OPERATION MANUAL

MP-2000

Dual Channel LVDT/RVDT Readout/Controller

Table of Contents

1. Introduction

The MP-2000 is an integrated microprocessor-based, dual-channel readout and set-point controller, designed for the excitation and readout of AC operated LVDT or RVDT type transducers.

The external power supply (provided with MP-2000) operates from 100 to 240 VAC. A US/Canada approved power cord is included. Although this device is CE approved for use in Europe, it is the responsibility of the customer to provide the proper power cord with the plug that is approved for their country.

The MP-2000 utilizes a ¼ DIN standard form factor, and is supplied with all the necessary hardware for panel mounting. Physical variables such as displacement, force and weight can be read out directly in engineering units (inch, mm, degree, etc., depending on the calibration) on the 5 digit display, which reads up to 99999.

A standard 9-pin RS-232 communications interface provides serial data output to a PLC or PC COM port.

Additional features:

- Four (4) user-programmable, opto-isolated, open-collector set-point outputs, with LED indicators
- Optional Relay Board with a current-handling capability of 5A per relay (sold separately)
- Master/Slave synchronization input/output for prevention of cross talk in multiple MP-2000 setups
- Remote zero and min/max/TIR (Total Indicated Runout) reset

2. Product Specifications

For complete specifications and ordering information, please refer to the datasheet at:
http://www.te.com/usa-en/product-CAT-PSI0007.html

Product specifications are also listed on the next page.

ELECTRICAL SPECIFICATIONS	
Power requirements	100 to 240 VAC ±10%, 47 to 63Hz
Display	
Digits (5)	0.4 [10] high, bitmapped LCD, electroluminescent backlit
Range	±99999
Decimal point position	User selectable
Annunciator lights (LED)	Each of the four set-points, zero, and preset
Transducer excitation	
Voltage	1 or 3 VRMS (user selectable)
Oscillator frequency	2.5, 3.3, 5 or 10kHz *(user selectable)*
Current drive capability	25mA maximum per LVDT
Transducer requirements	
Transducer type	LVDT or RVDT with 5 or 6 electrical connections
Full scale output	1.2VRMS maximum with 1 or 3 VRMS excitation
Input (primary) impedance	40Ω min with 1 VRMS excitation; 120Ω min with 3 VRMS excitation
Amplifier characteristics (transducer input)	
Input sensitivity range	High gain: 0.6 VRMS; Low gain: 1.2 VRMS
Input impedance	100kΩ minimum
Non-linearity	±0.02% of FSO, maximum
Analog output	
Unipolar voltage output	0 to +10VDC
Bipolar voltage output	±5VDC (may be over-ranged to ±10VDC)
Response	20mS
Set-points	
Description	4 user programmable, high or low, with LED indicators
Hysteresis (dead band)	User programmable
Outputs	Opto-isolated, open collector logic outputs, 5VDC, 4mA per set-point
Relay board *(optional and highly recommended)*	Four relays, Normally Open and Normally Closed contacts Maximum switching capability (each relay): 50VAC/30VDC, 5A
Serial communications	
Type	RS-232
Speed	1200, 2400, 4800, 9600, or 19200 Baud (user selectable)

ENVIRONMENTAL AND MECHANICAL SPECIFICATIONS	
Operating temperature range	+32°F to +131°F [0°C to +55°C]
IP Rating	IP61 (front panel only)
Mounting	¼ DIN panel mount
Depth behind panel (installed)	7.7 [196] with optional relay board installed (plugged into J4 connector)

Notes:

- *All values are nominal unless otherwise noted*
- *Dimensions are in inch [mm]*
- *FSO (Full Scale Output) is the largest absolute value of the outputs measured at the range ends*

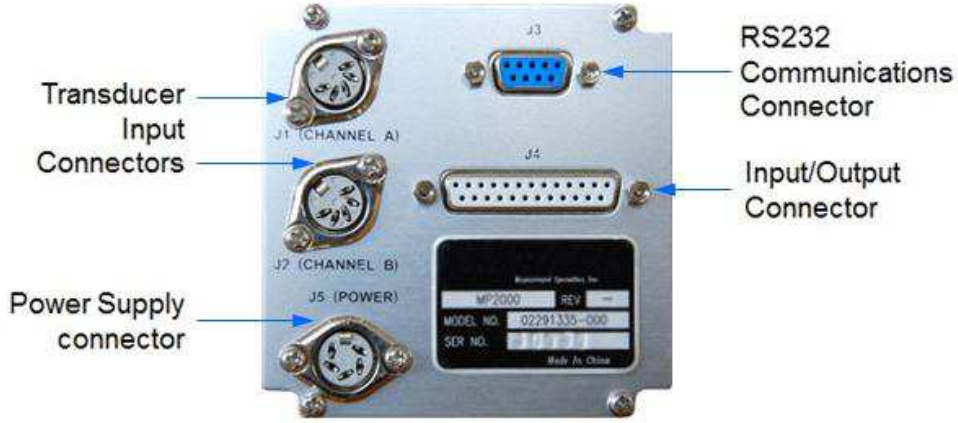
3. Product Overview

3.1 Front Panel

CAUTION

Never us a sharp or pointed object to operate the panel switches. Serious damage could result!

3.2 Rear Panel & Connections



Power Supply Connection
The external power supply is designed to operate on input line voltages from 100 to 240 VAC at 47 to 63 Hertz. The power supply connects to the MP-2000 via connector J5.

Transducer Input Wiring Connections
The transducers are connected using the two DIN style connectors (J1 & J2). Two male mating plugs are supplied with the MP-2000 to connect your transducers. The instrument is designed for use with 5 or 6 wire LVDT and RVDT type transducers. Best performance is achieved when using only five wires in the interconnecting cable (make secondary center tap connection as shown in wiring instructions below).

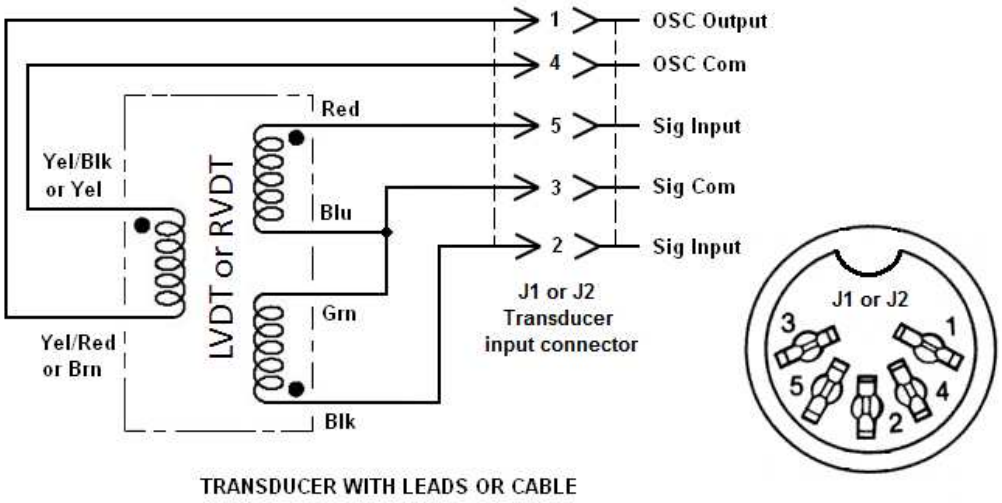
RS-232 Output Connections
The RS-232 connections are available on both the 9-pin and 25-pin connectors J3 and J4. A 25-pin male mating plug is supplied with the MP-2000. Be aware that miswiring may result in permanent damage.

Input/Output Connections
In addition to the RS-232 connections, connector J4 (25 pins) is used for the following: Analog output (DC Voltage), Reset (min/max/TIR) and Zero remote controls, Sync input and output, and Set-Point outputs.

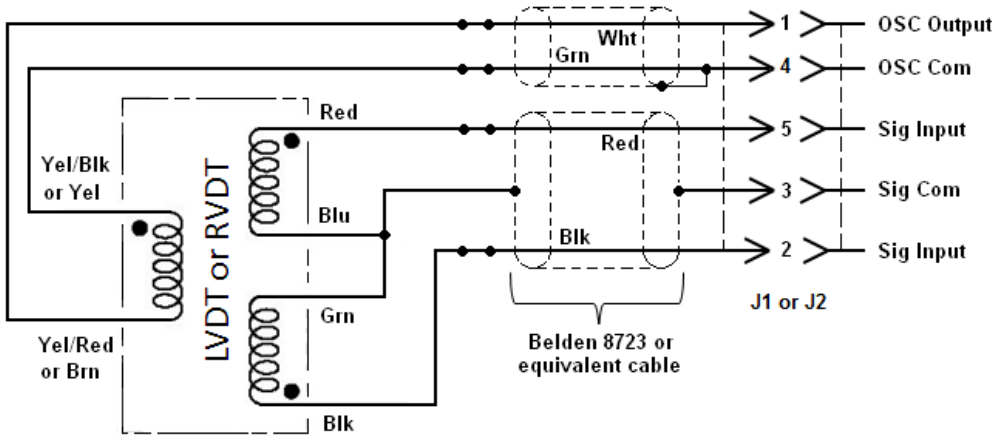
4. Wiring Instructions

4.1 Transducer Wiring & Schematics

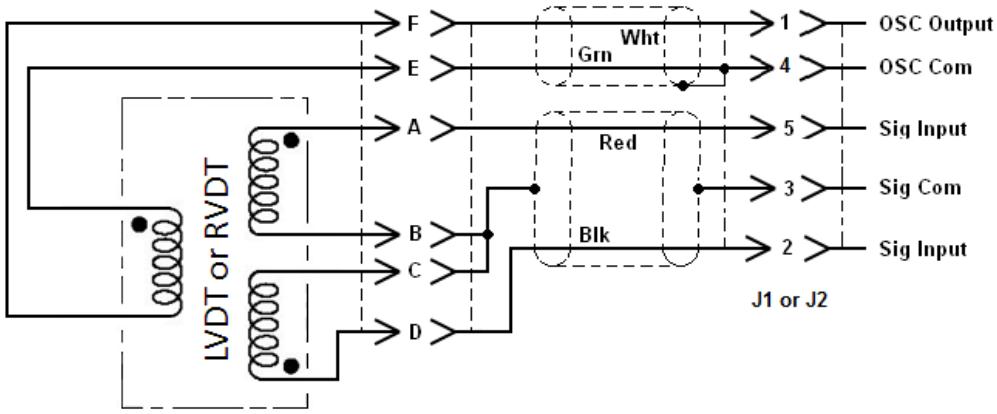
The schematics below show the proper connections for the various types of LVDTs and RVDTs in our catalog. Connection examples are shown for transducers with lead wires, connectors, with and without an extension cable.



TRANSDUCER WITH LEADS OR CABLE



TRANSDUCER WITH LEADS AND SPLICED CABLE



TRANSDUCER WITH CONNECTOR AND JUMPER CABLE

Extension cables should use shielded, twisted pair construction, to reduce sensitivity to radiated EMI/RFI. The cable shield should be connected to Pin 3 or Pin 4 of the input connector on the rear panel of the MP-2000, or to ground, except for our model LBB gage head applications where the shield at the MP-2000 end of the cable must be floated (not connected) to avoid ground loops. Primary leads do not systematically have to be shielded, as they are not as sensitive to noise pick up as the secondary leads. A cable, such as **Belden™** 8786, with two pairs of wires jointly shielded inside the center braid, and one unshielded pair of wires, is recommended. The unshielded wires should be used for connections to the transducer primary, and three of the four shielded wires for connections to the secondary windings.

