Watt&Well
CONVERTING POWER INTO CONFIDENCE

## High-Temp – 300 W Step Down DCDC

POWER SUPPLY	OIL&GAS APPLICATION	HIGH TEMPERATURE

OVERVIEW

Nar Power is a DC/DC step down isolated converter for medium power applications which does not need external low voltage supply. It is part of the Nar Power series.

Nar Power is our high temperature power supplies series providing optimal operation and **high reliability in harsh environment.**

Typical applications are Downhole Tools for Oil&Gas and Geothermal markets
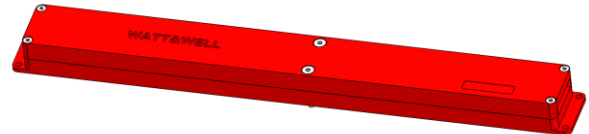
FEATURES

- High Temperature: up to 175 °C (347 °F)
- High Vibration: up to 20 G RMS
- Input Voltage: 300 V to 900 V
- Maximum Output Current: 5 A
- Output Voltage : 60 V
- Full Digital Control with monitoring and configuration via CAN bus
- Output voltage isolated from input voltage
- Chassis isolated from electrical grounds
- CAN bus isolated
- Programmable UVLO/OVLO and overcurrent protections
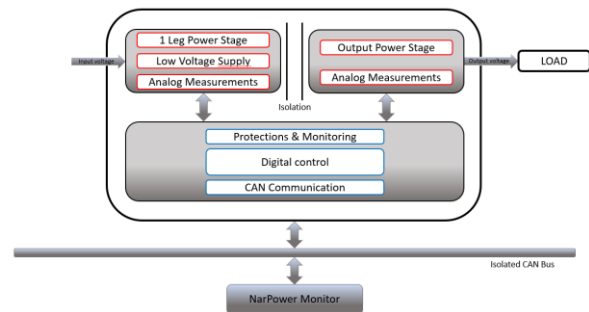- Highly Configurable through an extensive Graphical User interface with logging capability

VERSIONS

Part-number	Input Voltage	Output Voltage	Output Current
NP-40-900-60-5	900V	60 V	5 A

L x W x H (mm)
375.5x40x25

DIMENSIONS

Units	L x W x H
mm	375.5 x 40 x 25
in	14.78 x 1.57 x 0.98

BLOCK DIAGRAM

APPLICATIONS

- Drilling
- Wireline

CUSTOMIZATION OPTIONS

- Other form factor on demand
- Other output voltage on demand
- Custom Data Logging

Product datasheet. The given values are susceptible to change without prior notice
contact@wattandwell.com - wattandwell.com
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WARNING

This equipment operates at voltages and currents that can result in electrical shock, fire hazard and/or personal injury if not properly handled or applied. Equipment must be used with necessary caution and appropriate safeguards employed to avoid personal injury or property damage.

It must be used only by qualified engineers and technicians familiar with risks associated with handling high voltage electrical and mechanical components, systems and subsystems.

1. Absolute maximum ratings

Table 1: Absolute maximum ratings

Parameter	Condition	Min	Max	Units
HV input voltage	$V_{HV} - V_{HV-RTN}$	200	900	V
HV input current			1.15	A
HV input power			335	W
Operating temperature[1]		5	175	ºC
Long term storage temperature		5	85	ºC
Temperature change rate			3	ºC/min

[1]Temperature provided is the chassis temperature.

2. Electrical Characteristics

All specifications are given for ambient temperature up to 50ºC unless otherwise noted.

