1 Introduction

The 900W PDU has both RS232 and CANbus interfaces that perform essentially the same functions, these being:

- Configuration (of parameters stored in the PDU's non-volatile memory),
- Control (real-time control of the PDU's various features), and
- Monitoring (of measured voltages, currents, temperatures, etc).

Once the PDU has been configured, there is no requirement to connect anything to either communications interface – the PDU will operate quite normally with no communications at all.

This document describes the default CAN communications interface and protocol (RS232 is described in the 900W RS232 protocol document). Custom CAN protocols can also be developed to suit existing CAN ID structures; please contact us to discuss your requirements.

2 Overview of CAN

CAN is a multi-master broadcast serial bus, originally developed for automotive applications but now used extensively across a wide range of industries. CAN provides more robust communications than is possible with RS232, and includes automatic arbitration-free transmission, message prioritisation, automatic retries, CRC data protection, fault confinement and more.

Physically CAN is usually implemented as a 2-wire differential serial bus, although a third ground wire is always recommended. The bus must be terminated at each end. This can be a simple 120 Ohm resistor connected across the two signal lines, or it can be a pair of 60 Ohm resistors connecting each signal line to a rail biased midway between the minimum and maximum signal voltages. The second arrangement is superior as it provides far greater immunity from electrical noise. The 900W PDU does not terminate the bus.

The baud rate of this CAN implementation is 1Mbit/sec.

The CAN specification defines four frame types (data, remote, error and overload), but only the data frame can actually transmit any payload data. Like many CAN implementations, only the data frame is used here. Data frames can have 0 to 8 bytes of payload data.

This protocol is based on CAN 2.0B; i.e. CAN frames have a 29-bit message identifier associated with them. The message ID is divided into 3 parts as described in the next section.

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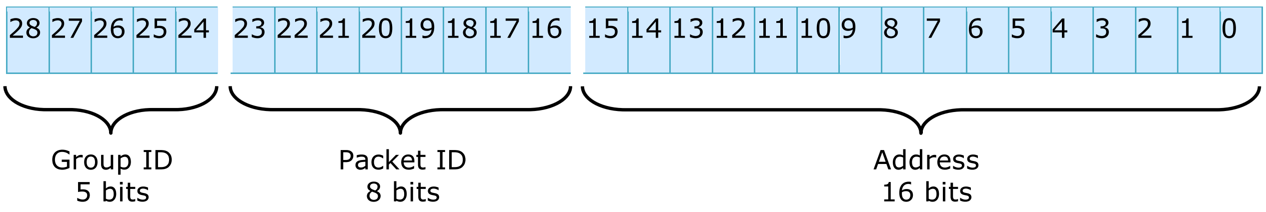
3 Contents

1 Introduction 1
2 Overview of CAN 1
3 Contents 3
4 CAN Message ID 4
4.1 Group ID 4
4.2 Packet ID 4
4.3 Address 4
5 CAN Packet Types 5
5.1 Packet ID 0x00 – Voltages 5
5.2 Packet ID 0x01 – Currents 6
5.3 Packet ID 0x02 – Battery statuses 6
5.4 Packet ID 0x03 – Temperatures 7
5.5 Packet ID 0x04 – Miscellaneous 7
5.6 Packet ID 0x0F – Measurement request 8
5.7 Packet ID 0x10 – Set (or Get) V_A 8
5.8 Packet ID 0x11 – Set (or Get) V_S 8
5.9 Packet ID 0x12 – Set (or Get) V_P 9
5.10 Packet ID 0x13 – Set (or Get) V_B 9
5.11 Packet ID 0x14 – Set (or Get) PP 9
5.12 Packet ID 0x15 – Set (or Get) PS 9
5.13 Packet ID 0x18 – Set (or Get) S_0 10
5.14 Packet ID 0x1B – Set (or Get) CA 10
5.15 Packet ID 0x20 – Set (or Get) output states 10
5.16 Packet ID 0x26 – Reset 10
5.17 Packet ID 0x30 – Serial number 11
5.18 Packet ID 0x31 – Firmware 11
6 Document version history 12
6.1 0.92 -> 0.93 12
6.2 0.93 -> 0.94 12
6.3 0.94 -> 0.95 12
6.4 0.95 -> 0.96 12
6.5 0.96 -> 1.0 12
6.6 1.0 -> 1.1 12

4 CAN Message ID

Each CAN message is preceded by the 29-bit CAN message ID, which specifies the type of hardware (group ID), the type of content (packet ID), and the address of the device associated with the message:



4.1 Group ID

Specifies the type of hardware that this CAN frame came from or is being sent to. The PDU always has a group ID of 30 (0x1E).

