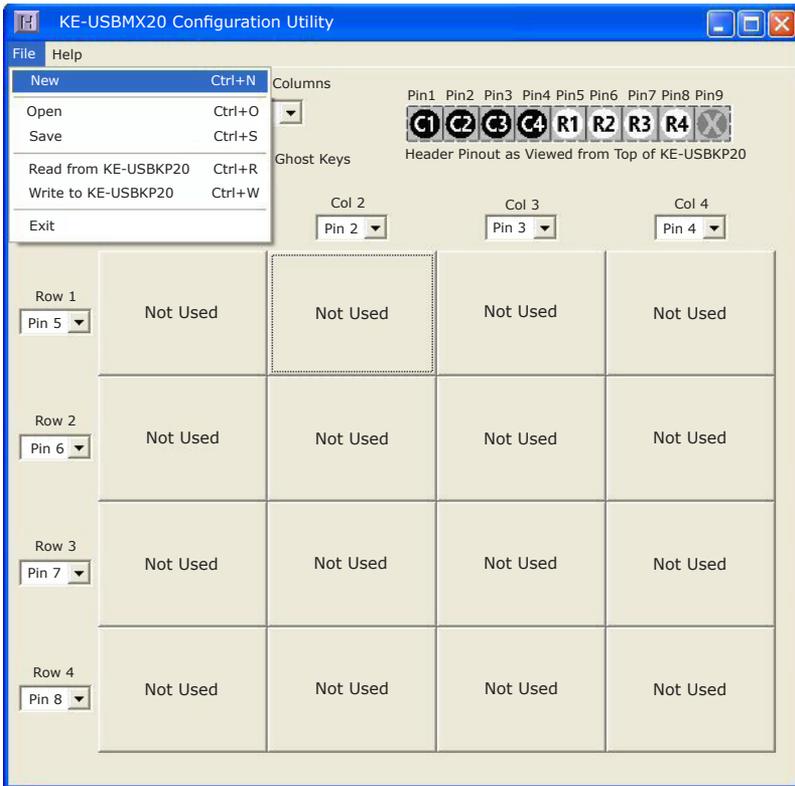
New: Creates a new configuration file by either clicking on "New" with the mouse or by pressing Ctrl+N on the keyboard. This option will also return the program screen to the default settings.

Open: Recall a previously saved configuration file by either clicking on "Open" with the mouse or by pressing Ctrl+O on the keyboard. Locate and select the name of the configuration file that is to be opened.

Save: Once a configuration setup has been created on the program screen, it is recommended that it be saved on the computer. Click on "Save" with the mouse or press Ctrl+S on the keyboard, then choose a location and name for saving the file.

Read from KE-USBMX20: This option will read the current configuration in the KE-USBMX20 and display it on the screen. Click on "Read from KE-USBMX20" with the mouse or press Ctrl+R on the keyboard to perform this operation. *

Write to KE-USBMX20: This option will write the current configuration displayed on the screen to the KE-USBMX20. The KE-USBMX20 can be programmed and re-programmed as many times as necessary. Click on "Write to KE-USBMX20" with the mouse or press Ctrl+W on the keyboard to perform this operation. After the KE-USBMX20 has been loaded with the new configuration, it will scan according to this new setup. *

* - Note that if multiple KE-USBMX20 units are detected, a selection window will be displayed asking the user to select the unit by it's serial number. The 8 digit serial number is located on the side label of the KE-USBMX20.

Exit: This option exits and closes the KE-USBMX20.EXE program.

*__*Note:__* Make sure that the KE-USBMX20 is connected to the computer before performing either the "Read to KE-USBMX20" or "Write to KE-USBMX20" operations. If the KE-USBMX20 is not present, a "The KE-USBMX20 was not Found" error will be displayed on the computer screen.*

Sample KE-USBMX20 Configuration

The following exercise demonstrates how to program the KE-USBMX20 to scan a keypad. The keypad used in the example is a 4 Column by 4 Row matrix (16 key) device.

The back of the keypad has eight pins. This header plugs directly into the KE-USBMX20 connector. In this example, we align pin 1 of the keypad header with pin 1 of the KE-USBMX20. The included keying plug can be placed in to pin 9 on the KE-USBMX20 to help with proper header alignment.

