TAQ06S12B-4
DC-DC Converter Technical Manual V1.1

Nonstandard Brick DC-DC Converter	42–160 V Input	12 V Output	6 A Current	Negative Logic

Product Description

The TAQ06S12B-4 is a new generation isolated DC-DC converter that uses an industry nonstandard quarter-brick structure, featuring high efficiency and power density with low output ripple and noise. It operates over an input voltage range of 42 V to 160 V, and provides the rated output voltage of 12 V as well as the maximum output current of 6 A.

TAQ06S12B-4

Operational Features

- Input voltage: 42–160 V
- Output current: 0–6 A
- Efficiency: 92.5% (V_{in} = 72 V, I_{out} = 6 A)
  91.0% (V_{in} = 110 V, I_{out} = 6 A)

Control Features

- Remote On/Off
- Output voltage trim

Mechanical Features

- Industry nonstandard quarter-brick (L x W x H): 60.6 x 39.0 x 12.7 mm (2.39 x 1.54 x 0.50 in.)
- Weight: 100 g

Protection Features

- Input undervoltage protection
- Output overcurrent protection (hiccup mode)
- Output short circuit protection (hiccup mode)
- Output overvoltage protection (hiccup mode)
- Overtemperature protection (self-recovery)

Safety Features

- UL, CE, TUV certification
- CB report available
- UL60950-1, C22.2 No. 60950-1, EN60950-1, IEC60950-1, and EN50155 compliant
- RoHS6 compliant

Applications

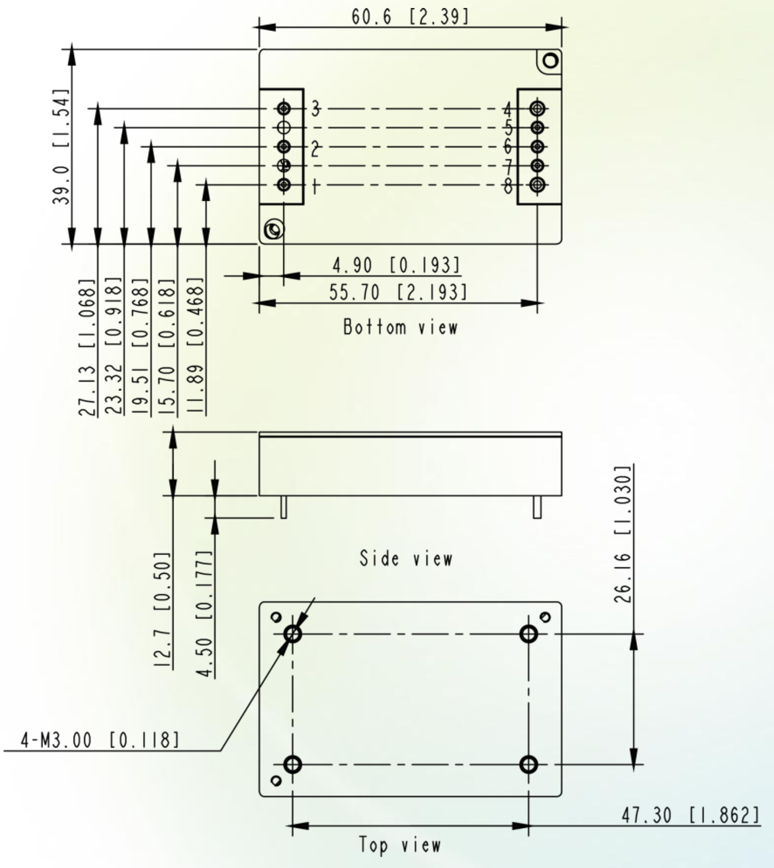
- Electric power
- Railway and metro
- Automobile
- Industrial equipment

Model Naming Convention

TAQ	06	S	12	B	-	4
1	2	3	4	5		6

1 — 42–160 V input, high performance, analog control, nonstandard quarter-brick
2 — Output current: 6 A
3 — Single output
4 — Output voltage: 12 V
5 — With a baseplate
6 — Pin length: 4.8 mm

Mechanical Diagram



Pin Description

Pin No.	Function
1	V_{in} (+)
2	On/Off
3	V_{in} (–)
4	V_{out} (–)
5	NC
6	Trim
7	NC
8	V_{out} (+)

NOTE

1. All dimensions in mm [in.]
   Tolerances: x.x±0.5 mm [x.xx±0.02 in.]
   x.xx ± 0.25 mm [x.xxx ± 0.010 in.]
2. Pins 1–3 and 5–7 are 1.00±0.05 mm [0.040±0.002 in.] diameter. Pin 4 and pin 8 are 1.50±0.05 mm [0.060±0.002 in.] diameter.
3. The depth of the M3 screw used to bolt the baseplate of the converter to other surfaces (such as a heat sink) must not exceed 2.5 mm [0.10 in.] below the surface of the baseplate.

