


BOURNS®

## Features

- Formerly a Riedon™ product
- 24-bit isolated current sensor with RS485/MODBUS interface
- 100 A (2 kA peak), 250 A (5 kA peak) or 500 A (10 kA peak)
- 1500 VDC reinforced galvanic isolation
- ±0.1 % tolerance
- 16-bit +150 °C microcontroller
- 24-bit ADC with buffered analog inputs
- ECC flash memory with autocorrect single bit errors
- Internal and external CRC data error detection
- Advanced non-linear temperature compensation
- RoHS compliant*

# SSD Series – Riedon™ Digital Current Sensor with RS485/MODBUS Interface by Bourns

## Specifications

| Characteristic | SSD-100A | SSD-250A | SSD-500A |
|---|---|---|---|
| Nominal Current (A) | ±100 | ±250 | ±500 |
| Peak Current (No Clipping) | +2 kA / -1 kA | +5 kA / -2.5 kA | +10 kA / -5 kA |
| Shunt Resistance (μΩ) Excluding primary termination resistance | 300 | 120 | 60 |
| Initial Accuracy | < ±0.1 % | | |
| Linearity Over Current Range | < ±0.1 % +5 mA | < ±0.1 % +13 mA | < ±0.1 % +25 mA |
| Bandwidth | 5 kHz | | |
| ADC Resolution | 24 bits | | |
| Speed (readings per second) | up to 1100 rps (0.9 - 3300 ms per reading) | | |
| Supply Voltage (5 - 60 VDC) | @ 5.0 V, 55 mA typical | | @ 24 V, 15 mA typical |
| DC Bus Voltage Measurement | ±1200 VDC max. (10 M input impedance) | | |
| Linearity Over Voltage Range | < ±0.1 % + 25 mV | | |
| RS-485 Interface (default) | Speeds: 4800, 9600, 14400, 19200 (default), 28800, 38400, 57600, 115200, 230400, 460800, 921600 8 bits, no parity, 1 stop | | |
| Long Term Stability | < ±0.1 % 1000 hours 60 °C terminal temperature < ±0.3 % 1000 hours 115 °C terminal temperature | | |
| Galvanic Isolation | 1500 VDC 1000 VAC RMS (maximum continuous working voltage) | | |
| Dielectric Strength | 3500 VAC RMS 1 minute | | |
| Operating Temperature | -40 °C to +115 °C ambient -40 °C to +125 °C primary conductor (see derating curve on page 2) | | |
| Storage Temperature | -55 °C to +125 °C | | |

## Additional Information

Click these links for more information:

PRODUCT | TECHNICAL LIBRARY | INVENTORY | SAMPLES | CONTACT

## Materials (RoHS Compliant)

Resistance Element.....CuMnNi
Current Terminal[1]....Nickel-plated copper
Electronics Housing.....94-V0 rated

Note:
1 Suitable for copper, copper-clad aluminum or aluminum conductors

## How to Order

**SSD - 100A - R**

Model

Nominal Current
- 100A = 100 A
- 250A = 250 A
- 500A = 500 A

Interface
- R = RS-485, MODBUS

## Product Safety Notice

The SSD Series Digital Current Sensor must be used in a manner specified by this data sheet, otherwise the protection provided by the equipment may be impaired. The SSD Series should not be treated as a structural part of the installation and must be properly supported on both ends.

## Specifications (continued)

| Model | Typical Noise (mA RMS) per ADC Reading Interval (ms), 1.25X Range, Zero Current | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 0.9 | 1.6 | 3.2 | 4.8 | 6.4 | 7.2 | 9 | 13 | 26 | 51 | 102 | 205 | 410 | 820 | 1640 | 3280 |
| SSD-100A | 3 | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 1 | <1 | <1 | <1 | <1 | <1 |
| SSD-250A | 8 | 7 | 6 | 5 | 5 | 4 | 4 | 3 | 3 | 2 | 2 | 1 | 1 | 1 | 1 | <1 |
| SSD-500A | 15 | 13 | 12 | 11 | 10 | 9 | 7 | 7 | 5 | 4 | 3 | 2 | 2 | 1 | 1 | 1 |

**WARNING Cancer and Reproductive Harm**
www.P65Warnings.ca.gov

*RoHS Directive 2015/863, Mar 31, 2015 and Annex.

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In April 2023, BE Services Company, Inc., a subsidiary of Bourns, Inc., purchased certain assets of Riedon, Inc., including its logo and trademarks and the right to continue to manufacture former Riedon™ products.
The "Riedon Logo" is a registered trademark of BE Services Company, Inc. in the United States.
"Riedon" is a trademark of BE Services Company, Inc.

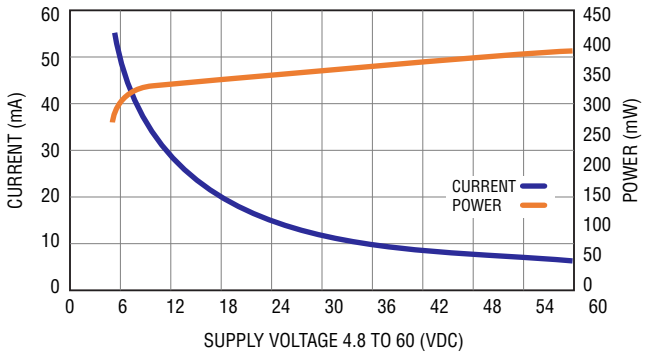
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## Applications

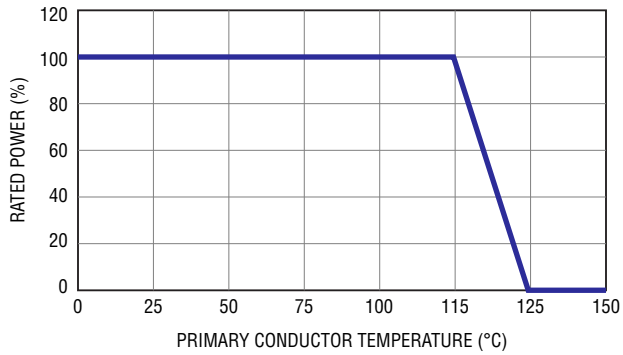
- EV charging stations
- Battery systems
- Renewable energy
- Motor drives



