SSD - Smart DC Current Sensor

24bit Isolated Shunt Current Sensor with CANbus 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***

YouTube Setup Video

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 - 3300 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)			
CAN Interface	CAN 2.0A Speeds: 125K, 250K, 500K (default), 1M baud			
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

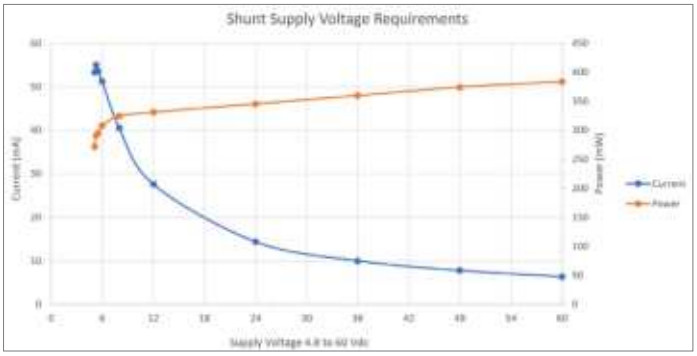
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www.riedon.com **sales@riedon.com**
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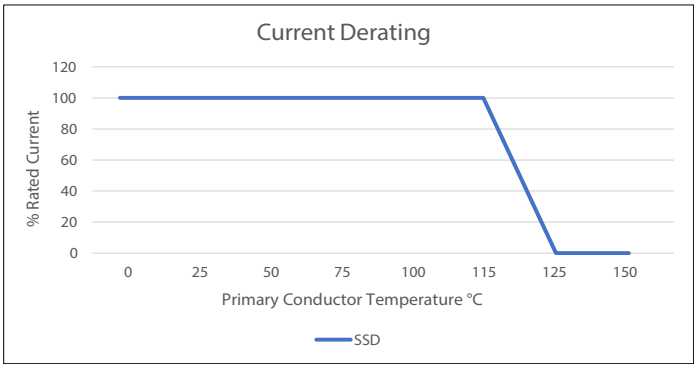
SSD - Smart DC Current Sensor

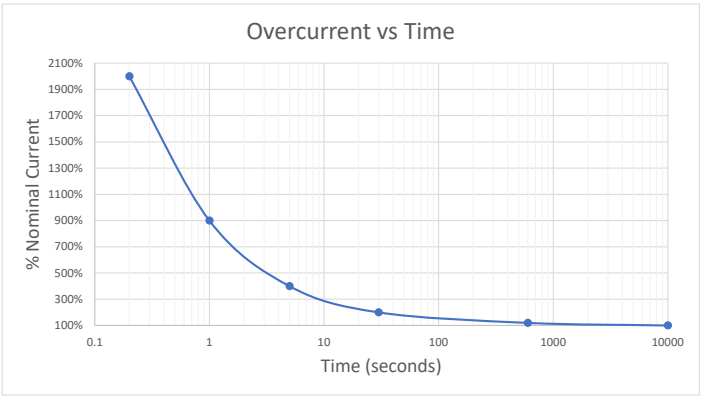
24bit Isolated Shunt Current Sensor with CANbus Interface

