CCBIDI15KW600-28

15 kW Bi-Directional DC-DC

A 15 kW Bi-Directional DC/DC converter that transfers power between 600 VDC high voltage bus and a 28 VDC low voltage bus. This supports power flow in both directions, allowing efficient energy management between systems.

The unit features high efficiency, liquid cooling, and a rugged ARINC 600-style enclosure with sealed connectors. Additional control level outputs are for integration and a self designed high voltage interlock circuit.

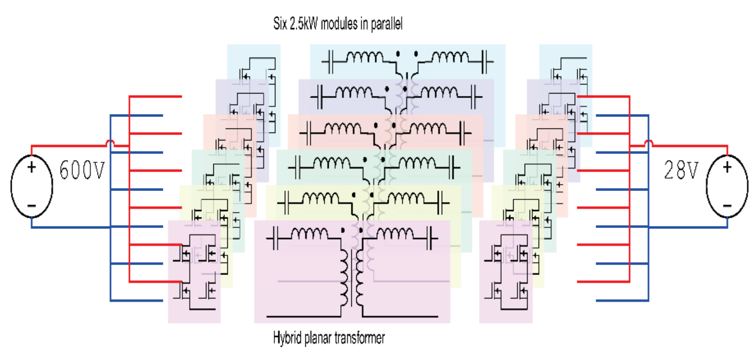
BENEFITS

- ☑ Very high efficiency up to 95.7%
- ☑ Liquid-cooled
- ☑ CAN with SAE J1939 protocol
- ☑ High voltage interlock circuit

APPLICATIONS INCLUDE

Commonly used in hybrid and electric vehicles, aerospace power distribution systems, military ground vehicles, battery charging and industrial electric platforms.

Assembly with ARINC enclosure



System level circuit model

Part Number	Package	Manufacturer
CCBIDI15KW600-28	ARINC 600 – 6 MCU	CoolCAD Electronics

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Features and Functionality:

The unit is designed for high-efficiency 15 kW bi-directional DC/DC power transfer with high and low voltage interfaces, integrated safety interlock for high voltage 600 VDC, and configurable CAN control. Provides monitoring access, auxiliary outputs, and robust reliability for demanding applications.

Power interfaces
- 600 VDC nominal high voltage interface
- 28 VDC nominal low voltage interface
- Bi-directional power transfer (step-up and step-down operation)

High voltage safety
- Integrated high voltage interlock circuit
- Interlock functions as a safety relay to protect against hazardous 600 VDC exposure
- Continuous interlock status monitoring
- External emergency interlock control

Control and Auxiliary interfaces
- ARINC 600 receptacle for high voltage and auxiliary supply (28V) connections
- 24 V PWM output (1kHz) with configurable duty cycle (0-100%), 1A continuous output
- Configurable 0-10V analog output , 10mA

Communication & Configuration
- CAN bus interface
- SAE J1939 protocol support
- 500 kbps data transmission rate
- 8-bit hardware address identifier circuit (configurable source address for the unit)
- Operating parameters configurable via CAN bus
- Monitoring access via CAN for:
  - ➢ DC port voltages and currents
  - ➢ Interlock circuit status

Thermals
- Liquid cooled thermal management
- 60/40 EGW as coolant
- High reliable operation

