SSD - Smart DC Current Sensor

24bit Isolated Shunt Current Sensor with RS485/MODBUS Interface



- **100A to 1000A (2kA to 20kA Peak)**
- **1500V_{DC} Reinforced Galvanic Isolation**
- **0.1% Tolerance**
- **Features:**
  - » ***16-bit Automotive +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***
- **Typical Applications:**
  - » ***Battery Systems***
  - » ***Renewable Energy***
  - » ***Motor Drives***
  - » ***EV Charging Stations***

SPECIFICATIONS

Nominal Current	± 100A	± 250A	± 500A	± 1000A
Peak Current (No Clipping)	+2kA / -1kA	+5kA / -2.5kA	+10kA / -5kA	+20kA / -10kA
Shunt Resistance (Micro-Ohms) Excluding primary termination resistance	300	120	60	30
Initial Accuracy	< ± 0.1%			
Linearity over Current Range	< ± 0.1% + 5mA	< ± 0.1% + 13mA	< ± 0.1% + 25mA	< ± 0.1% + 50mA
Bandwidth	5kHz			
ADC Resolution	24 bits			
Speed (readings per second)	up to 1100 rps (0.9 - 3280 ms per reading)			
Supply Voltage (5 - 60 Vdc)	@ 5.0V, 55mA typical		@ 24V, 15mA typical	
DC Bus Voltage Measurement	± 1200V_{DC} MAX (10M input impedance)			
RS485 Interface (default)	Speeds: 4800, 9600, 14400, 19200 (default), 28800, 38400, 57600, 115200, 230400, 460800, 921600 **8bits, No Parity, 1 Stop**			
MODBUS RTU Interface	Speeds: 4800, 9600, 14400, 19200 (default), 28800, 38400, 57600, 115200, 230400, 460800, 921600 **8bits, No Parity, 2 Stop**			
Long term stability	< ±0.1% 1000 hours 60°C terminal temperature < ±0.3% 1000 hours 115°C terminal temperature			
Galvanic Isolation	1500V_{DC} 1000$V_{AC\ RMS}$ (maximum continuous working voltage)			
Dielectric Strength	3500$V_{AC\ RMS}$ 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			
Materials (RoHS Compliant)	Resistance Element: CuMnNi Current Terminal: Nickel Plated Copper **Suitable for Copper, Copper-Clad Aluminum or Aluminum conductors** Electronics Housing: 94-V0 rated			

* 1200Vdc Highside Contact Riedon

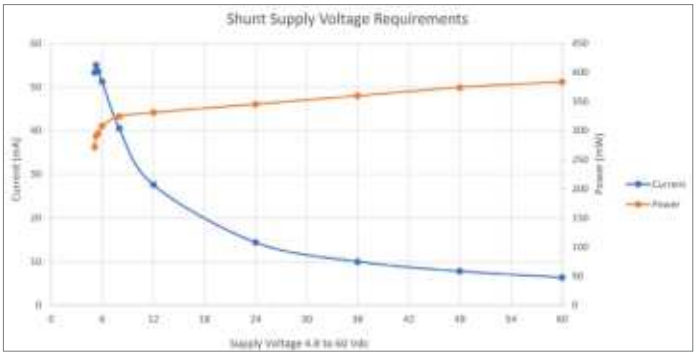
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Revised: 2024.02.01