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







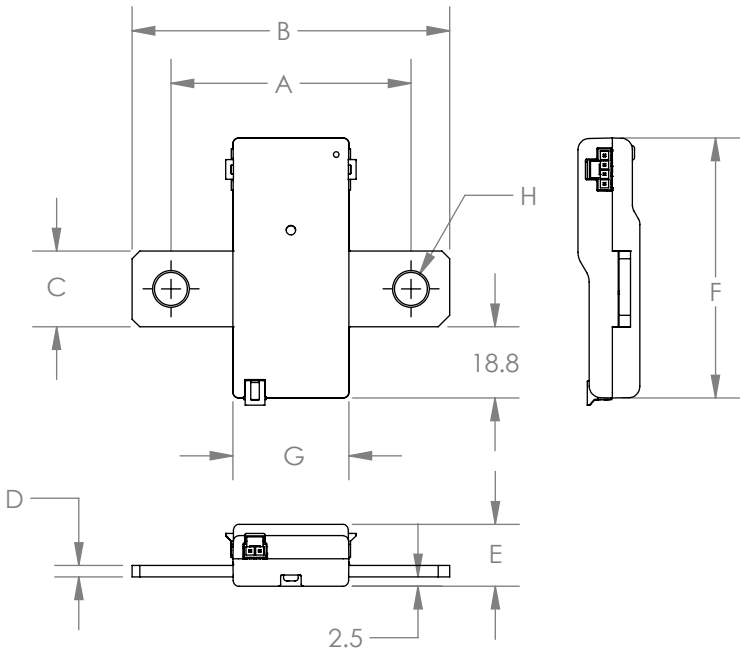
SSD Connector	Mating Connector	Molex Nano-Fit Part Number
4-Pin Male	4-Pin Female	1053071204
	20-22 AWG Female Contacts *	1053002200
	4-Pin TPA Strain Relief	1053251004
2-Pin Male Vbus	2-Pin Female	1053071202
	20-22 AWG Female Contacts *	1053002200
	2-Pin TPA Strain Relief	1053251002

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

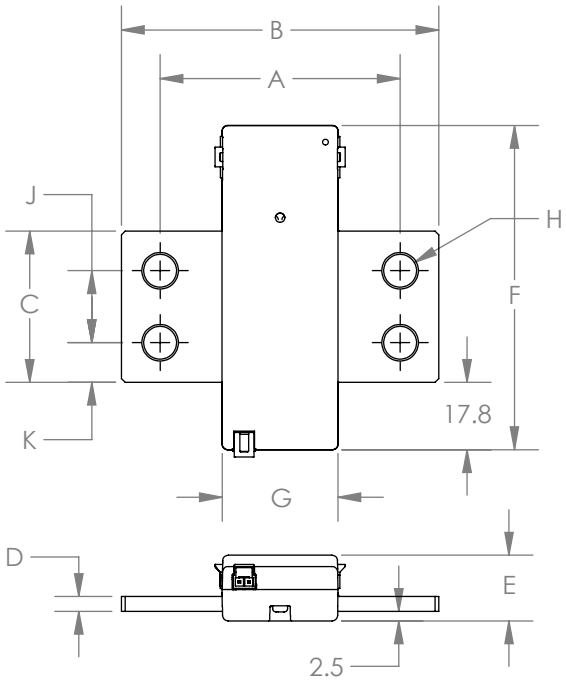
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Dimensions

		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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SSD - Smart DC Current Sensor

24bit Isolated Shunt Current Sensor with CANbus Interface

Ordering Information

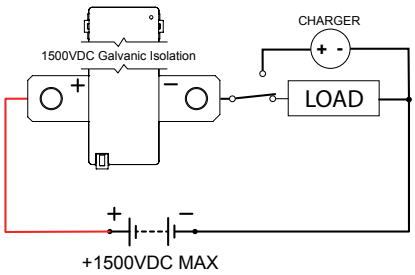
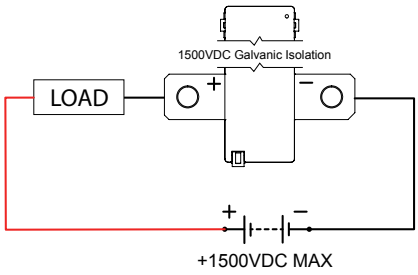
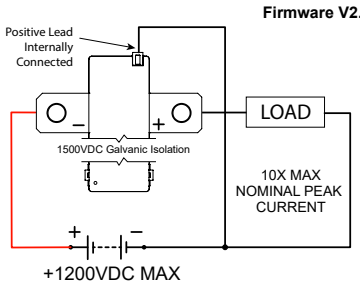
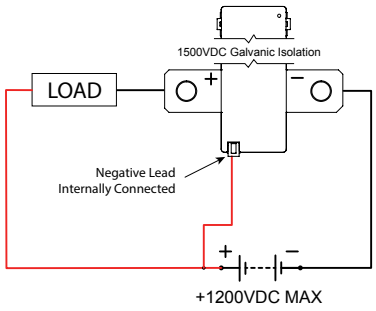
SSD -	AMPS -	Interface -	Options
	100	R (RS485, MODBUS)	T (Internal 120 Ohm Termination Resistor)
	250	C (CANbus)	Pxxx (Custom Settings Factory Programmed)
	500		
	1000		

