FQB DC-DC Transient Filter

-40V to 40V Wide Input, 20A Quarter Brick

FQB transient filter modules are designed to help reduce differential and common mode conducted emissions from dc-dc switching power supplies, and they contain transient suppression circuitry to block voltage spikes and surges. The modules take advantage of TDK technologies and simplify compliance for 28V systems. The low resistance quarter brick package offers high performance, and a wide input voltage operation range. The rugged package design with encapsulation and multiple baseplate options make FQB modules suitable for use in a wide variety of harsh and demanding environments, including MIL-COTs.

Features

- Size – 60.6mm x 55.9 mm x 12.7 mm (2.39 in. x 2.2 in. x 0.5 in.) – flanged base plate
- Encapsulated for rugged environments
- Qualification methods consistent with MIL-STD-883F, MIL-STD-202G, and MIL-STD-810
- Through hole pins 4.57mm tail length
- Up to 20A of current
- Low DC resistance and power Loss
- High Differential and Common Mode Noise Attenuation to support MIL-STD-461 requirements
- Current Limiting and Short Circuit Protection
- Input Under and Over voltage Protection
- Reverse Polarity Protection
- Soft-start to reduce inrush currents
- On/Off pass-through
- Highly reliable ceramic capacitors
- 2250Vdc isolation
- Spike and surge suppression for MIL-STD-1275D,E
- Spike and surge suppression for RTCA/DO-160 section 16-18 and MIL-HDBK-704-8 (A through F)
- ISO Certified manufacturing facilities

Options

- Size - 60.6mm x 39.5 mm x 12.7 mm (2.39 in. x 1.56 in. x 0.5 in.) – non-flanged base plate
- Enhanced Reliability M grade Screening

Ordering information:

Product Identifier	Package Size	Platform	Output Current	Output Units	Filter Type		Feature Set Indicator		Screening Indicator
F	Q	B	020	A	DC	-	007	-	S
Filter	Quarter brick	B series	020 - 20	A – Amps	DC – DC-DC Filter		007 – Standard		S- Standard M- Enhanced

Option Table:

Feature Set	0.180" Pin Length	Flanged Base Plate	Non-Flanged Base Plate	Standard Screening	Enhanced Screening
007-S	X	X		X	
N07-S	X		X	X	
007-M	X	X			X
N07-M	X		X		X

Product Offering:

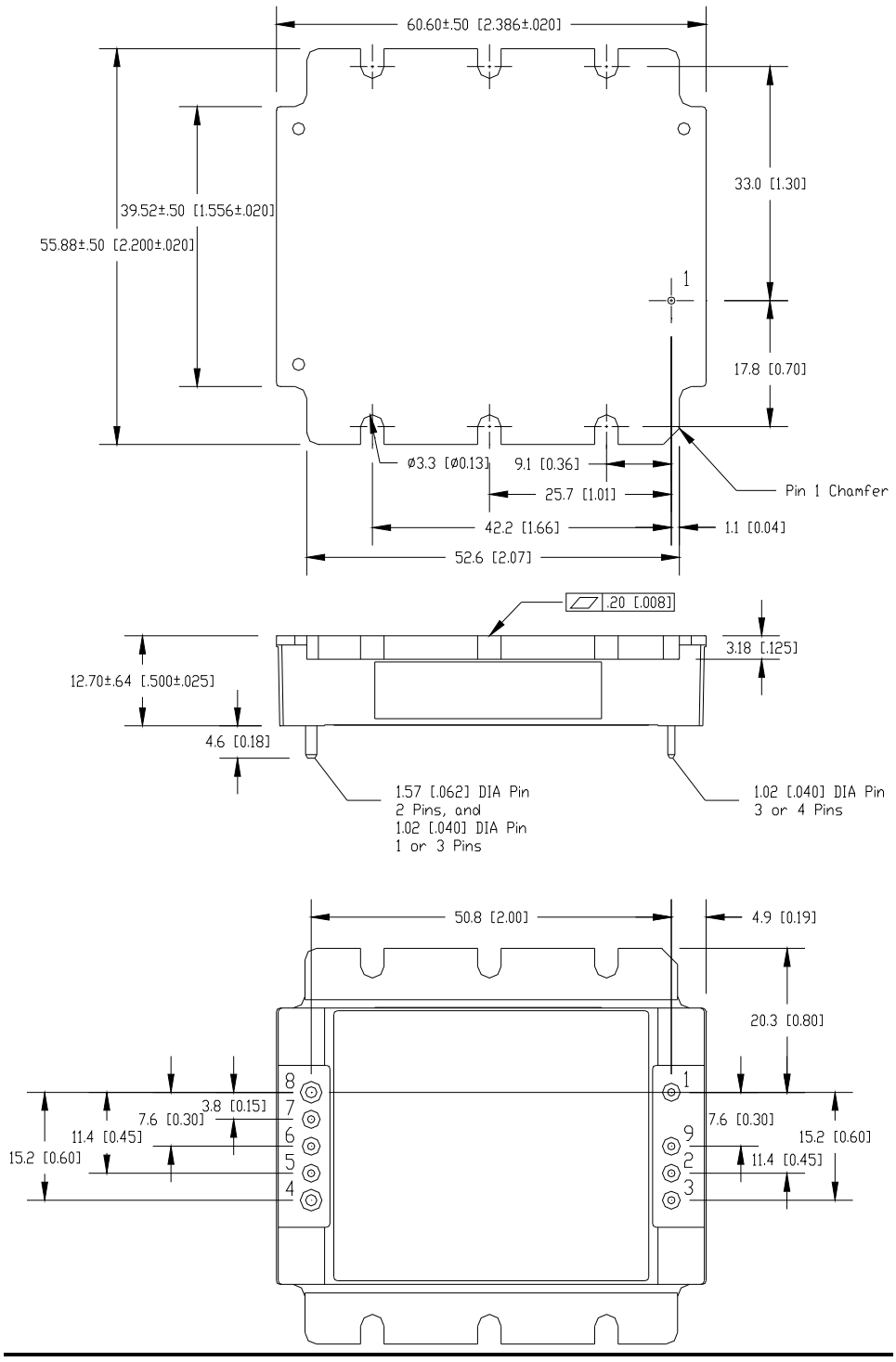
Code	Vin	Iout (A)
FQB020ADC-007-S	-40-40	20
FQB020ADC-N07-S	-40-40	20
FQB020ADC-007-M	-40-40	20
FQB020ADC-N07-M	-40-40	20

401 Mile Cars Way, Suite 125
National City, CA 91950
Phone (800)526-2324 Toll Free

Lambda.TechSupport@us.tdk-lambda.com
www.us.tdk-lambda.com/lp/

Mechanical Specification: (with flange)

