Power Distribution Panel

Distribute 12V power programmatically with current feedback

Features

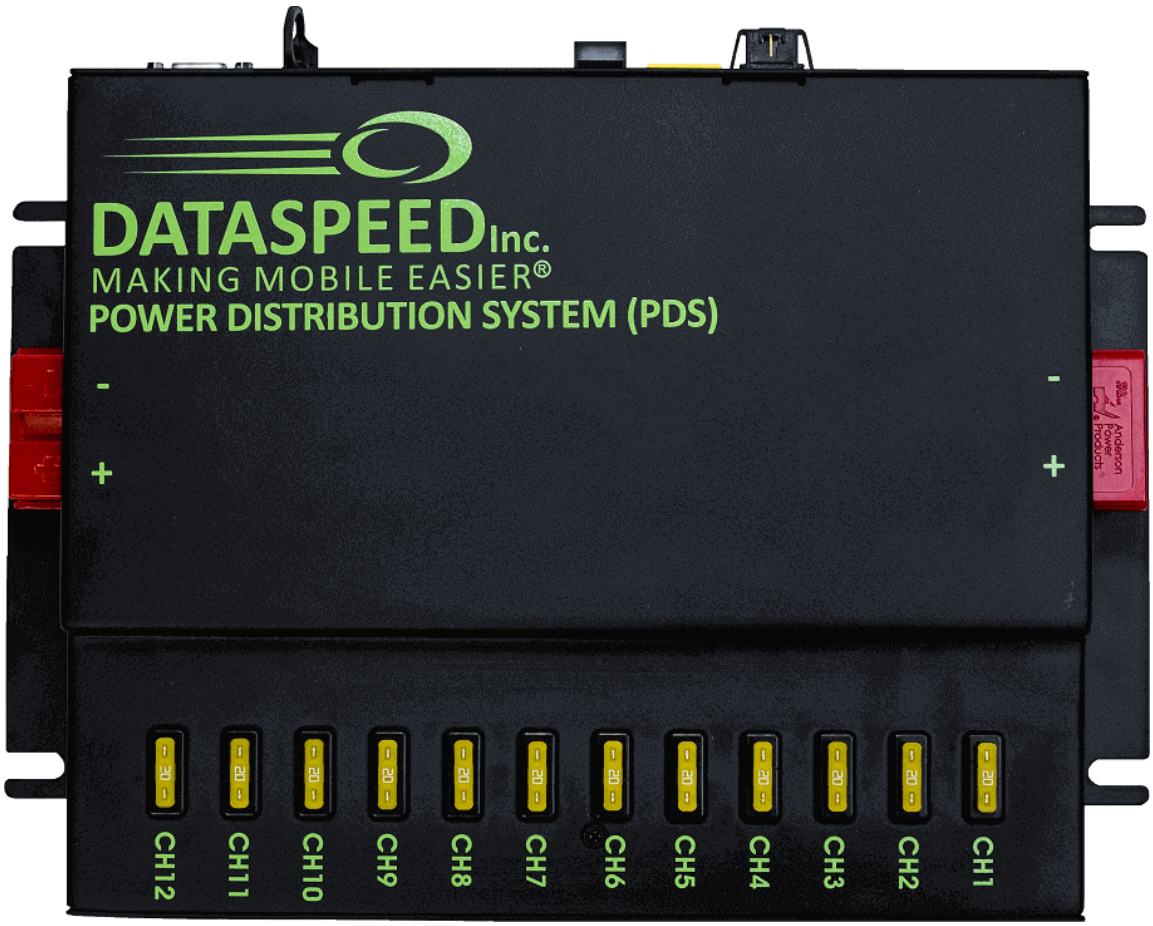
- 12 channels at 15A each
- Programmable startup and shutdown scripts
- Over-current feedback and diagnostics
- CAN, Ethernet, and USB communication
- Chain two units together for 24 channels

Applications

- Driverless car research
- Advanced Driver Assist (ADAS) research

Description

The Dataspeed Inc. Power Distribution System enables computer control of 12 fused power channels with programmable startup and shutdown sequences. Industry standard CAN, Ethernet, and USB communication interfaces.