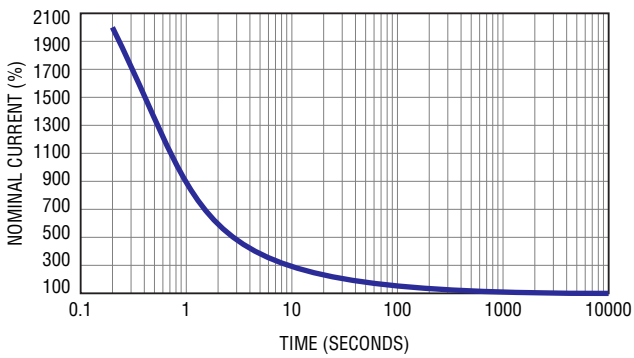
### Shunt Supply Voltage Requirements




### Derating Curve




### Overcurrent vs. Time




### Connectors

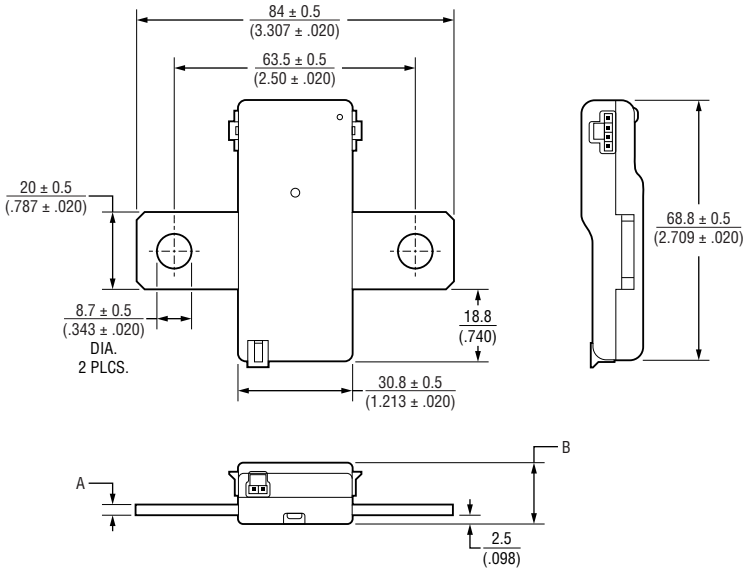
| SSD Connector | Mating Connector | Molex Nano-Fit Part Number |
|---|---|---|
| 4-Pin Male | 4-Pin Female | 1053071204 |
| | 0-22 AWG Female Contacts* | 1053002200 |
| | 4-Pin TPA Strain Relief | 1053251004 |
| 2-Pin Male Vbus | 2-Pin Female | 1053071202 |
| | 20-22 AWG Female Contacts* | 1053002200 |
| | 2-Pin TPA Strain Relief | 1053251002 |

* Use Gold (Au) plated contacts for 115 °C temperature rating.

### Product Dimensions

| Dimension | SSD-100A SSD-250A | SSD-500A |
|---|---|---|
| A | 3.0 ± 0.5 (.118 ± .020) | 4.0 ± 0.5 (.157 ± .020) |
| B | 16.4 ± 0.5 (.646 ± .020) | 17.4 ± 0.5 (.685 ± .020) |

DIMENSIONS: MM (INCHES)

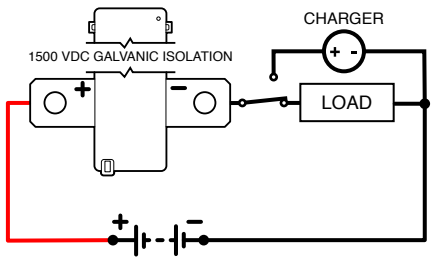
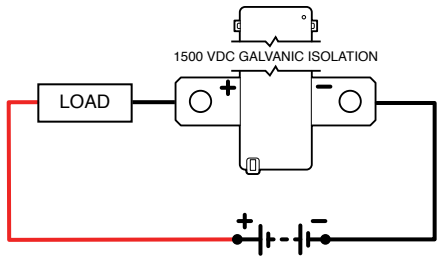
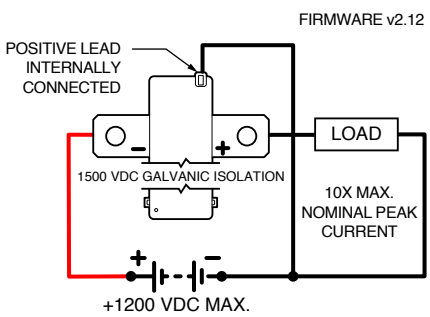
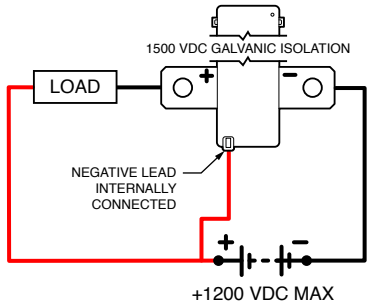



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## Installation

### Electrical Wiring

| | High Side | Low Side |
|---|---|---|
| Current Only<br>±1500 VDC<br>MAX. | <br>+1500 VDC MAX | <br>+1500 VDC MAX |
| Bus Voltage<br>Measurements<br><br>±1200 VDC | <br>+1200 VDC MAX.<br>Use SETMODE Command to Invert Current and Voltage.<br>Keep Positive DC Connection Short<br>to Minimize Bus Voltage Drop Errors. | <br>+1200 VDC MAX<br>Keep Negative DC Connection Short<br>to Minimize Bus Voltage Drop Errors. |

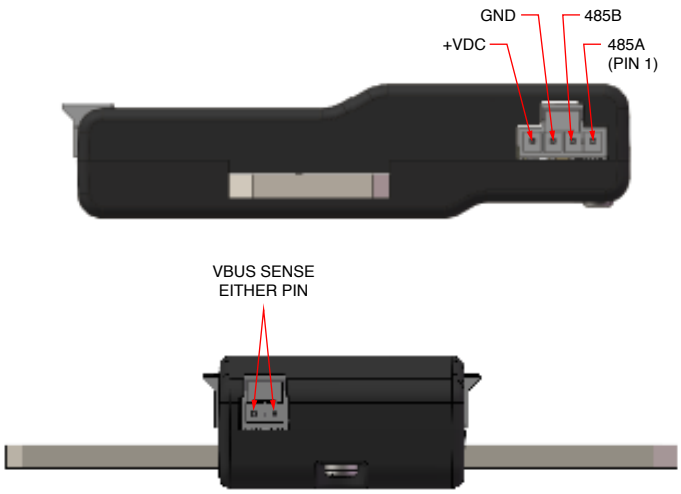
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## Connectors

Connectors on both sides have same pinout. Either or both connectors can be used.