Custom Settings Factory Programmed - 25pc minimum (Riedon will assign a Pxxx number when ordered)		
SSD Setting	**Factory Default**	**User Required**
CAN ID - SET Command	0x3FA	
CAN ID - GET Command	0x3FB	
CAN ID - REPLY	0x3FC	
CAN ID - Current	0x3F1	
CAN ID - Temperature	0x3F2	
CAN ID - Vbus	0x3F3	
CAN ID - Coulomb	0x3F4	
CAN ID - Power	0x3F5	
CAN ID - Energy	0x3F6	
CAN ID - Errors	0x3F7	
SETMODE	0x0002	
Baudrate	0x000B	
Reading Delay	0x03E8	
A2DCONFIG	0x035D	
Current Under Limit	0x0000	
Current Over Limit	0x0000	
Temperature Over Limit	0x007D	
Vbus Under Limit	0x0000	
Vbus Over Limit	0x0000	
Power Over Limit	0x00000000	

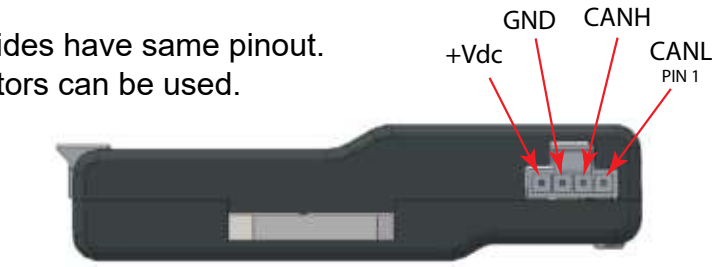
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Installation

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**

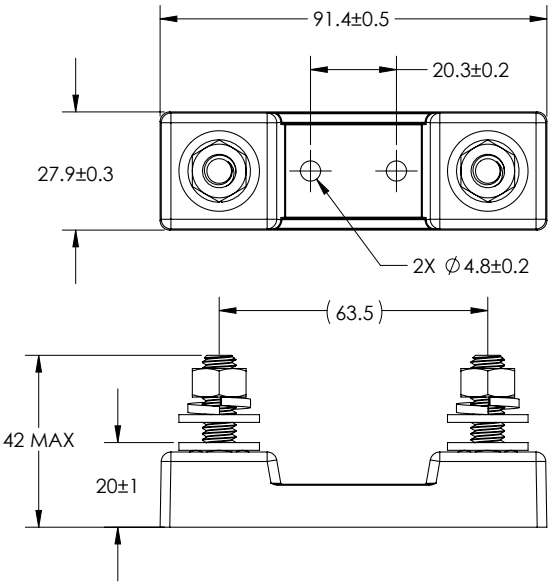
Connectors on both sides have same pinout.
Either or both connectors can be used.