Electrical Specifications

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Absolute maximum ratings					
Input voltage Continuous Transient (1s)	 - -	 - -	 160 170	 V V	 - -
Ambient operating temperature (T_A)	–40	-	85	°C	Baseplate temperature ≤ 100°C See the thermal derating curve.
Storage temperature	–55	-	125	°C	-
Operating humidity	5	-	95	% RH	Non-condensing
External voltage applied to On/Off	-	-	12	V	-
External voltage applied to Trim	-	-	3.5	V	-
Altitude	-	-	5000	m	-
Input characteristics					
Operating input voltage	42	-	160	V	See Figure 9.
Maximum input current	-	-	2	A	V_{in} = 0–160 V; I_{out} = 6 A
No-load loss	-	3.2	4.4	W	T_A = 25°C; V_{in} = 72 V
	-	4	5	W	T_A = 25°C; V_{in} = 110 V
Standby loss	-	-	0.55	W	T_A = 25°C; V_{in} = 110 V
Input capacitance	100	-	-	µF	Aluminum electrolytic capacitor
Response to Input Transient	-	-	-	V	U_e = 72 V, 110 V V_{in} = 60%U_e–140%U_e; dV/dT ≤ 6 V/ms; The converter will not shut down during test.
Output characteristics					
Output voltage setpoint	11.76	12.00	12.24	V	T_A = 25°C; V_{in} = 110 V; I_{out} = I_{onom}/2
Output current	0	-	6	A	V_{in} = 42–160 V
Output power	0	-	72	W	V_{in} = 42–160 V
Line regulation	–0.3	-	0.3	%	V_{in} = 49–160 V; I_{out} = I_{onom}
	–5	-	5	%	V_{in} = 42–49 V; I_{out} = I_{onom}
Load regulation	–0.3	-	0.3	%	V_{in} = 49–160 V; I_{out} = 0–I_{onom}
	–3	-	3	%	V_{in} = 42–49 V; I_{out} = 0–I_{onom}
Regulated voltage precision	–3	-	3	%	V_{in} = 49–160 V; I_{out} = 0–I_{onom}
	–7	-	7	%	V_{in} = 42–49 V; I_{out} = 0–I_{onom}

Electrical Specifications

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Output characteristics					
Temperature coefficient	–0.02	-	0.02	%/°C	T_A = –40°C to +85°C
External capacitance	440	-	1500	µF	Solid aluminum capacitor
Output ripple and noise (peak to peak)	-	50	150	mV	Oscilloscope bandwidth: 20 MHz
Output voltage trim range	90	-	110	%	-
Output voltage overshoot	-	-	5	%	Full range of V_{in}, I_{out}, and T_A
Output voltage delay time	-	-	5	s	From V_{in} connection to 10% V_{out}
Output voltage rise time	-	50	100	ms	From 10% V_{out} to 90% V_{out}
Switching frequency	120	140	160	kHz	T_A = 25°C; V_{in} = 110 V; I_{out} = I_{onom}/2
Protection characteristics					
Input undervoltage protection Protection threshold Recovery threshold Hysteresis	 36 38 1.5	 38 40 2	 40 42 -	 V V V	 - - -
Output overcurrent protection	110	-	160	%I_{onom}	V_{in} = 42–160 V; hiccup mode
Output short circuit protection	-	-	-	-	V_{in} = 42–160 V; hiccup mode
Output overvoltage protection	14.4	-	16.8	V	V_{in} = 42–160 V; hiccup mode
Overtemperature protection Threshold Hysteresis	 105 5	 115 -	 130 -	 °C °C	Self-recovery The overtemperature protection threshold is obtained by measuring the temperature of the PCB near the thermistor.
Dynamic characteristics					
Overshoot amplitude Recovery time	- -	- -	600 200	mV µs	Current change rate: 0.1 A/µs Load: 25%–50%–25%; 50%–75%–50%
Overshoot amplitude Recovery time	- -	- -	1200 200	mV µs	Current change rate: 0.1 A/µs Load: 10%–90%–10%
Efficiency					
100% load	91.5	92.5	-	%	T_A = 25°C; V_{in} = 72 V
50% load	90.5	91.5	-	%	T_A = 25°C; V_{in} = 72 V
100% load	90	91	-	%	T_A = 25°C; V_{in} = 110 V
50% load	87	88	-	%	T_A = 25°C; V_{in} = 110 V

Electrical Specifications

Parameter	Min.	Typ.	Max.	Unit	Notes & Conditions
Insulation characteristics					
Input to output insulation voltage	-	-	3000	V DC	Reinforced insulation (1-minute test)
Input to baseplate insulation voltage	-	-	3000	V DC	Reinforced insulation (1-minute test)
Output to baseplate insulation voltage	-	-	707	V DC	Functional insulation (1-minute test)
Input to output insulation resistance	100	-	-	MΩ	Test voltage: 500 V DC
Input to baseplate insulation resistance	100	-	-	MΩ	
Other characteristics					
Remote On/Off voltage Low level High level	 –0.7 3.5	 - -	 1.2 12	 V V	Negative logic
On/Off current Low level High level	 - -	 - -	 1.0 -	 mA μA	 - -
Reliability characteristics					
Mean time between failures (MTBF)	-	2.5	-	Million hours	Telcordia, SR332 Method 1 Case 3; 80% load; normal input; Baseplate temperature = 25°C

Specifications are subject to change without notice.

