MACRO SENSORS™
Division Of Howard A. Schaevitz Technologies, Inc.

USER MANUAL

DMI-A1 Series

LVDT Indicators

- **1/8 DIN Case**
- **3-button Front Panel Operation**
- **5-digit, 7-segment 0.56” (14.2 mm) LED Display**

The easiest solution to single input LVDT display and control applications

Introduction

The DMI-A1 Series are LVDT (Linear Variable Differential Transformer) indicators that deliver precise measurement and indication for applications using a single LVDT input.

The 5-digit, 7-segment LED display provides configuration setup prompts for LVDT parameters using intuitive, easy to follow text menus.

Setup

- Select 50 or 60 Hz supply frequency.
- Select decimal point position setting with resolution to 0.0001 of any engineering unit.

Calibration

- Locate the sensor NULL position.
- **Input Signal Calibration**: Perform 2-point zero and span input signal calibration setting.
- **Analog Output Signal Calibration**: Calibrate analog output milliamp or voltage output low and high settings.

Analog Output Scaling

Set the analog output low (zero) and high (full scale) range settings.

Setpoints

Four independent setpoints with individually configured setpoint actuation values, preprogrammed for above or below activation:

- Lo 1, Lo 2 activates below value.
- hi 1, hi 2 activates above value.

Options

- **Relays:** Four 5 amp relays.
- **Analog Output Options**

  0/4 to 20 mA (or reverse).

  Single 0 to 10 V DC (or reverse).
- **Display Zero**

  Preprogrammed function requires customer supplied switch to operate.
- **Reset Display Value**

  Preprogrammed function requires customer supplied switch to operate.

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Specifications

General

Digital Display: 7-segment, 0.56” (14.2 mm) LEDs.

Display Color: Red

Display Range: -19999 to 99999.

Display Update Rate: 10 times per second.

Display Dimming: 8 brightness levels. Front panel selectable.

Polarity: Assumed positive. Displays – negative.

Annunciators: 6 red LEDs on front panel.

Overrange Indication: oUEr

Underrange Indication: undEr

Front Panel Controls: PROGRAM, UP, and DOWN buttons.

Power Supplies

Standard high voltage AC / DC power supply 85-265 V AC / 95-370 V DC.

Optional low voltage AC / DC power supply 18-48 V AC / 10-72 V DC.

Environmental

Operating Temperature: 0 °C to 50 °C (32 °F to 122 °F).

Storage Temperature: -20 °C to 70 °C (-4 °F to 158 °F).

Relative Humidity: 95% (non-condensing) at 40 °C (104 °F).

Mechanical

Case Dimensions: 1/8 DIN, 96x48 mm (3.78” x 1.89”).

Case Depth: 137 mm maximum (5.39”).

Case Material: 94V-0 UL rated self-extinguishing polycarbonate.

Weight: 11.5 oz (0.79 lbs), 14 oz (0.96 lbs) when packed.

Approvals

CE: As per EN-61000-3/4/6 and EN-61010-1.

LVDT Input

Excitation Voltage: 3 V RMS sine wave, zero DC component THD <2% (1.2 kHz).

Excitation Frequency: 50 Hz: 3.2 kHz. 60 Hz: 2.88 kHz.

For other excitation frequencies contact Macro Sensors.

Temperature Coefficient: ± 50 ppm/ ° C of full scale (typical).

LVDT Input: 30 k input impedence. Synchronous demodulation of excitation carrier. >130 db rejection of excitation carrier.

Frequency Response: 500 Hz (–3 db) low-pass filter.

Analog to Digital: Single channel ΣΔ A/D convertor approaching 19-bit resolution. Ratiometric operation relative to excitation voltage magnitude.

Output Rate: 10 Hz averaged response output.

Line Frequency Rejection: 50 / 60 Hz noise rejection.

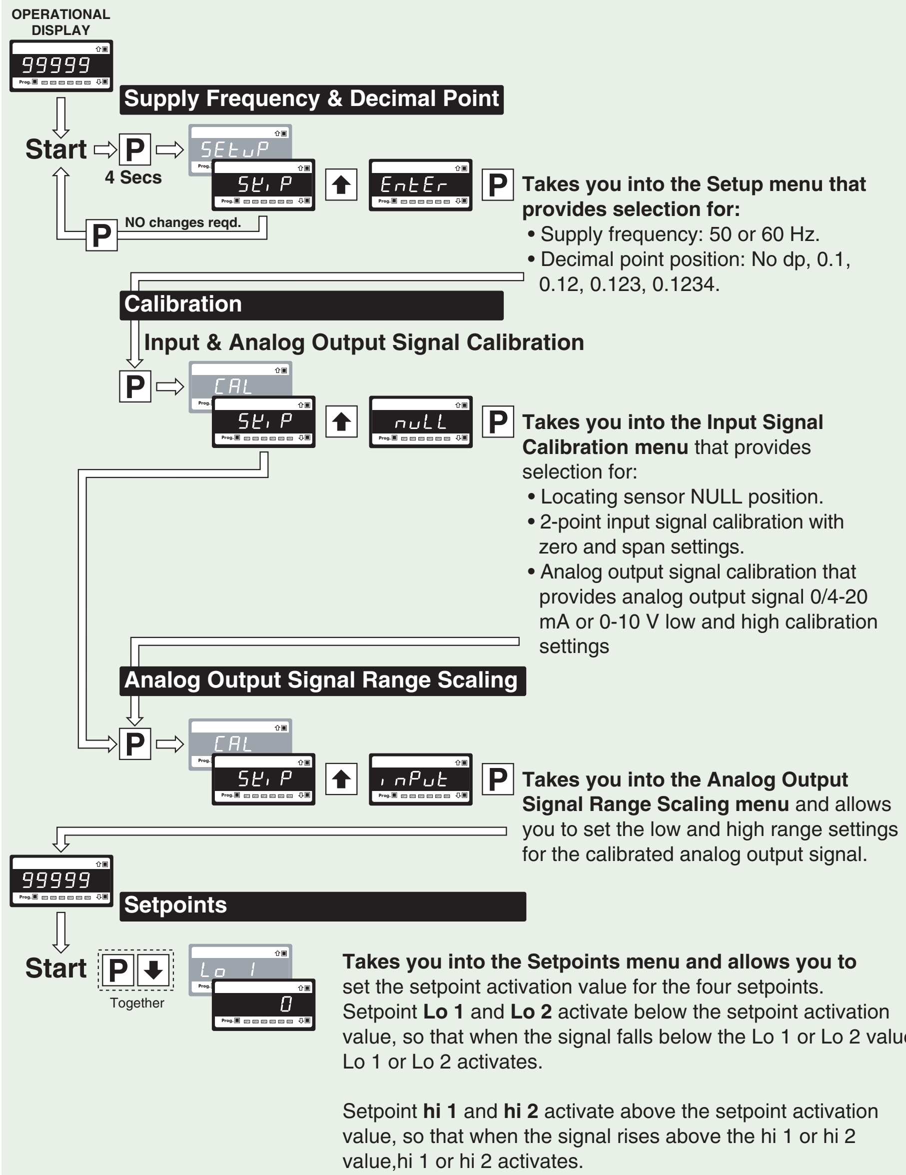
Relays

Plugs into carrier board from rear:

Four 5 A Form A Relays.

Form A Relay Specifications: 5 A 240 VAC. Isolation 3000 V. UL and CSA listed.

The Configuration Menu shown opposite is a flow diagram of the DMI-A1 Series configuration menus and describes the settings and parameters that can be applied in each menu.



Supply Frequency & Decimal Point

The **supply frequency and decimal point** menu allows you to configure:

- The power supply frequency: 50 or **60** Hz (60 Hz is the factory default setting).
- The position of the decimal point: No decimal point, 0.1, **0.12** (default), 0.123, 0.1234.

Calibration

The **LVDT input signal calibration** menu allows you to set the null position of the sensor, if required, and also allows you to perform a 2-point zero and span calibration of the input signal.

The **analog output signal calibration** menu allows you to calibrate the analog output's milliamp or voltage output to suit your application.

Calibrating the analog output requires setting the milliamp or voltage output low [CAL_L] and high [CAL_h] parameters using a multimeter connected to the analog output signal (See Figure 1 for an DMI-A1-100 to multimeter connection diagram). The calibrated low and high outputs can be set anywhere between –0.3 to +21 mA for current or –0.3 V to +10.5 V for voltage.

Once the milliamp or voltage output is calibrated, the analog output range can be easily rescaled [An Lo] [An hi] using the analog output scaling mode without having to recalibrate the milliamp or voltage output. The calibrated low and high milliamp or voltage output signal values follow the new span range.

See **Analog Output Procedures** for an analog milliamp or voltage output calibration procedure.

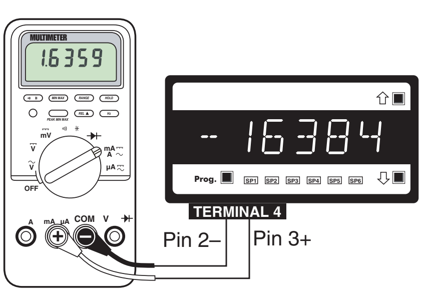


Figure 1 – Multimeter Connections

Analog Output Signal Range Scaling

The analog output module is a standard single channel, programmable, isolated, 16-bit analog output that can be scaled to any desired span between –19999 to 99999 display counts using the **analog output signal range scaling** menu.

Setpoints

The **setpoints** menu allows you to set the setpoint activation value for four separate setpoints (two low and two high) which can be used to activate the four 5A relays.

Display Zero and Reset Display Value

The DMI-A1 Series indicators are programmed with a **display zero** and **reset display value** function. The **display zero** function is used to zero the display when the sensor is in any position.

Display zero is initiated from a remote switch (not supplied) connected across the **common** and **hold** pins at the rear of the controller (Terminal 2: Pin 4 Common, Pin 2 Hold).

