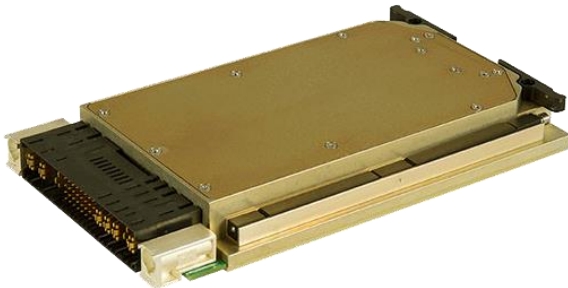


## **M4013 SERIES**

*DC/DC POWER SUPPLY*



### **PRODUCT HIGHLIGHTS**

- **VITA 62 COMPLIANT**
- **3U VPX FORM FACTOR**
- **SIX OUTPUTS**
- **DC/DC CONVERTER**
- **350W**
- **Input Options:**
  - **MIL-STD-704**
- **Cyber secure**

## M4013 SERIES VPX DC/DC POWER SUPPLY

### Applications

Military, Ruggedized, Telecom, Industrial

#### Special Features

- VITA 62 compliant
- Wide input range
- Remote sense
- Fixed switching frequency (220kHz)
- External synchronization capability
- Indefinite short circuit Protection
- Over-voltage shutdown with auto-recovery
- Reverse battery protection
- Over temperature shutdown with auto-recovery
- EMI filters included
- I2C communication

#### Environmental

Design to Meet MIL-STD-810G

#### Temperature

Operating: -55°C to +85°C at unit edge

Storage: -55°C to +125°C

#### Altitude

Method 500.5, Procedure I & II Storage/Air

Transport: 40 Kft

Operation/Air carriage: 70 Kft

#### Humidity

Method 507.5, Up to 95% RH

#### Fungus

Does not support fungus growth, in accordance with the guidelines of MIL-STD-454, Requirement 4.

#### Shock

Method 516.6

40g, 11msec saw-tooth (all directions)

#### Vibration

Vibration: Figure 514.6E-1. General minimum integrity exposure. (1 hour per axis.)

#### Salt Fog:

Method 509.5

**Reliability: 510,000 Hours, calculated IAW MIL-HDBK-217F Notice 2 at +65 °C, GF.**

*Note: Environmental Stress Screening (ESS) Including random vibration and thermal cycles is also available. Please consult factory for details.*

#### Electrical Specifications

##### DC Input

18 to 48 V<sub>DC</sub>

Max Non-Operating 100V

Options:

- 1) MIL-STD-704 (A-F) Normal and Abnormal Steady State
- 2) MIL-STD-704(A-F) transients Up to 50V, 80V.

##### Efficiency

Up to 86%

(Full load room temperature)

##### EMC

Design to meet with MIL-STD 461F (5μH LISN):

CE101, CE102, CS101, CS114, CS115, CS116

##### Load Transient Overshoot and

##### Undershoot

Output dynamic response of less than 5% at load Step of 60%-90%.

Output returns to regulation in less than 1mSec

##### Ripple and Noise

Typically, less than 50mV<sub>p-p</sub> (max.1%p). Measured across a 0.1μF capacitor and 10μF capacitor on load at Input Voltage of 18V-36V, all Temperature Range.

##### Communication

I2C protocol available for voltages, currents and temperature for all outputs (GAx, SCL, SDA)

##### DC Output

VS1: 12V, up to 20A

VS2: 3.3V, up to 5A

VS3: 5V, up to 12A

12V\_Aux: 12V, up to 1A

-12V\_Aux: -12V, up to 1A

3.3V\_Aux: 3.3V, up to 5A

## Protections

### Input

- **Inrush Current Limiter**  
Peak value of  $5 \times I_{IN}$  for initial inrush currents lasting more than  $50\mu\text{Sec}$ .
- **Under Voltage**  
Unit shuts down when input steady state voltage drops  
Automatic restart when input voltage returns to nominal range.
- **Over Voltage Lock-Out**  
Unit shuts down when input steady state voltage rise above  $55 \pm 2V_{DC}$ .  
Automatic restart when input voltage returns to nominal range.