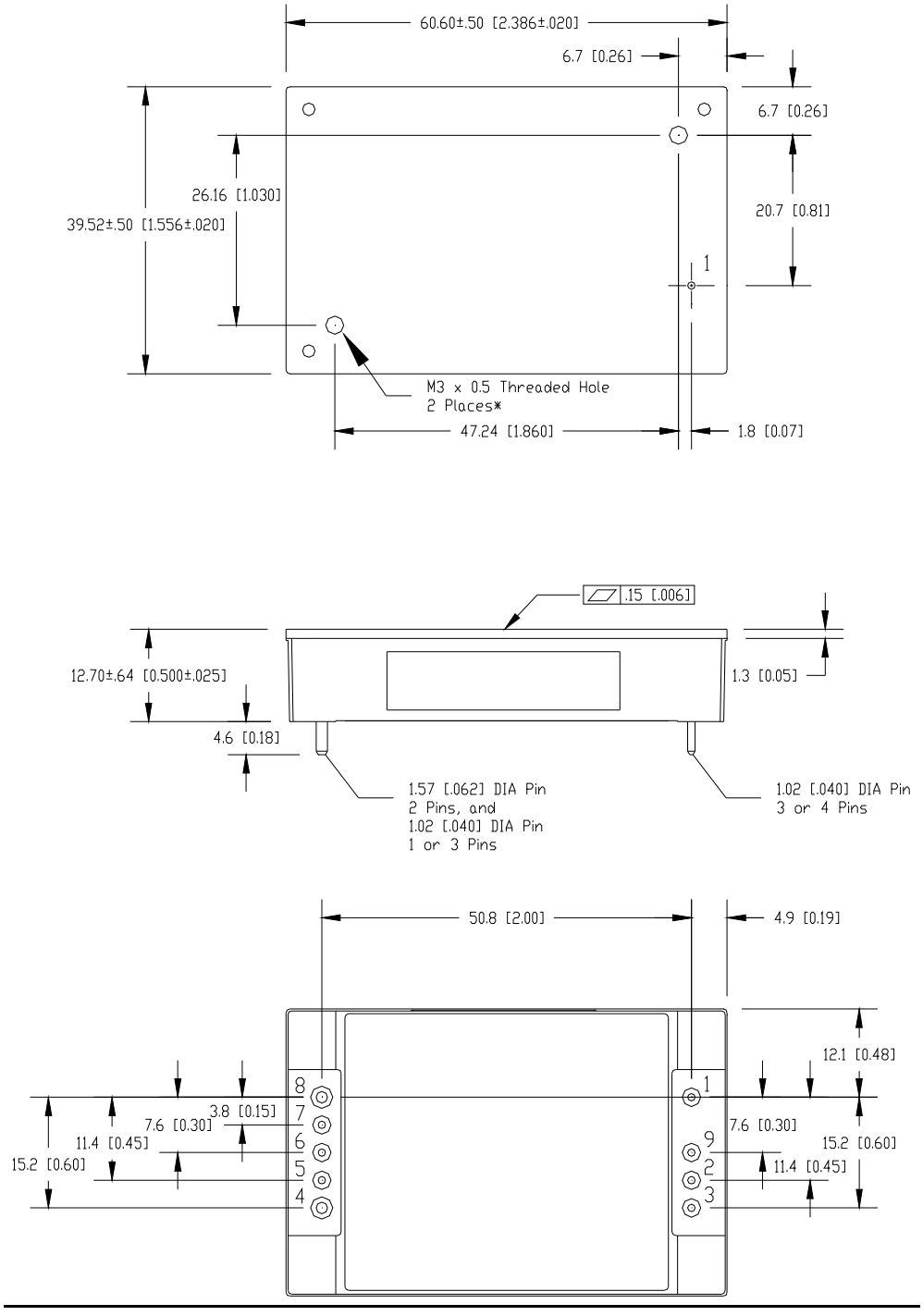
Dimensions are in mm [in]. Unless otherwise specified tolerances are:
x.x [x.xx] ± 0.5 [0.02] , x.xx [x.xxx] ± 0.25 [0.010]



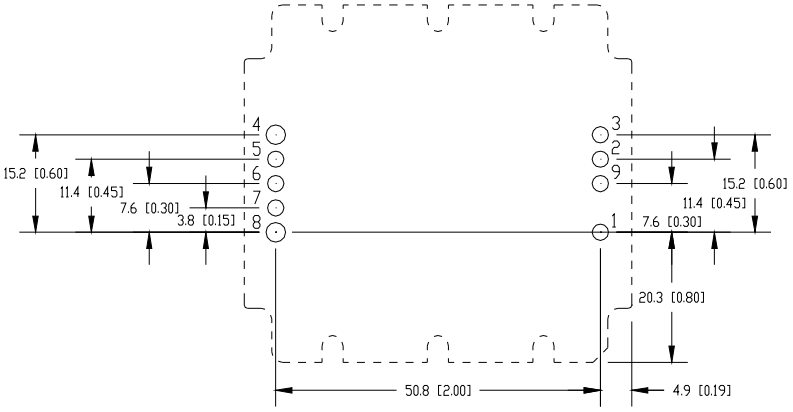
Mechanical Specification: (no flange)

Dimensions are in mm [in]. Unless otherwise specified tolerances are:
x.x [x.xx] ± 0.5 [0.02] , x.xx [x.xxx] ± 0.25 [0.010]

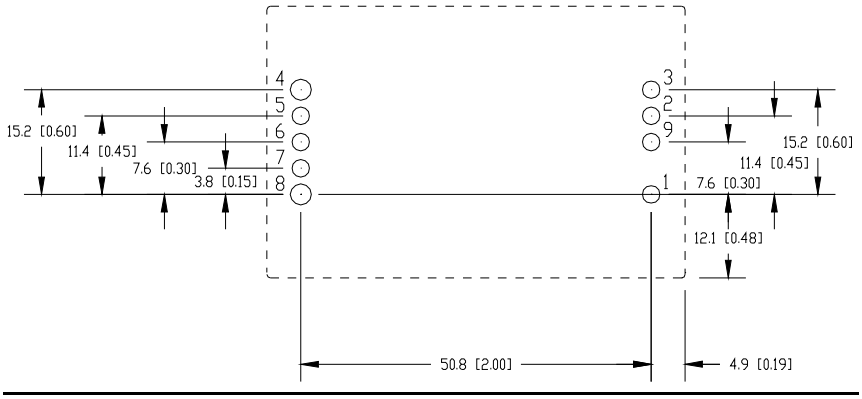
To avoid damaging components, do not exceed 3.0mm [0.12”] depth for M3 screws



Recommended Hole Pattern: (top view with flange)



(without flange)



Pin Assignment:

PIN	FUNCTION	PIN	FUNCTION
1	Vin(+)	4	Vo(-) connect to power module's Vin(-) pin
9	COM (IN) connect to system ground	5	No connect
2	On/Off (IN)	6	COM (OUT) connect to ground plane of power module
3	Vin(-)	7	On/Off (OUT) connect to on/off pin of power module
		8	Vo(+)connect to power module's Vin(+) pin

Pin base material is tellurium copper with tin over nickel plating; the maximum module weight is 100g (3.5oz)

Absolute Maximum Ratings:

Stress in excess of Absolute Maximum Ratings may cause permanent damage to the device.