**RS-485**

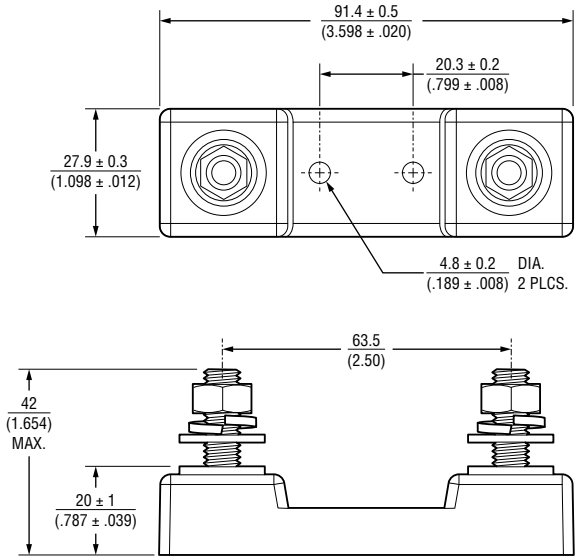



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## Optional Base Mounting Fixtures

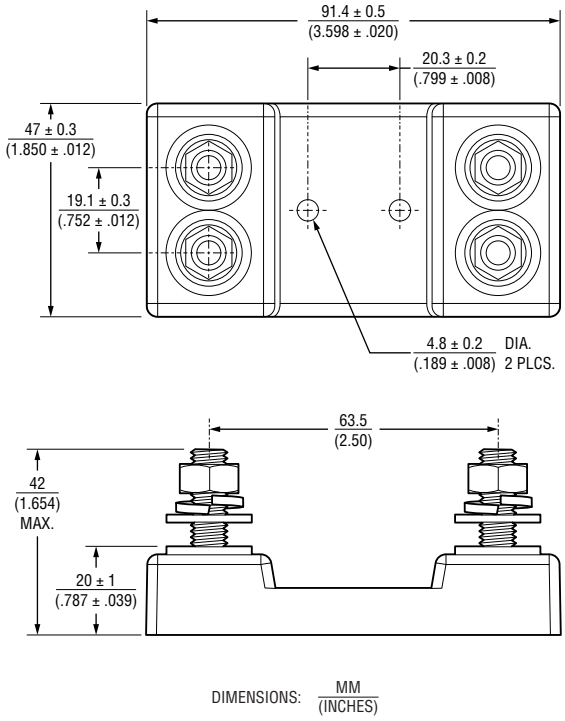
### SSA-BASE




DIMENSIONS: MM / (INCHES)



### SSA-BASE-1K




DIMENSIONS: MM / (INCHES)

- Robust design
- 5/16-18 Stainless Steel Hardware
- Torque Nuts:
  11-13 ft-lb (15-17.6 N-m)
- UL 94-V0 rated materials

## Optional SS-CABLE Power / Serial Connection

### SS-CABLE-1M



| Serial Output | | |
|---|---|---|
| White | CANL / 485A | Pin 1 |
| Yellow | CANH / 485B | Pin 2 |
| Black | Ground | Pin 3 |
| Red | +5 to 60 VDC | Pin 4 |

- For all SSD models
- Color-coded 22 ga wire
- Two twisted pairs
- 1 meter standard length

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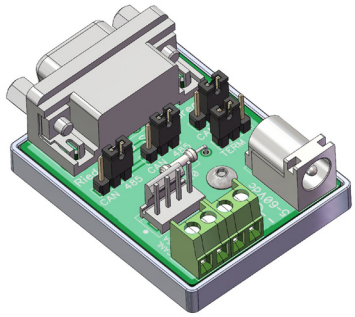
## Optional SSD Connector Sets

**SSD-CONN-SET**

| Standard Connector Set | | |
|---|---|---|
| **Includes** | **Molex P/N** | **Description** |
| 1 pc. | 1053071204 | 4-Pin Female |
| 1 pc. | 1053071202 | 2-Pin Female |
| 6 pcs. | 1053002200 | 20-22 AWG Female Crimp Terminals |
| 1 pc. | 1053251004 | 4-Pin TPA |
| 1 pc. | 1053251002 | 2-Pin TPA |

## Optional SSD Serial Connection Kit

**SSD-SERKIT**



| Serial Connection Kit | |
|---|---|
| **Includes** | **Description** |
| 1 pc. | SSD to DB-9F Serial Adapter |
| 1 pc. | 5 VDC USB Power Cable |
| 1 pc. | 4-Pin Programming Cable (1 m Length) |

The SSD serial connection kit simplifies the initial setup of the SSD Series Digital Current Sensor. It includes the necessary components to connect USB to CAN and USB to RS-485 serial adapters that have a 9-pin DB-9 male output connector. It includes jumpers to switch from RS-485 to CANbus and enable a termination resistor. USB to serial adapter not included.

USB to RS-485 Adapter - From DTEK, StarTech and others with RS-485 on DB9 pins 1 and 2 and the ground on pin 5. Note: Some adapters have the 485A and 485B pins reversed.

USB to CANbus adapter - From PEAK, Kvaser and others with CAN on DB9 pins 2 and 7 and the ground on pin 3.

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## Frequently Asked Questions

**Q: Is it necessary to install the Model SSD on the low side of the circuit?**

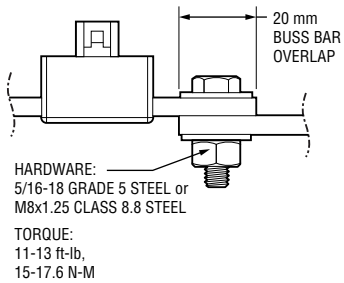
**A:** The Model SSD Digital Current Sensor is completely isolated, so it may be installed in either the low or high side of the circuit.