### Output

- **Passive or Active over voltage protection on VS2, VS3, 3.3Vaux and -12Vaux**  
Transorb, selected at  $25\% \pm 5\%$  above nominal voltage, is placed across the output for passive voltage limit.
- **Active over voltage protection on VS1 and 12Vaux**  
 $20\% \pm 5\%$  above nominal voltage.  
Automatic recovery when output voltage drops below threshold.
- **Overload / Short-Circuit Protection**  
VS#: Continuous protection ( $10\text{-}30\%$  above maximum current) for unlimited time (Hiccup). Automatic recovery when overload/short circuit removed.  
12Vaux: typical 1.5A to 2A  
-12Vaux: typical 2.5A to 3A  
3.3Vaux: typical 8A

### General

- **Over Temperature Protection**  
Automatic shutdown at internal temperature of  $95 \pm 5^\circ\text{C}$ .  
Automatic recovery when temperature drops below  $90 \pm 5^\circ\text{C}$ .

*Note: Thresholds and protections can be modified / removed (please consult factory)*

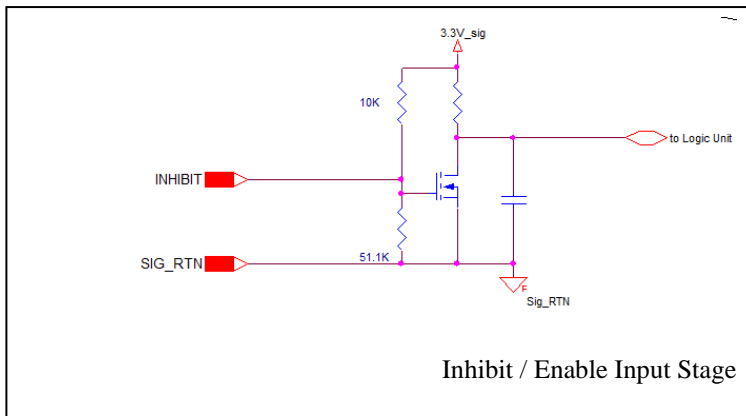
**Functions and Signals - According to VITA 62**

| Signal No. | Signal Name | Type          | Description   |
|------------|-------------|---------------|---|
| 1          | FAIL*       | Output        | Indicates to other modules in the system that a failure has occurred in one of the outputs. Please refer to Figure 2<br>This signal is referenced to <b>SIGNAL RTN</b> .                        |
| 2          | SYSRESET*   | Output        | Indicates to other modules in the system that all outputs are within their working level. Please refer to Figure 2<br>This signal is referenced to <b>SIGNAL RTN</b> .                          |
| 3          | INHIBIT*    | Input         | Controls power supply outputs.<br>This signal in conjunction with <b>INHIBIT</b> controls the outputs. Please refer to Table 1 and Figure 1<br>This signal is referenced to <b>SIGNAL RTN</b> . |
| 4          | ENABLE*     | Input         | Controls power supply outputs.<br>This signal in conjunction with <b>INHIBIT</b> controls the outputs. Please refer to Table 1 and Figure 1<br>This signal is referenced to <b>SIGNAL RTN</b> . |
| 5          | GA0*, GA1   | Input         | Used for geographical addressing.<br>GA1 is the most significant bit and GA0 is the least significant bit.  |
| 6          | SCL, SDA    | Bidirectional | I2C bus Clock and Data respectively.<br>Through this bus the voltage and temperature readouts can be shared.  |
| 7          | REF_CLK     | Input         | The Sync signal is used to allow the power supply frequency to sync with the system frequency. (Optional)   |
| 8          | VOUT SENSE  | Input         | The SENSE is used to achieve accurate load regulations at load terminals (this is done by connecting the pins directly to the load's terminals).  |