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1 Connector Pin Description

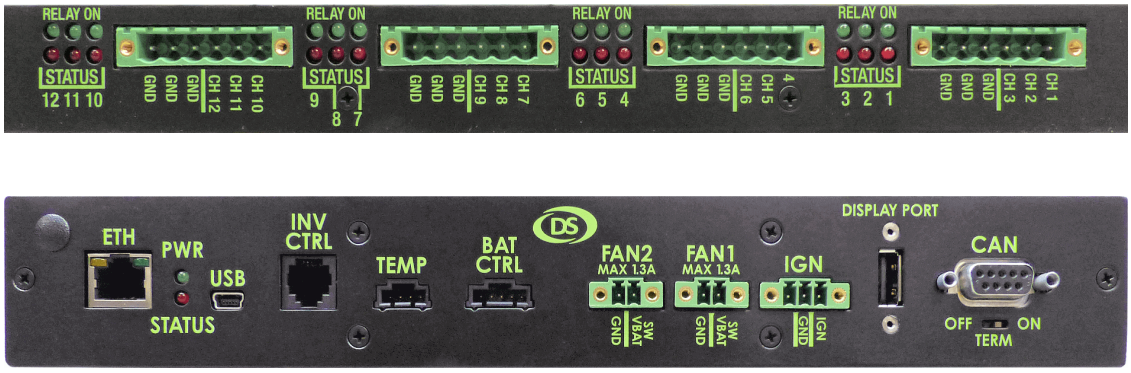

Table 1: Connector Description

Label	Manufacture	Mating P/N	Description
POWER	Anderson	6810G3-BK 1319G6	Power connector
CHx/GND	Phoenix	1805343	Channel outputs
CAN		DB9 Male	CAN and Ignition 1-2
Display Port		USB	Input for display
IGN	Phoenix	1827716	Ignition 3
FAN1 & FAN2	Phoenix	1827703	Fans
INV CTRL		RJ-11	Control lines to 110V AC power inverter
TEMP	Molex	50579404	External temperature sensor
BAT CTRL	Molex	50579405	Not used
USB		USB mini	USB mini
ETH		RJ45	Ethernet
TERM			CAN termination resistance ON/OFF (120Ω)

* Older revision A-F hardware uses a Type-K thermocouple for external temperature

1.1 CAN/DB9 Connector

The CAN/DB9 connector is used for CAN communication and to provide power.

Table 2: CAN/DB9 connector pin description.

Pin	Symbol	Description
1	NC	No Connect
2	CANL	CAN Low
3	GND	Ground
4	IGN1	Ignition 1
5	GND	Ground
6	GND	Ground
7	CANH	CAN High
8	IGN2	Ignition 2
9	POUT	Power Out (Switched VBat)

1.2 Display Port Connector

The Display Port connector is used to provide power and CAN communication to the touchscreen display. Note: This USB connector does not provide standard USB signals. Connecting a USB device may result in damage to your device.

Table 3: Display Port connector pin description.

Pin	Symbol	Description
1	POUT	Power Out (Switched VBat)
2	CANL	CAN Low
3	CANH	CAN High
4	GND	Ground

1.3 Ignition Connector

The Power Distribution System draws less than 0.2mA with ignition off. Applying voltage to any of the 3 ignition pins will power the device on. The startup and shutdown scripts will execute automatically in auto mode.

Table 4: Ignition connector pin description.

Pin	Symbol	Description
1	IGN3	Ignition 3
2	GND	Ground
3	NC	No Connect

1.4 Fan Connectors

Table 5: Fan connector pin description.

Pin	Symbol	Description
1	SW VBAT	Switched VBAT
2	GND	Ground

* Older revision A-F hardware uses a low side switch (VBAT and switched ground)

1.5 Inverter Remote

The inverter remote is used to control a Samlex Pure Sine Wave Inverter from the list of supported models below. The higher wattage models with an RJ50 connector require a special connector. Contact Dataspeed for more information.

