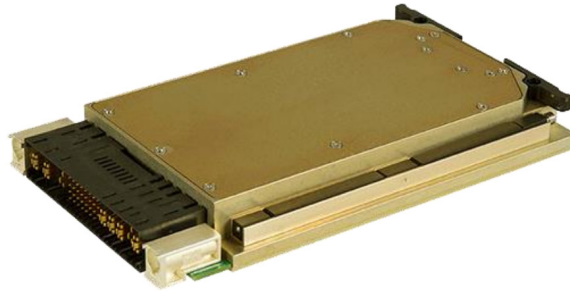


## M4012 SERIES

### DC/DC POWER SUPPLY



#### DESCRIPTION

M4012 is a military grade, 3U VPX, 28V DC-DC PSU card that provides six outputs per VITA 62 that is rated at 350W output power and 9-15 Joules of holdup for MIL-HDBK-704-8, LDC201 requirements. Features include: conduction cooling, reverse battery protection, internal EMI filters. DC input range is 18-50V per MIL-STD-704 and DO-160, but variants support ranges of 12-100V per MIL-STD-1275 and Def Stan 61-5. Designed to meet MIL-STD-810 and MIL-STD-461.

#### FEATURES

- VITA 62 Compliant
- Wide input range
- Remote sense
- Fixed switching frequency (250khz)
- 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

## HOW TO ORDER

PART NUMBER	CF-02EM4012	DC/DC Power Supply
-------------	-------------	--------------------

## PRODUCT SPECIFICATIONS:

<b>DC Input (18 to 48 VDC)</b>
MIL-STD-704 (A-F) Normal and Abnormal Steady State
MIL-STD-704(A-F) transients Up to 50V, 80V.
MIL-STD-704(A-F) Transients Under 18V and Starting transients.
<b>Efficiency</b>
Up to 85 % (Full load room temperature)
<b>EMC</b>
Design to meet with MIL-STD 461F(5μH LISN): CE101, CE102, CS101, CS114, CS115, CS116
<b>Load Transient Overshoot and Undershoot</b>
Output dynamic response of less than 5% at load Step of 60%-90%.
Output returns to regulation in less than 1mSec
<b>Ripple and Noise</b>
Typically, less than 50mVp-p (max. 1%p). Measured across a 0.1μF capacitor and 10μF capacitor on load at Input Voltage of 18V-36V, all Temperature Range.
<b>Communication</b>
I2C protocol available for voltages, currents and temperature for all positive voltages (GAX, SCL, SDA)
<b>DC Output</b>
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

Isolation
Over 20 MΩ at test voltage:
200V between Input and Output
200V between Input and Case
100V between Output and Case

## 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 MILHDBK-217F Notice 2 at +65°C, GF.	

## PRODUCT SPECIFICATIONS:

Input	Output	General
Inrush Current Limiter Peak value of 5 x IIN for initial inrush currents lasting more than 50µSec.	Passive or Active over voltage protection on VS2, VS3, 3.3Vaux and -12Vaux Transorb, selected at 25% ± 5% above nominal voltage, is placed across the output for passive voltage limit.	Over Temperature Protection Automatic shutdown at internal temperature of 95 ± 5°C. Automatic recovery when temperature drops below 90 ± 5°C.
Under Voltage Unit shuts down when input steady state voltage drops below 18V (after holdup delay) Automatic restart when input voltage returns to nominal range.	Active over voltage protection on VS1 and 12Vaux 20% ± 5% above nominal voltage. Automatic recovery when output voltage drops below threshold.	
Over Voltage Lock-Out Unit shuts down when input steady state voltage rise above 55 ± 2VDC. Automatic restart when input voltage returns to nominal range.	Overload / Short-Circuit Protection VS#: Continuous protection (10-30% 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	

## 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 This signal is referenced to SIGNAL RTN.
2	SYSRESET*	Output	Indicates to other modules in the system that all outputs are within their working level. Please refer to Figure 2 This signal is referenced to SIGNAL RTN.
3	INHIBIT*	Input	Controls power supply outputs. This signal in conjunction with INHIBIT controls the outputs. Please refer to Table 1 and Figure 1 This signal is referenced to SIGNAL RTN.
4	ENABLE*	Input	Controls power supply outputs. This signal in conjunction with INHIBIT controls the outputs. Please refer to Table 1 and Figure 1 This signal is referenced to SIGNAL RTN
5	GA0*, GA1	Input	Used for geographical addressing. GA1 is the most significant bit and GA0 is the least significant bit. This signal is referenced to SIGNAL RTN.
6	SCL, SDA	Bidirectional	I2C bus Clock and Data respectively. Through this bus the voltage and temperature readouts can be shared. This signal is referenced to SIGNAL RTN.
7	REF_CLK	Input	The REF_CLK signal is used to allow the power supply frequency to sync with the system frequency. This signal is referenced to SIGNAL RTN
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).
9	Alert Bit	Output	Indicates to other modules in the system about Holdup event. Please refer to This signal is referenced to SIGNAL RTN.