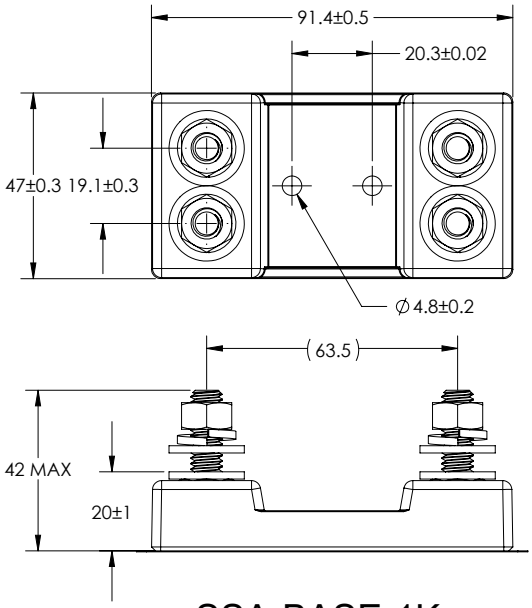




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BASE Mounting Fixtures (Optional)





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

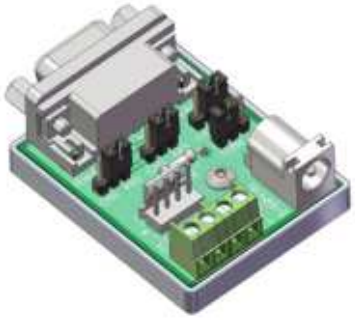
SSD Serial Connection Kit (Optional)

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.

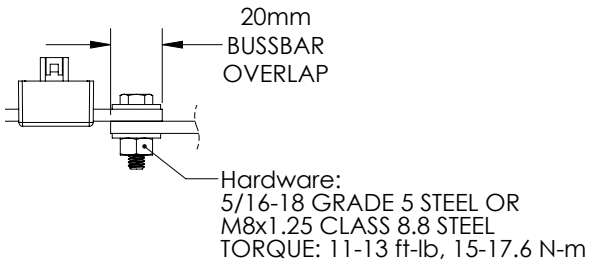
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Frequently Asked Questions

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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SSD Interface Manual

SSD CAN IDs for Settings (Defaults)

Default Baud 500 kbp/s

SET COMMAND ID	0x3FA	Motorola	Used to Write values
GET COMMAND ID	0x3FB	Motorola	Used to Read values
REPLY ID	0x3FC	Motorola	Returned Data from Get Command

CAN IDs for Sensor Readings (Defaults)

CURRENT	0x3F1	Intel	Sensor Current
TEMPERATURE	0x3F2	Intel	Sensor Temperature
VBUS	0x3F3	Intel	Bus Voltage
COULOMB	0x3F4	Intel	Coulomb Counter
POWER	0x3F5	Intel	Power
ENERGY	0x3F6	Intel	Energy Counter
ERRORS/ALERT	0x3F7	Intel	Errors or Alerts

Intel (Data Byte 0 = LSB) data format for Sensor Readings
Motorola (Data Byte 0 = MSB) data format for all Settings to improve legibility with setup

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

* Values outside specification are reported

COMMAND LIST

GET ALL ENABLED	0x00 - Read Only	TEMP OVER LIMIT	0x1A
GET CURRENT	0x01 - Read Only	VBUS UNDER LIMIT	0x1B
GET TEMPERATURE	0x02 - Read Only	VBUS OVER LIMIT	0x1C
GET VBUS	0x03 - Read Only	POWER OVER LIMIT	0x1D
GET COULOMB	0x04 - Read Only	SHUNT NANO-OHM	0x1E
GET POWER	0x05 - Read Only	CURRENT ZERO OFFSET	0x21
GET ENERGY	0x06 - Read Only	VBUS FACTOR	0x22
GET ERRORS	0x07 - Read Only	VBUS ZERO OFFSET	0x23
RESET COMMAND	0x10 - Write only	TEMP OFFSET	0x24
SET CAN IDS	0x11 - Write only	T0 TEMP COMPENSATION	0x25 - Read Only
SETMODE	0x12	T1 TEMP COMPENSATION	0x26 - Read Only
BAUDRATE	0x14	T2 TEMP COMPENSATION	0x27 - Read Only
READING DELAY	0x16	RESET CAUSES	0x28 - Read Only
A2D CONFIG	0x17	FIRMWARE VERSION	0x30 - Read Only
CURRENT UNDER LIMIT	0x18	SERIAL NUMBER	0x31 - Read Only
CURRENT OVER LIMIT	0x19		

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0x00 - Command GET ALL ENABLED - Read Only

Used to get all enabled readings in the SETMODE command. Current, Temperature, Vbus, etc....

