SPM & SRD
Users Manual
(VERSION 2.0, DATED MAY 2015)

4 1/2 LED .6"

3 1/2 LED .8"

4 LED .8"

OTEK™ CORP

SINCE 1974

OVER 35 YEARS OF INNOVATION

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HOW TO USE THIS MANUAL

Note: This manual for SPM and SRD is a variation of the LPE user's Manual (same commands).

This manual details the operation of the SPM & SRD. This includes both the microcontroller and non-microcontroller versions. Due to the different configurations that can be ordered some portions of this manual may not apply to the unit you have purchased. The portions that do not apply should be skipped. Material is presented in five different sections: Introduction, Hardware Options, General Operation, Quick Reference and Command Set.

DESCRIPTION OF MODELS:

A. The **SPM** (**S**ignal **P**owered **M**eter) uses unique circuitry to allow it to be Loop Powered (Powerless™) and its RS232**E** (if included) is only "**E**" complaint (± 5V Logic Levels). The **SPM** can also be powered by **USB** or other voltages including VAC & VDC.

B. The **SRD** (**S**erial **R**emote **D**isplay) is the serial input equivalent of the **SPM** and it offers ASCII serial input to access all display segments for displaying alpha numeric characters.

Once you learn one of the models, you have learned all!

1. Introduction – This section covers the basics of using the meters. All information necessary to unpack the unit and establish communications can be found here.

2. Hardware Options – Detailed connection diagrams for the meters showing how to hook up power, inputs, outputs and serial communication for the different models can be found on the data sheets.

3. General Operation – This section explains the general operation of the meters. It explains how to calibrate the unit. If a ***microcontrolled*** unit is present the programming section can be found here.

4. Quick Reference – A troubleshooting guide, ASCII codes, application notes and technical data can be found here.

5. Command Set

Tip: Should any problems arise while setting up the meters, refer to Sections 6.1 & 5.2.2.

Printed in the United States of America

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I. Introduction

This section begins with an overview of the features and options. It continues with a quick guide for unpacking, Communication setup is then discussed, along with commands for changing communication parameters.
Notes: 1. Also see description of models on page 2.
2. For ease of description, the **SPM** it is referred to here, but the instruction applies to the SRD as well.

1. Signal Power Meter (SPM)

The SPM Series of meters offers the latest technology in one easy-to-use package. The SPM has the ability to function as a stand-alone unit to display important process information. When the serial I/O option is included, the SPM becomes a powerful microprocessor-based DPM with scaling, zero offset, decimal point selection, and more. The SPM can also be used as a serial input remote SRD display when interfaced with an appropriate device.

1.1 Features

- 4 ½ Digits (1.9.9.9.9) ½" LED or LCD or 3 ½ (1.888) 0.8" or 4 Digits (8.8.8.8) or 0.8" LED
- Loop Powered, Low Burden or Externally Powered
- Mil-Spec, Nuclear & Industrial Grades
- Plastic or 100% Metal Housing Nickel Plated
- Captive Screw Terminal Connector
- Wide Zero & Span Adjustments
- Loop Powered Backlight
- NEMA 4X, EMI/RFI Gaskets & Filters
- RS232, 485, or USB I/O
- Remote Display with Serial Input
- No Input-Reflected Noise
- Stand Alone/SCADA/DCS Use

1.2 Functional Overview

A block diagram of the SPM is shown in ***Figure 1***. The unit is either loop powered or powered from an external voltage source. Analog inputs are conditioned, converted to digital and then sent to the CPU for processing. The CPU handles all data processing such as scaling and averaging. The data to display is then sent to a Display Coprocessor and finally to the display. Both incoming and outgoing serial communication is handled directly by the CPU.

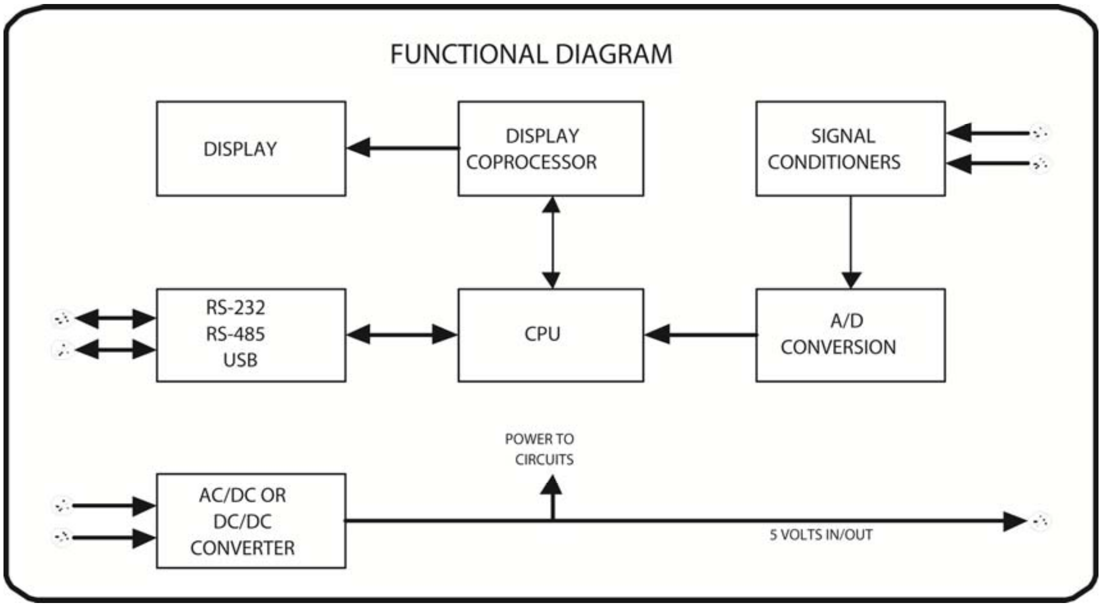


Figure 1: A simplified internal structure of the SPM/SRD series controller

1.3. Common Questions

Where can a SPM be used?

The SPM is extremely versatile and can be used in any number of situations where a Loop or Externally Powered Meter or remote display is needed.

Do I have to learn a programming language to use a SPM/SRD?

No. If serial I/O is not included with your unit, all that you need to do is connect + & - loop (loop powered) or your voltage supply and + & - signal. For units with serial I/O, the SPM comes preprogrammed, and all you need to learn are simple commands that change values such as math functions, X-Y tables, polynomials, tare, scale and offset inside the software. The SPM uses commands similar to those found in our other products. Once you know the commands for one model, changing to another model is a snap.

Do I need a terminal to configure and communicate with a SPM?

Yes, but only when serial I/O is present. The more advanced functions found in the SPM must be accessed and changed through a terminal or other handheld device that can communicate in ASCII characters via RS-232, RS-485 or USB protocols.

How do I connect the SPM/SRD for custom or standard inputs?

Custom units include wiring diagrams. For standard units, see the data sheet.

What if I need a feature not found in the SPM?

