

# **2240001 Power Supply Quick Start Guide**

## 2G Engineering



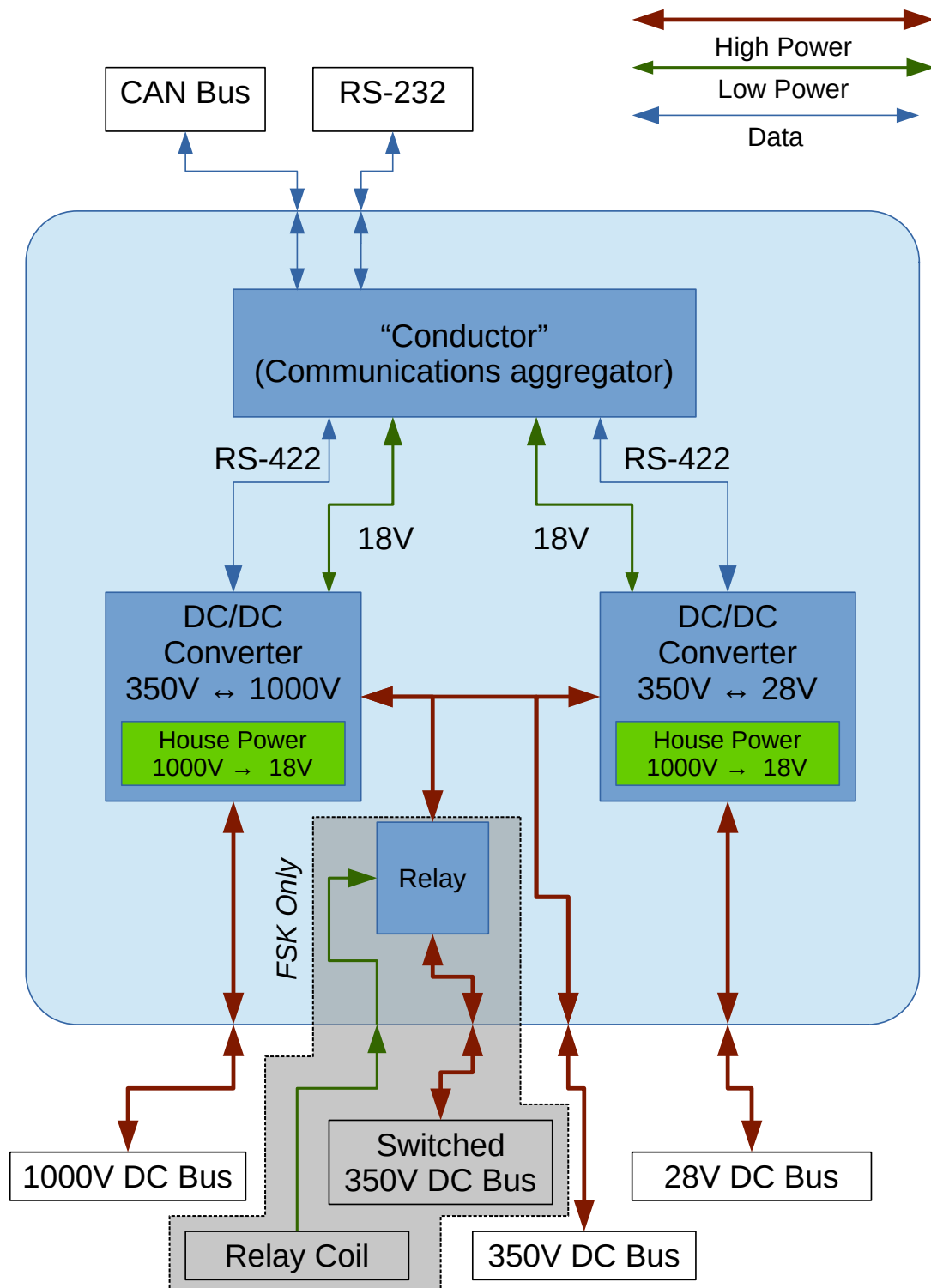
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**REVISION HISTORY**

REV	DATE	Editor	DESCRIPTION
-	1-16-2024	JL	Initial Release

## Block Diagram



## Theory of Operation

The power supply system is designed to facilitate bidirectional transfer of DC power along a tether by converting two 350V nominal busses to a 1000V nominal tether bus. Two power supply boxes are provided per system, one for each end of the tether. The boxes are configured as either EHM (base station) or FSK (remote). Each box is made up of two bidirectional DC/DC converter modules, one in a 350 to 1000V configuration, and one in a 350 to 28V configuration. Communications between these modules and the outside world is facilitated using a communications aggregator board called the conductor.