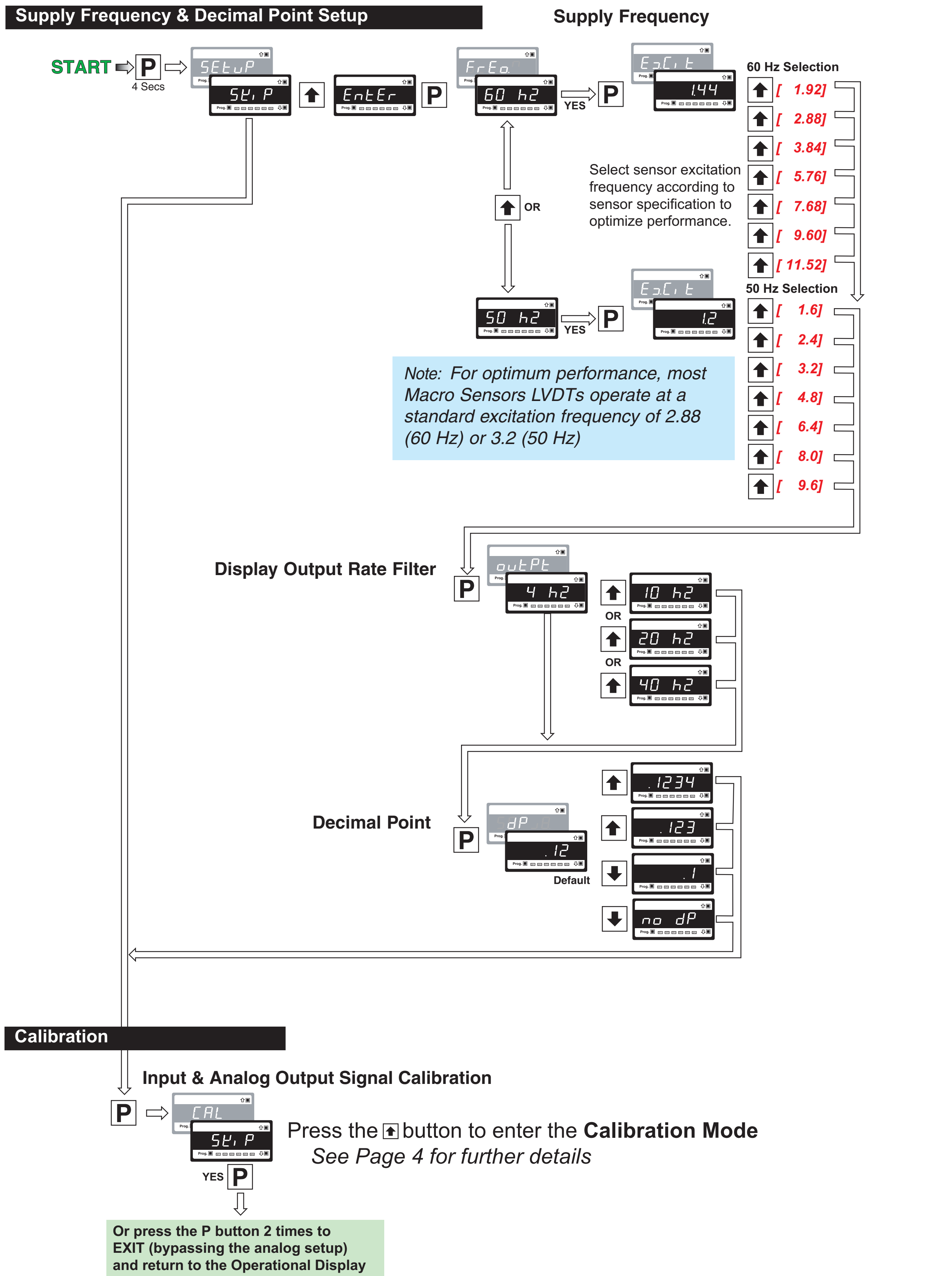
The **reset display value** function is used to restore the true calibrated value on the display.

Reset display value is initiated from a remote switch (not supplied) connected across the **common** and **lock** pins at the rear of the controller (Terminal 2: Pin 4 Common, Pin 1 Lock).

The display zero value and reset display value are not retained during a power outage. The display zero and reset display value functions are often used for cut, measure, and trim applications.

Supply Frequency & Decimal Point Setup

The **supply frequency & decimal point setup** mode allows you to configure the power supply frequency and the position of the display decimal point.



Calibration Mode (LVDT Input Signal Calibration)

The Calibration Mode is divided into two separate sections;

a) **calibration of the LVDT input signa**l and

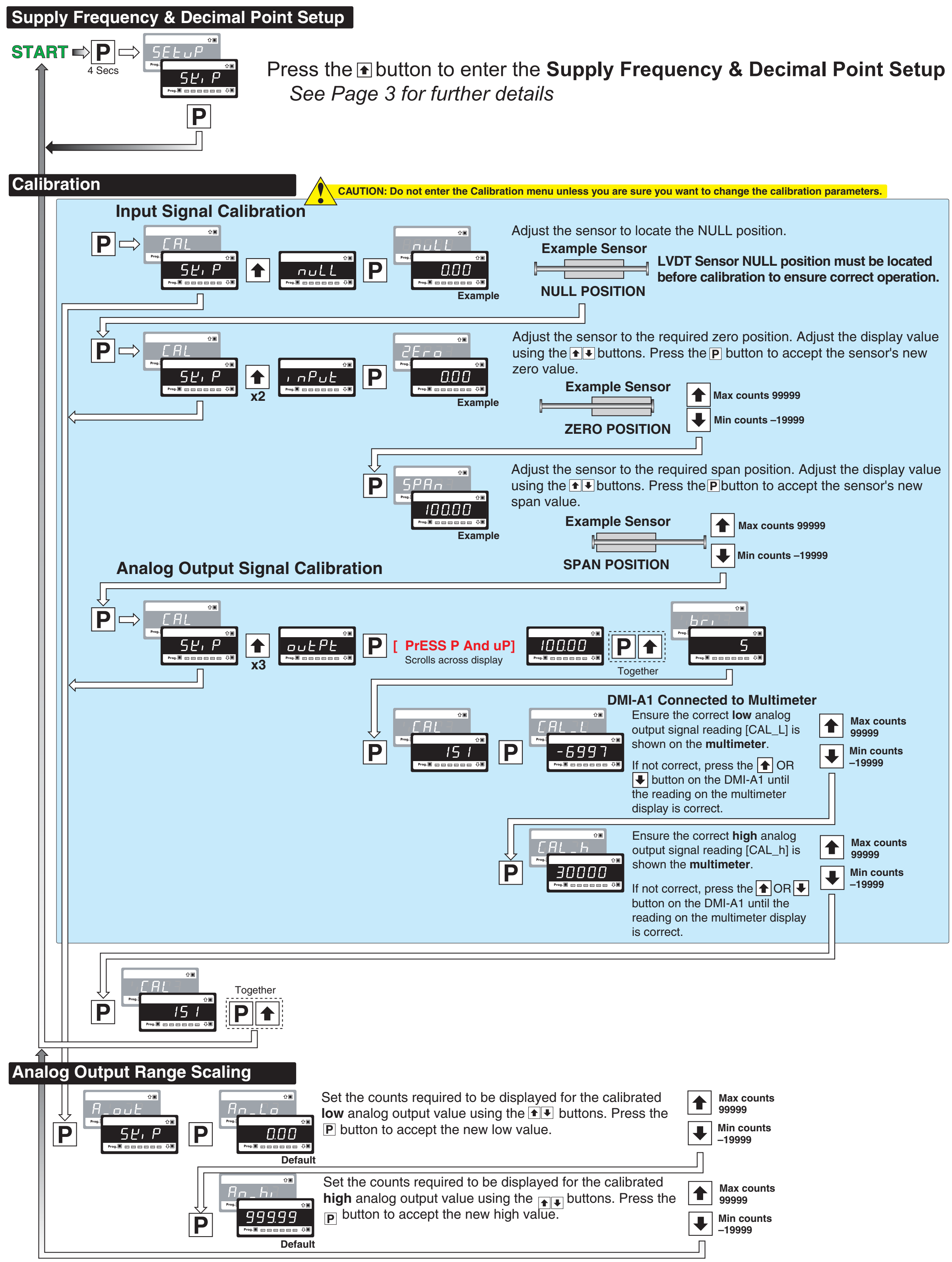
b) **calibration of the analog output signal**

The **Input Signal Calibration** mode is used to calibrate the physical position of the sensor to the meter display. The Input Signal Calibration mode provides two individual calibration techniques which are shown in the diagram below.

These are:

- Adjusting the LVDT to a null position.
- A dual position, zero and span calibration procedure.

Note: Calibration procedures can not be carried out on a signal if the signal has an active linearization table. The table or tables must be disabled before calibration and then re-activated when calibration is complete.



Calibration Mode (Zero Options)

NULL

The NULL position allows the user to adjust the LVDT core until the LVDT output is zero. The sensor must be brought to NULL position before calibrating. The "NULL" position is the physical point at which the LVDT output is "electrically centered" (neither positive or negative). This corresponds roughly to the mechanical center of the unit. Please refer to the "N" dimension on the line drawing of your particular LVDT at www.macrosensors.com.

Display Zero and Reset Display Value Function

The controller has been programmed with a **display zero** and **reset display value** function that operates on the selected primary display reading only.

The **display zero** function is used to zero the display. Display zero is initiated from a remote momentary switch (not supplied) connected across the **common** and **hold** pins at the rear of the controller (Terminal 2: Pin 4 Common, Pin 2 Hold).

The **reset display value** function is used to restore the true calibrated value on the display. Reset display value is initiated from a remote momentary switch connected across the **common** and **lock** pins at the rear of the controller (Terminal 2: Pin 4 Common, Pin 1 Lock).

The display zero value and reset display value are not retained during a power outage. The display zero and reset display value functions are often used for cut, measure, and trim applications.

Calibration Mode (Analog Output Signal Calibration)

Calibrating the analog output means ensuring the LOW and HIGH analog output signals are correct using a calibration device such as a multimeter. **<u>This should not be confused with calibrating the physical position of the sensor to the meter (see page 4)!</u>**

Calibration requires setting the [CAL_L] and [CAL_h] parameters. [CAL_L] is used to set the calibrated **low** analog output, and [CAL_h] is used to set the calibrated **high** analog output. The calibrated low and high outputs can be set anywhere between –0.3 to 21 mA for current, or –0.3 to 10.5 V for voltage.

Before calibrating the analog output:

- See Figure 1. Connect a multimeter to the analog output connector at the rear of the meter (Terminal 4: Pin 3 positive, Pin 2 negative).
- Make sure the multimeter is set to read the appropriate signal type: volts or milliamps.
- Check the analog output scaling (zero and full scale display settings) and if necessary, carry out the analog output scaling procedure to set zero and full scale settings.
- Check the analog output on the multimeter at the zero and full scale display settings and, if required, carry out the analog output calibration procedure to calibrate the millamp (or voltage) output low and high settings.

A step by step procedure that shows an actual example of how to calibrate the analog output signal is shown on page 11 of this manual.

Note: Calibration procedures can not be carried out on a signal if the signal has an active linearization table. The table or tables must be disabled before calibration and then re-activated when calibration is complete.

Analog Output Range Scaling Mode

The analog output module is a standard single channel, programmable, isolated, 16-bit analog output that can be scaled to any desired span between –19999 to 99999 display counts using the **analog output scaling mode**.

Range Scaling

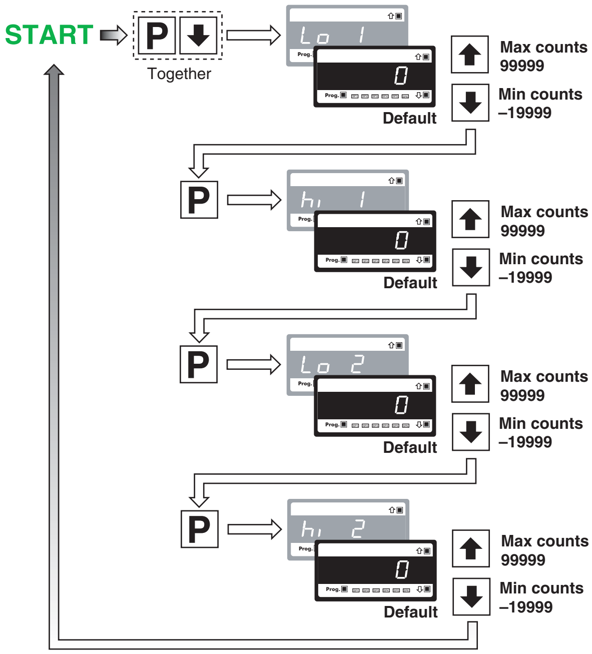
Range scaling requires setting the low analog output value [Ao_Lo] and high analog output value [Ao_hi] of the analog output.