OTEK offers software and product development. Our software, hardware and product lines are continuously expanding so custom features you want may already have been implemented. Dial (520) 748-7900 to speak to a representative and see how OTEK can address your needs. FAX your needs to OTEK Corporation at (520) 790-2808, or email sales@OTEKCORP.com.

1.4 Revision History

Date	Edition	Description	Software Revision
October 2013	1st	New Publication	SPM V2.3/SRD V2.3
May 2015	2nd	Updated Sections: 2.2, 6.3, 6.4	SPM V2.3/SRD V2.3

2. Quick Start Guide

This section explains how to remove the SPM, from its box and put it into operation. The goal is to familiarize the user with the basic function of the SPM.

2.1 Unpacking the Unit

While unpacking the SPM, inspect it carefully for damage or missing items. If an item is missing or broken, contact your place of purchase immediately. The SPM shipping package contains:

(1) SPM/SRD

2.2 Power Requirements

Loop Powered Models:

- Maximum voltage drop: 4.5V Red LED (green LED on request)
- Input current range: 3-36mA
- Maximum input current: 36mA

VDC Powered Models:

- Loop burden: 1.0V @ 20mA; 50Ω
- Current requirement @ 5V: 1mA + backlight (20mA) (without microcontroller)
- Current requirement @ 5V: 10mA + backlight (20mA) (with microcontroller)
- Power input: USB, 5V, 7-3.2VDC, 90-265VAC on request

2.3 Applying Power to the Unit

Refer to the Power Supply Options in section 3 and the Ordering Information to determine which terminals power your particular model. To reduce the risk of shock or damage to the SPM make all connections with the power off.

NOTE: Loop powered models only require the "+" & "-" loop (2 wires) unless you use the serial I/O option. Then it will require additional connections. With Serial I/O, the SPM will still function as a stand-alone instrument.

2.4 Configuring the Serial Communication

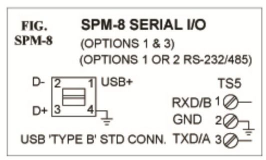
The SPM supports the use of RS-232 ("**D**" & "**E**") (**E** only for SPM & SRD when Loop Powered), RS-485 and USB protocols. Refer to section 4 for a wiring diagram showing how to connect the communication network. The default settings for communication are:

9600 baud, 1 start bit, 8 data pits, no parity, 1 stop bit, no flow control

Any terminal program (emulator) that can receive and send serial I/O can be used such as Microsoft HyperTerminal™, Procomm, etc. With the serial lines properly connected apply power to the unit. The following power-on message will be transmitted:

SPM/SRD by OTEK
Version X.X
Address : 000

warming up.....



If this message does not appear, check to make sure the proper connections have been made to the unit. If you are having problems remember these facts:

- For RS-232 your TX is connected to the computer's RX & vice versa
- For RS-485 & USB the connections are 1:1
- For RS-485 don't forget the terminating resistor (120Ω) on 1st & last unit in the bus.

Also check to make sure that the correct baud rate, flow control, and COM port settings are set in any communications software being used.

If necessary, hardware flow control may be used with serial communication. The wiring diagram in section 4.1 shows how to wire the SPM/SRD to simulate hardware handshaking. While true handshake signals are not being generated, a PC will send and receive serial data as if the SPM/SRD is generating the proper signals.

2.5 Changing the Default Communications settings

Note: Make sure you write down the new baud rate and address before the "WRITE" command is entered.

If a baud rate other than 9600 is desired, follow these simple steps to change the baud rate to a new setting.

1. Decide desired baud rate: 1200, 2400, 9600 or 19200.

2. Send the command:

    S000BAUDXXXX

Where XXXX is the desired baud rate.

The unit will respond with:

R000*

if the command is successful. The unit will show

R000?

if the command was not understood.

3. Switch the terminal emulator communications baud rate to the new baud rate.

4. Send the command:

S000WRITE

This will write the setting to the EEPROM making it the default when the unit is powered on.

The unit will respond with:

R000*

if the command is successful. The unit will show

R000?

if the command was not understood.

This is the end to the quick start guide. For more information on functionality and programming of the unit, please refer to the Hardware and Programming sections.

II. Hardware Options

3. Power Options

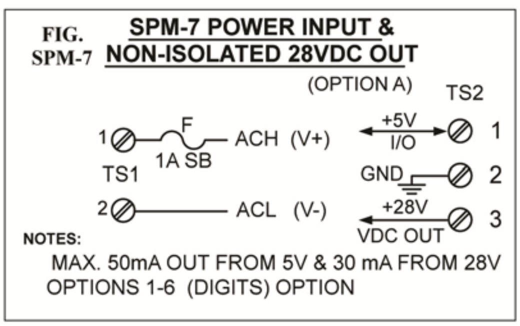
This section covers the different hardware configurations of the SPM/SRD. It contains wiring diagrams for power, inputs and serial communication. This section should be used to verify that all connections are made properly and that the appropriate signal levels are being used. A full description of all wiring options can be found in the products data sheet.

The SPM/SRD has several different models, and not all models have the same functionality please refer only to the options specified for the particular unit being connected, per complete MODEL# vs. ordering information in section 6.4.

3.1 Non-Isolated Power Input

Option 1 or 7: Non-Isolated 5 or 7-32 VDC Power**:** See Specific Option # & Connections. **A**ll listed I/O options (except Powerless™) are available. Power requirements vary with options included. The SPM with No Control and Power Out (Digit 6, Option 0) requires under 150 mW (30 mA@5VDC) for LED and under 100 mW with LCD display.

Options 2-6: Isolated Power: These options offer minimum isolation of 500 VAC or DC and their efficiency is about 80%. Again, add all the options: power x1.2 to arrive at total power required. Options 3, 4, 5 & 7 have wide input range, all others +/- 5%. Option 7 is non-isolated 7-32 VDC/input range.



3.2 Externally Powered Input Signal Connections

Please refer to specific input option number and typical connections on data sheet.

4. Serial Communication

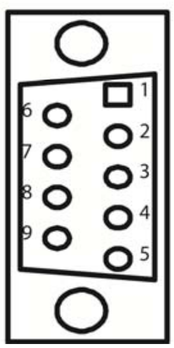
This section will explain how to hook up the serial communication on the SPM/SRD to a computer or any compatible device. The SPM has several serial communication options (USB, RS-232 and RS-485). The type of communication is model specific, so please refer to your ordering information to find out which, if any, is supported by your SPM. Since the SPM only has screw connectors, you must make an interface cable to your specific connector.
NOTE: The only difference between RS232**D** and RS232**E** is the output logic level of the meter. For RS232**D**, the output level is ±15V; RS232**E** has an output level of ±5V. Most computers and other equipment accept logic levels as low as ± 4V. When **Loop Powered**, the meter can only comply with RS232**E** (Parasitic).

4.1 RS-232 Serial Communication

The following figures will aid in connecting serial communication.

