Features & Benefits

- Isolated DC/DC Rugged Module
- EMI Filter Module is included
- Communication Capability
- 90% Efficiency at Full Load
- Input Under/Over Voltage Lockout
- Input Phase Reversal Protection
- Output Over Voltage Protection
- Output Short Circuit Protection
- Output Over Load Protection
- Thermal Shutdown
- Remote ON/OFF Control
- Output Voltage Remote Sense
- Output Voltage Trim Range +10%, -40%
- Baseplate Cooled

Compliance

Converter is designed to meet:

- MIL-STD-461G
- MIL-STD-810G
- MIL-STD-1275E

Typical Applications

- Military/Defense Power Systems
- Armored Vehicles
- Land Platforms
- Aerospace Platforms
- Communications and Radar Systems

Product Ratings	
V_{IN}	18 – 40 V
V_{OUT}	28 V
I_{OUT_MAX}	10.7 A
P_{OUT_MAX}	300 W

Product Description

Rugged Module is a 300 W DC/DC converter in rugged module that operates from nominal 28 V input and generates 28 V isolated output. It is designed to meet MIL-STD-461G EMI requirements with the built-in EMI filter module and has superior noise and ripple performance. Converter is fully protected to operate reliably under all kinds of disturbances. Casing is creatively designed to provide efficient cooling to facilitate reliable operation up to 100 °C base plate temperature.

Size: 100 x 80 x 23.4 mm
[3.94" x 3.15" x 0.92"]

Weight: 340 ± 20 g

Signals and Functions

+IN: Input supply voltage positive line.

-IN: Input supply voltage return line.

ON/OFF: Remote on/off pin. Referenced to **-IN** input return line. Should be pulled to input return line to turn the converter on. Can be left open to turn off the converter.

CHASSIS: Chassis connection for cabling purposes.

+OUT: Output voltage positive line.

-OUT: Output voltage return line.

+SNS: Remote sense positive line. Could be used to regulate output voltage at load terminals. Should be connected to positive side of Load. Using sense function with an ORing circuit may cause unstable output voltages. It is recommended not to connect this pin while using an ORing circuit.

-SNS: Remote sense negative line. Could be used to regulate output voltage at load terminals. Should be connected to negative side of Load. Using sense function with an ORing circuit may cause unstable output voltages. It is recommended to not connect this pin while using an ORing circuit.

TRIM: Trim pin can be used to increase or decrease output voltage within specified limit via a resistor. Trim up and down equations are given in Basic Operation and Features section.

PMBUS_SDA*: I2C communication data line. Internally pulled up to 3.3 Vdc via 10 kΩ resistor. Can be left open if not used. Referenced to output return line(-OUT).

PMBUS_SCL*: I2C communication clock line. Internally pulled up to 3.3 Vdc via 10 kΩ resistor. Can be left open if not used. Referenced to output return line(-OUT).

PMBUS_ADDRESS*: I2C communication address selection line. Can be left open or connected to Output return line to choose I2C address of converter between 0x81 and 0x83, respectively. Referenced to output return line(-OUT).

NC: DO NOT CONNECT. Connecting these pins to any other terminal may damage the converter.

All pins with identical function and name should be connected together for the best results.
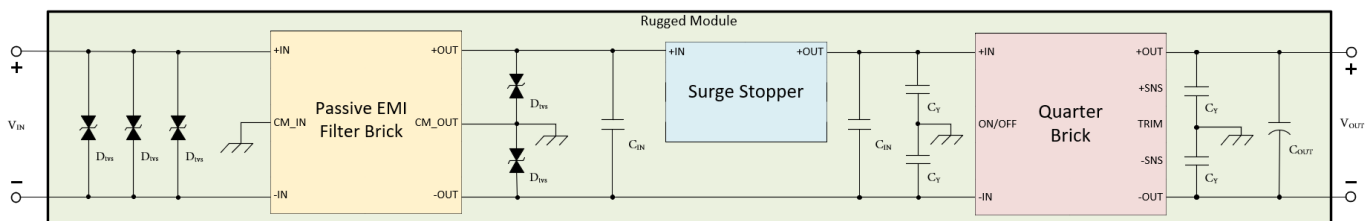
*: Available on PMBUS option.

Figure A. Rugged module internal block diagram

C_Y: CHV1206N2K0472KXT (4700 pF 2kV X7R Ceramic Capacitor)
C_{IN}: CL32Y106KCVZNWE (11 x 10uF 100V Ceramic Capacitor)
C_{OUT}: A759KS476M1KAAE045 (2 x 47uF 80V Aluminum-Polymer Capacitor)
D_{TVS}: 5.0SMDJ100CA (Bi-directional 100Vwm TVS Diode)

Electrical Characteristics

All data are obtained at nominal line and full load unless otherwise specified. (Ta = 25 °C)

Input Characteristics					
Parameters	**Notes & Conditions**	**Min**	**Typ**	**Max**	**Unit**
Non-Operating Input Voltage Range	Continuous	-40		60	V
Input Voltage Transient	50ms			50	V
Operating Input Voltage Range		18	28	40	V
Input Under Voltage Turn-On Threshold		15	16	17	V
Input Under Voltage Turn-Off Threshold		14	15	16	V
Input Over Voltage Turn-On Threshold		35.5	36.5	37.5	V
Input Over Voltage Turn-Off Threshold		40.5	41.5	42.5	V
No-Load Input Current			283	300	mA
Disabled Input Current			9.5	12	mA

Output Characteristics					
Parameters	**Notes & Conditions**	**Min**	**Typ**	**Max**	**Unit**
Output Voltage			28		V
Output Voltage Set Point			± 1		%
Output Voltage Line Regulation			± 2		%
Output Voltage Load Regulation			± 0.2		%
Output Voltage Ripple and Noise (pk-pk)	20 MHz bandwidth		350		mV
Operating Output Current Range		0		10.7	A
Output Current Limit		11			A
Output Current Shutdown Limit			15.5		A
Output DC Current-Limit Shutdown Voltage			14		V
Output Power			300		W
Maximum Output Capacitance	Nominal output voltage			3	mF
Input Voltage Transient Response	50 V/ms; See Figure D				
Step Change	28V to 40V to 28V input voltage		0.5		V
Settling Time	Within 1% output voltage		2		ms
Load Current Transient Response	1 A/µs; See Figure F and Figure C				
Step Change	50% to 75% to 50% output load		0.8		V
Settling Time	Within 1% output voltage		1		ms
Output Voltage Trim Range	Across Sense+ and Sense- Pins	-40		+10	%
Output Over-Voltage Protection			33.6		V

KOLT

General Characteristics					
Parameters	**Notes & Conditions**	**Min**	**Typ**	**Max**	**Unit**
Efficiency	From half load to full load	90		91.8	%
Turn-On Transient Time	Within 90% output voltage		35		ms
Turn-On Transient Output Voltage Overshoot	Maximum output capacitance		1		%
Soft-Start Time	Within 90% output voltage		5		ms
Switching Frequency			150		kHz
Non-Operating ON/OFF Pin Voltage	Continuous	-1		60	V
ON/OFF Control On-State Voltage		-1		10	V
ON/OFF Control Off-State Voltage		16		40	V
MTBF	Ground Begin, 30°C Ta		2947		10^3 Hrs.
	Ground Fixed, 40°C Ta		308		10^3 Hrs.
	Ground Mobile, 45°C Ta		107		10^3 Hrs.
Over Temperature Shutdown Trip Point			115		°C
Over Temperature Shutdown Hysteresis			15		°C

Isolation Characteristics					
Parameters	**Notes & Conditions**	**Min**	**Typ**	**Max**	**Unit**
Insulation Resistance	$500V_{DC}$				
Output to Base Plate			1		GΩ
Isolation Voltage	60s dwell, 1mA trip current				
Input to Output			1000		V_{DC}
Input to Chassis			100*		V_{DC}
Output to Chassis			1000		V_{DC}

* There are TVSs with Reverse Standoff voltage of 100 V for lightning protection at the input. See Figure A.