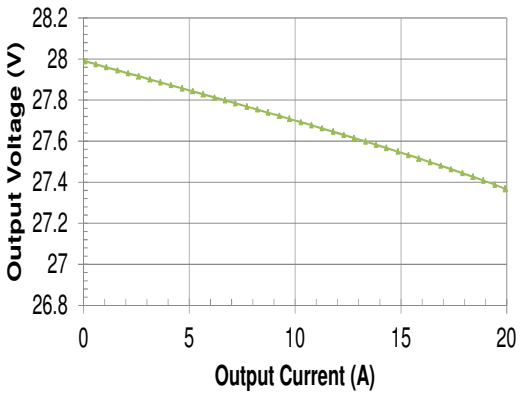
Characteristic		Min	Max	Unit	Notes & Conditions
Continuous Input Voltage		-40	40	Vdc	
Control pins		-0.5	50	V	
Transient Input Voltage		-50	210	V	(t < 1s, varies w/ loading)
Isolation Voltage		---	2250	Vdc	Common Pins to other pins
		---	2250	Vdc	Baseplate to Input or Output
Storage Temperature		-65	125	˚C	
Operating Temperature Range (Tc)	-S option	-40	115	˚C	Measured at the location specified in the thermal measurement figure. Maximum temperature varies with model number, output current, and module orientation – see curve in thermal performance section of the data sheet.
	-M option	-55	115	˚C	

Electrical Characteristics:

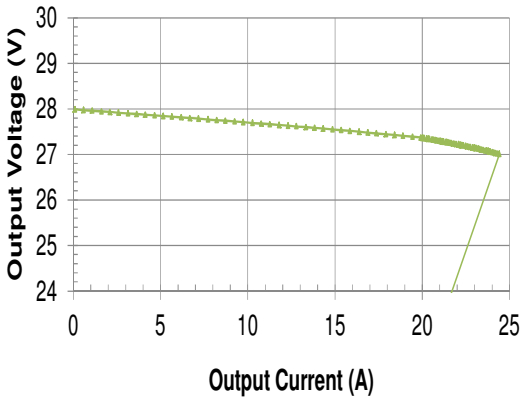
Unless otherwise specified, specifications apply over all rated Input Voltage, Resistive Load, and Temperature conditions.

Characteristic	Min	Typ	Max	Unit	Notes & Conditions
Continuous Input Voltage	-40	---	40	Vdc	
Transient Input Voltage	-50	---	202	V	(t < 1s, varies w/ loading, refer to input surge protection)
Turn-On Voltage	---	8.5	---	Vdc	
Turn-Off Voltage	---	8.3	---	Vdc	
Resistance Positive Leg	---	25	---	mohm	
Resistance Negative Leg	---	5	---	mohm	
Power Loss	---	12.5	---	W	20A output current
Zero Load Input Current	---	3	---	mA	Vin =28V
Standby Input Current	---	1.5	---	mA	Vin = 28V, Input On/Off = off
Maximum Current	---	---	20	A	
Output capacitance	---	---	3000	uF	Contact TDK-Lambda if different range is required
Differential Mode Attenuation at 300 KHz	---	50	---	dB	50 ohm source & load impedance
Common Mode Attenuation at 1 MHz	---	30	---	dB	50 ohm source & load impedance

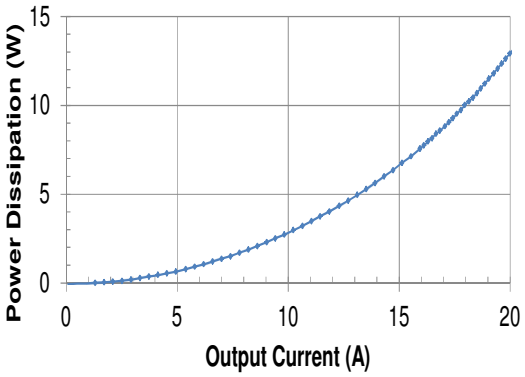
Electrical Characteristics:



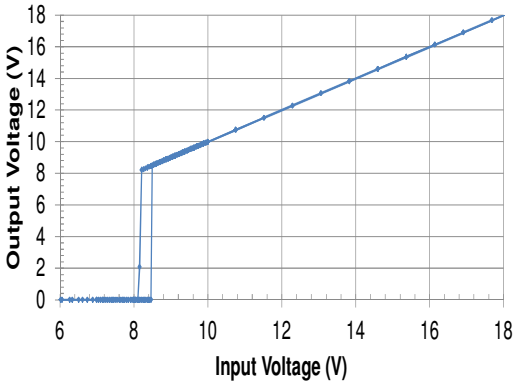
FQB typical load regulation characteristic



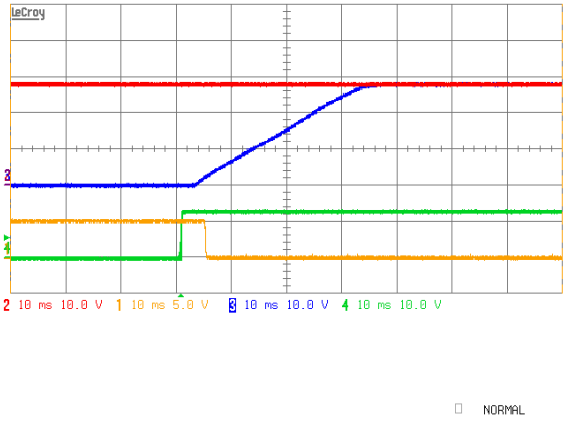
FQB typical current limiting characteristic



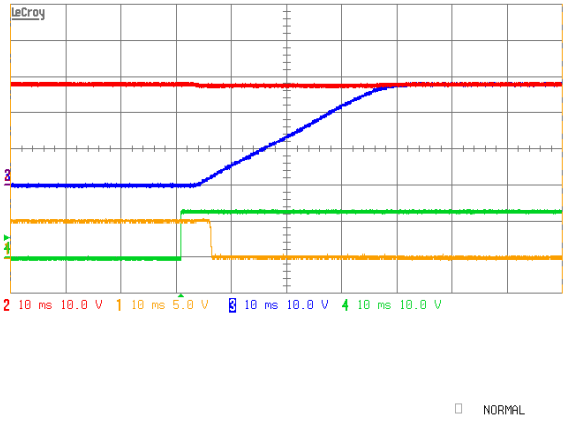
FQB typical power loss characteristics



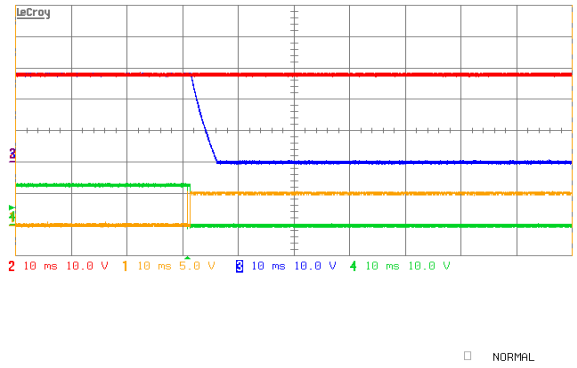
FQB typical input voltage versus output voltage characteristics