Table 6: Supported Samlex part numbers

Model	Wattage	Voltage DC	Voltage AC	Connector
PST-600-12	600W	12V	120VAC	RJ11
PST-1000-12	1000W	12V	120VAC	RJ11
PST-1500-12	1500W	12V	120VAC	RJ50
PST-2000-12	2000W	12V	120VAC	RJ50
PST-60S-12E	600W	12V	230VAC	RJ11
PST-100S-12E	1000W	12V	230VAC	RJ11
PST-150S-12E	1500W	12V	230VAC	RJ50
PST-200S-12E	2000W	12V	230VAC	RJ50

1.6 Battery Control

This connector is not presently used.

1.7 USB Connector

The USB connector is used for introspection and firmware upgrade.

1.8 Ethernet Connector

The Ethernet connector supports 10/100 Mbit/s communication. The Ethernet protocol is Lightweight Communications and Marshalling (LCM).

2 Electrical Characteristics

Table 7: Electrical Characteristics.

Characteristic	Min	Typ	Max	Units	Conditions
$V_{IGNITION}$ ON	9	12	16	V	
$V_{IGNITION}$ OFF	-0.3	0	2	V	
V_{POWER}	9	12	16	V	
I_{POWER}		1500		mA	V_{POWER}=12V, $V_{IGNITION}$>9V, all channels on
I_{POWER}		250		mA	V_{POWER}=12V, $V_{IGNITION}$>9V, all channels off
I_{POWER}			0.2	mA	V_{POWER}=12V, $V_{IGNITION}$<2V
$I_{CHANNEL}$			15	A	Continuous for each channel
I_{TOTAL}			180	A	Total current (device and all channels)
R_{CAN}		120		Ω	TERM=ON
Temperature	-40		+85	°C	