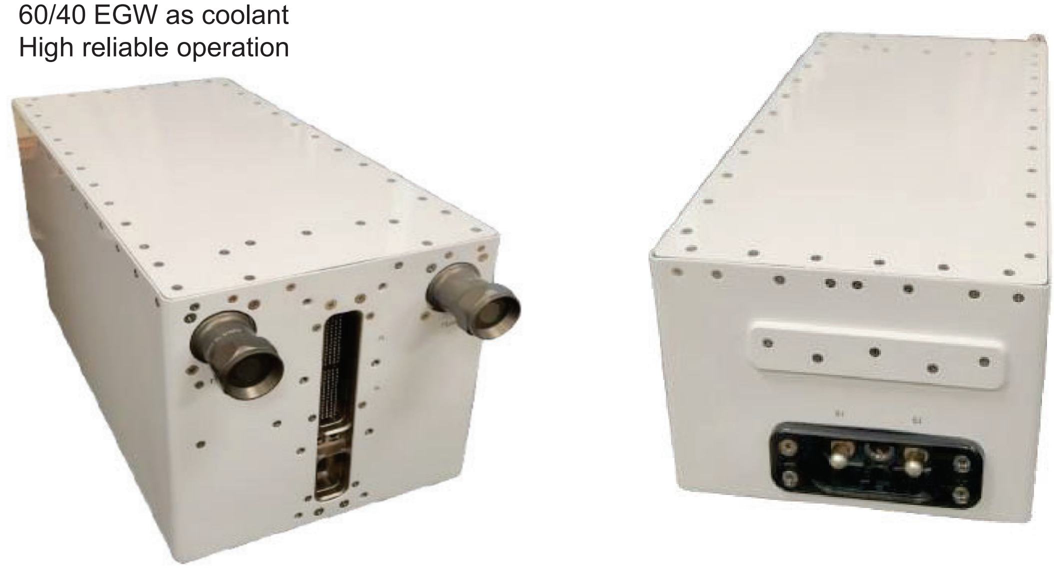

Figure 1 : 15 kW Bi-directional DC/DC converter unit integrated in ARINC enclosure

Table 1: Assembly dimensions.

	Dimension (ARINC 6 MCU)
Length	16.5" (with coolant fixtures) 15.25" (without coolant fixture) 12.675" (bottom)
Width	7.50"
Height	7.6"

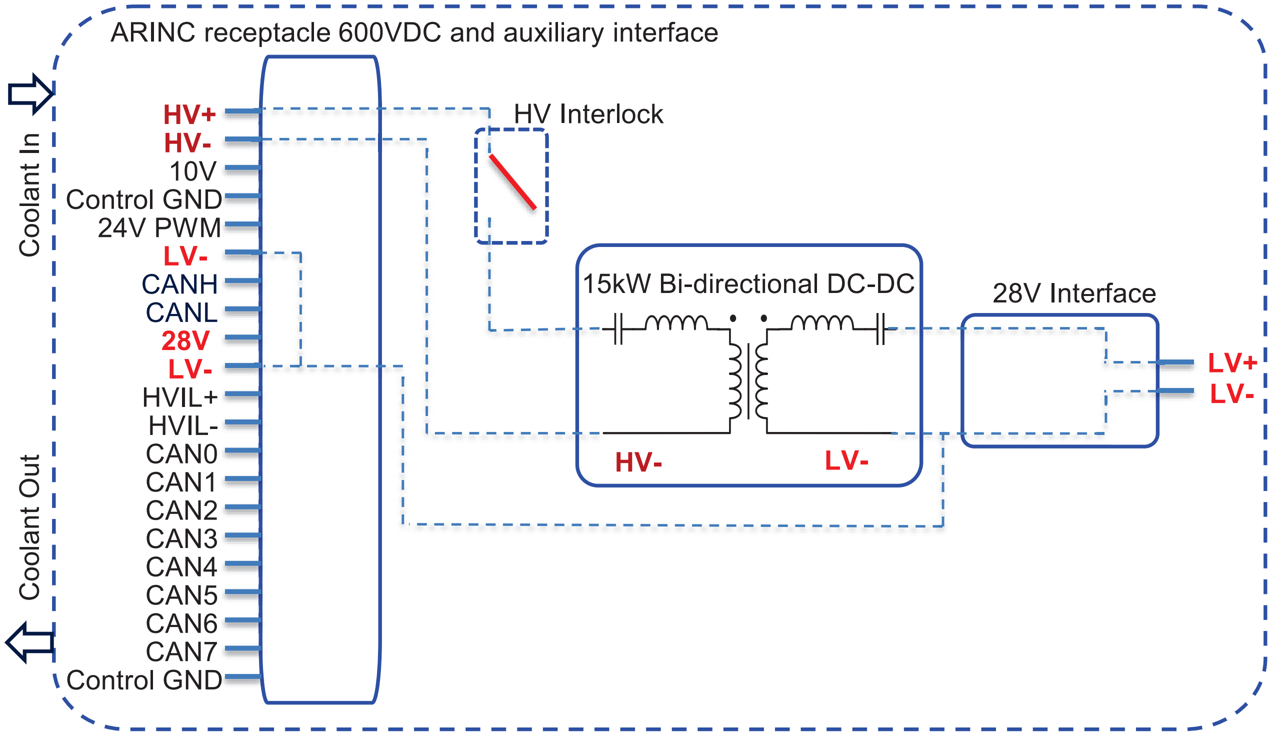

Figure 2 : Block diagram of the unit with high voltage (HV), low voltage (LV), and auxiliary interfaces