Environmental Characteristics

Parameters	Standard	Min	Typ	Max	Unit	Status
Operational Baseplate Temperature	MIL-STD-810G_CHG-1 Method 501.6/502.6 Procedure II	-40	-	+100	°C	Passed*
Storage / Transport Temperature	MIL-STD-810G_CHG-1 Method 501.6/502.6 Procedure I	-55	-	+125	°C	Passed*
Operational Low Pressure	MIL-STD-810G_CHG-1 Method 500.6 Procedure II	-	-	3000	m	Passed*
Storage / Transport Low Pressure	MIL-STD-810G_CHG-1 Method 500.6 Procedure I	-	-	9000	m	Designed to Meet

Parameters	Standard	Waveform	Peak Value	Pulse Duration	Axis	Status
Shock	MIL-STD-810G_CHG-1 Method 516.7 Procedure I	Half-Sine	10g	11 ms	±X, ±Y, ±Z	Passed*

Parameters	Standard	Category	Figure	Platform	Vehicle	Status
Vibration	MIL-STD-810G_CHG-1 Method 514.7 Procedure I	Category 4	514.7C-2	Secured Cargo	Truck Transportation and Composite Wheeled Vehicles	Passed*
		Category 8	514.7C-8	Aircraft	Propeller	Passed*
		Category 11	514.7C-11	Railroad	Train	Passed*
		Category 20	514.7C-4	Ground	Wheeled Vehicles	Passed*
		Category 21	514.7D-9	Watercraft	Marine Vehicles	Passed*

Parameters	Standard	Condition				Status
Salt Fog	MIL-STD-810G_CHG-1 Method 509.6	24 hours spray, 24 hours dry, applied 2 times				Designed to Meet
Sand and Dust	MIL-STD-810G_CHG-1 Method 510.6 Procedure I/II	<150 μm Dust 150-850 μm Sand				Designed to Meet
Fungus	MIL-STD-810G_CHG-1 Method 508.7	Analysis of the degree of inertness to fungus growth of the components.				Analysis
Solar Radiation	MIL-STD-810G_CHG-1 Method 505.6 Procedure I	A2				Passed*
Humidity	MIL-STD-810G_CHG-1 Method 507.6 Procedure II	≥ %95 Relative @30°C				Passed*

| Parameters	Standard	Test				Status
EMI/EMC	MIL-STD-461G Ground Army	CE102	CS101 CS114 CS115 CS116 CS118	RE102	RS103	Passed*

* Verified in a multi-channel power supply.
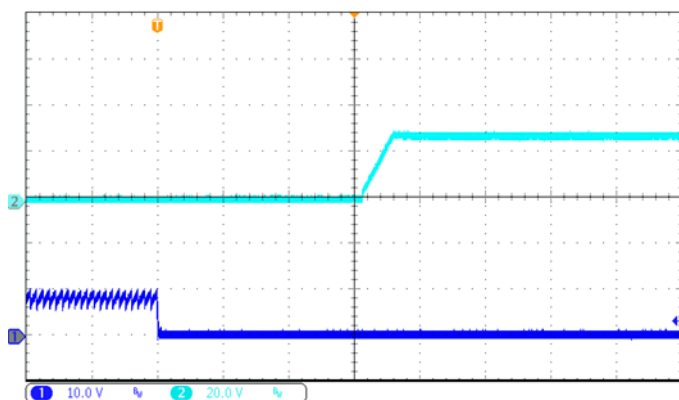
Output voltage (blue) (20 V/div)   Time base: 10 ms/div
ON/OFF pin voltage (navy blue) (10 V/div)

Figure B. Startup waveform, input voltage pre-applied with 1 µF ceramic capacitor across the load terminals
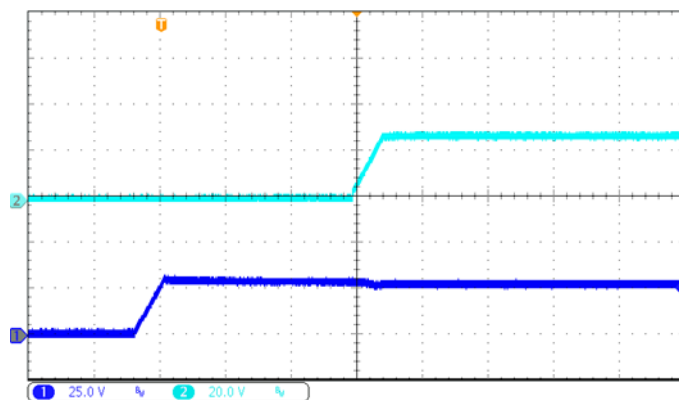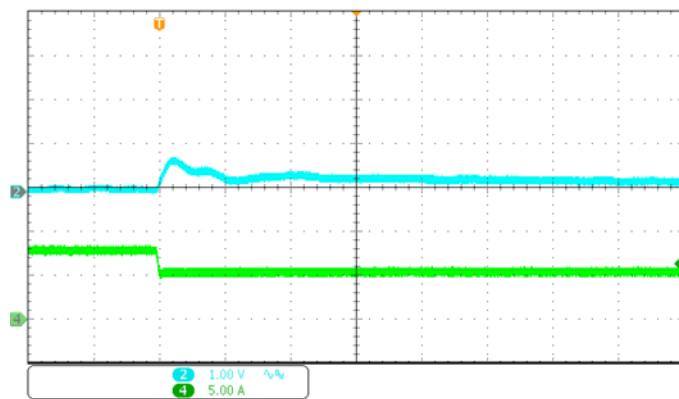

Output voltage (blue) (10 V/div)   Time base: 10 ms/div
Input voltage (navy blue) (25 V/div)

Figure E. Turn on transient at full resistive load with 1 µF ceramic capacitor across the load terminals
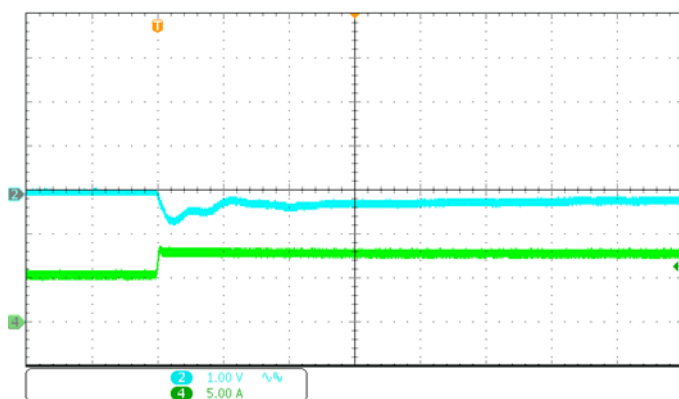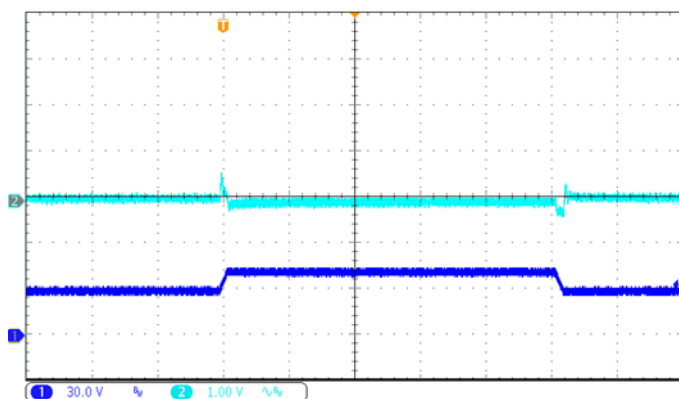

Output voltage (blue) (1 V/div)   Time base: 200 µs/div
Output current (green) (5 A/div)

Figure C. Load current transient response (AC Coupled): from 50% to 75% with 1 µF ceramic capacitor across the load terminals (di/dt = 1 A/µs)

Output voltage (blue) (1 V/div)   Time base: 200 µs/div
Output current (green) (5 A/div)

Figure F. Load current transient response (AC Coupled): from 75% to 50% with 1 µF capacitor across the load terminals. (di/dt = 1 A/µs)

Output voltage (blue) (1 V/div)   Time base: 10 ms/div
Input voltage (navy blue) (30 V/div)