If the transducer is located in an extremely noisy environment, the primary leads should be shielded separately from the secondary leads. It is undesirable to have the primary and secondary leads within the same shield as this may cause detrimental coupling between them. If more than one MP-2000 is to be used, primary and secondary pairs must be shielded separately, for each LVDT or RVDT, and attention given to cable dress to prevent heterodyning resulting from unwanted crosstalk. If heterodyning problems do occur and cannot be eliminated by shielding and/or physical separation of cables, the carrier signals must be synchronized between MP-2000's. See the section on Master/Slave (Synchronized Operation) for further instructions. At excitation frequencies up to 2.5 kHz, many types of AC LVDTs can be operated with cables exceeding 350 feet in length. However, the maximum usable cable length is dependent upon the LVDT and cable types used. Contact our factory or one of our distributors for extended length cable assemblies sold as accessories for our LVDT and RVDT models.

4.2 Output Wiring & Schematics

RS-232 Output Wiring

RS-232 line	9-pin connector J3	25-pin connector J4
DTR out	Pin 6	Pin 4
DSR in	Pin 4	Pin 2
TxD out	Pin 2	Pin 3
RxD in	Pin 3	Pin 5
COMMON	Pin 5	Pin 24

The DTR (Data Terminal Ready) line, from the MP-2000, is active high when the MP-2000 is powered and ready to interact with your DTE (Data Terminal Equipment, the control device, PLC, or PC the MP-2000 is connected to). It is not necessary for this line to be tied to the DTE, if it is not required to activate the RS-232 interface. The DSR (Data Set Ready) line, from the DTE to the MP-2000, must be active high to allow the MP-2000 to recognize commands from the DTE. This line can be tied active high, at the MP-2000, by a connection to the DTR line. The RS-232 data is transmitted in 8 sequential Bytes, in binary or bit significant format, depending on the parameter. Refer to the section "RS-232 Programming" herein.

Analog Output
The MP-2000 features a ±5VDC output for each transducer channel which is automatically scaled during calibration to the calibrated LVDT or RVDT displacements. This output may be shifted by 5VDC (using the **ZERO** button) for 0 to 10VDC range, or over-ranged to ±10VDC with no degradation in linearity. Signals are at connector J4, Pins 21, 20 and 25.

Remote Control
The MP-2000 has two remote functions, Zero and Reset (for max/min/TIR). These functions may be controlled by a remote contact closure such as a PLC output or a pushbutton switch wired to Connector J4, Pins 24, 19 and 14.

Remote Zero
The remote zero performs the same function as the **ZERO** pushbutton on the front panel. A momentary closure of Pins 14 and 24 on connector J4 will cause the meter display to zero out; the ZERO light will illuminate to indicate that this function is active. Zeroing the display remotely or using the front panel pushbutton will cause the analog output to zero as well. Remote zero only responds when the MP-2000 is in single-line (single item) display mode

Remote Reset
Remote reset (momentary closure of Pins 19 and 24 of Connector J4) clears:

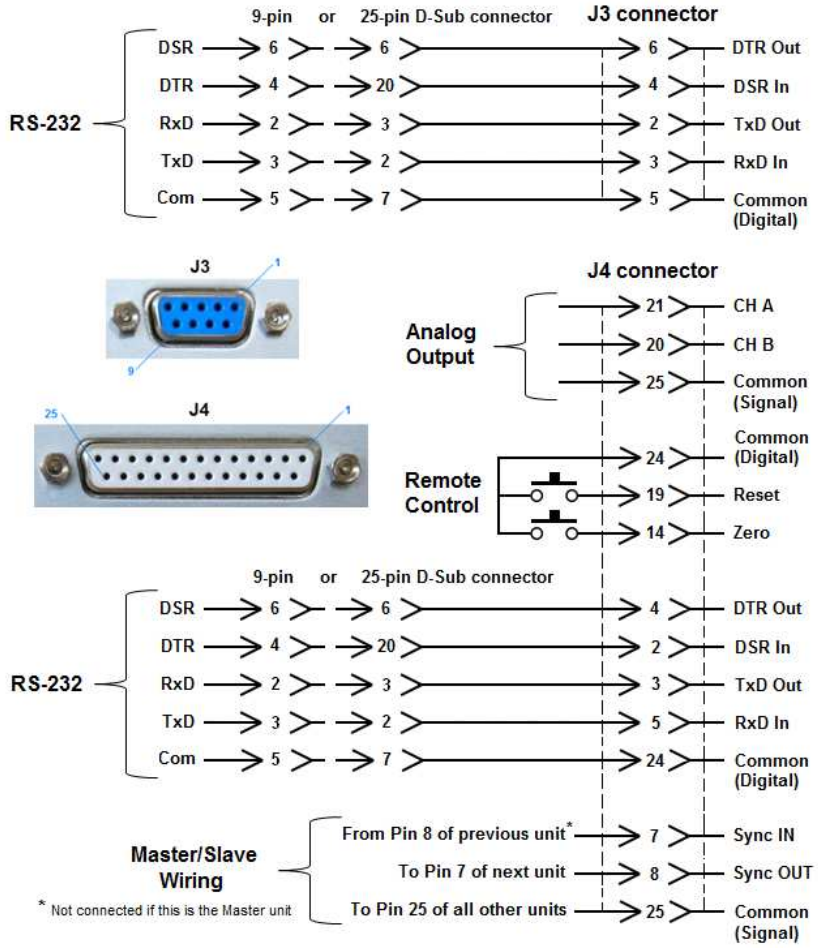
- All the memory Min/Max/TIR (both channels) when the MP-2000 is in two-line display mode
- The memory Min/Max/TIR of the displayed channel (when in single-line display mode). Pressing **[MENU]** and **[ENTER]** together will perform the same function; clear all the Max/Min/TIR of the displayed channel (except in PROGRAM mode).

Master/Slave Operation and Wiring
Multiple MP-2000 setups with LVDTs and/or RVDTs in close proximity to each other, or with long common cable runs, should have their oscillators synchronized to the same frequency. Failure to do this may result in low-frequency beat (heterodyning) of the MP-2000 output signals due to crosstalk. Select one MP-2000 as the master (do not connect its Sync input, leave Pin 7 of Connector J4 open); the remaining MP-2000's will be wired as slaves per the schematic below (using Pins 7, 8 and 25 of Connector J4). Proper shielded, twisted pair cable with lengths kept as short as possible, should be used.

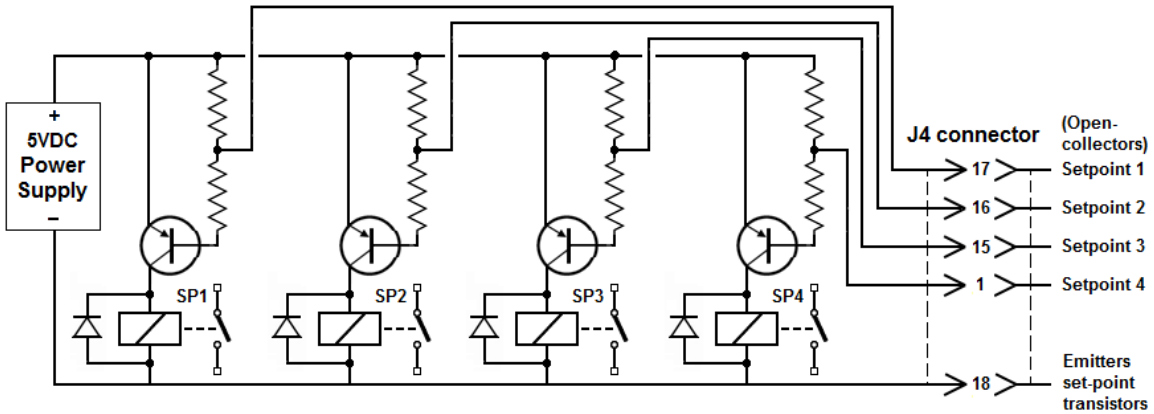
Set-Point Outputs

Each of the four set-points has an optically isolated transistor (NPN) output to operate external devices, such as relays or PLC digital inputs. These outputs are open-collector, TTL level, each capable of sinking 4mA at 5VDC. The four emitters are connected together and to Pin 18 of Connector J4, but not to the MP-2000 power common (the MP-2000 Power Common for digital outputs is available at Pin 24). When using an external power supply (5VDC), connect the relays per the schematic below. Suppression diodes must always be used across relay coils to prevent CEMF spikes from feeding back into the open collectors. Our optional Relay Board has a current-handling capability of 5A per relay at 50VAC/30VDC.

Wiring schematics



OUTPUT WIRING



SETPOINT OUTPUT WIRING

5. Getting Started

5.1 Settings

Oscillator Settings (Voltage & Frequency)
The oscillator signal, a digitally generated sine wave for the excitation of LVDT or RVDT transducers, is controlled by soft switches in the PROGRAM menu. The available oscillator frequencies are 2.5, 3.3, 5, and 10 kHz. The oscillator voltages for channel A and B can be set separately to 1 or 3 Volts RMS.

Sensitivity Settings
The sensitivity may be individually set for each channel, to either 0.6 (HIGH GAIN), or 1.2 (LOW GAIN) VRMS full scale. See the section "Operating Instructions" for details. To achieve proper range and best analog to digital converter resolution it is desirable to operate between 60 and 95% of full scale input.

To select the sensitivity setting, determine the full scale output voltage of the transducer at the operating frequency for both 1 and 3 VRMS excitation voltages. The full scale output voltage may be obtained from the individual data sheet or calculated by multiplying the sensitivity of the transducer by the excitation voltage and the full scale displacement or rotation.

Use the oscillator voltage and gain (sensitivity setting) combination that allows operation between 60 and 95% of the MP-2000 input range. That is 0.36 to 0.57 VRMS for HIGH GAIN or 0.72 to 1.14 VRMS for LOW GAIN. If a choice is possible between the two oscillator voltages (1 and 3 VRMS), 3 VRMS is the best as the output voltage will be higher, therefore improving electrical noise immunity.

Note: In selecting the oscillator voltage, make sure that the excitation current is less than the rated oscillator current of 25 mA maximum (oscillator voltage divided by transducer input impedance).

The input impedance of our LVDT and RVDT transducers are specified in our datasheets. Selecting a higher excitation (oscillator) frequency allows a higher input impedance and therefore lower current. Our application note "LVDT Selection Handling and Installation Guidelines" contains a detailed discussion on the maximum current to apply to an LVDT input.

Examples:

Transducer model	**HR 100 LVDT**	**R30A RVDT**	**MHR 1000**	**Fictitious**
Transducer Full Range	±0.1 inch	±60 degrees	±1 inch	±5mm
Transducer Full Scale	0.1 inch	60 degrees	1 inch	5mm
Excitation Frequency	2.5kHz	10kHz	10kHz	
Transducer Sensitivity	4.2V/V/inch	2.9mV/V/Degree	0.77V/V/inch	0.06V/V/mm
Input (primary) impedance	1070 Ohms	370 Ohms	155 Ohms	80 Ohms
Full Scale Output @ **3** VRMS excitation	4.2 x 3 x 0.1 = **1.26** VRMS	2.9 x 3 x 60/1000 =**0.522** VRMS	0.77V/V/in x 3 x 1 = **2.31** VRMS	0.06 x 3 x 5 = **0.9** VRMS
Input current at 3 VRMS	3/1070 = 2.8mA	3/370 = 8.1mA	3/155 = 19.4mA	3/80 = **37.5**mA
Full Scale Output @ **1** VRMS excitation	4.2 x 1 x 0.1 = **0.42** VRMS	3.9 x 1 x 60/1000 = **0.174** VRMS	0.77V/V/in x 1 x 1 = **0.77** VRMS	0.06 x 1 x 5 = **0.3** VRMS
Input current at 1 VRMS	1/1070 = 0.93mA	1/370 = 2.7mA	1/155 = 6.4mA	1/80 = 12.5mA
Settings to be used	1VRMS excitation	3VRMS excitation	1VRMS excitation	1VRMS excitation
	HI GAIN (0.6V)	HI GAIN (0.6V)	LO GAIN (1.2V)	HI GAIN (0.6V)
Comment	3 VRMS setting gives too high Full Scale output	3 VRMS setting gives the highest acceptable output	3 VRMS setting gives too high Full Scale output	3 VRMS setting exceeds 25mA max. rating

5.2 Front Panel Switches

Refer to the Front Panel view in the Product Overview section of this manual during the following discussion of the front panel pushbutton switches.