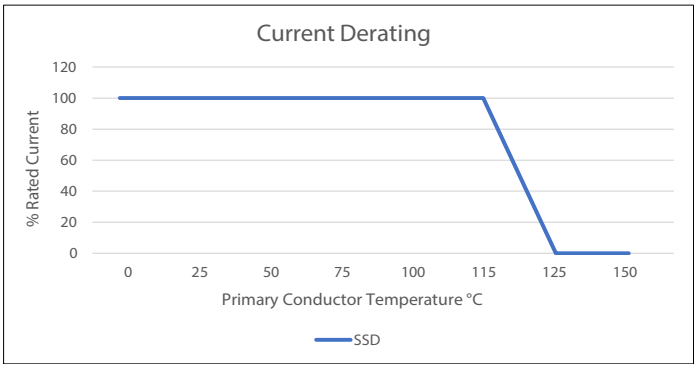
SSD - Smart DC Current Sensor

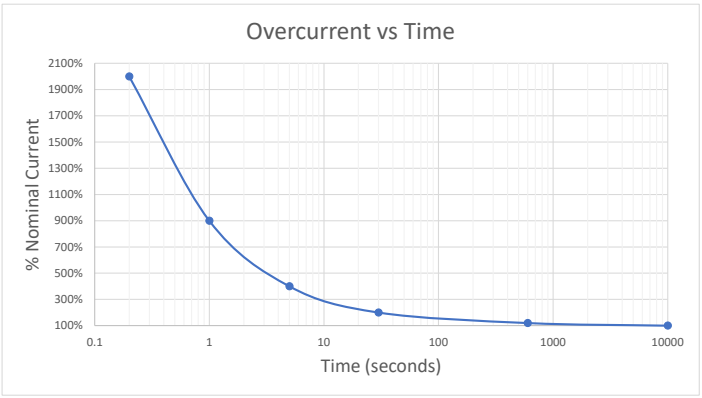
24bit Isolated Shunt Current Sensor with RS485/MODBUS Interface

Specifications (Cont.)

SENSOR	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-100	3	3	2	2	2	2	1	1	1	1	1	<1	<1	<1	<1	<1
SSD-250	8	7	6	5	5	4	4	3	3	2	2	1	1	1	<1	<1
SSD-500	15	13	12	11	10	9	7	7	5	4	3	2	2	1	1	1
SSD-1000	31	27	24	21	19	17	15	13	11	9	6	4	3	2	2	1







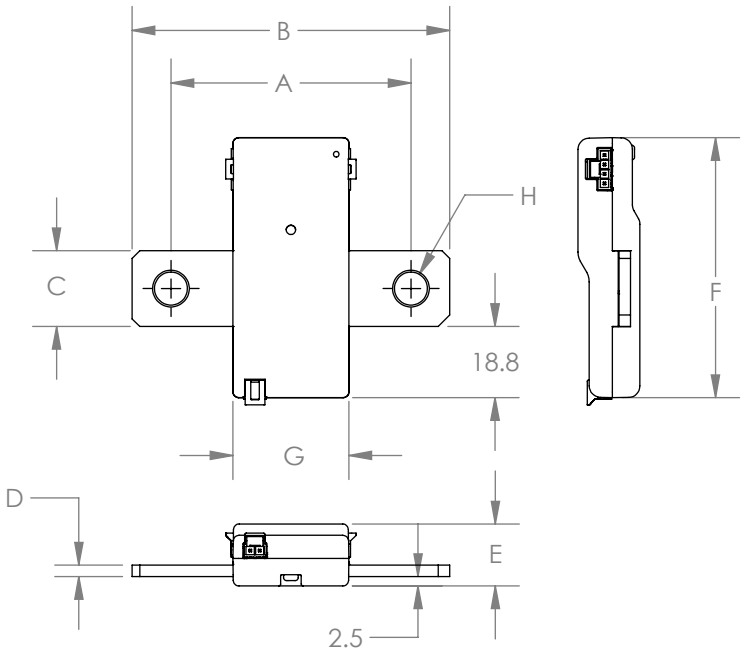
SSD Connector	Mating Connector	Molex Nano-Fit Part Number
4-Pin Male	4-Pin Female	1053071204
	20-22 AWG Female Contacts *	1053002200
	4-Pin TPA Strain Relief	1053251004
2-Pin Male Vbus	2-Pin Female	1053071202
	20-22 AWG Female Contacts *	1053002200
	2-Pin TPA Strain Relief	1053251002

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

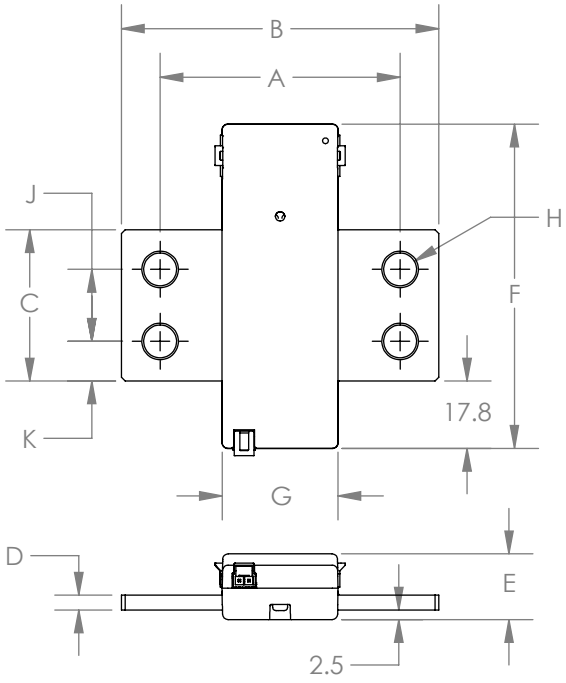
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Dimensions