4.2 Packet ID

Specifies the contents of a packet. The following packet types are defined for the 900W PDU:

Packet ID	Name	Direction (with respect to PDU)	Length (number of data bytes)	Description
0x00	Voltages	Out	14	Contains measured voltages
0x01	Currents	Out	14	Contains measured currents
0x02	Battery statuses	Out	4	Contains calculated battery energy
0x03	Temperatures	Out	1	Contains measured temperatures
0x04	Miscellaneous	Out	4	Contains miscellaneous quantities
0x0F	Measurement request	In	1 -> 0 to 7 packets	Request a set of measurement values
0x10	Set V_A	In	2	Set Avionics voltage
0x11	Set V_S	In	2	Set Servo voltage
0x12	Set V_P	In	2	Set Payload voltage
0x13	Set V_B	In	2	Set Battery voltage
0x14	Set PP	In	1	Set packet period
0x15	Set PS	In	1	Set packets streamed
0x18	Set S_0	In	1	Set power-up state
0x1B	Set CA	In	2	Set CAN address
0x20	Set output state	In	1	Control or determine the enable status of the payload output
0x26	Reset	In	0	Restart the PDU
0x30	Serial number	In	0 -> 2 bytes	Request PDU serial number
0x31	Firmware	In	0 -> 6 bytes	Request firmware information

Table 1 – Blue: Measured/calculated values; Green: User-defined values stored in non-volatile memory; Red: Volatile values & commands; Black: Fixed values stored in non-volatile memory.

For packets with IDs up to 0x20 inclusive, if sent to the PDU with zero data bytes the PDU will return a packet (or pair of packets) containing the current values.

4.3 Address

Each PDU within any given network must have a unique address between 0 and 65534 inclusive. 65535 (0xFFFF) is reserved to form a broadcast message ID to which all PDUs will respond. PDUs are shipped with a default address of 1.

5 CAN Packet Types

Please note that all 2-byte quantities are transmitted and received in big-endian format; i.e. high byte first, followed by the low byte.

5.1 Packet ID 0x00 – Voltages

This pair of packets contain measured voltages. The PDU can be configured to stream these packets at regular intervals, or they can be requested by issuing this packet ID with zero data bytes.

Byte	Name	Description
0, 1	Avionics output voltage, A-side	An unsigned integer with value 10 times the measured voltage (i.e. in 0.1V increments). Value ranges from 0 to 300 (0.0 to 30.0V).
2, 3	Avionics output voltage, B-side	An unsigned integer with value 10 times the measured voltage (i.e. in 0.1V increments). Value ranges from 0 to 300 (0.0 to 30.0V).
4, 5	Servo output voltage, A-side	An unsigned integer with value 10 times the measured voltage (i.e. in 0.1V increments). Value ranges from 0 to 300 (0.0 to 30.0V).
6, 7	Servo output voltage, B-side	An unsigned integer with value 10 times the measured voltage (i.e. in 0.1V increments). Value ranges from 0 to 300 (0.0 to 30.0V).

Table 2 – Voltages (packet 1 of 2)

Byte	Name	Description
0, 1	Payload output voltage	An unsigned integer with value 10 times the measured voltage (i.e. in 0.1V increments). Value ranges from 0 to 300 (0.0 to 30.0V).
2, 3	Battery A voltage	An unsigned integer with value 10 times the measured voltage (i.e. in 0.1V increments). Value ranges from 0 to 600 (0.0 to 60.0V).
4, 5	Battery B voltage	An unsigned integer with value 10 times the measured voltage (i.e. in 0.1V increments). Value ranges from 0 to 600 (0.0 to 60.0V).

