250 WATT QMW DC/DC CONVERTERS

Features

- 4:1 Input voltage range
- High power density
- Small size 1.54” x 2.39” x 0.52”
- Efficiency up to 93%
- Excellent thermal performance with metal case
- Over-Current and Short Circuit Protection
- Over-Temperature protection
- Auto-restart
- Monotonic startup
- Constant frequency
- Remote ON/OFF
- Good shock and vibration damping
- RoHS Compliant
- UL60950 Approved

Description

The 4:1 Input Voltage 250 Watt Single QMW DC/DC converter provides a precisely regulated dc output. The output voltage is fully isolated from the input, allowing the output to be positive or negative polarity and with various ground connections. The 250 Watt QMW meets the most rigorous performance standards in an industry standard footprint for mobile (12V_{IN}), process control (24V_{IN}), and military COTS (28V_{IN}) applications.

The 4:1 Input Voltage 250 Watt QMW includes remote ON/OFF. Threaded through holes are provided to allow easy mounting or addition of a heatsink for extended temperature operation.

The converters high efficiency and high power density are accomplished through use of high-efficiency synchronous rectification technology, advanced electronic circuit, packaging and thermal design thus resulting in a high reliability product. Converter operates at a fixed frequency and follows conservative component de-rating guidelines.

Product is designed and manufactured in the USA.

Model	Input Range VDC		Vout VDC	Iout ADC
	Min	Max		
24S12.20QMW (ROHS)	9	36	12	20.5

1. Designed to meet MIL-STD-810G for functional shock and vibration. The unit must be properly secured to the interface medium (PCB/Chassis) by use of the threaded inserts of the unit.

2. A thermal management device, such as a heatsink, is required to ensure proper operation of this device. The thermal management medium is required to maintain baseplate temperature below value provided in derating guideline.

Vitec POWER GmbH
Bahnstraße 65-67/2/2, 2230 Gänserndorf, AUSTRIA
Tel.: +43 (0) 2282 3144, E-Mail: office@vitecpower.com

Electrical Specifications:

Conditions: T_A = 25ºC, airflow = 300 LFM (1.5m/s), V_{IN} = 24VDC, unless otherwise specified. Specifications subject to change without notice.

24S12.20QMW

Parameter	Notes	Min	Typ	Max	Units
Absolute Maximum Ratings					
Input Voltage	Continuous	0		40	V
	Transient (100ms)			50	V
Operating Temperature[1]	Baseplate (100% load)	-40		105	ºC
Storage Temperature		-55		125	ºC
Isolation Characteristics and Safety					
Isolation Voltage	Input to Output	2250			V
	Input to Baseplate & Output to Baseplate	1500			V
Isolation Capacitance			4500		pF
Isolation Resistance		10	20		MΩ
Insulation Safety Rating			Basic		
	Designed to meet UL/cUL 60950, IEC/EN 60950-1				
Feature Characteristics					
Fixed Switching Frequency			275		kHz
Remote Sense Compensation	This function is not provided		N/A		%
Output Overvoltage Protection	Non-latching	110	115	120	%
Over Temperature Shutdown (Baseplate)	Non-latching		115	125	ºC
Auto-Restart Period	Applies to all protection features	450	500	550	ms
Turn-On Time from V_{IN}	Time from UVLO to V_O=90% V_{OUT} (NOM)	7	11	15	ms
Turn-On time from ON/OFF Control	Time from ON to V_O=90% V_{OUT} (NOM) Resistive load	13	17	21	ms
Rise Time	VOUT from 10% to 90%	3	5.5	7	ms
ON/OFF Control – Positive Logic					
On State	Pin open = ON or external voltage applied	2		5.5	V
Current Control	Leakage current			0.16	mA
OFF State		0		0.8	V
Control Current	Sinking			0.36	mA
Thermal Characteristics					
Thermal resistance Baseplate to Ambient	Unit mounted horizontally, using Calex Brick Test Fixture (bottom side of fixture covered to prevent airflow across unit), No Heatsink & Fan used.		6.2		ºC/W

1) See Fig. A for derating guideline

Electrical Specifications (Continued):

Conditions: T_A = 25ºC, airflow = 300 LFM (1.5m/s), V_{IN} = 24VDC, unless otherwise specified. Specifications subject to change without notice.