**Q: The sensor is only sending whole Coulombs and Watt-hours, how precise are these?**

**A:** Internally, micro-coulombs and micro-joules are counted; so very short ADC timing intervals and very low currents are accurately counted.

**Q: What is the best way to connect to the SSD Series terminals?**

**A:** Make sure connections are clean and well prepared. Bolts to be torqued to the hardware manufacturer's recommendations. There should be sufficient clamping force to ensure proper connection. Overlap shown below should be taken as a minimum. Suitable for Copper, Copper-Clad Aluminum or Aluminum conductors.




**Q: What is the best way to cool the Model SSD Digital Current Sensor?**

**A:** A majority of the heat generated by the SSD is dissipated through the primary conductors. Care should be taken to ensure that the primary conductors are sized appropriately given expected amperage and conductor length. Bourns recommends a 115 °C maximum conductor temperature at rated current. If there are thermal concerns, oversizing the conductors will help minimize the operating temperature of the Digital Current Sensor.

**Q: What size wire is suitable for the SSD Series?**

**A:**

| Copper Conductor Ampacity Ratings (continuous) | | | | | |
|---|---|---|---|---|---|
| mm² | AWG | Amps (75 °C) | mm² | AWG | Amps (75 °C) |
| 13.3 | 6 | 65 | 107 | 0000 (4/0) | 230 |
| 21.2 | 4 | 85 | 127 | 250 MCM | 255 |
| 33.6 | 2 | 115 | 152 | 300 MCM | 285 |
| 42.4 | 1 | 130 | 203 | 400 MCM | 335 |
| 54 | 0 (1/0) | 150 | 253 | 500 MCM | 380 |
| 67 | 00 (2/0) | 175 | 380 | 750 MCM | 475 |
| 85 | 000 (3/0) | 200 | 887 | 1500 MCM | 625 |

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## SSD Interface Manual

| Name | Size | Units | Range |
|---|---|---|---|
| Current | Signed int32 | 1 mA | ± 20 X Nominal |
| Temperature | Signed int32 | 0.1 °C | -40 °C to +125 °C* |
| Bus Voltage (Vbus) | Signed int32 | 1 mV | ±1200 VDC |
| Coulomb | Signed int64 | C (A•s) | $\pm 2^{60}$ |
| Power | Unsigned int32 | 0.1 W | 0 to $2^{32}$ |
| Energy | Unsigned int64 | W•h | 0 to $2^{60}$ |

*Values outside specification are reported.

This sensor is software selectable between plain RS485 or MODBUS RTU. If changing from one format to the other, set SET MODE configuration bit2 to the correct value (page 16), save settings to EEPROM (RESET COMMAND page 15), then reboot the sensor. It will boot to the correct format.

### STANDARD RS485

Default COM Settings – 19200 baud, 8 bits, No Parity, 1 Stop (no echo)

**Message Format**

:1XX1234<cr>

All SSD commands begin with a colon ':'
Then the sensor address (1 to 255)
Then a two letter command
Then an optional value
Command is terminated with a <cr>
Line feeds <lf> are ignored
NOTE: In RS485 mode, the SSD sensor does not check to see if bus is free when sending data.
Use caution when enabling automatic sending modes.

### MODBUS RTU

Default COM Settings – 19200 baud, 8 bits, No Parity, 2 Stop

MODBUS registers larger than 16 bits have a little-endian byte swap format.

MODBUS is a purely master / slave protocol with the SSD sensor as a slave device.

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## SSD Interface Manual (continued)

### MODBUS RTU

The following two tables show the locations of the SSD Input and Holding Registers.
See the standard RS485 commands for detailed descriptions of each register.
**Modbus Poll** files are available for easy setup as shown below.

| MODBUS Input Registers | | |
|---|---|---|
| 0 | Current | 0 |
| 1 | | – |
| 2 | Temperature | 0 |
| 3 | | – |
| 4 | Bus Voltage | 0 |
| 5 | | – |
| 6 | Charge | 0 |
| 7 | | – |
| 8 | | – |
| 9 | | – |
| 10 | Power | 0 |
| 11 | | – |
| 12 | Energy | 0 |
| 13 | | – |
| 14 | | – |
| 15 | | – |
| 16 | Errors | 0000 0000 0000 0000 |
| 17 | Firmware Version | 0x0204 |
| 18 | Serial Number | 1234 |
| 19 | – | |
| 20 | Restart Causes | 0x0000 |

MODBUS registers larger than 16 bits have a little-endian byte swap format.

The sensor does not respond to broadcast messages on address Ø.

| MODBUS Holding Registers | | |
|---|---|---|
| 0 | RESET (Write Only) | 0x0000 |
| 1 | ADDRESS | 1 |
| 2 | SETMODE | 0x0006 |
| 3 | A2D CONFIG | 0x335C |
| 4 | BAUD RATE | 3 |
| 5 | Read Delay (ms) | 1000 |
| 6 | Current Under Limit (A) | 0 |
| 7 | Current Over Limit (A) | 0 |
| 8 | Temperature Over Limit (°C) | 125 |
| 9 | VBUS Under Limit (V) | 0 |
| 10 | VBUS Over Limit (V) | 0 |
| 11 | Power Over Limit (W) | 0 |
| 12 | | – |
| 13 | Shunt Nano-Ohms | 120000 |
| 14 | | – |
| 15 | Current Offset (mA) | 0 |
| 16 | Vbus Factor | 10000 |
| 17 | Vbus Offset (mV) | 0 |
| 18 | Temp Offset (0.1 °C) | 0 |
| 19 | TC0 | 50000 |
| 20 | TC1 | 0 |
| 21 | | – |
| 22 | TC2 | 0 |
| 23 | | – |
| 24 | Reserved | 0 |
| 25 | | – |

**NOTE: No settings are saved until a save settings to EEPROM command is issued!**
**Power cycling will restore previous settings. Write 0x0F to Holding Register 0.**

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## RS485 Command List

Note: In the command examples an SSD sensor address of 1 (default) is used.
If the address is changed, substitute the new value in the command.