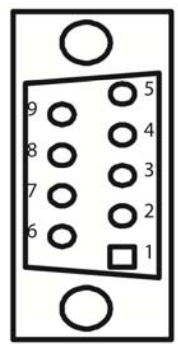
MALE

1. No Connection
2. RXD Receive Data
3. TXD Transmit Data
4. No Connection
5. Ground
6. No Connection
7. RTS Request To Send
8. CTS Clear To Send
9. No Connection

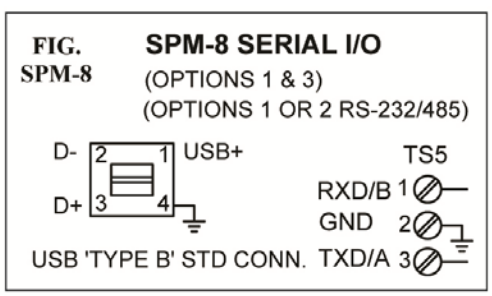


FEMALE

1. No Connection
2. RXD Receive Data
3. TXD Transmit Data
4. No Connection
5. Ground
6. No Connection
7. RTS Request To Send
8. CTS Clear To Send
9. No Connection



CONNECTION DIAGRAM



The connections for RS-232 are as follows:

- Pin 5(ground) on the serial port goes to TS5 terminal 2(ground) on the SPM/SRD.
- Pin 2(RXD) on the serial port is connected to TS5 terminal 3(TXD) on the SPM/SRD.
- Pin 3(TXD) on the serial port is connected to TS5 terminal 1(RXD) on the SPM/SRD.

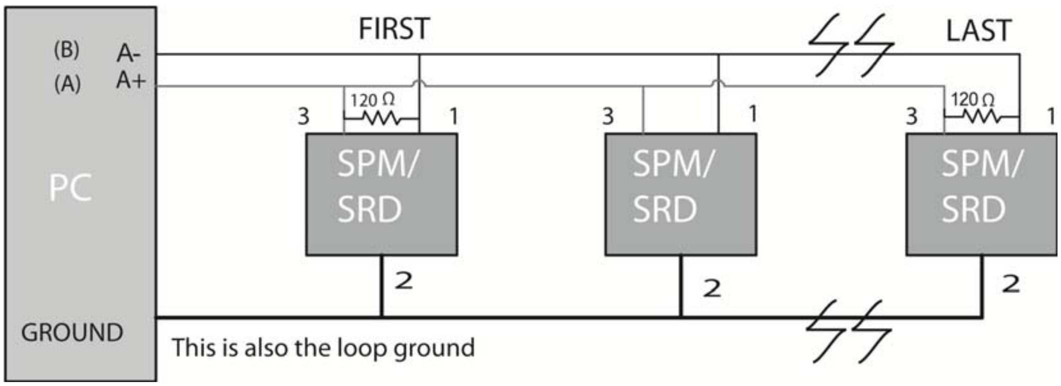
TIP: If the meter is not communicating, try reversing the RXD and TXD lines.

4.2 Hardware Handshaking

The SPM/SRD does not generate the hardware-handshaking signals RTS and CTS. However, these signals can be simulated if needed for your particular application. On the serial port connector on the computer side, connect the RTS and CTS lines together. This way, whenever the computer requests to send, it will immediately get a clear to send and communication will occur.

4.3 RS-485 Serial Communication

The normal value for the **terminating resistor** for RS-485 is 120Ω.



The connections for RS-485 are as follows:

- Computer Ground goes to TS5 terminal 2(ground) on the SPM/SRD.
- Computer A- is connected to TS5 terminal 3(D-) on the SPM/SRD.
- Computer A+ is connected to TS5 terminal 1(D+) on the SPM/SRD.

TIP: If the meter is not communicating, check to make sure A+ and A- are wired correctly.

4.4 USB Communication

The SPM/SRD is considered a "client" and your PC or HUB the "host." Modern computers should have no issues with communication. With older computers, you will need to download the drivers from our website (http://www.otekcorp.com). Once the drivers are installed, you will be able to use a terminal emulation program to communicate with the meter. It will appear as an additional comport on your computer.

The connections for USB are as follows:

- Terminal 2 is connected to D-
- Terminal 3 is connected to D+
- Terminal 4 is connected to ground
- Terminal 1 is connected to +5V.

NOTE: If the USB port is supplying power to the SPM/SRD (~150mA required), no other power input is required.

NOTE: If you power the meter with **USB** (Digit 4, option 3) and turn the PC off, you will be powering off the meters. **USB** normally can supply 0.5A per port. Theoretically, you could power up to 20 SPMs or SRDs from one **USB** port.

III. General Operation

5. Hardware Calibration

The SPM can be calibrated in software when the serial communication option is ordered. Otherwise, calibration and offset can be manually adjusted as described in section 5.1.

5.1 Zero Offset & Full Scale

5.1.1. NEMA 4X & Non-NEMA 4X adjustment

The adjustment screws can be found inside the two holes on the front of the panel near the display. If you have ordered a NEMA *4X compliant unit, the screw holes will be missing. Remove the unit from its housing.* ***Full scale adjustment is on the left, and*** **zero/offset is on the right**. A small, flat-tip screw driver is used to turn the screws: clockwise to increase, and counter-clockwise to decrease. For example, if you are measuring a 4-20mA loop but you want a zero offset of 200 units and a span of 10000 units (maximum reading being 10000 at 20mA), you would do the following:

Apply power to the unit and supply the signal that corresponds to 0 (in this case 4mA). Adjust the ZERO screw until the unit reads 200, this offsets the zero point. You would then supply the signal that corresponds to the maximum signal (in this case 20mA). Adjust the span screw until the unit reads 10000. In this way you have calibrated the unit for the desired zero offset and span. If you have a NEMA 4X unit replace it in its housing at this time.

Note: Always calibrate for zero before span and check midpoints for linearity check.

5.2 Programming

Only units with built-in serial communication have the ability to be programmed via a terminal. The default communication settings are:

9600baud, 1 start bit, 8 data pits, no parity, 1 stop bit, no flow control.

5.2.1 Important Concepts

- The SPM/SRD communicates using ASCII.
- Every unit has a default address of 000. Even after this address is changed to another value, the unit will still respond to 000 or the new address. This feature can be used if the user has forgotten the address that was assigned, or to program multiple units at that same time.

5.2.2 Resetting to Factory Defaults

If it is desired that the unit be reset to its factory defaults because of an unknown communication error, there are two ways to do this.

A) If communication is still present, send the command S000default.

B) If communication is not present, you must power off the unit and remove it from its casing. Identify the board number 80-SPM-8 which has the TS5 connector and its 6 pin header (PGM1) and jump pins 1 & 6.

After the jumper wire is in place, power the unit on and off again. This will cause the unit to reset back to factory defaults. Remove the jumper wire and return the unit to its casing.