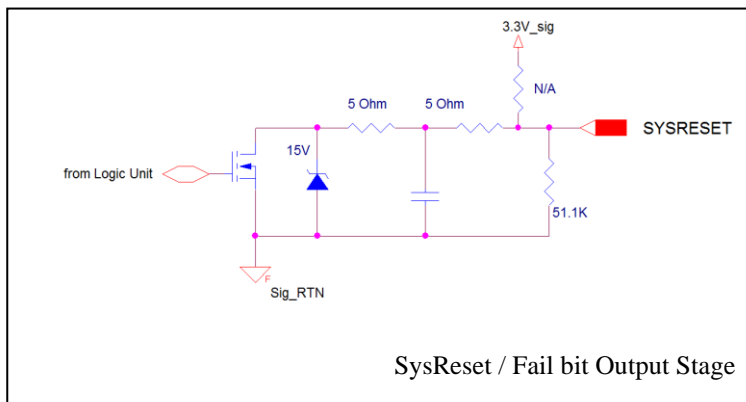
**Table 1 – Inhibit and Enable Functionality**

|                              |            |             |             |             |
|------------------------------|------------|-------------|-------------|-------------|
| <b>INHIBIT*</b>              | <b>Low</b> | <b>Low</b>  | <b>High</b> | <b>High</b> |
| <b>ENABLE*</b>               | <b>Low</b> | <b>High</b> | <b>Low</b>  | <b>High</b> |
| <b>VS1, VS2, VS3,±12VAux</b> | OFF        | OFF         | ON          | OFF         |
| <b>3.3V_AUX</b>              | ON         | OFF         | ON          | OFF         |

**Figure 1 – Inhibit and Enable Input stage**



**Figure 2 – SysReset and Fail Bit output stage**



# M4013 SERIES VPX DC/DC POWER SUPPLY

## Detailed Information

### 1. M4013 Input Voltage Operation.

The M4013 steady state operation voltage is 18V to 48V and will continuously work up to 50V Input line. When Configurable to support MIL-STD 704/1275 transients or surges, the unit will shut down when input voltage rises above 60V or under 16V for more than 2 sec and immediate shut down under 12V or above 100V Input. Power supply automatically recover when it's Input goes back to normal steady state line.

### 2. Outputs Voltage Regulation

The M4013 contains accurate internal sense lines to keep output voltage at less than 4% regulation for all Line/ Load and temperature range (see Table 2).

| Output        | 12V/15A       | 5V/12A    | 3.3V/5A     | 3.3VAux/5A | 12VAux/1A      | (-)12VAux/1A       |
|---------------|---------------|-----------|-------------|------------|----------------|--------------------|
| Voltage Range | 11.85 - 12.15 | 4.9 - 5.1 | 3.28 - 3.42 | 3.2 - 3.4  | VS1 - VS1-0.2V | (-)11.8 - (-)12.15 |

Table 2: Outputs voltage regulation. VIN 18V – 48V, Temperature -55°C – 85°C

#### 2.1. Sense Lines

*Sense Lines* are provided for VS1, VS2 and VS3 output to compensate line voltage drop. *Sense Lines* proper connection is shown in Figure 3.

Each VSx output has its own *Sense Lines*, additional common *Sense RTN Line* is provided for all VSx Outputs (VITA 62 Standard). Contact Factory for Sense configuration different than the VITA 62 standard

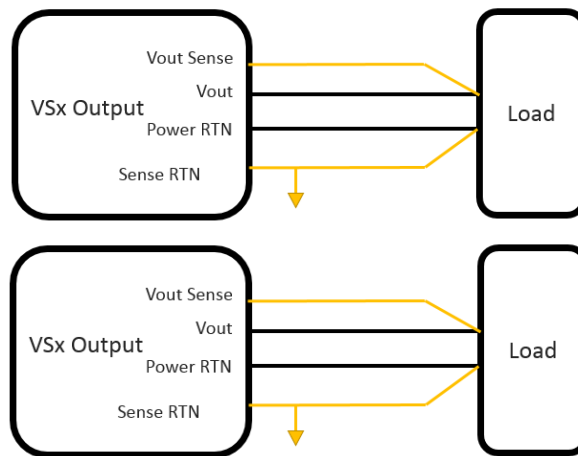


Figure 3: M4013 Sense line connection

### 3 Output Power

The M4013 can deliver up to 350W steady State at all temperature and input range.

| Total Power Output | 12V/20A | 5V/12A | 3.3V/5A | 3.3VAux/5A | 12VAux/1A | (-)12VAux/1A |
|--------------------|---------|--------|---------|------------|-----------|--------------|
|                    |         |        |         |            |           |              |