**READ Commands**

| | |
|---|---|
| GA | GET CURRENT |
| GT | GET TEMPERATURE |
| GV | GET BUS VOLTAGE |
| GC | GET COULOMBS |
| GP | GET POWER |
| GE | GET ENERGY |
| G! | GET ERRORS |
| GX | GET ALL ENABLED READINGS |
| VE | GET FIRMWARE VERSION |
| GS | GET SERIAL NUMBER |
| GM | GET MODE |
| GR | GET A2D CONFIG |
| GB | GET BAUD RATE |
| GD | GET READING DELAY |
| GF | GET CURRENT UNDER LIMIT |
| GG | GET CURRENT OVER LIMIT |
| GI | GET TEMPERATURE OVER LIMIT |
| GL | GET VBUS UNDER LIMIT |
| GQ | GET VBUS OVER LIMIT |
| GU | GET POWER OVER LIMIT |
| GN | GET SHUNT NANO-OHMS |
| GH | GET CURRENT OFFSET |
| GK | GET VBUS FACTOR |
| GJ | GET VBUS OFFSET |
| GO | GET TEMPERATURE OFFSET |
| GW | GET TC0 |
| GY | GET TC1 |
| GZ | GET TC2 |
| RC | GET RESET CAUSES |

**WRITE Commands**

| | |
|---|---|
| RS | RESET COMMAND |
| SA | SET ADDRESS |
| SM | SET MODE |
| SR | SET A2D CONFIG |
| SB | SET BAUD RATE |
| SD | SET READING DELAY |
| SF | SET CURRENT UNDER LIMIT |
| SG | SET CURRENT OVER LIMIT |
| SI | SET TEMPERATURE OVER LIMIT |
| SL | SET VBUS UNDER LIMIT |
| SQ | SET VBUS OVER LIMIT |
| SU | SET POWER OVER LIMIT |
| SN | SET SHUNT NANO-OHMS |
| SH | SET CURRENT OFFSET |
| SK | SET VBUS FACTOR |
| SJ | SET VBUS OFFSET |
| SO | SET TEMPERATURE OFFSET |

**NOTE: No settings are saved until a save settings to EEPROM command is issued!**
**Power cycling will restore previous settings. See RESET command `:1RS0F<cr>`**

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## SSD Interface Manual (continued)

**GA GET CURRENT**
Used to get the last current reading in milliamps

Send: `:1GA<cr>`
Receive: `A*****_<cr>`

**GT GET TEMPERATURE**
Used to get the last temperature reading in 0.1 °C

Send: `:1GT<cr>`
Receive: `T***_<cr>`

**GV GET BUS VOLTAGE**
Used to get the last temperature reading in millivolts

Send: `:1GV<cr>`
Receive: `V***_<cr>`

**GC / SC GET / SET COULOMBS**
Used to get the last coulomb count in Coulombs. Note: The coulomb reading can overflow! It is up to the user to check if very large values (> $\pm 2^{60}$) are expected. See G! command to read overflow bit.

Example: To set Coulombs to 500,000

WRITE
Send: `:1SC500000<cr>`
Receive: `(none)`

READ
Send: `:1GC<cr>`
Receive: `C******_<cr>`

**GP GET POWER**
Used to get the last power reading in 0.1 Watts

Send: `:1GP<cr>`
Receive: `P******_<cr>`

**GE GET ENERGY**
Used to get the last energy count in Watt-hours (Wh). Note: The energy reading can overflow! It is up to the user to check if very large values (> $2^{60}$) are expected. See G! command to read overflow bit.

Send: `:1GE<cr>`
Receive: `E******_<cr>`

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## SSD Interface Manual (continued)

### G! GET ERRORS

Used to get the error register to check sensor status. Returned data is an int16 which can be decoded below.

Send: `:1G!<cr>`
Receive: `!****_<cr>`

| Returned ERROR / ALERT bits | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 |
| N/A | 1 = ECC Single Bit | 1 = EEPROM Corrupt | 1 = EEPROM R/W | 1 = ADC Initialization | 1 = ADC CRC Read | 1 = Energy Overflow | 1 = Coulomb Overflow | 1 = Power Over Limit | 1 = Vbus Over Limit | 1 = Vbus Under Limit | 1 = Temp Over Limit | 1 = Current Over Limit | 1 = Current Under Limit | 1 = Current Range Over | 1 = Vbus Range Over |

Bit0 Vbus Range Over - Bus Voltage exceeds the MAX voltage for the range selected, see **0X17** command

Bit1 Current Range Over - Peak current exceeded the range selected, see **0X17** command

Bit2 Current Under Limit - Current is below the limit set, see **0X18** command

Bit3 Current Over Limit - Current is above the limit set, see **0X19** command

Bit4 Temp Over Limit - Temperature is above +125 °C or the limit set, see **0X1A** command.

Bit5 Vbus Under Limit - Bus Voltage is below the limit set, see **0X1B** command

Bit6 Vbus Over Limit - Bus Voltage is above the limit set, see **0X1C** command

Bit7 Power Over Limit - Power is above the limit set, see **0X1D** command

Bit8 Coulomb Overflow - Coulombs have exceeded the range of $\pm 2^{47}$

Bit9 Energy Overflow - Energy has exceeded $2^{48}$

Bit10 ADC CRC Read - The ADC's CRC doesn't match the calculated CRC of the returned data

Bit11 ADC Initialization - The ADC's initialized registers don't match the written values

Bit12 EEPROM R/W - Error reading or writing to the internal EEPROM

Bit13 EEPROM Corrupt - The EEPROM CRC doesn't match saved value

Bit14 ECC Single Bit Error - Flash Femory had an Auto-Correctable Error

**NOTE: No settings are saved until a save settings to EEPROM command is issued!**
**Power cycling will restore previous settings. See RESET command `:1RS0F<cr>`**

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## SSD Interface Manual (continued)

### GX GET ALL ENABLED READINGS

Used to get all readings that are enabled in the SET MODE command (page 14).

Example:
If Send Current, Send Temperature, and Send Power are enabled the following will be returned.