Characteristic Curves

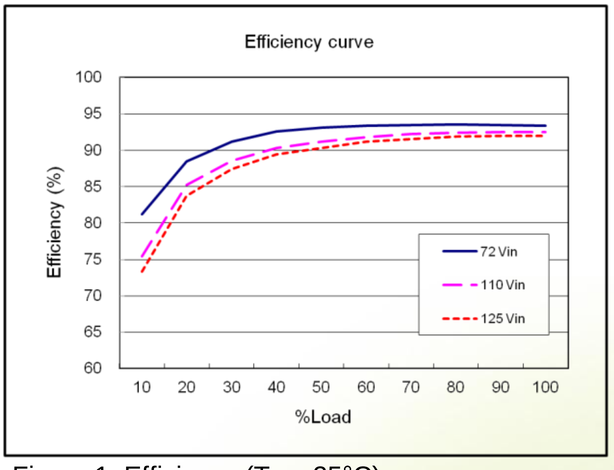


Figure 1: Efficiency (T_A = 25°C)

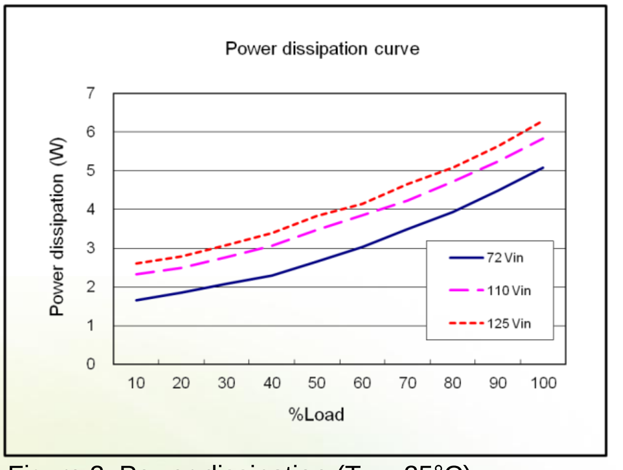


Figure 2: Power dissipation (T_A = 25°C)

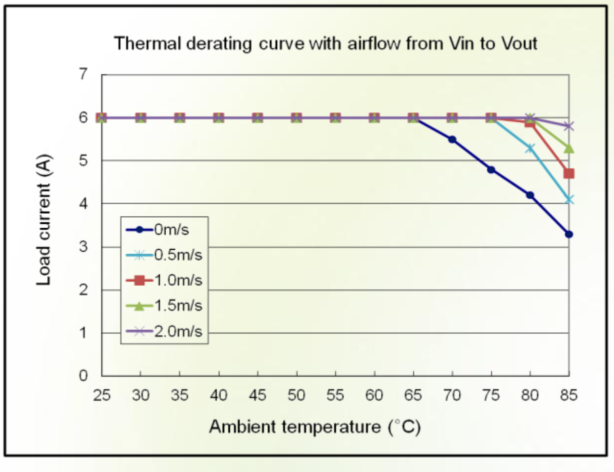


Figure 3: Thermal derating with airflow from V_{in} to V_{out} (V_{in} = 72 V, V_{out} = 12 V)

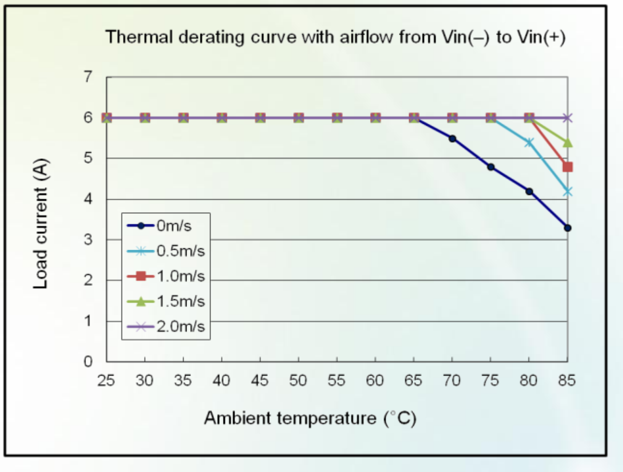


Figure 4: Thermal derating with airflow from V_{in} (–) to V_{in} (+) (V_{in} = 72 V, V_{out} = 12 V)

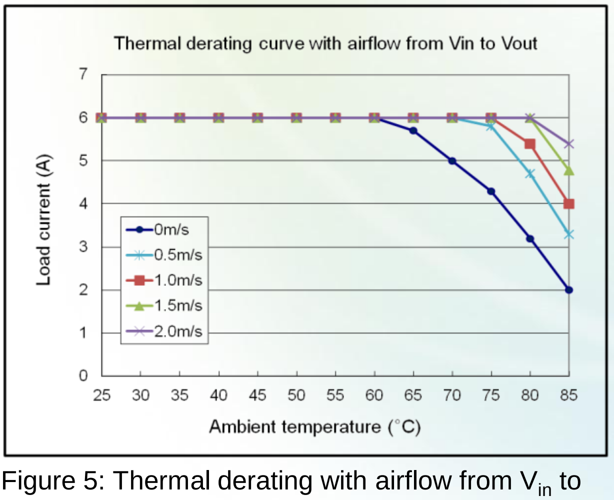


Figure 5: Thermal derating with airflow from V_{in} to V_{out} (V_{in} = 110 V, V_{out} = 12 V)