Figure D. Input voltage transient response (AC Coupled): from 28 V to 40 V and back to 28 V with 1 µF ceramic capacitors across the load terminals. (dV/dt = 50 V/ms)
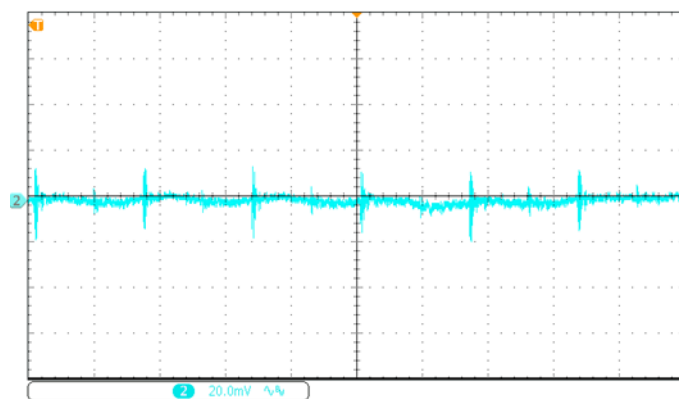
Output voltage ripple (200 mV/div)   Time base: 2 µs/div

Figure G. Output voltage ripple at nominal input voltage and full load current with 1 µF ceramic capacitor across the load terminals **(**Bandwidth: 20 MHz)
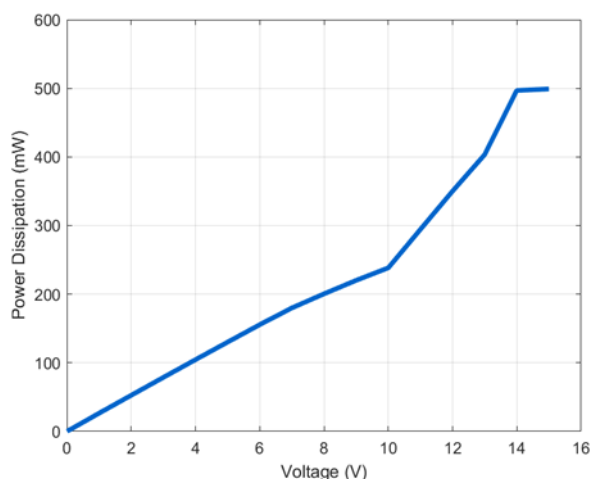
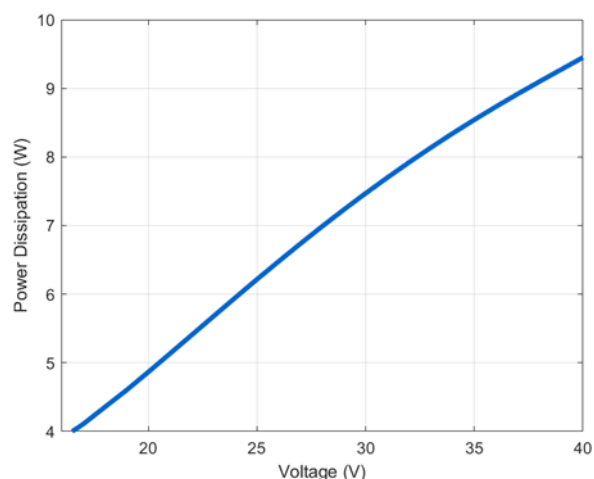**Figure H.** Disabled power dissipation versus input voltage

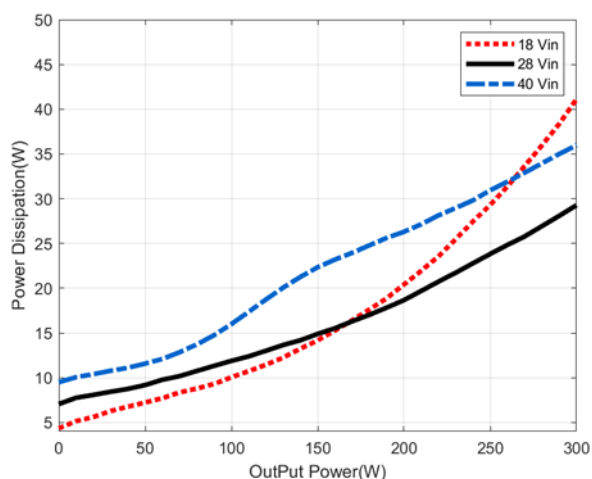**Figure K.** Enabled power dissipation versus input voltage

Figure I. Power dissipation versus output power at minimum, nominal and maximum input voltage at nominal output voltage
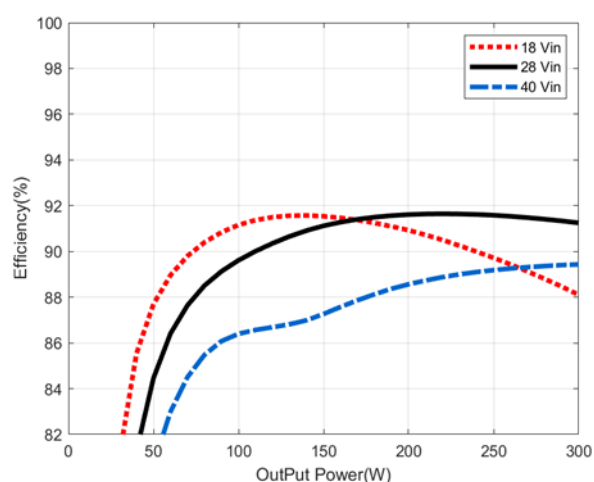

Figure L. Efficiency versus output power at minimum, nominal and maximum input voltage at nominal output voltage
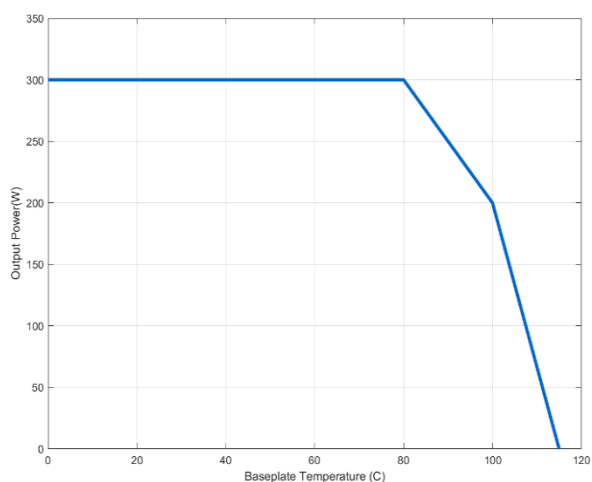

Figure J. Thermal Derating (maximum output power vs baseplate temperature) at nominal input voltage
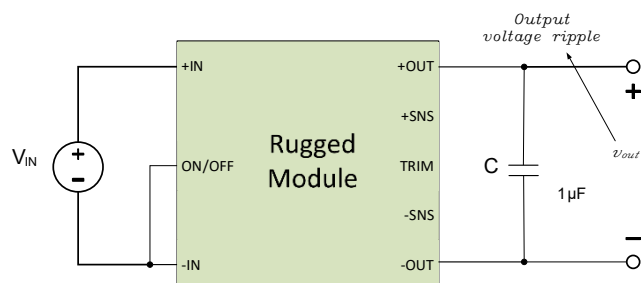

Figure M. Test set-up showing measurement point for output voltage ripple (Figure G).

Basic Operation and Features

REMOTE ON/OFF

The ON/OFF input, Pin 23, allows the user to control the ON and OFF states of the module. This input, which is referenced to the return terminal of the input bus (-IN), is held as active low to keep the module in ON state. If it is pulled down to the return terminal of the input bus (-IN), converter goes into ON state. Moreover, the ON/OFF function allows the product to be turned on/off by an external device like a semiconductor or a mechanical switch.
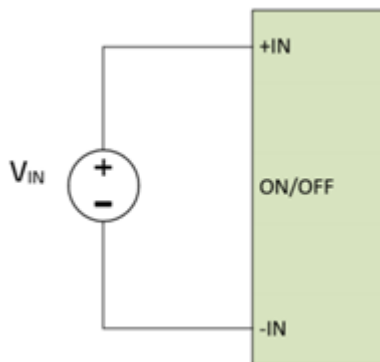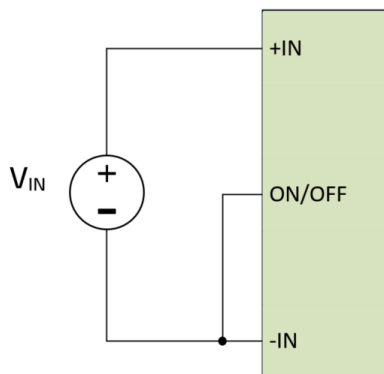

Figure N. Recommended OFF State Connection

Figure O. Recommended ON State Connection

SENSE

Sense terminals are placed at the load side of the converter module. The sense inputs are used to adjust and fine tune the output voltage and compensate for any error at the voltage level. If the load is away from the unit, which may require connection over a long pair of cable, connect +SNS and -SNS to the terminal of the load respectively to compensate for the voltage drop across the line.