Send: `:1GX<cr>`
Receive: `A******_T******_P******_<cr>`

### VE GET FIRMWARE VERSION

Used to get the SSD firmware version.

Send: `:1VE<cr>`
Receive: `*.**_<cr>`

### GS GET SERIAL NUMBER

Used to get the SSD Serial Number

Send: `:1G9<cr>`
Receive: `******_<cr>`

### RS RESET COMMAND

Used to reset errors, coulomb count, and energy count. Can also save settings to EEPROM and restore default settings. Send hex codes shown.

Rebooting will restore previously saved settings if current settings are not saved. This will prevent baud rate or address change errors since you will need to connect with the new values before you can issue the save to EEPROM command.

| | |
|---|---|
| 0x01 | - Reset Coulomb and Energy counters |
| 0x04 | - Reset Errors |
| 0x0F | - Save settings to EEPROM |
| 0XAA | - Reset settings to defaults (command must be sent 3X in a row) |

Example: Reset Errors
Send: `:1RS04<cr>`
Receive: (none)

### SA SET ADDRESS

Used to change the SSD address. Send the new address (1-255) and the SSD will immediately change to it. Connect with the new address and issue a save settings to EEPROM command, RS0F, otherwise the old address will be restored on reboot.

Example: Set SSD address from 1 to 25, then save settings to EEPROM.

Send: `:1SA25<cr>`
Receive: (none)

Send: `:25RS0F<cr>`
Receive: (none)

**NOTE: No settings are saved until a save settings to EEPROM command is issued!**
**Power cycling will restore previous settings. See RESET command `:1RS0F<cr>`**

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## SSD Interface Manual (continued)

**GM / SM GET / SET MODE COMMAND**
Used to change the sensor options.

Bit0 Invert Current – This will flip the Current and Coulomb signs if necessary.
Bit1 Autorange – Sensor will switch to high range if reading exceeds 85 % of standard range. It will switch back when reading drops to below 50 % of standard range. See A2D CONFIG for more info.
Bit2 Modbus Enable – Enables Modbus on reboot.
Bit3 Auto Reset Errors – Self clears errors once sent or read, the error will re-enable if it persists.
Bit4 Invert Voltage – Use for Highside Voltage Measurements.
Bit7 Send on Conversion – The sensor will send the latest data as soon as available per A2D CONFIG.
Bit8 Autosend – The sensor will send readings at the Read Delay timer interval unless Bit7 is enabled.
Bit9 to Bit15 – Enable the readings to be automatically sent. Otherwise read them manually.

Value is an unsigned Int16. SET MODE default is: 0x0002.
Example: Set SSD to Autorange, Autosend Current and Temperature at the read delay interval, and Autoreset Errors. (0x070A)
Send value in hex format.

| WRITE | READ |
|---|---|
| Send: `:1SM070A<cr>` | Send: `:1GMcr>` |
| Receive: (none) | Receive: `070A<cr>` |

| SETMODE Configuration Bytes | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| HEXCODE: 0000<br>Check boxes below to calculate HEX value | | | | | | | | | | | | | | | |
| | | | | | | | | | | | | | | | |
| **15** | **14** | **13** | **12** | **11** | **10** | **9** | **8** | **7** | **6** | **5** | **4** | **3** | **2** | **1** | **0** |
| 1 = Send Errors/Alerts | 1 = Send Energy Cnt | 1 = Send Power | 1 = Send Coulomb Cnt | 1 = Send Vbus | 1 = Send Temperature | 1 = Send Current | 1 = Autosend | 1 = Send on Conversion | N/A | N/A | 1 = Invert Voltage | 1 = Auto Reset Errors/Alerts | 1 = Modbus Enable (RS485 Only) | 1 = Autorange | 1 = Invert Current |

**NOTE: No settings are saved until a save settings to EEPROM command is issued!**
**Power cycling will restore previous settings. See RESET command `:1RS0F<cr>`**

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## SSD Interface Manual (continued)

**GB / SB** GET / SET BAUD RATE

Used to set the SSD Baud Rate. Values other than the following are ignored.

| Value | Baud Rate (bit/s) |
|---|---|
| 0 | 9600 |
| 1 | 14400 |
| 2 | 19200 (default) |
| 3 | 38400 |
| 4 | 57600 |
| 5 | 115200 |
| 6 | 230400 |
| 7 | 460800 |
| 8 | 921600 |

Notes: Baud rate is changed immediately. Connect using new baud rate and use RESET COMMAND (`RS0F`) to save current settings to EEPROM. If unable to connect, reboot to restore the previous setting.

Value is an unsigned Int16. BAUD RATE default is: 2
Example: To set Baud Rate to 115200 bps

| | WRITE | READ |
|---|---|---|
| Send: | `:1SB5<cr>` | `:1GBcr>` |
| Receive: | (none) | `5<cr>` |

**GD / SD** GET / SET READING DELAY

Used to set the delay between readings automatically sent via RS485 (Not available with MODBUS). Autosend must be enabled (see SET MODE bit8). Note: If the Conversion Time is greater than the reading delay, the shunt will send the same value until the next set of readings is available. For readings faster than 5 ms use SET MODE Bit7 Send on Conversion. This will send the data as soon as it's available. Valid Range: 5 ms to 60000 ms.