		Dimensions (mm)			
		SSD-100	SSD-250	SSD-500	SSD-1000
A	(±0.5)	63.5	63.5	63.5	63.5
B	(±0.5)	84	84	84	84
C	(±0.2)	20	20	20	40
D	(±0.2)	3	3	4	4
E	(±0.3)	16.4	16.4	17.4	17.4
F	(±0.5)	68.8	68.8	68.8	85.8
G	(±0.5)	30.8	30.8	30.8	30.8
H	(±0.2)	8.7	8.7	8.7	8.7
J	(±0.3)	-	-	-	19
K	(±0.3)	-	-	-	10.5
Mass (g)		67	69	84	145



SSD-100 to SSD-500



SSD-1000

Product Safety notice - The SSD current sensor must be used in a manner specified by this datasheet, 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.

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Ordering Information

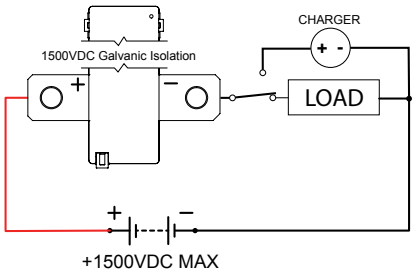
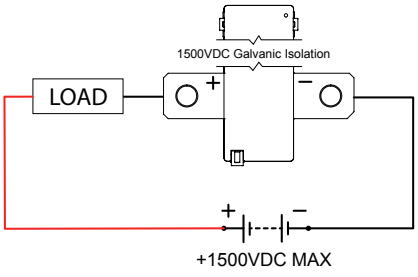
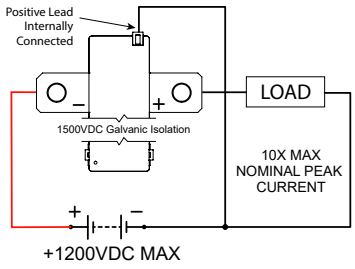
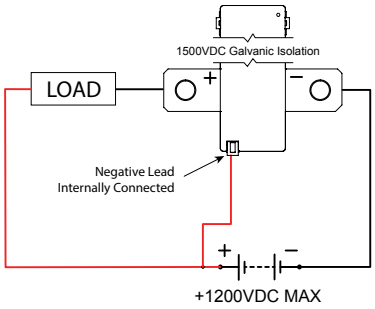
SSD -	AMPS -	Interface -	Options
	100	R (RS485, MODBUS)	T (Internal 120 Ohm Termination Resistor)
	250	C (CANbus)	Pxxx (Custom Settings Factory Programmed)
	500		
	1000		

Custom Settings Factory Programmed - 25pc minimum (Riedon will assign a Pxxx number when ordered)		
SSD Setting	**Factory Default**	**User Required**
ADDRESS	1	
SETMODE	0x0002	
Baudrate	2	
Reading Delay	1000	
A2DCONFIG	0x035D	
Current Under Limit	0	
Current Over Limit	0	
Temperature Over Limit	125	
Vbus Under Limit	0	
Vbus Over Limit	0	
Power Over Limit	0	

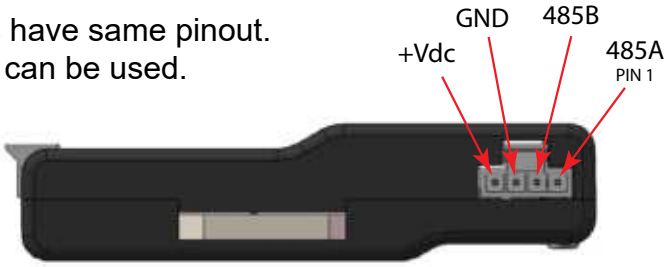
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Installation

Electrical Wiring

	Highside	Lowside
Current Only ±1500 VDC MAX		
Bus Voltage Measurements ±1200 VDC	**Firmware V2.12+**  **Use SETMODE Command to Invert Current and Voltage. Keep Positive DC Connection Short to Minimize Bus Voltage Drop Errors**	 **Keep Negative DC Connection Short to Minimize Bus Voltage Drop Errors**