[MENU] Switch (S1)
Press S1 to return to the upper level of the menu, or to exit a submenu.

[▲] / ZERO Switch (S2)
S2 has two functions:

1) **[▲]**: In PROGRAM mode, pressing S2 moves a menu cursor upward, or increments the value of the highlighted digit while setting the value of a parameter.
2) **ZERO**: In RUN mode, when only one channel is displayed, pressing S2 will zero (tare) the output of the displayed channel and illuminate the ZERO light. Zero is performed by using the last reading made prior to initiating the zeroing function and subtracting this value from all subsequent readings.

   Pressing **ZERO** (S2) and **[ENTER]** (S5) simultaneously will undo the zeroing of the readout and extinguish the ZERO light. The instrument may be zeroed anywhere within the specified operating range of the transducer without affecting the calibration. Zeroing the display will cause the analog output to zero as well. Depressing **ZERO** at minus full scale will provide 100% zero suppression: The normally zero centered ±5 VDC output will become 0VDC at minus full scale, +5VDC at null and +10VDC at plus full scale.

[▼] / CAL Switch (S3)
S3 has two functions:

1) **[▼]**: In PROGRAM mode, pressing S3 moves a menu cursor downward, or decrements the value of the highlighted digit while setting the value of a parameter.
2) **CAL**: In RUN mode, if only one channel is displayed, and provided that the Calibration Switch parameter is set to ENABLE, pressing S2 will perform calibration of the displayed channel.

Performing the digital calibration will automatically scale the analog output to ±5 VDC for the full linear (LVDT) or angular (RVDT) range. Calibrating over a smaller range than the transducer full operating range will result in the analog output exceeding ±5VDC over the full range. The analog output may be over ranged to ±10VDC with no adverse effect on linearity.

Note: When MP2000 is rebooted (unplugged and plugged back in), the Calibration Switch automatically defaults to DISABLE, to prevent an unintended operation of the S3 switch. Channel calibration values are stored in EEPROM, and are maintained until next Cal operation occurs.

[►] / PRESET Switch (S4)
Switch S4 has two functions:

1) **[►]**: In PROGRAM mode, pressing S4 moves the cursor toward the right, one increment at a time (item by item or digit by digit, depending on the displayed information).
2) **PRESET**: In RUN mode, with only one channel displayed, pressing S4 will turn on the Preset function, for the displayed channel only. The PRESET light on the front panel will illuminate and the readout will display the preset value previously programmed into the instrument during the PROGRAM operation. The preset value is a constant added to, or subtracted from the scaled and zeroed value prior to being displayed. It can be applied to CH(A) or CH(B) readings and is maintained and used for calculating (A+B), (A-B), TIR(A), etc.

[ENTER] / A/B Select Switch (S5)
S5 has two functions:

1) **[ENTER]**: In PROGRAM mode, press S5 to enter the menu of a selected item.
2) **A/B**: In RUN mode, pressing S5 will toggle between the single line display of CH(A) or CH(B). Pressing **[MENU]** will return to the two-line (two items) display mode.

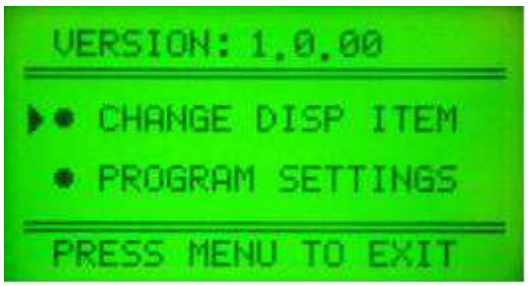
6. Operating Instructions

6.1 Boot

After power is turned on, it takes 20 seconds for the MP-2000 to boot. During this time, it displays:

6.2 Top Level Menu

After booting for the first time, the top level menu appears (if the MP-2000 was previously programmed, it will instead go directly into the RUN mode, and pressing **[MENU]** will go to the top level menu):



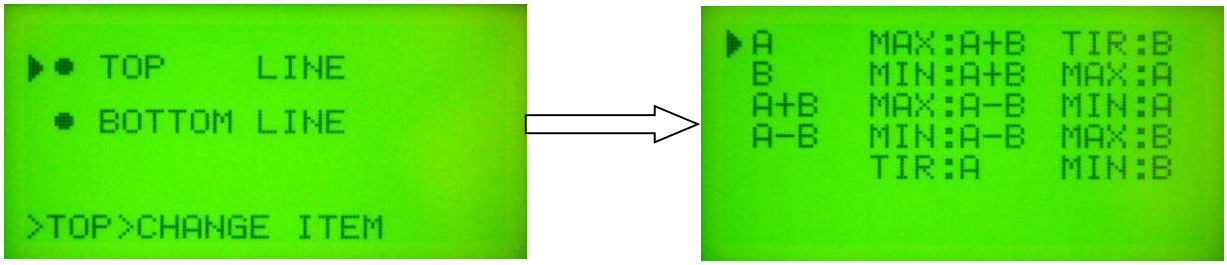
Use the **[▲] [▼]** buttons to move the cursor up and down and select one of the two following items:

- CHANGE DISP ITEM allows the selection of two items to be displayed in the RUN mode.
- PROGRAM SETTINGS enters the PROGRAM mode.

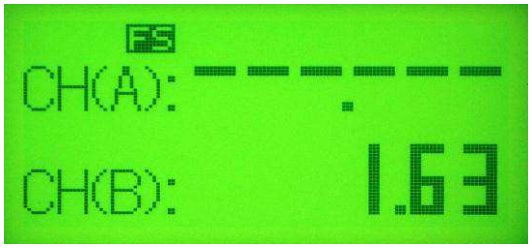
Press **[MENU]** (Switch S1) to exit this screen and enter into the RUN mode.

6.3 RUN Mode Setup

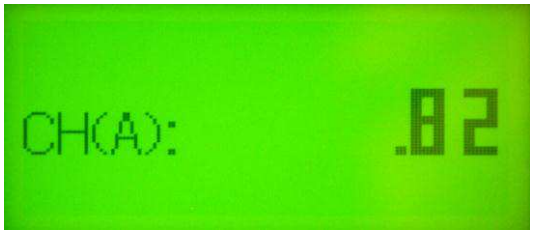
In the previous top level menu, select CHANGE DISP ITEMS and then press **[ENTER]**. Select TOP LINE or BOTTOM LINE then press **[ENTER]**:



Use the **[▼] [▲] [►]** buttons to select the parameter to be displayed, and then press **[MENU]** or **[ENTER]** to exit. In RUN mode, the display will automatically show two items. If an actual value is larger than the full scale value (over-range), the warning "**FS**" will display above the appropriate item:



In the RUN mode, pressing **[ENTER]** will enable the one item display mode. Pressing **[ENTER]** again will toggle between CH(A) and CH(B). Single channel display mode with CH(A) selected is shown below:

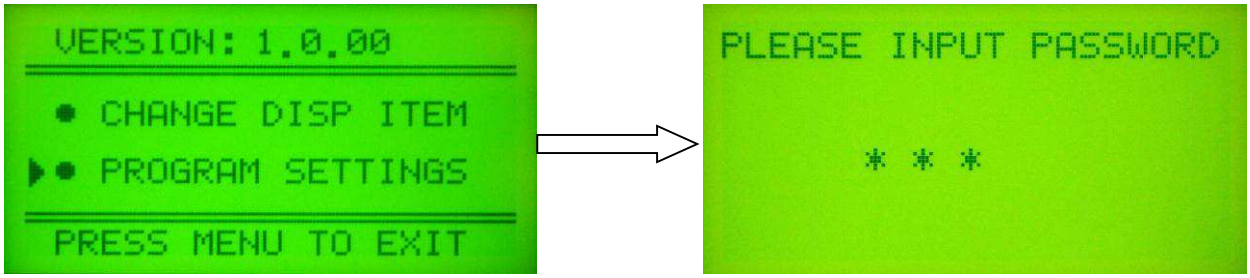


In the single channel display mode above:

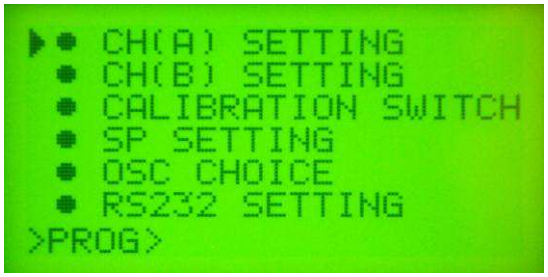
- Pressing the **ZERO** button will zero the displayed channel, Press **ZERO** and **[ENTER]** simultaneously will cancel the zero and resume the original value.
- Pressing the **CAL** button will invoke the calibration function (provided the CALIBRATION SWITCH is set to ENABLE in the PROGRAM SETTINGS menu).
- Pressing the **PRESET** will turn ON or OFF the Preset function.
- Pressing **[MENU]** will return to the two items display mode.
- Pressing **[MENU]** again returns to the top level menu.
- Pressing **[▼]** and **[ENTER]** simultaneously while displaying CH(A) or CH(B) individually (with CALIBRATION SWITCH setup to DISABLE), will enter into the Voltmeter mode and display:

6.4 PROGRAM Mode

In the top level menu below, select PROGRAM SETTINGS and then press **[ENTER]**. The system will ask for the password to go into PROGRAM mode. The password is **[▲] [▼] [►] [▼]** (successively press these 4 buttons). If entered incorrectly, the system will ask for the password again. After four incorrect attempts, the system will exit and return to the top level menu.