Table 2: Electrical characteristics

Parameter	Condition	Value			Units
		Min	Typ	Max	
DC Input					
Supply voltage		200	–	900	V
Quiescent current: Standby mode	$V_{DC} = 900V, T = [25ºC; 175ºC]$	–	2.2	–	mA
Quiescent current: Standby mode	$V_{DC} = 300V, T = [25ºC; 175ºC]$	–	6.6	–	mA
Input current	Input voltage = 300V, Output voltage = 60V, Full load	–	–	1.2	A
LV power supply startup voltage		200	–	–	V
Under voltage shutdown (programmable)		280	–	–	V
Over voltage shutdown (programmable)		–	–	925	V
Over current shutdown (programmable)		–	–	1.5	A
Maximum transient voltage	1 second pulse every minute	–	–	925	V
Negative voltage protection		No			
CAN communication					
CAN baud rate		1000			kbps
CAN differential output (dominant)	$CAN_H - CAN_L$	3.3V compatible			
CAN common mode range	$(CAN_H + CAN_L) / 2 - V_{CAN-GND}$	–2	–	+3	V
CAN differential input voltage	(compatible with external transceivers from 3.3 to 5V)	–5	–	+5	V
DC Output					
Output voltage		55	60	65	V

Output power	@125ºC and @175ºC, for the 60 V version	–	–	300	W
Output current	@125ºC and 175ºC	–	–	5	A
Over current shutdown (programmable)		–	–	5.5	A
Output voltage accuracy		–	–	2	%
Maximum capacitive load		–	–	1	mF
Frequency					
Switching Frequency		–	90	–	kHz
Efficiency					
DC_{in} = 300 V, I_{out}=5 A	DC_{out}=60V, over full temperature range	–	94	–	%
DC_{in} = 900 V, I_{out}=5 A	DC_{out}=60V, over full temperature range	–	90	–	%
Insulation					
Insulation between DC input and output grounds	1 mA maximum for 1 minute	–	720	–	V_{DC}
Insulation between DC input ground and CAN	1 mA maximum for 1 minute	–	720	–	V_{DC}
Insulation between DC output ground and CAN	1 mA maximum for 1 minute	–	720	–	V_{DC}
Insulation between DC input and chassis	1 mA maximum for 1 minute	–	1440	–	V_{DC}
Insulation between DC output and chassis	1 mA maximum for 1 minute	–	720	–	V_{DC}
Insulation between CAN ground and chassis	1 mA maximum for 1 minute	–	1440	–	V_{DC}

3. Safety instruction

3.1.   Caution

The following safety instruction must be observed during all phases of operation, service and repair of this equipment. Failure to comply with the safety precautions or warnings in this documentation violates safety standards of design, manufacture and intended use of this equipment and may impair the built-in protections within. Watt and Well shall not be liable for users to comply with these requirements.

3.2.   Input rating

Do not use power supplies which exceeds the input voltage rating of this instrument. The electrical rating of this instrument is given into the chapter 2 of this document.

3.3.   Live circuits

Operating personnel are not allowed to open the case of this equipment. Internal adjustment or component replacement is not allowed by non WATT AND WELL qualified personnel. Never replace components with cable connected to this instrument. To avoid injuries, always disconnect power and remove external voltage sources before touching components.

3.4.   Hot surface

Surface of the product could be hot during and after operation. Use protection before touching the device.

3.5.   Parts substitution and modifications

Parts substitutions and modifications are allowed by authorized WATT AND WELL service personnel only. For repairs or modification, the unit must be returned to WATT AND WELL's After Sale Service. Contact After Sale Service (aftersaleservice@wattandwell.com) to obtain RMA number.

    WATT AND WELL
    After Sale Service
    121 Rue Louis Lumière
    84120 PERTUIS
    FRANCE

4. Installation

Do not use or install product in case of visible physical damage.

4.1.   Mechanical installation

4.1.1.   Mounting

Refer to chapter 7 Mechanical specifications for the dimensions of the product.

4.2.   Electrical installation

Never invert polarity of the connector. Never force to place a connector. Use only approved manufacturer parts for electrical or mechanical connection.
It is strongly recommended to fix the cables to avoid any stress on connection.
Be careful if other devices are connected, risk of electrical charge transfer.

Wait two minutes before touching the device after complete suppression of input voltage. Check for lack of voltage, on all access, with the correct equipment.

4.2.1. Disposal

Do not dispose of electronic tools tighter with household waste material. In accordance with WEEE European Directive (2012/19/UE), Electric material that have reach the end of their life must be collected separately and return to an environmentally compatible recycling facility. Please contact WATT AND WELL for any questions about WEEE.