OUTPUT VOLTAGE TRIM

TRIM input feature of the module permits the user to adjust the output voltage across the sense leads up or down according to the trim range. To decrease the output voltage, the user should connect a resistor between TRIM and +SNS input.

For a desired decrease of the nominal output voltage, the value of the resistor should be calculated as below.

$$R_{TRIM\_DOWN} = 9.18 * \frac{\left(V_{OUT_{nom}} - V_{OUT_{desired}} * 1.99\right)}{\left(V_{OUT_{desired}} - V_{OUT_{nom}}\right)} \; k\Omega$$

Output Voltage resulting from trim down resistor can be calculated as below. R_{TRIM_DOWN} is trim down resistor's value in kΩ.

$$V_{Generated} = V_{OUT_{nom}} * \frac{\left(9.18 + R_{TRIM\_DOWN}\right)}{\left(R_{TRIM_{DOWN}} + 18.27\right)} \; V$$

To increase the output voltage, the user should connect a resistor between TRIM and -SNS input. For input voltages below 18 V at full-load, converter is not able to regulate output voltage above 28 V. So, for input voltages lower than 18 V, trim-up capability is limited.

Converter is able to regulate output voltage to 28 V at full load, starting from 18 V input voltage.

For a desired increase of the nominal output voltage, the value of the resistor should be calculated as below.

$$R_{TRIM\_UP} = \frac{\left(9.18 * V_{OUT_{nom}} - V_{OUT_{desired}} * 8.25\right)}{\left(V_{OUT_{desired}} - V_{OUT_{nom}}\right)} \; k\Omega$$

Output Voltage resulting from trim up resistor can be calculated as below. R_{TRIM_UP} is trim up resistor's value in kΩ.

$$V_{Generated} = V_{OUT_{nom}} * \frac{\left(9.18 + R_{TRIM\_UP}\right)}{\left(R_{TRIM_{UP}} + 8.25\right)} \; V$$
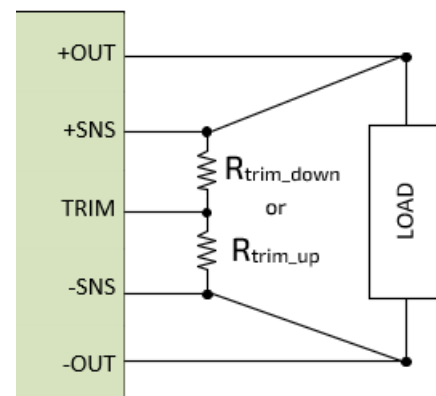

Figure P. Typical Trim Application Circuit

DROOP CURRENT SHARING

For "droop active" models (part numbers with PR option), output voltage has a 1 V slope from full load to no load. In other words, output voltage of the module is 28.5 V for no load and 27.5 V for full load. This enables safe parallel connection of multiple models.

For connection diagram, please refer to Figure U. Recommended Application N+1 Redundant Parallel Connection Figure U. ORing diodes (simple diode or ideal diode) are required for parallel connection.

PMBUS

PM option field in KOLT Rugged Module part numbers indicates I2C capability. I2C digital interface can be used to monitor input and output parameters.

Rugged module provides a two-wire I2C compatible communication interface that enables host device to monitor device parameters including Input Voltage, Output Voltage and Current, Device Temperature and Status.

I2C PIN DESCRIPTIONS AND RATINGS

Pin Name	Absolute Maximum Voltage Ratings
PMBUS_C2	3.6 V
GND	3.6 V
PMBUS_SDA*	3.6 V
PMBUS_SMBALERT*	3.6 V
PMBUS_SCL*	3.6 V
PMBUS_ADDRESS*	3.6 V

*: Internal 10kOhm pull-up resistor to 3.3 V

I2C SIGNAL SPECIFICATIONS

Parameter	Min	Typ	Max	Unit
High Level Input Voltage	2.64		3.5	V
Low Level Input Voltage	0		1	V
SDA and SCL Bus Capacitive Load			400	pF
Bus Frequency		100		kHz
Clock Low Time	4.7			µs
Clock High Time	4			µs
SDA and SCL Fall Time			300	ns
SDA and SCL Rise Time			1000	ns
Data Input Setup Time	250			ns
Start Condition Setup Time	4.7			µs
Start Condition Hold Time	4.0			µs
Stop Condition Setup Time	4.0			µs
Stop Condition Hold Time	>0			µs
Bus Free Time	4.7			µs

I2C READ OPERATION

Rugged module supports 100 kHz bus frequency and always acts as a slave. I2C Master can only read registers of rugged module. Write to registers is not possible. Read register sequence is detailed in Figure Q.
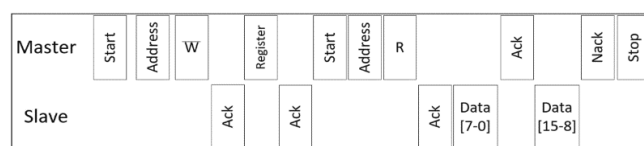

Figure Q. Read Register Operation

Rugged modules incorporate internal 10kOhm pull-up resistors to 3.3V on SDA and SCL lines.

Depending on the bus load SDA and SCL lines may require additional pull-up resistors to 2.8 to 3.5V external supply. Absolute maximum capacitive load on SDA and SCL lines are 400pF.

I2C ID SELECTION

I2C address of device is combination of physical address and Read/Write bit. Default I2C physical address for a rugged module is 0x2. Alternate physical I2C address of 0x6 is selected when PMBUS_ADDRESS pin tied to Digital Ground (GND) pin.

PMBUS_ADDRESS Pin State	I2C Address Byte	
	Read	Write
Float	0x3	0x2
Tied to GND	0x7	0x6

I2C REGISTERS

I2C digital interface is used to monitor input, output and status information of converter.

Digital configuration via Write to registers with I2C interface feature for rugged modules will be implemented in the future.

Register Address	R/W	Register Name	Scale Factor	Description
0x79	Read Only	STS	-	Status Register
0x88	Read Only	VIN	1mV/LSB	Input Voltage Reading Register
0x8B	Read Only	VOUT	1mV/LSB	Output Voltage Reading Register
0x8C	Read Only	IOUT	1mA/LSB	Output Current Reading Register
0x8D	Read Only	TEMP	1 °C/LSB	Temperature Reading Register

STATUS REGISTER (STS) 0x79

Status Register (0x79) is a 16-bit register containing status information and last logged fault of rugged module.

Status Register (STS)							
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**
Reserved			LOT	LOC	LREG	LOV	LUV
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
Reserved			OT	OC	REG	OV	UV

Eight least significant bits (LSBs) of STS (0x79) holds status information of the device. If any bit is set to 1, this indicates output is turned off due to fault conditions described in Status Register Fields table.

Eight most significant bits (MSBs) of STS (0x79) holds last fault log since power up. Fault log can only be cleared by powering down the converter or by pulling Remote ON/OFF pin to OFF state.