After entry of the correct password, the PROGRAM SETTINGS menu will display:



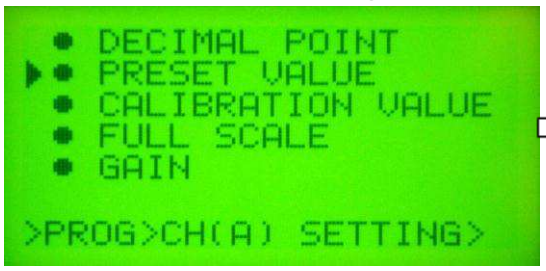
Note: Pressing **[ENTER]** *will enter the menu of the selected item, except in the lowest menu levels where pressing* **[ENTER]** *will perform the same task as* **[MENU]***: Returning back to the previous menu.*

PROGRAM SETTINGS MENU, Available Settings for CH(A) and CH(B):

Decimal Point Setting

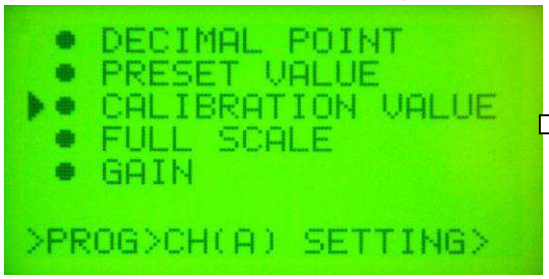
Press the **[►]** button to move the decimal point

Preset Value Setting

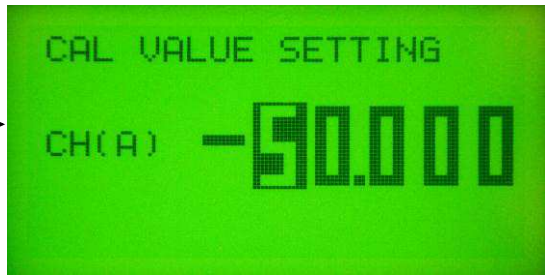


Press **[▲]** **[▼]** to increment/decrement the digit or to toggle +/–; press **[►]** to move to the next

Calibration Value Setting



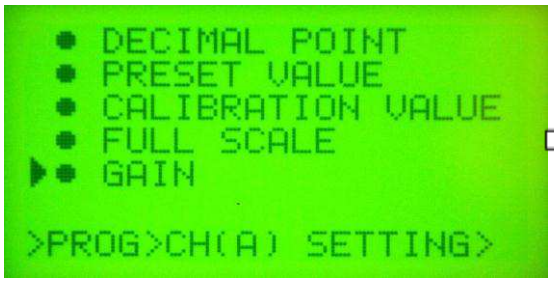
Same method as above to enter value



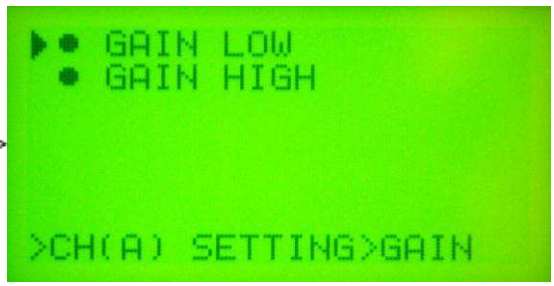
Full Scale Setting

Press **[▲]** **[▼]** to increment/decrement the digit
Press **[►]** to move to the next digit

Gain Setting

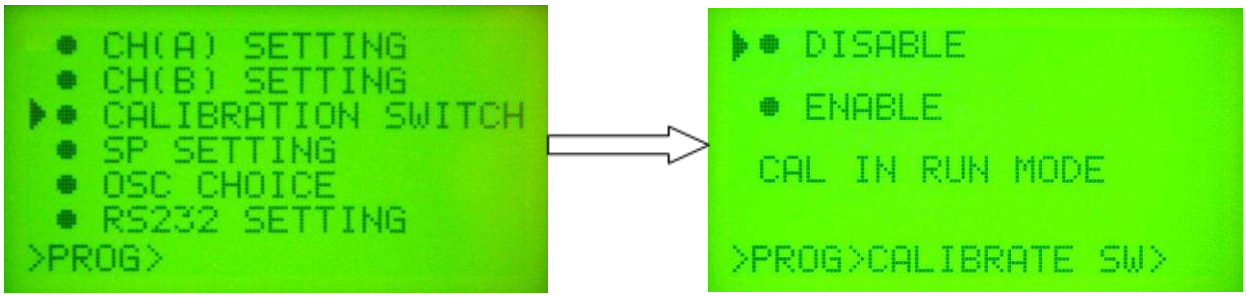


Press **[▲]** or **[▼]** to select an item



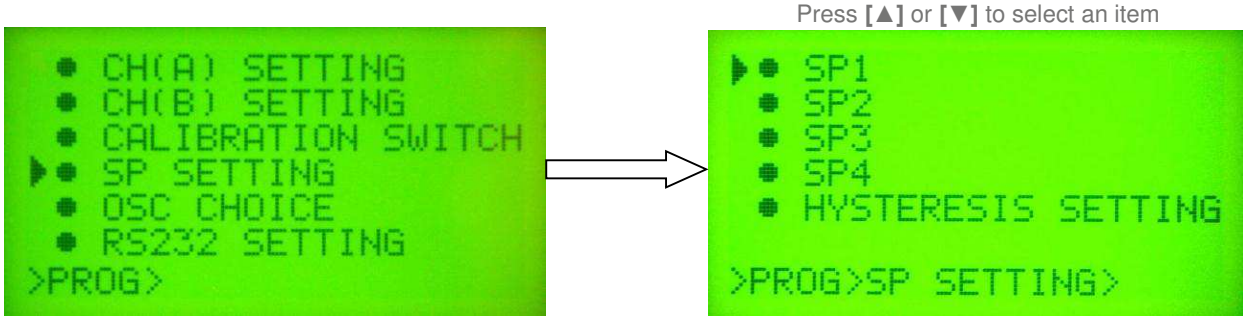
PROGRAM SETTINGS MENU, Calibration Switch:

Press **[▲]** or **[▼]** to select an item



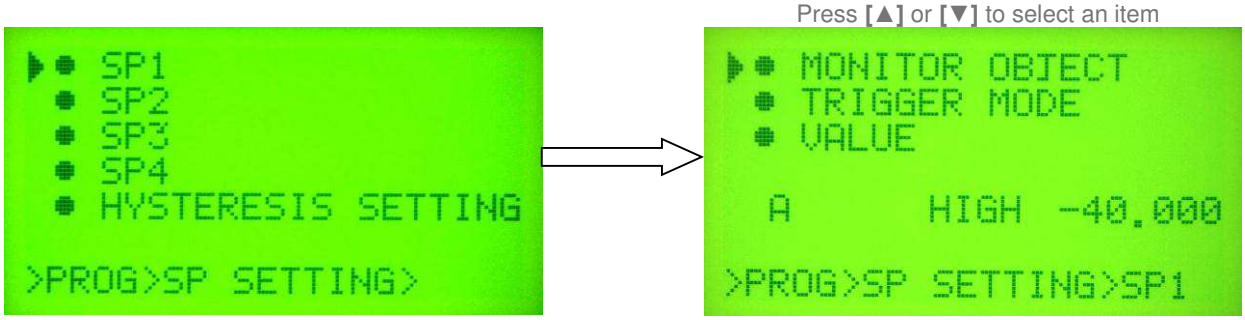
PROGRAM SETTINGS MENU, Set-Point Settings:

Press **[▲]** or **[▼]** to select an item



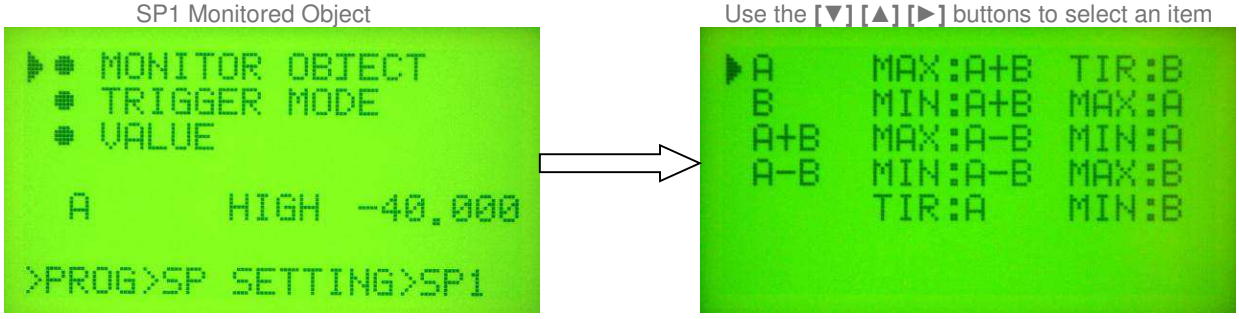
The following are the submenus for the Set-Point Settings (same submenus for SP1, SP2, SP3, & SP4):

Press **[▲]** or **[▼]** to select an item



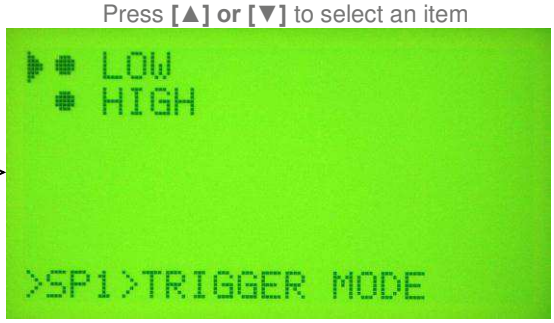
SP1 Monitored Object

Use the **[▼]** **[▲]** **[►]** buttons to select an item

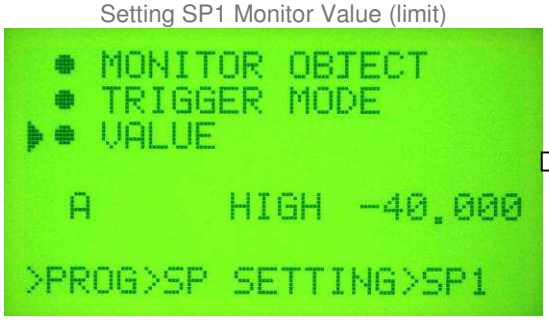


SP1 Trigger Mode of Monitored Object

Press **[▲] or [▼]** to select an item

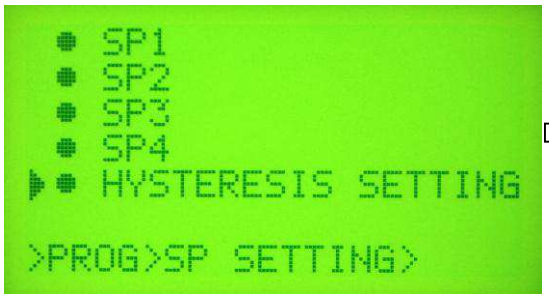


Setting SP1 Monitor Value (limit)

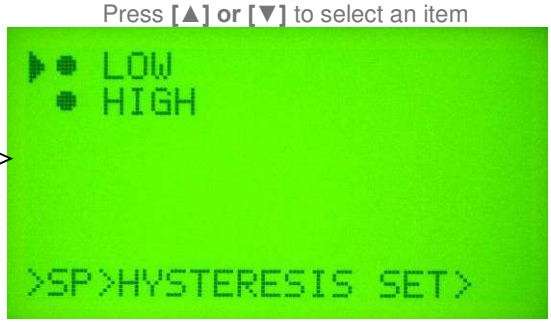


Press **[▲] [▼]** to increment/decrement the digit or to toggle +/–; press **[►]** to move to the next

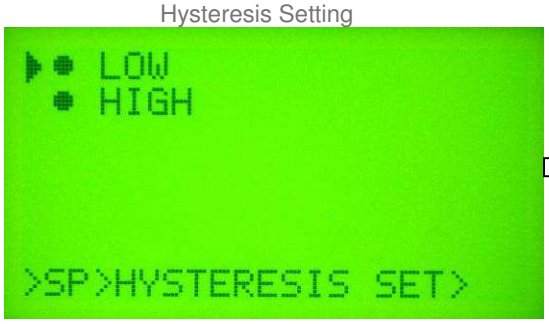
Setting the Hysteresis Values for the Set Points:



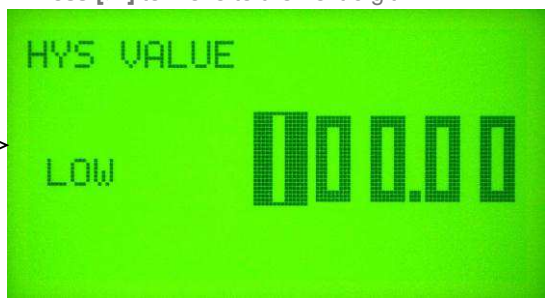
Press **[▲] or [▼]** to select an item



Hysteresis Setting

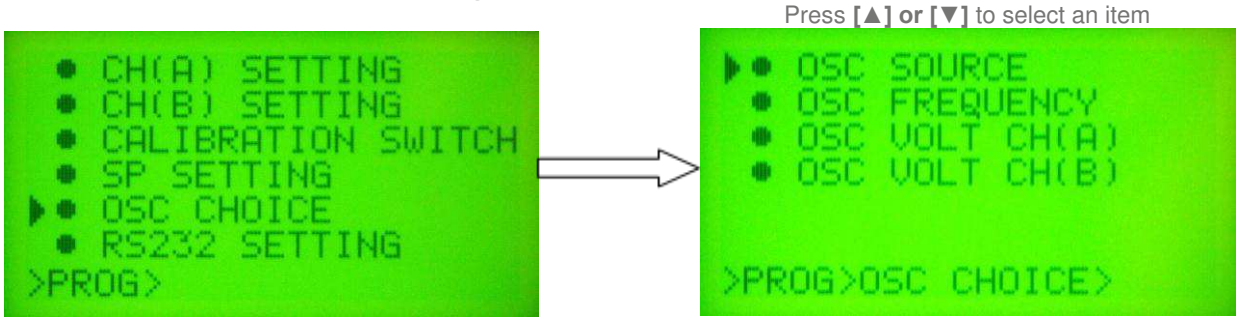


Press **[▲] [▼]** to increment/decrement the digit
Press **[►]** to move to the next digit

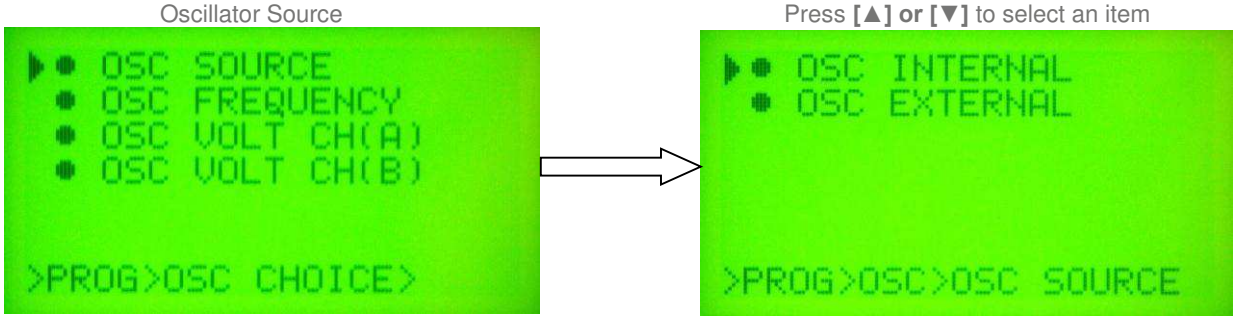


Note: The same value setting screen will allow entering the hysteresis value for the HIGH setting.

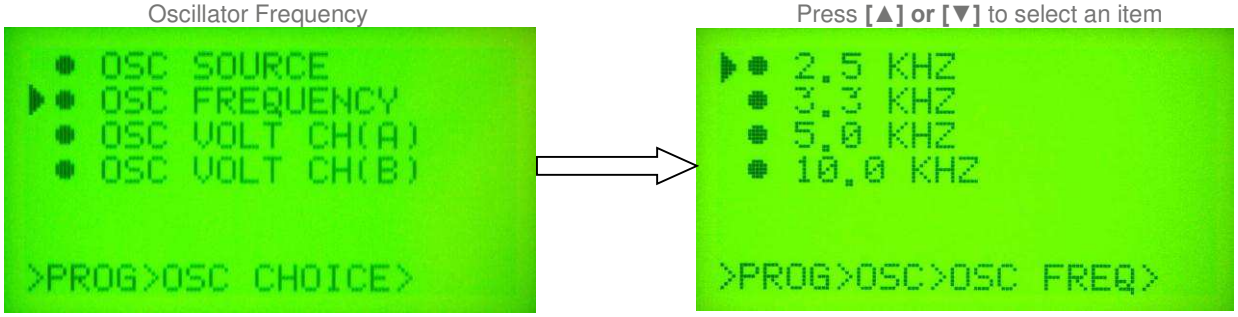
PROGRAM SETTINGS MENU, Oscillator Settings:



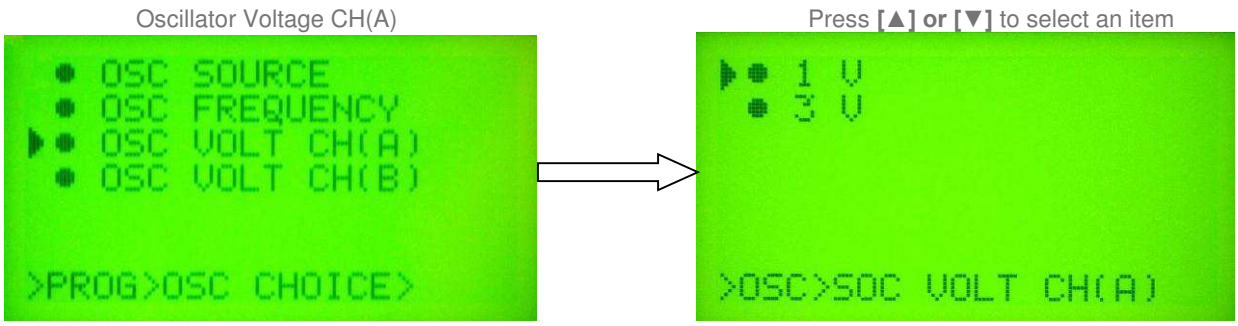
Oscillator Source



Oscillator Frequency



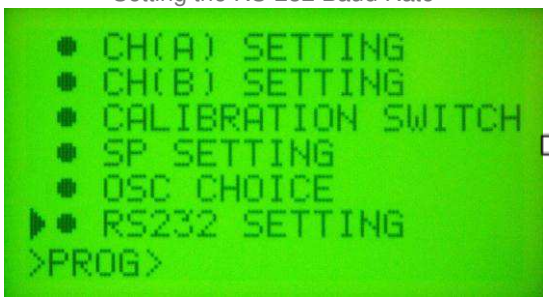
Oscillator Voltage CH(A)



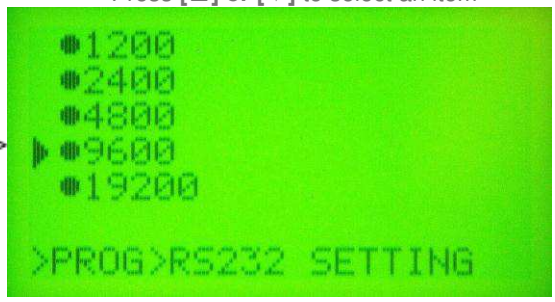
Note: The oscillator voltage setup menu is the same for CH(B). Each channel can be setup for a different oscillator voltage or the same. However, the oscillator frequency is common for both channels.

PROGRAM SETTINGS MENU, RS-232 Settings:

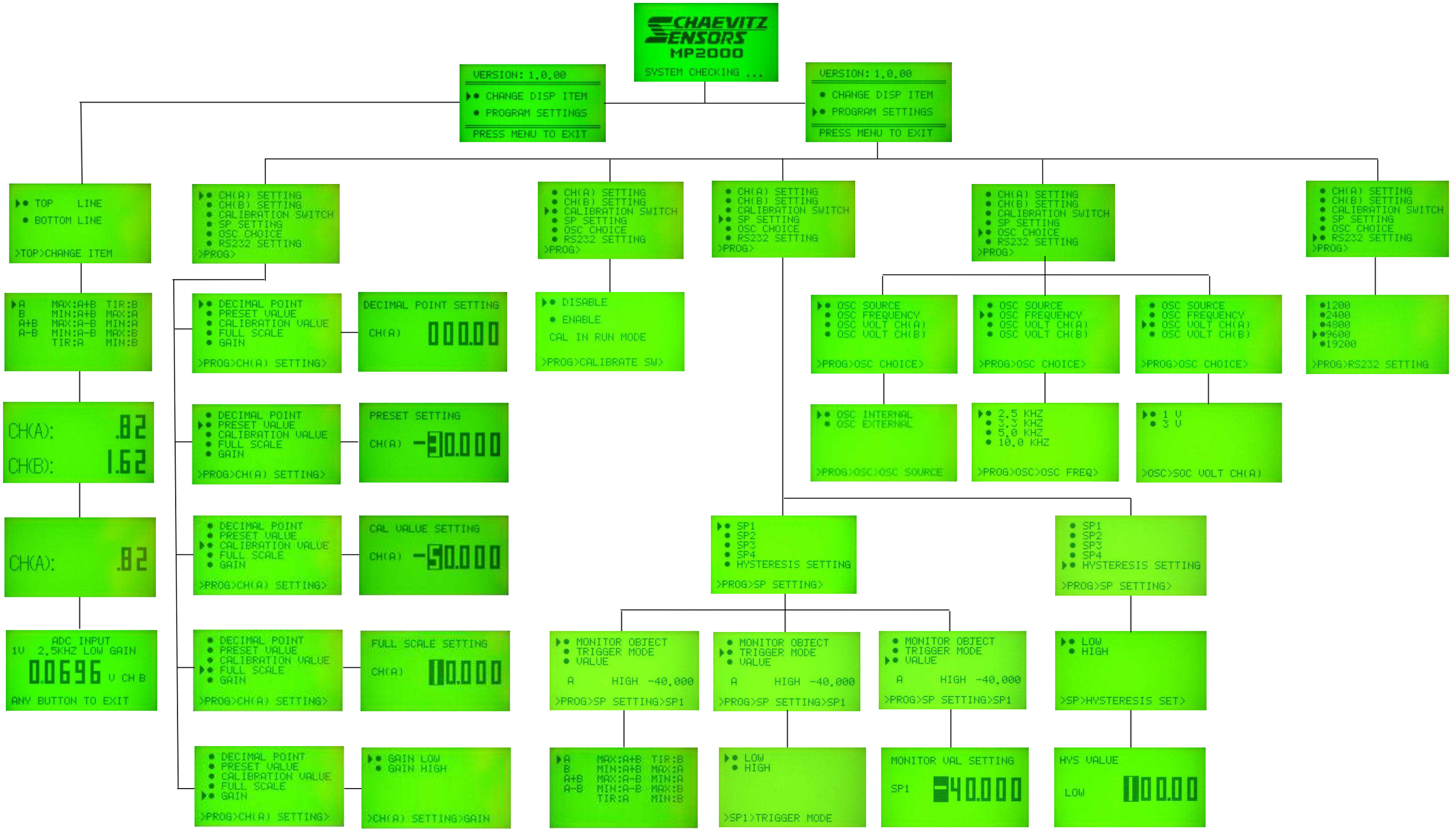
Setting the RS-232 Baud Rate



Press **[▲] or [▼]** to select an item



6.5 Menu Tree


CHAEVITZ SENSORS
MP2000
SYSTEM CHECKING ...
VERSION: 1.0.00
CHANGE DISP ITEM
PROGRAM SETTINGS
PRESS MENU TO EXIT
TOP LINE
BOTTOM LINE
>TOP>CHANGE ITEM
A MAX:A+B TIR:B
B MIN:A+B MAX:A
A+B MAX:A-B MIN:A
A-B MIN:A-B MAX:B
TIR:A MIN:B
CH(A): .82
CH(B): 1.62
CH(A): .82
ADC INPUT
1V 2.5KHZ LOW GAIN
0.0696 V CH B
ANY BUTTON TO EXIT
CH(A) SETTING
CH(B) SETTING
CALIBRATION SWITCH
SP SETTING
OSC CHOICE
RS232 SETTING
>PROG>
DECIMAL POINT
PRESET VALUE
CALIBRATION VALUE
FULL SCALE
GAIN
>PROG>CH(A) SETTING>
DECIMAL POINT SETTING
CH(A) 000.00
PRESET SETTING
CH(A) -30.000
CAL VALUE SETTING
CH(A) -50.000
FULL SCALE SETTING
CH(A) 100.000
GAIN LOW
GAIN HIGH
>CH(A) SETTING>GAIN
DISABLE
ENABLE
CAL IN RUN MODE
>PROG>CALIBRATE SW>
OSC SOURCE
OSC FREQUENCY
OSC VOLT CH(A)
OSC VOLT CH(B)
>PROG>OSC CHOICE>
OSC INTERNAL
OSC EXTERNAL
>PROG>OSC>OSC SOURCE
2.5 KHZ
3.3 KHZ
5.0 KHZ
10.0 KHZ
>PROG>OSC>OSC FREQ>
1 V
3 V
>OSC>SOC VOLT CH(A)
1200
2400
4800
9600
19200
>PROG>RS232 SETTING
SP1
SP2
SP3
SP4
HYSTERESIS SETTING
>PROG>SP SETTING>
MONITOR OBJECT
TRIGGER MODE
VALUE
A HIGH -40.000
>PROG>SP SETTING>SP1
LOW
HIGH
>SP1>TRIGGER MODE
MONITOR VAL SETTING
SP1 -40.000
LOW
HIGH
>SP>HYSTERESIS SET>
HYS VALUE
LOW 100.00