The 1000V module in the EHM is configured to regulate the tether at a constant ~850V DC. This allows for approximately 150V of drop across the tether when the FSK module is sourcing power. It will automatically move energy either from the 1000V bus to the 350V bus or from the 350V bus to the 1000V bus, as necessary, to maintain tether bus regulation. This implies that the 350V bus, in turn, needs to be able to both source and sink power.

The 1000V module in the FSK is configured to regulate its 350V bus at a constant 350V. It will automatically move energy either from the 1000V bus to the 350V bus or from the 350V bus to the 1000V bus, as necessary, to maintain local 350V bus regulation. This allows for use with a 4-quadrant source/load such as a motor-generator. From the perspective of the FSK, the 1000V bus is more or less unregulated; It is allowed to rise as high as the fault shutdown limit of the module (typically 1075V), or fall as low as the undervoltage lockout limit (typically 775V). Under normal operating conditions, it should be constrained by the EHM bus regulation and the resistance of the tether.

The 28V modules in both the EHM and FSK are configured as unidirectional DC/DC converters with constant current/constant voltage (CC/CV) control. This makes them suitable for use as battery chargers for lithium-ion batteries.

The conductor is used to bridge communications between the two DC/DC converter modules and the outside world. It combines communications from multiple devices into a single Modbus endpoint and provides protocol bridging for CANopen access.

## Hardware Setup

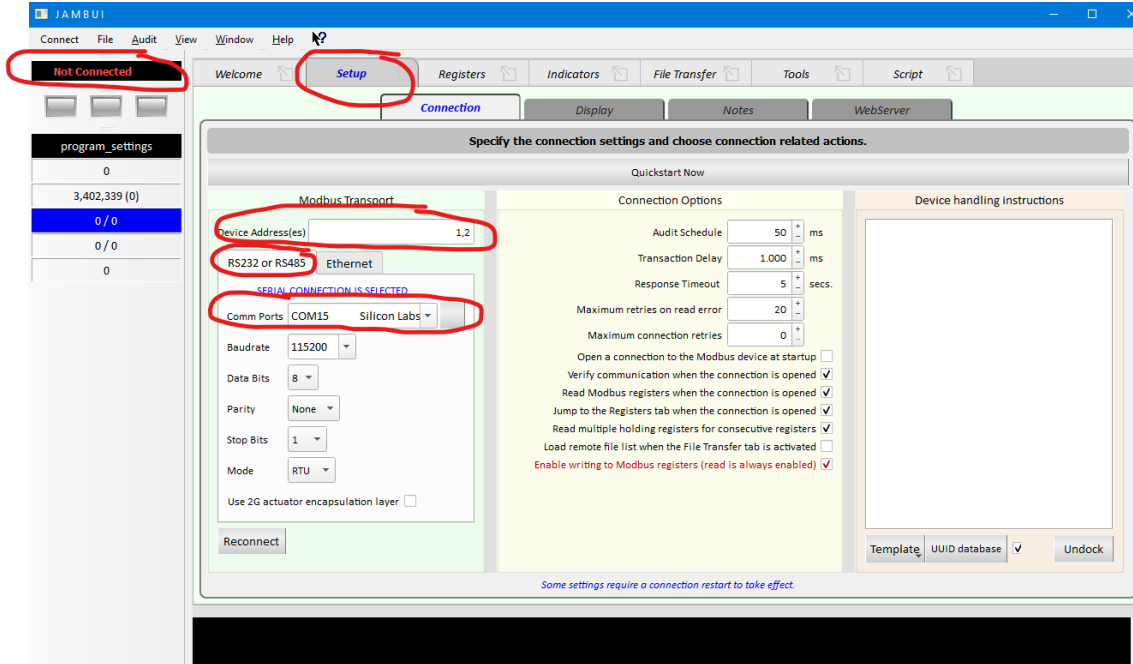
1. Connect RS-232 and/or CAN data lines from the appropriate connector on the power supply to an RS-232 port or PCAN-USB adapter.
2. Connect DC power to the 350V DC pins (EHM variant) or the 1000V DC pins (FSK variant).
3. Assuming there are no faults in the system, the ~1000V bus (EHM variant) or 350V bus (FSK variant) will be energized 15 seconds after the DC input is applied. The 28V bus will be energized 25 seconds after the DC input is applied.
4. 15 seconds after power is applied, the power supply should be ready to accept a connection from JAMBUI or another Modbus or CANOpen client.