The low value is the display setting at which the analog output is required to be at its calibrated **low** output. The high value is the full scale display setting at which the analog output is required to be at its calibrated **high** output.

There are no limits to the difference between the zero and full scale settings. The difference can be anywhere between 1 count and the entire display range of the meter.

A step by step procedure that shows an actual example of how to scale the analog output is shown on page 10 of this manual.

Setpoints



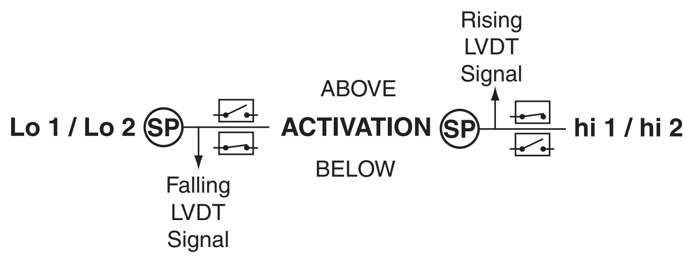
Setpoint Activation

The four setpoints are grouped together in two pairs:

- Setpoint Lo 1 (SP1) and hi 1 (SP2).
- Setpoint Lo 2 (SP3) and hi 2 (SP4).

Low setpoints Lo 1 and Lo 2 are programmed to activate on a **falling signal below** the setpoint activation setting.

High setpoints hi 1 and hi 2 are programmed to activate on a **rising signal above** the setpoint activation setting.



Input Signal Setup Procedures

Technical Description

See Figure 2. The LVDT smart input module is designed to drive and condition the signal from an LVDT transducer. The module contains two high-speed microcontrollers and a synchronous demodulator 16-bit dual channel A/D convertor. It communicates with a DMI-A1 indicator via the I^{2}C data bus. One of the microcontrollers generates the sine wave for the LVDT excitation frequency. The frequency is produced as multiples of the line frequency (either 50 Hz or 60 Hz). The output to the primary coil of the LVDT is a 3 V RMS sine wave. The received LVDT signal is synchronously demodulated and filtered to remove the carrier frequency. The Σ Δ 16-bit A/D convertor has over 130 dB noise rejection at the excitation frequency.

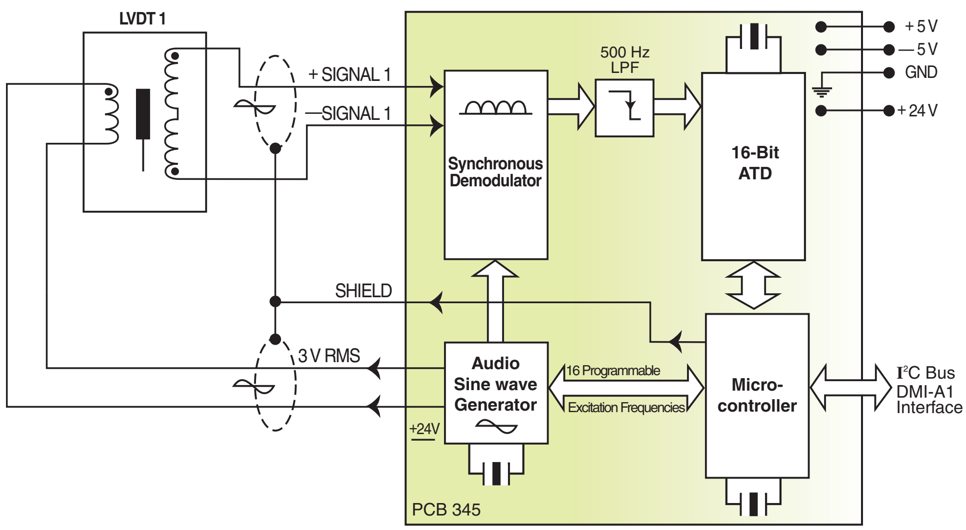


Figure 2 – LVDT Smart Input Module Functional Schematic

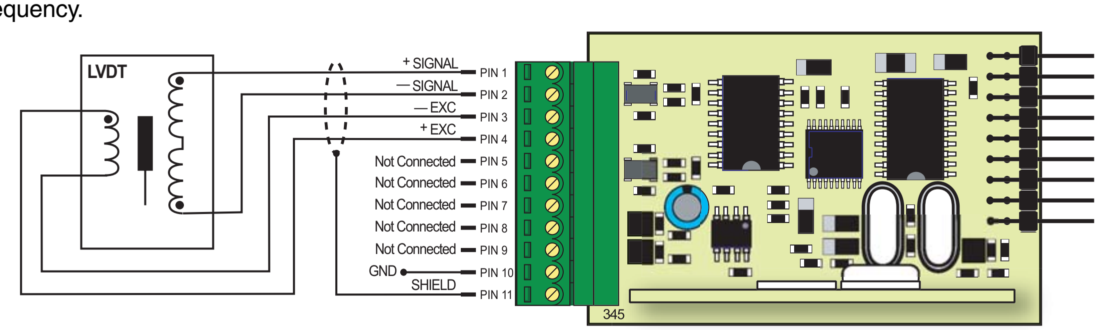


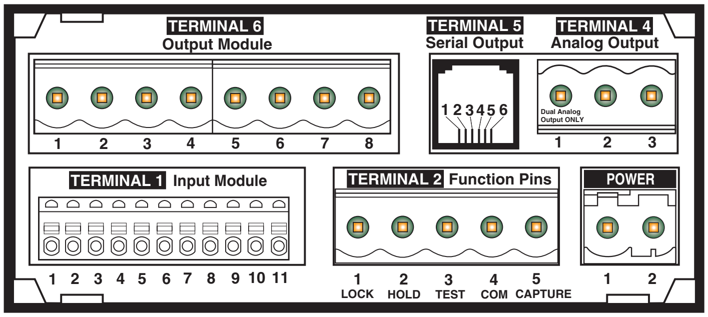
Figure 3 – Example LVDT Input Connection to LVDT Smart Input Module

Connector Pinouts

All external connections to the DMI-A1 is via the following six connector terminal blocks located at the rear of the controller:

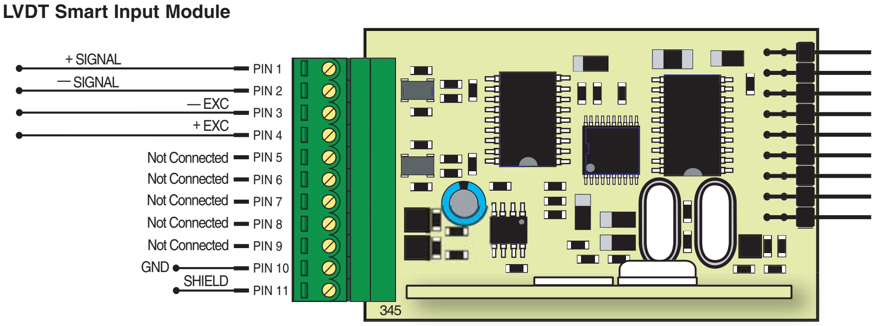
- Terminal 1: LVDT Input Signals.
- Terminal 2: Function Pins.
- Power: AC / DC Power Supply.
- Terminal 4: Analog Output (optional).
- Terminal 5: Serial Output (optional).
- Terminal 6: Relay Output Module.

DMI-A1 indicators use plug-in type screw terminal connectors for most input and output connections, an RJ-11 phone connector for the optional RS-232 serial output, and an RJ-45 phone connector for the optional Ethernet output.



WARNING: AC and DC input signals and power supply voltages can be hazardous. Do not connect live wires to screw terminal plugs, and do not insert, remove, or handle screw terminal plugs with live wires connected.

Figure 4 – Rear Panel Pinout Diagram

Connector	Pin	Name	Description
TERMINAL 1 **Input Signals** Pins 1 up to 11	1 2 3 4 5 6 7 8 9 10 11	+ Signal – Signal –Excitation +Excitation Not Connected Not Connected Not Connected Not Connected Not Connected Ground Shield	**LVDT Smart Input Module** 
TERMINAL 2 **Function Pins** Pins 1 to 5	1	Reset Display Value (Lock)	By connecting Pin 1 (**lock**) to Pin 4 (**common**) with a remote spring-return switch restores the display to the true calibrated value.
	2	Display Zero (Hold)	By connecting Pin 2 (**hold**) to Pin 4 (**common**) with a remote spring-return switch zeroes the display.
	3	Display Test and Reset	Pin 3 (**display test** and **reset** pin) provides a test of the controller's display and resets the microprocessor when Pin 3 is connected to Pin 4.
	4	Common	To activate the **hold**, **test and reset**, or **lock** pins from the rear of the controller, the respective pins have to be connected to the **common** pin.
	5	-	- **For further details on the function pins, contact Macro Sensors.**
POWER **Auto Sensing AC / DC Power Supply** Pins 1 and 2	1 2	AC Neutral / DC – AC Line / DC +	The **power** connector supplies AC / DC power to the controller via a standard high voltage or optional low voltage auto-sensing power supply mounted on the main board. **PS1**: Standard High Voltage option. 85-265 V AC / 95-370 V DC. **PS2**: Optional Low Voltage option. 14-48 V AC / 10-72 V DC.

Connector	Pin	Name	Description

TERMINAL 4

Analog Outputs

Pins 1 to 3

TERMINAL 4 connects the analog output module to external devices. A single 0~4 to 20 mA (standard) or (optional) 0 to 10 V DC is supported on the standard or Ethernet carrier board.

Pin	Name	Description
1	-	-
2	Negative (–)	Negative for Analog Output.
3	Positive (+)	Positive for Analog Output .

TERMINAL 5

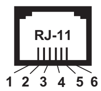
Serial Outputs

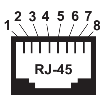
Pins 1 up to 8

TERMINAL 5 connects an optional serial output module to external devices.

The **standard** carrier board supports a single or dual RS-232 ASCII or Modbus serial card connected thru an RJ-11 socket.

The **Ethernet** carrier board uses an RJ-45 socket at 10/100 Base-T.