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

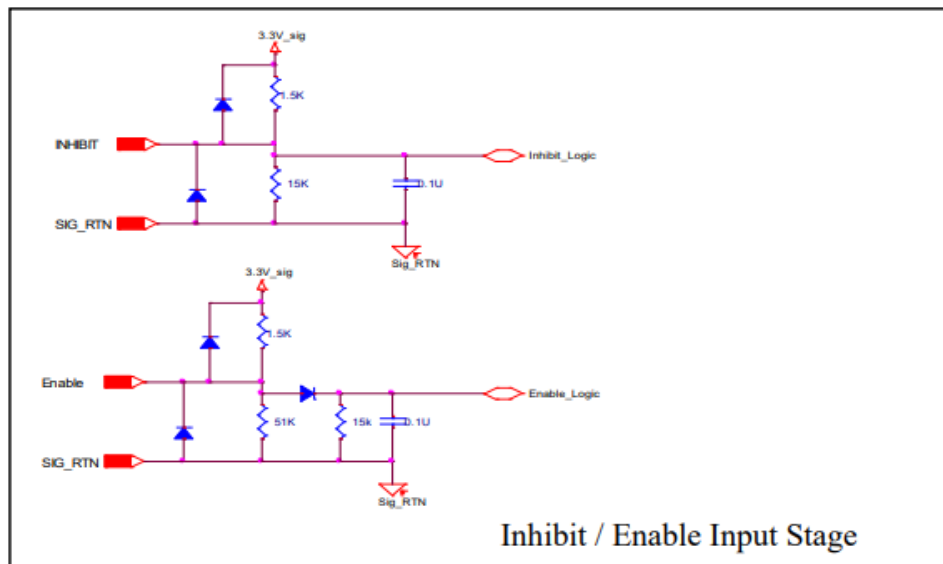
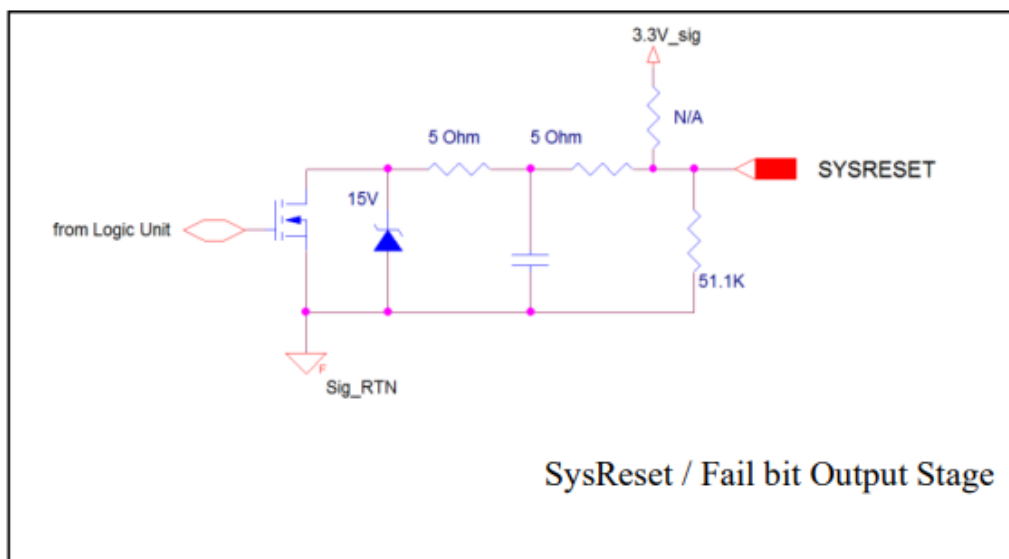


Figure 2 – SysReset and Fail Bit output stage



## DETAILED INFORMATION:

### M4012 Input Voltage Operation.

The M4012 steady state operation voltage is 18V to 48V and will continuously work up to 50V Input line. The unit will shut down when input voltage rises above  $55 \pm 2\text{VDC}$  for more than 2Sec. The unit will shut down when input voltage drops below 18V after holdup delay. Power supply automatically recovers when its Input goes back to normal steady state line.