5.2.3 Programming Instructions

The letter 'S' and the unit's address must precede all commands sent to the SPM. Commands are not case-sensitive. After receiving a command successfully, the unit will respond with "r<addr>*." If the unit doesn't understand the command, it will respond "r<addr>?." A "?" always indicates command (or address) not understood. A "*" means everything is okay.

5.2.3.1 Command Format

S[XXX][COMMAND][ARGUMENT]

'S'	precedes every command sent to the unit
'XXX'	is the unit's address
'COMMAND'	is the command to be executed
'ARGUMENT'	is used if the command accepts an argument

5.3 Serial Communications

The meter offers several options for communication. Please refer to the ordering information found at the end of this manual to correctly determine your communication option.

5.3.1 Serial Communications Port Settings

The meter supports the use of RS-232D or E, RS-485 and USB. The factory preset communication settings are:

9600 baud, 1 start bit, 8 data bits, no parity, 1 stop bit, no flow control (8N1). A terminal emulator works best if set to TTY emulation.

5.3.2 Connecting to the Unit

With the serial communication lines properly connected and your terminal emulator powered connected, apply power to the unit. The following power-on message will be transmitted:

```
SPM/SRD by OTEK
VERSION X.X
ADDRESS: “000”
Warming-up…done
*
```

If this message does not appear, check to make sure the proper connections have been made to the unit. Also make sure the proper baud rate, flow control and COM port settings are selected in any communication software being used.

If necessary, hardware flow control may be used with serial communications. The RTS and CTS lines on the DB9 connecter will need to be shorted together. This simulates hardware handshaking but handshake signals are not being generated. The PC will send and receive serial data as if the unit was generating the proper signals.

5.3.3 Sending Serial Commands

All commands sent to the unit must be preceded by the letter ‘S’ and the unit’s address. Since each controller can be assigned a unique address, multiple units can be on the same communication lines without interfering with each other. The current address for the unit is shown in its power-on message and is by default “000”. Commands are not case-sensitive, and ASCII characters are automatically converted to uppercase. A command will be processed after a Carriage Return (<CR>) is sent. Commands that are accepted and understood by the unit will be answered with an ‘*’. Commands not accepted or not understood will be answered with a ‘?’ after the <CR>.

The following command format is used to send commands to the meter:
S<ADDRESS><COMMAND><PARAMETER>
For example, to change the unit’s address, use the following command:
S000ADDR123
This would change the unit’s address from the default of “000” to “123”.
Before changing anything, print the unit’s present configuration for reference. You can do this by giving the following command:
S<ADDRESS><SHOW>

To save the unit’s current configuration, a write command must be sent. After the write command, all previous settings will be overwritten, so make sure the unit is behaving in the desired manner before issuing a write command.

5.3.3 Command Set

COMMAND	WHAT IT DOES	EXAMPLE
ADDR[address]	This command changes the unit's address. The address must be in ASCII and have a minimum of two and a maximum of six characters. If the command is given without an argument, the address is changed to NULL meaning the unit has no address. Leading zeros are stripped from the assigned address. Note: the unit will always respond to "000" the default address.	S000ADDR045 This command changes the units address from 000 to 45. The unit will now only respond when S45 or S000 precedes a command. S45ADDR This sets the unit's address to NULL. Even though the address is now NULL 'S' must still precede every command sent to the unit.
AVG1[sample]	This command is used to average x number of samples before displaying them or sending them over the serial port. Valid arguments are 0, 4 and 16.	S000AVG0 This turns the built in averaging off. S000AVG4 This activates the running averager for 4 samples.
BAUD[baudrate]	This command changes the baud rate of the unit. After execution of this command the unit changes its baud rate immediately, so the subsequent commands must be sent with the new baud rate. The default baud rate is 9600, and valid arguments are 1200, 2400, 4800, 9600, 19200 or 19.2K. Don't forget to change your PC's baud rate.	S000BAUD19.2K This changes the unit's baud rate from 9600 to 19200.
CH1[ON/OFF]		S000CH1OFF Unit can now display ASCII Strings.
CHN1[XXXX]	This command will display an alphanumeric value that is 4 characters long. Note: If the character is invalid (cannot be shown on 7 segments) the SPM/SRD will not accept it & will display "?"	S000CHN1PASS This command will display the word PASS on the display.
DEFAULT	This command resets the unit back to its factory defaults. This command has no arguments. Note: Print "show" before you do default.	S000DEFAULT WARNING! This will reset the unit and erase the EEPROM data. All user settings will be lost upon execution of this command.
DFIX1[n]	This command sets the decimal point on the display. Valid arguments are 0, 1, 2, 3 and 4.	S000DFIX1 This will select the first decimal point on the display (1XXX.X).
DH1[n]	This command will set the DAC hi limit. This is the value in mA that the DAC is not allowed to exceed. N <= 24mA	S000DH119 This will set the DAC hi limit to 19mA, the DAC will not be allowed to exceed this value.

DIAG	This command runs the diagnostic test on the display. This command does not have any arguments.	S000DIAG This will test the display by running through a display diagnostic.
DL1[n]	This command will set the DAC low limit. This is the value in mA that the DAC is not allowed to go below. N >= 0mA	S000DL12 This will set the DAC low limit to 2mA, the DAC will not be allowed to go below this value.
DOFFSET1[n]	This command is used to offset the DAC output. By default, this is 0mA, and 4-20mA in equals 4-20mA out. -1999 <= n <= 9999 DAC output = (DSCALE)(INPUT)+DOFFSET)	S000DOFFSET14 This command will offset the DAC 4mA. If your output is 4mA after this command it would be 8mA.
DSCALE1[n]	This command is used to scale the DAC output. By default this is 1 and 4-20mA in equals 4-20mA out. -1999 <= n <= 9999 DAC output = (DSCALE)(INPUT)+DOFFSET)	S000DSCALE12 This command will scale the DAC by a factor of 2. If your output was 4mA after this command it would be 8mA
HELP	When this command is sent to the unit, it will respond with a list of valid commands. This command does not have any arguments.	S000HELP The unit will respond with a list of all commands.
H1[n]	This command sets the Hi limit. -1999 <= n <= 9999 HH > H > L > LL	S000H180 This changes the Hi limit value to 80 and controls relay K2.
HH1[n]	This command sets the HiHi limit. -1999 <= n <= 9999 HH > H > L > LL	S000HH190 This changes the HiHi limit value to 90 an controls relay K1.
HOLD[ON/OFF]	This command holds the last displayed value by turning off the A/D converter. Valid commands are ON or OFF.	S000HOLDON This command will cause the unit to hold the last value on the display.
HYST1[n]	This command sets the limit hysteresis. This is mainly used for the relay outputs with a noisy signal input. The hysteresis is a dead zone around the limit that the value must exceed before the limit actions will be triggered. The hysteresis is defined in counts. 0 <= n <= 9999	S000HYST1.25 This will change the limit hysteresis to .25. This means that the limit will have to be exceeded by .25 counts before the relay will activate.
L1[n]	This command sets the Low limit. -1999 <= n <= 9999 HH > H > L > LL	S000L120 This changes the Low limit value to 20 and controls relay K3.
LIN1[n]	This command turns on the internal linearization for thermocouple or user-defined tabled and polynomials. Valid inputs are OFF, TZ, RTDC, ANSI, PZ, JC, KC and TC. TZ=user table PC=user polynomial RTDC=0.00385 (DIN) PT100 ANIS=0.00392 TC JC=type J degrees C TC=type K degrees C	S000LIN1ANSI This command will change the Linearization to ANSI RTD. To display degree F instead of C do the following. Set scale to 1.8 and offset 32. S000SCALE11.8 S000Offset132