Note: $V_{IGNITION}$ is the maximum of V_{IGN1},V_{IGN2},V_{IGN3}

3 Mechanical Drawings

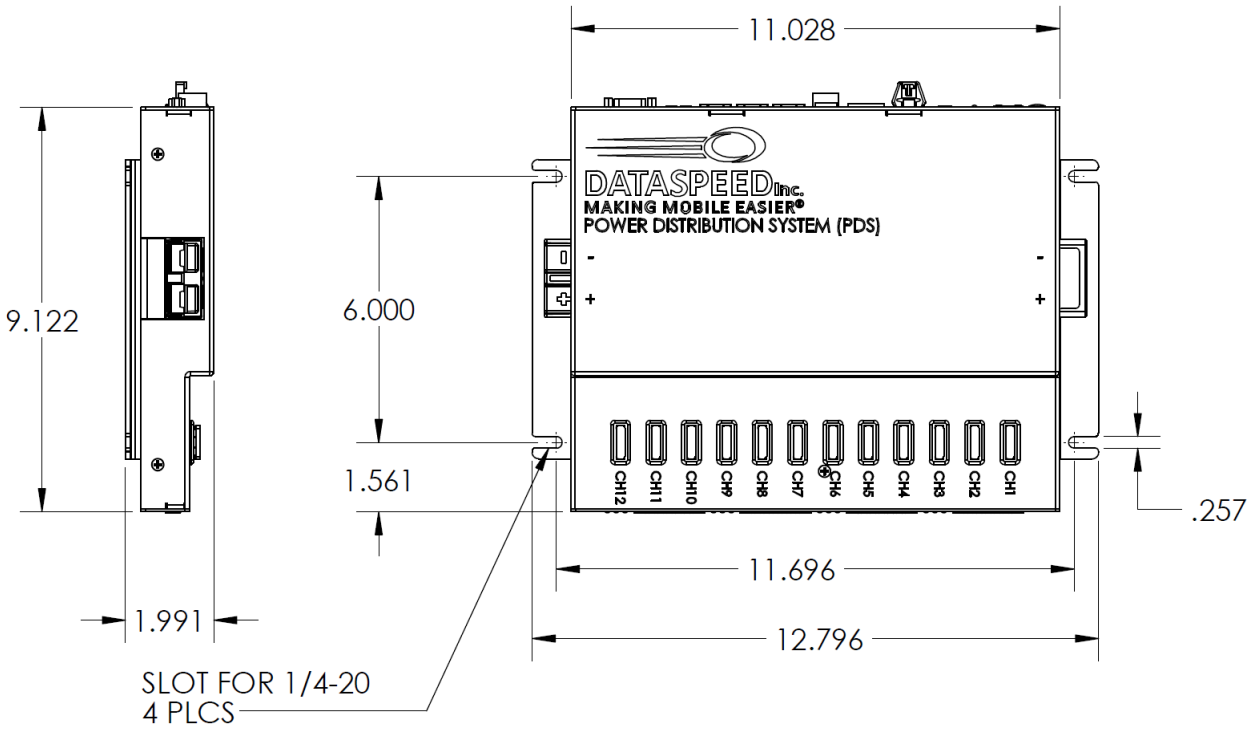

Figure 1: Mechanical Drawing

4 LEDs

4.1 Main

The power LED (green) indicates that power and ignition have been applied.
The status LED (red) blinks at a frequency of 1Hz to indicate normal operation.

4.2 Channels

Each channel has a green and red LED.
The green LED is driven with the relay. If this LED is on, the relay is on.
The red LED indicates a fault status:

Table 8: Red LED status

Solid off	NORMAL	On and load is above 150mA
Solid on	NO LOAD	On and load is below 100mA
1 blink	BAD RELAY	Relay failed to contact
2 blinks	BAD FUSE	Fuse is blown
3 blinks	OVER CURRENT	Channel disabled to protect fuse

5 Modes

Mode AUTO uses all communication interfaces and automatically executes startup/shutdown scripts.
Mode MANUAL uses all communication interfaces and automatically executes the shutdown script.
Mode VALET only responds to USB. This is a lockout mode. Separate startup and shutdown scripts are executed.

Table 9: Mode Descriptions

Mode	USB	CAN	Ethernet	Bluetooth	Shutdown	Startup
AUTO	X	X	X	X	X	X
MANUAL	X	X	X	X	X	
VALET	X					

6 CAN Messages

Table 10: CAN bus configuration.

Parameter	Value	Units
Terminated	Yes	120Ω
BitRate	500	k
t_q	200	ns
SyncSeg	1	t_q
PropSeg	3	t_q
PhaseSeg1	3	t_q
PhaseSeg2	3	t_q
SyncJumpWidth	2	t_q

6.1 Request

Message ID: 0x410
Receive Rate: On Event

Table 11: Request CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	INDEX							
1	15:8	REQUEST							

bit 0-7 **INDEX:** Channel Index
0 = Channel 1
1 = Channel 2
2 = Channel 3
...
23 = Channel 24
—
48 = Inverter 1
49 = Inverter 2

bit 8-15 **REQUEST:** Relay Request
0 = Off
1 = On
2 = Toggle

6.2 Mode

Message ID: 0x411
Receive Rate: On Event

Table 12: Mode CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	MODE							

bit 0-7 **MODE:** Mode Request
0 = Auto
1 = Manual
2 = Valet

6.3 Script

Message ID: 0x412
Receive Rate: On Event

Table 13: Script CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	SCRIPT							

bit 0-7 **SCRIPT:** Script Request
0 = None
1 = Startup
2 = Shutdown

6.4 Reserved

Message ID: 0x413
Receive Rate: On Event

6.5 Reserved

Message ID: 0x430
Transmit Rate: 200ms

6.6 Reserved

Message ID: 0x431
Transmit Rate: On Event

6.7 Reserved

Message ID: 0x432
Transmit Rate: 200ms

6.8 Status Master

Message ID: 0x420
Transmit Rate: 50ms

Table 14: Status CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	INVERTER BITS				RESERVED			
1	15:8	SCRIPT				MODE			
2	23:16	STATUS2				STATUS1			
3	31:24	STATUS4				STATUS3			
4	39:32	STATUS6				STATUS5			
5	47:40	STATUS8				STATUS7			
6	55:48	STATUS10				STATUS9			
7	63:56	STATUS12				STATUS11			