7. Calibration Instructions

Each channel is calibrated separately. LVDT or RVDT calibration with the MP-2000 requires a minimum amount of equipment: A displacement standard such as a barrel micrometer, gage blocks or protractor (for RVDTs). Cabling capacitance affects the scale factor; therefore calibration must be done with the required cable in place between the transducer and the MP-2000. To perform a traceable calibration, NIST traceable equipment must be used, (meter and gage blocks). For the purpose of calibration, it is assumed that you have the LVDT, RVDT, or gage head (spring or air actuated LVDT) mounted in some sort of fixture, a dial indicator stand, or a piece of equipment onto which you intend to install the transducer. If you have a fixture gaging application, you may use zero and set masters or zero masters and gage blocks.

Note: If an RVDT is used instead of an LVDT, the following procedures are the same except that you would be rotating the shaft instead of moving a core or a plunger, and you would be using a different positioning fixture (angular instead of linear setup).

Step 1: Transducer Full Scale Output

Find the sensitivity of your LVDT or RVDT by referring to the calibration sheet accompanying your unit, or by checking the specification for your specific model. The sensitivity of an LVDT is usually expressed in V/V/inch or mV/V/.001inch (RMS output voltage, per RMS excitation voltage, per unit of displacement from null or "0" position). For metric calibration it needs to be converted to V/V/mm or mV/V/mm. For an RVDT, replace “inch” or “mm” by “degree”.

Note: The sensitivity is dependent on the excitation frequency.

Calculate the Full Scale Output according to the “Sensitivity Settings” paragraph in the “Getting Started” section of this manual.

Step 2: Meter Input Range

Use the transducer full scale output that is the closest number of the meter range without exceeding it (600mV in high gain or 1200mV in low gain). Refer to the “Sensitivity Settings” paragraph in the “Getting Started” section of this manual for details.

Step 3: Oscillator and Gain Settings

In the PROGRAM mode, set the oscillator frequency (common to both channels) and voltage (individually for each channel) : >PROG>OSC CHOICE> and the Gain: >PROG>CH(A) SETTING>GAIN>, or >PROG>CH(B) SETTING>GAIN>, depending on the channel used).

Step 4: Power ON and Warmup

Plug the transducer into the MP-2000, turn on the power, and wait for at least 10 minutes. This warmup time ensures that the MP-2000 is stabilized for best accuracy.

Step 5: Calibration Switch Enable

Set the Calibration Switch to ENABLED in the PROGRAM mode: >PROG>CALIBRATE SW>

Step 6: Decimal Point Setting

Set the Decimal Point in the PROGRAM mode: >PROG>CH(A) SETTING>, or >PROG>CH(B) SETTING> depending on the channel you are using.

Step 7: Preset Value

The Preset value is a fixed offset usually added to differential measurements in order to display the full dimension. This is an optional step. I f not required, skip to Step 8.

Adjust the Preset value to your desired output offset in the PROGRAM mode: >PROG>CH(A) SETTING>, or >PROG>CH(B) SETTING>.

Note: To enter values, use the **[►]** *button to move the cursor from one digit to the next. Increment with the* **[▲]** *button, or decrement with the* **[▼]** *button until the right number is displayed. Depress the* **[MENU]** *or* **[ENTER]** *button when finished to save the entry.*

Step 8: Calibration Value

The Calibration Value is the distance the LVDT core will be moved, or the angle the RVDT shaft will be rotated, from the electrical zero (null position) during the calibration. The calibration calculates and stores the Calibration Factor (accessible via the RS-232 interface only) to display the calibrated position information (engineering unit) and calibrated analog output (DC voltage). The Calibration Value must be less or equal to the Full Scale Value in the next step.

This operation must be performed using the gage block, micrometer, protractor, or other reference positioning device.

Enter the Calibration Value in engineering units (inch, millimeter, degree, etc.), in the PROGRAM mode: >PROG>CH(A) SETTING>, or >PROG>CH(B) SETTING>.

Step 9: Full Scale Value

This number is the displacement (linear for LVDT, angular for RVDT) for which the transducer is rated (from its zero). Usually an LVDT or RVDT is specified with +/-X range (inch, mm or degree). The full scale is X. It is used to keep track of the transducer's position relative to the electrical zero (null) of the transducer when the ZERO button is pressed to zero the meter.

CAUTION **Exceeding this full scale value will result in an over-range and the display will indicate "FS" in the RUN mode.**

Step 10: Null Position

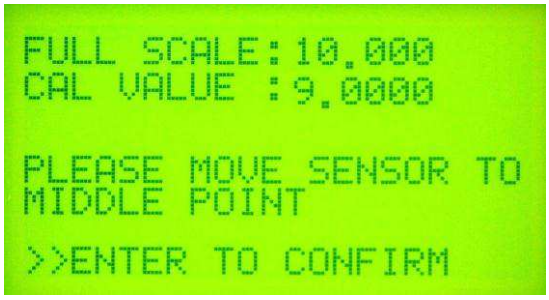
Position the transducer at its zero (middle of the range) or null position. The built-in voltmeter function (see Run Mode in the Operating Instructions section) of the MP-2000 will help you to quickly locate the null position (zero reading). The mechanical zero of the transducer may not be exactly at the null position, but it will be close enough.

You are now ready to calibrate this channel.

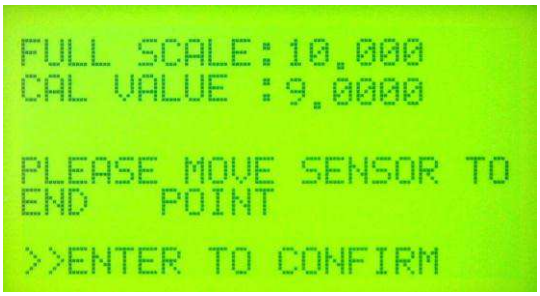
Step 11: Full Scale Setting

In the RUN mode, press **[ENTER]** to go into the one-channel display mode. Press **[ENTER]** again to toggle between CH(A) and CH(B) so you can calibrate the proper channel.

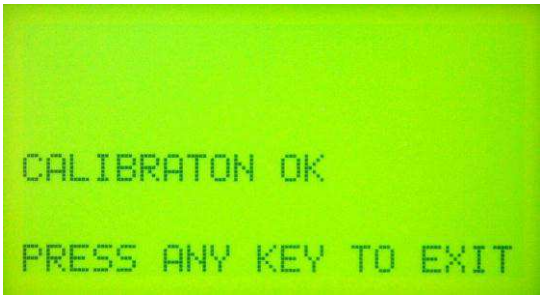
Pressing the **[▼] CAL** button will open the following calibration menu:



Next, press **[ENTER]** to accept this first point of calibration. Ensure that the LVDT does not exceed the Full Scale setting, during the next step.



Displace the sensor the exact distance (in the positive direction), as defined by the calibration value. Press **[ENTER]** to accept this second point of calibration. The screen will display:



Press any key to exit. The calibration process of the selected channel is completed.

Note: The same calibration steps will be used for the other channel (second transducer) if you are using it.

8. RS-232 Programming

8.1 General

See Paragraph "Output Wiring & Schematics" in the "Wiring Instructions" section, which also discusses the DTR and DSR lines. The data is transmitted in the following frame format:

- One Start Bit
- Eight Data Bits
- No Parity Bit
- One Stop Bit

The RS-232 port is active only in the two-line display RUN mode and will not respond in the PROGRAM mode, or in the one-channel display RUN mode.

The MP-2000 can be set to the PROGRAM mode using the front panel pushbuttons. To prevent the risk of someone inadvertently interfering with RS-232 operation, the front panel can be locked by sending the 0x80 Byte periodical to the MP-2000 (please see next paragraph for details). Please refer to the demo program supplied with the MP-2000 for applications of the communication procedures, data format, data-check methods, etc.

8.2 Baud Rate Setting, Auto-Detection, and Handshaking

The RS-232 baud rate can be set to 1200, 2400, 4800, 9600, and 19200. The baud rate is updated as soon as changed.

When the MP2000 receives the 0x80 Byte, it sends the 0x80 Byte in response. This feature is used for two purposes:

1) Baud rate auto-detection: If the DTE (or PC to which the MP-2000 RS-232 is connected) sends 0x80 and receives 0x80 back, then the correct baud rate is being used.

2) Panel lock: The DTE must periodically send the 0x80 Byte to ensure that the RS-232 interface is still connected. Otherwise, the front panel will automatically unlock after it has been missing 0x80 for approximately 30 seconds.

8.3 Commands

RS-232 commands use the following format:

CommandID CommandString VerifyByte 0x0d

0x0d (Carriage return) is always the End Byte for every Command.

When the DTE sends a command to the MP-2000, if the correct response is not received within 1 second, the DTE must repeat the command until the correct response is received.

Note: The CAL (calibration) function is not available via the RS-232 interface. It is only available by using the front panel CAL switch in the RUN menu.

List of the available commands:

Command ID	Command Description	Command/Data String Format
0x50	Preset value for CH(A)	nnnnnnn
0x51	Preset value for CH(B)	nnnnnnn
0x52	Zeroed value for CH(A)	nnnnnnn
0x53	Zeroed value for CH(B)	nnnnnnn
0x54	Full Scale value for CH(A)	nnnnnnn
0x55	Full Scale value for CH(B)	nnnnnnn
0x60	Object to be monitored by SP1	n
0x56	Value of monitored object for SP1	nnnnnnn
0x61	Object to be monitored by SP2	n
0x57	Value of monitored object for SP2	nnnnnnn
0x62	Object to be monitored by SP3	n
0x58	Value of monitored object for SP3	nnnnnnn
0x63	Object to be monitored by SP4	n
0x59	Value of monitored object for SP4	nnnnnnn
0x65	Set point trigger modes	n
0x64	CH(A) and CH(B) gain and excitation voltage	n
0x66	Decimal point CH(A)	n
0x67	Decimal point CH(B)	n
0x6d	Hysteresis value, set-point trigger HIGH	nnnnnnn
0x6c	Hysteresis value, set-point trigger LOW	nnnnnnn
0x68	Oscillator frequency	n
0x69	RS-232 communication baud rate	n
0x6e	Top line display item	n
0x6f	Bottom line display item	n
0x6b	Oscillator source and calibration switch	n
0x46	CH(A) calibration factor	nnnnnnn
0x47	CH(B) calibration factor	nnnnnnn
0x48	CH(A) preset/zero	n
0x49	CH(B) preset/zero	n
0x78	Front panel switches & 300ms data update Byte	n
0x79	CH(A) or (B) reset	n

Note: 0x stands for "Hexadecimal".