## Connecting

### Using RS-232

- Open the JAMBUI application.
- Switch to the Setup tab.
- Make sure “RS232 or RS485” is selected as the communications type.
- Select the RS-232 COM port from the “Comm Ports” dropdown menu in JAMBUI.

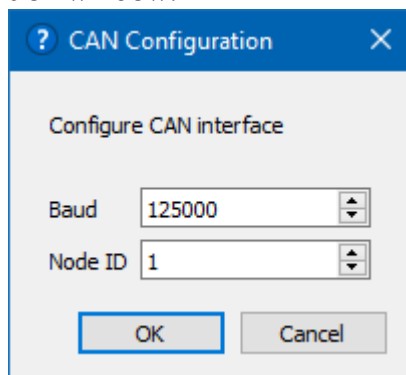
- Enter the Modbus address that you wish to connect to. The power supplies default to Modbus address 1.



- Follow the instructions in the “Using JAMBUI” section to open the connection and begin communication with the power supply.

## Using CAN

- Make sure the unit is connected to the PCAN-USB adapter, and the PCAN-USB adapter is connected to your computer.
- Open the CANOpen-Modbus bridge application. You will see the following CAN Configuration window:



The default settings in this window correspond with the unit’s factory default settings. You should only need to modify this configuration if you have changed the unit’s CAN settings.

- The console window will report progress as it downloads the register map from the device. This will take about 30 seconds. Once connected, you can save a copy of the register map using JAMBUI to speed up future connections.



```
C:\Windows\System32\cmd.exe - python app_canopen_bridge.py
Got 175 map lines
Got 176 map lines
Got 177 map lines
Got 178 map lines
Got 179 map lines
Got 180 map lines
Got 181 map lines
Got 182 map lines
Got 183 map lines
Got 184 map lines
Got 185 map lines
Got 186 map lines
Got 187 map lines
Got 188 map lines
Got 189 map lines
Got 190 map lines
Got 191 map lines
Got 192 map lines
Got 193 map lines
Got 194 map lines
Got 195 map lines
Got 196 map lines
loaded 166 items from register map
Updated CANOpen Node Object Dictionary
```

- Once the map has been loaded, the following app configuration window will be displayed:

The image shows a configuration window titled "app\_canopen\_bridge.py". It contains four input fields: "Host" with the value "127.0.0.1", "Port" with the value "502", "SlaveID" with the value "1", and "MapRev" with the value "0". Each field has a small up/down arrow icon to its right. At the bottom of the window are two buttons: "OK" and "Cancel".

You should be able to click OK here without making any changes.