Pin No.	STANDARD CARRIER BOARD RS-232 (ASCII or Modbus) RJ-11 Socket Single Output	Dual Output	ETHERNET CARRIER BOARD RJ-45 Socket (10/100 Base-T)	
1	Reserved for future use	RXD1	White/Orange	TXD+
2	Isolated Ground	0 V	Orange	TXD–
3	+5 VDC to power external converters	0 V1	White/Green	RXD+
4	TXD. Transmitted Serial	TXD	Blue	–
5	RXD. Received Serial	RXD	White/Blue	–
6	Reserved for future use	TXD1	Green	RXD–
7	Not applicable	Not applicable	White/Brown	–
8	Not applicable	Not applicable	Brown	–

TERMINAL 6

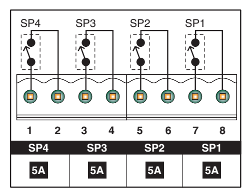
Relay Outputs

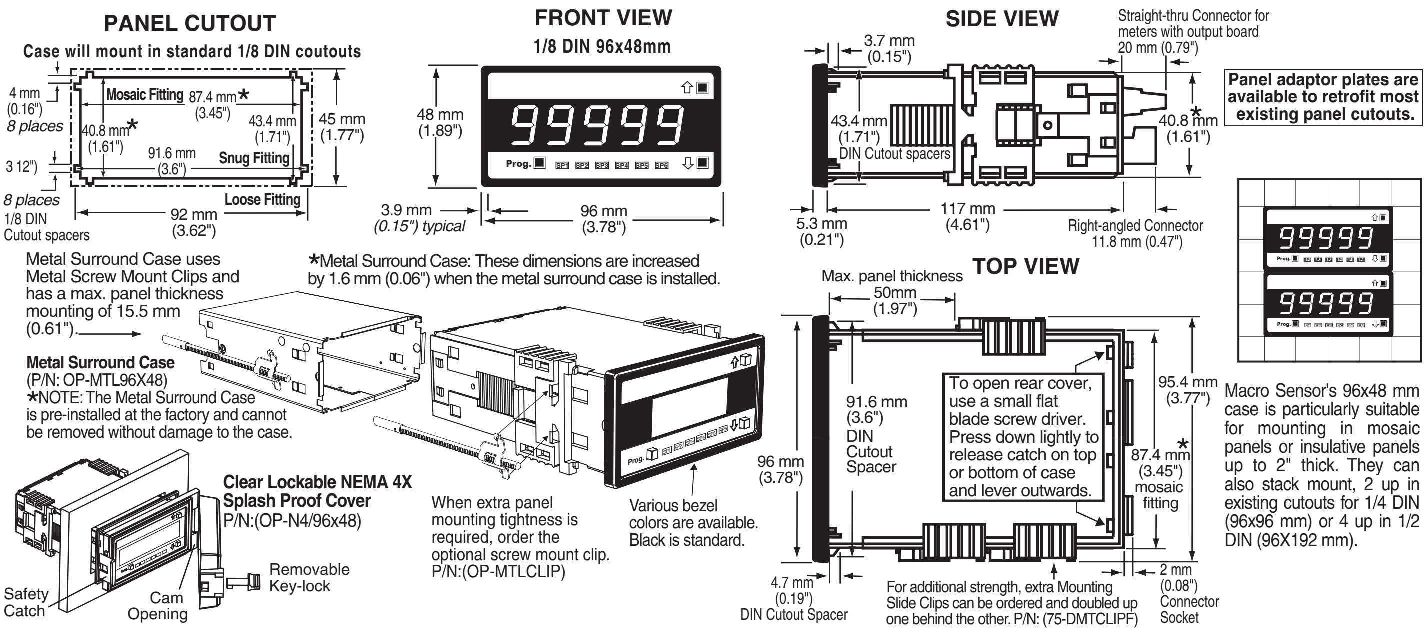
Pins 1 up to 8

TERMINAL 6 connects electromechanical relays to external applications.

With 4 relays installed, an 8-pin connector block is used.

Pin	Name	Description
1	Normally Open SP4	Relay Modules with Four 5 A Form A Relays
2	Common SP4	
3	Normally Open SP3	
4	Common SP3	
5	Normally Open SP2	
6	Common SP2	
7	Normally Open SP1	
8	Common SP1	





Installation Procedure

WARNING

AC and DC power supply voltages are hazardous. Make sure the power supply is isolated before connecting to the meter.

STEP A Prepare the Panel

1) Cut a hole in the panel to suit the panel cutout. See panel cutout sizes above.

STEP B Install the Meter

1) Remove both mounting clips from the meter. ①

2) Push the meter into the panel cutout from the front of the panel. ②

3) Attach both mounting clips to the meter from the rear of the panel and push them towards the front of the panel until the meter is firmly held. ③

STEP C Connect the Cables

1) Connect all input and output signal cables to the connector pins (See *Connector Pinouts* for details).

2) Connect the power cables to the connector pins (See *Connector Pinouts* for details).

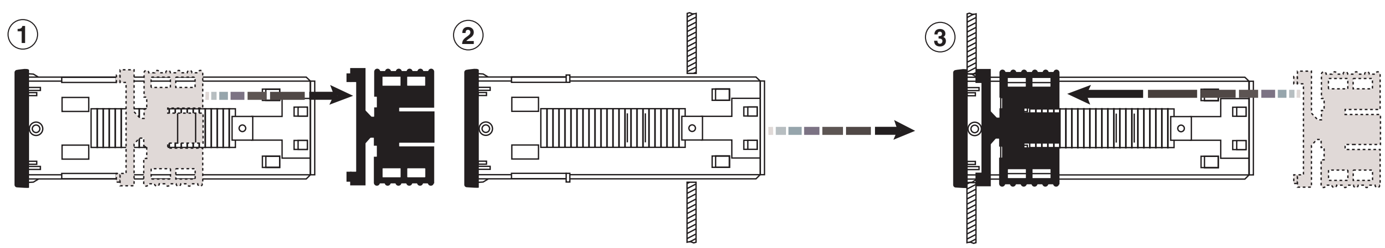
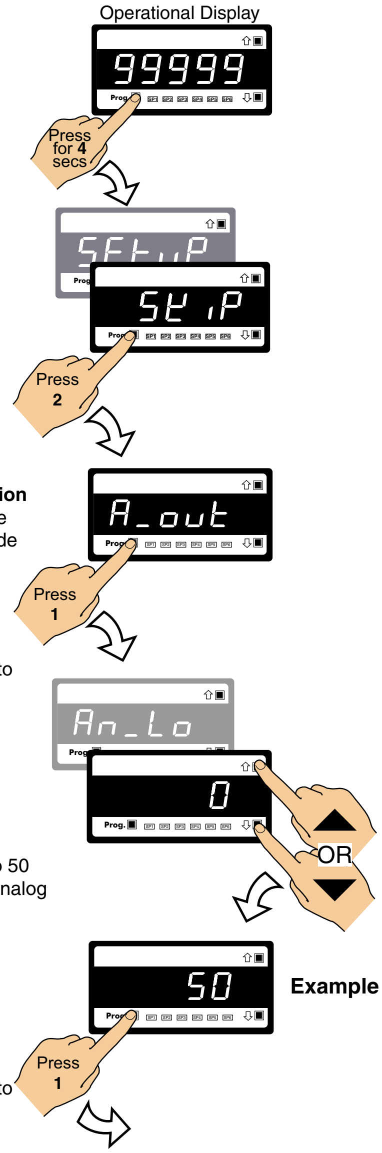


Figure 5 – DMI-A1 Series Installation Sequence

In this example the analog output signal is scaled over a range of 50 to 3000 counts.

Scaling the Analog Output Signal

START HERE



Step 1
Press the P button for **4** secs

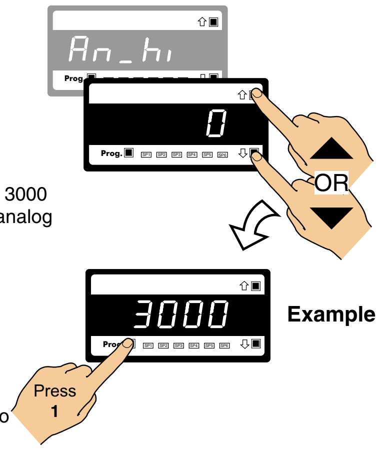
Step 2
Press the P button two times to skip the **Supply Frequency and Decimal Point Setup** and **Calibration** modes and enter the **Analog Output** mode

Step 3
Press the P button to confirm the Analog Output Selection.

Step 4
Adjust the display to 50 counts for the **low** analog output scale setting

Step 5
Press the P button to accept the new low value

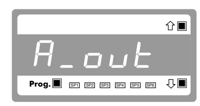
To Step 6



Step 6
Adjust the display to 3000 counts for the **high** analog output scale setting

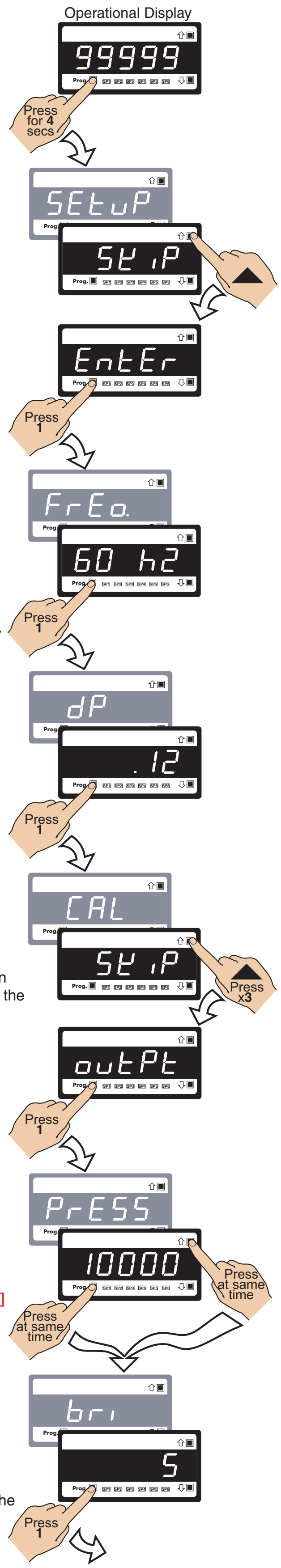
Step 7
Press the P button to accept the new high value

Scaling of the analog output signal is now complete!



Calibration of the Analog Output Signal

START HERE



Step 1
Press the P button for **4** secs

Step 2
Select **Enter**

Step 3
Enter the Supply Frequency menu

Step 4
Pass thru the Supply Frequency menu

Step 5
Pass thru the Decimal Point menu

Step 6
Press the ⬆ button **3** times to jump to the **Output** menu

Step 7
Enter the Analog Output menu

Step 8
Display scrolls
[PrESS P and uP]
Press P and ⬆ buttons at the same time

Step 9
Press P to enter the Calibration menu

To Step 10

From Step 9

Step 10
With the DMI-A1 connected to a multimeter, the DMI-A1 displays [CAL] [151]. This is the setting for **analog output 1**.

Press P to start the calibration procedure

Step 11
Ensure the **low** analog output signal reading [CAL L] on the multimeter display is 0.00 V DC.

If not correct, press the ⬆ OR ⬇ button on the DMI-A1 until the reading on the multimeter display is correct.