This example uses the keypad shown above.
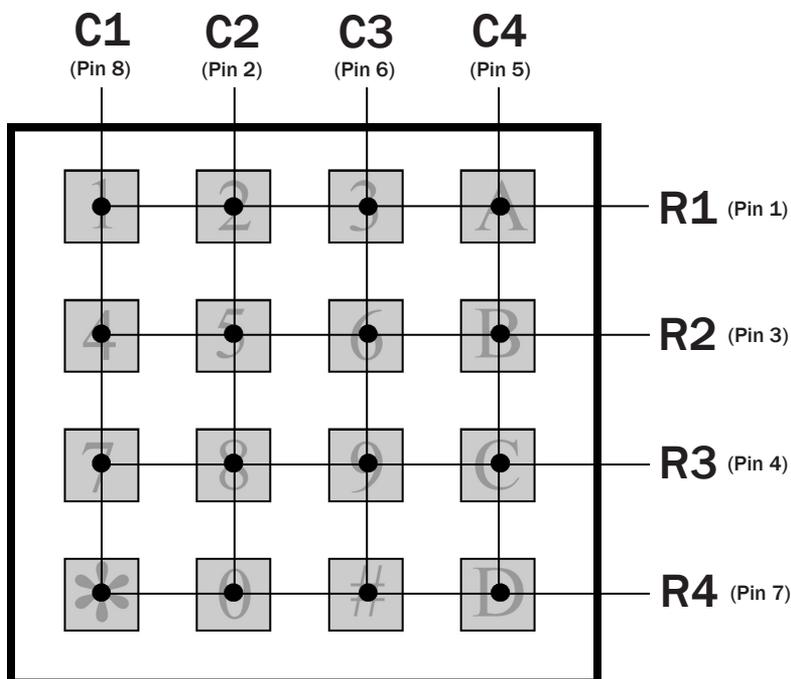
The keypad matrix layout is shown in the figure above. Note that the Row and Column signals are intermixed on the keypad. The KE-USBMX20 can be configured to scan the keypad with it plugged directly into the header with no added wiring.

Step 1

Select the Number of Rows on the screen and set it to 4.

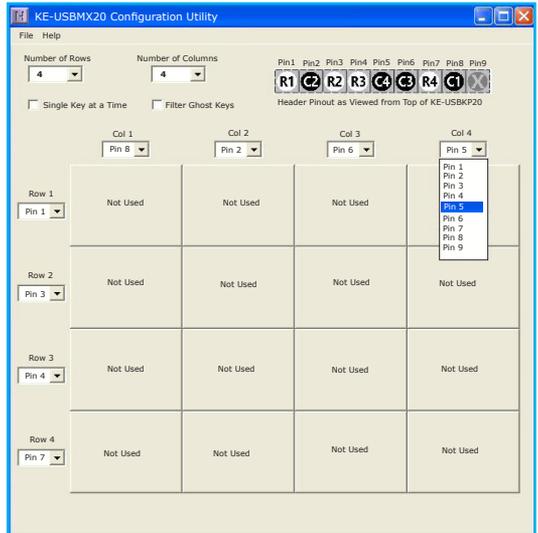Select the Number of Columns, and set that value to 4 as well.

The screen should appear as shown to the right.
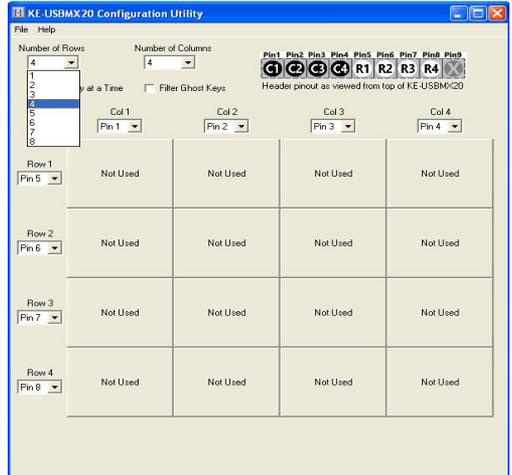
Step 2

After the matrix size has been assigned in step 1, the pins of the KE-USBMX20 header to be used as rows and columns must be defined.

On the keypad pins, the row and column assignments from the keypad layout diagram are,

Col1 = Pin 8,   Col2 = Pin 2,   Col3 = Pin 6,   Col4 = Pin 5

Row1 = Pin 1,   Row2 = Pin 3,   Row3 = Pin 4,   Row4 = Pin 7

Step 3

With the size of the matrix and row and column pins defined, assign the keys to be emulated to each position in the matrix.