4.2.2. Thermal and lifetime in operation

The lifetime in operation depends on the operation temperature.
It is limited to:
- 1500 Hours of operation at 150 deg C
- 450 hours of operation at 175 deg C

As defined in the maximum absolute rating, the board must not be used above 175 deg C.

4.2.3. Humidity

The Nar Power device shall be stored, as provided by Watt&Well, with sealed ESD bag with moisture indicator cards and desiccant bag.
Maximum relative humidity in operation: 30% at 20°C, to avoid condensation and icing.

4.2.4. Vibrations

The NarPower device is compliant with vibrations, up to 20g RMS on 3 axes

5. Hardware specification

5.1. Theory of operation

NP-40-900-5-60 product consists of a power stage with a DC/DC isolated converter and a control stage with the following blocks:
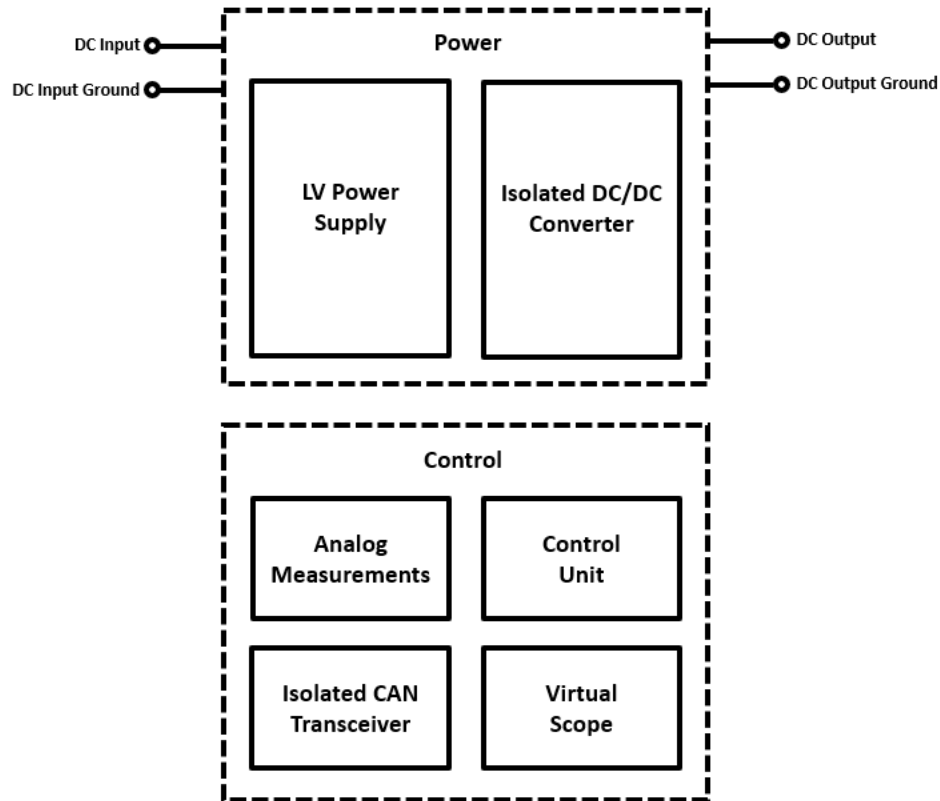

Figure 1 - Block Diagram

5.2. Control Unit

The control unit is based on a low power consumption microcontroller. This component performs analog data acquisition, CAN communication, output voltage control and regulation. Protections parameters can be changed via CAN bus.

5.3. Isolated CAN transceiver

Isolated CAN transceiver to communicate through a high-speed CAN bus. The driver itself is powered at 3.3V (CMOS levels) but it accepts inputs from CAN transceiver powered at 5V (TTL or CMOS levels).