24S12.20QMW

Parameter	Notes		Min	Typ	Max	Units
Input Characteristics						
Operating Input Voltage Range			9	24	36	V
Input Under Voltage Lockout	Non-latching					
Turn-on Threshold			8.3	8.6	8.9	V
Turn-off Threshold			7.6	7.9	8.2	V
Lockout Hysteresis Voltage			0.3	0.6	0.9	V
Maximum Input Current	V_{IN} = 9V, Iout=16.4A				26	A
	V_{IN} = 24V, Iout=20.5A				12	A
	V_{IN} = 24V, Output Shorted			0.09		A_{RMS}
Input Stand-by Current	Converter Disabled			17	20	mA
Input Current @ No Load	Converter Enabled			234		mA
Minimum Input Capacitance (external)	ESR < 0.1 Ω		470			µF
Inrush Transient	Vin = 36V (0.4V/µs) no input external capacitor			0.05		A^2s
Input Terminal Ripple Current, i_C	25 MHz bandwidth, 100% Load (Fig. 2)			4.85		A_{RMS}
Output Characteristics						
Output Voltage Range			11.64	12.00	12.36	V
Output Voltage Set Point Accuracy	(50% Rated Load)		11.88	12.00	12.12	V
Output Regulation						
Over Line	V_{IN} = 9V to 36V			0.2	1	%
Over Load	V_{IN} = 24V, Load 0% to 100%			0.2	1	%
Temperature Coefficient				0.02	0.03	%/ºC
Over Voltage Protection			13.2		14.4	V
Output Ripple and Noise – 20 MHz bandwidth	(Fig. 3) 100% Load			50		mV_{PK-PK}
				15		mV_{RMS}
External Load Capacitance	Full Load (resistive) -40 ºC < Ta < +105 ºC	C_{EXT}	330		2200	µF
		ESR	10		100	mΩ
Output Current Range (See Fig. B)	12V ≤ Vin ≤ 36V		0		20.5	A
	Vin = 9V		0		16.4	A
Current Limit Inception				26		A
RMS Short-Circuit Current	Non-latching, Continuous			0.7		A_{RMS}
Dynamic Response						
Load change 50% - 75% - 50%, di/dt = 1A/µs	C_o = 330 µF/75mΩ + 1 µF ceramic			± 250		mV
Load change 50% - 100%, - 50%, di/dt = 1A/µs	C_o = 330 µF/75mΩ + 1 µF ceramic			± 400		mV
Setting Time to 1% of V_{OUT}				200		µs
Efficiency						
100% Load	V_{IN} = 24 V			92.4		%
	V_{IN} = 12 V			92		%
50% Load	V_{IN} = 24 V			92.6		%
	V_{IN} = 12 V			93.7		%

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Environmental and Mechanical Specifications: Specifications subject to change without notice.

Parameter	Notes	Min	Typ	Max	Units
Environmental					
Operating Humidity	Non-condensing			95	%
Storage Humidity	Non-condensing			95	%
ROHS Compliance [1]	See Calex Website http://www.calex.com/RoHS.html for the complete RoHS Compliance Statement				
Shock and Vibration	Designed to meet MIL-STD-810G for functional shock and vibration				
Water Washability	Not recommended for water wash process. Contact the factory for more information.				
Mechanical					
Weight			2.4		Ounces
			68		Grams
PCB					
Operating Temperature				130	ºC
Tg		170			ºC
Through Hole Pin Diameters	Pins 1 ,2 and 3	0.038	0.04	0.042	Inches
		0.965	1.016	1.067	mm
	Pins 4 and 5	0.058	0.06	0.062	Inches
		1.4732	1.524	1.575	mm
Through Hole Pin Material	All Pins	Brass Alloy TB3 or "Eco Brass"			
Through Hole Pin Finish	All pins	10µ" Gold over Nickel			
Case Dimensions			1.54 x 2.39 x 0.52		Inches
			39.116 x 60.706 x 13.21		mm
Case Material	Plastic: Vectra LCP FIT30: ½ - 16 EDM Finish				
Baseplate	Material	Aluminum			
	Flatness		0.008		Inches
			0.20		mm
Reliability					
MTBF	Telcordia SR-332, Method 1 Case 1 50% electrical stress, 40ºC components		8.6		MHrs
Agency Approvals	UL60950 Approved				
EMI and Regulatory Compliance					
Conducted Emissions	MIL-STD-461F CE102 with external EMI filter network (see Figs, 12 and 13)				

Additional Notes:
1. the RoHS marking is as follows: Pb RoHS

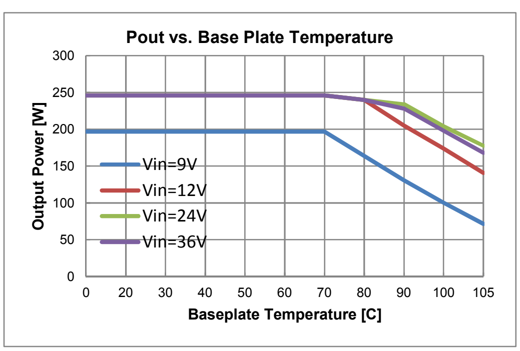

Figure A: Power derating as function of baseplate temperature.