	Message ID	Length	Data Fields (LSB First)					
SEND	0x3FB	0x01	0x00					
RECEIVE	Multiple replies from all enabled readings in the SETMODE Command							

0x01 - Command GET CURRENT - Read Only

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

Reply is 4 bytes from CAN ID 0x3F1 (default) - Intel Format (Data Byte 0 = LSB)

	Message ID	Length	Data Fields (LSB First)					
SEND	0x3FB	0x01	0x01					
RECEIVE	0x3F1	0x04	0xXX	0xXX	0xXX	0xXX		

0x02 - Command GET TEMPERATURE - Read Only

Used to get the last sensor temperature reading in 0.1 centigrade.

Reply is 4 bytes from CAN ID 0x3F2 (default) - Intel Format (Data Byte 0 = LSB)

	Message ID	Length	Data Fields (LSB First)					
SEND	0x3FB	0x01	0x02					
RECEIVE	0x3F2	0x04	0xXX	0xXX	0xXX	0xXX		

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0x03 - Command GET VBUS - Read Only

Used to get the last external bus voltage reading in milli-Volts.

Reply is 4 bytes from CAN ID 0x3F3 (default) - Intel Format (Data Byte 0 = LSB)

	Message ID	Length	Data Fields (LSB First)					
SEND	0x3FB	0x01	0x03					
RECEIVE	0x3F3	0x04	0xXX	0xXX	0xXX	0xXX		

0x04 - Command GET COULOMB - Read / Write

Used to get or set the last coulomb count which is continuously updated with current.
Note: The coulomb reading can overflow! It is up to the user to check if very large values (> $\pm 2^{60}$) are expected. See 0x07 command to read overflow bit.

Reply is 8 bytes from CAN ID 0x3F4 (default) - Intel Format (Data Byte 0 = LSB)

Note: Writing a new value is limited to signed int32 values.
Example: write 500,000 (0x7A120) to coulomb counter

Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x05	0x04	0x00	0x07	0xA1	0x20	
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields (LSB First)							
SEND	0x3FB	0x01	0x04							
RECEIVE (int64)	0x3F4	0x08	0xXX	0xXX	0xXX	0xXX	0xXX	0xXX	0xXX	0xXX

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0x05 - Command GET POWER - Read Only

Used to get the last power reading in 0.1 Watts.

Reply is 4 bytes from CAN ID 0x3F5 (default) - Intel Format (Data Byte 0 = LSB)

	Message ID	Length	Data Fields (LSB First)					
SEND	0x3FB	0x01	0x05					
RECEIVE	0x3F5	0x04	0xXX	0xXX	0xXX	0xXX		

0x06 - Command GET ENERGY - Read Only

Used to get the last energy count in Watt-hours (Wh) which is continuously updated.
Note: The energy reading can overflow! It is up to the user to check if very large values (> 2^{60}) are expected. See 0x07 command to read overflow bit.