CAN bus is expected to be terminated at both ends with a resistance matching the intrinsic impedance of the twisted pair used (typically 120 Ω). By default, Nar Power has a 120 Ω resistor internally connected.
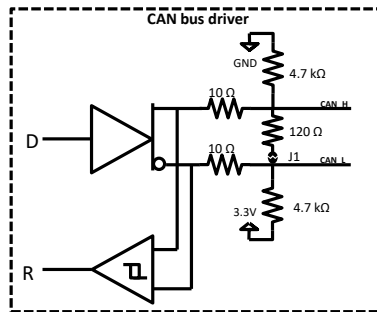
Figure 2 - CAN transceiver simplified diagram

5.4. Analog measurement

The following parameters are acquired by the control unit and can trigger protections if one of these is out specification:

- DC Input Voltage
- DC Input Current
- DC Output Voltage
- DC Output Current
- Temperature

Note: The temperature sensor is located on the control board.

5.5. Interfaces

For the input side, the two high power signals (DC link) are accessible using flying wires (Length 400mm)

Table 3: High power signal wires

Signal Name	Color	AWG
DC Input	Red	18
DC Input ground	Black	18

For the output side, the connector described in this section is placed at the product end. P1 (15 pins) is used for CAN communication and output voltage connections.

Recommended matting micro-sub D connectors are a MDAL15PCW100M (or any MDAL15P series) from Axon. Pinout is shown in Table 5.

Table 4: Connector and Harness references

	Connector reference	Mating connector reference
P1 (Output side)	MDAL15SCBPPT1	MDAL15PCW100M

Table 5: P1 pinout (Output side)

Pin	Signal Name	Details	Harness MIL-STD-681 Wire Color
1	DC Output	Output voltage	Black
2	DC Output	Output voltage	Brown
3	DC Output Ground	Output Ground	Red
4	DC Output Ground	Output Ground	Orange
5	NC	Not connected	Yellow
6	NC	Not connected	Green
7	CAN-GND	CAN bus ground	Blue
8	CAN-L	CAN bus low	Purple
9	DC Output	Output voltage	Grey
10	DC Output	Output voltage	White
11	DC Output Ground	Output Ground	White/Black
12	DC Output Ground	Output Ground	White/Brown
13	NC	Not connected	White/Red
14	CAN-GND	CAN bus ground	White/Orange
15	CAN-H	CAN bus High	White/Yellow

5.6.   Recommended connection for CAN bus

CAN bus signals can be connected to a 9 pin Sub-D socket connector (also known as female DB9) for easy interface with commercial CAN transceivers (such as NI CAN 8473 which features a DB9 header connector). The pin-out of such connector is as follow:

Table 6: CAN pinout on external connector

Signal Name	Pin in P1	Pin in DB9 (female)
CAN-H	15	7
CAN-L	8	2
CAN Ref	7	3
CAN Shield	7	5

CAN bus shield

Although ISO-11898-2 does not specify the wires type or the need for a shield, a shielded cable is recommended for electronically harsh environments. It is recommended to ground the shield at a single point on one of the dedicated CAN Shield pins of the Nar Power boards to avoid ground loops.

6. System setting

6.1.   Safety notice

The NarPower is configured in factory. It is strictly forbidden to change or modify internal firmware parameters.

6.2.   CAN communication

See "8.Firmware specifications" chapter and annex A for more information.

7. Mechanical specifications

NP-40-900-5-60 is packaged in aluminum housing with the following dimensions:

Table 7: NP-40-900-5-60 dimensions

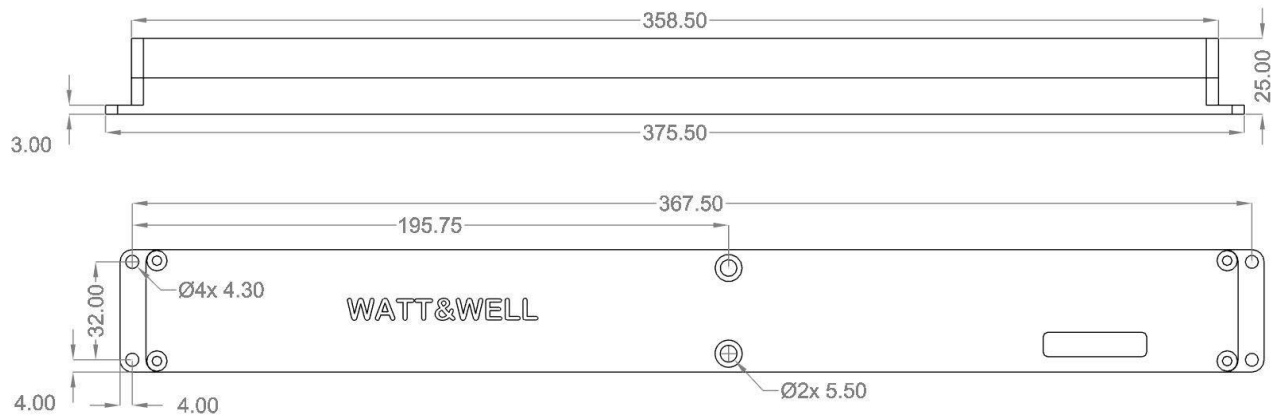| Parameter	Value			Units
	Min	Typ	Max	
Length	-	375.5	-	mm
Width	-	40	-	mm
Height	-	25	-	mm

Figure 3 - NP-40-900-60-5 Mechanical Dimension

8. Firmware specifications

8.1. CAN protocol

The DC/DC converter can be operated by a CAN bus communication.

The DC/DC converter parameters are configurable through the CAN communication, each parameter has a unique index and sub-index, refer to the datadefinition.xml file for more information, which allows to have a distinctive access to the parameter in order to read it or write it depending on its access type. The accessible parameters cover many functions like voltage and current limitation, control loop gains, faults thresholds …

The Nar Power CAN protocol is a simple protocol designed for **real time efficiency** (low CPU overhead) and **simplicity** (no communication stack required). Nar Power CAN protocol does not conform to a predefined standard, but it is fully documented, and the protocol can be reused on other projects without licensing restrictions.

When using this protocol, Nar Power boards include high level monitoring of DC/DC converter.

8.2. Digital bus configuration

Each DC/DC converter features a CAN transceiver to communicate with a bus master. In this Master/Slave scheme, each converter is considered as a slave, while the master can be either a Graphical User Interface in a PC or another electronic board.

CAN bus is configured to respect the standard 2.0B (29-bit message identifier) at a default baud rate of **500 kbps** with sampling point at **80**%. For best result, it is advised that all CAN nodes use the same sampling point configuration.

8.3. Graphical User Interface

The product is provided with a graphical user interface that contains a large variety of functionalities:

- Basic Operation: enable start /stop the drive, set the voltage set point, and get the main measurements from the Nar Power board.
- Parameters access: enable to tune the whole board parameters, including controllers' loops constants, limitations, calibrations, etc.
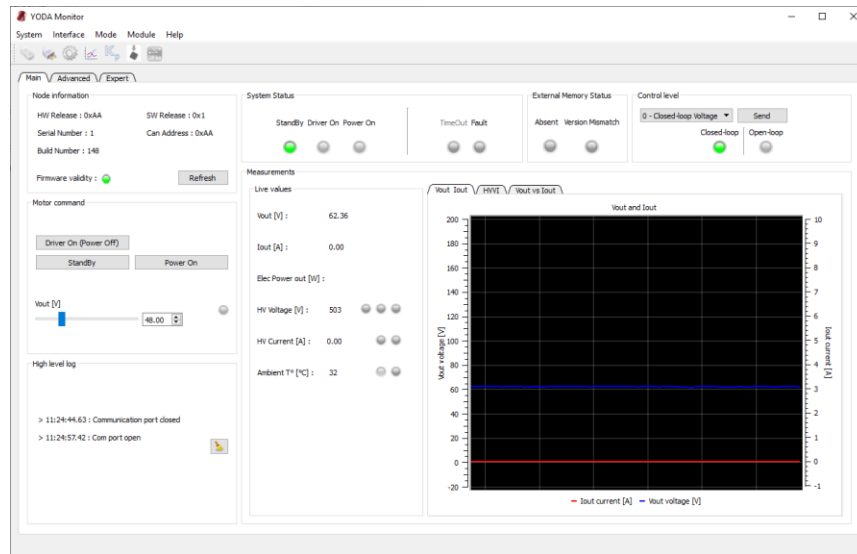
Figure 4: GUI Main panel
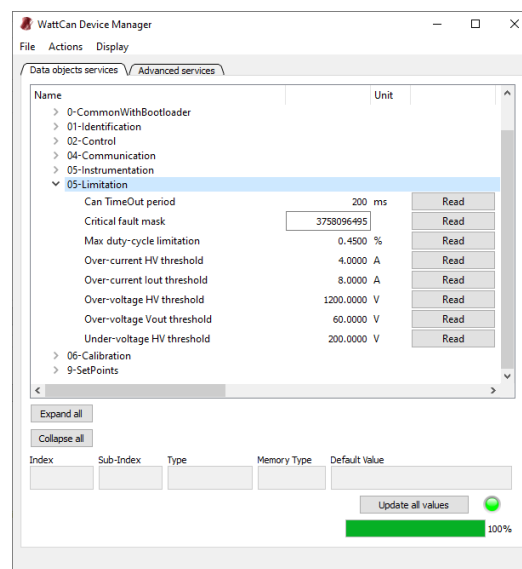
Figure 5: Parameters access panel