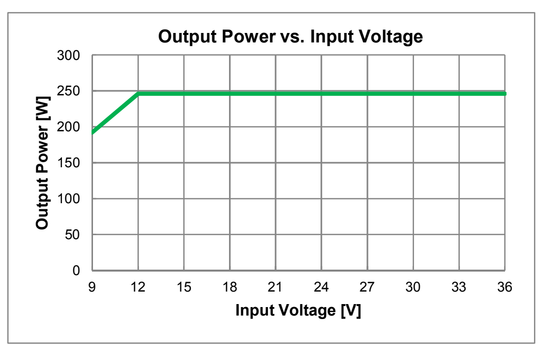

Figure B: Output Power as function of input voltage

Operations:

Input and Output Capacitance

In many applications, the inductance associated with the distribution from the power source to the input of the converter can affect the stability of the converter. This becomes of great consideration for input voltage at 12V or below. In order to enable proper operation of the converter, in particular during load transients, an additional input capacitor is required. Minimum required input capacitance, mounted close to the input pins, is 470µF with ESR < 0.1 Ω. Since inductance of the input power cables could have significant voltage drop due to rate of change of input current di(in)/dt during transient load operation an external capacitance on the output of the converter is required to reduce di(in)/dt. It is required to use at least 330µF (ESR < 0.1Ω) on the output. Another constraint is minimum rms current rating of the input and output capacitors which is application dependent. One component of input rms current handled by input capacitor is high frequency component at switching frequency of the converter (typ. 275kHz) and is specified under "Input terminal ripple current" ***ic***. Typical value at full rated load and 24 V_{IN} is provided in Section "Characteristic Waveforms" and is in range of 4A - 5A. Second component of the ripple current is due to reflected step load current on the input of the converter. Similar consideration needs to be taken into account for output capacitor and in particular step load ripple current component. Consult the factory for further application guidelines.
Additionally, for EMI conducted measurement it is necessary to use 5µH LISNs instead of typical 50µH LISNs.

ON/OFF (Pin 2)

The ON/OFF pin is used to turn the power converter on or off remotely via a system signal and has positive logic. A typical connection for remote ON/OFF function is shown in Fig. 1.

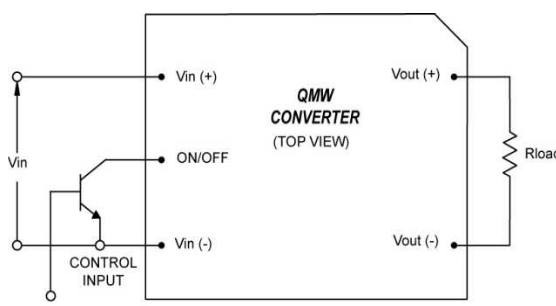

Fig 1: Circuit configuration for ON/OFF function.

The positive logic version turns on when the ON/OFF pin is at logic high and turns off when at logic low. The converter is on when the ON/OFF pin is either left open or external voltage not more than 5.5V is applied between ON/OFF pin and -INPUT pin. See the Electrical Specifications for logic high/low definitions.
The ON/OFF pin is internally pulled up to typically 4.5V via resistor and connected to internal logic circuit via RC circuit in order to filter out noise that may occur on the ON/OFF pin. A properly de-bounced mechanical switch, open-collector transistor, or FET can be used to drive the input of the ON/OFF pin. The device must be capable of sinking up to 0.36mA at a low level voltage of ≤ 0.8V. During logic high, the typical maximum voltage at ON/OFF pin (generated by the converter) is 4.5V, and the maximum allowable leakage current is 160µA. If not using the remote on/off feature leave the ON/OFF pin open.

TTL Logic Level - The range between 0.81V as maximum turn off voltage and 2V as minimum turn on voltage is considered the dead-band. Operation in the dead-band is not recommended.

External voltage for ON/OFF control should not be applied when there is no input power voltage applied to the converter.