FQB typical startup from input on/off signal application, Io=0.5A

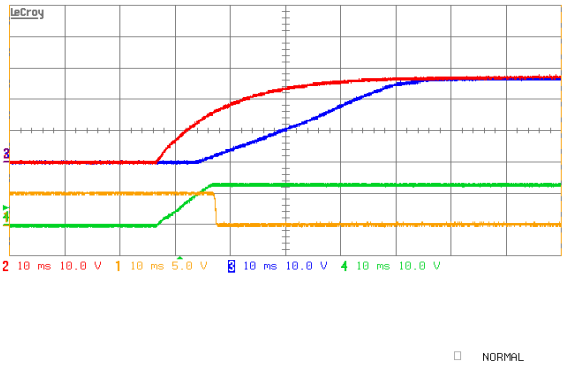


FQB typical startup from input on/off signal application w/ 5000uF electrolytic load capacitor, Io=0.5A



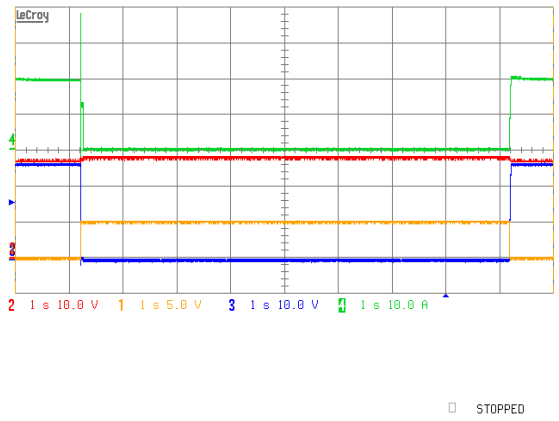
Ch3=Vout, Ch2 = Vin, Ch1 = On/off (out), Ch4 = On/off (in)

FQB typical shut down from input on/off signal application, Io=0.5A



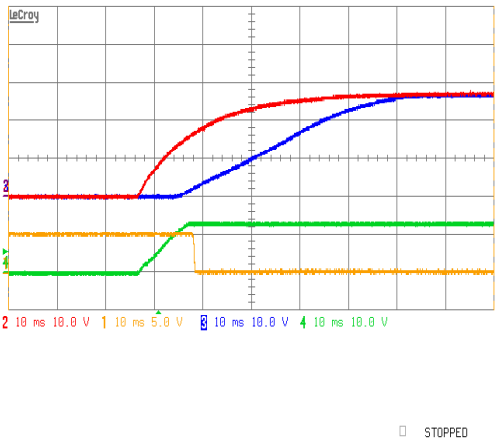
Ch3=Vout, Ch2 = Vin, Ch1 = On/off (out), Ch4 = On/off (in)

FQB typical startup from input voltage application, Rload = 1.4 ohm = 20A at 28V



Ch3=Vout, Ch2 = Vin, Ch1 = On/off (out), Ch4 = Iout

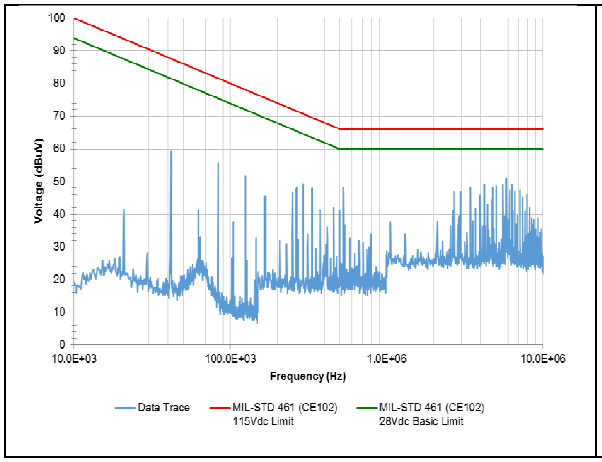
FQB typical response to severe overload event at output, (1s/div)



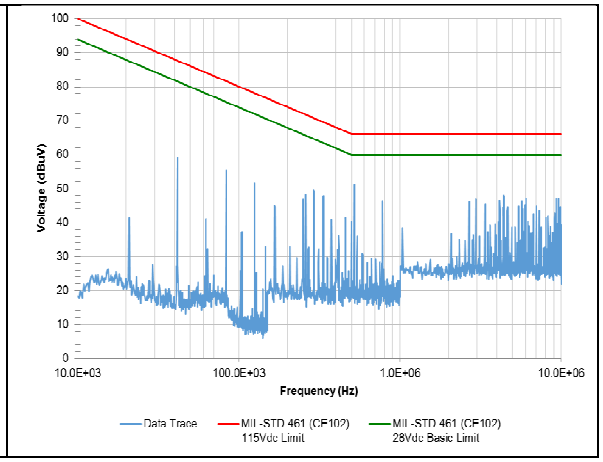
Ch3=Vout, Ch2 = Vin, Ch1 = On/off (out), Ch4 = On/off (in)

FQB typical startup from input voltage application, Rload = 1.4 ohm = 20A at 28V w/ 5,000uF electrolytic load capacitor

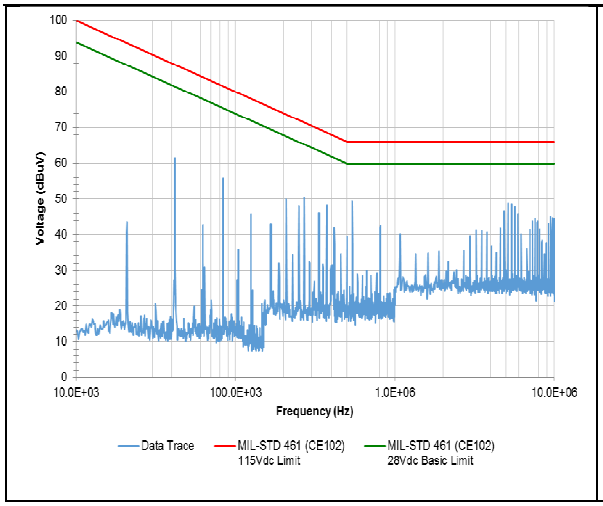
Electrical Characteristics: MIL-STD-461G Method CE102