LL1[n]	This command sets the LowLow limit. -1999 <= n <= 9999 HH > H > L > LL	S000LL110 This changes the LowLow limit value to 10 and controls relay K4.
LIM[ON/OFF]	This command will turn the limit checking on or off. If limit checking is turned off the bargraph won't change color and the relays will not change state.	S000LIMOFF This turns off limit checking.
LOC	This command is the equivalent to ECHO ON; the unit will send back everything that is transmitted to it.	S000LOC This command will cause the unit to echo back everything that is sent to it.
NET	This command is the equivalent to ECHO OFF; the unit will only respond when it is directly queried	S000NET This command will cause the unit to only respond when it is directly queried.
OFFSET1[n]	This command adds the offset specified to the value processed by the A/D conversion. This command can be used just like the hardware offset. Valid arguments are any number in the range -1999 to 9999. Offset will also accept the decimal representation of a fraction.	S000OFFSET100 This will offset the number displayed by positive 100
PEAK[ON/OFF]	This command turns peak detection on or off. With peak detection off, the display constantly changes to reflect the changing A/D result. When peak detection is on, the unit will only display the peak value i.e. the highest value currently detected. Valid arguments are ON or OFF. When you use the command SHOW and peak is on, the peak value will be shown. NOTE: For faster sampling rates, contact OTEK.	S000PEAKON The unit will now only display the largest value thus far obtained from the A/D conversion.
POLL[ON/OFF]	This command is used to enable/disable the polling for status command. If poll is off, then a continuous serial representation of the display information is being broadcast (**in a RS-485 network no polling "POLLOFF" is not advised**, the constant transmission of data will overwhelm the network). If poll is on, then the unit is awaiting the status command to send data to the serial port. Valid arguments are ON and OFF **(see status command)**.	S000POLLON This command will cease the constant broadcast of serial data from the unit. The unit will still accept all commands but will only send A/D information when the **status** command is used.
SCALE1[n]	This command scales the output displayed on the display using a multiplying factor. This can be used in a similar way as the hardware scale. The final result is in the form: (A/D result) * (scale) = displayed value Valid arguments are -1999 to 9999.	S000SCALE2 This command will multiply the final A/D result by a factor of 2 and display it on the display.

SETA[n][x]	This command sets the coefficients of the user polynomial. The polynomial is of the form: OUTPUT = $A_9X^9 + A_8X^8 + A_7X^7 + A_6X^6 + A_5X^5 + A_4X^4 + A_3X^3 + A_2X^2 + A_1X + A_0$	S000SETA012.3 This would set the A^0 term of the polynomial to 2.3.
SETX[n][x]	This command sets the n^{th} variable to the value specified by x in the X portion of the X-Y table.	S000SETX0 1 This command will set the first x value in the table to 1.
SETY[n][y]	This command sets the n^{th} variable to the value specified by y in the Y portion of the X-Y table.	S000SETY0 1 This command will set the first y value in the table to 1.
SHOW	This command will show the settings for all user-programmable features on the unit. The command accepts no arguments.	S000SHOW The unit will then respond with a listing off all programmed settings and their current value.
SHOWPOLY	This command will show the current user polynomial.	S000SHOWPOLY
SHOWTABLE	This command will show the current X-Y table.	S000SHOWTABLE
STATUS[n]	This command triggers the unit to send the last 'n' numbers processed by the A/D conversion. The valid inputs are in the range from 1 to 9.	S000STATUS4 After executing this command the unit will send back the last 4 values processed by the A/D conversion. **(See POLL)**
TARE1[ON/OFF]	This is the tare value subtracted from the processes A/D conversion. When tare is on, the current processed value is taken as the tare value. From this point on, the tare value is subtracted from every processed A/D value. When tare is off, the subtraction no longer occurs. Valid arguments are ON or OFF.	S000TAREON If the current A/D value was 200 and a subsequent value after the command was issued was 400 then the unit would show and transmit 200.
WRITE	This command writes the current configuration data to the EEPROM. This allows the unit to go back to the user-programmed settings when power is lost. If this command is not issued after user configurable settings have been changed, the next time the unit is powered down, these settings will be lost. There are no arguments for this command.	S000WRITE This command saves the user configurable settings to EEPROM. These settings are address, baud, averaging, echo, tare, scale, offset, polling and decimal point.

5.4. Calibration and Linearization

Also see section 5.1.

5.4.1 Analog Input Field Calibration

The following procedure explains how to calibrate using the potentiometers.

1) Apply your zero signal and adjust the zero potentiometer so the meter reads the desired value. In the case of a 4-20mA loop, your zero value is usually 4mA.
2) Apply your full-scale signal and adjust the span potentiometer so the meter reads the desired full- scale value.
3) Check your zero and repeat steps 1-3 if necessary.

5.4.2 Analog Input Full Factory Calibration

4.2.1 Overview for Calibration

The meter has 1 analog input channel. This analog input has 2 sets of calibration data; factory calibration and user calibration. If either of these is incorrect, then the unit will not display the correct information. Both factory and user calibration use the following linear equation to scale and offset the reading:

Y = (m*X) + b

In this equation, X is your input, m is the scale factor, b is the offset and Y is the output.
So the equation would then look like this to more closely correspond to the meter's command terminology:

(Value Displayed) = ((Scale) * (input)) + Offset

For example if you have a 4-20mA input and you want this to equal 0-100% then:

Scale = 6.25
Offset = -25

(4*6.25) -25 = 0
(20 * 6.25) -25 = 100

The downloadable Excel spreadsheet from our website will help you to easily calculate the scale and offset values needed. Otherwise, the following examples serve as an explanation for how to calculate the values by hand.

To communicate with the meter, you will need a computer with a terminal emulation program. Windows comes standard with HyperTerminal, but there are many programs available. The communication settings for the HI-Q are 9600 baud, 8 data bits, no parity bit, 1 stop bit and no flow control. Usually, if you are connecting to the DB-9 in the back of the computer, this is Com Port 1.