Table 3 – Voltages (packet 2 of 2)

5.2 Packet ID 0x01 – Currents

This pair of packets contain measured currents. The PDU can be configured to stream these packets at regular intervals, or they can be requested by issuing this packet ID with zero data bytes.

Byte	Name	Description
0, 1	Avionics output current, A-side	An unsigned integer with value 10 times the measured current (i.e. in 0.1A increments). Value ranges from 0 to 50 (0.0 to 5.0A).
2, 3	Avionics output current, B-side	An unsigned integer with value 10 times the measured current (i.e. in 0.1A increments). Value ranges from 0 to 50 (0.0 to 5.0A).
4, 5	Servo output current, A-side	An unsigned integer with value 10 times the measured current (i.e. in 0.1A increments). Value ranges from 0 to 300 (0.0 to 30.0A).
6, 7	Servo output current, B-side	An unsigned integer with value 10 times the measured current (i.e. in 0.1A increments). Value ranges from 0 to 300 (0.0 to 30.0A).

Table 4 – Currents (packet 1 of 2)

Byte	Name	Description
0, 1	Payload output current	An unsigned integer with value 10 times the measured current (i.e. in 0.1A increments). Value ranges from 0 to 300 (0.0 to 30.0A).
2, 3	Battery A current	An unsigned integer with value 10 times the measured current (i.e. in 0.1A increments). Value ranges from 0 to 300 (0.0 to +30.0A).
4, 5	Battery B current	An unsigned integer with value 10 times the measured current (i.e. in 0.1A increments). Value ranges from 0 to 300 (0.0 to +30.0A).

Table 5 – Currents (packet 2 of 2)

5.3 Packet ID 0x02 – Battery statuses

This packet contains calculated battery charge statuses. The PDU can be configured to stream this packet at regular intervals, or it can be requested by issuing this packet with zero data bytes.

Byte	Name	Description
0, 1	Battery A energy	A signed integer with value equal to the time-integral of current into battery A since power up in mAH. Value ranges from −32768 to +32767.
2, 3	Battery B energy	A signed integer with value equal to the time-integral of current into battery B since power-up in mAH. Value ranges from −32768 to +32767.

Table 6

5.4 Packet ID 0x03 – Temperatures

This packet contains measured temperatures. The PDU can be configured to stream this packet at regular intervals, or it can be requested by issuing this packet with zero data bytes.

Byte	Name	Description
0	Internal PDU temperature	A signed byte with value equal to the temperature inside the PDU in degrees Celsius. Value ranges from −10 to +125.

Table 7

5.5 Packet ID 0x04 – Miscellaneous

This packet contains miscellaneous measured and derived quantities. The PDU can be configured to stream this packet at regular intervals, or it can be requested by issuing this packet with zero data bytes.

Voltage limits are +12.5% / -6.25% from configured value. Current limits are as per product manual.

Byte	Name	Description
0	Flag register 0	The following bits are defined: Bit 7: Payload shedding flag (1 = shed)
1	Flag register 1	No bits defined.
2	Flag register 2 (A-side power supplies and Battery A)	The following bits are defined: Bit 0: Avionics A voltage flag (1 = within tolerance) Bit 1: Servo A voltage flag (1 = within tolerance) Bit 2: Payload voltage flag (1 = within tolerance) Bit 3: Battery A voltage flag (1 = within tolerance) Bit 4: Avionics A current flag (1 = below limit) Bit 5: Servo A current flag (1 = below limit) Bit 6: Payload current flag (1 = below limit) Bit 7: Battery A current flag (1 = below limit)
3	Flag register 3 (B-side power supplies and Battery B)	The following bits are defined: Bit 0: Avionics B voltage flag (1 = within tolerance) Bit 1: Servo B voltage flag (1 = within tolerance) Bit 2: Payload voltage flag (1 = within tolerance) Bit 3: Battery B voltage flag (1 = within tolerance) Bit 4: Avionics B current flag (1 = below limit) Bit 5: Servo B current flag (1 = below limit) Bit 6: Payload current flag (1 = below limit) Bit 7: Battery B current flag (1 = below limit)

Table 8

Note that payload flags in registers 2 and 3 are duplicates of each other (the payload output is not redundantly powered).