9. Troubleshooting

Contact Watt and Well for assistance.

10. Ordering Information

Part Number	Output Voltage / Output Power
NP-40-900-60-5	60 V / 300 W

contact@wattandwell.com

Engineering Center: 129 avenue de Paris - Massy (91300) France
Production Facilities: 121 rue Louis Lumière - Pertuis (84120) France
USA Subsidiary: 3500 Washington Ave - Suite 100 - HOUSTON - TX 77007 USA

Annex A - Nar Power CAN protocol

1) Message Identifier format

Each CAN 2.0B frame has a 29-bits identifier and up to 64 bits of data. Nar Power CAN protocol uses this message ID for node addressing and message description (opcodes):

Bit	28-27	26-19	18-11	10-9	8-0
Field	Priority Bits (2bits)	SRC Address (8bits)	DST Address (8bits)	MSG Type (2bits)	Opcode (9bits)

- Priority bits: priority level of the message. Priority bits can be used to optimize message delivery but should be ignored by each node when decoding the message.
  - o   00 : highest priority
  - o   01: high priority
  - o   10: low priority
  - o   11 : lowest priority
- SRC Address: source address.
- DST Address: destination address.
- MSG type: 3 types of message are defined :
  - o   Type 0 or « Slave Tx »: Message sent from slave to master
  - o   Type 1 or « Data Set »: Message sent from master to the slave to set a value on the slave memory.
  - o   Type 2 or « Data Request » Message sent from master to slave to request data from slave. Each data request will trigger Type 0 (Slave Tx) from the slave.
- OpCode: Identifier of message used to describe signification of message.

By default, the setting is the following:

	Address	Priority
Master (Monitor)	0xAA	1
Slave (Nar Power)	0x55	1

Table 8: Default CAN settings

11. CAN messages dictionary

With the 29 bits CAN ID defined above, each node can build a message dictionary using the 9-bits Opcode.

OpCode Name	OpCode value	Msg type	Format	Word 0	Word 1	Word 2	Word 3	Comment
BUILD_INFO	0	0	Uint16 / Uin32 / Uint16	BuildNb	SrcModified	BuildDate		Answer
BUILD_INFO	0	2	Uint16	(0x0000)	(0x0000)	(0x0000)	(0x0000)	Request
DEVICE_INFO	1	0	Uint16	HwRelease	SwRelease	DeviceNumber	CanAddress	Answer
DEVICE_INFO	1	2	Uint16	(0x0000)	(0x0000)	(0x0000)	(0x0000)	Request
REQUEST_WORD	2	1	Bit-Wise	RequestWord		(0x0000)	(0x0000)	State request
STATUS_WORD	3	0	Bit-Wise	StatusWord		(0x0000)	(0x0000)	State feedback - Sent periodically by the slave
FAULT_WORD	4	0	Bit-Wise	FaultWord		(0x0000)	(0x0000)	Sent periodically by the slave
CRITICAL_FAULT	5	0	Bit-Wise	Critical FaultWord		ExtendedFaultCode	(0x0000)	Sent asynchronously when system is shuted down (on rising edge of a critical fault)
EMERGENCY_SHUTDOWN	100	0	Uint16	Ack(0x0001)	(0x0000)	(0x0000)	(0x0000)	
REBOOT	101	0	Uint16	Ack(0x0001)	(0x0000)	(0x0000)	(0x0000)	