To assign keystrokes, click on the desired matrix position. A diagram of the keyboard will be displayed, as shown below. Click on the representation of the key to assign it to the matrix position.
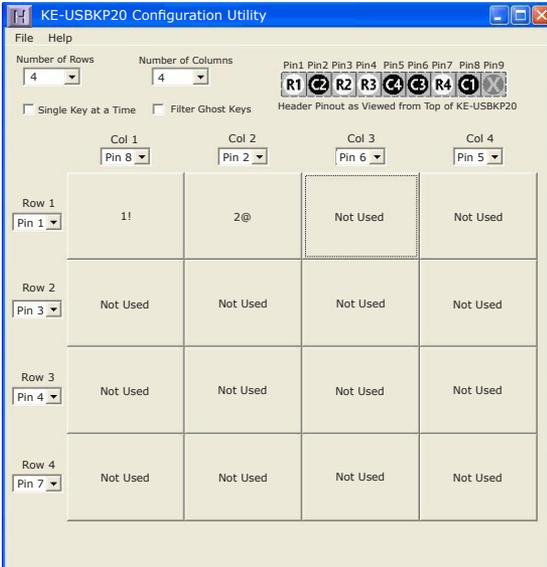
Note the repeat selection box at the bottom in the middle of the key selection screen. If the key is to send only one keystroke per activation, leave this box unselected. If the key is to repeat when held active, select this box before choosing the key.

The repeat selection only applies to the current matrix key position being defined. Repeated and non-repeated keys may be intermixed within the same configuration.

In the example illustrations, the user clicked matrix position Row 1, Col 4 and assigned the key "A" to it. The repeat box was checked before selecting "A" from the key selection screen.
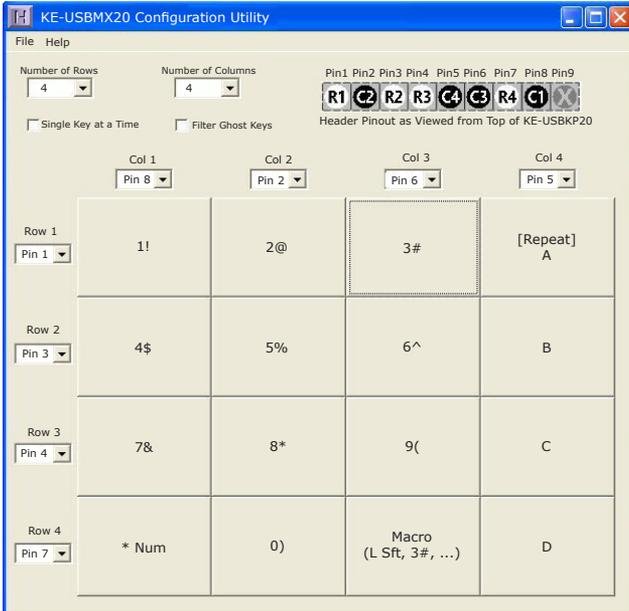
Continue selecting each position in the matrix and assign the desired key from the keyboard diagram for each position.

Step 4

The KE-USBMX20 has the capability of sending a macro, or sequence of keystrokes for a single key activation. To program a macro sequence, hold the Ctrl key before clicking on the matrix cell to be defined. A macro sequence box will be displayed.
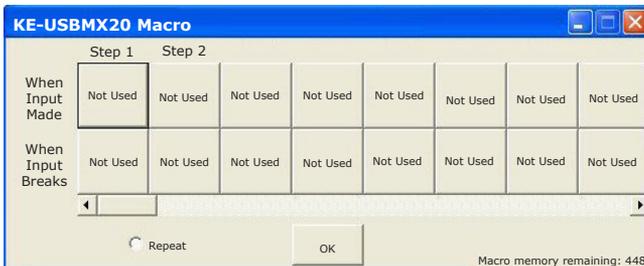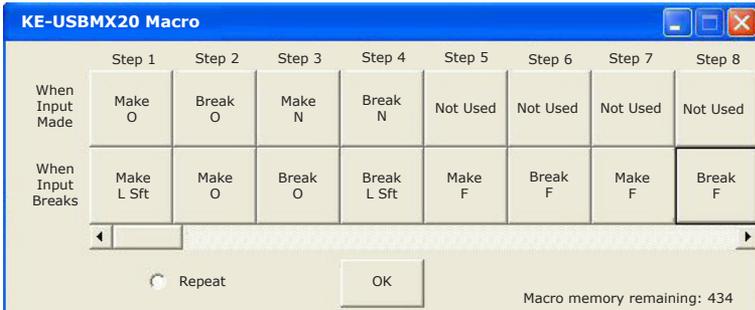
When defining a macro, each action is either the press (make) or release (break) of a key. In this example, the desired character for the key is "#". In order to get this character, it must be entered the same way as it would be manually typed on a keyboard.