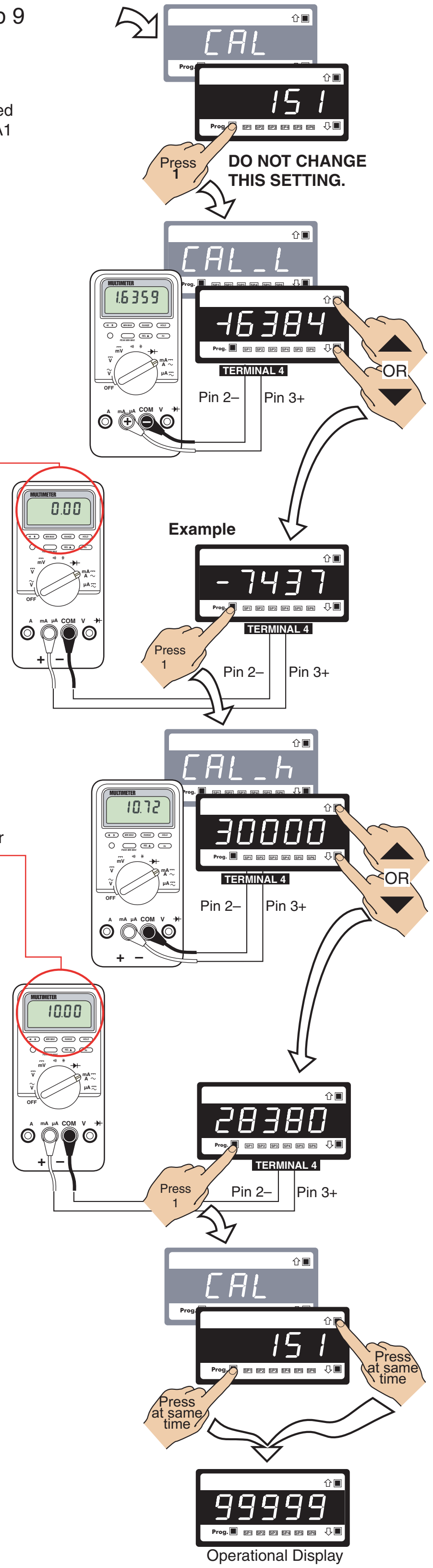
Step 12
Save the **low** analog output signal setting. Enter analog output **high** signal calibration

Step 13
Ensure the **high** analog output signal reading [CAL_h] on the multimeter display is 10.00 V DC.

If not 10.00 V DC, press the ⬆ OR ⬇ button on the DMI-A1 until the reading on the multimeter display is correct.

Step 14
Press P button to leave the CAL menu

Step 15
Press P and ⬆ buttons at the same time to return to the operational display



Note:
*In **Steps 11** and **13** the 0-10 V DC settings can be replaced by other ranges such as 0-20 mA or 4-20 mA, or settings within these ranges.*

Differential measurements are now available with Macro Sensors' dual input LVDT controllers

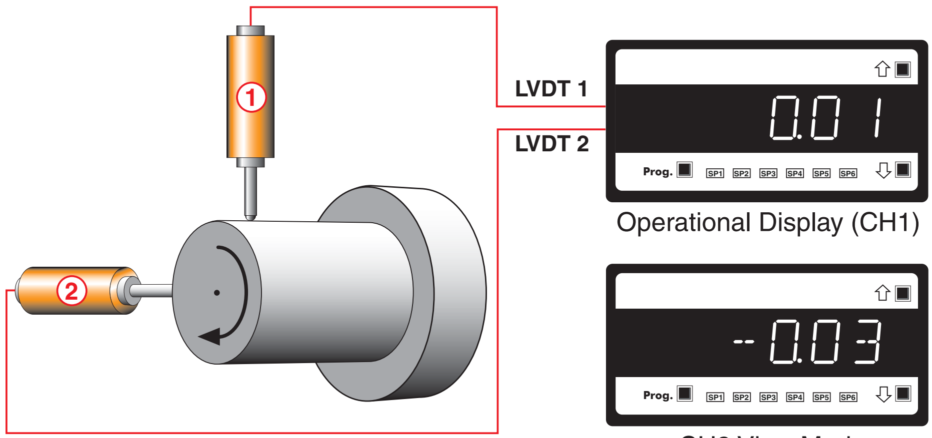
LVDT sensors can be applied in almost all engineering applications covering civil, mechanical, petrochemical, power generation, production, aerospace, defence, and much more.

They can be used on production lines to automatically gauge products for quality control and product sorting.

In the power generation and petrochemical industries they can be used, for example, as servo position feedback on actuated equipment such as valves and dampers, or for measuring turbine casing expansion.

Submersible units can be used in marine and offshore mining applications. Sensors that meet military environmental standards have been applied to defence and aerospace applications.

Following are applications that show the power and versatility of Macro Sensors' DMC-A2 Series dual input differential measurement controllers.



Operational Display (CH1)

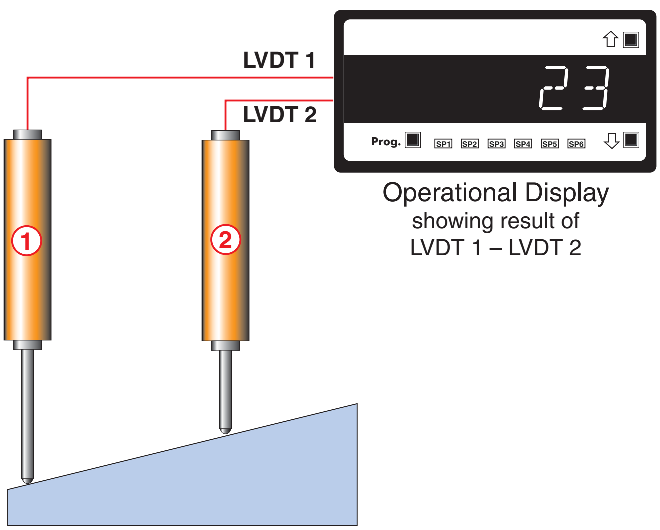
CH2 View Mode

ALIGNMENT TOOL

Measured using two LVDT sensors at 90°

LVDT 1 to CH1 = Shown on Display

LVDT 2 to CH2 = Use View Mode to view CH2

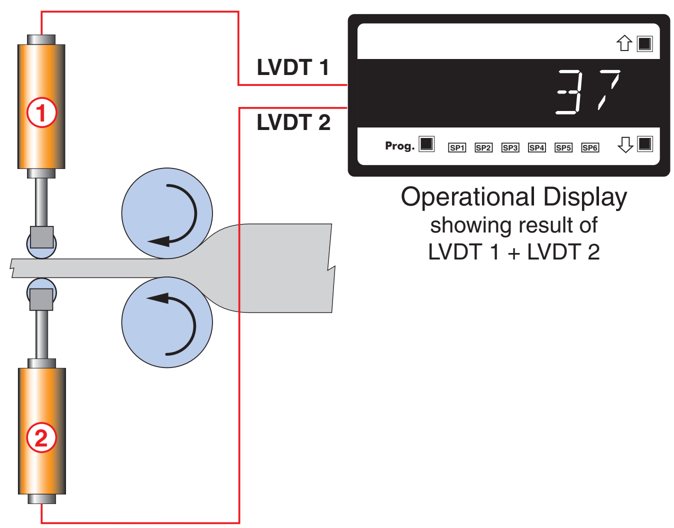


Operational Display
showing result of
LVDT 1 – LVDT 2

SLOPE INDEXING

Measured using two parallel LVDT sensors (1 – 2)

LVDT 1 minus LVDT 2 = Displayed Result



Operational Display
showing result of
LVDT 1 + LVDT 2

THICKNESS MONITORING

Measured using two opposed LVDT sensors (1 + 2)

LVDT 1 plus LVDT 2 = Displayed Result

For further information on Macro Sensor's DMC-A2 Series dual input differential measurement controllers contact Macro Sensors and request:

Brochure:	***DMC-A2 Series***
User Manual:	***DMC-A2 Series***

Or go to www.macrosensors.com and download a pdf of either document from our free downloadable literature.

Communication Formats

ASCII Mode

The ASCII mode is a simple, isolated ASCII communication protocol using the standard ASCII character set. This mode provides external communication between the meter and a PC allowing remote programming to be carried out.

DMC-A2 Series meters use a serial communication channel to transfer data from the meter to another device. With serial communications, data is sent one bit at a time over a single communications line. The voltage is switched between a high and a low level at a predetermined transmission speed (baud rate) using ASCII encoding. Each ASCII character is transmitted individually as a byte of information (eight bits) with a variable idle period between characters. The idle period is the time between the receiving device receiving the stop bit of the last byte sent and the start bit of the next byte. The receiving device (for example a PC) reads the voltage levels at the same interval and then translates the switched levels back to an ASCII character. The voltage levels depend on the interface standard being used.

Table 1 lists the voltage level conventions used for RS-232. The voltage levels listed are at the receiver.

See Table 2 for a list of the most commonly accessed ASCII mode registers.

Each ASCII character is 'framed' with:

- A start bit.
- An optional error detection parity bit.
- And one or more ending stop bits.

For communication to take place, the data format and baud rate (transmission speed) must match that of the other equipment in the communication circuit. Figure 6 shows the character frame formats used by the meter.

Table 1	Interface Voltage Level Conventions	
Logic	**Interface State**	**RS-232**
1	Mark (idle)	TXD, RXD: -3 to -15 V
0	Space (active)	TXD, RXD: +3 to +15 V

Table 2	Common ASCII Registers (32-bit Registers)	
ASCII Reg. #	**Function**	**Modbus Reg. #**
1	Alarm Status	40000
2	Display Register	40513
3	Processed Data Result	40515
4	Processed Data – Channel 1	40517
5	Processed Data – Channel 2	40519
39	Processed Data – Channel 3	40521
40	Processed Data – Channel 4	40523
6	Setpoint 1	40535
7	Setpoint 2	40537
8	Setpoint 3	40539
9	Setpoint 4	40541
10	Setpoint 5	40543
11	Setpoint 6	40545
12	Peak	40525
13	Valley	40527
14	Tare	40533
15	*Reserved for Texmate Use*	–
16	Total 1	40529
17	Total 2	40531

Character Frame Formats

Start Bit and Data Bits

Data transmission always begins with the start bit. The start bit signals the receiving device to prepare to receive data. One bit period later, the least significant bit of the ASCII encoded character is transmitted, followed by the remaining data bits. The receiving device then reads each bit position as they are transmitted and, since the sending and receiving devices operate at the same transmission speed (baud rate), the data is read without timing errors.

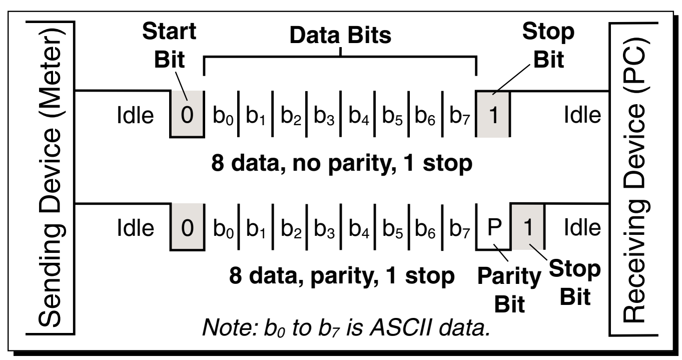


Figure 6 – Character Frame Formats

Parity Bit

To prevent errors in communication, the sum of data bits in each character (byte) must be the same: either an odd amount or an even amount. The parity bit is used to maintain this similarity for all characters throughout the transmission.

It is necessary for the parity protocol of the sending and receiving devices to be set before transmission. There are three options for the parity bit, it can be set to either:

- None – which means there is no parity.
- Odd – which means the sum of bits in each byte is odd.
- Even – which means the sum of bits in each byte is even.

After the start and data bits of the byte have been sent, the parity bit is sent. The transmitter sets the parity bit to 1 or 0 making the sum of the bits of the first character odd or even, depending on the parity protocol set for the sending and receiving devices.