### Low Line Turn-on and Turn-off Limits

To avoid Turn-on and Turn-off glitch the unit has about 2V Hysteresis. The Turn-on threshold is under 20V and turn- off under 18V. Those limits can be adjusted, contact Factory for more information.

### Outputs Voltage Regulation

The M4012 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/20A	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

### 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

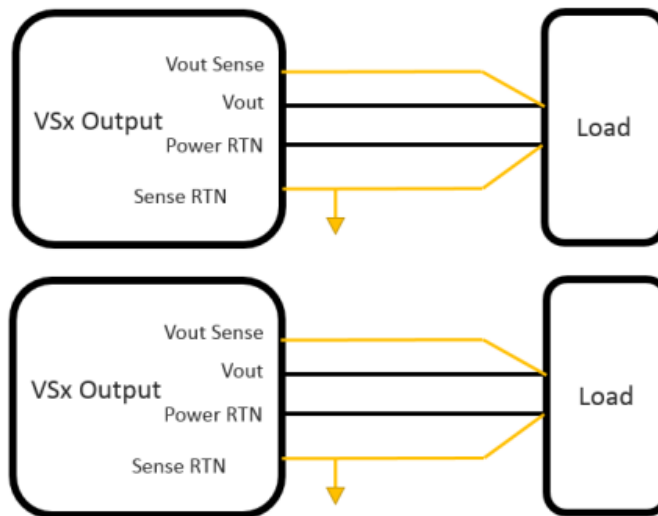


Figure 3: M4012 Sense line connection

## Output Power

The M4012 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
--------------------	---------	--------	---------	------------	-----------	--------------

## Holdup

Unit can support up to 250W@50mSec Holdup per Mil-STD-704

Greater Holdup is optional by using a specialized capacitor or increasing the unit pitch to 1.2". Please contact factory for more details.

## 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 R/W
	A6	A5	A4	A3	A2	A1/*GA1	A0/*GA0	
Slot0	0	1	0	0	0	0	0	
Slot1	0	1	0	0	0	0	1	
Slot2	0	1	0	0	0	1	0	
Slot3	0	1	0	0	0	1	1	

## Communications 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

<b>Master Transmit</b>	<b>Unit Transmit</b>
------------------------	----------------------

## MEMORY SPACE:

Response # Byte	Data Type	Meaning	Interpretation	Reading Range / Factor
0	U Integer, MSB First	Echo of Command		0x21
1	S Integer, MSB First	Reserved		
2	S Integer, MSB First	Temperature (-)55C to 120C	T(C°)=+/- 7bit Dec	-55°C to 125°C
3	S Integer, MSB First	Reserved		
4-5	U Integer, MSB First	12V VS1 Voltage	V(out) = Data · m2	M2 = 16.38/(2 <sup>16</sup> -1)
6-7	U Integer, MSB First	3.3V VS2 Voltage	V(out) = Data · m2	M2 = 16.38/(2 <sup>16</sup> -1)
8-9	U Integer, MSB First	5V VS3 Voltage	V(out) = Data · m2	M2 = 16.38/(2 <sup>16</sup> -1)
10-11	U Integer, MSB First	3.3V Aux Voltage	V(out) = Data · m2	M2 = 16.38/(2 <sup>16</sup> -1)
12-13	U Integer, MSB First	12V Aux Voltage	V(out) = Data · m2	M2 = 16.38/(2 <sup>16</sup> -1)
14-15	U Integer, MSB First	-12V Aux Voltage	V(out) = Data · m2	M2 = 16.38/(2 <sup>16</sup> -1)
16-17	U Integer, MSB First	12V VS1 Current	I(out) = Data · m3	M3 = 37.03/(2 <sup>16</sup> -1)
18-19	U Integer, MSB First	3.3V VS2 Current	I(out) = Data · m3	M3 = 37.03/(2 <sup>16</sup> -1)
20-21	U Integer, MSB First	5V VS3 Current	I(out) = Data · m3	M3 = 37.03/(2 <sup>16</sup> -1)
22-23	U Integer, MSB First	3.3V Aux Current	I(out) = Data · m3	M3 = 37.03/(2 <sup>16</sup> -1)
24-25	U Integer, MSB First	12V Aux Voltage Current	I(out) = Data · m3	M3 = 37.03/(2 <sup>16</sup> -1)
26-27	U Integer, MSB First	-12V Aux Voltage  Current	I(out) = Data · m4	M4 = 4/(2 <sup>16</sup> -1)
28-29	U Integer, MSB First	Input Voltage	V(out) = Data · m5	M5 = 131/(2 <sup>16</sup> -1)
30-31	U Integer, MSB First	Holdup Voltage	V(out) = Data · m5	M5 = 131/(2 <sup>16</sup> -1)
32-40	Character String (ASCII)	Part Number	M4012-XXX*	Characters 9
41-51	Decimal, MSB First	Reserved		
52-53	Decimal, MSB First	Serial Number, 2MSB Dig		(optional, default N/A)
54-55	Decimal, MSB First	Serial Number, 2LSB Dig		(optional, default N/A)
56-57	Decimal, MSB First	Date Code		(optional, default N/A)
58	Character String (ASCII)	Unit Rev		(optional, default N/A)
59	U Integer, MSB First	Reserved		
60	Decimal, MSB First	Firmware Rev	X.Y "4MSB,4LSB"	(optional, default N/A)
61	U Integer, MSB First	Reserved		
62	U Integer, MSB First	Reserved		
63	U Integer, MSB First	Zero Checksum		Value required to make the sum of bytes 0 to 62 added to a multiple of 256