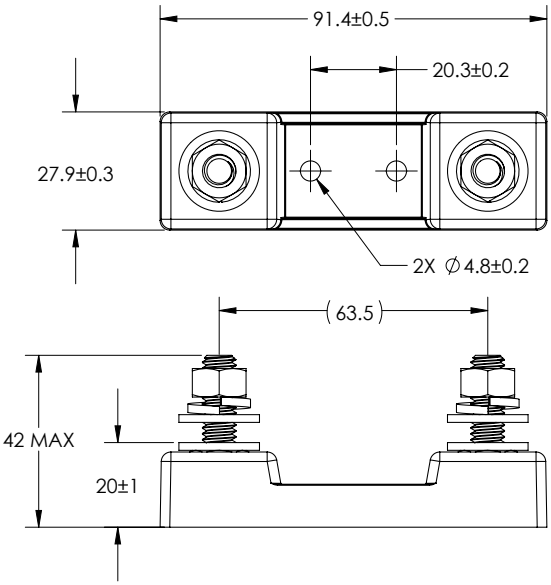
Connectors on both sides have same pinout.
Either or both connectors can be used.

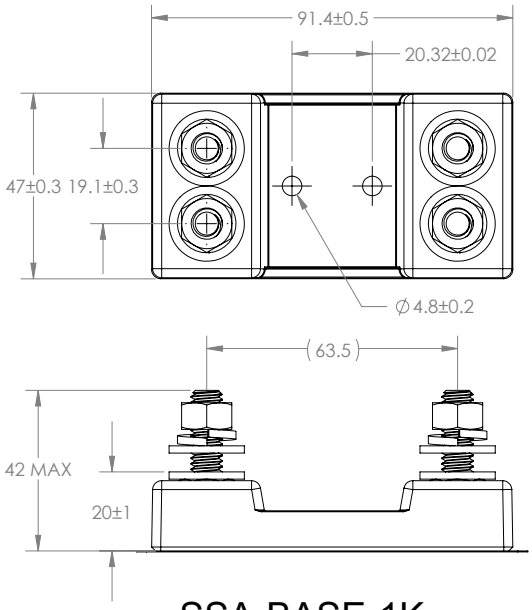




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BASE Mounting Fixtures (Optional)





Ordering Info: SSA-BASE

SSA-BASE-1K



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

SS-CABLE Power/Serial Connection (Optional)



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

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

Ordering Info: SS-CABLE-1M

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SSD Connector Sets (Optional)

Standard Connector Set

Includes:	Molex PN	
1pc	1053071204	4-Pin Female
1pc	1053071202	2-Pin Female
6pc	1053002200	20-22 AWG Female Crimp Terminals
1pc	1053251004	4-Pin TPA
1pc	1053251002	2-Pin TPA

Ordering Info: SSD-CONN-SET

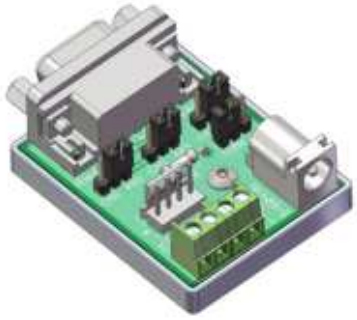
SSD Serial Connection Kit (Optional)

Serial Connection Kit

Includes:

1pc	SSD to DB-9F Serial Adapter
1pc	5 VDC USB Power Cable
1pc	4-Pin Programming Cable (1m length)

Ordering Info: SSD-SERKIT



The SSD serial connection kit simplifies the initial setup of the SSD Current Sensor. It includes the necessary components to connect USB to CAN and USB to RS485 serial adapters that have a 9-pin DB-9 male output connector. Includes jumpers to switch from RS485 to CANbus and enable termination resistor. USB to serial adapter not included.

USB to RS485 adapter - From DTEK, StarTech and others with RS485 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 SSD on the low side of the circuit?

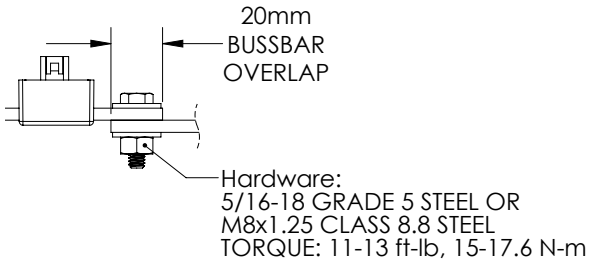
A: The SSD series of smart current sensors is completely isolated, so it may be installed in either the low or high side of the circuit.

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's 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 SSD smart 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. We recommend 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 smart current sensor.

Q: What size wire is suitable for the SSD?

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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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	±1200VDC
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 ssensor. 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 16bits 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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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 16bits have a little-endian byte swap format.

The sensor does not respond to broadcast messages on address `0`

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 (0.1C)	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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GA GET CURRENT

Used to get the last current reading in milli-Amps.