Status Register (STS) Fields			
Bits	**Field**	**Reset**	**Description**
0	UV	0	Input Under Voltage Fault bit 1: Input Voltage is lower than "Under Voltage Turn-Off Threshold". 0: Input Voltage is higher than "Under Voltage Turn-On Threshold".
1	OV	0	Input Over Voltage Fault bit 1: Input Voltage is higher than "Over Voltage Turn-Off Threshold". 0: Input Voltage is lower than "Over Voltage Turn-On Threshold".
2	REG	0	Regulation Fault bit 1: Output Voltage is lower than "Output DC Current-Limit Shutdown Voltage" or higher than "Output Over Voltage Protection Limit". 0: Output Voltage is OK.
3	OC	0	Output Over Current Fault bit 1: Output Current is higher than "Output Current Shutdown Limit". 0: Output Current is in operating limits.
4	OT	0	Over Temperature Fault bit 1: Temperature is higher than "Over Temperature Shutdown Trip Point". 0: Temperature is in operating limits.
5-7	Res	0	Reserved
8	LUV	0	Logged Input Under Voltage Fault bit
9	LOV	0	Logged Input Over Voltage Fault bit
10	LREG	0	Logged Regulation Fault bit
11	LOC	0	Logged Output Over Current Fault bit
12	LOT	0	Logged Over Temperature Fault bit
13-15	Res	0	Reserved

INPUT VOLTAGE REGISTER (VIN) 0x88

Input Voltage Register (0x88) is a 16-bit register containing unsigned input voltage reading information of rugged module. This register has a scale factor of 1 mV/LSB.

Input Voltage Register (VIN)							
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**
VIN [15-8]							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
VIN [7-0]							

Lower 8-bit part of VIN (0x88) register holds eight least significant bits (LSBs) of input voltage reading.

Upper 8-bit part of VIN (0x88) register holds eight most significant bits (MSBs) of input voltage reading.

Input Voltage Register (VIN) Fields			
Bits	**Field**	**Reset**	**Description**
0-15	VIN	0	Input Voltage Reading 0 = 0 V 1 = 0.001 V . . 28000 = 28.0 V . . 50000= 50.0 V

OUTPUT VOLTAGE REGISTER (VOUT) 0x8B

Output Voltage Register (0x8B) is a 16-bit register containing unsigned output voltage reading information of rugged module. This register has a scale factor of 1 mV/LSB.

Output Voltage Register (VOUT)							
15	**14**	**13**	**12**	**11**	**10**	**9**	**8**
VOUT [15-8]							
7	**6**	**5**	**4**	**3**	**2**	**1**	**0**
VOUT [7-0]							

Lower 8-bit part of VOUT (0x8B) register holds eight least significant bits (LSBs) of output voltage reading.

Upper 8-bit part of VOUT (0x8B) register holds eight most significant bits (MSBs) of output voltage reading.

Output Voltage Register (VOUT) Fields			
Bits	**Field**	**Reset**	**Description**
0-15	VOUT	0	Output Voltage Reading 0 = 0 V 1 = 0.001 V . . 28000 = 28.0 V . . 50000= 50.0 V

OUTPUT CURRENT REGISTER (IOUT) 0x8C

Output Current Register (0x8C) is a 16-bit register containing unsigned output current reading information of rugged module. This register has a scale factor of 1 mV/LSB.

Output Current Register (IOUT)							
15	14	13	12	11	10	9	8
IOUT [15-8]							
7	6	5	4	3	2	1	0
IOUT [7-0]							

Lower 8-bit part of IOUT (0x8C) register holds eight least significant bits (LSBs) of output current reading.

Upper 8-bit part of IOUT (0x8C) register holds eight most significant bits (MSBs) of output current reading.

Output Current Register (IOUT) Fields			
Bits	Field	Reset	Description
0-15	IOUT	0	Output Current Reading 0 = 0 A 1 = 0.001 A . . . 10700 = 10.7 A . . 16500= 16.5 A

TEMPERATURE REGISTER (TEMP) 0x8D

Temperature Register (0x8D) is a 16-bit register containing temperature reading information of rugged module in twos complement format. This register has a scale factor of 1 ℃/LSB

Temperature Register (TEMP)							
15	14	13	12	11	10	9	8
TEMP [15-8]							
7	6	5	4	3	2	1	0
TEMP [7-0]							

Lower 8-bit part of TEMP (0x8D) register holds eight least significant bits (LSBs) of temperature reading.

Upper 8-bit part of TEMP (0x8D) register holds eight most significant bits (MSBs) of temperature reading.

Temperature Register (TEMP) Fields			
Bits	Field	Reset	Description
0-15	TEMP	0	Temperature Reading 155: 155 ℃ . . 1: 1 ℃ 0: 0 ℃ 65535: -1 ℃ . 65481: -55 ℃

Protection Features

Reverse Input Protection

Converter module stays unharmed even if it is subjected to reverse input voltages. The associated limits are given in Input Characteristics Table.

Input Under Voltage Lockout

Converter module protects itself by ceasing operation when input goes below "Under Voltage Turn-Off Threshold". It resumes operation when input rises above "Under Voltage Turn-On Threshold". The associated limits are given in Input Characteristics Table.

Input Over Voltage Lockout

Converter module protects itself by ceasing operation when input goes above "Over Voltage Turn-Off Threshold". It resumes operation when input falls below "Over Voltage Turn-On Threshold". The associated limits are given in Input Characteristics Table.

Output Current Limit

If the output current exceeds the "Output Current Limit" value, the converter will immediately stop operating. The control waits for cooldown period, resets the fault status automatically and resumes operation with soft start. If the fault condition is still persisting, it shuts off again. This sequence is repeated indefinitely. The associated limits are given in Output Characteristics Table.

Output Over Voltage Protection

If the output voltage exceeds the "Output Over Voltage-Protection" value the converter outputs are disabled immediately and retries after cooldown period. The "Output Over Voltage Protection Limit" is 120% of Output Voltage. If trim up or down is used protection limit will change according to output voltage setting.

Output Over Current Protection

If the current voltage exceeds the "Output Current Shutdown Limit" value the converter outputs are disabled immediately and retries after cooldown period.

Short Circuit Protection

The short circuit condition is an extreme case of the Output Current Limit condition. When output Voltage drops below "Output DC Current-Limit Shutdown Voltage" limit, the converter outputs are disabled immediately and retries after cooldown period. The "Output DC Current-Limit Shutdown Voltage" is 50% of Output Voltage. If trim up or down is used protection limit will change according to output voltage setting.

Thermal Shutdown

The brick has a thermistor located at the hottest point inside the module. The thermal shutdown circuit is designed to turn the converter off when the temperature at the sensed location goes above the "Over Temperature Shutdown" limit. It locks itself and waits to cool off. Converter then resumes operation automatically when the temperature of the sensed location falls below the trip point by the amount equal to the "Over Temperature Shutdown Hysteresis". The associated limits are given in General Characteristics Table.