As each subsequent character in the transmission is sent, the transmitter sets the parity bit to a 1 or a 0 so that the protocol of each character is the same as the first character: odd or even.

The parity bit is used by the receiver to detect errors that may occur to an odd number of bits in the transmission. However, a single parity bit cannot detect errors that may occur to an even number of bits. Given this limitation, the parity bit is often ignored by the receiving device. The user sets the parity bit of incoming data and sets the parity bit to odd, even or none (mark parity) for outgoing data.

The parity bit is set in the Calibration Mode.

Stop Bit

The stop bit is the last character to be transmitted. The stop bit provides a single bit period pause to allow the receiver to prepare to re-synchronize to the start of a new transmission (start bit of next byte). The receiver then continuously looks for the occurrence of the start bit.

Note: DMI-A1Series meters use only one stop bit.

Command Response Time

The meter uses half-duplex operation to send and receive data. This means that it can only send or receive data at any given time. It cannot do both simultaneously. The meter ignores commands while transmitting data, using RXD as a busy signal.

When the meter receives commands and data, after the first command string has been received, timing restrictions are imposed on subsequent commands. This allows enough time for the meter to process the command and prepare for the next command.

See Figure 7. At the start of the time interval t_1, the sending device (PC) prints or writes the string to the com port, thus initiating a transmission. During t_1 the command characters are under transmission and at the end of this period the command terminating character is received by the meter. The time duration of time interval t_1 is dependent on the number of characters and baud rate of the channel:

$$t_1 = (10 * \text{\# of characters}) / \text{baud rate}$$

At the start of time interval t_2, the meter starts to interpret the command, and when complete performs the command function.

After receiving a valid command string, the meter always indicates to the sending device when it is ready to accept a new command. After a read command, the meter responds with the requested data followed by a carriage return (øDH) and a line feed (øAH) character. After receiving a write command, the meter executes the write command and then responds with a carriage return/line feed.

The sending device should wait for the carriage return/line feed characters before sending the next command to the meter.

If the meter is to reply with data, time interval t_2 is controlled by using the command terminating character: **$** or *****. The **$** terminating character results in a response time window of 50 ms minimum and 100 ms maximum. This allows enough time to release the sending driver on the RS-485 bus. Terminating the command line with the * symbol, results in a response time window (t_2) of 2 ms minimum and 50 ms maximum. The faster response time of this terminating character requires that sending drivers release within 2 ms after the terminating character is received.

At the start of time interval t_3, the meter responds with the first character of the reply. As with t_1, the time duration of t_3 is dependent on the number of characters and baud rate of the channel:

$$t_3 = (10 * \text{\# of characters}) / \text{baud rate}$$

At the end of t_3 the meter is ready to receive the next command.

The maximum throughput of the meter is limited to the sum of the times: t_1, t_2, t_3.

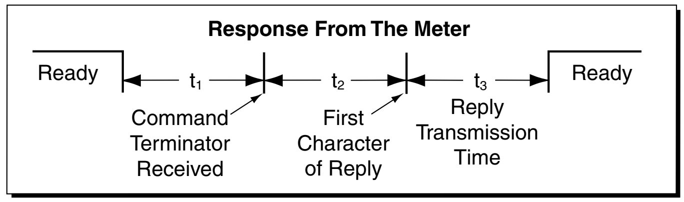


Figure 7 – Timing Diagram

ASCII Serial Mode Read/ Write Information

ASCII Command Character Descriptions

Table 3 describes the functions of the command string characters. Table 4 shows examples of how the command string is constructed.

Command String Construction

When sending commands to the meter using a Terminal emulation program, a string containing at least one command character must be constructed. A command string consists of the following characters and must be constructed in the order shown:

1) A start character.
2) The meter (node) address (optional).
3) The read/write command.
4) The register address.
5) A separator character.
6) The data value.
7) The message terminator.

Figure 8 shows an example of a command string.

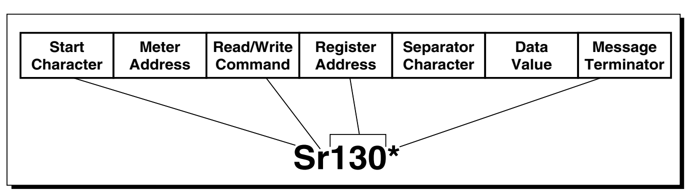


Figure 8 – Example of a Command String

Table 3		Command Character Descriptions
Command	**Description**	**Function**
S or **s**	Start Character	The **start character** must be the first character in the string.
0 to **255**	Meter (Node) Address Specifier	The next character assigns an address to a specific meter. If the character following the start character is not an ASCII number, then address 0 is assumed. All meters respond to address 0.
R or **r** for read **W** or **w** for write	Read/Write Command	The next character is the **read/write command** character. The **read command** reads a register from the meter. The **write command** writes to a register of the meter. Using any other character for the read or write character will abort the operation
ASCII number **1** to **65535**	Register Address	The **register address** for the read/write operation is specified next. It can either be an ASCII number from 1 to 65535 or register 1 to 18 can be accessed by entering an ASCII letter from A to R (not case sensitive). If the address character is omitted in a read command, the meter will always respond with the data value currently on the display. The register address must be specified for a write command.
Space or **","**	Separator Character	After the register address in a write command, the next character must be something other than an ASCII number. This is used to separate the register address from the data value. It can be a **space** or a "**,**" or any other character except a "**$**" or a "*****".
Range between **–9999999** to **9999999**	Data Value	After theeseparator character, th **data value** is sent. It must be an ASCII number in the range of **–9999999** to **9999999** (Fixed Point Register). Note: The range will vary depending on which register is accessed.
$ or *****	Message Terminator	The last character in the message is the **message terminator**. This must be either **$** or *****. If the **$** is used as a terminator, a minimum delay of 50 ms is inserted before a reply is sent. If the ***** is used as a terminator, a minimum delay of 2 ms is inserted before a reply is sent. The **$** and ***** characters must not appear anywhere else in the message string.
CR/LF	Meter Response	After the meter has completed a read or write instruction, it responds by sending a **carriege return/ line feed** back to the host. If the instruction was a read command, the CR/LF follows the last character in the ASCII string. If it was a write command, the CR/LF is the only response sent back to the host. The host must wait for this before sending any further commands to the meter. A read or write to a not valid or non-existant register, produces a null character followed by a CR/LF.

Table 4	ASCII Command String Examples
Command String	**Command String Description**
SR$	Read display value, 50 ms delay, all meters respond.
s15r$	Read display value, 50 ms delay, meter address 15 responds.
SR12*	Read peak value, 2 ms delay, all meters respond.
Sr130*	Read Code 1 setting, 2 ms delay, all meters respond.
s2w2 -10000$	Write 10 000 to the display register of meter address 2, 50 ms delay.
SWT Chan_1$	Write ASCII text string **Chan_1** to text register T, 50 ms.
S10w148,7*	Change brightness to 7 on meter address 10, 2 ms delay.

Multiple Write

The multiple write feature of the DMC-A2 meter allows multiple registers to be written to in a single ASCII command string. It is similar to a normal write command but with the following differences:

- After the first data value, a separator character is inserted instead of the message terminator. The next register address is then specified, followed by another separator character and the next data value. This procedure is repeated for each new register. The message terminator is added after the last data value in the string.
- Any number of registers can be written to using the multiple write feature, as long as the total length of the command string does not exceed 73 ASCII characters, including spaces and the message terminator.

Figure 9 shows two examples of the multiple write command.

Note: The multiple write feature cannot be used with special ASCII registers (H to X).

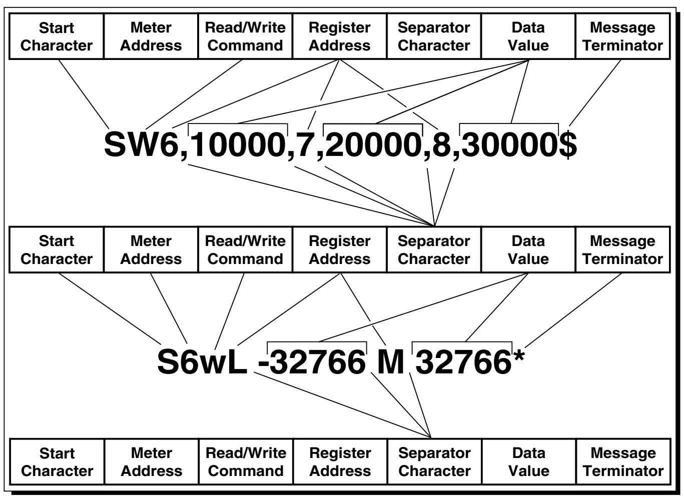


Figure 9 – Examples of Multiple Write Command

Special ASCII Registers

DMI-A1 Series meters have 5-digit displays using 7-segment display LEDs. Table 5 shows which characters can be used with a 7-segment display LED along with the associated ASCII value.

7-Segment ASCII Characters

Some characters, such as Kk, Mm, Qq, Ww, Zz, can not be displayed correctly on a 7-segment LED display. For these characters the closest possible display has been chosen. The letters M and W can only be represented by using two digits of the display. This means that each time an M or W is used, the maximum amount of characters to be displayed is reduced by one (e.g. Power would be displayed as Powr). If both letters are used, for example in the abbreviation MW for megawatt, the amount of characters to be displayed is reduced by two. Upper or lower case letters are accepted by the meter but the resulting display is set to the standard 7-segment character map. See Table 5.

Registers H to W – Display Customizing

Text can be customized on the following text displays to suit a particular application:

- Register H – Text display for peak.
- Register I – Text display for valley.
- Register J – Text display for total.
- Register K – Text display for sub-total.
- Register L – Text display for setpoint 1.
- Register M – Text display for setpoint 2.
- Register N – Text display for setpoint 3.
- Register O – Text display for setpoint 4.
- Register P – Text display for setpoint 5.
- Register Q – Text display for setpoint 6.
- Register R – Text display for overrange.
- Register S – Text display for underrange.
- Register T – Text display for channel 1.
- Register U – Text display for channel 2.
- Register V – Text display for channel 3.
- Register W – Text display for channel 4.

The text string displayed by the meter can be 6 ASCII characters long.

If a text string is read in the usual manner. For example, **SRT$**, where:

- **S** for the start character.
- **R** for the read character.
- **T** for the text display for Channel 1.
- **$** for the message terminator.

The meter responds by displaying the stored string: **CH_1**.

To customize the text string of the text display for Channel 1, from **CH_1** to **Hello**, issue the following command:

SWT Hello$

When the text display for Channel 1 is displayed on the meter, instead of **CH_1** being displayed, **Hello** is now displayed.

Register X – Print String

The print mode allows the meter to print data from any meter register directly to a serial printer, or to a PC where it can be imported into a spreadsheet.

Register X is a special register that allows you to specify the text and data stored in specific registers to be printed out when a print command is issued by the meter while in the print mode. Through the serial port, register X can be either written to or read from using a terminal program on a PC.

Writing To Register X

Writing to register X tells the meter to print the data stored in one or more of the meter's registers when the print command is issued. To get the meter to print, the printer must be connected to the meter through the serial port and the meter must be programmed to [XX3] in Code 3. The data to be printed depends on how the meter has been programmed, for example, to display a flow rate and total.