POWER_CONVERTER_CMD	102	0	Fixed-point	VoutSetPoint	(0x0000)	(0x0000)	(0x0000)	Setpoint write
POWER_CONVERTER_CMD	102	1	Fixed-point	VoutSetPoint	(0x0000)	(0x0000)	(0x0000)	Setpoint feedback
MEASUREMENT_0	200	0	Fixed-point	HV Voltage	HV Current	Output Voltage	Output Current	Sent periodically by the slave
MEASUREMENT_1	201	0	Fixed-point	Output Voltage	(0x0000)	(0x0000)	Electrical input Power	Sent periodically by the slave
MEASUREMENT_3	202	0	Fixed-point	PCB Temperature	(0x0000)	(0x0000)	(0x0000)	Sent periodically by the slave

Table 9: CAN message frame dictionary

CAN data description details data contained in those message frames and, where applicable, gives the normalization value (for details on how to convert these fixed-point values to physical unit see section Conversion factor and units).

Frame	Data	Format	Description
BUILD_INFO	BuildNb	Uint16	Version control number
BUILD_INFO	SrcModified	Uint16	Version control check result (0-> OK, 1-> fail)
BUILD_INFO	BuildDate	Uint16	Build date (second since 1900)
BUILD_INFO	SwRelease	Uint16	Software Release version
BUILD_INFO	HwRelease	Uint16	Hardware Release version
BUILD_INFO	DeviceNumber	Uint16	Number of the device
BUILD_INFO	CanAddress	Uint16	CAN address of device
REQUEST_WORD	RequestWord	Uint32 bit wise	System Control Request Word
STATUS_WORD	StatusWord	Uint32 bit wise	System Control Status Word
FAULT_WORD	FaultWord	Uint32 bit wise	Fault word
CRITICAL_FAULT	CriticalFaultWord	Uint32 bit wise	Critical fault word
POWER_CONVERTER_CMD	VoutSetPoint	Signed Q8.7	Output Voltage SetPoint
MEASUREMENT_0	HV Voltage	Signed Q11.4	HV Voltage
MEASUREMENT_0	HV Current	Signed Q5.10	HV Current
MEASUREMENT_0	Output Voltage	Signed Q8.7	Output Voltage
MEASUREMENT_0	Output Current	Signed Q5.10	Output Current
MEASUREMENT_1	Electrical input Power	Signed Q10.5	Electrical input Power
MEASUREMENT_3	PCB Temperature	Signed Q8.7	PCB Temperature

Table 10: CAN data description

11.1. Request word, status word and fault word messages

Three words are defined bit wise:

- Request Word: used to configure the state of the system. Table 11: Request Word/Status Word Bit definition details these words.
- Status word: acknowledges that status in the system. It has a similar definition to the request word but is read only. This word is sent by controller periodically.
- Fault Word: word containing flag errors. This word is sent by controller synchronously. Table 12: Fault word bit wise definition details these words.

Bit	Request Word	Status Word	Description
0:3	System Mode		Set/acknowledge the system state 0 - System Off : PWM off (power switches in high impedance) 1 - Driver ON and Control OFF (PWM OFF) 2 - Driver ON and Control ON (PWM ON) 7 - Fault Mode: PWM off because of a critical fault. System status should be set to system off to clear the fault
4-31	Reserved		

Table 11: Request Word/Status Word Bit definition

Bit	Description
0	Over voltage Fault on output voltage
1	Over current Fault on output current
2	Warning temperature Fault on PCB temperature
3	Shut-down temperature Fault on PCB temperature
4	Over voltage Fault on HV voltage
5	Under voltage Fault on HV voltage
6	Over current Fault on HV current
7	Over current on HV Current (HW detection)"
8 - 26	Unused
27	Emergency Shutdown
28	External Shutdown
29	Keep Alive Can Message Timeout
30 - 31	Unused

Table 12: Fault word bit wise definition

11.2. Can error code

Not implemented in this version.