MIL-STD-461E CE102 Test Results

Following EMI measurements have been performed in KOLT's EMI test laboratory using Rohde&Schwarz FPC1000 Spectrum Analyzer. Rugged module loaded to supply 300 W to a resistive load at nominal input and output voltage. No external EMI filter is needed.
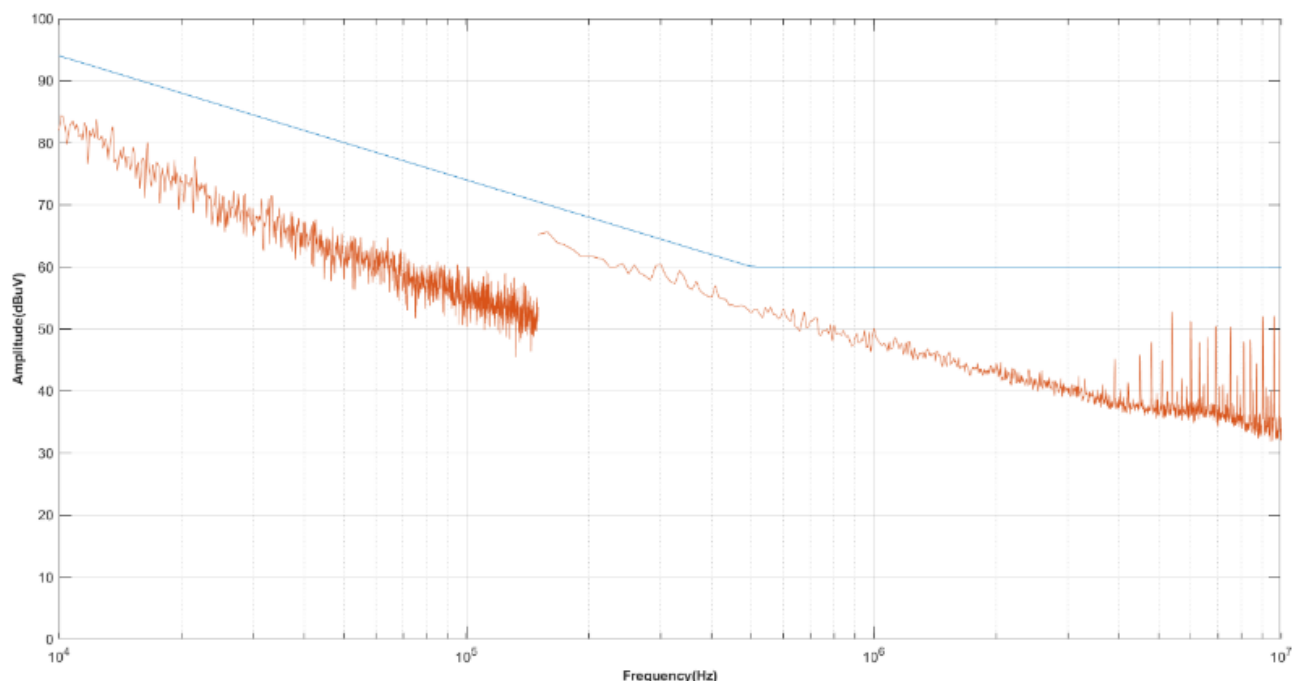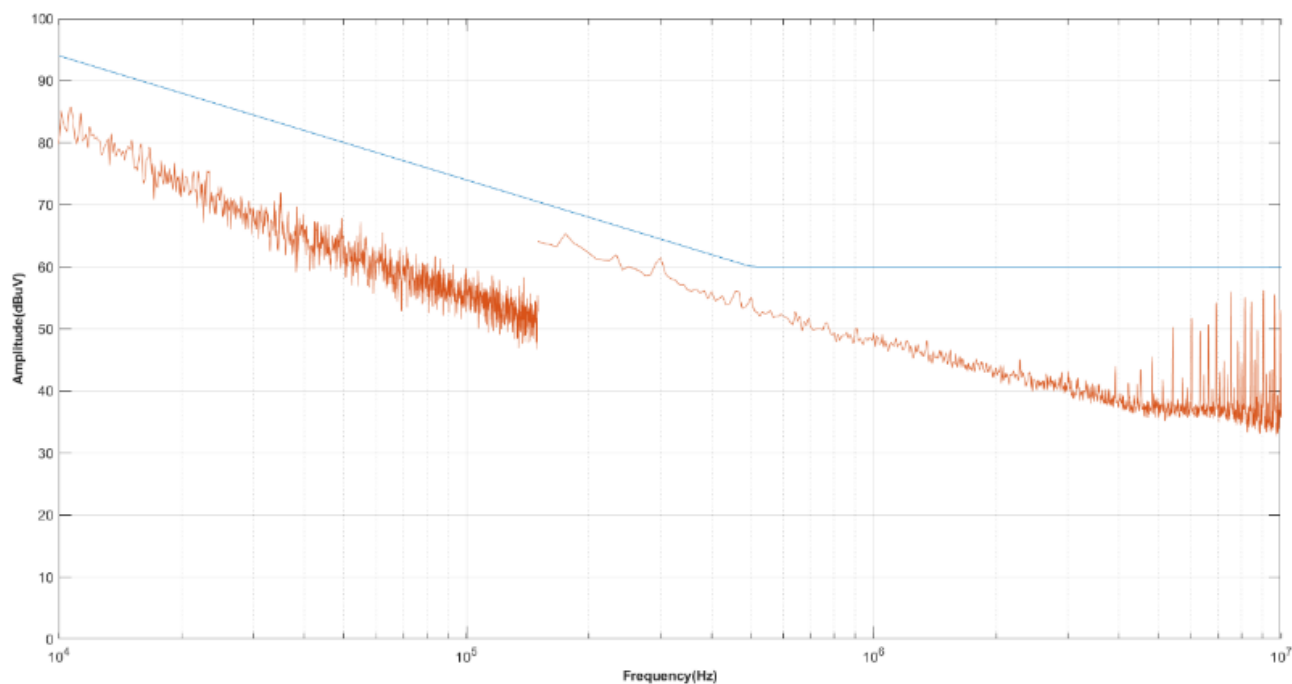

Figure R. MIL-STD-461G CE102 Positive Line

Figure S. MIL-STD-461G CE102 Negative Line
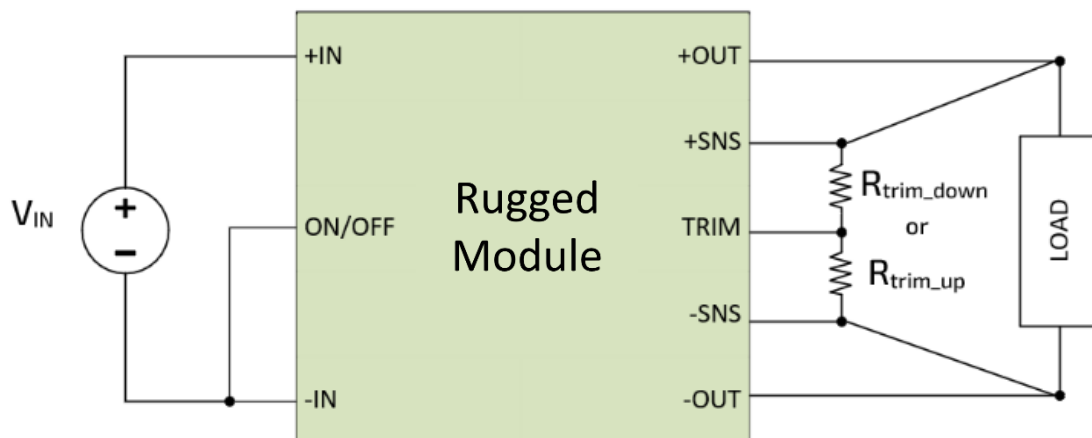
Application Considerations