The shift key will be "pressed" ("make"), then the "3" key is pressed. At this point, both keys are being held down. In order to release them, a "break" must be done for each key currently being held on. First the "3" key is released, then the shift key. Before selecting a key, be sure to check the "make" or "break" selection box above the keyboard before the key, to achieve the desired press or release of the key.
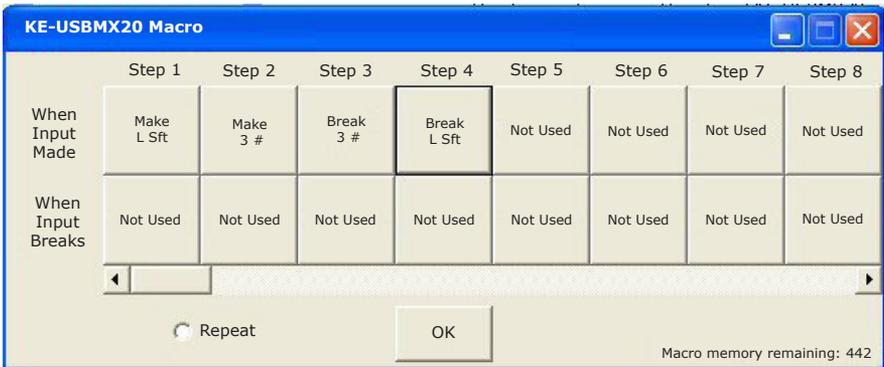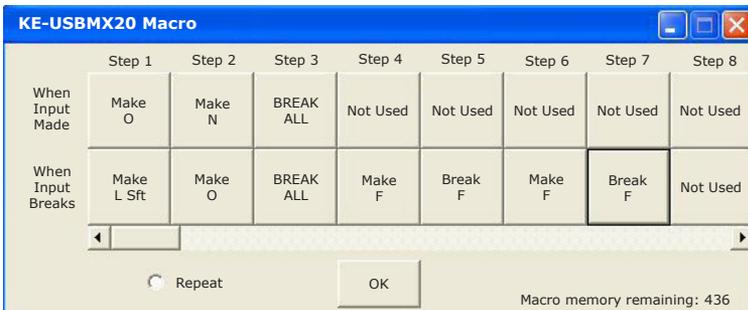

When defining a macro, the key actions may be done when the input is activated, "When Input Made", or when the key is released "When Input Breaks", or at both events. Always be sure to issue a "break" for any key in the macro sequence that was activated with a "make". Failure to release keys will result in a stuck key, which can affect all further key actions.

Macro Example 1: The following macro demonstrates using a macro to send the text "on" when the input is activated and the text "Off" when the input is deactivated. Note also that sending a second make of the "f" key requires that it be issued a "break" before the next "f" make, just as if the sequence were being manually entered from a keyboard.

KE-USBMX20 Macro								
	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8
When Input Made	Make O	Break O	Make N	Break N	Not Used	Not Used	Not Used	Not Used
When Input Breaks	Make L Sft	Make O	Break O	Break L Sft	Make F	Break F	Make F	Break F

Repeat   OK   Macro memory remaining: 434

Macro Example 2: The macro below demonstrates the same macro sequence as above, but with use of the "Break All" macro function to release keys that are currently being held on from an earlier "make" action.

KE-USBMX20 Macro								
	Step 1	Step 2	Step 3	Step 4	Step 5	Step 6	Step 7	Step 8
When Input Made	Make O	Make N	BREAK ALL	Not Used	Not Used	Not Used	Not Used	Not Used
When Input Breaks	Make L Sft	Make O	BREAK ALL	Make F	Break F	Make F	Break F	Not Used

Repeat   OK   Macro memory remaining: 436

Note in the example above that "break all" only releases the keys held active on the current line, and only those keys held on up to the point the "Break All" appears. In the "When Input Made" line, "Break All" releases the "O" and "N" keys. On the "When Input Breaks" sequence, the "Break All" releases the Left Shift and "O", then proceeds with the rest of the line to produce the two "f" characters.
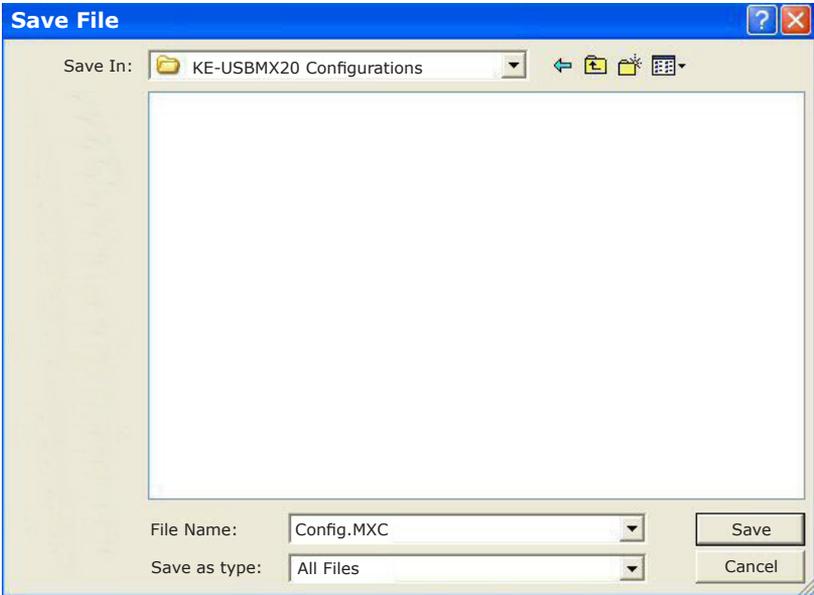
Macro sequences can be up to 16 steps long for both when the input is made (activated) and when the input breaks (released or deactivated).