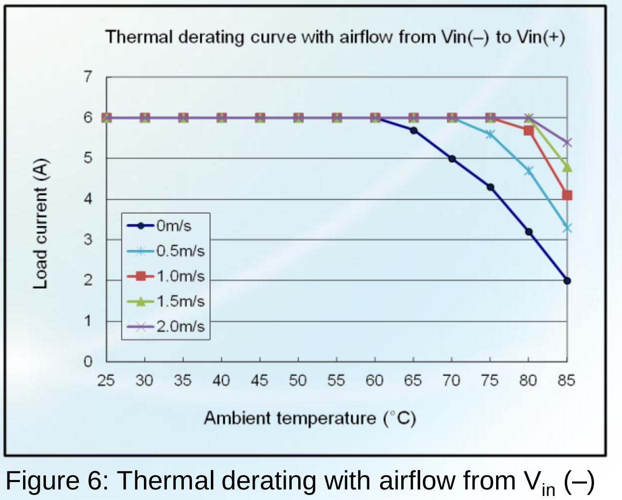


Figure 6: Thermal derating with airflow from V_{in} (–) to V_{in} (+) (V_{in} = 110 V, V_{out} = 12 V)

Characteristic Curves

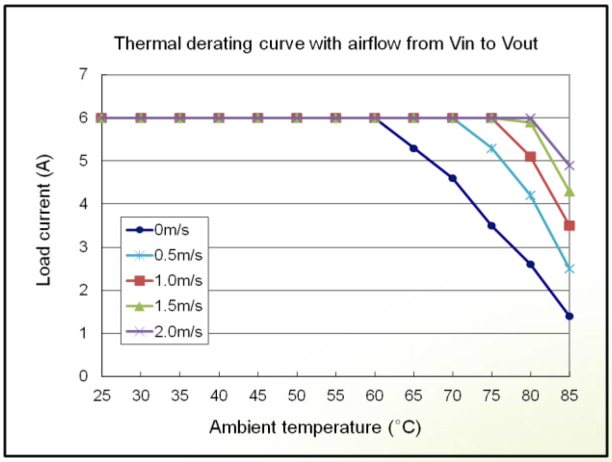


Figure 7: Thermal derating with airflow from V_{in} to V_{out} (V_{in} = 125 V, V_{out} = 12 V)

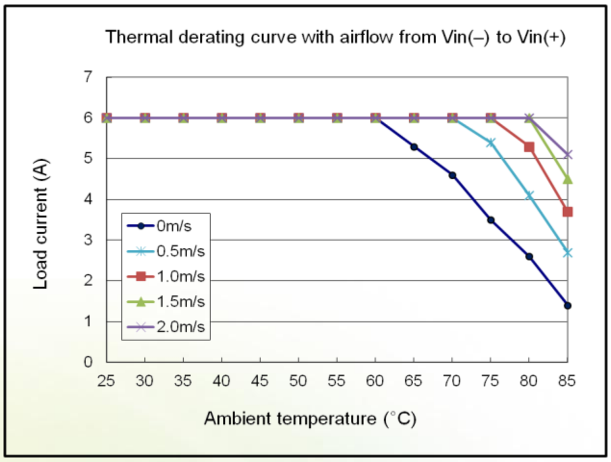


Figure 8: Thermal derating with airflow from V_{in} (–) to V_{in} (+) (V_{in} = 125 V, V_{out} = 12 V)

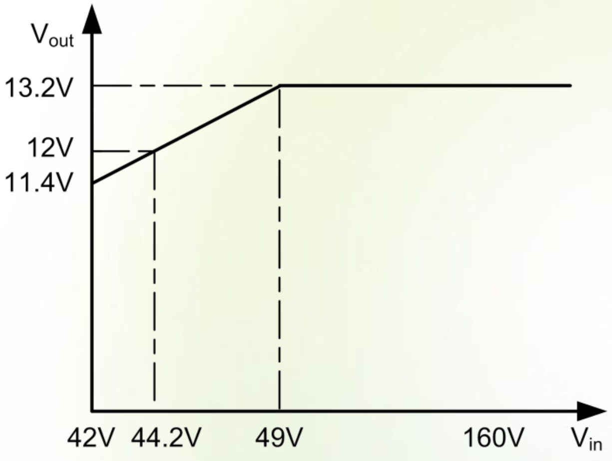


Figure 9: V_{in} vs. V_{out} (V_{out} can achieve the maximum value 13.2 V through Trim adjustment when $V_{in} \geq 49$ V. Refer to the input voltage range when conducting an output voltage performance test on the converter.)

Typical Waveforms

NOTE

1. During the test of the input reflected ripple current, the input must be connected to an external input filter (including a 12 μH inductor and a 220 μF electrolytic capacitor), which is not required in other tests.
2. Points B and C, which are used for testing the output voltage ripple, must be 25 mm (0.98 in.) away from the V_{out} (+) pin and the V_{out} (–) pin, respectively.