Command String

1) For reading a setting:

The Command ID from the DTE is from the above table and the Command String it is the fixed Byte **0x7f.** Format:

CommandID 0x7f VerifyByte 0x0d

The MP-2000 responds with the setting value in the following format:

CommandID DataString VerifyByte 0x0d

The Data String formats are in the above table and in the next pages. In case of an error, the DTE must repeat the command as many times as necessary.

2) For changing a setting:

The Command ID and the Command String formats from the DTE are in the above table and in the next pages. The MP-2000 responds with confirmation of a successful change as follows:

CommandID 0x0d

If no response is received, the command sent by the DTE must be repeated; otherwise the setting will be unknown and could cause unexpected behaviors.

Verify Byte

This Byte (8 bits) is a result of calculation which includes the signed sum (SUM) of the Command IDs and the Command String Bytes:

[(–[Sum of Bytes] + 1) Mod 128] – 1.

However, if the result is 0x0d (which is used as the End Byte), the result will be 0x0d – 1 = 0x0c to avoid an error.

Example:

Reading the Preset Value of CH(A): Command ID = **0x50**
Command String = **0x7f**
Verify byte value = **0x31**
Command format: **0x50 0x7f 0x31**

Calculation for Verify byte: Sum of Bytes = 0x50 + 0x7f = 0xcf = 20710 (decimal); – 20710 = 4910; 4910 + 1 = 5010; 5010 Mod 128 = 5010; 5010 – 1 = 4910 = **0x31**

300ms Data Update

When the DTE initiates this function, and the MP-2000 is in the two-item RUN mode, the values of the two displayed items and the SP status will be broadcast via the RS-232 interface approximately every 300 milliseconds, as long as the MP-2000 it is not busy executing other tasks. To start or stop this function, see under the “Data Formats” paragraph below.

The data is transmitted in 17 sequential Bytes, in text format (ASCII):

Byte number(s):	1 to 7	8 to 14	15	16	17
Description:	Object1 (Item1) value	Object2 (Item2) value	SP Byte	Verify Byte	End Byte 0x0d

8.4 Command/Data String Formats

Menu (mode)	Description	Command ID	Parameter	n hex Byte	Parameter	n hex Byte
CHANNEL DSP ITEM (RUN)	Top or bottom line display	Top line 0x6e Bottom line 0x6f	A	0x30	MIN: A-B	0x37
			B	0x31	TIR: A	0x38
			A+B	0x32	TIR: B	0x39
			A-B	0x33	MAX: A	0x3a
			MAX: A+B	0x34	MIN: A	0x3b
			MIN: A+B	0x35	MAX: B	0x3c
			MAX: A-B	0x36	MIN: B	0x3d
CH SETTING (PROGRAM)	Decimal point	CH(A) 0x66 CH(B) 0x67	.XXXXX	0x30	XXX.XX	0x33
			X.XXXX	0x31	XXXX.X	0x34
			XX.XXX	0x32	XXXXX	0x35
RS-232 SETTING (PROGRAM)	Baud rate	0x69	1200	0x30	9600	0x33
			2400	0x31	19200	0x34
			4800	0x32		
OSC CHOICE (PROGRAM)	Oscillator frequency	0x68	2.5kHz	0x30	5.0kHz	0x32
			3.3kHz	0x31	10kHz	0x33

Description	Byte	nnnnnnn format (7 ASCII Bytes)	Example
Calibration Factor data format Command ID: 0x46 for CH(A); 0x47 CH(B)		**$SEN_1N_2N_3N_4N_5$**	**–254436**
Sign of Exponent	S = + or –		–
Exponent	E = Positive Integer		2
Nx Digits (x=1 to 5)	Nx = Positive Integer		N_1=5; N_2=4; N_3=4;N_4=3; N_5=6
Result	$N_1.N_2N_3N_4N_5$ * 10^(±E)		5.4436 * 10^(–2)

Description	Byte	nnnnnnn format (7 ASCII Bytes)	Example
Data format for all other values (Various commands)		**$SB_1B_2B_3B_4B_5B_6$**	**+25443.**
Sign of Exponent	S = + or –		+
Bx ASCII Byte (x=1 to 6)	Bx = Positive Integer or Decimal Point		B_1=2; B_2=5; B_3=4; B_4=4; B_5=3; B_6=. (Decimal Point)
Range/Result	-99999. To +99999.		-25443

Description	Menu	Bits	n Byte format (8 bits)
CH(A)/(B) Gain & Osc. Volt. Command ID 0x64	PROGRAM mode (see rows below for details)		**0011$V_B V_A G_B G_A$**
CH(B) Oscillator Voltage	OSC CHOICE>OSC VOLT CH(B)	V_B = 1 for 3V; 0 for 1V	
CH(A) Oscillator Voltage	OSC CHOICE>OSC VOLT CH(A)	V_A = 1 for 3V; 0 for 1V	
CH(B) Gain	CH(B) SETTING>GAIN	G_B = 1 for HIGH; 0 for LOW	
CH(A) Gain	CH(A) SETTING>GAIN	G_A = 1 for HIGH; 0 for LOW	
Lock/Unlock front panel & 300ms Data Update Command ID 0x78	Not available in pushbutton menus		**001100PU**
Lock/Unlock panel		P = 1 Locked; 0 Unlocked	
300ms Data Update		U = 1 Start; 0 Stop	
Set-point Trigger Modes Command ID 0x65	PROGRAM mode		**0011$M_1 M_2 M_3 M_4$**
SPx Trigger Mode, x=1-4	SP SETTING>SPx>TRIGGER MODE	Mx = 1 HIGH; 0 LOW	
Calibration Switch & Oscillator Source Command ID 0x6b	PROGRAM SETTINGS mode		**001100CO_S**
CAL in RUN mode switch	CALIBRATE SW>	C=1 ENABLED; 0 DISABLED	
Oscillator Source	OSC CHOICE>OSC SOURCE	O_S = 1 INT; 0 EXT	
Preset and Zero functions Command ID 0x48 for CH(A) and 0x49 for CH(B)	RUN mode, Single Channel Display		**0011$Z_D P_D Z_E P_E$**
Default setting		Default	**00110000**
Zero	Press the **ZERO** button	Z_E = 1 Zero; 0 no action	
Un-zero	Press the **ZERO** and **[ENTER]** buttons simultaneously	Z_D = 1 Un-zero; 0 no action	
Enable the Preset	Press the **PRESET** button	P_E = 1 ON; 0 no action	
Disable the Preset	Press the **PRESET** button again	P_D = 1 OFF; 0 no action	
Note: Only one bit can be changed to 1 at the time. If more than one bit is changed to 1 at once, the command will be ignored.		*Example, Enable Preset:*	**00110001**
CH(A)/(B) Min/Max/TIR Reset Command ID 0x79	RUN mode, single channel display Press **[MENU]** and **[ENTER]** simultaneously to reset the channel		**001100$R_B R_A$**
CH(B) Reset		R_B = 1 Reset; 0 no action	
CH(A) Reset		R_A = 1 Reset; 0 no action	

9. Glossary of Terms

Full Scale Value

Usually an LVDT or RVDT is specified with +/-X range (inch, mm or degree). The full scale is X.

Calibration Value

A number used by the MP-2000 microprocessor as the value to be displayed when the front panel CAL switch is depressed during calibration. The value is used as one the two points, along with the zero, to define the straight line and calculate the calibration slope.

Calibration Factor

The calibration (CAL) uses the Calibration Value defined above to calculate and store the Calibration Factor (accessible via the RS-232 interface only) which enables display of the calibrated position information (engineering unit) and output of the calibrated analog DC voltage.

Hysteresis

These are two absolute value numbers that are added to or subtracted from the set-point values only when the set-points are activated.

The HIGH Hysteresis value is subtracted from the high set-point values and compared to the scaled reading. If the scaled reading is less than the net value, the high set-point is deactivated.

The LOW Hysteresis value is added to the low set-point values and compared to the scaled reading. If the scaled reading exceeds the net value, the low set-point is deactivated.

Open Collector

This is a type of digital TTL output. It consists of an output from the Collector of a transistor (without a pull-up or pull-down resistor) whose Emitter is tied to common (NPN transistor) or +VDC (PNP transistor). Normally, the output is floating. When the transistor is turned on, the output is tied to +VDC (NPN) or Common (PNP). It may be thought of as a normally open switch. The Set-point outputs of the MP-2000 use NPN transistors.

Preset Value

The Preset value is a constant that is added to or subtracted from the pre-scaled and zeroed reading. It is normally used to add a fixed value to differential measurements in order to display the full dimension.

Set-points (SP1 thru SP4)

These four programmed values are constantly compared to the scaled reading on the display.

A HIGH set-point will trigger when the scaled reading exceeds the set-point value. The open collector output for the activated set-point will turn on and the corresponding front panel annunciator light will illuminate. If the displayed reading is equal to or less than the high set-point value, nothing will happen. If the high set-point value is exceeded, the reading must then drop below the set-point value less the HIGH Hysteresis value before the output deactivates and the annunciator light turns off.

A LOW set-point activates when the scaled reading is less than the set-point value. The open collector output for the activated set-point will turn on and the corresponding front panel annunciator light will illuminate. If the displayed reading equals or exceeds the set-point value, nothing will happen. If the displayed reading drops below the set-point value, it must then exceed the set-point value plus the LOW Hysteresis value before the output deactivates and the annunciator light turns off.

10. Error Codes

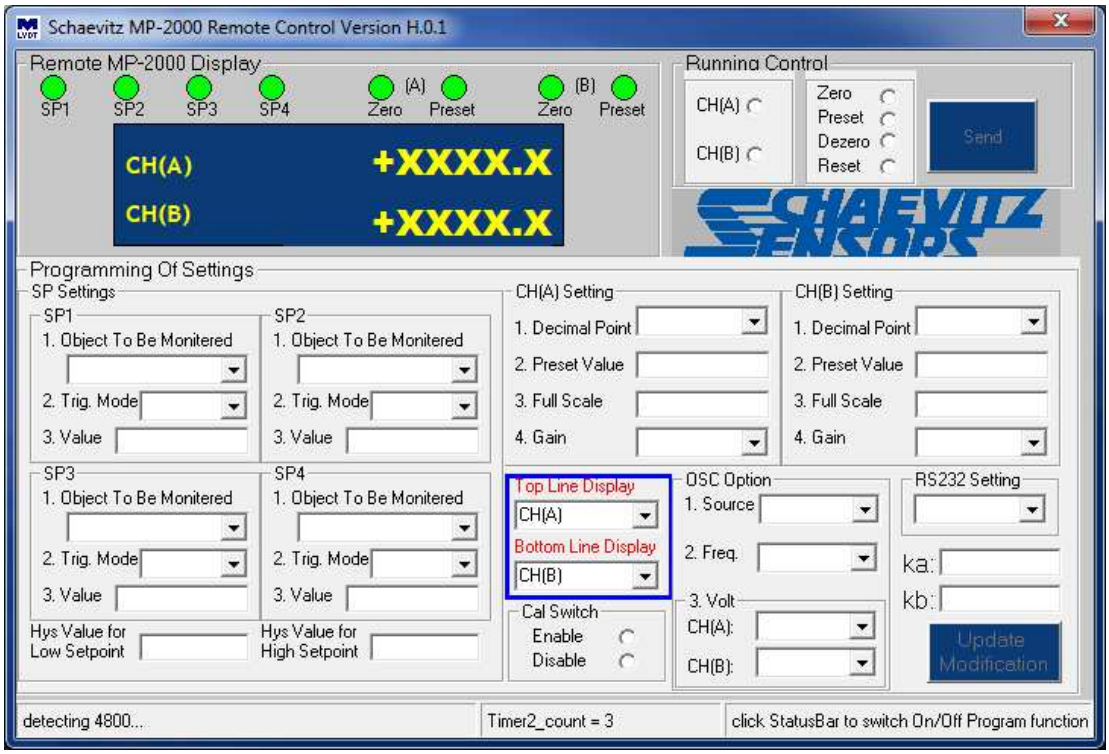
The MP-2000 may display some warnings if you perform an improper operation or enter an incorrect setting input. Here is a list of all the error codes and their references.