5.6 Packet ID 0x0F – Measurement request

This packet requests a set of measurements from the PDU. The measurements that are required may be specified in the data byte. If this packet is issued with zero data bytes all measurements will be returned.

Use of this packet allows the supervising entity to poll the PDU, as an alternative to having the PDU push values onto the CAN bus at regular intervals using the PDU's packet streaming features.

Byte	Name	Description
0	MR	Measurements requested. This byte indicates the measurements that are to be returned. Bits have the following significance: Bit 0: Packet ID 0x00 (Voltages) Bit 1: Packet ID 0x01 (Currents) Bit 2: Packet ID 0x02 (Battery Statuses) Bit 3: Packet ID 0x03 (Temperatures) Bit 4: Packet ID 0x04 (Miscellaneous) Bits 5–7: X (don't care) 0 = disabled, 1 = enabled.

Table 9

5.7 Packet ID 0x10 – Set (or Get) V_A

This packet sets the stored value of V_A, the avionics output voltage. Note that V_A is the configuration value stored in non-volatile memory, not the measured value. The value of V_A may be obtained by issuing this packet with zero data bytes.

Byte	Name	Description
0, 1	V_A	Avionics output voltage. An unsigned integer with value 10 times the configured voltage (i.e. in 0.1V increments). V_A may be set to any value from 12.0 to 28.0V inclusive, corresponding to unsigned integer values of 120 to 280.

Table 10

5.8 Packet ID 0x11 – Set (or Get) V_S

This packet sets the stored value of V_S, the servo output voltage. Note that V_S is the configuration value stored in non-volatile memory, not the measured value. The value of V_S may be obtained by issuing this packet with zero data bytes.

Byte	Name	Description
0, 1	V_S	Servo output voltage. An unsigned integer with value 10 times the configured voltage (i.e. in 0.1V increments). V_S may be set to any value from 6.0 to 28.0V inclusive, corresponding to unsigned integer values of 60 to 280.

Table 11

5.9 Packet ID 0x12 – Set (or Get) V_P

This packet sets the stored value of V_P, the payload output voltage. Note that V_P is the configuration value stored in non-volatile memory, not the measured value. The value of V_P may be obtained by issuing this packet with zero data bytes.

Byte	Name	Description
0, 1	V_P	Payload output voltage. An unsigned integer with value 10 times the configured voltage (i.e. in 0.1V increments). V_P may be set to any value from 12.0 to 28.0V inclusive, corresponding to unsigned integer values of 120 to 280.

Table 12

5.10 Packet ID 0x13 – Set (or Get) V_B

This packet sets the stored value of V_B, the nominal (fully charged) battery voltage. Note that V_B is the configuration value stored in non-volatile memory, not the measured value. The value of V_B may be obtained by issuing this packet with zero data bytes.

Byte	Name	Description
0, 1	V_B	Battery voltage. An unsigned integer with value 10 times the configured voltage (i.e. in 0.1V increments). V_B may be set to any value from 24.0 to 55.0V inclusive, corresponding to unsigned integer values of 240 to 550.

Table 13

5.11 Packet ID 0x14 – Set (or Get) PP

This packet sets the stored value of PP, the packet period. This is the interval of time between successive transmissions of streamed data. The packets that are streamed are defined by PS, the packets streamed value. The value of PP may be obtained by issuing this packet with zero data bytes.

Byte	Name	Description
0	PP	Packet period. An unsigned byte with value 10 times the packet period (i.e. in 0.1S increments). The packet period may be set to any value from 0.1 to 25.5 seconds, corresponding to unsigned byte values of 1 to 255.

Table 14

5.12 Packet ID 0x15 – Set (or Get) PS

This packet sets the stored value of PS, the packets that are streamed. The value of PS may be obtained by issuing this packet with zero data bytes.