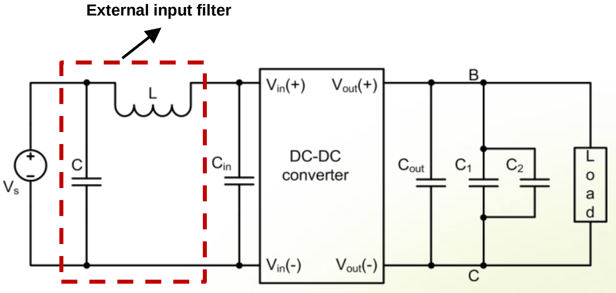


Figure 10: Test set-up diagram

C_{in}: The 100 μF aluminum electrolytic capacitor is recommended.
C_{out}: Two 220 μF aluminum electrolytic capacitors are recommended.
C_1: The 0.1 μF ceramic capacitor is recommended.
C_2: The 10 μF electrolytic capacitor is recommended.

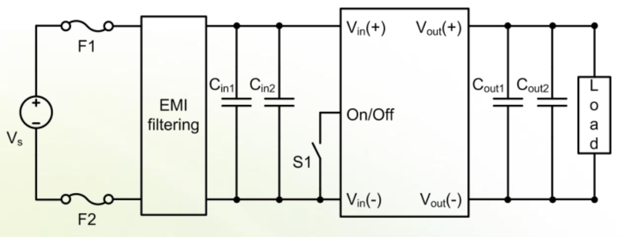


Figure 11: Typical application circuit

F1, F2: 5 A fuse (fast-blow)
C_{in1}, C_{in2}: The 150 μF aluminum electrolytic capacitor is recommended.
C_{out1}, C_{out2}: The 220 μF solid aluminum capacitor is recommended.

Conditions: T_A = 25°C, V_{in} = 125 V, V_{out} = 12 V

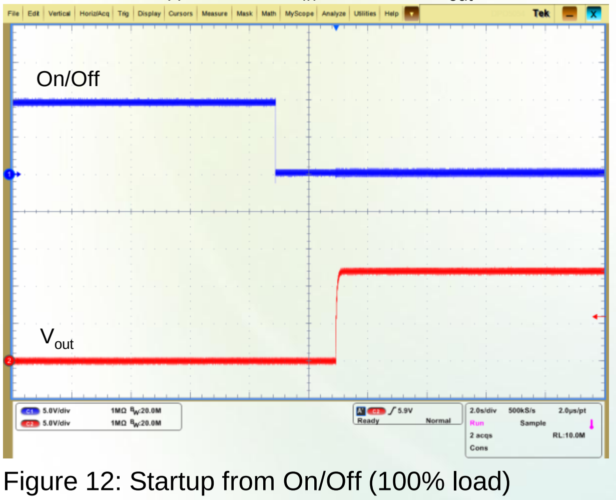


Figure 12: Startup from On/Off (100% load)

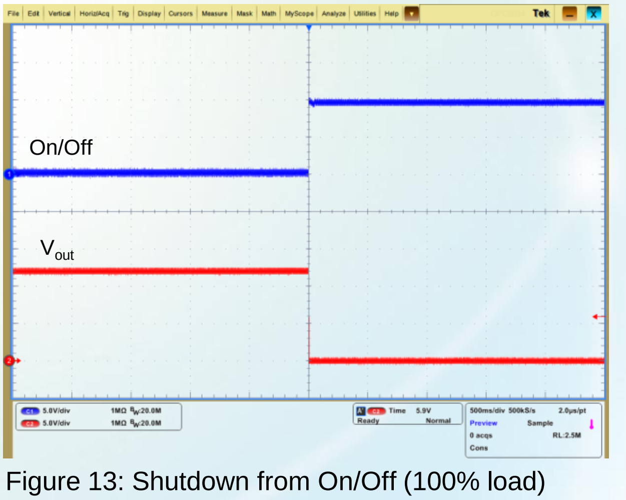


Figure 13: Shutdown from On/Off (100% load)

Typical Waveforms

Conditions: T_A = 25°C, V_{in} = 125 V, V_{out} = 12 V

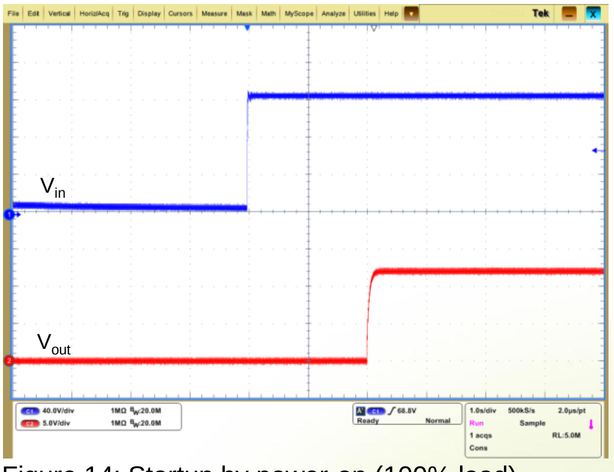


Figure 14: Startup by power-on (100% load)