Figure T. Typical Application

NOTE: If the output voltage is to be used in its default state, there is no need to use trim resistors.
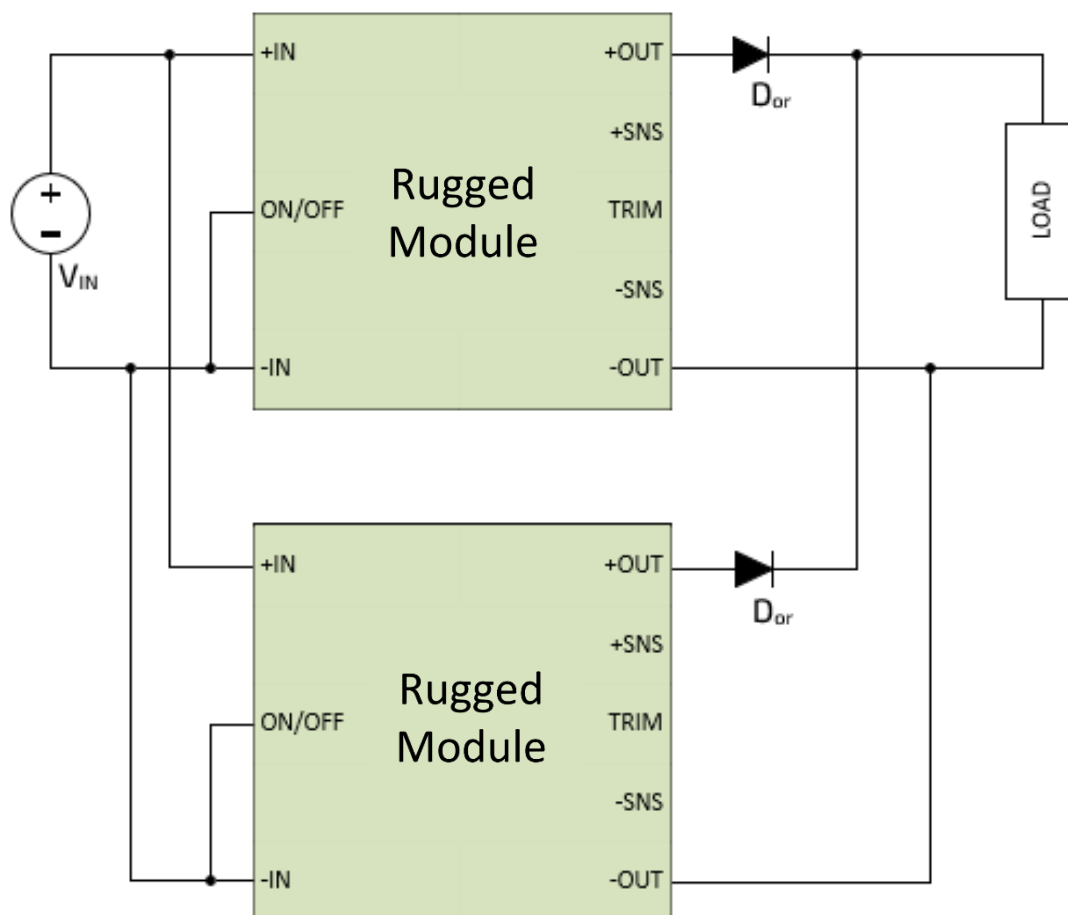
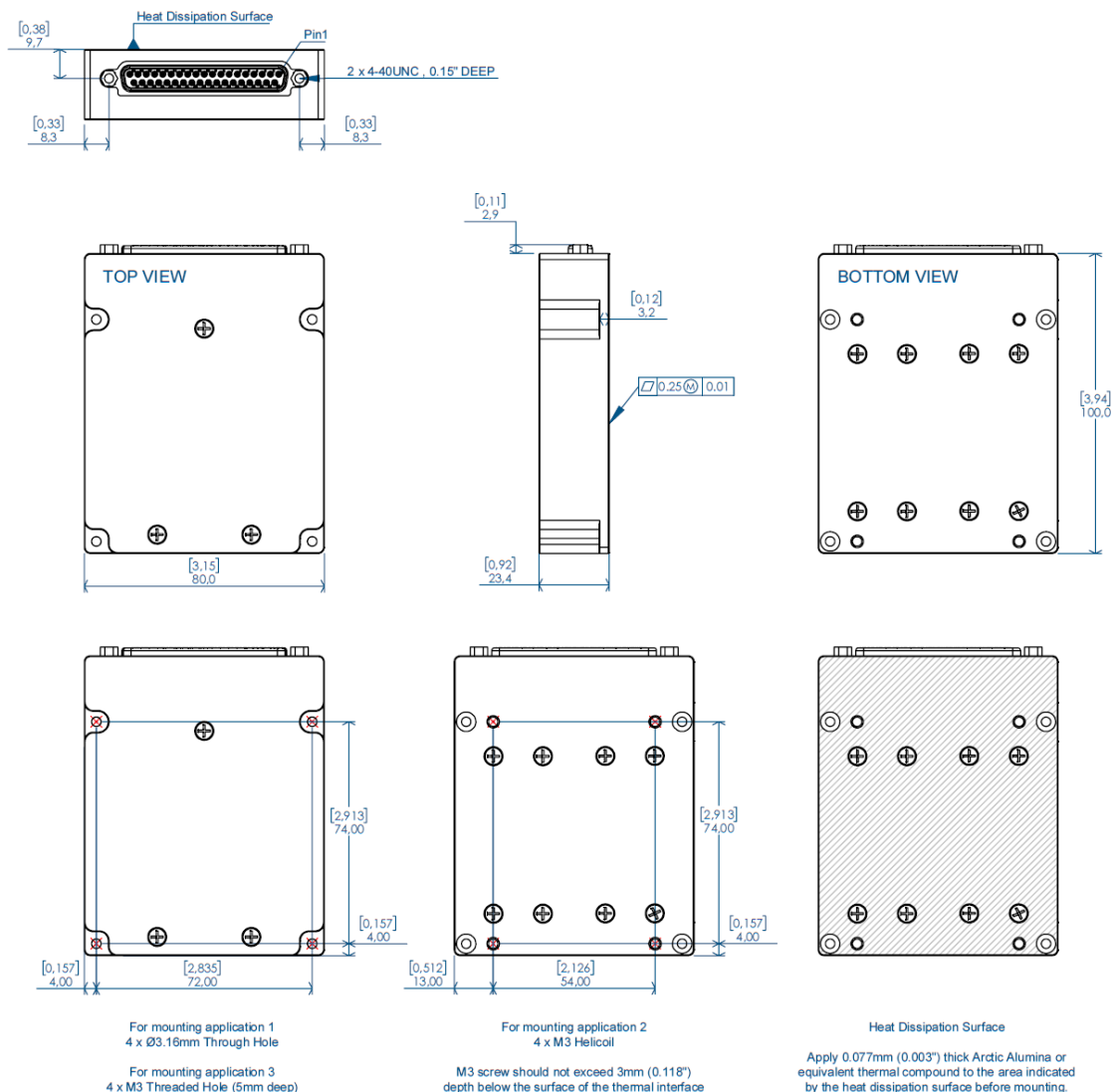**Figure U.** Recommended Application N+1 Redundant Parallel Connection
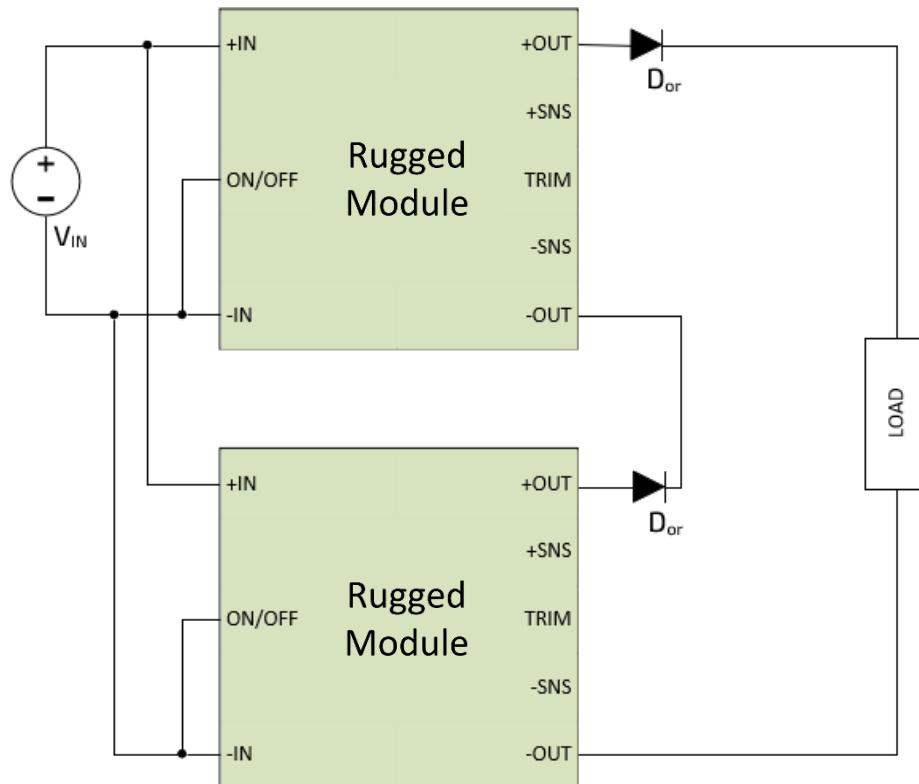
Figure V. Recommended Application Series Connection

D_{OR}: Can be either an ORing diode or ideal diode driver circuit

Mechanical Drawing

For mounting application 1
4 x Ø3.16mm Through Hole

For mounting application 3
4 x M3 Threaded Hole (5mm deep)

For mounting application 2
4 x M3 Helicoil

M3 screw should not exceed 3mm (0.118")
depth below the surface of the thermal interface

Heat Dissipation Surface

Apply 0.077mm (0.003") thick Arctic Alumina or
equivalent thermal compound to the area indicated
by the heat dissipation surface before mounting.