Value is an unsigned Int16. READING DELAY default is: 1000 ms

Example: To set Reading Delay to 100 ms

| | WRITE | READ |
|---|---|---|
| Send: | `:1SD100<cr>` | `:1GDcr>` |
| Receive: | (none) | `100<cr>` |

**NOTE: No settings are saved until a save settings to EEPROM command is issued!**
**Power cycling will restore previous settings. See RESET command `:1RS0F<cr>`**

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## SSD Interface Manual (continued)

**GR / SR** GET / SET A2D CONFIG REGISTER

**A2D Configuration Register**

**HEXCODE: 0000**

**Check boxes below to calculate HEX value**

| N/A | Bus Voltage MAX Voltage | | | N/A | High Range MAX Current | | | N/A | Normal Range MAX Current | | | Reading Interval | | | | Time (ms) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | |
| 15 | 14 | 13 | 12 | 11 | 10 | 9 | 8 | 7 | 6 | 5 | 4 | 3 | 2 | 1 | 0 | |
| | 0 | 0 | 0 | | 0 | 0 | 0 | | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0.9 |
| | 1200 VDC | | | | 40X Nominal | | | | 40X Nominal | | | 0 | 0 | 0 | 1 | 1.6 |
| | 0 | 0 | 1 | | 0 | 0 | 1 | | 0 | 0 | 1 | 0 | 0 | 1 | 0 | 3.2 |
| | 600 VDC | | | | 20X Nominal | | | | 20X Nominal | | | 0 | 0 | 1 | 1 | 4.8 |
| | 0 | 1 | 0 | | 0 | 1 | 0 | | 0 | 1 | 0 | 0 | 1 | 0 | 0 | 6.4 |
| | 300 VDC | | | | 10X Nominal | | | | 10X Nominal | | | 0 | 1 | 0 | 1 | 7.2 |
| | 0 | 1 | 1 | | 0 | 1 | 1 | | 0 | 1 | 1 | 0 | 1 | 1 | 0 | 9 |
| | 150 VDC | | | | 5X Nominal | | | | 5X Nominal | | | 0 | 1 | 1 | 1 | 13 |
| | 1 | 0 | 0 | | 1 | 0 | 0 | | 1 | 0 | 0 | 1 | 0 | 0 | 0 | 26 |
| | 75 VDC | | | | 2.5X Nominal | | | | 2.5X Nominal | | | 1 | 0 | 0 | 1 | 51 |
| | | | | | 1 | 0 | 1 | | 1 | 0 | 1 | 1 | 0 | 1 | 0 | 102 |
| | | | | | 1.25X Nominal | | | | 1.25X Nominal | | | 1 | 0 | 1 | 1 | 205 |
| | 1 | 0 | 1 | | 1 | 1 | 0 | | 1 | 1 | 0 | 1 | 1 | 0 | 0 | 410 |
| | 37.5 VDC | | | | 0.63X Nominal | | | | 0.63X Nominal | | | 1 | 1 | 0 | 1 | 820 |
| | | | | | 1 | 1 | 1 | | 1 | 1 | 1 | 1 | 1 | 1 | 0 | 1640 |
| | | | | | 0.31X Nominal | | | | 0.31X Nominal | | | 1 | 1 | 1 | 1 | 3280 |

**NOTE: No settings are saved until a save settings to EEPROM command is issued!**
**Power cycling will restore previous settings. See RESET command `:1RS0F<cr>`**

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## SSD Interface Manual (continued)

**GR / SR** GET / SET A2D CONFIG REGISTER (Continued)

Set the bits required for the application.

Notes:

High Range must be greater than or equal to the Normal Range. If SET MODE Bit1 (Autorange) is not set, High Range will be ignored. If it is set, the sensor will automaitcally switch between the two ranges specified when necessary.

Reading intervals 13 ms and below utilize hardware averaging, 26 ms and above start using software averaging with a 13 ms hardware interval time. If it is necessary to capture and report fast current spikes, use fast reading intervals otherwise they will be averaged out.

Set the Vbus MAX voltage to the highest peak voltage expected. If using the sensor on the highside with voltage measuring, use 300 VDC range or lower.

Value is an unsigned Int16. A2D CONFIG default is: 0x035D

Example: Vbus Max Voltage 300 VDC, High Range 5X Nominal, Normal Range 1.25X Nominal, Reading Interval 820 ms (0x335D). Send value in hex format.

| | WRITE | READ |
|---|---|---|
| Send: | `:1SR335C<cr>` | `:1GRcr>` |
| Receive: | (none) | `335C<cr>` |

**NOTE: No settings are saved until a save settings to EEPROM command is issued!**
**Power cycling will restore previous settings. See RESET command `:1RS0F<cr>`**

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## SSD Interface Manual (continued)

**GF / SF** GET / SET CURRENT UNDER LIMIT

Used to configure the optional lower limit for current readings. Currents below this value will cause an error that can be read with the GET ERRORS command if errors aren't automatically sent. A zero value disables this alert, non-zero values enable alert.

Value is an signed Int16. Default CURRENT UNDER LIMIT: 0 (Disabled).

Example: Set the lower limit to 25 amps

| | WRITE | READ |
|---|---|---|
| Send: | `:1SF25<cr>` | `:1G0<cr>` |
| Receive: | (none) | `25<cr>` |

**GG / SG** GET / SET CURRENT OVER LIMIT

Used to configure the optional upper limit for current readings. Currents above this value will cause an error that can be read with the GET ERRORS command if errors aren't automatically sent. A zero value disables this alert, non-zero values enable alert.

Value is an signed Int16. Default CURRENT OVER LIMIT: 0 (Disabled).

Example: Set the lower limit to 620 amps

| | WRITE | READ |
|---|---|---|
| Send: | `:1SG620<cr>` | `:1G1<cr>` |
| Receive: | (none) | `620<cr>` |

**GI / SI** GET / SET TEMPERATURE OVER LIMIT

Used to configure the temperature limit for the error. Temperatures above this value will cause an error that can be read with the GET ERRORS command if errors aren't automatically sent.

Value is an unsigned Int16 in centigrade. Default TEMP OVER LIMIT: 125 °C (Cannot Disable)

Valid Range: 0 °C to +125 °C (MAX)

Example: Set the upper limit to 90 °C

| | WRITE | READ |
|---|---|---|
| Send: | `:1SI90<cr>` | `:1G2<cr>` |
| Receive: | (none) | `90<cr>` |

**GL / SL** GET / SET VBUS UNDER LIMIT

Used to configure the optional lower limit for the bus voltage readings. Voltages below this value will cause an error that can be read with the GET ERRORS command if errors aren't automatically sent. A zero value disables this alert, non-zero values enable alert.

Value is a signed Int16 in volts. Default VBUS UNDER LIMIT: 0 (Disabled).