## REF\_CLK and Switching Frequency

The unit free running switching frequency is 220KHz±5%

Unit can be synchronized to External clock signal with frequency range of 200KHz to 300KHz

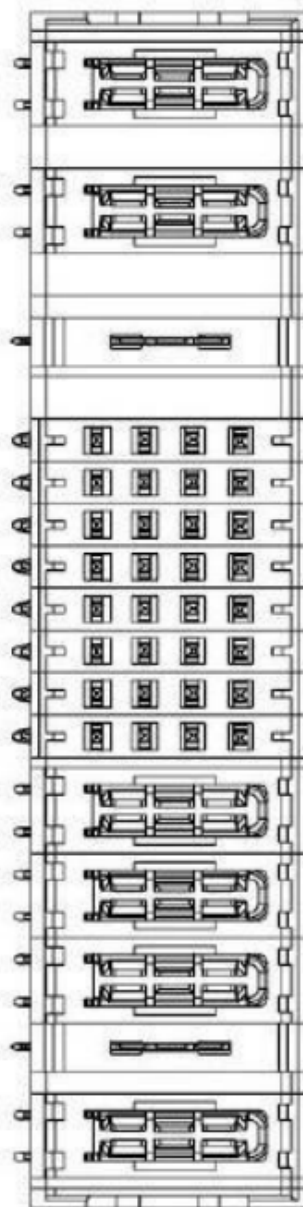
External clock should be 3.3V CMOS standard logic level with duty cycle between 20% to 80%.

The Internal clock will sync after 32, within tolerance, external clock cycles.