Before we begin, it is a good idea to write down the old calibration so we have a known point we can get back too. The following command will display the calibration information:

S000show

5.4.2.1 Checking Factory Calibration
To check the factory calibration we will need to clear out the old user calibration settings. The syntax for commands issued to the meter is as follows:

S<address><command><channel><value>

The following 2 commands will clear out the user calibration data:

S000scale11 //sets user scale factor for channel 1 to 1
S000offset10 //sets user offset for channel 1 to 0

We now need to check the factory calibration. Apply an input to channel 1. In this example, our input is 4-20mA. At 4mA, the meter should display 4, and at 20mA, the meter should display 20. If these values are accurate, you can skip to the next step "Setting User Calibration." Otherwise, we will need to do a Factory Calibration which is covered in the following section.

5.4.2.2. Setting Factory Calibration
The following 2 commands will clear out the factory calibration data for channel 1:

S000gaco11 //sets factory scale factor for channel 1 to 1
S000ofco10 //sets factory offset for channel 1 to 0

To calculate the new gaco (gain coefficient) and ofco (offset coefficient) values, use the following table and system of equations.

Signal IN	Displayed Value
Y1	X1
Y2	X2

GACO = (Y1-Y2)/(X1-X2)
OFCO = Y1-(GACO*X1)

Example:
1) Apply a 4mA signal to the meter. Let the unit stabilize and then write down the value displayed in the table. For this example we use 0.4.

2) Apply a 20mA signal to the meter, let the unit stabilize and then write down the value displayed in the table. For this example we use 1.0.

Signal IN	Displayed Value
4	0.4
20	1.0

3) Solve the system of equations to find GACO and OFCO
GACO = (4-20)/(0.4-1) = 26.6667
OFCO = 4 – (26.6667 * 0.4) = -6.6667

4) The following 2 commands will set the factory calibration values:
S000GACO1<calculated value>
S000OFCO1<calculated value>

5) If you now apply a 4-20mA signal, the meter should display 4-20. If it doesn't, the factory calibration will need to be repeated.

6) We now need to save the current calibration. This is done using the write command:
S000write

The unit will respond with an '*' when the calibration is saved.

5.4.2.3 Setting User Calibration
The first step is to clear out the old user-calibration values. The following 2 commands will clear out the user calibration data:

S000scale11 //sets user scale factor for channel 1 to 1
S000offset10 //sets user offset for channel 1 to 0

To calculate the new scale and offset values, use the following table and system of equations.

Desired Display Value	Displayed Value
Y1	X1
Y2	X2

SCALE = (Y1-Y2)/(X1-X2)
OFFSET = Y1-(SCALE*X1)

Example:
1) Apply a 4mA signal to the meter. Let the unit stabilize and then write down the value displayed in the table. For this example, we use 4.

2) Apply a 20mA signal to the meter. Let the unit stabilize and then write down the value displayed in the table. For this example, we use 20.

Desired Display Value	Displayed Value
0	4
100	20

3) Solve the system of equations to find SCALE and OFFSET
SCALE = (0-100)/(4-20) = 6.25
OFFSET = 0 – (6.25 * 4) = -25

4) The following 2 commands will set the user calibration values:
S000SCALE1<calculated value>
S000OFFSET1<calculated value>

5) If you now apply a 4-20mA signal, the meter should display 0-100 or your desired engineering units. If it doesn't, the user calibration will need to be repeated.

6) We now need to save the current calibration. This is done using the write command:
S000write
The unit will respond with an '*' when the calibration is saved.

5.4.3 Analog Output Calibration
Your meter is configured from the factory so that zero to full-scale corresponds to 4-20mA or 0-5VDC for your analog output. This output should rarely need adjustment unless your analog input display range has changed. The following procedure outlines how to recalibrate the analog output.

The first step is to clear out the old calibration values. The following 2 commands will clear out the calibration data:

S000dscale11 //sets user dscale factor for channel 1 to 1
S000doffset10 //sets user doffset for channel 1 to 0

With the calibration data cleared, the meter should have close to a one-to-one ratio between displayed value and analog output. The analog output can put out at most 24mA. Because of this limitation, care needs to be taken to exceed this value while calibrating.

To calculate the new scale and offset values, use the following table and system of equations:

Desired Output	Actual Output
Y1	X1
Y2	X2

DSCALE = (Y1-Y2)/(X1-X2)
DOFFSET = Y1-(SCALE*X1)

Example:
1) Apply a 4mA signal to the meter. Let the unit stabilize and then write down the value for the analog output in the table. For this example, we use 2mA.

2) Apply a 20mA signal to the meter. Let the unit stabilize and then write down the value displayed in the table. For this example, we use 20.

Desired Output	Actual Output
4	2
20	10

3) Solve the system of equations to find DSCALE and DOFFSET
DSCALE = (4-20)/(2-10) = 2
DOFFSET = 4 – (2 * 2) = 0

4) The following 2 commands will set the user calibration values:
S000DSCALE1<calculated value>
S000DOFFSET1<calculated value>

5) If you now apply a 4-20mA signal, the meter should output 4-20mA or your desired output range. If it doesn't the output calibration will need to be repeated.

6) We now need to save the current calibration. This is done using the write command:
S000write
The unit will respond with an '*' when the calibration is saved.

5.4.4 Linearization Tables and Polynomials
Inputs from non-linear sources such as thermocouples, RTDs and horizontal cylindrical tanks can be manipulated to provide linear output values. The controllers have two methods of providing linearization: lookup tables and polynomials.

Lookup tables compare input values to sets of desired input/output results and determine the output value through interpolation. Polynomials linearize data by passing the input value through the ninth order equation:

$$Y = A_9X^9 + A_8X^8 + A_7X^7 + A_6X^6 + A_5X^5 + A_4X^4 + A_3X^3 + A_2X^2 + A_1X + A_0$$

The linearization method used by the meter is determined with the LIN command:

LIN1[OFF,PZ,TZ,SENSOR TYPE]
TZ = user table
PZ = user polynomial
RTDC = 0.00385 (DIN) PT100
ANSI = 0.00392 TC
JC = type J degrees C

TC = type K degrees C

All built-in temperature linearization is in degrees C. To display degrees F instead of C, do the following: Set scale to 1.8 and offset to 32.

5.4.4.1 The user-defined polynomial (PZ) is a 9th order polynomial defined by its coefficients. The current values of these coefficients can be viewed with the SHOWPOLY command. To change an individual coefficient, use the SETA command:

SETA[n][m]
Where ‘n’ is the coefficient to set and ‘m’ is the value.

5.4.4.2 The user-defined table (TZ) is a set of 25(X,Y) points which are used to interpolate input data for linearization. The current user table can be seen with the SHOWTABLE command. The X coordinates correspond to inputs values for the table, whereas the y coordinates represent the displayed value. To enter or modify a table entry use the SETX and SETY commands.

SETX[n][m]
Where ‘n’ is the table entry and ‘m’ is the value.

SETY[n][m]
Where ‘n’ is the table entry and ‘m’ is the value.