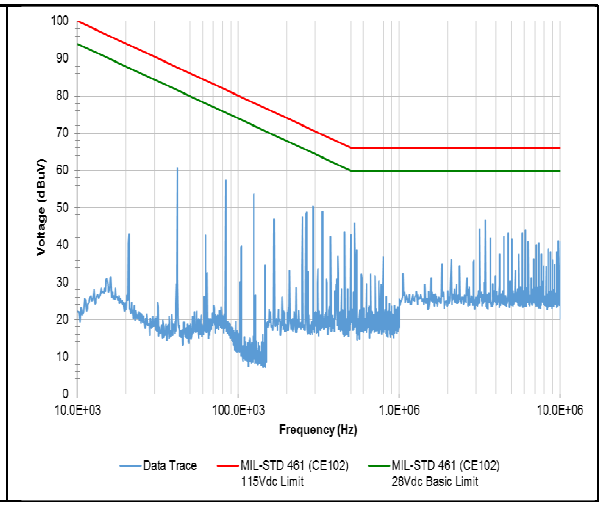
HQA24120W480V-007-S typical conducted emissions with FQB filter module and 0.01uF common mode capacitors



HQA2W120W280V-007-S typical conducted emissions with FQB filter module and 0.01uF common mode capacitors

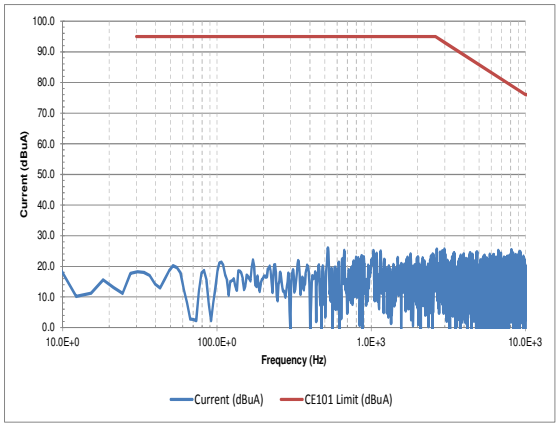


HQA2W120W120V-007-S typical conducted emissions with FQB filter module and 0.01uF common mode capacitors

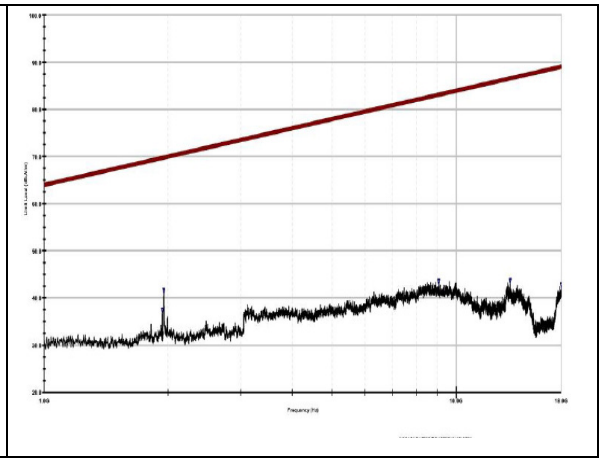


HQA2W120W050V-007-S typical conducted emissions with FQB filter module and 0.01uF common mode capacitors

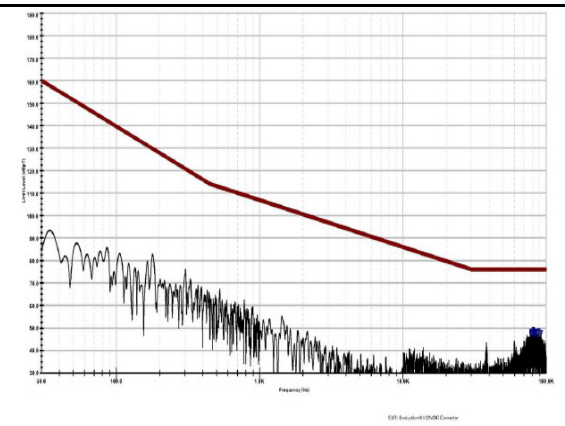
Electrical Characteristics:



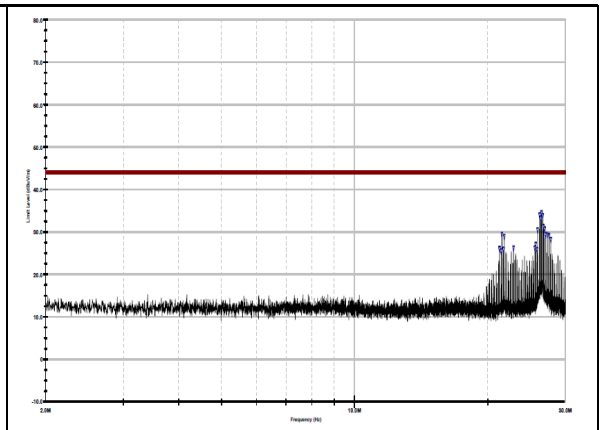
MIL-STD-461G Method CE101 Typical Low Frequency Conducted Emissions



MIL-STD-461 Method RE102 Typical High Frequency Radiated Emissions

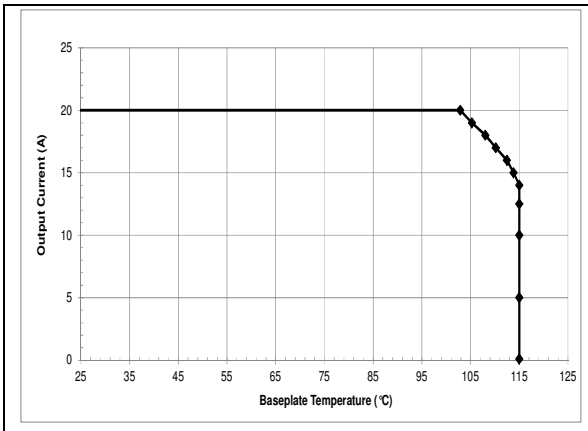


MIL-STD-461G Method RE101 Typical Low Frequency Radiated Emissions

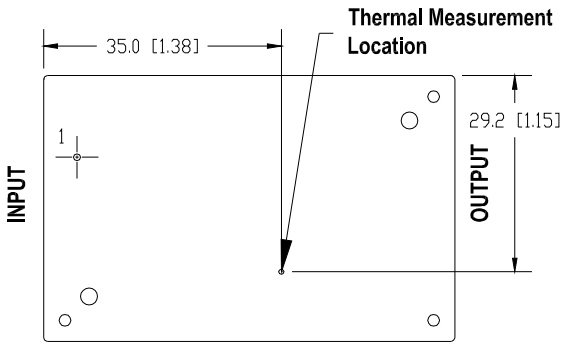


MIL-STD-461 Method RE102 Typical High Frequency Radiated Emissions

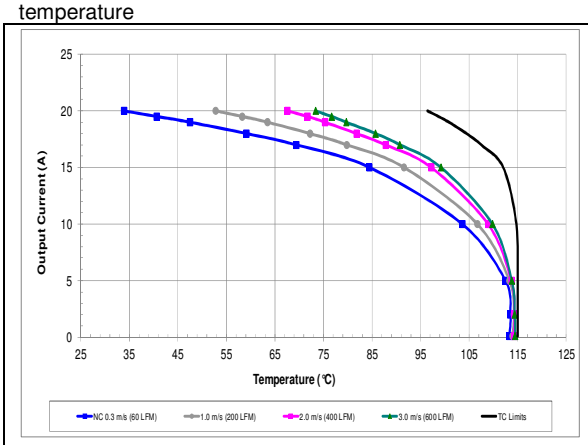
Thermal Performance:



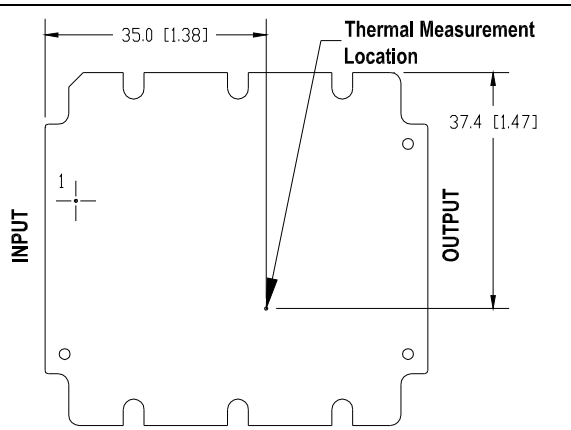
FQB020ADC maximum output current vs. baseplate temperature



FQB020ADC thermal measurement location – top view



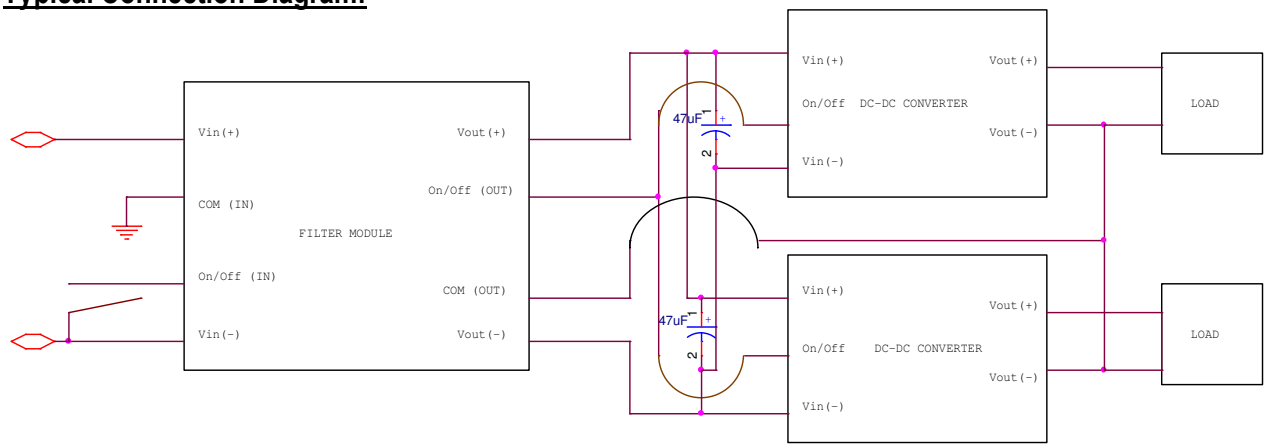
Maximum output current vs. ambient temperature at nominal input voltage for natural convection (60lfm) to 400lfm with airflow from pin 1 to pin 3.



FQB020ADC thermal measurement location – top view

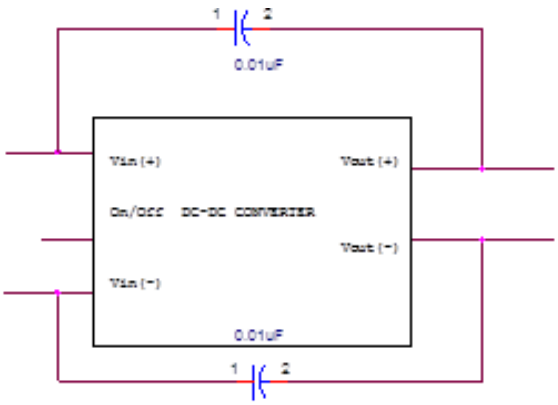
The thermal curves provided are based upon measurements made in TDK Lambda's experimental test setup that is described in the Thermal Management section. Due to the large number of variables in system design, TDK Lambda recommends that the user verify the module's thermal performance in the end application. The critical component should be thermocoupled and monitored, and should not exceed the temperature limit specified in the derating curve above. It is critical that the thermocouple be mounted in a manner that gives direct thermal contact or significant measurement errors may result. TDK Lambda can provide modules with a thermocouple pre-mounted to the critical component for system verification tests.

Typical Connection Diagram:



When combined with an isolated HQA MIL-COTs dc-dc power module, the FQB filter typically produces noise attenuation that results in MIL-STD-461 compliance. The FQB modules are multi-stage differential and common mode emi filters that offer active circuitry to help protect downstream circuitry from a variety of faults and transient events.

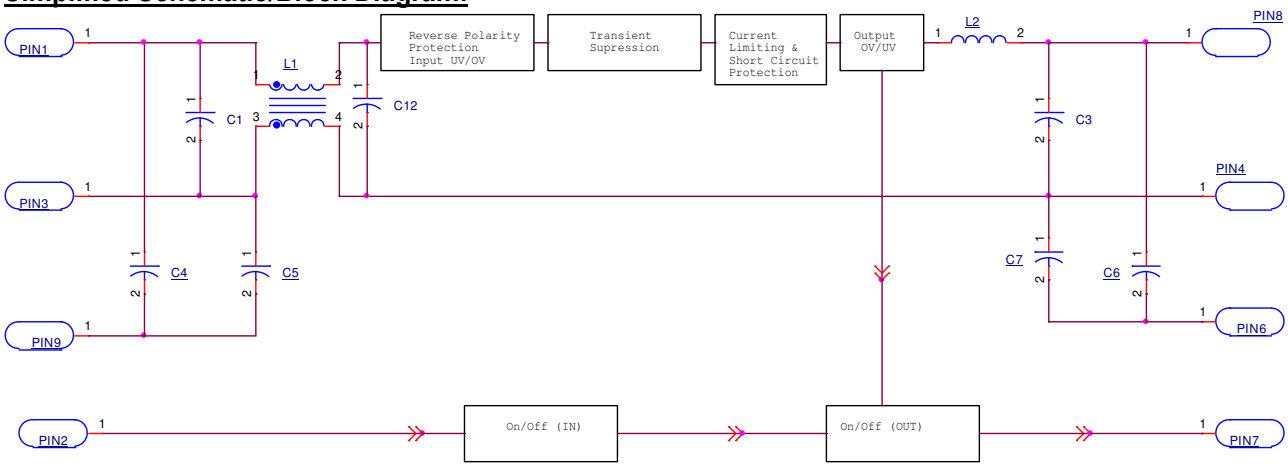
In typical applications the FQB module is placed close to the dc-dc module(s) it is filtering. The input side common mode, pin 9, is connected to the chassis ground used for emi measurement, while the output side, pin 6, is connected to the ground plane of the power modules.