A delay function is provided within the macro sequences that may be used to slow typing down to human speeds.

Step 5
Now that the setup is complete, it can be saved to disk. Specify a file name under which to save the configuration.

Step 6
Load the KE-USBMX20 with the configuration. Be sure that the KE-USBMX20 is connected to the PC. Once the KE-USBMX20 is loaded, it will begin running the new configuration.

KE-USBMX20 Configuration with FN key

The KE-USBMX20 allows assignment of a key as a "Function" key. This key produces no keystroke itself, but when held down, it alters the keystroke sent by the rest of the matrix. This feature is useful when the keypad has dual legends or needs to respond with different keystrokes for the same key.

This example uses the keypad shown on the left. The keys "A","B", and "C" will be programmed to send lower case characters when the FN key is not held. If the FN is held, upper case characters will be sent for the "A", "B", and "C" keys. Numeric Keys "0"-"9" will send the same character regardless of FN.

The key "F1/F3" will send the F1 keystroke when FN is not held, and send the F3 keystroke if FN is held when the key is pressed. The key "F2/F4" will send the F2 keystroke when FN is not held, and send the F4 keystroke if FN is held when the key is pressed.

Using the same techniques in the previous example, set up the rows and columns as before. Assign the matrix with the keys assigned as shown below.
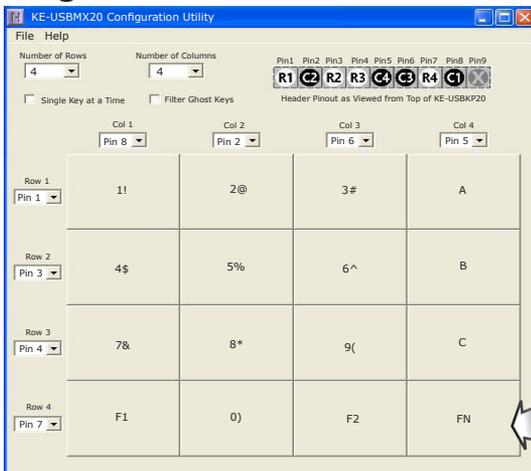

Note the use of the "FN" key for this matrix position.

The "FN" key produces no keystroke of it's own, but will select an alternate matrix table if held when pressing other keys.

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The keystrokes shown for each cell are the keys that will be sent if the FN key is not active when those keys are activated.

To define the alternate keystrokes for each key that will be sent when the FN key is held, put the cursor on the FN cell in the matrix. While holding the right mouse button down, click the left mouse button. This action will toggle between the key sets that are sent with the FN held on and the FN key off.
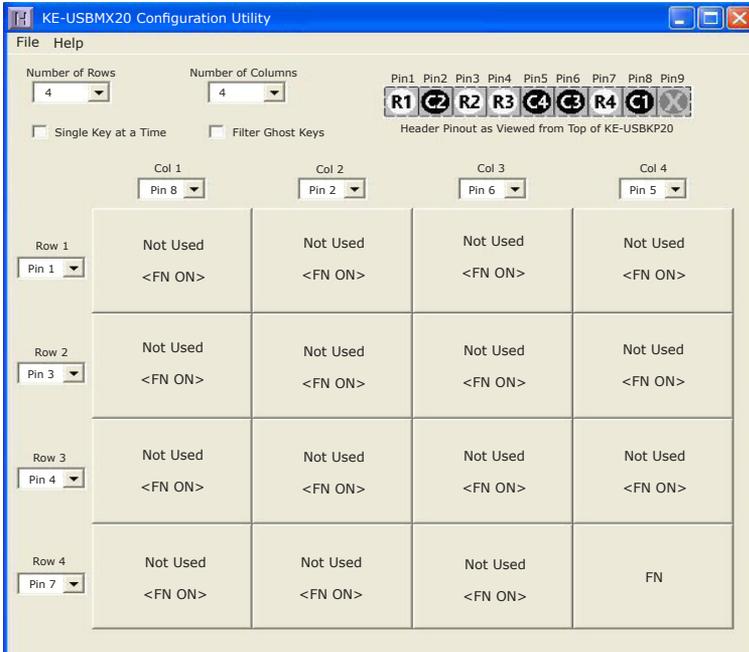

Each matrix cell now shows "<FN ON>" to indicate that keys defined in that position are the keys to be sent when the FN key on the keypad is held.