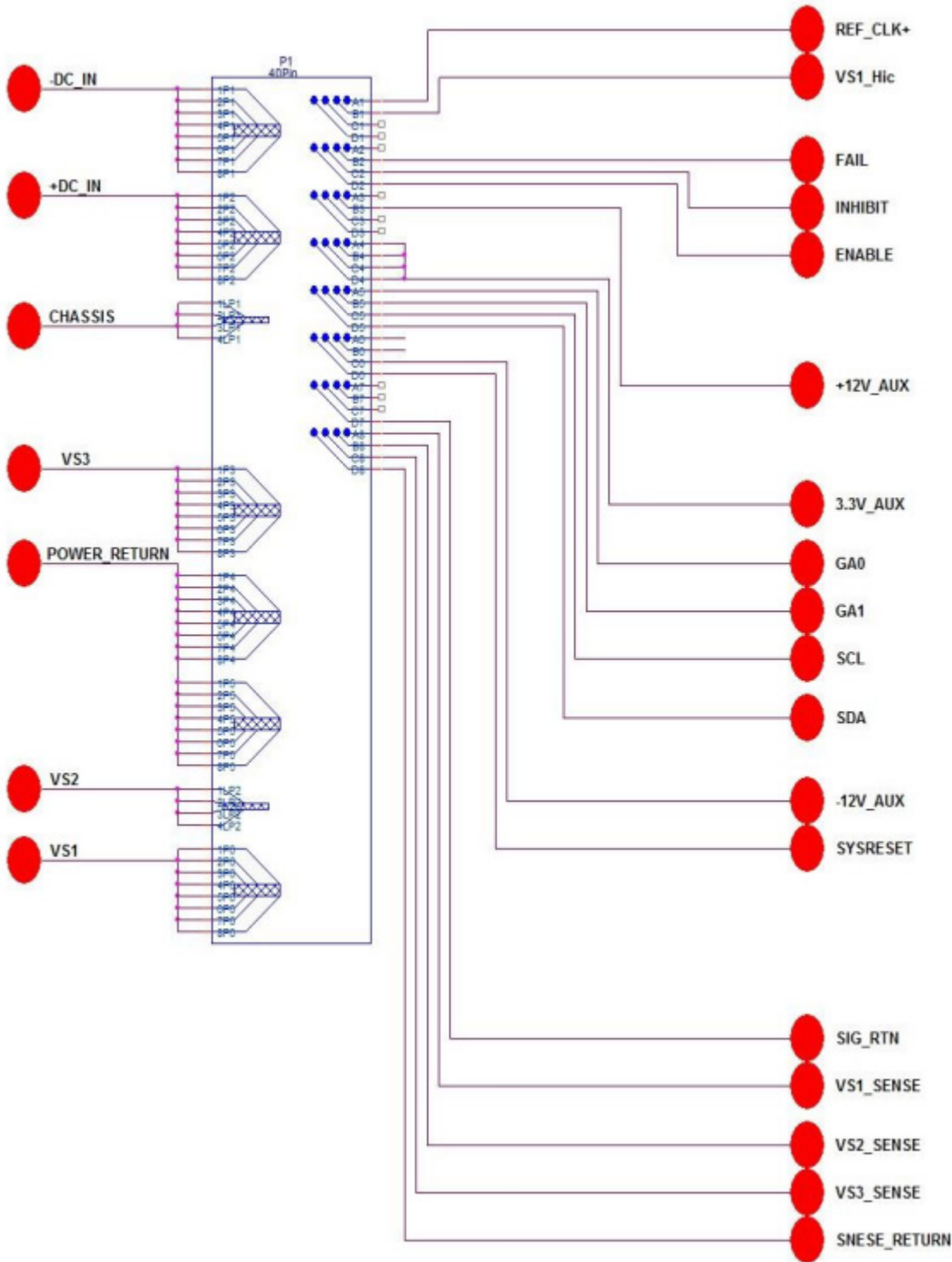
Unit will revert to its internal clock upon any out of tolerance external clock and will require another 32 clocks to re synchronized.

Note: REF\_CLK function is optional, please contact factory if required.