## M4013 SERIES VPX DC/DC POWER SUPPLY

### 4 Advanced I2C Protocol

#### Electrical Parameters

Vcc: 3.3Vdc  
 Pull-up: 10kOhm  
 Input Capacitance 330pF

#### Slave Device Addressing

- 256 address spaces
- Baud rate: 200kHz maximum
- 7 Bit Protocol
- Support Slot Addressing per VITA 62

| Slot Number | MSB |         |          |         |         |         |         | LSB |
|-------------|-----|---------|----------|---------|---------|---------|---------|-----|
|             | A6  | A5/*GAP | A4/*GA41 | A3/*GA3 | A2/*GA2 | A1/*GA1 | A0/*GA0 | R/W |
| Slot0       | 1   | 0       | 0        | 0       | 0       | 0       | 0       |     |
| Slot1       | 1   | 0       | 0        | 0       | 0       | 0       | 0       | 1   |
| Slot2       | 1   | 0       | 0        | 0       | 0       | 1       | 0       |     |
| Slot3       | 1   | 0       | 0        | 0       | 0       | 1       | 1       |     |

\* Slot location is determined by GAx per VITA 62.

#### Communication Supported

Read Command – 21Hex, deliver 64Bytes of Data. (More commands are available by request)  
 The communication starts when the master sends a start followed by the unit slave address, command, checksum and a stop. A second start followed by the slave address and a read will be followed by a 64 Bytes response.

| S | Slave Address | R/W | A | Command | A | Check sum | A | P |
|---|---------------|-----|---|---------|---|-----------|---|---|
|   | A6:A0         | 0   | 0 | 21 Hex  | 0 | DF Hex    | 0 |   |

| S | Slave Address | R/W | A | DATA  | A | DATA  | A | DATA  | A | ... | DATA  | A | Check sum | N/A | P |
|---|---------------|-----|---|-------|---|-------|---|-------|---|-----|-------|---|-----------|-----|---|
|   | A6:A0         | 1   | 0 | D7:D0 | 0 | D7:D0 | 0 | D7:D0 | 0 |     | D7:D0 | 0 | D7:D0     | 1   |   |

Command – 21Hex read all 64 Bytes  
 S - Start  
 P - Stop

| Master Transmit | Unit Transmit |
|-----------------|---------------|
|                 |               |

## M4013 SERIES VPX DC/DC POWER SUPPLY

### Memory Space

| Response Byte # | Data Type                | Meaning                 | Interpretation  | Reading Range |
|-----------------|--------------------------|-------------------------|---|---------------|
|                 | Integer, MSB First       | cho of Command          |   | 1 Hex         |
|                 | Integer, MSB First       | /A                      |   | 0 Hex         |
|                 | Integer, MSB First       | emperature              | (C°)=+/- 7bit Dec   | 5 to 125 °C   |
|                 | Integer, MSB First       | eserved                 | 0Hex  |               |
| 5               | Integer, MSB First       | O1 12V Voltage          | (out) = Data/ m2  | 0.48V         |
| 7               | Integer, MSB First       | O2 12V Voltage          | (out) = Data/ m2  | 0.48V         |
| 9               | Integer, MSB First       | O3 12V Voltage          | (out) = Data/ m2  | 0.48V         |
| 10-11           | Integer, MSB First       | 3.3V Aux Voltage        | (out) = Data/ m2  | 0.48V         |
| 12-13           | Integer, MSB First       | 2VAux Voltage           | (out) = Data/ m2  | ptional       |
| 14-15           | Integer, MSB First       | )12V Aux Voltage        | (out) = Data/ m2  | ptional       |
| 16-17           | Integer, MSB First       | 2V Total Current        | (out) = Data/ m3  | 0A            |
| 18-19           | Integer, MSB First       | 2V Total Current - Copy | (out) = Data/ m3  | 0A            |
| 20-21           | Integer, MSB First       | 2V Total Current - Copy | (out) = Data/ m3  | 0A            |
| 22-23           | Integer, MSB First       | .3VAux Current          | (out) = Data/ m5  | 0A            |
| 24-35           | Integer, MSB First       | 2V Aux Current          | (out) = Data/ m4  | ptional       |
| 26-27           | Integer, MSB First       | )12V Aux Current        | (out) = Data/ m4  | ptional       |
| 28-29           | Integer, MSB First       | eserved                 | 0Hex  |               |
| 30-31           | Integer, MSB First       | eserved                 | 0Hex  |               |
| 2-51            | Character String (ASCII) | art Number              | 14013-xxx* (Note1)  | 0 Characters  |
| 2-53            | ecimal, MSB First        | erial Number, 2MSB Dig  | ,X Dec (Note2)  | ptional       |
| 4-55            | ecimal, MSB First        | erial Number, 2LSB Dig  | ,X Dec (Note2)  | ptional       |
| 6-57            | ecimal, MSB First        | ate Code                | Week, Year (Note3)  | ptional       |
| 8-59            | Character String (ASCII) | ardware Rev             | 01 & B02 Boards (note4)   | Characters    |
| 0-61            | ecimal, MSB First        | irmware Rev             | ,X,X,X Dec (Note5)  | digits        |
| 2               | Integer, MSB First       | eserved                 |   | A Hex         |
| 3               | Integer, MSB First       | ero Checksum            | alue required to make the sum of bytes 0 to 62 added to a multiple of 256 |               |