Protection Features:

Input Undervoltage lockout (UVLO)

Input undervoltage lockout is standard with this converter. The converter will shut down when the input voltage drops below a pre-determined voltage.
The input voltage must be typically above 8.5V for the converter to turn on. Once the converter has been turned on, it will shut off when the input voltage drops typically below 8V.

Output Overcurrent Protection (OCP)

The converter is protected against overcurrent or short circuit conditions. At slight overload conditions cycle-by-cycle mode activates then transfers to hiccup mode at more severe overloading conditions.
Once the converter has shut down, it will attempt to restart nominally every 500msec with a typical 3% duty cycle. The attempted restart will continue indefinitely until the overload or short circuit conditions are removed. Once the output current is brought back into its specified range, the converter automatically exits the hiccup mode and continues normal operation.

Output Overvoltage Protection (OVP)

The converter will shut down if the output voltage across V_{OUT} (+) (Pin 5) and V_{OUT} (-) (Pin 4) exceeds the threshold of the OVP circuitry. The OVP circuitry contains its own reference, independent of the output voltage regulation loop. Once the converter has shut down, it will attempt to restart every 500 msec until the OVP condition is removed.

Over Temperature Protection (OTP)

The QMW converter has non-latching over temperature protection. It will shut down and disable the output if temperature at the center of the base plate exceeds a threshold of 115ºC (typical).

The converter will automatically restart when the base temperature has decreased by approximately 10ºC.

Safety Requirements

Basic Insulation is provided between input and the output.
The converters have no internal fuse. To comply with safety agencies requirements, a fast-acting or time-delay fuse is to be provided in the unearthed lead.
Recommended fuse values are:
a) 34A for 9V < V_{IN} < 18V
a) 17A for 18V < V_{IN} < 36V

Electromagnetic Compatibility (EMC)

EMC requirements must be met at the end-product system level, as no specific standards dedicated to EMC characteristics of board mounted component dc-dc converters exist.

With the addition of a single stage external filter, the QMW converter will pass the requirements of MIL-STD-461F CE102 Base Curve for conducted emissions.

Absence of the Remote Sense Pins and Trim Up/Down Feature

Customers should be aware that QMW converters do not have a Remote Sense feature and Output Voltage Trim Up/Down feature. Care should be taken to minimize voltage drop on the user's motherboard.

Non-standard output voltages are available. Please contact the factory for additional information.

Thermal Consideration

The QMW converter can operate in a variety of thermal environments. However, in order to ensure reliable operation of the converter, sufficient cooling should be provided. The QMW converter is encapsulated in plastic case with metal baseplate on the top. In order to improve thermal performance, power components inside the unit are thermally coupled to the baseplate. In addition, thermal design of the converter is enhanced by use of input and out pins as heat transfer elements. Heat is removed from the converter by conduction, convection and radiation.
There are several factors such as ambient temperature, airflow, converter power dissipation, converter orientation how converter is mounted as well as the need for increased reliability that need to be taken into account in order to achieve required performance. It is highly recommended to measure temperature in the middle of the baseplate in particular application to ensure that proper cooling of the convert is provided.
A reduction in the operating temperature of the converter will result in an increased reliability.

Thermal Derating

There are two most common applications: 1) the QMW converter is thermally attached to a cold plate inside chassis without any forced internal air circulation; 2) the QMW converter is mounted in an open chassis on system board with forced airflow with or without an additional heatsink attached to the baseplate of the QMW converter.

The best thermal results are achieved in application 1) since the converter is cooled entirely by conduction of heat from the top surface of the converter to a cold plate and temperature of the components is determined by the temperature of the cold plate. There is also some additional heat removal through the converters pins to the metal layers in the system board. It is highly recommended to solder pins to the system board rather than using receptacles. Maximum Power derating vs. base plate temperature is shown in Fig. A. Note that values of available output power for given base plate temperature in Fig A can vary between 5% -10% from sample to sample. Operating converter at the limits provided in Fig.A for prolonged time will affect reliability.

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Soldering Guidelines

The ROHS-compliant through hole QMW converter uses Sn/Ag/Cub-free solder and ROHS compliant components. They are designed to be processed through wave soldering machines. The pins are 100% matte tin over nickel plated and compatible with both Pb and Pb-free wave soldering processes. It is recommended to follow specifications below when installing and soldering QMW converter. Exceeding these specifications may cause damage to the QMW converter.