bit 0-3 **RESERVED:**
bit 4 **INV-REQUEST:** Inverter request: 0 = Off, 1 = On
bit 5 **INV-STATUS:** Inverter status: 0 = Off, 1 = On
bit 6 **INV-OVERLOAD:** Inverter over-load: 0 = No Fault, 1 = Fault
bit 7 **INV-OVERTEMP:** Inverter over-temperature: 0 = No Fault, 1 = Fault
bit 8-11 **MODE:** Current mode
0 = Auto
1 = Manual
2 = Valet
bit 15-12 **SCRIPT:** Running script
0 = None
1 = Startup
2 = Shutdown
bit 19-16 **STATUS1:** Channel 1 status
0 = Off
1 = On
2 = No Load
3 = Bad Relay
4 = Bad Fuse
5 = Over Current
bit 23-20 **STATUS2:** Channel 2 status (same as 1)
bit 27-24 **STATUS3:** Channel 3 status (same as 1)
bit 31-28 **STATUS4:** Channel 4 status (same as 1)
bit 35-32 **STATUS5:** Channel 5 status (same as 1)
bit 39-36 **STATUS6:** Channel 6 status (same as 1)
bit 43-40 **STATUS7:** Channel 7 status (same as 1)
bit 47-44 **STATUS8:** Channel 8 status (same as 1)
bit 51-48 **STATUS9:** Channel 9 status (same as 1)
bit 55-52 **STATUS10:** Channel 10 status (same as 1)
bit 59-56 **STATUS11:** Channel 11 status (same as 1)
bit 64-60 **STATUS12:** Channel 12 status (same as 1)

6.9 Status Slave

Message ID: 0x421
Transmit Rate: 50ms

Table 15: Status CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	INVERTER BITS				RESERVED			
1	15:8	SCRIPT				MODE			
2	23:16	STATUS14				STATUS13			
3	31:24	STATUS16				STATUS15			
4	39:32	STATUS18				STATUS17			
5	47:40	STATUS20				STATUS19			
6	55:48	STATUS22				STATUS21			
7	63:56	STATUS24				STATUS23			

bit 0-3 **RESERVED:**
bit 4 **INV-REQUEST:** Inverter request: 0 = Off, 1 = On
bit 5 **INV-STATUS:** Inverter status: 0 = Off, 1 = On
bit 6 **INV-OVERLOAD:** Inverter over-load: 0 = No Fault, 1 = Fault
bit 7 **INV-OVERTEMP:** Inverter over-temperature: 0 = No Fault, 1 = Fault
bit 8-11 **MODE:** Current mode
0 = Auto
1 = Manual
2 = Valet
bit 15-12 **SCRIPT:** Running script
0 = None
1 = Startup
2 = Shutdown
bit 19-16 **STATUS13:** Channel 13 status
0 = Off
1 = On
2 = No Load
3 = Bad Relay
4 = Bad Fuse
5 = Over Current
bit 23-20 **STATUS14:** Channel 14 status (same as 13)
bit 27-24 **STATUS15:** Channel 15 status (same as 13)
bit 31-28 **STATUS16:** Channel 16 status (same as 13)
bit 35-32 **STATUS17:** Channel 17 status (same as 13)
bit 39-36 **STATUS18:** Channel 18 status (same as 13)
bit 43-40 **STATUS19:** Channel 19 status (same as 13)
bit 47-44 **STATUS20:** Channel 20 status (same as 13)
bit 51-48 **STATUS21:** Channel 21 status (same as 13)
bit 55-52 **STATUS22:** Channel 22 status (same as 13)
bit 59-56 **STATUS23:** Channel 23 status (same as 13)
bit 64-60 **STATUS24:** Channel 24 status (same as 13)

6.10 Status2 Master

Message ID: 0x43C
Transmit Rate: 50ms

Table 16: Status2 CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	BOARDTEMP							
1	15:8	THERMOCOUPLE							
2	23:16	VOLTAGE<7:0>							
3	31:24	—	—	—	—	VOLTAGE<11:8>			

bit 0-7 **BOARDTEMP:** Internal Board Temperature
0x80 = -20.0°C
0xA8 = 0.0°C
0xA9 = 0.5°C
0x00 = 44.0°C
0x01 = 44.5°C
0x7F = 107.5°C

bit 8-15 **THERMOCOUPLE:** External Thermocouple
0x80 = -20.0°C
0xA8 = 0.0°C
0xA9 = 0.5°C
0x00 = 44.0°C
0x01 = 44.5°C
0x7F = 107.5°C

bit 16-27 **VOLTAGE:** Input Voltage
0x000 = 0.00V
0x001 = 0.01V
0x3FF = 40.95V

bit 28-31 **Unimplemented:** Set to '0'