The total length of a write string can be up to 30 ASCII characters long

See Printing Restrictions below.

Reading From Register X

Reading from register X allows you to check your settings prior to removing the PC from the serial port and connecting to a printer. Register X can be read in the normal manner (i.e. SRX$).

Example of Writing To Register X

The following example shows a write to register X with the meter set to display flow rate and total flow of channel 1 in Code 2.

swx Rate = ~2 (add carriage return and line feed)

Total = ~16$

The above write to register X means the following:

swx: Start writing to register X.

Rate =: Tells the meter to print the word Rate =.

~2: Tells the meter to print the current flow rate (display data), held in register 2, after the word Rate =.

Total =: Tells the meter to print the word Total =.

~16: Tells the meter to print the current total flow (stored data), held in register 16, after the word Flow =.

The printer would then print, for example, the following:

Rate = 2000

Total = 25000

This means that the current flow rate is 2000 and the total flow at this point is 25000.

Example of Reading From Register X

Having written the above example to the meter, to check the contents of register X using the terminal program through the PC, type the following:

srx$

The following is shown on the PC screen:

Rate = ~2

Total = ~16$

Table 5	ASCII Characters for 7-Segment Display		
Character	**Register Control value (Decimal)**	**Character**	**Register Control value (Decimal)**
Space	32	**@**	64
!	33	**A**	65
"	34	**b**	66
#	35 (not supported)	**C**	67
$	36 (not supported)	**d**	68
%	37 (not supported)	**E**	69
&	38 (not supported)	**F**	70
'	39	**G**	71
(	40	**H**	72
)	41	**i**	73
*****	42 (not supported)	**J**	74
+	43 (not supported)	**k**	75
,	44 (displayed as decimal point)	**L**	76
-	45	**M**	77 (supported, but requires two digits)
.	46	**n**	78
/	47	**o**	79
0	48	**P**	80
1	49	**q**	81 (not supported)
2	50	**r**	82
3	51	**S**	83
4	52	**t**	84
5	53	**u**	85
6	54	**V**	86
7	55	**W**	87 (supported, but requires two digits)
8	56	**X**	88
9	57	**Y**	89
:	58 (displayed as decimal point)	**Z**	90 (same as "2")
;	59 (displayed as decimal point)	**[**	91 (same as "C")
<	60	****	92
=	61	**]**	93
>	62	**^**	94
?	63	**_**	95

Printing Restrictions

When printing, any alphanumeric ASCII character can be used within the following restrictions:

- The **$** and ***** characters are reserved for the terminating character at the end of the string and cannot be used as part of the text string.
- The total string length must be no greater than 30 bytes long. This includes spaces, tabs, carriage returns, line feeds, and the terminating character. There must be a separator space between the register address X and the start of the string. This separator space does not have to be included in text string length calculations.
- Any number following a ~ character will be interpreted as a register address. During a printout the register's current value will be printed out in this position.
- The ASCII character **** is treated as a special character in the print string. When a **** is encountered, a ***** is printed in its place (***** is reserved as a terminating character and normally can not appear anywhere in the text string). This allows the print output of one meter to be connected to another meter that is operating in the ASCII mode.

For example, if the print string reads:

swx sw3 ~5\ sw4 ~12\ sw6 ~2\$

The printer prints the following:

sw3 (current register value)***** **sw4** (current register value)*****

sw6 (current register value)*****

Note: As a new line is usually represented by a carriage return and a line feed, two bytes should be added for each new line in text string length calculations.

Up to seven different registers can be specified in one text string, provided that the total string length is no greater than 30 bytes long and the total length of the resulting printout is less than 100 bytes long (including time stamp if selected).

For example, the following tab delimited output could be specified to input display data, processed result, processed channel 1, processed channel 2, peak, valley, and total, directly into a spreadsheet:

swx~2(tab)~3(tab)~4(tab)~5(tab)~12(tab)~13(tab)~p$

When calculating the length of the printout, an allowance of 7 bytes for each register address should be used, plus any extra text or separating characters such as tabs or spaces.

Serial Output Module Settings

Setting the 1st digit to 2 and the 2nd digit to 0 [CAL] [20X] accesses the serial communications output module properties: baud rate, parity, transmit time delay, and address settings.

Baud Rate

The baud rate range is selectable from 600 to 38400 baud. The default baud rate is 9600.

- 600.
- 1200.
- 2400.
- 4800.
- 9600.
- 19200.
- 38400.

Parity

The default parity setting is [oFF]. Parity [odd] or [EVEn] can also be selected.

Transmit Time Delay

The transmit time delay restricts the meter from transmitting a reply to a slow or busy master device (PC, PLC, etc.) by providing time delays of 2, 20, 50, or 100 milliseconds for all serial modes except ASCII (Code 3 set to XX0).

The ASCII Mode uses message terminating characters:

- ***** = 2 milliseconds.
- **$** = 50 milliseconds.

Address

The default address setting is 1, but can be set to anywhere between 1 and 255.

Serial Communications Hardware Pinouts & Interconnections

RS-232 Interconnections

Hardware Requirements

The following hardware is required to set the meter up for simple RS-232 communications (see Figure 10):

- DMC-A2 Series meter with RS-232 serial output module option installed.
- RJ-11 to DB-25 interface connector (and possibly a DB-25 to DB-9 interface connector depending on PC serial port).
- Standard 4-wire cable with male RJ-11 connectors (see Figure 11 and 12, and Tables 6 and 7 for a wiring diagram and pin descriptions).
- PC running a terminal program.

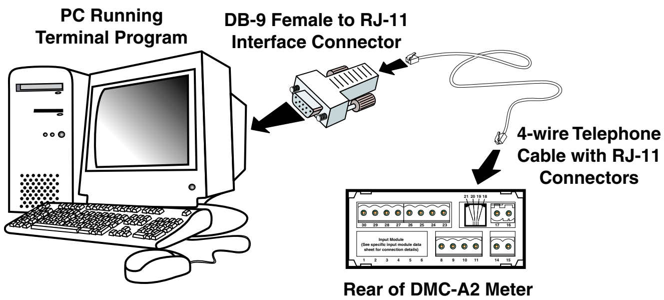


Figure 10 – RS-232 Hardware Connections

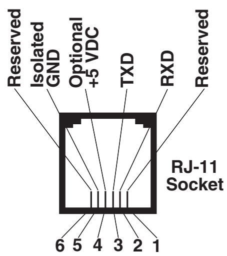
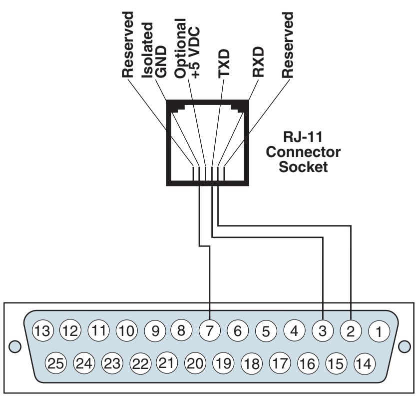
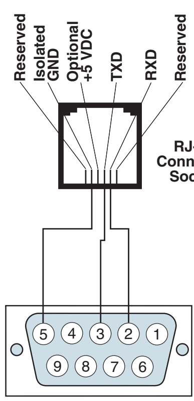


Figure 11 – RJ-11 Connections



25-Pin D Connector
(See Table 8 for pin descriptions)
(Viewed from the pin side of a female connector)



9-Pin D Connector
(See Table 8 for pin descriptions)
(Viewed from the pin side of a female connector)

Figure 12 – RJ-11 to 9-pin and 25-pin D Connectors

Table 6 lists the pinouts for an RS-232 to RJ-11 socket configuration.

Table 6	Serial Communication Pinouts (RJ-11 Socket)
TERMINAL PINS	**RS-232**
1	Reserved for future use
2	RXD. Received Serial
3	TXD. Transmitted Serial
4	Optional +5 VDC to power external converters (jumper on RS-232 or RS-485 boards must be soldered)
5	Isolated Ground
6	Reserved for future use

Table 7 lists the pinouts for an RS-232 to 9-pin or 25-pin D connector.

Table 7	RS-232 to 25-Pin & 9-Pin D Connectors	
25-Pin	**Pin Name**	**9-Pin**
1	Frame Ground	-
2	Receive Data	3
3	Transmit Data	2
4	Request to Send	7
5	Clear to Send	8
6	Data Set Ready	6
7	Signal Ground	5
8	Data Carrier Detect	1
9	Reserved	-
10	Reserved	-
11	Unassigned	-
12	Sec. Carrier Detect	-
13	Sec. Carrier Send	-
14	Sec. Transmit Data	-
15	Transmitter Clock	-
16	Sec. Receive Data	-
17	Receiver Clock	-
18	Local Loopback	-
19	Sec. Request to Send	-
20	Data Terminal Ready	4
21	Remote Loopback/Signal Quality Detect	
22	Ring Indicator	9
23	Data Rate Select	-
24	Transmitter Clock	-
25	Test Mode	-

Meter Functions using Serial Communications

Meter Programming via Serial Port

With a serial output module installed, the meter can be fully configured using a PC and either:

- The Meter Configuration Utility Program.
- Or a terminal emulation program such as HyperTerminal.

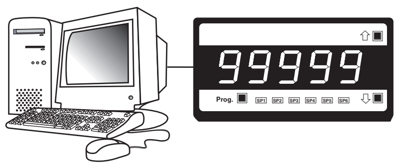


Figure 13 – Programming via Serial Port

Meter Configuration Utility Program

The **meter configuration utility program** is an intuitive, user oriented Windows based interface between the PC and the meter. In addition to all application function settings, the configuration program also provides access to the following additional features.

Configuration Data Copying

This function allows the current meter configuration settings to be copied and saved for later referral or for restoration.

Macros

A growing library of macros is available to suit a wide range of standard customer applications. Macros can be installed in the meter, via the configuration utility program and run automatically when the meter is powered up.

Terminal Emulation Program

A terminal emulation program, such as HyperTerminal, provides another interface between a PC and the meter. The terminal program allows you to read from or write to any register in the meter using an ASCII character command string.

Terminal Program Configuration & Use Procedures

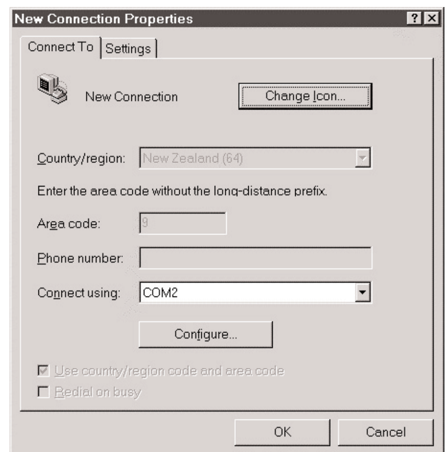
The following procedures describe how to set the Microsoft HyperTerminal properties, as well as using HyperTerminal to write to and read from the meter:

STEP A Set the HyperTerminal Program Properties

1) Start the Microsoft HyperTerminal program on the PC.

2) On the **File** menu, click **Properties**.