In order to process inputs quickly, the meter requires the X coordinates to be in ascending order. The first X coordinate that is smaller than the previous X coordinate will mark the end of the table. This is useful for defining tables less than 25 points. For example, to use a 3 point table, the following coordinated could be entered:

Coordinate Number	X	Y
0	4	0
1	12	10
2	20	100
3	0	0

The following table shows the input to output correlation from the above table:

INPUT	OUTPUT
4	0
8	5
12	10
16	55
20	100

6. Quick Reference

6.1 Troubleshooting

SYMPTOM	SOLUTION
No startup message on serial port	Check power connections. Make sure the TXD, RXD or D-, D+ lines are wired properly. Verify communications protocol for baud rate, parity, number of start/data/stop bits.
Garbage appears instead of a startup message	Check communications protocol for proper baud rate, parity, number of start/data/stop bits. Standard settings are 8N1, 9600 baud.
Characters sent to unit appear twice on terminal	Turn off LOCAL ECHO.
After the startup message, the unit does not respond to commands	Make sure the RXD or D- line is properly connected. Check communications software for proper settings. Be sure to use 'S' + the units *address* when sending commands.
Analog input always reads zero or doesn't change	Check connections between unit and input signal. Check Typical Connections for signal input location.

6.2 Accepted ASCII TO SEVEN (7) SEGMENT TABLE

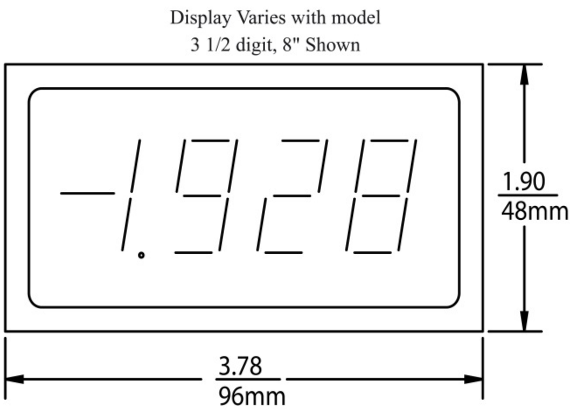
This table shows the ASCII equivalent of decimal and hexadecimal inputs that the meter can understand and display. Some values not shown are understood by the meter but cannot be displayed on the 7 segment display. Both the upper and lowercase decimal and hexadecimal values are shown for the alphabetic characters but only the ASCII characters shown will be displayed (the displayed characters are not case sensitive).

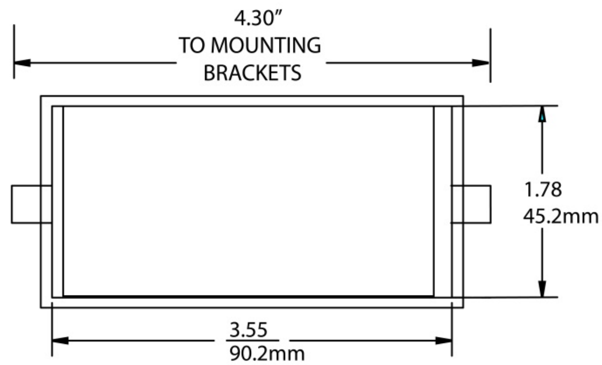
Decimal	Hexa-decimal	ASCII
48	30	0
49	31	1
50	32	2
51	33	3
42	34	4
53	35	5
54	36	6
55	37	7
56	38	8
57	39	9

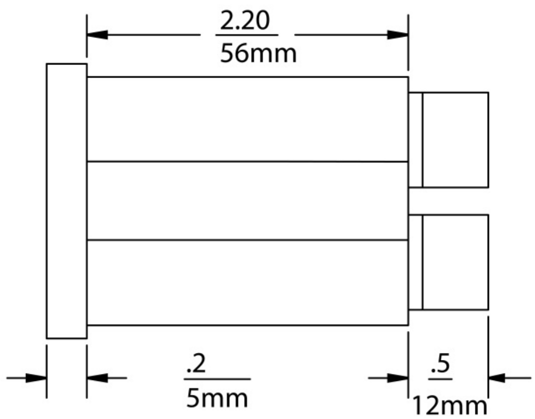
Decimal		Hexa-decimal		ASCII
65	97	41	61	A
66	98	42	62	b
67	99	43	63	C
68	100	44	64	d
69	101	45	65	E
70	102	46	66	F
71	103	47	67	g
72	104	48	68	H
73	105	49	69	I
74	106	4A	6A	J

Decimal		Hexa-decimal		ASCII
76	108	4C	6C	L
78	110	4E	6E	n
79	111	4F	6F	o
80	112	50	70	P
82	114	52	72	r
83	116	53	73	S
84	117	54	74	t
85	118	55	75	U
87	120	58	78	ū
88	121	59	79	-

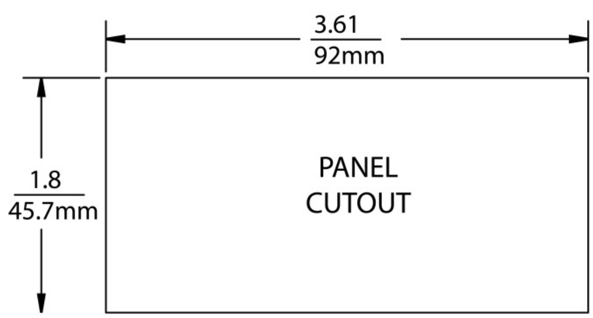
SPM/SRD MECHANICAL INFORMATION

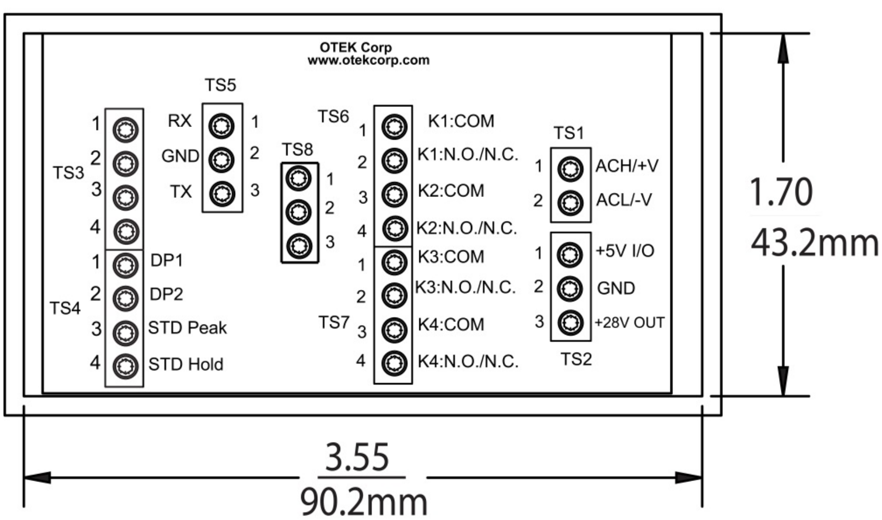






PLUG IN SCREW CONNECTORS
(19-26 GA WIRES)





Decimal Point Control

DP	
1.XXX	No Connection
1X.XX	DP2+GND
1XX.X	DP1+GND
1XXX.	DP1+DP2 +GND

Decimal Point Selection
Behind Filter or on Connector

SPM SERIES ORDERING INFORMATION 9-9-14

NOTE: Please READ BEFORE building part number:

1. If digits 2 & 3 are options 00 or 02, then digit 4 must be option 0 or 4, and digits 5 and 6 must be option 0.
2. If digits 2 & 3 are options 40, 41, 42 or 43, then digits 4, 5 and 6 must be 0.
3. If digit 6 are options 1-3 or 5-8, then digit 5 must be options 1-7 and digit 4 must be options 1-3.
4. See notes at bottom of page.