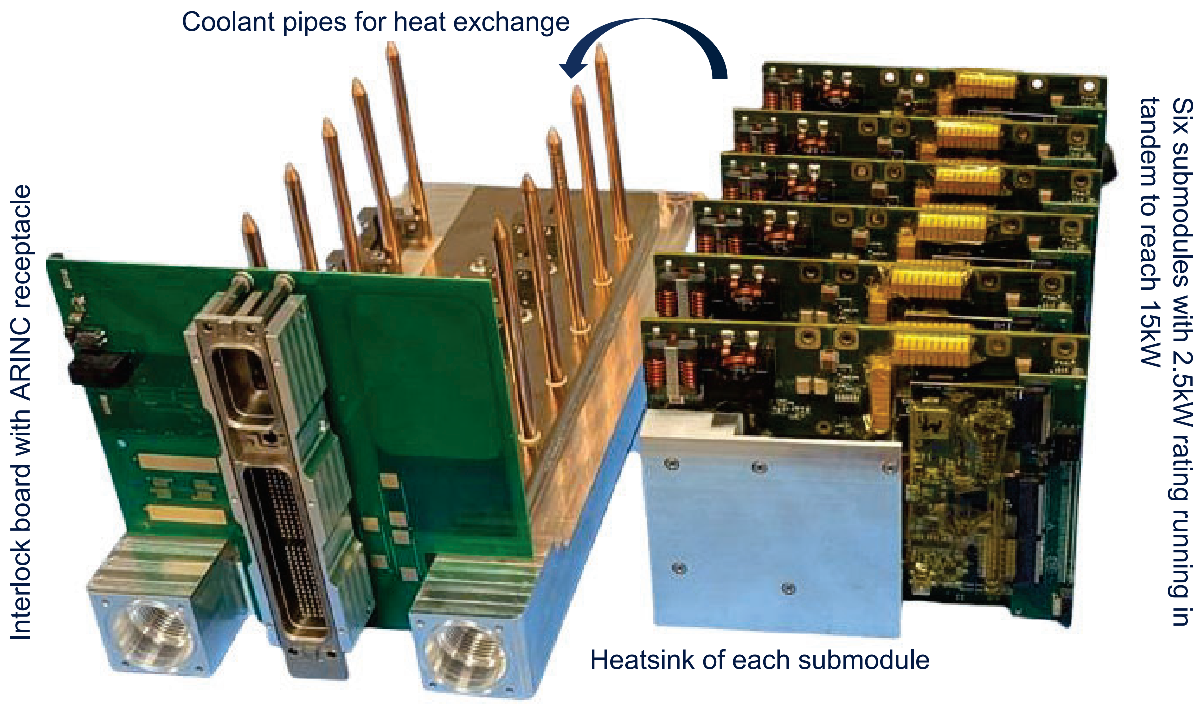

Figure 3 : Modular 15 kW Converter – 6 parallel modules each rated for 2.5 kW, enclosed

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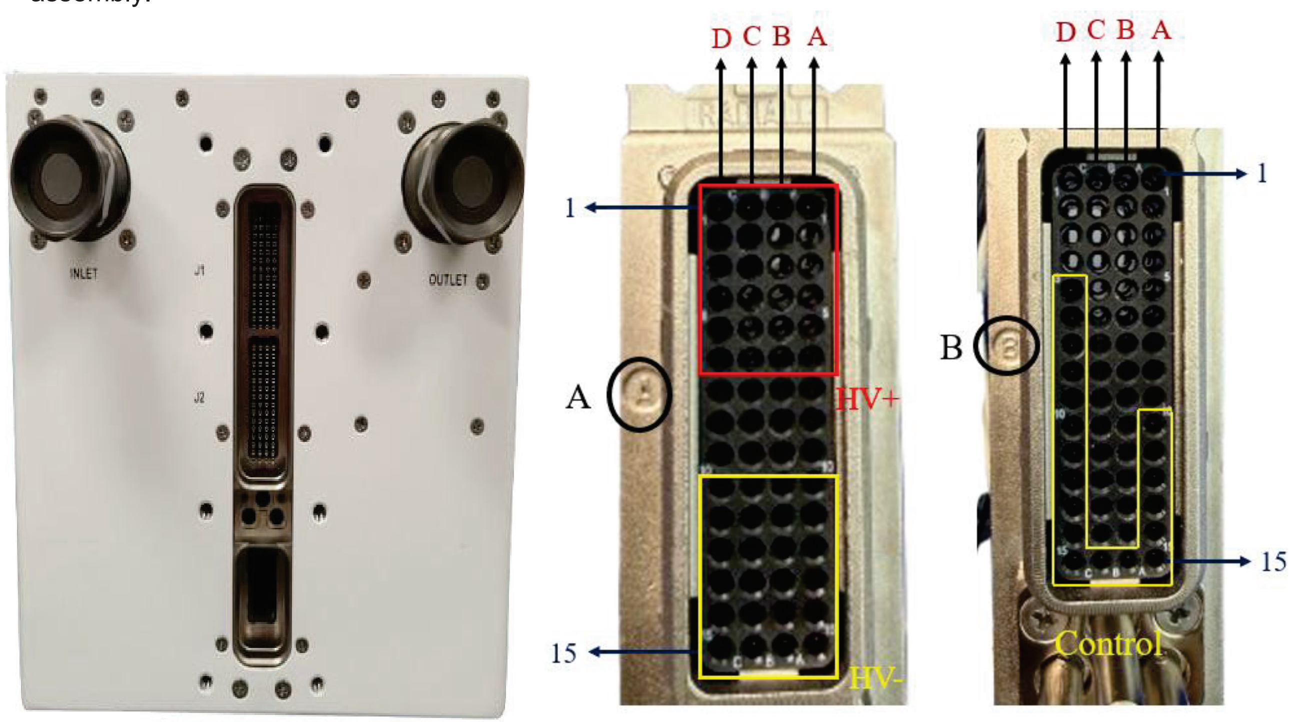
Connectors:

Parameter	Description	Manufacturer	MPN
ARINC 600 receptacle	High voltage connector with HVIL function, control/auxiliary pins	Radiall	NSXF1F101RA02
MIL-PRF-18148/3 battery adapter	Low voltage, high current receptacle	Rebling Plastics	7002-7

For ARINC receptacle, a mating connector from ARINC 600 series can be used and we recommend using NSXN1B101S00 from 'Radiall' manufacturer. This perfectly mates the ARINC receptacle on the assembly.



(a) (b)

Figure 4: (a) Exterior of the unit showing ARINC receptacle along with coolant inlet/outlet (b) ARINC receptacle showing high voltage and control/auxiliary connections

Table 2: Description of control/auxiliary connections

S.no	Pin	Name	Description
1	A10	**10V**	**10V O/P positive**
2	A11	**Control GND**	**10V O/P return**
3	A12	**24V_PWM**	**24V_PWM positive**
4	A13	**LV-**	**24V_PWM return**
5	A14	**CANH**	**CAN bus high**
6	A15	**CANL**	**CAN bus low**
7	B15	**28V**	**Control supply**
8	C15	**LV-**	**Control supply return**
9	D6	**HVIL+**	**External HVIL positive**
10	D5	**HVIL-**	**External HVIL negative**
11	D15	**CAN0**	**CAN external identifier 0**
12	D14	**CAN1**	**CAN external identifier 1**
13	D13	**CAN2**	**CAN external identifier 2**
14	D12	**CAN3**	**CAN external identifier 3**
15	D11	**CAN4**	**CAN external identifier 4**
16	D10	**CAN5**	**CAN external identifier 5**
17	D9	**CAN6**	**CAN external identifier 6**
18	D8	**CAN7**	**CAN external identifier 7**
19	D7	**Control GND**	**GND for CAN identifier**