Wave Solder Guideline for Sn/Ag/Cu based solders	
Maximum Preheat Temperature	115ºC
Maximum Pot Temperature	270ºC
Maximum Solder Dwell Time	7 seconds

Wave Solder Guideline for SN/Pb based solders	
Maximum Preheat Temperature	105ºC
Maximum Pot Temperature	250ºC
Maximum Solder Dwell Time	6 seconds

QMW converters are not recommended for water wash process. Contact the factory for additional information if water wash is necessary.

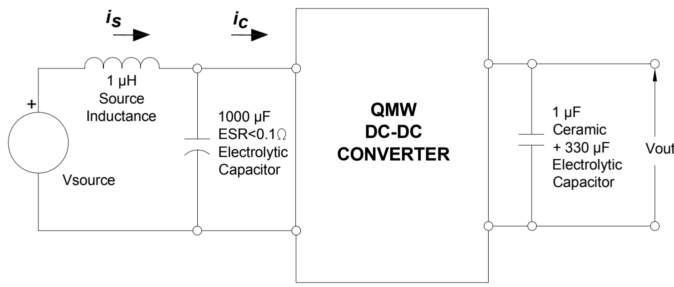

Fig. 2: Test setup for measuring input reflected ripple currents i_C and i_S.

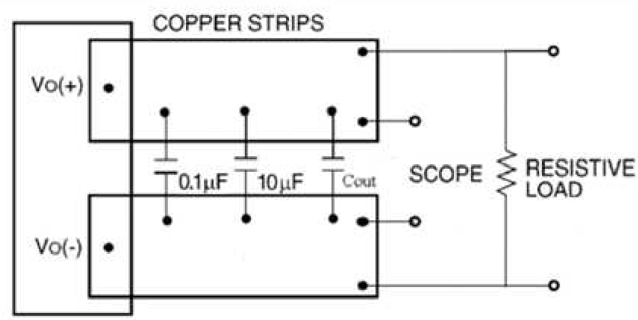

Fig. 3: Test setup for measuring output voltage ripple, startup and step load transient waveforms.

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Characteristic Curves – Efficiency and Power Dissipation