Error Code #	Cause/Explanation
01	Calibration switch is disabled
02	Calibration value is invalid. Must be positive and less than 99999.0
03	Calibration value for CH(A) is invalid. Must be positive and less than 99999.0
04	Calibration value for CH(B) is invalid. Must be positive and less than 99999.0
05	Full Scale value for CH(A) is invalid. Must be positive and less than 99999.0
06	Full Scale value for CH(B) is invalid. Must be positive and less than 99999.0
07	SP1 monitored value for CH(A) is invalid. Must be between -99999.0 and +99999.0
08	SP2 monitored value for CH(A) is invalid. Must be between -99999.0 and +99999.0
09	SP3 monitored value for CH(A) is invalid. Must be between -99999.0 and +99999.0
10	SP4 monitored value for CH(A) is invalid. Must be between -99999.0 and +99999.0
11	Preset value for CH(A) is invalid. Must be between -99999.0 and +99999.0
12	Preset value for CH(B) is invalid. Must be between -99999.0 and +99999.0
13	Zero value for CH(A) is invalid. Must be between -99999.0 and +99999.0
14	Zero value for CH(B) is invalid. Must be between -99999.0 and +99999.0
15	Calibration factor for CH(A) is invalid. Must be positive.
16	Calibration factor for CH(B) is invalid. Must be positive.
17	SP1 monitored object value is invalid. Must be 13 maximum (14 choices)
18	SP2 monitored object value is invalid. Must be 13 maximum (14 choices)
19	SP3 monitored object value is invalid. Must be 13 maximum (14 choices)
20	SP4 monitored object value is invalid. Must be 13 maximum (14 choices)
21	Decimal point value for CH(A) is invalid. Must be 5 maximum (6 places only)
22	Decimal point value for CH(B) is invalid. Must be 5 maximum (6 places only)
23	Oscillator frequency value is invalid. Must be 3 maximum (4 frequency choices)
24	Preset or Zero error for CH(A) or (B).
25	Hysteresis LOW value is invalid. Must be between -99999.0 and +99999.0
26	Hysteresis HIGH value is invalid. Must be between -99999.0 and +99999.0
27	Run mode top line display item number is invalid. Must be 13 maximum (14 choices)
28	Run mode bottom line display item number is invalid. Must be 13 maximum(14 choices)
29	RS-232 Baud rate is invalid. Must be 4 maximum (5 baud rate choices)
30	Will restore MP-2000 settings to factory defaults
31	Displacement exceeds 2x Full Scale; the Zero function is disabled

The error codes will be displayed as shown in the following screen shot (example shown for Error Code #01):

11. Remote Control Program

A remote control demo program is provided with the MP-2000. After selecting the COM port of the DTE (or PC to which the MP-2000 is connected), the following setup screen will allow setting up the parameters instead of using the front panel switches:



12. Mounting Instructions

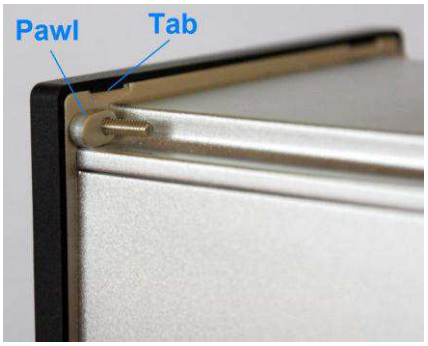
12.1 Cutout

The MP-2000 is designed for ¼ DIN panel mounting. The cutout dimensions are 3.622 +0.032/-0.000 inch (92 +0.8/-0.0mm) square. The mounting system will accommodate any panel thickness between 1/16 inch (1.6 mm) and 1/4 inch (6.35 mm

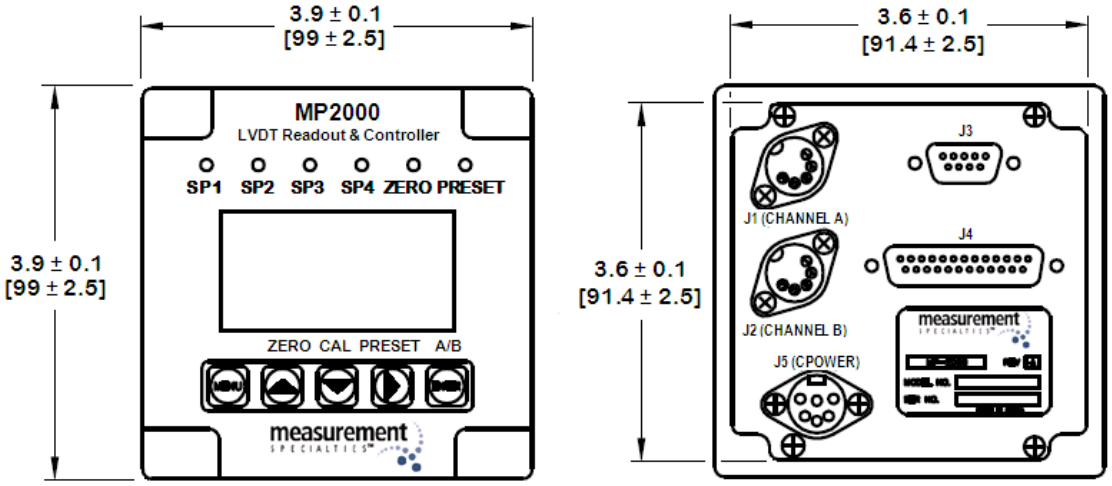
12.2 Installation

To panel mount the MP-2000, perform the following steps:

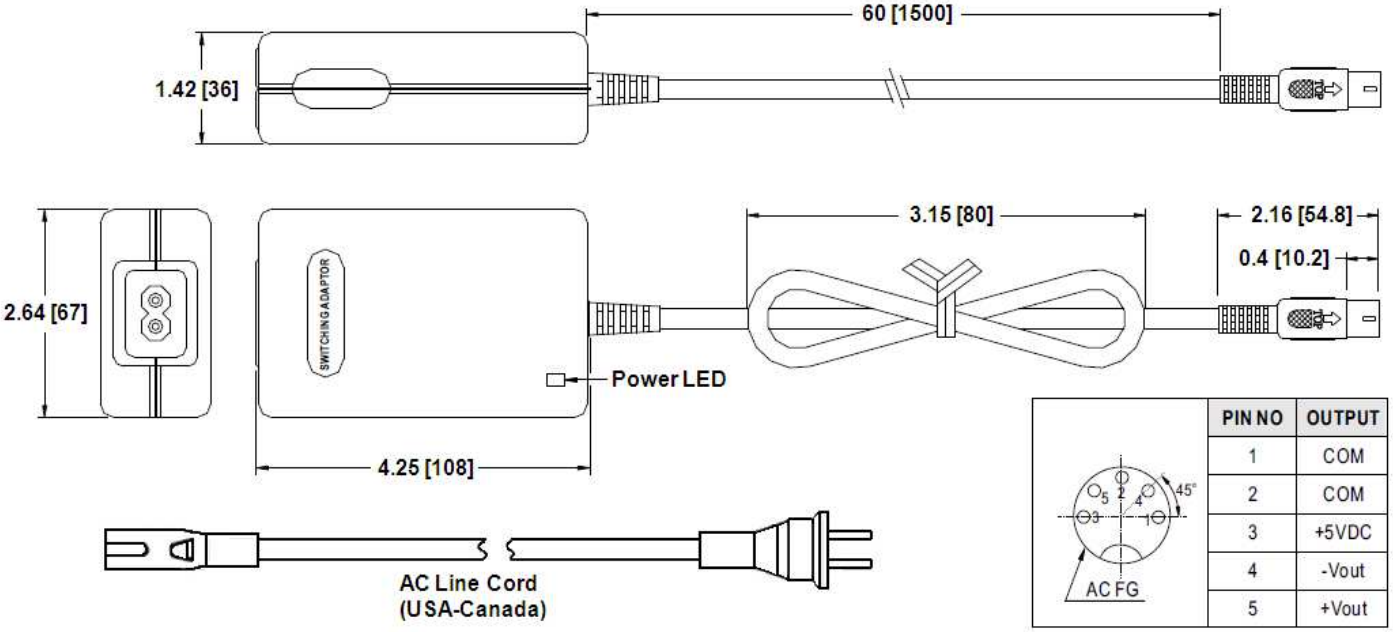
- Remove the plastic bezel from the front of the unit being careful not to damage it (pull it out with two fingers at the top or bottom tabs).
- Rotate the four pawl screws (outside screw in each corner) several turns counter-clockwise to retract the pawls. Make sure the pawls retract enough to clear the back of the mounting panel.
- Insert the unit into the panel cutout.
- Position pawls so that their elongated dimension overlaps the panel cutout; then tighten the screws. Do not over-tighten.
- Re-install the bezel, being careful not to damage it (make sure to align the tabs)



13. Dimensions, MP-2000

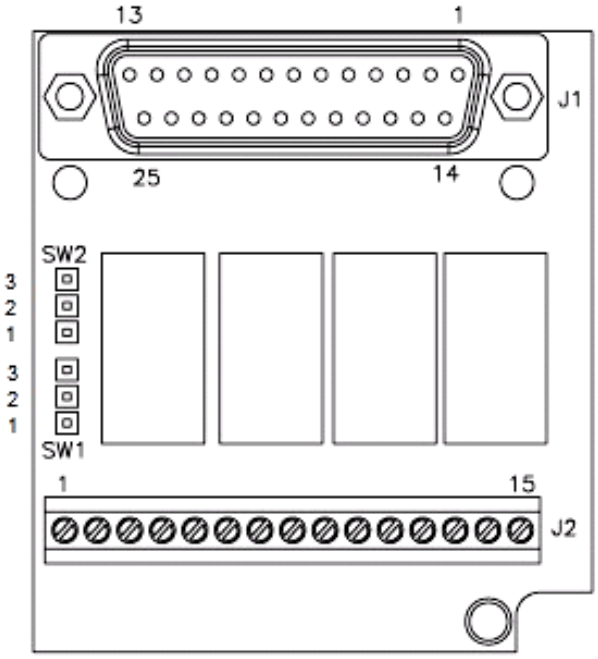


14. Dimensions, Power Supply *(Provided with MP-2000)*



PIN NO	OUTPUT
1	COM
2	COM
3	+5VDC
4	-Vout
5	+Vout

15. Relay Board (Sold separately)



J1

Func.	Term #
Analog Gnd	25
Digital Gnd	24
Analog Out Ch A	21
Analog Out Ch B	20
Remote Reset	19
Remote Zero	14
Osc Sync Output	8
Osc Sync Input	7
Reboot	6
RXD	5
DTR	4
TXD	3
DSR	2

J2

Relay	Func.	Term #
Set-point 1	NO	8
	NC	7
	COM	15
Set-point 2	NO	6
	NC	5
	COM	14
Set-point 3	NO	4
	NC	3
	COM	11
Set-point 4	NO	2
	NC	1
	COM	9
	+5VDC	12
	Return	13

Jumpers

SW1	Pin #1 and #2 shorted	Pin #2 and #3 shorted
SW2	Pin #2 and #3 shorted	Pin #1 and #2 shorted
Function	+5Vdc relay power supplied by MP-2000	External +5Vdc relay power required on terminal #12 on J2

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