NOTES:
- APPLIED TORQUE PER M3 SCREW 1.5Nm (13in-lb) RECOMMENDED [1.6Nm (14in-lb) LIMIT].
- RECOMMENDED COOLING METHOD: CONDUCTION COOLED.
- THERMAL INTERFACE FLATNESS TOLERANCE IS 0.25mm (0.01") TIR FOR SURFACE.
- CONNECTOR MPN: 164A17969X
- MATE MPN: 163A11099X or EQ.
- BACKSHELL: 165X02719X or EQ.
- CASE MATERIAL: AL6061-T6
- FINISH: MIL-C-5541 / Type II, Class 1A
- WEIGHT: 340g (12oz)
- ALL DIMENSIONS IN MILIMETERS [inches]
- TOLERANCES:
  X.Xmm ±0.5mm (X.XXIN ±0.020)
  X.XXmm ±0.25mm (X.XXXIN ±0.010)

Pin	Name	Function
4	CHASSIS	Earth
1, 3, 21	+IN	Positive input voltage
23	ON/OFF	Remote on/off, referenced to -IN
2, 20, 22	-IN	Input return
11, 13, 15, 17, 29, 30, 32, 34, 36	-OUT	Output return
27	-SNS	Negative remote sense
8	TRIM	Output voltage trim
26	+SNS	Positive remote sense
12, 14, 16, 18, 19, 31, 33, 35, 37	+OUT	Positive output voltage
25*	PMBUS_SDA	I2C Data
24*	PMBUS_SCL	I2C Clock
5*	PMBUS_ADDRESS	I2C Address selection
6, 7, 9, 10, 28	NC	DO NOT CONNECT

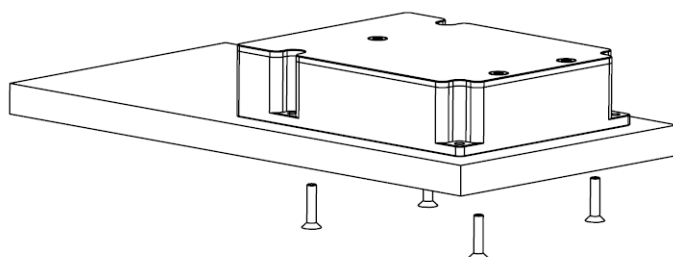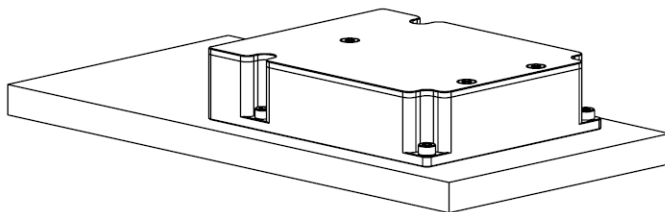*: AVAILABLE ON PMBUS OPTION (ALL REFERENCED TO -OUT)

Mounting Applications
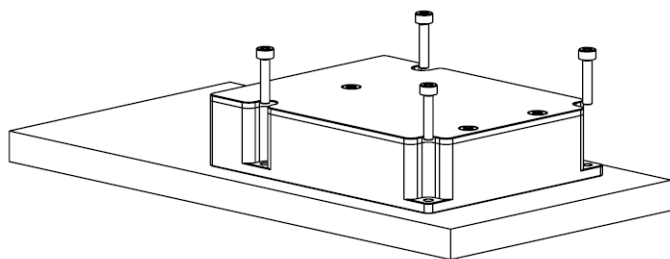
For mounting application 1;

Using four M3 cylindrical head screws, M3 washers and M3 spring washers, you can assemble as shown in the example.
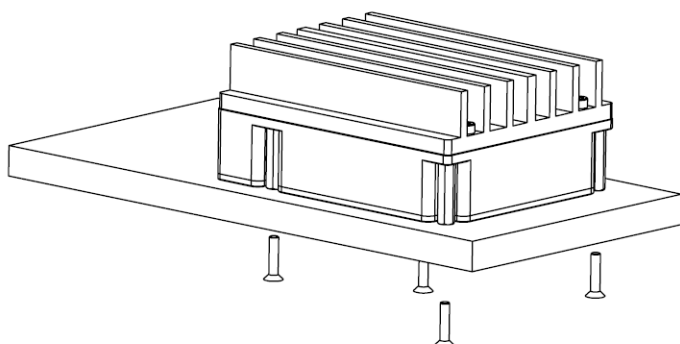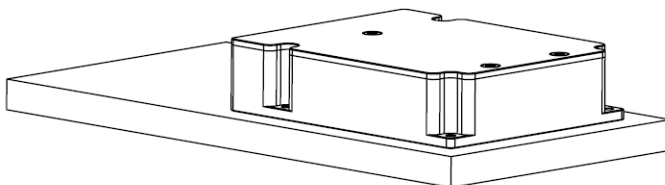
Pay attention to the notes on the previous page before assembly.

For mounting application 2;

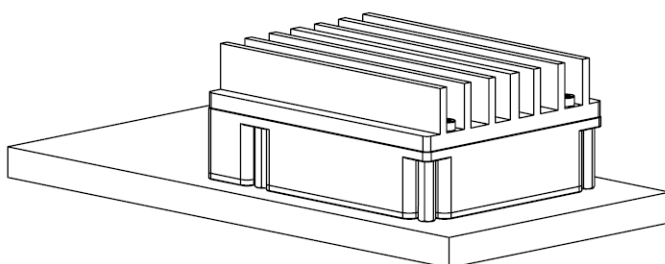Using four M3 countersunk screws, you can assemble as shown in the example.

Pay attention to the notes on the previous page before assembly.

For mounting application 3;

Using a heatsink and four M3 countersunk screws, you can assemble as shown in the example.

Pay attention to the notes on the previous page before assembly.

Part Ordering Information

Family	Product Variant	Option Variant	Compliance
KEU-RM165	**-002**	-XXX	**R:** RoHS & REACH

Ordering Number	Communication	Current Sharing	RoHS (Note*)
KEU-RM165-002-001	No communication capability	Not Available	RoHS compliant with exemptions
KEU-RM165-002-002	No communication capability	Droop Sharing	RoHS compliant with exemptions
KEU-RM165-002-003	With PMBUS communication capability	Not Available	RoHS compliant with exemptions
KEU-RM165-002-004	With PMBUS communication capability	Droop Sharing	RoHS compliant with exemptions
KEU-RM165-002-001R	No communication capability	Not Available	RoHS-3 & REACH compliant
KEU-RM165-002-002R	No communication capability	Droop Sharing	RoHS-3 & REACH compliant
KEU-RM165-002-003R	With PMBUS communication capability	Not Available	RoHS-3 & REACH compliant
KEU-RM165-002-004R	With PMBUS communication capability	Droop Sharing	RoHS-3 & REACH compliant

RoHS & REACH Compliance*

All KOLT products ship by default with SnPb solder under EU RoHS Directive 2011/65/EU, utilizing lead Exemption 7(a).

To obtain a lead-free build that meets **RoHS-3** requirements and REACH compliancy, add the "-R" suffix to the part number. These units are CE marked.

Revision History

Document Number	Revision	Date	Description	Page Number(s)
109392	A-PC1	17.03.2023	Initial Prototype Release	-
109392	A-PC2	04.10.2023	Second Prototype Release	All
109392	A-PC3	08.11.2023	Third Prototype Release	All
109392	01	18.09.2024	<u>Initial Release</u> - Minimum Operating Input Voltage is updated from 16 V to 18 V. - Input Under Voltage Turn-On Threshold and Turn-Off Threshold tolerances is updated from ± 0.5 V to ± 1 V. - Input Over Voltage Turn-On Threshold and Turn-Off Threshold tolerances is updated from ± 0.5 V to ± 1 V. - Input Over Voltage Turn-Off is updated from 40.5 V to 41.5 V. - Figure A is updated. - Minimum Efficiency is updated from 91% to 90%. - Output current limit updated to minimum instead of maximum. - Input to Output Isolation Voltage is updated from 2250 VDC to 1000 VDC. - Input to Chassis Isolation Voltage is updated from 2250 VDC to 100 VDC. - Output to Chassis Isolation Voltage is updated from 2250 VDC to 1000 VDC. - Output to Base Plate Insulation Resistance is updated from >45 GΩ to 1 GΩ. - Input to Base Plate Insulation Resistance is removed. - MTBF values is added for Ground Benign and Ground Mobile. - Protection Features title is updated. - ± 20g tolerance is added to weight. - Output Voltage Line Regulation increased to 2% from 0.2%	1, 2 3, 4 8, 9
109392	02	20.03.2025	Second Release	-
109392	03	4.08.2025	Part Number Updated	-

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