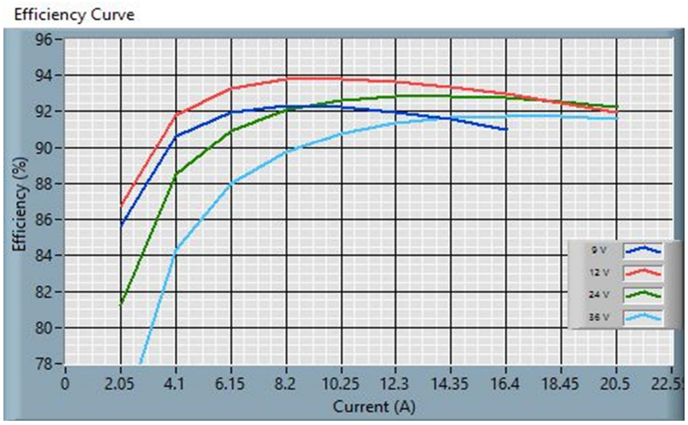


Fig. 4: Efficiency Curve

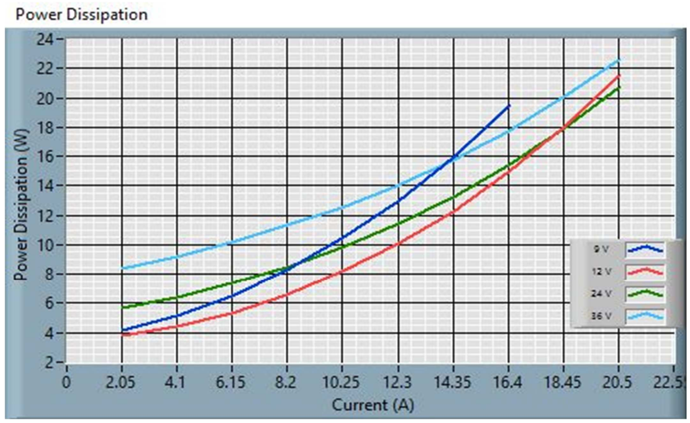


Fig. 5: Power Dissipation

Characteristic Waveforms

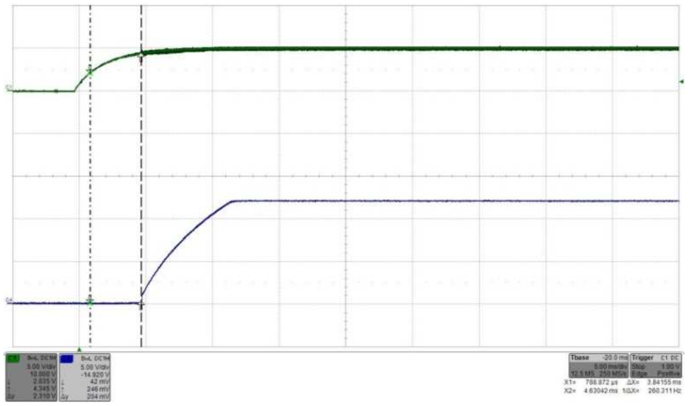


Fig. 6: Turn-on by ON/OFF transient (with V_{IN} applied) at full rated load current (resistive) at V_{IN} = 24V. Top trace (C1): ON/OFF signal (5V/div.). Bottom trace (C4): Output voltage (5 V/div.). Time 5 ms/div.

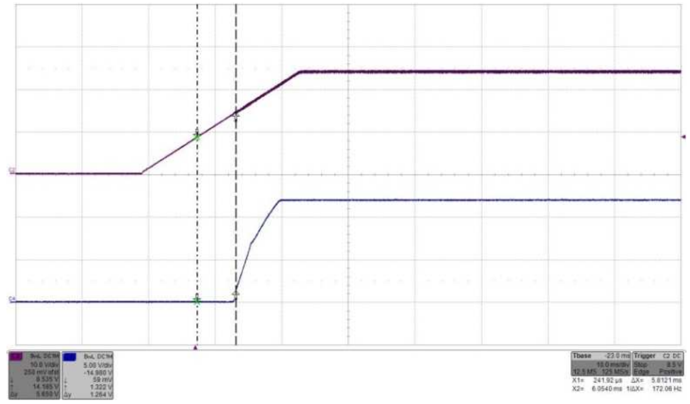


Fig. 7: Turn-on by V_{IN} transient (ON/OFF high) at full rated load current (resistive) at V_{IN} = 24V. Top trace (C2): Input voltage V_{IN} (10 V/div.). Bottom trace (C4): Output voltage (5 V/div.). Time 10 ms/div.

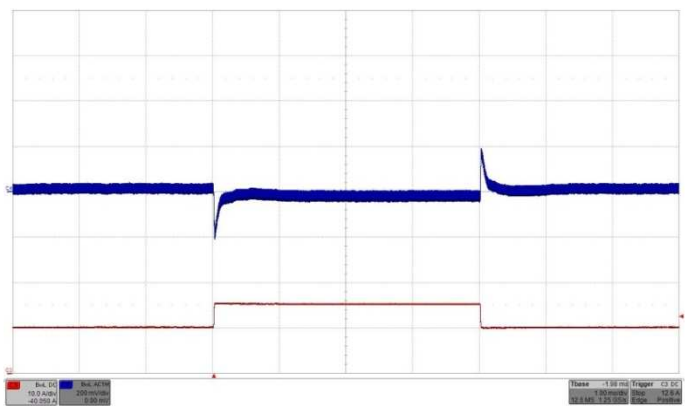


Fig. 8: Output voltage response to load current step change 50% - 75% - 50% (10A – 15A – 10A) with di/dt = 1A/µs at V_{IN} = 24V. Top trace (C4): Output voltage (200 mV/div.). Bottom trace (C3): Load current (10A/div.). C_O 330µF/75mΩ. Time: 1ms/div.

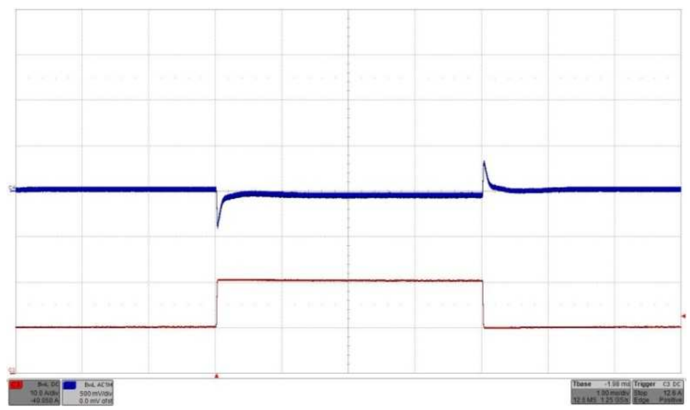


Fig. 9: Output voltage response to load current step change 50% - 100% - 50% (10A – 20A – 10A) with di/dt = 1A/µs at V_{IN} = 24V. Top trace (C4): Output voltage (500 mV/div.). Bottom trace (C3): Load current (10A/div.). C_O 330µF/75mΩ. Time: 1ms/div.