Figure 5: Exterior of the unit showing ARINC 600 receptacle

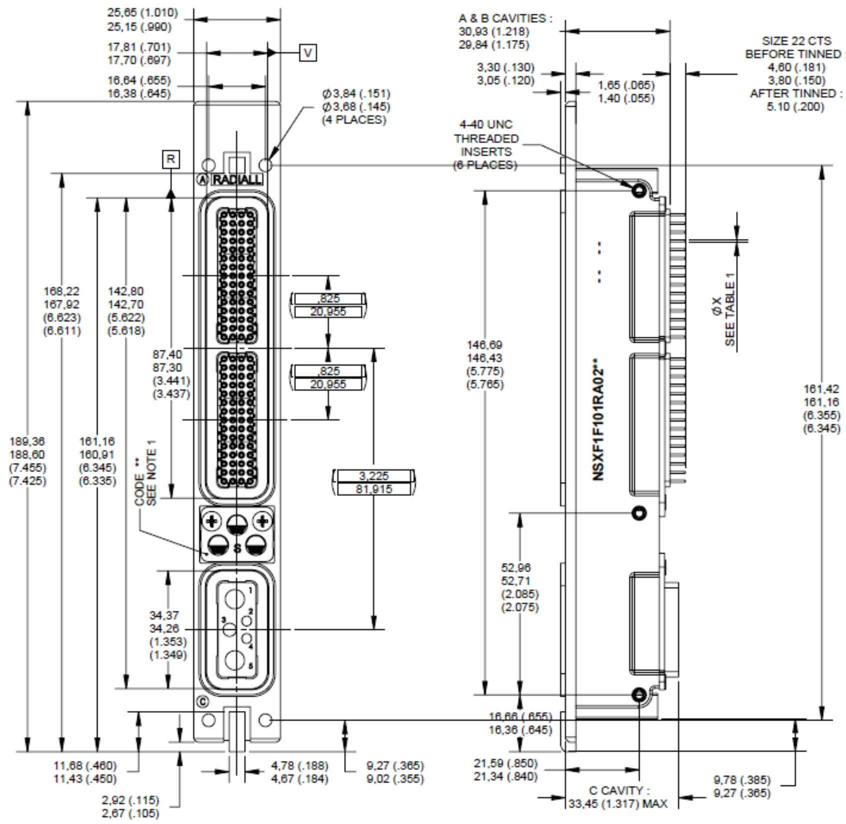


TABLE 1		
SIZE	ØX before tinning	ØX after tinning
22	0,67/0,60 (.026/.023)	0,80 max (.031)

Figure 6: ARINC 600 receptacle mechanical drawing.

Figure 7: Exterior of the unit showing low voltage side battery adapter

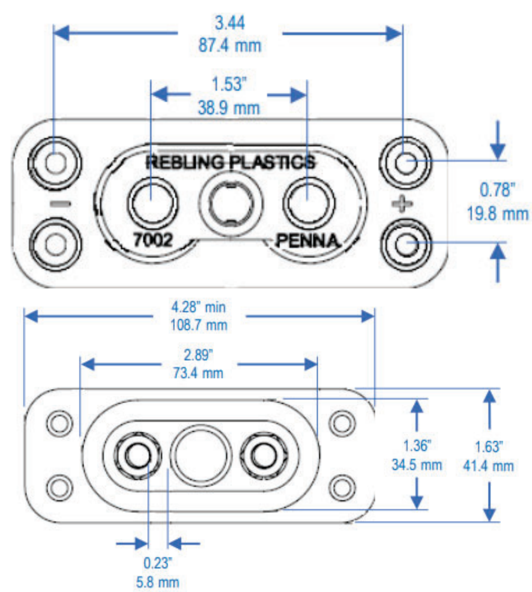


Figure 8: Military spec battery adapter mechanical drawing

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Specifications:

Table 3: Technical specifications of the unit.

Model	Version I
Power	15kW DC (Max)
Efficiency	95.7% (Max)
Voltage	600V-28V
Forward / Reverse power transfer (600 VDC – 28 VDC)	
Input Voltage	600V / 28V
Input Current	25A / 536A
Output Voltage	28V / 560V
Output Current	536A / 27A
Control	
Supply Voltage	28V
External Identifier Circuit	3.3V (Typ.)
Interlock Open	25V (Typ.)
Others	
Temperature	70ºC (Ambient Max)
Dimensions	16.5" x 7.5" x 7.6"
Weight	45.75 lbs / 20.75 kg

Quick Start Instructions:

1. Make the High Voltage power connections and auxiliary connections with the external ARINC 600 adapter according to the wiring diagram shown in **Figure 4/Table 2**. Following this, plug in the adapter to the appropriate receptacle on the converter.
2. CANH and CANL pins can be connected to any of the user interfaces that supports J1939 protocol.
3. Make the low voltage power connections with the external MIL spec low voltage adapter and plug it into the appropriate receptacle on the converter.
4. Start the 28V auxiliary supply and check for appropriate current draw (~0.9A)
5. For power conversion, specific sequence must be followed to ensure proper operation of the unit in both forward and reverse power transfers. See **Figure 9** that shows flowchart depicting proper sequence in bi-directional mode
   - Refer user manual for detailed information on parameter data formats, data types, and proper operation of the unit. It is available upon user's request.
   - Note: the default condition of the converter is forward power transfer with a CAN source address of 0x1
6. On J1939 protocol, specific parameter group numbers (PGN) are used to transmit and receive information.
   - PGN 61716 is used by the converter to send DC/DC voltage and current information for high voltage and low voltage ports as a broadcast message on the CAN bus
   - PGN 130817 is a proprietary PGN that can be sent by the user on the CAN bus to configure certain parameters of the unit.
7. Configuration parameters consists of 5 commands each with 1 byte of data starting from interlock, convert, reverse power transfer enable, 10V circuit output and 24V PWM duty output, respectively.
8. For forward power transfer, enable convert by setting byte 2 to 0x1 via CAN followed by shorting interlock by setting byte 1 to 0x1. This starts the power conversion and for powering off, open the interlock by setting both bytes 1 and 2 to 0x0. This leaves the unit in standby mode.
   - Note: once power conversion is active, the auxiliary current draw will increase to ~1.56A.