**Note:**

$M_2 = 20.48 / 2^{16-1}$

$M_3 = 40 / 2^{16-1}$

$M_4 = 10 / 2^{16-1}$

$M_5 = 20 / 2^{16-1}$

\*Matching unit part number



## M4013 SERIES VPX DC/DC POWER SUPPLY

Notes 1 to 5:

**1. Part Number Example: M4065-4**

| Byte No'  | 32 | 33 | 34 | 35 | 36 | 37  | 38 | 39-51 |
|-----------|----|----|----|----|----|-----|----|-------|
| Character | M  | 4  | 0  | 6  | 5  | (-) | 4  | 0     |
| Hex       | 4D | 34 | 30 | 36 | 35 | 2D  | 34 | 00    |

**2. Serial Number Example: 25**

| Byte No'   | 52     |        | 53     |        | 54     |        | 55     |        |
|------------|--------|--------|--------|--------|--------|--------|--------|--------|
| Dec Number | 0      | 0      | 0      | 0      | 0      | 0      | 2      | 5      |
| Binary     | "0000" | "0000" | "0000" | "0000" | "0000" | "0000" | "0010" | "0101" |

**3. Date Code Example: week 35 of 2018**

| Byte No'   | 56     |        | 57     |        |
|------------|--------|--------|--------|--------|
| Dec Number | 3      | 5      | 1      | 8      |
| Binary     | "0011" | "0101" | "0001" | "1000" |