11.3. Critical Fault frame

When critical fault occurred, a critical fault message is sent asynchronously. It supplies the last fault word to indicate which critical fault puts the system in "Fault Mode".
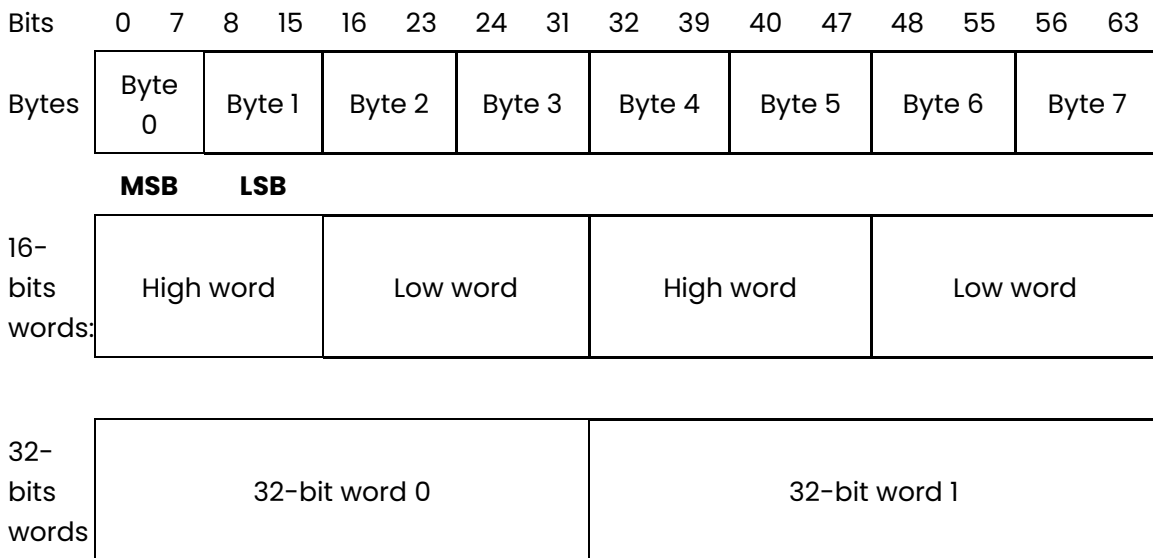This frame includes the fault word (state of each fault flag) at the instant of the fault trip.
The extended fault code is not implemented in this version.

11.4. Endianness

Endianness and data format within a CAN frame is application dependent (not part of the CAN specification). Nar Power protocol uses Big Endian (also known as Network Order)[1].

The resulting byte order for Nar Power communications is the following:

Bits	0 7	8 15	16 23	24 31	32 39	40 47	48 55	56 63
Bytes	Byte 0	Byte 1	Byte 2	Byte 3	Byte 4	Byte 5	Byte 6	Byte 7

MSB   LSB

16-bits words:	High word	Low word	High word	Low word

32-bits words	32-bit word 0	32-bit word 1

For example, the 64-bit hexadecimal number « 0x0001 0203 0405 0607 » will be send in CAN bus as follows:

Bytes	16-bits words	32-bits words
Byte 0: 0x00	High word: 0x0001	32-bit word: 0x00010203
Byte 1: 0x01		
Byte 2: 0x02	Low word: 0x0203	
Byte 3: 0x03		
Byte 4: 0x04	High word: 0x0405	32-bit word: 0x04050607
Byte 5: 0x05		
Byte 6: 0x06	Low word: 0x0607	
Byte 7: 0x07		

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[1] Computers are usually based on the x86 architecture which is little endian for 16-bits and 32-bits words. 64-bit numbers (not used on NarPower communications) in 32-bits architectures are compiler dependent.