When toggling between the FN "key on" table and the FN "key off" table, the "<FN ON>" will appear only on the table with keystrokes that will be sent when the FN key is held.

To define the keys for each of the positions on this screen, select each cell and then the keystroke for each just as done previously for the non-FN altered keystrokes.

To get the desired keystrokes for the keypad with the FN key pressed, each cell has been programmed as shown below.

The keystrokes defined include macros to get the upper case characters for the "A", "B", and "C" keys.
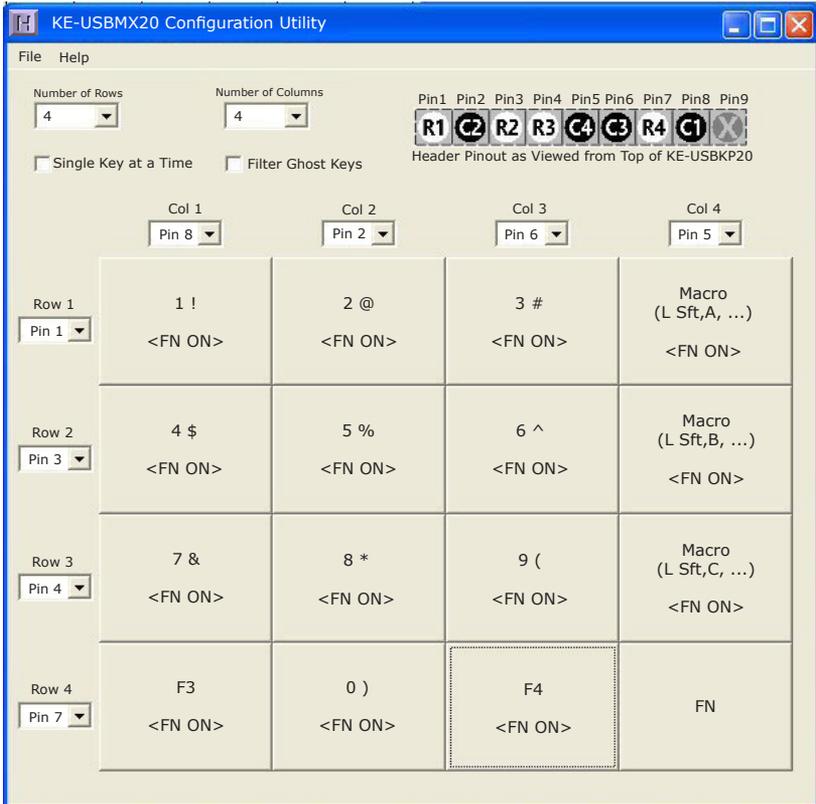
Now that the configuration has been created, be sure to save it to disk and then Write it into the KE-USBMX20.

The following page shows the two matrix configurations based on the state of the FN key.

Only one FN key should be used per configuration and the "Single Key at a Time" checkbox must <u>not</u> be checked when using the FN key.
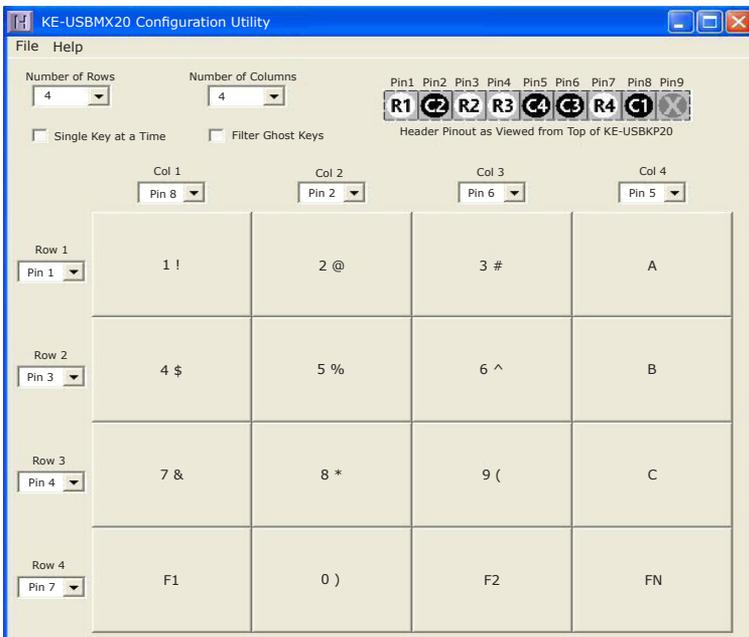
The above matrix shows the keystrokes sent when keys are pressed and the FN key is not active.