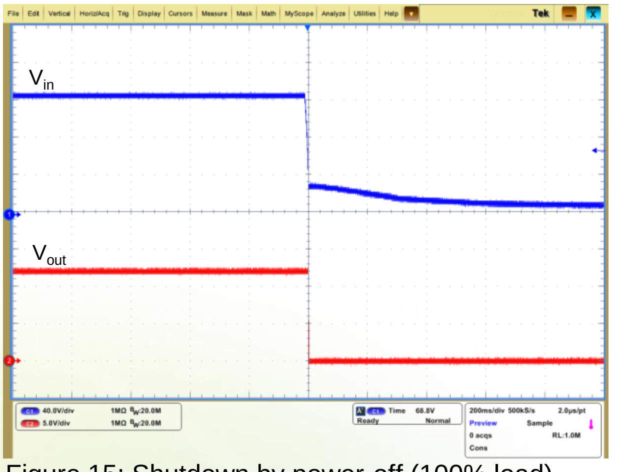


Figure 15: Shutdown by power-off (100% load)

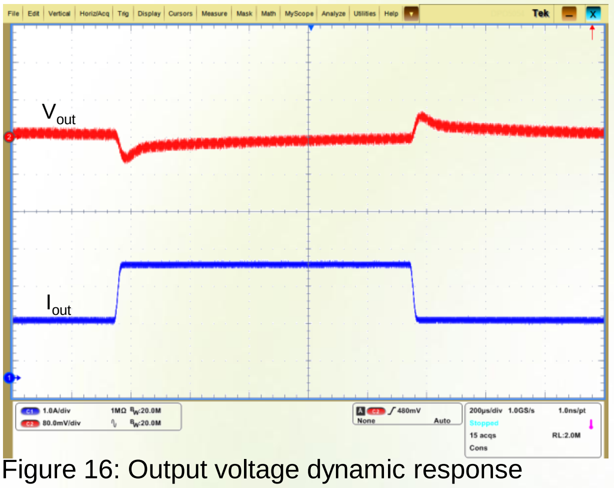


Figure 16: Output voltage dynamic response
(load: 25%–50%–25%, di/dt = 0.1 A/µs)

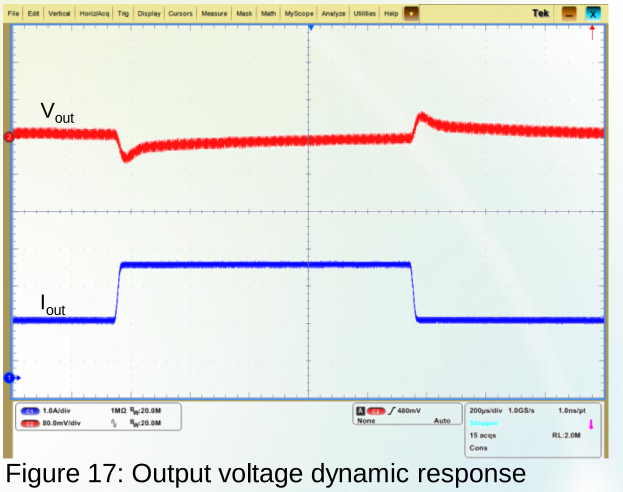


Figure 17: Output voltage dynamic response
(load: 50%–75%–50%, di/dt = 0.1 A/µs)

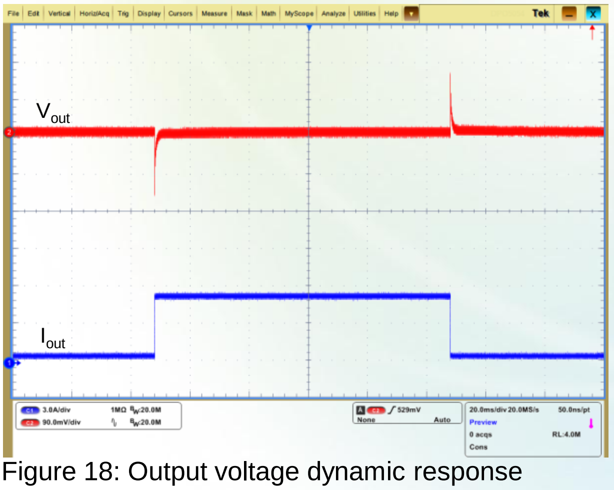


Figure 18: Output voltage dynamic response
(load: 10%–90%–10%, di/dt = 0.1 A/µs)

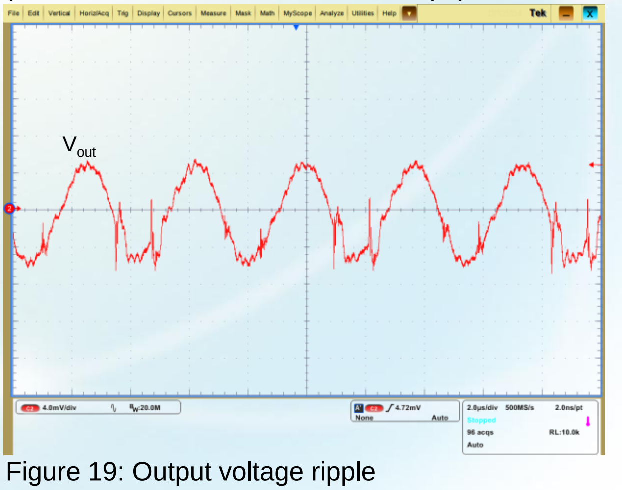


Figure 19: Output voltage ripple
(for points B and C in the test set-up diagram)