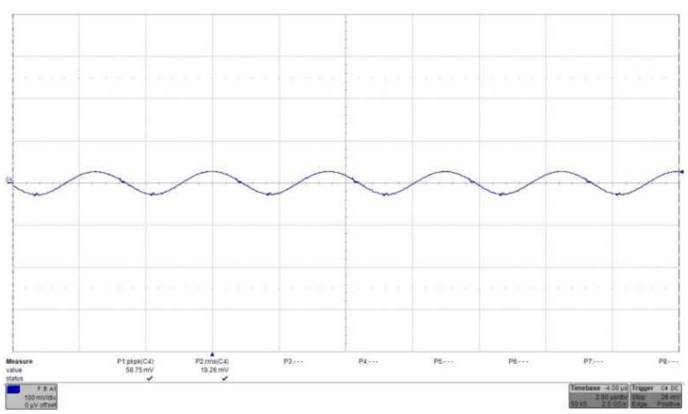


Fig. 10: Output voltage ripple (100mv/div.) at full rated load at V_{IN} = 24V. C_O 330µF/75mΩ. Time: 2µs/div.

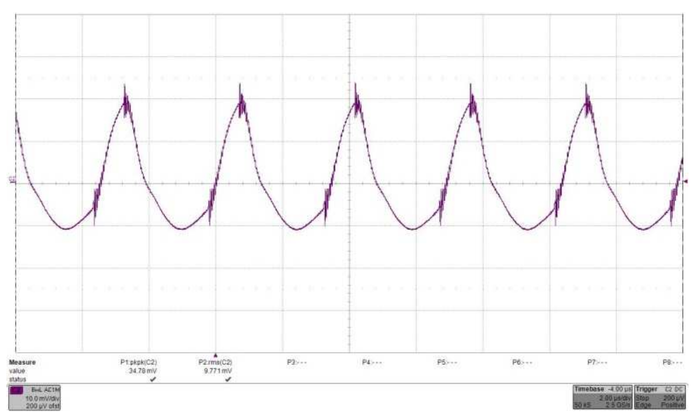
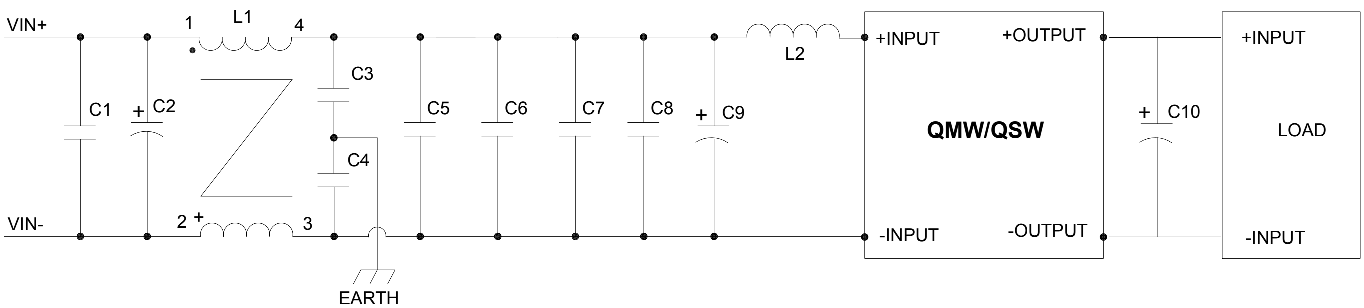


Fig. 11: Input reflected ripple current, i_C (10A/div), measured at input terminals at full rated load current at V_{IN} = 24V. Refer to Fig. 2 for test setup. Time: 2 µs/div. RMS input ripple current is 4.85A.

EMC Consideration:

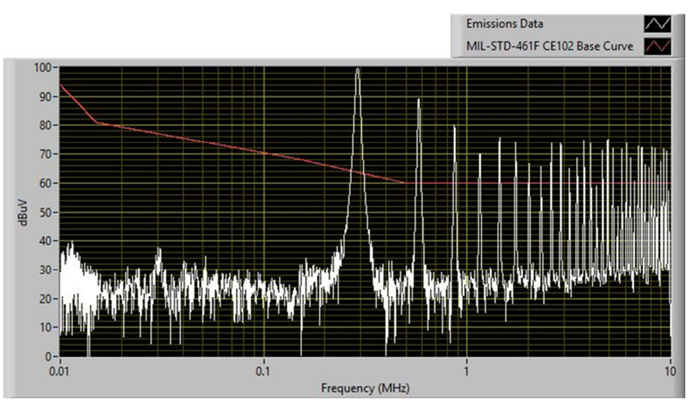
The filter schematic for suggested input filter configuration as tested to meet the conducted emission limits of MIL-STD-461F CE102 Base Curve is shown in Fig. 12. The plots of conducted EMI spectrum are shown in Fig 13.