Reply is 8 bytes from CAN ID 0x3F6 (default) - Intel Format (Data Byte 0 = LSB)

	Message ID	Length	Data Fields (LSB First)							
SEND	0x3FB	0x01	0x06							
RECEIVE (int64)	0x3F6	0x08	0xXX	0xXX	0xXX	0xXX	0xXX	0xXX	0xXX	0xXX

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0x07 - Command GET ERRORS/Alerts - Read Only

Used to get any errors or alerts which are continuously updated.
Reply is 2 bytes from CAN ID 0x3F7 (default) - Motorola Format (Big Endian)

	Message ID	Length	Data Fields (LSB First)					
SEND	0x3FB	0x01	0x07					
RECEIVE	0x3F7	0x02	0xXX	0xXX				

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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SSD Interface Manual

0x10 - Command RESET COMMAND - Write only

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

0x0001	- Reset Coulomb and Energy counters
0x0004	- Reset Errors
0x000F	- Save settings to EEPROM
0X00AA	- Reset settings to defaults (command must be sent 3X in a row)

Example: To save settings to EEPROM

	Message ID	Length	Data Fields					
SEND	0x3FA	0x03	0x10	0x00	0x0F			
RECEIVE	(none)							

0x11 - Command SET IDs - Write only

Used to change the default SSD CAN bus IDs to different ID numbers.

Example: To change the default CURRENT CAN ID from 0x03F1 (1009) to 0x04B0 (1200)

	Message ID	Length	Data Fields					
SEND	0x3FA	0x05	0x11	0x03	0xF1	0x04	0xB0	
RECEIVE	(none)							

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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0x12 - Command SETMODE - Read / Write

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 - Not used on Canbus version
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.

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	Reserved	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 command 0x10 0x000F.

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0x12 (Continued) - Command SETMODE - Read / Write

SETMODE default is: 0x0002.

Example: To enable Autosend, Send Current, Send Errors, Auto Reset Errors (0x8308)

Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x03	0x12	0x83	0x08			
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x12					
RECEIVE	0x3FC	0x03	0x12	0x83	0x08			

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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0x14 - Command BAUD RATE - Read / Write

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

HEX Value	Baud Rate (kbit/s)
0x0009	125
0x000A	250
0x000B	500
0x000C	1000

Notes: Baud rate is changed immediately so you may get an error after change. Connect using new baud rate and use Command RESET MODE (0x10 0x000F) to save current settings to EEPROM. If unable to connect, reboot to restore the previous setting. BAUD RATE is defaulted to: 0x000B (500 kb/s).

Example: To set Baud Rate to 250kbps

Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x03	0x14	0x00	0x0A			
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x14					
RECEIVE	0x3FC	0x03	0x14	0x00	0x0A			

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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0x16 - Command SET READING DELAY - Read / Write

Used to set the delay between readings automatically sent to the CAN bus. Autosend must be enabled (see SETMODE bit8). Note: If the Conversion Time is greater than the reading delay, the sensor will send the same value until the next set of readings is available. For readings faster than 5ms use SETMODE Bit7 Send on Conversion. This will send the data as soon as it's available.

Delay value from 5 to 60000 milli-seconds. READING DELAY default is: 0x03E8 (1s).

Example: To set delay to 1 second between readings, 1s = 1000 = 0x03E8

Delay (ms)		HEX Value
0	CONVERT	0000

Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x03	0x16	0x03	0xE8			
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x16					
RECEIVE	0x3FC	0x03	0x16	0x03	0xE8			

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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0x17 - Command A2D CONFIG - Read / Write

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 18.7 Vdc				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 9.37 Vdc				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 command 0x10 0x000F.

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0x17 (Continued) - Command A2D CONFIG - Read / Write

Set the bits required for the application.

Notes:

High Range must be greater than or equal to the Normal Range. If SETMODE 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.

A2D CONFIG default is: 0x035D.

Example: Vbus Max Voltage 1200VDC, High Range 5X Nominal, Normal Range 1.25X Nominal, Reading Interval 820ms (0x035D)

Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x03	0x17	0x03	0x5D			
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x17					
RECEIVE	0x3FC	0x03	0x17	0x03	0x5D			

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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0x18 - Command CURRENT UNDER LIMIT - Read / Write

Used to configure the optional lower limit for current readings. Currents below this value will cause an error that can be read with the 0x07 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 amps. Default CURRENT UNDER LIMIT: 0x0000 (Disabled).