(Hold the right mouse button down while left clicking the FN key to toggle between the two matrix tables)

The matrix below shows the keystrokes sent in the same matrix when the FN key is held active.
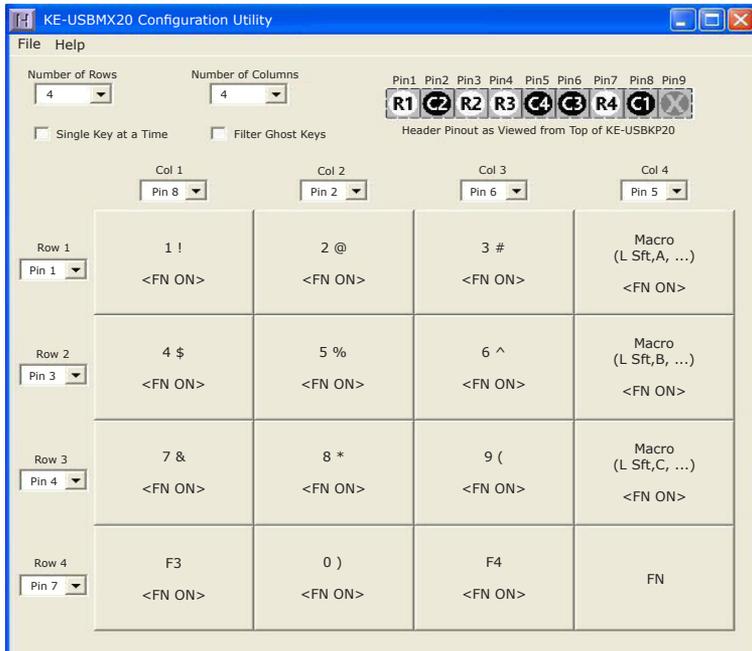
Error Messages

"The KE-USBMX20 was not found"
This error occurs if the computer cannot communicate with the KE-USBMX20 when trying to save to the KE-USBMX20 or read from the KE-USBMX20. Check the cable connections to make sure none of them are loose or unplugged.

"Error while reading from the KE-USBMX20"
"Error while writing to the KE-USBMX20"
This indicates that, while the computer can communicate with the KE-USBMX20, it was not able to read or write the configuration. Communication may be interrupted if another program takes the focus away from the KE-USBMX20 application. If this error message is displayed, load the configuration again.

"Invalid configuration"
"Invalid configuration file"
When loading an already existing configuration from a file or uploading a configuration from the KE-USBMX20, the program will give this error message if the file is corrupted or if it is the wrong file type.

"Error opening the file"
This error message is shown if the KE-USBMX20.EXE program attempts to open a file that is already open in another application. If this happens, close the other application and open the file again.

"Error saving file"

This error message is shown if the KE-USBMX20.EXE program attempts to save a file that is already open in another application, or if there is not enough disk space. If this happens, close the other application and try saving the file again.

"Error: Pin * is used for multiple scan lines"

If a header pin is used to designate more than one row or column or is used for both a row and a column, this error will be displayed when saving the configuration to a file or to the KE-USBMX20. Check the matrix configuration and eliminate redudant pin numbers. The error message will give the number of the duplicate pin.

(Example: "Error: Pin 5 is used for multiple scan lines")
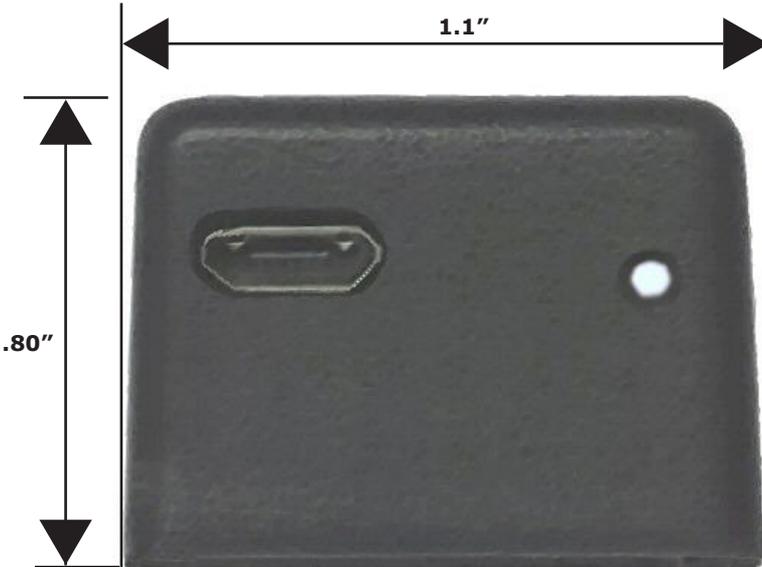
KE-USBMX20 Operating Tips

Please check the following items before contacting us.