**4. Hardware Rev Example: B01 Rev (-), B01 Rev A**

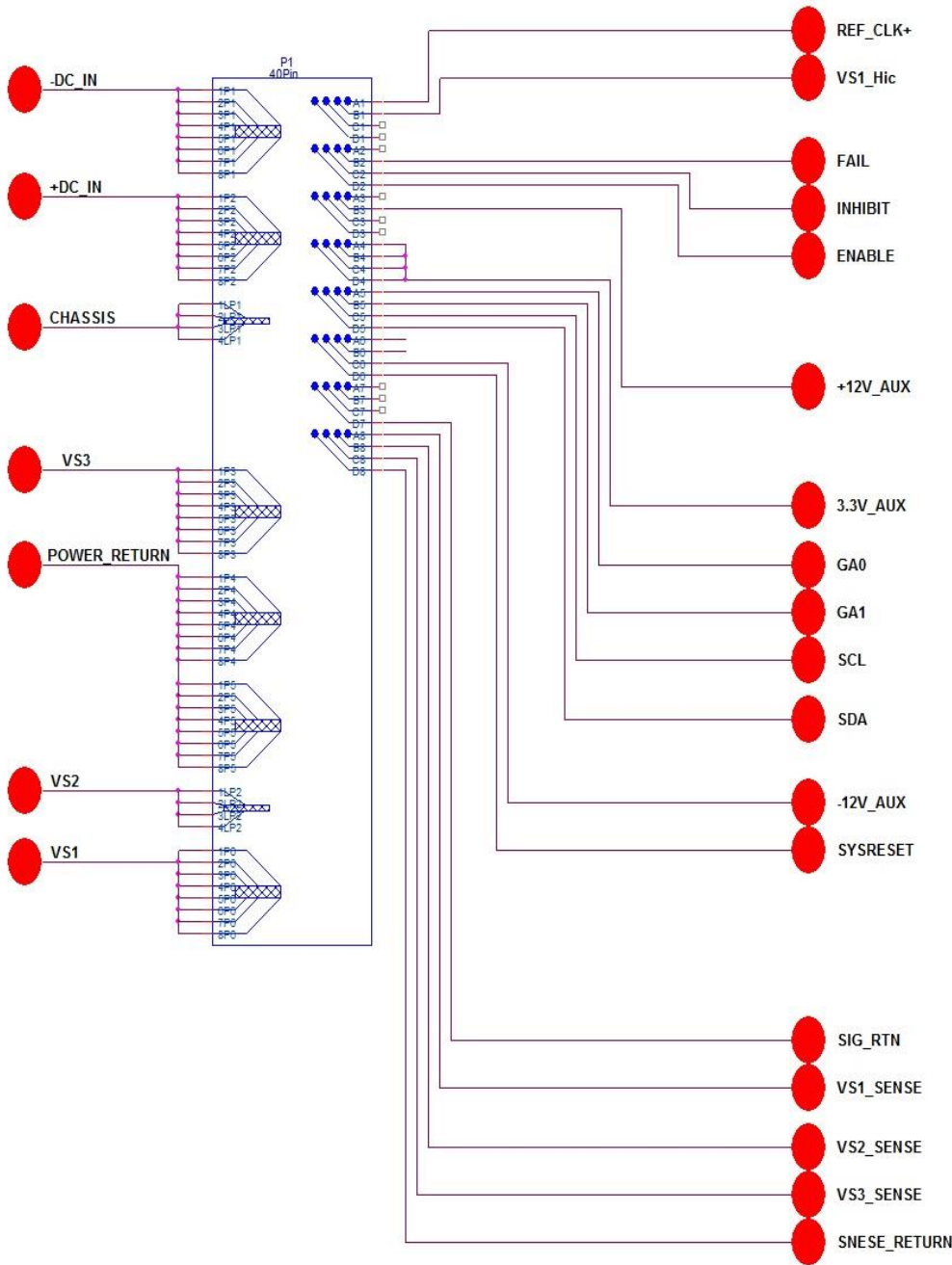
| Byte No'  | 58  |  | 59 |  |
|-----------|-----|--|----|--|
| Character | (-) |  | A  |  |
| Hex       | 2D  |  | 41 |  |

**5. Firmware Rev Example: 2.1.0.0**

| Byte No'   | 60     |        | 61     |        |
|------------|--------|--------|--------|--------|
| Dec Number | 2      | 1      | 0      | 0      |
| Binary     | "0010" | "0001" | "0000" | "0000" |