## PIN ASSIGNMENT:

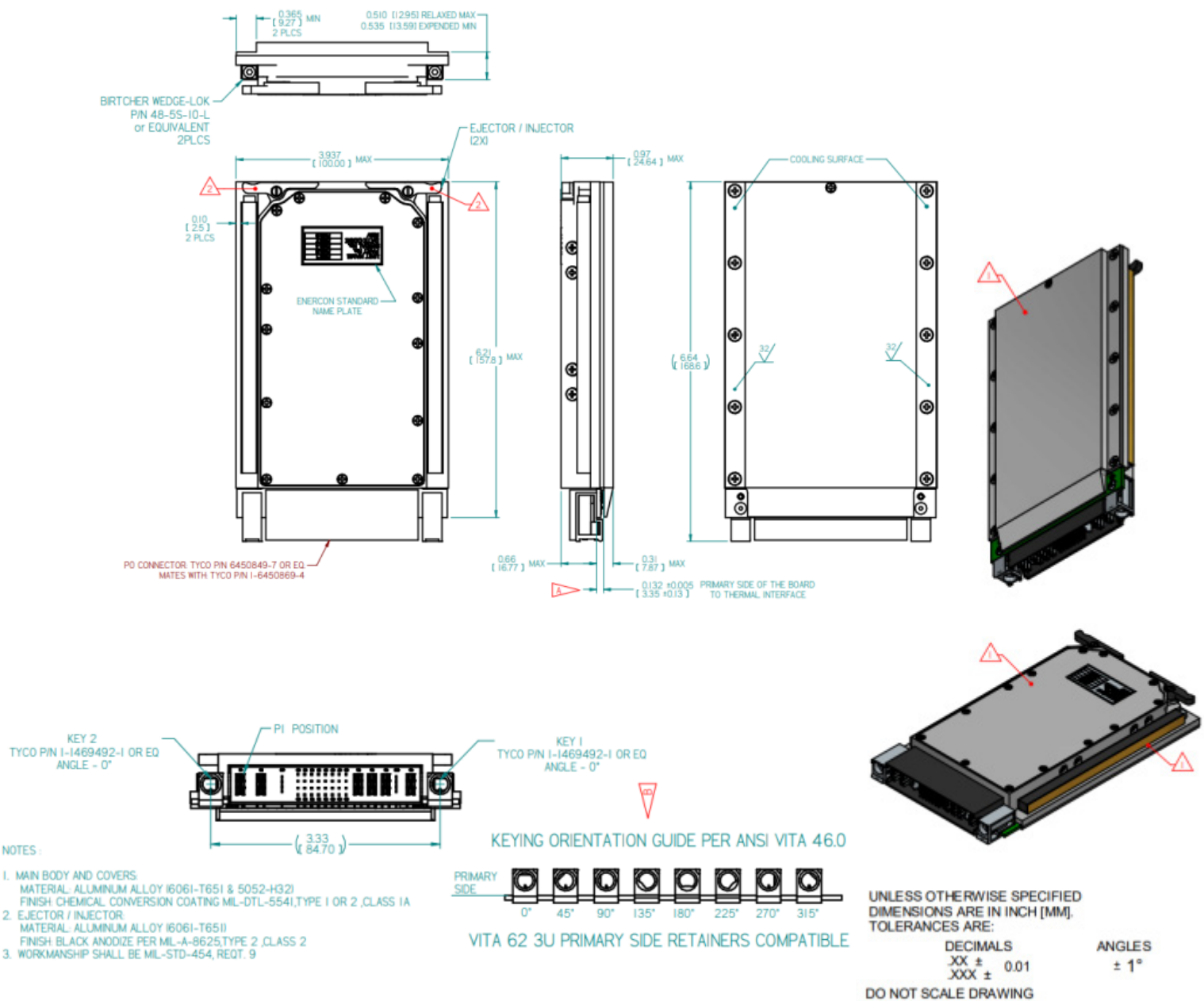


PART NUMBER	ROWS	POWER						SIGNAL						POWER						
		P1	P2	LP1				1	2	3	4	5	6	7	8	P3	P4	P5	LP2	P6
6450849-7	D							Z5	Z5	Z5	Z5	Z5	Z5	Z5	Z5					
	C							Y5	Y5	Y5	Y5	Y5	Y5	Y5	Y5					
	B							R5	R5	R5	R5	R5	R5	R5	R5					
	A							05	05	05	05	05	05	05	05					
2ACP+1LP+32S+3HDP+1LP+1HDP																				



Pin Number	Pin Name
P1	-DC_IN
P2	+DC_IN
LP1	CHASSIS
P3	VS3
P4	POWER_RETURN
P5	POWER_RETURN
LP2	VS2
P6	VS1
AB	VS1_SENSE
BB	VS2_SENSE
C8	VS3_SENSE
D8	SENSE_RETURN
A7	
B7	
C7	
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	Alert Bit
B3	+12V_AUX
C3	N.C
D3	N.C
A2	N.C
B2	FAIL*
C2	INHIBIT*
D2	ENABLE*
A1	REF_CLK+
B1	
C1	N.C
D1	N.C

## OUTLINE DRAWING:



Notice: Specifications are subject to change without notice. Contact your nearest Amphenol Corporation Sales Office for the latest specifications. All statements, information and data given herein are believed to be accurate and reliable but are presented without guarantee, warranty, or responsibility of any kind, expressed or implied. Statements or suggestions concerning possible use of our products are made without representation or warranty that any such use is free of patent infringement and are not recommendations to infringe any patent. The user should assume that all safety measures are indicated or that other measures may not be required. Specifications are typical and may not apply to all connectors.

AMPHENOL is a registered trademark of Amphenol Corporation.  
PRELIMINARY

©2023 Amphenol Corporation REV:



40-60 Delaware Avenue  
Sidney, NY 13838  
amphenol-aerospace.com | amphenolmao.com