6.11 Status2 Slave

Message ID: 0x43D
Transmit Rate: 50ms

Table 17: Status2 CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	BOARDTEMP							
1	15:8	THERMOCOUPLE							
2	23:16	VOLTAGE<7:0>							
3	31:24	—	—	—	—	VOLTAGE<11:8>			

bit 0-7 **BOARDTEMP:** Internal Board Temperature
0x80 = -20.0°C
0xA8 = 0.0°C
0xA9 = 0.5°C
0x00 = 44.0°C
0x01 = 44.5°C
0x7F = 107.5°C

bit 8-15 **THERMOCOUPLE:** External Thermocouple
0x80 = -20.0°C
0xA8 = 0.0°C
0xA9 = 0.5°C
0x00 = 44.0°C
0x01 = 44.5°C
0x7F = 107.5°C

bit 16-27 **VOLTAGE:** Input Voltage
0x000 = 0.00V
0x001 = 0.01V
0x3FF = 40.95V

bit 28-31 **Unimplemented:** Set to '0'

6.12 Current 1 Master

Message ID: 0x424
Transmit Rate: 50ms

Table 18: Current 1 CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	CURRENT1<7:0>							
1	15:8	CURRENT1<15:8>							
2	23:16	CURRENT2<7:0>							
3	31:24	CURRENT2<15:8>							
4	39:32	CURRENT3<7:0>							
5	47:40	CURRENT3<15:8>							
6	55:48	CURRENT4<7:0>							
7	63:56	CURRENT4<15:8>							

bit 0-15 **CURRENT1:** Channel 1 current
0x8000 = -32.768A
0xFFFF = -0.001A
0x0000 = 0.000A
0x0001 = 0.001A
0x7FFF = 32.767A
bit 31-16 **CURRENT2:** Channel 2 current (same as 1)
bit 47-32 **CURRENT3:** Channel 3 current (same as 1)
bit 63-48 **CURRENT4:** Channel 4 current (same as 1)

6.13 Current 1 Slave

Message ID: 0x425
Transmit Rate: 50ms

Table 19: Current 1 CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	CURRENT13<7:0>							
1	15:8	CURRENT13<15:8>							
2	23:16	CURRENT14<7:0>							
3	31:24	CURRENT14<15:8>							
4	39:32	CURRENT15<7:0>							
5	47:40	CURRENT15<15:8>							
6	55:48	CURRENT16<7:0>							
7	63:56	CURRENT16<15:8>							

bit 0-15 **CURRENT13:** Channel 13 current
0x8000 = -32.768A
0xFFFF = -0.001A
0x0000 = 0.000A
0x0001 = 0.001A
0x7FFF = 32.767A

bit 31-16 **CURRENT14:** Channel 14 current (same as 13)

bit 47-32 **CURRENT15:** Channel 15 current (same as 13)

bit 63-48 **CURRENT16:** Channel 16 current (same as 13)

6.14 Current 2 Master

Message ID: 0x428
Transmit Rate: 50ms

Table 20: Current 2 CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	CURRENT5<7:0>							
1	15:8	CURRENT5<15:8>							
2	23:16	CURRENT6<7:0>							
3	31:24	CURRENT6<15:8>							
4	39:32	CURRENT7<7:0>							
5	47:40	CURRENT7<15:8>							
6	55:48	CURRENT8<7:0>							
7	63:56	CURRENT8<15:8>							

bit 0-15 **CURRENT5:** Channel 5 current
0x8000 = -32.768A
0xFFFF = -0.001A
0x0000 = 0.000A
0x0001 = 0.001A
0x7FFF = 32.767A
bit 31-16 **CURRENT6:** Channel 6 current (same as 5)
bit 47-32 **CURRENT7:** Channel 7 current (same as 5)
bit 63-48 **CURRENT8:** Channel 8 current (same as 5)