Remote On/Off

Logic Enable	On/Off Pin Level	Status
Negative logic	Low level	On
	High level or left open	Off

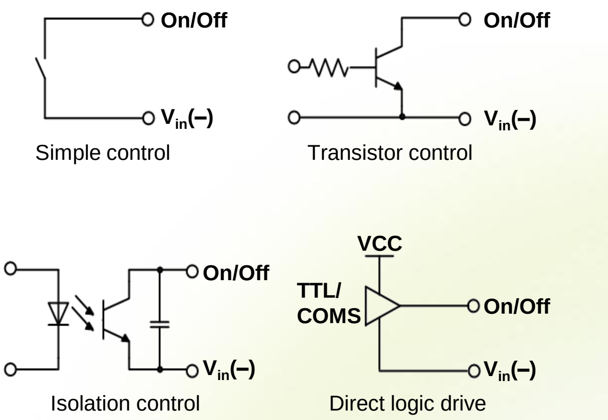


Figure 20: Various circuits for driving the On/Off pin

Output Voltage Trim

The output voltage can be adjusted within the trim range by using the Trim pin.

Trim Up

The output voltage can be increased by connecting an external resistor between the Trim pin and the V_{out}(+) pin.

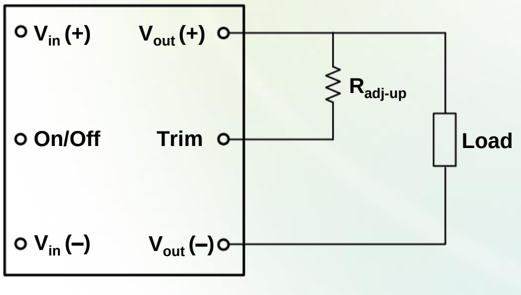


Figure 21: Configuration diagram for Trim up

Relationship between R_{adj-up} and V_{out}:

$$R_{adj-up} = \frac{5.1 \times V_{nom} \times (100 + \Delta)}{1.225 \times \Delta} - \frac{510}{\Delta} - 10.2(k\Omega)$$

$$\Delta = \frac{V_{out} - V_{nom}}{V_{nom}} \times 100$$

NOTE

1. If the trim pin is not used, it should be left open.
2. Ensure that the actual output power does not exceed the maximum output power when raising the voltage.

Trim Down

The output voltage can be decreased by connecting an external resistor between the Trim pin and the V_{out}(–) pin.

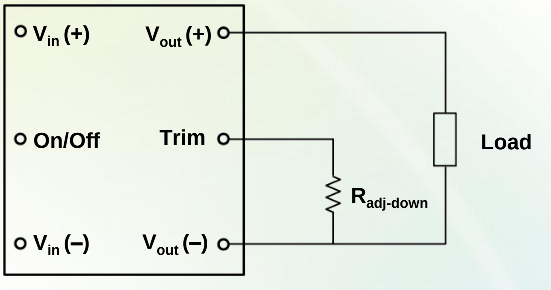


Figure 22: Configuration diagram for Trim down

Relationship between $R_{adj-down}$ and V_{out}:

$$R_{adj-down} = \frac{510}{\Delta} - 10.2(k\Omega) \qquad \Delta = \frac{V_{nom} - V_{out}}{V_{nom}} \times 100$$

Input Undervoltage Protection

The converter will shut down after the input voltage drops below the undervoltage protection threshold. The converter will start to work again after the input voltage reaches the input undervoltage recovery threshold. For the hysteresis, see the Protection characteristics.

Output Overcurrent Protection

The converter equipped with current limiting circuitry can provide protection from an output overload or short circuit condition. If the output current exceeds the output overcurrent protection setpoint, the converter enters hiccup mode. When the fault condition is removed, the converter will automatically restart.

Output Overvoltage Protection

When the output voltage exceeds the output overvoltage protection threshold, the converter will enter hiccup mode. When the fault condition is removed, the converter will automatically restart.

Overtemperature Protection

A temperature sensor on the converter senses the average temperature of the converter. It protects the converter from being damaged at high temperatures. When the temperature exceeds the overtemperature protection threshold, the output will shut down. It will allow the converter to turn on again when the temperature of the sensed location falls by the value of the overtemperature protection hysteresis.

Recommended Fuse

The converter has no internal fuse. To meet safety requirements, a 5 A fuse is recommended.

Recommended Reverse Polarity Protection Circuit

Reverse polarity protection is recommended under installation and cabling conditions where reverse polarity across the input may occur.