Quick Start Instruction (cont.):

9. Changing the direction of power conversion can only be carried out when interlock and convert commands are disabled (standby mode). In this mode, there are no pulses being generated in the unit, the interlock is open, and a reduced auxiliary current (~0.9A) can be observed.
10. For reverse power transfer, while in standby mode, first set byte 3 to 0x1. Following this, short the interlock by setting byte 1 to 0x1 over CAN followed by enabling convert by setting byte 2 to 0x1. This starts the power conversion and for powering off, set both bytes 1 and 2 to 0x0. This leaves the unit in standby mode.
11. Other auxiliary circuits can be accessed by sending appropriate inputs to the unit via CAN.
    - Configure the 0-10V output through byte 4 (takes values 0x0-0xFF)
    - Configure the duty cycle % of the 24V PWM output through byte 5 (takes values 0x0-0x64)

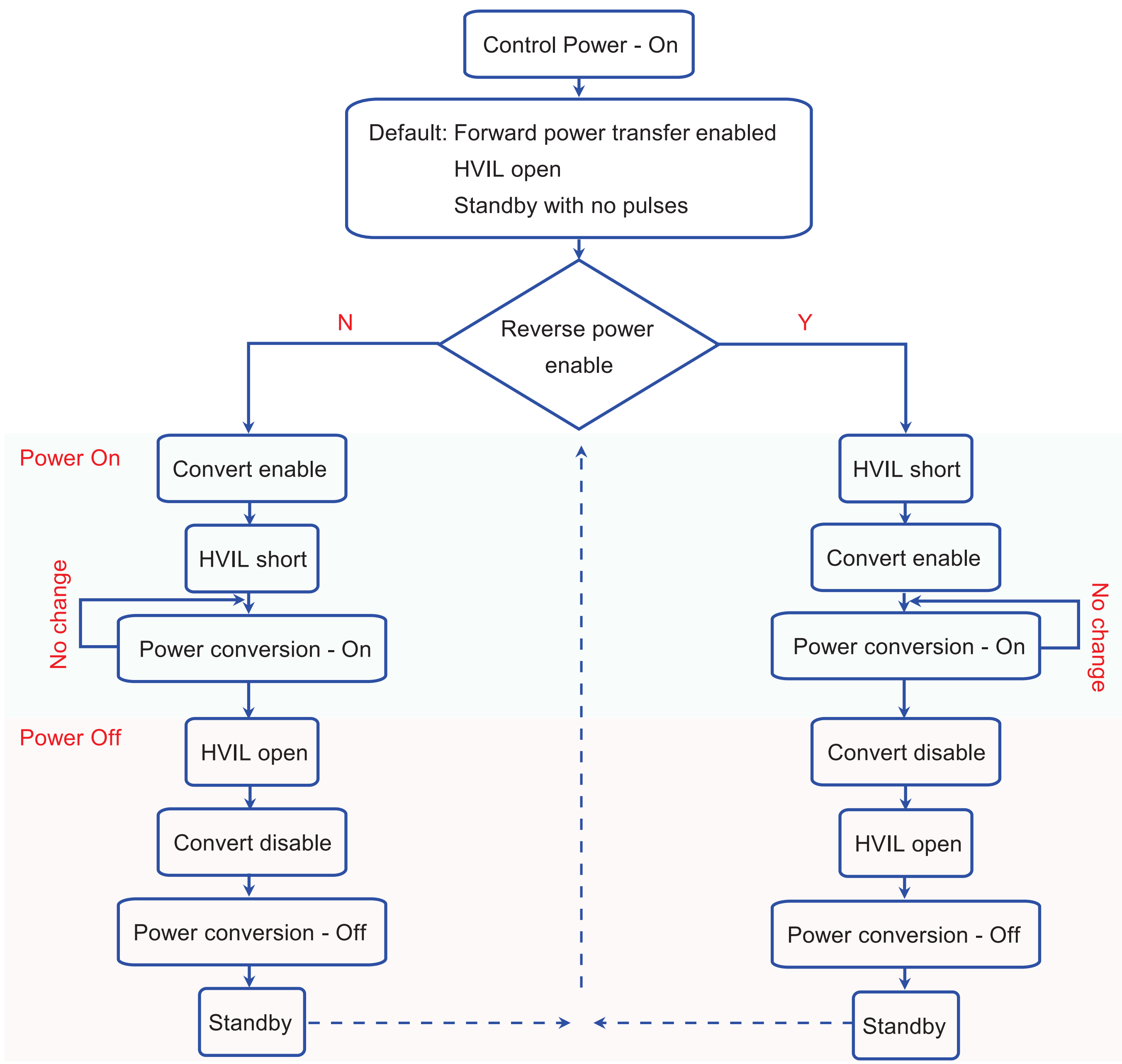
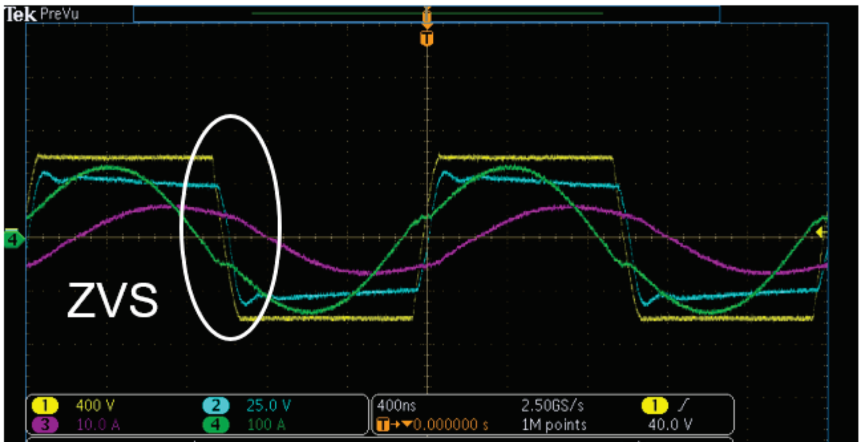