Byte	Name	Description
0	PS	Packets streamed. This byte indicates the packets that are streamed. Bits have the following significance: Bit 0: Packet ID 0x00 (Voltages) Bit 1: Packet ID 0x01 (Currents) Bit 2: Packet ID 0x02 (Battery Statuses) Bit 3: Packet ID 0x03 (Temperatures) Bit 4: Packet ID 0x04 (Miscellaneous) Bits 5–7: X (don't care) 0 = disabled, 1 = enabled.

Table 15

5.13 Packet ID 0x18 – Set (or Get) S_0

This packet sets the stored value of S_0, the PDU's initial state. S_0 defines how the PDU's miscellaneous features are configured after power-up or reset. The value of S_0 may be obtained by issuing this packet with zero data bytes.

Byte	Name	Description
0	S_0	Initial state. Bits have the following significance: Bit 5: Load balancing Bit 6: Keep fans on Bit 7: Payload shedding Bits 0-4: X (don't care) 0 = disabled, 1 = enabled.

Table 16

5.14 Packet ID 0x1B – Set (or Get) CA

This packet sets the stored values of CA, the CAN address. The value of CA may be obtained by issuing this packet with zero data bytes.

Byte	Name	Description
0, 1	CA	CAN address. The CAN address may be set to any value from 0 to 65534 (0x0000 to 0xFFFE) inclusive. 65535 (0xFFFF) is a "broadcast" address to which all PDUs will respond (provided that the rest of the ID is valid). This is useful for determining unknown or forgotten addresses.

Table 17

5.15 Packet ID 0x20 – Set (or Get) output states

This packet enables or disables the various outputs. Conversely, the enable status of the various outputs may be obtained by issuing this packet with zero data bytes.

Byte	Name	Description
0	State	Bits have the following significance: Bit 6: Payload output Bits 0–5, 7: X (don't care) 0 = disabled, 1 = enabled.

Table 18

5.16 Packet ID 0x26 – Reset

Restarts the PDU. The payload output is set to its power-up state, and the battery energies are reset to zero. Must be issued with zero data bytes.

The avionics and servo outputs remain stable throughout the restart process.

5.17 Packet ID 0x30 – Serial number

On reception of this packet ID (with zero data bytes), the PDU will respond with a packet containing the following data:

Byte	Name	Description
0, 1	Serial number	Unsigned word, range 0 – 65535. Every PDU is given a unique serial number at manufacture. This is a read-only value and cannot be changed. It is not affected by firmware updates.

Table 19

5.18 Packet ID 0x31 – Firmware

On reception of this packet ID (with zero data bytes), the PDU will respond with a packet containing the following data:

Byte	Name	Description
0	Version major	Unsigned byte, range 0 – 99.
1	Version minor	Unsigned byte, range 0 – 99.
2	Build day	Unsigned byte, range 1 – 31.
3	Build month	Unsigned byte, range 1 – 12.
4, 5	Build year	Unsigned word, ranges from 2020 and up.

Table 20

6 Document version history

6.1 0.92 -> 0.93

- Added Packet ID 0x18 – Set power-up state.
- Added Packet ID 0x20 – Set output state.
- Removed mention of internal CANbus termination.

6.2 0.93 -> 0.94

- This section renamed to Document version history.
- Document reformatted to suit printing and binding.
- Added Packet ID 0x0F – Measurement request.
- Table 1 (Packet ID) updated to improve clarity. Packet descriptions updated to improve clarity.
- Packet ID 0x04 – Miscellaneous changed to include more useful information and also allow for better PMU family compatibility.

6.3 0.94 -> 0.95

- Packet numbering scheme changed to improve PMU family compatibility.
- Packet IDs 0x00 and 0x01 now correspond to 2 actual packets of data.

6.4 0.95 -> 0.96

- Power-up states removed.
- Packet ID 0x04 – Miscellaneous changed.
- Packet ID 0x11 – Set (or Get) V_S range updated.
- Packet ID 0x20 – Set (or Get) output states bit significance changed.
- Load balancing added.

6.5 0.96 -> 1.0

- Initial release.

6.6 1.0 -> 1.1

- Packet ID 0x20 – Set (or Get) output states bit significance changed.