Placing 0.01uF capacitors between the Vin(+) and Vo(+) pins and between Vo(-) to Vin(-) pins of the dc-dc converter is recommended. These capacitors will further reduce high frequency common-mode noise and minimize chance of layout related compliance issues.

Since these capacitors cross the dc-dc converter's isolation boundary, the capacitors must be selected to meet the system isolation requirements. The capacitors inside the FQB module are tested at 2250Vdc, but lower rated parts may be acceptable in many applications depending on the grounding configuration and system safety requirements.

Simplified Schematic/Block Diagram:



The FQB features high value TDK ceramic capacitors to help to avoid input filter oscillations that can be problematic with competitive solutions' highly inductive filter designs. In many applications C3 may be sufficient to ensure system stability without additional bulk capacitors. For added margin, particularly in higher power applications, or those operating at cold temperatures an additional bulk capacitance on the order of 47-220uF is recommended at the input of each dc-dc power module. The additional capacitance will offset source impedance and help ensure a stable input supply for the dc-dc converters.

The protection features reduce stress and risk for downstream equipment during events such as input voltage surges and spikes, overload, short circuit and reverse polarity.

In all applications, but particularly high current applications, the thermal and electrical performance should be confirmed in the end application.

Input Voltage Spike Suppression:

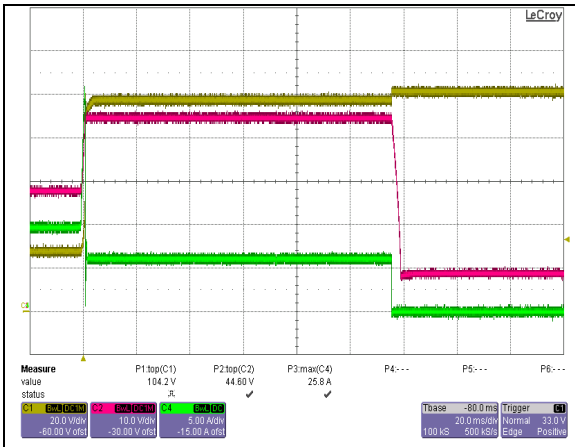
Vin = 28V, Pout = 280W unless otherwise specified

Characteristic	Min	Typ	Max	Unit	Notes & Conditions
+/- 250V, 100uS, 15mJ	--	5	--	V deviation	MIL-STD-1275 B,D
+/- 600V, 10uS, 50 ohm source impedance	--	5	--	V deviation	RTCA/DO-160G

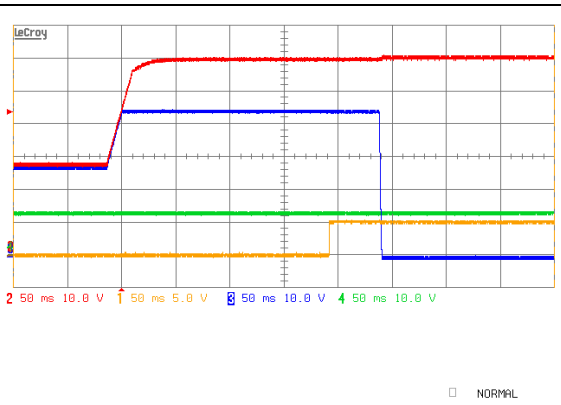
Input Voltage Surge Protection:

Vin = 28V, Pout = 280W unless otherwise specified

Characteristic – output during surge	Min	Typ	Max	Unit	Notes & Conditions
60V, 550mS	0	43.5	47	V	MIL-HDBK-704A
80V, 80mS	40	43.5	47	V	MIL-HDBK-704A
100V, 50mS	40	43.5	47	V	MIL-STD-1275D,E
174V, 350mS	0	43.5	47	V	DEF-STAN 61-5 Part 6, Po < 75W

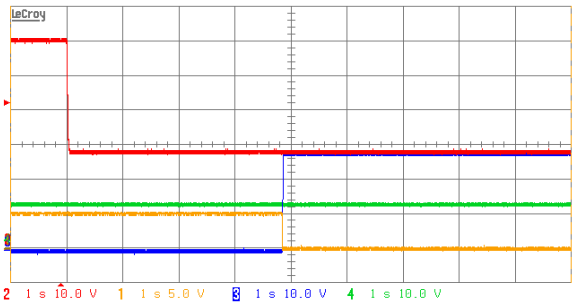


FQB typical response to 28V to 100V input voltage step, Time = 20ms/div, Ch1 = Vin (20V/div), Ch2 = Vo (10V/div)

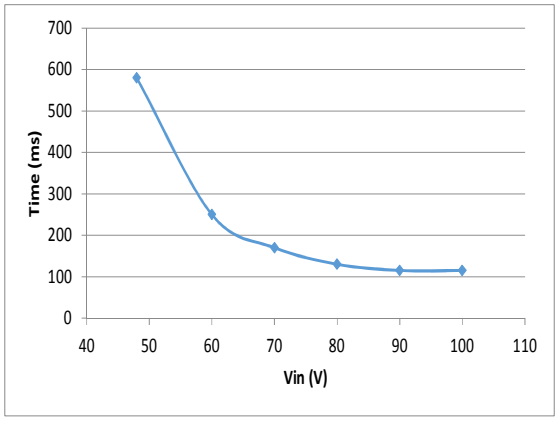


Ch1=Vout, Ch2 = Vin, Ch3 = On/off (out), Ch4 = On/off (in)

FQB typical response to 28V to 60V input voltage step, Time = 50mS/div



FQB typical auto-recovery response during 60V to 28V input voltage recovery, time = 1s/div



FQB typical input over-voltage shutdown envelope

Thermal Management:

An important part of the overall system design process is thermal management; thermal design must be considered at all levels to ensure good reliability and lifetime of the final system. Superior thermal design and the ability to operate in severe application environments are key elements of a robust, reliable power module.

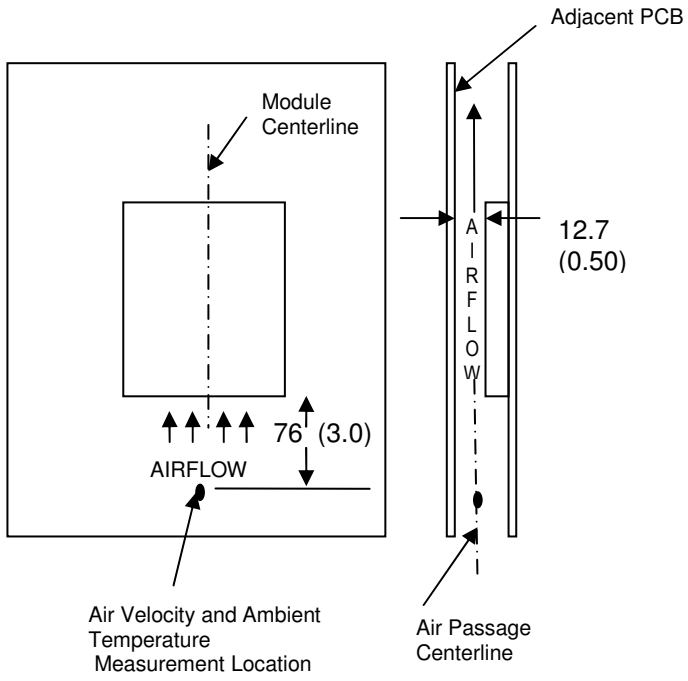
The mechanical design provides a low impedance thermal path from hot components to the base plate, which reduces areas of heat concentration and resulting hot spots.