Figure 9: Flowchart depicting sequence of operational modes

Example waveforms:

Figure 10 illustrates zero voltage switching (ZVS) for one of the internal modules at its rated forward power conversion. The highlighted area shows that ZVS is occurring for both high voltage and low voltage sides. It can be confirmed by the smooth voltage switching transition along with the corresponding switching currents indicating discharging of drain-source capacitances of the power devices. ZVS ensures minimization of switching losses across the power devices during turn on resulting in increased efficiency of the converter.



Ch1 (yellow) = High voltage side switching voltage
Ch2 (blue) = Low voltage side switching voltage
Ch3 (pink) = High voltage side switching current
Ch4 (green) = Low voltage side switching current

Figure 10: Switching waveform for one of the internal modules with ZVS

Figure 11 shows the transient behavior during a load change to and from 50% to 10% load in forward power transfer mode. The discontinuous points in the current waveform indicate when load transients occur. Despite load transients, a steady state control of these parameters can be observed through the nearly constant output DC voltage.

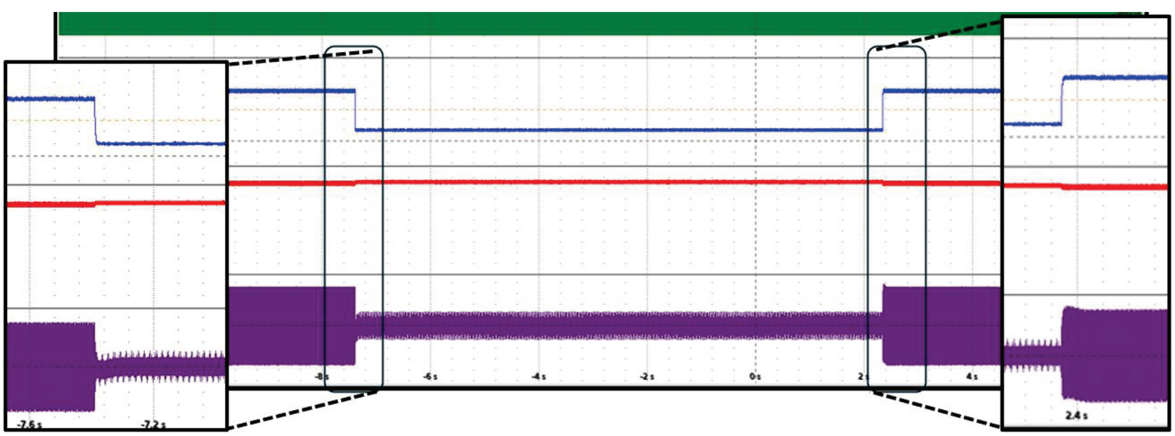
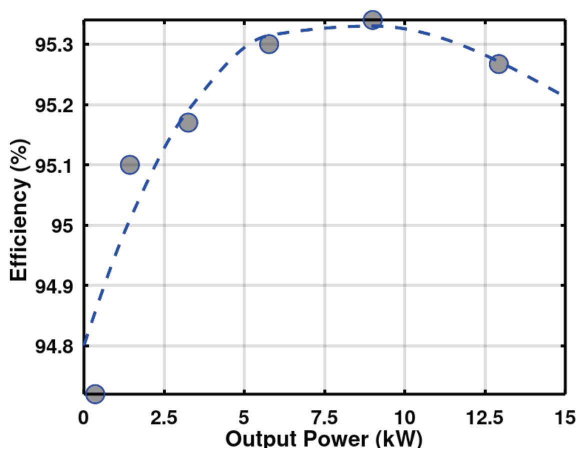