Note: Customer is ultimately responsible for the proper selection, component rating and verification of the suggested parts based on the end application.

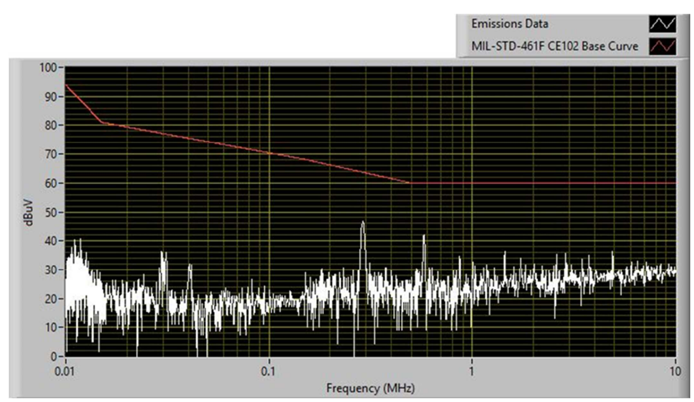


Comp. Des.	Description
C1, C5, C6, C7, C8	10µF/1210/X7R/50V Ceramic Capacitor
C2	220µF/50V Electrolytic Capacitor (Vishay MAL214699106E3 or equivalent)
C3, C4	4.7nF/1206/X7R/1500V Ceramic Capacitor
C9, C10	330µF/50V Electrolytic Capacitor (Vishay MAL214699107E3 or equivalent)
L1	300µH, CM Choke (6 turns on toroid 22.1mm x 13.7mm x 7.92mm) L_{lkg} = 1.2µH, R_{dc} =2mΩ
L2	0.22uH/32A inductor (IHLP3232CZERR22M01 – Vishay)

Fig.12: Typical input EMI filter circuit to attenuate conducted emissions per MIL-STD-461F CE102 Base Curve.



a) Without input filter. C9 = 330µF/50V.



b) With input filter from Fig. 12.

Fig. 13: Input conducted emissions measurement (Typ.) of 24S12.20QMW (ROHS)

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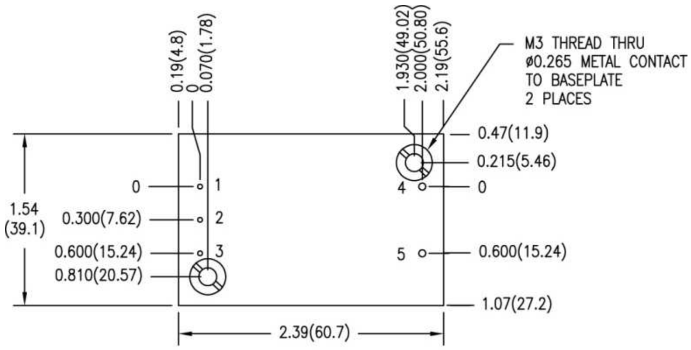
Mechanical Specification:



Notes:
Unless otherwise specified:
All dimensions are in inches [millimeters]
Tolerances: x.xx in. ±0.02 in [x.x mm ±0.5mm]
x.xxx in. ±0.010 in [x.xx mm ±0.25mm]
Torque fasteners into threaded mounting inserts at 10in.lbs. or less. Greater torque may result in damage to unit and void the warranty.

Input Output Connections:

Pin	Name	Function
1	-INPUT	Negative input voltage
2	ON/OFF	TTL input with internal pull up, referenced to –INPUT, used to turn converter on and off
3	+INPUT	Positive input voltage
4	-OUTPUT	Negative output voltage
5	+OUTPUT	Positive output voltage

Notes:
1) Pinout is inconsistent between manufacturers of the quarter brick converters. Follow the table above.

Vitec POWER GmbH
Bahnstraße 65-67/2/2, 2230 Gänserndorf, AUSTRIA
Tel.: +43 (0) 2282 3144, E-Mail: office@vitecpower.com