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 milli-Volts

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>`

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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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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 +125C 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

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GX GET ALL ENABLED READINGS

Used to get all readings that are enabled in the SET MODE command (page 16).

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>`

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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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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
Send: `:1SM070A<cr>`
Receive: `(none)`

READ
Send: `:1GMcr>`
Receive: `070A<cr>`

SETMODE Configuration Bytes

HEXCODE: 0000 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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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>	Send:	:1GBcr>
Receive:	(none)	Receive:	5<cr>

GD / SD GET / SET READING DELAY

Used to set the delay between readings automatically sent via RS485. (Not avaliable 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 5ms use SET MODE Bit7 Send on Conversion. This will send the data as soon as it's available. Valid Range: 5ms to 60000ms.

Value is an unsigned Int16. READING DELAY default is: 1000ms
Example: To set Reading Delay to 100ms

WRITE		READ	
Send:	:1SD100<cr>	Send:	:1GDcr>
Receive:	(none)	Receive:	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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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 1200 Vdc				0 0 0 40X Nominal				0 0 0 40X Nominal			0 0 0 0				0.9
												0 0 0 1				1.6
	0 0 1 600 Vdc				0 0 1 20X Nominal				0 0 1 20X Nominal			0 0 1 0				3.2
												0 0 1 1				4.8
	0 1 0 300 Vdc				0 1 0 10X Nominal				0 1 0 10X Nominal			0 1 0 0				6.4
												0 1 0 1				7.2
	0 1 1 150 Vdc				0 1 1 5X Nominal				0 1 1 5X Nominal			0 1 1 0				9
												0 1 1 1				13
	1 0 0 75 Vdc				1 0 0 2.5X Nominal				1 0 0 2.5X Nominal			1 0 0 0				26
												1 0 0 1				51
	1 0 1 37.5 Vdc				1 0 1 1.25X Nominal				1 0 1 1.25X Nominal			1 0 1 0				102
												1 0 1 1				205
					1 1 0 0.63X Nominal				1 1 0 0.63X Nominal			1 1 0 0				410
												1 1 0 1				820
					1 1 1 0.31X Nominal				1 1 1 0.31X Nominal			1 1 1 0				1640
												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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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 13ms and below utilize hardware averaging, 26ms and above start using software averaging with a 13ms 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 300Vdc range or lower.

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

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

WRITE		READ	
Send:	`:1SR335C<cr>`	Send:	`:1GRcr>`
Receive:	`(none)`	Receive:	`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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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>`	Send:	`:1G0<cr>`
Receive:	`(none)`	Receive:	`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>`	Send:	`:1G1<cr>`
Receive:	`(none)`	Receive:	`620<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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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>`	Send:	`:1G2<cr>`
Receive:	`(none)`	Receive:	`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>`	Send:	`:1G3<cr>`
Receive:	`(none)`	Receive:	`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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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:	:1SQ70<cr>	Send:	:1G4<cr>
Receive:	(none)	Receive:	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:	:1SU22000<cr>	Send:	:1G5<cr>
Receive:	(none)	Receive:	22000<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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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>`	Send:	`:1GN<cr>`
Receive:	`(none)`	Receive:	`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 +8mA

WRITE		READ	
Send:	`:1SH8cr>`	Send:	`:1GH<cr>`
Receive:	`(none)`	Receive:	`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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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>`

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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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>`

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>`

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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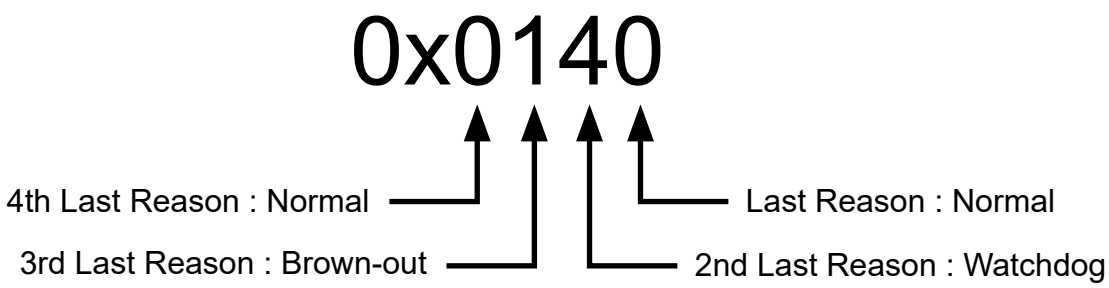
RC GET RESET CAUSES (read only)

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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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.

v2.12
Bus Voltage is now signed int32, +/-1200Vdc
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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