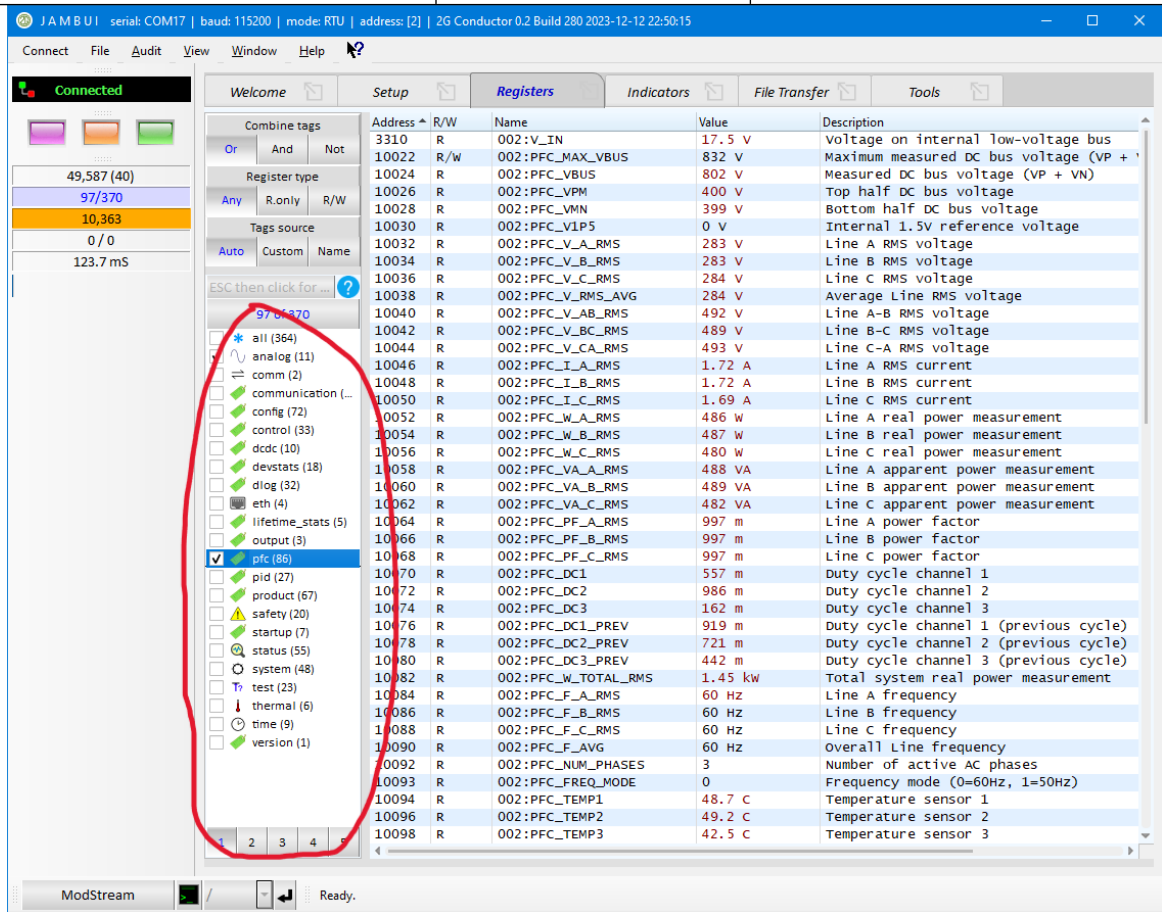
- Open the JAMBUI application.
- Switch to the Setup tab.
- Make sure "Ethernet" is selected as the communications type.
- Enter 127.0.0.1 for the IP address, and 502 for the port.
- Follow the instructions in the "Using JAMBUI" section to open the connection and begin communication with the power supply.



## Using JAMBUI

- Once the connection settings have been entered, click the “Not Connected” button to open the connection. If everything is connected and configured correctly, JAMBUI will begin communication with the selected device(s) and start downloading the register map(s). A bar at the bottom of the window will indicate the progress of this operation.
- Once the connection has completed and all the registers have been downloaded, JAMBUI will automatically switch to the Registers tab.
- The registers tab shows a list of all registers on the connected devices. By default, registers are sorted by their register number.
  - Registers on the power supply are subdivided by subsystem. All registers associated with the 1000V-350V power supply stage will be prefixed with either “EHMPUSU1KV” or “FSKPSU1KV”, and all registers associated with the 350V-28V power supply stage will be prefixed with either “EHMPUSU28V” or “FSKPSU28V”. Registers from the power supply without one of these prefixes are related to the power supply conductor subsystem and are generally irrelevant for customer use.
  - Each register has one or more category tags associated with it. Registers can be filtered based on these category tags by selecting them from the list on the left half of the window. Category tags that may be of interest for customer use include:
    - analog – for feedback on the operation of the DC/DC subsystem, such as voltages and current.
    - dc/dc – for controlling the operation of the power supply outputs and feedback on system state.
    - config – for configuration of power supply operating parameters.
  - In addition to reducing the amount of visual clutter on the screen, selecting fewer registers will also increase the update rate, giving you a better view of what the system is doing.
  - If you would like to show individual registers, rather than an entire category, you can do this by pressing the F4 key and selecting the “Persist” checkbox for the register(s) of interest, then pressing F4 again.





J A M B U I serial: COM17 | baud: 115200 | mode: RTU | address: [2] | 2G Conductor 0.2 Build 280 2023-12-12 22:50:15

Connect File Audit View Window Help

Welcome Setup **Registers** Indicators File Transfer Tools

Combine tags: Or And Not  
 Register type: Any R-only R/W  
 Tags source: Auto Custom Name  
 ESC then click for ...