1 2 3 4 5 6 7 8 9 10

Model: SPM - □ - □ □ - □ □ □ - □ □ - 0 □

GRADE (5)

- I..Industrial
- M......................................Mil-Spec
- N...............Nuclear (Contact OTEK)
- 9................Custom (Contact OTEK)

INPUT SIGNAL (1,2,6)

- 00................. 4-20mA Loop Powered
- 01.............4-20mA External Powered
- 02.............4-30VDC Signal Powered
- 03..........Serial Input Remote Display
- 04..................................±200mVDC
- 05..±2VDC
- 06..±20VDC
- 07......................................±200VDC
- 08.....................................±50mVDC
- 09................Custom (Contact OTEK)
- 10.................................± 200µADC
- 11..±2mADC
- 12.....................................±20mADC
- 13...................................±200mADC
- 14...................................200mV RMS
- 15...2V RMS
- 16.......................................20V RMS
- 17.....................................200V RMS
- 18....................................50mV RMS
- 20.......................................2mA RMS
- 21.....................................20mA RMS
- 22...................................200mA RMS
- 23...................................5 Amp RMS
- 24...................Strain-Gage (<1K Ohm)
- 25.................Strain-Gage (>1K Ohm)
- 26.................................RTD (PT100)
- 27...............................RTD (PT1000)
- 28....................................TC (Type J)
- 30....................................TC (Type K)
- 31....................................TC (Type T)
- 32..................Frequency (40-20KHz)
- 33...........Frequency (50-440Hz Line)
- 34.................% RH (Specify Sensor)
- 35...................................pH (0-14.00)
- 36..........................ORP (0-2000mV)
- 37...Hi Speed Peak & Hold (2 VDC)
- 40....................VAC Signal Powered
- 41....................AAC Signal Powered
- 42........50-440 AcHz Signal Powered
- 43....................WAC Signal Powered

SERIAL I/O (1,2,3)

- 0...None
- 1........................Non-Isolated RS232
- 2........................Non-Isolated RS485
- 3...........................Non-Isolated USB
- 4............................Parasitic RS232E
- 9................Custom (Contact OTEK)

RANGE/CALIBRATION

- 0..Standard
- 9..............Custom (Contact OTEK)

DISPLAY TYPE (8)

- 0..................4 1/2 Digits 0.6" Red LED
- 2......................3 1/2 Digits 0.8" Red LED
- 6...........................4 digits 0.8" Red LED
- 9.....................Custom (Contact OTEK)

CASE (7)

- 0...Plastic
- 1...Metal
- 2 ....Plastic/Nema 4X
- 3 ....Metal/Nema 4X
- 9......................Custom (Contact OTEK)

CONTROL & POWER OUT (1,2,3)

- 0.. None
- 1...Relays (4)
- 2.. O.C.T. (4)
- 3...Isol. 4-20mA
- 4.............................. Isol. 30VDC For XMTR
- 5.................................Relays & Isol. 4-20mA
- 6.................................O.C.T. & Isol. 4-20mA
- 7............... Relays & Isol. 30VDC For XMTR
- 8.............. O.C.T. & Isol. 30 VDC for XMTR
- 9..............................Custom (Contact OTEK)
- A....................Non-Isol. 28 VDC For XMTR
- B................................Non-Isol. 4-20 mA Out

POWER INPUT (1,2,3)

- 0...Signal/Loop Powered
- 1...Non-Isolated 5VDC
- 2...Isolated 5VDC
- 3...Isolated 7-32VDC
- 4.. Isolated 90-265VAC
- 5...Isolated 9-36VDC
- 6... Isolated 48VDC
- 7......................................Non-Isolated 7-32VDC
- 9....................................Custom (Contact OTEK)

NOTES (Continued):

5. Otek will build to certain nuclear or MIL-standards but testing and confirmation of compliance, if required, will need to be done by a third party and at customer's expense.
6. See "ACS" series for V, A, W, Hz, AC Powerless.
7. NEMA 4x front panel only.
8. LED standard color is red. For orange, yellow, green or blue use option 9 and specify color.

SRD SERIES ORDERING INFORMATION 5-12-15

Model: SRD - 1 2 3 4 - 5 6

GRADE (1) (Digit 1)
I..........Industrial
M..........Mil-Spec (Contact OTEK)
N..........Nuclear (Contact OTEK)
9..........Custom (Contact OTEK)

SERIAL I/O (Digit 2)
1..........RS232
2..........RS485
3..........USB
9..........Custom (Contact OTEK)

POWER INPUT (Digit 3)
1..........Non - Isolated 5VDC
2..........Isolated 5VDC
3..........Isolated 7-32VDC
4..........Isolated 90-265VAC
5..........Isolated 9-36VDC
6..........Isolated 48VDC
7..........Non-Isolated 7-32VDC
9..........Custom (Contact OTEK)

CONTROL & POWER OUT (Digit 4)
0..........None
1..........Relays (4)
2..........O.C.T. (4)
3..........Isol. 4-20mA
4..........Isol. 30VDC For XMTR
5..........Relays & Isol. 4-20mA
6..........O.C.T. & Isol. 4-20mA
7..........Relays & Isol. 30VDC For XMTR
8..........O.C.T. & Isol. 30 VDC for XMTR
9..........Custom (Contact OTEK)
A..........Non-Isol. 28 VDC For XMTR
B..........Non-Isol. 4-20 mA Out

CASE (1) (Digit 5)
0..........Plastic
1..........Metal
2..........Plastic/Nema 4X
3..........Metal/Nema 4X
9..........Custom (Contact OTEK)

DISPLAY TYPE (2) (Digit 6)
0..........4 1/2 Digits 0.6" Red LED
2..........3 1/2 Digit 0.8" Red LED
6..........4 digits 0.8" Red LED
9..........Custom (Contact OTEK)

NOTES:

1. Otek will build to certain nuclear or MIL-standards but testing and confirmation of compliance, if required, will need to be done by a third party and at customer's expense. "M" & "N" grades must have metal case (Digit 5, Option 1).
2. LED standard color is red. For orange, yellow, green or blue use option 9 and specify color.

***DOWNLOADS:* For manuals, user-software or drivers:**

www.otekcorp.com