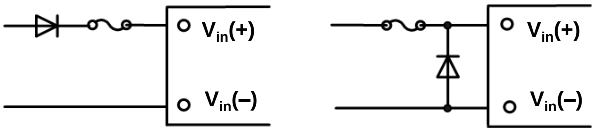


Figure 23: Recommended reverse polarity protection circuits

EMC

Figure 24 shows the EMC test set-up diagram. The acceptance standard must meet the requirements of the conducted emission limits of CISPR22 Class B with 6 dB margin.

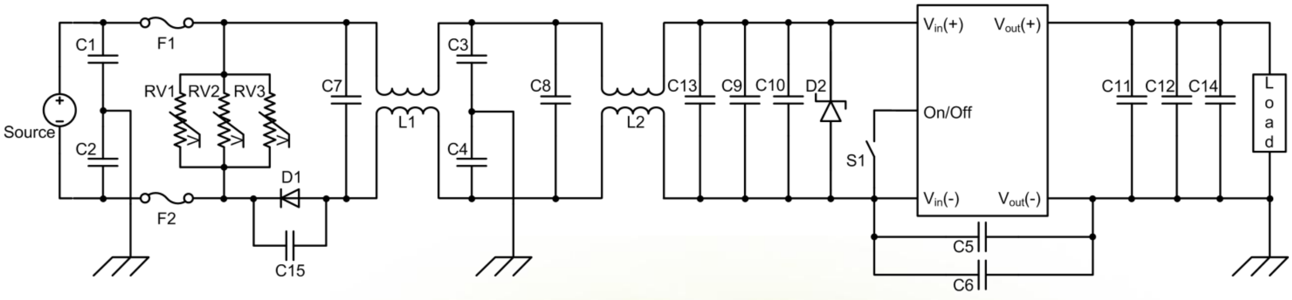


Figure 24: EMC test set-up diagram

C1, C2, C6: ceramic capacitor, 1 nF, 250 V
C3, C4: film capacitor, 15 nF, 440 V
C5: film capacitor, 10 nF, 300 V
C7, C8: film capacitor, 1.5 μF, 450 V
C9, C10: aluminum electrolytic capacitor, 150 μF, 250 V
C11, C12: solid aluminum capacitor, 220 μF, 16 V
C13: ceramic capacitor, 100 nF, 250 V
C14: ceramic capacitor, 100 nF, 50 V
C15: ceramic capacitor, 22 nF, 2000 V

D1: fast recovery diode, 15 A, 600 V
D2: transient suppression diode, 1.5 kW, 162 V

RV1, RV2, RV3: varistor, 1.2 kA, 220 V

F1, F2: fuse, 5 A, 400 V

L1: common-mode inductor, 4.5 mH, 5 A
L2: common-mode inductor, 1 mH, 5 A

Qualification Testing

Parameter	Units	Condition
Highly accelerated life test	4	Lowest operating temperature: –60°C; highest operating temperature: +110°C; temperature change rate: 40°C/min; vibration limit: 40 G
Thermal shock	32	500 temperature cycles between –40°C and +125°C with the temperature change rate of 20°C per minute; lasting for 30 minutes both at –40°C and +125°C
Temperature humidity bias	32	Maximum input voltage; 85°C; 85% RH; 1000 operating hours under lowest load power
High temperature operation bias	32	Rated input voltage; 1000 operating hours under 50% to 80% load power; air temperature: 45°C–55°C
Power and temperature cycling test	32	Rated input voltage, 50% load, ambient temperature between –40°C and +85°C, 1000 cycles

Thermal Consideration

Thermal Test Point

Decide proper airflow to be provided by measuring the temperature of the baseplate shown in Figure 25 to protect the converter against overtemperature. Proper airflow can be verified by measuring the temperature at the middle of the baseplate.

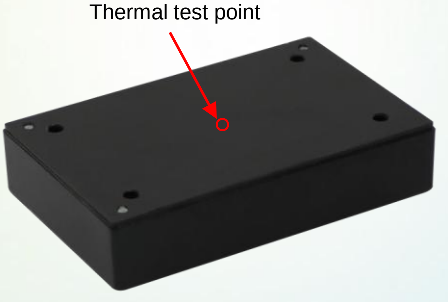


Figure 25: Thermal test point

Power Dissipation

The converter power dissipation is calculated based on efficiency. The following formula reflects the relationship between the consumed power (P_d), efficiency (η), and output power (P_o): $P_d = P_o (1 – η)/η$

MSL Rating

Store and transport the converter as required by the moisture sensitivity level (MSL) rating 1 specified in the J-STD-020/033. The surface of a soldered converter must be clean and dry. Otherwise, the assembly, test, or even reliability of the converter will be negatively affected.

Mechanical Consideration

Installation

Although the converter can be mounted in any direction, free airflow must be available.

Soldering

The converter supports standard wave soldering and hand soldering. Reflow soldering is not allowed.

1. For wave soldering, the converter pins can be soldered at 260°C for less than 7 seconds.
2. For hand soldering, the iron temperature should be maintained at 350°C to 420°C and applied to the converter pins for less than 10 seconds.

The converter can be rinsed using the isopropyl alcohol (IPA) solvent or other suitable solvents.

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