49,587 (40)  
 97/370  
 10,363  
 0 / 0  
 123.7 mS

all (364)  
 analog (11)  
 comm (2)  
 communication (...)  
 config (72)  
 control (33)  
 dcdc (10)  
 devstats (18)  
 dlog (32)  
 eth (4)  
 lifetime\_stats (5)  
 output (3)  
**pfc (86)**  
 pid (27)  
 product (67)  
 safety (20)  
 startup (7)  
 status (55)  
 system (48)  
 test (23)  
 thermal (6)  
 time (9)  
 version (1)

Address	R/W	Name	Value	Description
3310	R	002:V_IN	17.5 V	voltage on internal low-voltage bus
10022	R/W	002:PFC_MAX_VBUS	832 V	Maximum measured DC bus voltage (VP + VN)
10024	R	002:PFC_VBUS	802 V	Measured DC bus voltage (VP + VN)
10026	R	002:PFC_VPM	400 V	Top half DC bus voltage
10028	R	002:PFC_VMN	399 V	Bottom half DC bus voltage
10030	R	002:PFC_VIP5	0 V	Internal 1.5V reference voltage
10032	R	002:PFC_V_A_RMS	283 V	Line A RMS voltage
10034	R	002:PFC_V_B_RMS	283 V	Line B RMS voltage
10036	R	002:PFC_V_C_RMS	284 V	Line C RMS voltage
10038	R	002:PFC_V_RMS_AVG	284 V	Average Line RMS voltage
10040	R	002:PFC_V_AB_RMS	492 V	Line A-B RMS voltage
10042	R	002:PFC_V_BC_RMS	489 V	Line B-C RMS voltage
10044	R	002:PFC_V_CA_RMS	493 V	Line C-A RMS voltage
10046	R	002:PFC_I_A_RMS	1.72 A	Line A RMS current
10048	R	002:PFC_I_B_RMS	1.72 A	Line B RMS current
10050	R	002:PFC_I_C_RMS	1.69 A	Line C RMS current
10052	R	002:PFC_W_A_RMS	486 W	Line A real power measurement
10054	R	002:PFC_W_B_RMS	487 W	Line B real power measurement
10056	R	002:PFC_W_C_RMS	480 W	Line C real power measurement
10058	R	002:PFC_WA_A_RMS	488 VA	Line A apparent power measurement
10060	R	002:PFC_WA_B_RMS	489 VA	Line B apparent power measurement
10062	R	002:PFC_WA_C_RMS	482 VA	Line C apparent power measurement
10064	R	002:PFC_PF_A_RMS	997 m	Line A power factor
10066	R	002:PFC_PF_B_RMS	997 m	Line B power factor
10068	R	002:PFC_PF_C_RMS	997 m	Line C power factor
10070	R	002:PFC_DC1	557 m	duty cycle channel 1
10072	R	002:PFC_DC2	986 m	duty cycle channel 2
10074	R	002:PFC_DC3	162 m	duty cycle channel 3
10076	R	002:PFC_DC1_PREV	919 m	duty cycle channel 1 (previous cycle)
10078	R	002:PFC_DC2_PREV	721 m	duty cycle channel 2 (previous cycle)
10080	R	002:PFC_DC3_PREV	442 m	duty cycle channel 3 (previous cycle)
10082	R	002:PFC_W_TOTAL_RMS	1.45 kW	Total system real power measurement
10084	R	002:PFC_F_A_RMS	60 Hz	Line A frequency
10086	R	002:PFC_F_B_RMS	60 Hz	Line B frequency
10088	R	002:PFC_F_C_RMS	60 Hz	Line C frequency
10090	R	002:PFC_F_AVG	60 Hz	Overall Line frequency
10092	R	002:PFC_NUM_PHASES	3	Number of active AC phases
10093	R	002:PFC_FREQ_MODE	0	Frequency mode (0=60Hz, 1=50Hz)
10094	R	002:PFC_TEMP1	48.7 C	Temperature sensor 1
10096	R	002:PFC_TEMP2	49.2 C	Temperature sensor 2
10098	R	002:PFC_TEMP3	42.5 C	Temperature sensor 3

ModStream Ready.

## Power Supply Control & Configuration

Please see the separate document “2240003 DC-DC Converter Module User Manual” for documentation of the control and configuration registers for the individual DC/DC modules.