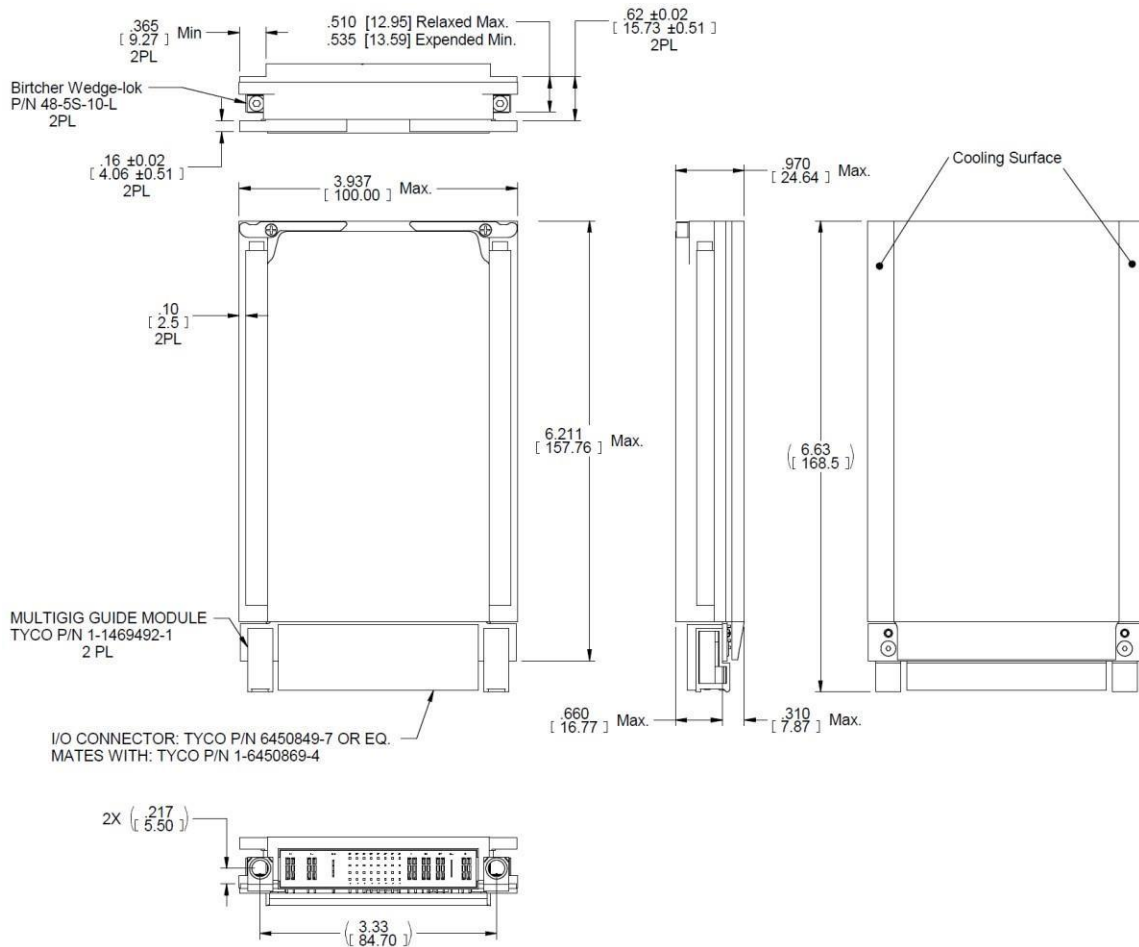
**M4013 SERIES VPX DC/DC POWER SUPPLY**



| Pin Number | Pin Name     |
|------------|--------------|
| P1         | -DC_IN       |
| P2         | +DC_IN       |
| LP1        | CHASSIS      |
| P3         | VS3          |
| P4         | POWER_RETURN |
| P5         | POWER_RETURN |
| LP2        | VS2          |
| P6         | VS1          |
| A8         | VS1_SENSE    |
| B8         | VS2_SENSE    |
| C8         | VS3_SENSE    |
| D8         | SENSE_RETURN |
| A7         | N.C          |
| B7         | N.C          |
| C7         | N.C          |
| D7         | SIG_RTN      |
| A6         | N.C          |
| B6         | N.C          |
| C6         | -12V_AUX     |
| D6         | SYSRESET*    |
| A5         | GA0*         |
| B5         | GA1*         |
| C5         | SCL          |
| D5         | SDA          |
| A4         | +3.3V_AUX    |
| B4         | +3.3V_AUX    |
| C4         | +3.3V_AUX    |
| D4         | +3.3V_AUX    |
| A3         | N.C          |
| B3         | +12V_AUX     |
| C3         | N.C          |
| D3         | N.C          |
| A2         | N.C          |
| B2         | FAIL*        |
| C2         | INHIBIT*     |
| D2         | ENABLE*      |
| A1         | REF_CLK+     |
| B1         | N.C          |
| C1         | N.C          |
| D1         | N.C          |

**M4013 SERIES VPX DC/DC POWER SUPPLY**

**Outline Drawing**



**Notes**

1. Dimensions are in Inches [mm]
2. Tolerance is:  
.XX ± 0.02 IN  
.XXX ± 0.008 IN
3. Weight: Approx. 690 g (24.34) oz
4. 3D model available

**Note: Specifications are subject to change without prior notice by the manufacturer**