 • When connecting the KE-USBMX20 to a PC use a standard USB A- micro B type Cable. Maximum length 15 ft.

 • Check the KE-USBMX20 configuration. Check the matrix configuration for the number of Columns, Rows, etc. Review the matrix table for the desired responses.

 • If the keypad attached to the header has a connecting cable (such as with a membrane switch) be sure it is no more than 10 feet in length.

 • The KE-USBMX20 scans a matrix size in any combination of the pins from 1 x 8, to 4 x 5.   This arrangement allows for scanning of most keypads up to a 20 key matrix. When using less than the full 9 pins on the KE-USBMX20, insert the included keying plug to help with the header alignment.

 • When using a macro sequence, a break or release of a key must be made for any make or press of the key that was done earlier in the macro.

 • The KE-USBMX20 sends keystrokes. To get a specific character, a macro may need to be created to emulate the same sequence normally used to manually type the character. For example, "$" is a shifted "4" key on the USA keyboard. The macro for "$" would make (press) the Shift, then make the "4" key, then break (release) both keys.

Note: For any questions that are not answered in this manual, please send us an email.

 customer service email: **sales@hagstromelectronics.com**

Appendix A:
KE-USBMX20 Specifications

| Operating Voltage	5 Volts DC +/- 5%
Operating Current	10 ma Typical
Operating Temp.	-40 to 85 Degrees C
Computer Interface	Full Speed USB
Input Debounce Time	10 - 15 Msec Typical
KE-USBMX20 Header	9 Pins, up to a 5 x 4 Matrix Female .100" center
Mating Header (on keypad)	.100" Pitch Male .025" posts Up to 9 pins
ESD Input Protection	20kV direct, 30kV air
Max Switch Resistance	900 Ohms

Appendix B:
Command Line Loader

The KE-USBMX20 can also be loaded through a command line by using the supplied KE-USBMX20LOAD.EXE program. Refer to readme. txt located under the Command Line Loader folder on the supplied CD ROM for further details.

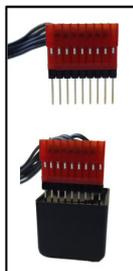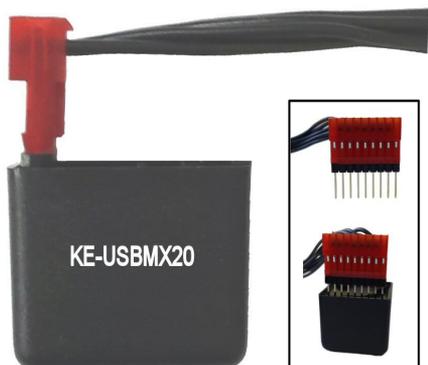# Accessories

Connection to Membrane Female

#PH-9-RA
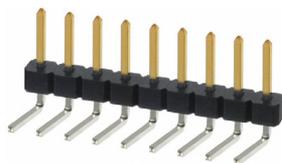
The PH-9-RA is a 9 pin male right angle header that attaches from the KE-USBMX20 header to a female membrane switch header.

Connection to Discrete Wires

#MTA100-9H-12

The MTA100-9H-12 provides 9 individual wires that are attached to a connector which plugs directly into the KE-USBMX20 header.

Use this harness to attach to individual switches or keypads that do not have a single row male header for direct plug in to the KE-USBMX20.

Warranty

HAGSTROM ELECTRONICS, INC. warrants this product against defects in material or workmanship for a period of ONE YEAR from the original purchase date. We will repair or replace (at our option) the returned defective unit at no charge during this warranty period.

No responsibility is assumed for any special, incidental, or consequential damage resulting from the use of or inability to use this product. In no case is **HAGSTROM ELECTRONICS, INC.** to be liable for any amount which exceeds the purchase price of the unit, regardless of the claim.

No other warranty, written or verbal, is authorized. This warranty is applicable only to units sold in the United States. Units sold outside the United States are covered by a similar warranty.

Depending on the state in which you live, you may have additional rights.

Great care has been taken during the assembly, testing, and burn-in of your KE-USBMX20 to ensure its performance. If you have any questions, please send us an email.

customer service email*:* ***sales@hagstromelectronics.com***

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