Test Setup: The thermal performance of the power module was evaluated both in cold plate, conduction cooling environments and also in wind tunnel tests using the setup shown in the wind tunnel figure. The thermal test setups are intended to replicate some of the typical thermal environments that could be encountered in modern electronic systems.

The power module, as shown in the figure, is mounted on a printed circuit board (PCB) and is vertically oriented within the wind tunnel. The cross section of the airflow passage is rectangular. The spacing between the top of the module and a parallel facing PCB is kept at a constant (0.5 in). The power module's orientation with respect to the airflow direction can have an impact on the module's thermal performance.

Thermal Derating: For proper application of the power module in a given thermal environment, output current derating curves are provided as a design. The module temperature should be measured in the final system configuration to ensure proper thermal management of the power module.

For thermal performance verification, the module temperature should be measured at the base plate location indicated in the thermal measurement location figure on the thermal performance page for the power module of interest.



Wind Tunnel Test Setup Figure Dimensions are in millimeters and (inches).

In all conditions, the power module should be operated below the maximum operating temperature shown on the derating curve. For improved design margins and enhanced system reliability, the power module may be operated at temperatures below the maximum rated operating temperature.

In convection applications, heat transfer can be enhanced by increasing the airflow rate that the power module experiences. The maximum output current of the power module is a function of ambient temperature and airflow

Reverse Polarity Protection:

FQB power modules feature a mosfet in the power path that is held in an off condition to prevent reverse current flow if the input is attached with a reverse polarity.

During regular operation the switch is turned on. By using a mosfet in place of a blocking diode, the power loss and voltage drops typically associated with this protection feature are both significantly reduced.

Over Current Protection:

FQB power modules feature overload and short circuit protection features to protect against faults or excessive load current. During an overcurrent event, the FQB module will limit the output current and initiate a timer. Once the timer reaches its threshold, it will shut off the internal power switches to cool down and then attempt to auto-restart. The shut-down timing varies, becoming shorter as the severity of the fault increases.

The modules feature a soft start function to help avoid tripping the over-current protection feature while output load capacitors are charging.

Input Under and Over Voltage Protection:

FQB power modules feature input under voltage and over voltage protection circuits. If under or over voltage conditions are detected, the module will shut down. A graph of the input over-voltage shut down envelope is provided on the electrical characteristics charts. Once the input returns to a normal operating range, the units will auto-restart.

On/Off (IN):

FQB power modules feature a positive logic on/off feature at pin 2. The pin is referenced to pin 3, Vin(-), and it can be driven by an open-collector switch. The filter module will turn on if pin 2 is left open and will be off if pin 2 is connected to pin 3. If the positive logic circuit is not being used, pin 2 should be left open.

The maximum voltage generated by the FQB filter module at the on/off pin is 15V. The maximum allowable leakage current of the switch is 10uA. The switch must be capable of maintaining a low signal Von/off < 1.2V while sinking 1mA.

Fault Warning / On/Off (OUT):

FQB power modules feature a signal at pin 7 which can be used to interface directly and provide a negative logic remote on/off signal to one or more dc-dc converters.

Pin 7 features an open-collector switch which is referenced to pin 4 of the FQB module. When the FQB input on/off signal is set to an ON state and the FQB detects it has a power good condition, it will turn on the internal switch and enable the dc-dc converters.

When a current or voltage fault occurs, the internal switch will open allowing the dc-dc converters to turn-off and reducing the stress on the power system. The timing of the signal varies, becomes shorter as the severity of the fault increases.

When using this feature the stress on the dc-dc converters and FQB module are reduced, enhancing overall system reliability. The timing characteristics of the surge protection and on/off signal must both be taken into account when determining load availability and system compliance.

The internal switch is rated for 30V and has a maximum leakage current of 20uA. When on, the switch has a maximum resistance of 20 ohms and can sink 50mA.

Alternatively, Pin 7 can be used as a power good signal to provide an early indication of a pending fault.

When an input over-voltage fault is detected, the on/off (out) switch will turn-off the internal pull down switch for typically 50mS before the FQB output is shut down. If the fault condition is removed before the timer triggers the shutdown, normal operation will resume.

Test Options:

OPERATION	S-Grade	M-Grade
Functional Test	Functional Test	Cold, Room, and Hot Test
Burn In	Yes	Extended, 96 hour
Temperature Cycling	N/A	10 Cycles
Hi-Pot	2250Vdc	2250Vdc
Visual Inspection	Yes	Yes

Compliance Testing:

MIL-STD 461G

Tested using TDK-Lambda evaluation kit containing FQB020ADC-007-S transient filter, combined with HQA2W120W280V-007-S and HQA2W120W050V-007-S power modules and a 200W resistive load.

	Tested to most stringent test listed
Radiated Emissions	
RE101	Navy
RE102	10KHz to 18GHz Fixed Wing internal, >25m Nose to Tail
Conducted Emissions	
CE101	Surface ships and submarine,
CE102	Basic Curve
Conducted Susceptibility	
CS101	Curve 2, Imax=10A
CS114	Curve 5
CS115	Basic Test Signal
CS116	10KHz to 100MHz

Reliability:

The power modules are designed using TDK-Lambda's stringent design guidelines for component derating, product qualification, and design reviews. Early failures are screened out by both burn-in and an automated final test.

Improper handling or cleaning processes can adversely affect the appearance, testability, and reliability of the power modules. Contact technical support for guidance regarding proper handling, cleaning, and soldering of TDK Lambda's power modules.

Safety Considerations:

As of the publishing date, certain safety agency approvals may have been received on the FQB series and others may still be pending. Check with TDK Lambda for the latest status of safety approval on the FQB product line.

For safety agency approval of the system in which the DC-DC power module is installed, the power module must be installed in compliance with the creepage and clearance requirements of the safety agency. The isolation is operational insulation. Care must be taken to maintain minimum creepage and clearance distances when routing traces near the power module.

As part of the production process, the power modules are hi-pot tested from primary and secondary at a test voltage of 2250Vdc.

To preserve maximum flexibility, the power modules are not internally fused. An external input line normal blow fuse with a maximum value of 30A is required by safety agencies. A lower value fuse can be selected based upon the maximum dc input current and maximum inrush energy of the power module.

The module meets all of the requirements for SELV, provided that the input meets SELV requirements.

Warranty:

TDK Lambda's comprehensive line of power solutions includes efficient, high-density DC-DC converters. TDK Lambda offers a three-year limited warranty. Complete warranty information is listed on our web site or is available upon request from TDK Lambda.

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