Figure 11: Load transient for one of the internal modules in forward power transfer mode

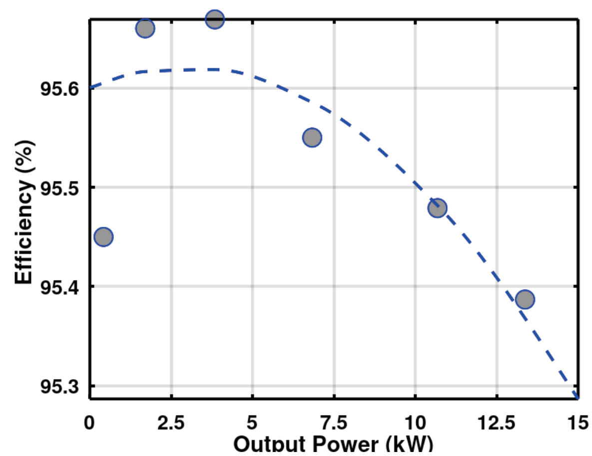
Red - Low voltage side DC output voltage
Blue – High voltage side input DC current
Purple - Low voltage side switching current

Example waveforms (cont.):

Figure 12 illustrates the efficiency performance of the unit under both forward and reverse power transfer modes as a function of output power. In **Figure 11(a)**, the efficiency (%) is plotted against output power (kW) during forward power transfer operation. The results show that efficiency remains nearly constant across the entire tested power range. Notably, once the output power exceeds 1 kW, the efficiency consistently stays above 95%. In **Figure 11(b)**, the efficiency characteristics in reverse power transfer mode are presented. Like the forward mode, the efficiency profile is relatively flat across different output power levels, demonstrating consistent performance. Throughout the measured range, the efficiency remains above 95%, confirming that the unit maintains high conversion effectiveness even when operating in reverse power flow. Overall, the results demonstrate that the system achieves high and nearly load-independent efficiency in both operating modes, highlighting its robustness and suitability for bidirectional power transfer applications.



(a)



(b)

Figure 12: Efficiency vs output power of the unit in bi-directional power transfer
(a) Forward power transfer; (b) Reverse power transfer

Warnings

1. The unit should only be used by experts, knowing and understanding of its configuration.

2. The choices of using additional auxiliary circuits require understanding of the circuit operation.

3. The user is responsible for the electrical safety and the proper handling and use of the converter. It is your responsibility to use this unit correctly and safely following instructions from the user manual.

4. When operating this converter at rated power and rated voltages, use it in an environment where sufficient safety measures have been taken.

5. Never touch the 600 VDC connector pins directly without confirming the interlock status received over CAN bus.

6. CoolCAD Electronics is not responsible for accidents or injuries caused when using this unit.

7. CoolCAD Electronics is not responsible for any consequences arising from the use of this unit.

8. The unit is provided as is without any warranties, except for in the case of shipping damage or existing manufacturing issue. The customer should alert CoolCAD Electronics within 30 days of purchase of this board for warranty.

9. If this unit is modified or damaged by the customer, it cannot be replaced.

10. This datasheet is provided for reference only.

11. The data collected using this unit may not be considered as a guarantee of components characteristics. Components must be tested thoroughly depending on intended application as adjustments may be necessary.

12. This unit cannot be commercialized or sold by incorporating it into another product or equipment.

13. CoolCAD Electronics reserves the right to make any or all changes to the converter's documentation, reference manuals, designs and specifications at any time without notice.

14. Diagrams and photos may differ from the actual unit you have.

15. Please contact the distributor you purchased from for any inquiries.

CAUTION: These devices and circuits are ESD sensitive. Use proper handling procedures.