Example: Set the lower limit to 25 amps (0x0019)

Amps		HEX Value
0	CONVERT	0000

Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x03	0x18	0x00	0x19			
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x18					
RECEIVE	0x3FC	0x03	0x18	0x00	0x19			

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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SSD Interface Manual

0x19 - Command CURRENT OVER LIMIT - Read / Write

Used to configure the optional upper limit for current readings. Currents above this value will cause an error that can be read with the 0x07 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 amps. Default CURRENT OVER LIMIT: 0x0000 (Disabled).

Example: Set the upper limit to 620 amps (0x026C)

Amps		HEX Value
0	CONVERT	0000

Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x03	0x19	0x02	0x6C			
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x19					
RECEIVE	0x3FC	0x03	0x19	0x02	0x6C			

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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SSD Interface Manual

0x1A - Command TEMP OVER LIMIT - Read / Write

Used to configure the temperature limit for the error. Temperatures above this value will cause an error that can be read with the 0x07 GET ERRORS command if errors aren't automatically sent.

Value is an unsigned Int16 in centigrade. Default TEMP OVER LIMIT: 125°C (0x007D, Cannot Disable)
Valid Range: 0°C to +125°C (MAX)

Example: Set the upper limit to 90°C (0x005A)

TEMP (°C)		HEX Value
0	⇐ CONVERT ⇒	0000

Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x03	0x1A	0x00	0x5A			
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x1A					
RECEIVE	0x3FC	0x03	0x1A	0x00	0x5A			

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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0x1B - Command VBUS UNDER LIMIT - Read / Write

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 0x07 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: 0x0000 (Disabled).

Example: Set the lower limit to 29 Volts (0x001D)

Volts		HEX Value
0	CONVERT	0000

Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x03	0x1B	0x00	0x1D			
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x1B					
RECEIVE	0x3FC	0x03	0x1B	0x00	0x1D			

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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0x1C - Command VBUS OVER LIMIT - Read / Write

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 0x07 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 OVER LIMIT: 0x0000 (Disabled).

Example: Set the upper limit to 70 Volts (0x0046)

Volts		HEX Value
0	CONVERT	0000

Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x03	0x1C	0x00	0x46			
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x1C					
RECEIVE	0x3FC	0x03	0x1C	0x00	0x46			

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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0x1D - Command POWER OVER LIMIT - Read / Write

Used to configure the optional upper limit for power readings. Power above this value will cause an error that can be read with the 0x07 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: 0x00000000 (Disabled).

Example: Set the upper limit to 22000 Watts (0x000055F0)

Power (W)		HEX Value
0	CONVERT	00000000

Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x05	0x1D	0x00	0x00	0x55	0xF0	
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x1D					
RECEIVE	0x3FC	0x05	0x1D	0x00	0x00	0x55	0xF0	

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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SSD Interface Manual

0x1E - Command SHUNT NANO-OHMS - Read / Write

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 Int32

Example: To set SHUNT NANO-OHMS to 300156 (0x0004947C) nano-ohms



Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x05	0x1E	0x00	0x04	0x94	0x7C	
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x1E					
RECEIVE	0x3FC	0x05	0x1E	0x00	0x04	0x94	0x7C	

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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0x21 - Command CURRENT ZERO OFFSET - Read / Write

Used to override the sensor zero offset current. Value can be reset back to factory defaults.
Value is a signed Int16.

Example: To set CURRENT OFFSET to +8 (0x0008) mA.

Offset (mA)		HEX Value
0	CONVERT	0000

Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x03	0x21	0x00	0x08			
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x21					
RECEIVE	0x3FC	0x03	0x21	0x00	0x08			

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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0x22 - Command VBUS FACTOR - Read / Write

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

Example: To set VBUS FACTOR to 10023 (0x2727)

Vbus Factor		HEX Value
0	CONVERT	0000

Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x03	0x22	0x27	0x27			
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x22					
RECEIVE	0x3FC	0x03	0x22	0x27	0x27			

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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0x23 - Command VBUS ZERO OFFSET - Read / Write

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

Value is a signed Int16.