Example: Set the lower limit to 29 Volts

| | WRITE | READ |
|---|---|---|
| Send: | `:1SL29cr>` | `:1G3<cr>` |
| Receive: | (none) | `29<cr>` |

**NOTE: No settings are saved until a save settings to EEPROM command is issued!**
**Power cycling will restore previous settings. See RESET command `:1RS0F<cr>`**

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## SSD Interface Manual (continued)

**GQ / SQ** GET / SET VBUS OVER LIMIT

Used to configure the optional upper limit for bus voltage readings. Voltages above this value will cause an error that can be read with the GET ERRORS command if errors aren't automatically sent. A zero value disables this alert, non-zero values enable alert.

Value is an signed Int16 in Volts. Default VBUS OVER LIMIT: 0 (Disabled).

Example: Set the upper limit to 70 Volts

| | WRITE | READ |
|---|---|---|
| Send: | :1SQ70cr> | :1G4<cr> |
| Receive: | (none) | 70<cr> |

**GU / SU** GET / SET POWER OVER LIMIT

Used to configure the optional upper limit for power readings. Power above this value will cause an error that can be read with the GET ERRORS command if errors aren't automatically sent. A zero value disables this alert, non-zero values enable alert.

Value is an unsigned Int32 in Watts. Default POWER OVER LIMIT: 0 (Disabled).

Example: Set the upper limit to 22000 Watts

| | WRITE | READ |
|---|---|---|
| Send: | :1SU22000cr> | :1G5<cr> |
| Receive: | (none) | 22000<cr> |

**GN / SN** GET / SET SHUNT NANO-OHMS

Used to override the resistance of the SSD from the factory calibration. This is typically not necessary and the correct equipment is essential to properly set it. Value can be reset back to factory defaults.

Value is an unsigned Int32 in nano-ohms.

Example: To set SHUNT NANO-OHMS to 300156 nano-ohms

| | WRITE | READ |
|---|---|---|
| Send: | :1SN300156cr> | :1GN<cr> |
| Receive: | (none) | 330156<cr> |

**GH / SH** GET / SET CURRENT ZERO OFFSET

Used to override the shunt zero offset current. Value can be reset back to factory defaults..

Value is a signed Int16 in mA.

Example: To set SHUNT OFFSET to +8 mA

| | WRITE | READ |
|---|---|---|
| Send: | :1SH8cr> | :1GH<cr> |
| Receive: | (none) | 8<cr> |

**NOTE: No settings are saved until a save settings to EEPROM command is issued!**
**Power cycling will restore previous settings. See RESET command :1RS0F<cr>**

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## SSD Interface Manual (continued)

**GK / SK** GET / SET VBUS FACTOR

Used to adjust the Bus Voltage reading from the factory calibration. This is typically not necessary and the correct equipment is essential to properly set it. See reset command to set the value back to factory default. Voltage is calibrated at 25 °C. Power and Energy values are scaled appropriately.

Value is an unsigned Int16. Value is divided by 10000 in firmware to create the factor.

Example: To set VBUS FACTOR to 10023

| | WRITE | READ | |
|---|---|---|---|
| Send: | `:1SK10023cr>` | Send: | `:1GK<cr>` |
| Receive: | (none) | Receive: | `10023<cr>` |

**GJ / SJ** GET / SET VBUS ZERO OFFSET

Used to override the bus voltage zero offset. Value can be reset back to factory defaults.

Value is a signed Int16 in mV.

Example: To set VBUS OFFSET to -6 mV

| | WRITE | READ | |
|---|---|---|---|
| Send: | `:1SJ-6cr>` | Send: | `:1GJ<cr>` |
| Receive: | (none) | Receive: | `-6<cr>` |

**GO / SO** GET / SET TEMPERATURE OFFSET

Used to adjust the Temperature reading from the factory calibration. This is typically not necessary. See reset command to set the value back to factory default.

Value is an Signed Int16 in 0.1 °C

Example: To set TEMP OFFSET to -2.2 °C send -22

| | WRITE | READ | |
|---|---|---|---|
| Send: | `:1SO-22<cr>` | Send: | `:1GO<cr>` |
| Receive: | (none) | Receive: | `-22<cr>` |

**NOTE: No settings are saved until a save settings to EEPROM command is issued!**
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## SSD Interface Manual (continued)

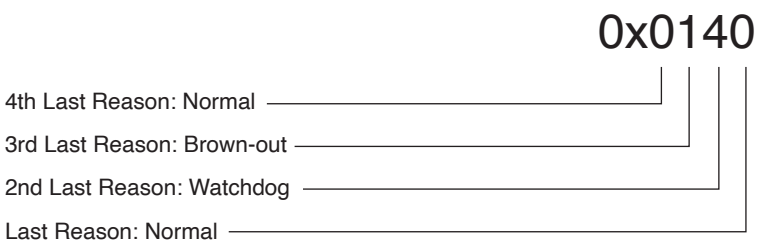
**GW** GET TC0 (read only)
**GY** GET TC1 (read only)
**GZ** GET TC2 (read only)
Used to get the factory calibrated settings for the temperature compensation constants.

TC0 - unsigned int16
TC1 - signed int32
TC2 - signed int32
Example: To get the compensation constant TC2

Send: `:1GZ<cr>`
Receive: `3089694<cr>`

**RC** GET RESET CAUSES (read only)
Used to read the reasons for the last four SSD sensor restarts.
Value is an unsigned Int16
Example: The following shows abnormal restarts (0x0140)

READ
Send: `:1RC<cr>`
Receive: `0x0140<cr>`




**Reason Codes**
0 - Normal Power-on Reset
1 - Brown-out Reset
4 - Watchdog Timer Time-Out Reset
6 - Software RESET Instruction
7 - Master Clear Pin Reset
9 - Configuration Mismatch Reset
E - Illegal Condition Device Reset
- Illegal Opcode Reset
- Uninitialized W Register Reset
- Security Reset

F - Trap Conflict Reset

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## SSD Interface Manual (continued)

Firmware Revisions-

v2.10
Added Invert Bus Voltage bit to SETMODE command for highside sensor mounting.

v2.11
Updated internal ADC settings to reduce noise. This reduces some of the fixed ADC reading intervals.
Fixed reading Coulombs and Energy manually after changing CAN IDs

v2.12
Bus Voltage is now signed int32, ±1200 VDC
Current and Voltage Under and Over limits are now signed int16
Can now write Coulomb value to sensor and the sensor will count from there.

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