6.15 Current 2 Slave

Message ID: 0x429
Transmit Rate: 50ms

Table 21: Current 2 CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	CURRENT17<7:0>							
1	15:8	CURRENT17<15:8>							
2	23:16	CURRENT18<7:0>							
3	31:24	CURRENT18<15:8>							
4	39:32	CURRENT19<7:0>							
5	47:40	CURRENT19<15:8>							
6	55:48	CURRENT20<7:0>							
7	63:56	CURRENT20<15:8>							

bit 0-15 **CURRENT17:** Channel 17 current
0x8000 = -32.768A
0xFFFF = -0.001A
0x0000 = 0.000A
0x0001 = 0.001A
0x7FFF = 32.767A
bit 31-16 **CURRENT18:** Channel 18 current (same as 17)
bit 47-32 **CURRENT19:** Channel 19 current (same as 17)
bit 63-48 **CURRENT20:** Channel 20 current (same as 17)

6.16 Current 3 Master

Message ID: 0x42C
Transmit Rate: 50ms

Table 22: Current 3 CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	CURRENT9<7:0>							
1	15:8	CURRENT9<15:8>							
2	23:16	CURRENT10<7:0>							
3	31:24	CURRENT10<15:8>							
4	39:32	CURRENT11<7:0>							
5	47:40	CURRENT11<15:8>							
6	55:48	CURRENT12<7:0>							
7	63:56	CURRENT12<15:8>							

bit 0-15 **CURRENT9:** Channel 9 current
0x8000 = -32.768A
0xFFFF = -0.001A
0x0000 = 0.000A
0x0001 = 0.001A
0x7FFF = 32.767A

bit 31-16 **CURRENT10:** Channel 10 current (same as 9)

bit 47-32 **CURRENT11:** Channel 11 current (same as 9)

bit 63-48 **CURRENT12:** Channel 12 current (same as 9)

6.17 Current 3 Slave

Message ID: 0x42D
Transmit Rate: 50ms

Table 23: Current 3 CAN Message Description.

Byte	Bits	Bit 7	Bit 6	Bit 5	Bit 4	Bit 3	Bit 2	Bit 1	Bit 0
0	7:0	CURRENT21<7:0>							
1	15:8	CURRENT21<15:8>							
2	23:16	CURRENT22<7:0>							
3	31:24	CURRENT22<15:8>							
4	39:32	CURRENT23<7:0>							
5	47:40	CURRENT23<15:8>							
6	55:48	CURRENT24<7:0>							
7	63:56	CURRENT24<15:8>							

bit 0-15 **CURRENT21:** Channel 21 current
0x8000 = -32.768A
0xFFFF = -0.001A
0x0000 = 0.000A
0x0001 = 0.001A
0x7FFF = 32.767A
bit 31-16 **CURRENT22:** Channel 22 current (same as 21)
bit 47-32 **CURRENT23:** Channel 23 current (same as 21)
bit 63-48 **CURRENT24:** Channel 24 current (same as 21)

APPENDIX A: REVISION HISTORY

Revision A-00 (July 2015)
Modifications:

1. Initial release of this document.

Revision A-01 (September 2015)
Modifications:

1. Added CAN messages for multiple units to achieve 24 channels.
2. Added description for each mode.
3. Added section describing LED status codes.

Revision A-02 (October 2015)
Modifications:

1. Changed all CAN IDs to 0x4XX.

Revision A-03 (December 2015)
Modifications:

1. Added inverter to messages.

Revision A-04 (May 2016)
Modifications:

1. Added mechanical drawing.
2. Added connector pictures and part numbers.
3. Changed RESERVED pins on CAN/DB9 connector to ignition pins.

Revision A-05 (August 2016)
Modifications:

1. Updated LED table.
2. Added power usage to electrical specs.
3. Added Status2 CAN message

Revision A-06 (August 2017)
Modifications:

1. Fixed main LED color (power/status).
2. Fixed CAN bus termination value.
3. Added reserved CAN messages.
4. Added connector descriptions for inverter remote and battery control.
5. Added electrical characteristics for each channel

Revision A-07 (October 2017)
Modifications:

1. Split inverter status into 4 individual bits.

Revision A-08 (January 2018)
Modifications:

1. Updated mechanical drawing
2. Added note about multiple ignition voltages

Revision A-09 (May 2018)
Modifications:

1. Updated for changes in revision 'G' hardware
2. Changed IGN connector from 2-pin to 3-pin
3. Changed temperature sensor connector