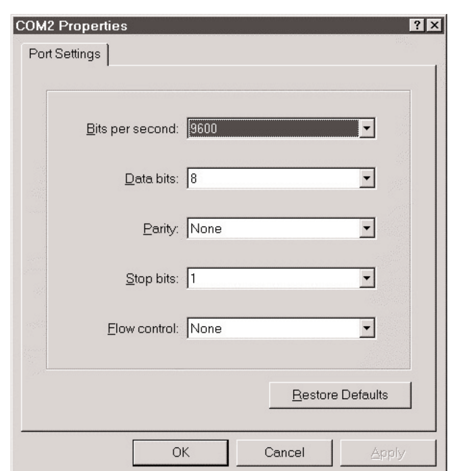
The **New Connection Properties** dialog box opens.



3) In the **Connect To** dialog click the arrow on the **Connect using** window and click a COM port (usually COM2).

4) Click the **Configure** button.

The **COM2 Properties** dialog opens.



5) In the **Port Settings** dialog click the arrow on the **Bits per second** window and click 9600.

6) Click the arrow on the **Data bits** window and click **8**.

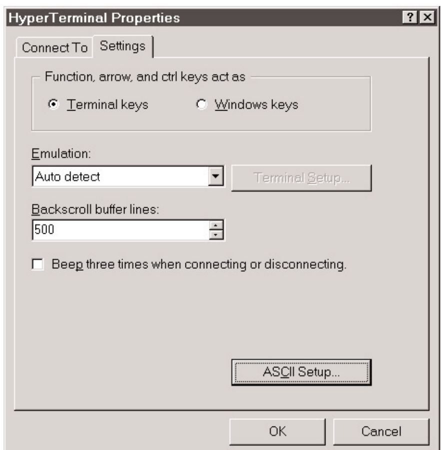
7) Click the arrow on the **Parity** window and click **None**.

8) Click the arrow on the **Stop bits** window and click **1**.

9) Click the arrow on the **Flow control** window and click **None**.

10) Click OK.

The **HyperTerminal Properties** dialog appears.



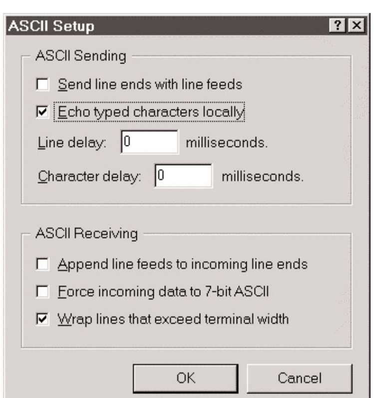
11) Click the **Settings** tab.

12) In the **Emulation** list box, click **Auto detect**.

The other settings are not relevant to this procedure and can be left as they are.

13) Click on the **ASCII Setup** button.

The **ASCII Setup** dialog opens.



14) In the **ASCII Sending** group box, click the **Echo typed characters locally** check box.

The other settings are not relevant to this procedure and can be left as they are.

15) In the ASCII receiving group box, make sure the **Append line feeds to incoming line ends** check box is **not** checked.

16) Click OK.

The **ASCII Setup** dialog closes.

17) Click OK on the **New Connection Properties** dialog.

The **New Connection Properties** dialog closes.

STEP B Check Communications Between the Meter and the PC

1) Type the following in the terminal program: **SR***

The current meter reading is displayed on the PC screen.

STEP C Configure the Print String by Writing to Register X

1) Set the print string by selecting the register data to be downloaded by writing to register X. For example, to set the print string to download the current display value (from display register 2) and peak value (from peak register 12), type the following:

SWX ~2 ~12* (the spaces must be included).

This means that the data from the meter will display on the PC screen when the PRINT trigger is activated.

STEP D Set the Meter to the PRINT Mode

1) Set Code 3 to [XX3] in the meter's main programming mode.

This allows the meter to send the measurement data to the PC.

STEP E Download the Data from the Meter to the PC

1) Type the following in the terminal program: **P**

The P requests the meter to download the configured print string.

STEP F Capture the Meter Measurement Data on the PC

1) On the **Transfer** menu, click **Capture Text**.

The **Capture Text** dialog opens.

2) In the **File** window, type the destination for the capture text file, or click the **Browse** button and select the destination.

3) Name the file with **.txt** file extension, or leave it as CAPTURE.TXT.

4) Click the **Start** button.

This opens the file.

5) Type the following in the terminal program: **SR727***

The data saves to a text file in the destination you selected. It can be opened and printed, or loaded into a word processing or spreadsheet program for further processing.

6) When the download is complete, on the **Transfer** menu, click the **Capture Text** menu, and then click **Stop**.

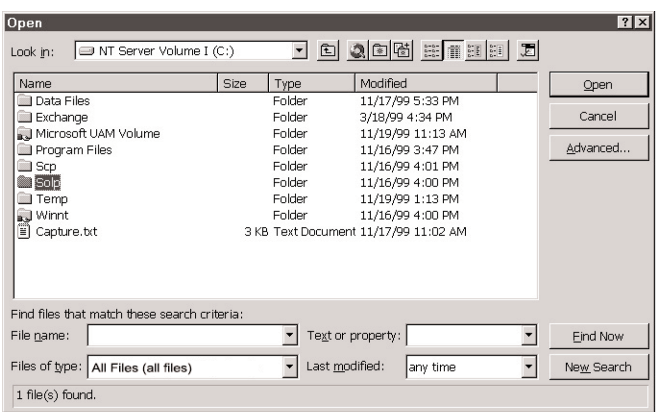
7) When the data logging operation is complete, exit the HyperTerminal program.

STEP G To Open the Captured Text in Microsoft Excel

1) Open Microsoft Excel.

2) Select **Open** in the **File** menu.

The **Open** dialog opens.

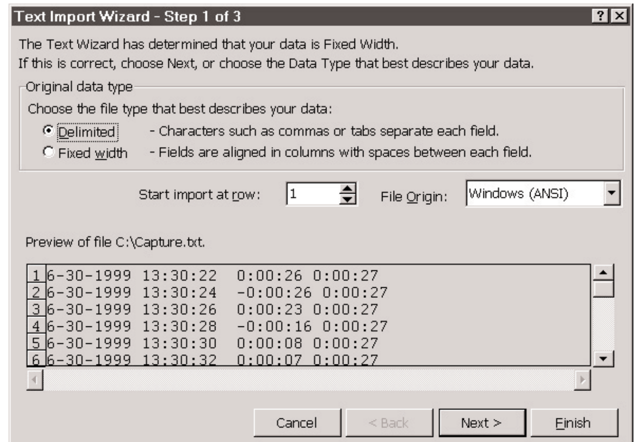


*Note: When loading the text file into a spreadsheet like MS Excel, it should be opened as **a space delimited file**.*

3) In the **Open** dialog, click on the arrow in the **Files of type** window and select the **All Files (all files)** file type.

4) Find your captured text file and click the **Open** button.

The **Text Import Wizard – Step 1 of 3** dialog opens.

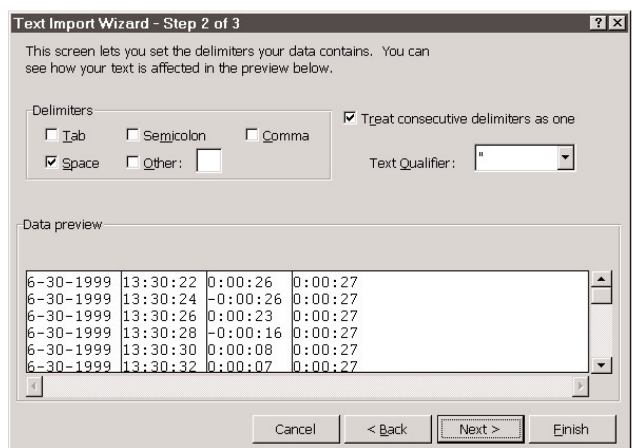


5) Click the **Delimited** radio button in the **Original data type** section.

6) Select the row you wish to start from in the **Start import at row** window.

7) Click the **Next** button.

The **Text Import Wizard – Step 2 of 3** dialog opens.



8) Check the **Space** check box in the **Delimiters** section.

9) Check the **Treat consecutive delimiters as one** check box.

10) Click the **Finish** button.

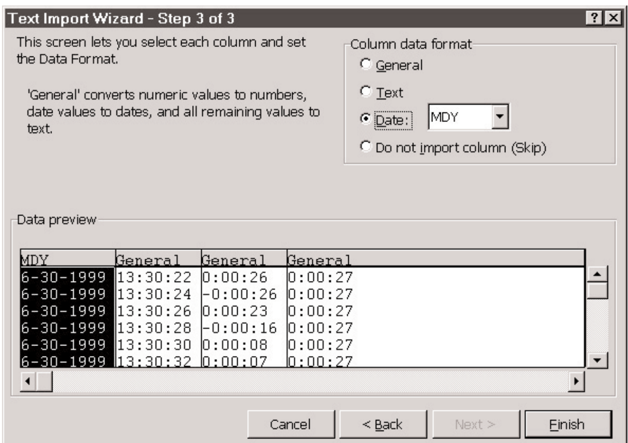
Excel will import your data and display it in four columns:

Column A: Date.

Column B: Time.

Column C: Register #2 – Rate.

Column D: Register #12 – Total.



*Note: If you want, you can also set the format of the data in the columns in **Text Import Wizard – Step 3 of 3**.*

You can now use your text file data to compile graphs, etc.

Figure 13 is an example of a graph constructed from captured text in Microsoft Excel.

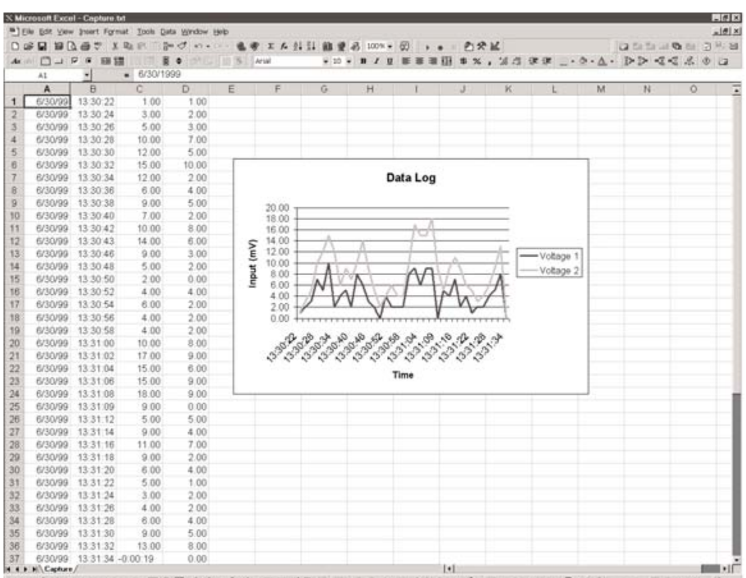
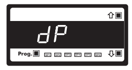


Figure 13 – Example Graph in Microsoft Excel

Frequency Range:

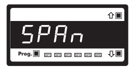
Decimal Point Position:



Input Signal

ZEro:

SPAn:



Analog Output Signal

Calibration

CAL_L:

CAL_h:

Scale Range

An_Lo:

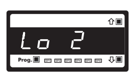
An_hi:

Setpoint Activation Values

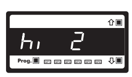
Lo 1:

hi 1:

Lo 2:



hi 2:



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