Example: To set VBUS OFFSET to -6 (0xFFF9) mV.

Vbus Offset (mV)		HEX Value
0	CONVERT	0000

Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x03	0x23	0xFF	0xF9			
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x23					
RECEIVE	0x3FC	0x03	0x23	0xFF	0xF9			

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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0x24 - Command TEMP OFFSET - Read / Write

Used to adjust the Temperature 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. Value is an Signed Int16.

Example: To set TEMP OFFSET to -2.2°C send -22 (0xFFEA)

Temp Offset (0.1°C)		HEX Value
0	⇐ CONVERT ⇒	0000

Write Message

	Message ID	Length	Data Fields					
SEND	0x3FA	0x03	0x24	0xFF	0xEA			
RECEIVE	(none)							

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x24					
RECEIVE	0x3FC	0x03	0x24	0xFF	0xEA			

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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0x25 - Command GET T0 TEMPERATURE COMPENSATION - Read Only
0x26 - Command GET T1 TEMPERATURE COMPENSATION - Read Only
0x27 - Command GET T2 TEMPERATURE COMPENSATION - Read Only

Used to get the factory calibrated settings for the temperature compensation constants.

T0 - unsigned int16
T1 - signed int32
T2 - signed int32

Example: The following shows T1 compensation constant of FFBE E23D (-4267459)

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x26					
RECEIVE	0x3FC	0x05	0x26	0xFF	0xBE	0xE2	0x3D	

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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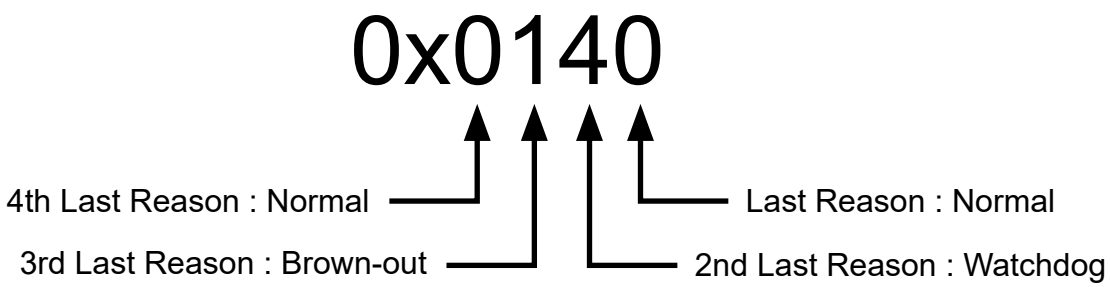
0x28 - Command GET RESET CAUSES - Read Only

Used to get the reasons for the last four SSD sensor restarts.

Example: The following shows abnormal restarts (0x0140)

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x28					
RECEIVE	0x3FC	0x03	0x28	0x01	0x40			



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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0x30 - Command GET FIRMWARE VERSION - Read Only

Used to get the SSD firmware version. Data Returned: Version (byte) and subversion (byte)

Example: The following shows version (v1.2)

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x30					
RECEIVE	0x3FC	0x03	0x30	0x01	0x02			

0x31 - Command GET SERIAL NUMBER - Read Only

Used to get the SSD serial number.

Example: The following shows SN:00012345 (0x3039)

Read Message

	Message ID	Length	Data Fields					
SEND	0x3FB	0x01	0x31					
RECEIVE	0x3FC	0x05	0x31	0x00	0x00	0x30	0x39	

NOTE: No settings are saved until a save settings to EEPROM command is issued!
Power cycling will restore previous settings. See command 0x10 0x000F.

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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.
Fixed reading Coulombs and Energy manually after changing CAN IDs

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.
Get all enabled readings changed from register 0x08 to 0x00

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