Railway Quarter-Brick QBR Series
Ultra-Wide Input (14-160V) Up to 50 Watts DC-DC Converter

PRODUCT OVERVIEW

This QBR railway series offers up to 50 watts of output power housed in an industry standard quarter-brick package. This QBR series features wide input voltage range from 14 to 160VDC (72 Volts nominal), high efficiency isolation of 3000VDC and provide a precise regulated voltage output.

All QBR models operate over the temperature range of – 40°C to +100°C. The modules offer Input under voltage lock out (UVLO), and are fully protected against output overvoltage and over temperature conditions. All models have internal over current and continuous short circuit protection. The output voltage can be trimmed to the required voltage and the product includes Remote On/Off function.

This QBR series provides efficiency up to 89%, meet industrial standard and is the best choice for railway system, industrial, distributed power architectures, telecommunications, and mobile applications.

Please contact DATEL if your application requires different output voltage or any other special feature.

FEATURES

- Standard Quarter Brick Dimension
- Isolated Output up to 50 Watts
- Wide input range 12:1 (14 – 160 VDC)
- Regulated Outputs
- Efficiency to 93%
- Remote On/Off
- Continuous Short Circuit Protection
- -40 °C to +100 °C
- Voltage/Current/Over-temperature Protection
- Designed to meet UL60950-1 and EN50155
- Shock and Vibration meets EN61373

APPLICATIONS:

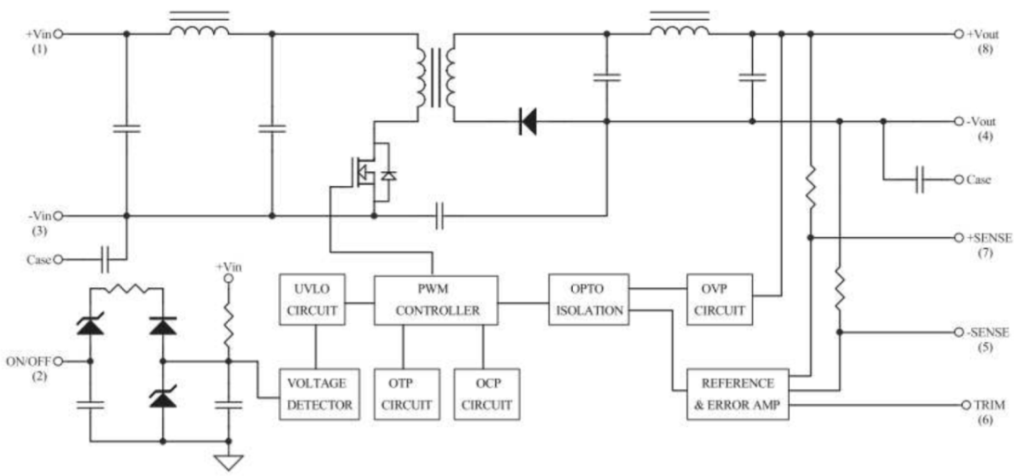
- Driver Computer System
- Communications System
- Remote & Car Control
- Emergency Start
- Media / Alarms / Horn / Cameras
- Windshield Washer Wipers
- Remote Control / Operation
- Passenger Comfort Systems
- Ticketing / Counting / Tracking Systems
- Doors / Lifts (Including Disabling Facilities)

AVAILABLE OPTIONS

- Customizable Input/ Output voltages
- Heatsink, customizable packaging
- UL/CSA60950-1
- CE Mark 2004/30/EU

MODEL NUMBER	INPUT VOLTAGE	OUTPUT VOLTAGE	OUTPUT CURRENT MAX	EFFICIENCY %	LOAD REGULATION	OPTIONS
QBR87S5-6	14-160 VDC	5 VDC	6 A	83	± 0.2 %	N, M
QBR87S12-4.2	14-160 VDC	12 VDC	4.2 A	87	± 0.2 %	N, M
QBR87S24-2.1	14-160 VDC	24 VDC	2.1 A	89	± 0.2 %	N, M
QBR87S48-1.05	14-160 VDC	48 VDC	1.05 A	88	± 0.2 %	N, M

BLOCK DIAGRAM



ABSOLUTE MAXIMUM RATINGS

PARAMETER	CONDITIONS	Model	Min.	Typical	Max.	Units
Input Voltage						
Continuous	DC	All	-0.3		160	Volts
Transient	100 ms, DC	All			200	Volts
Operating Case Temperature		All	-40		+100	°C
Storage Temperature		All	-55		+125	°C
Isolation Voltage	1 minute; input/output, input/case, DC	All	3000			Volts
	1 minute; input/case, DC	All	2500			
	1 minute; output/case, DC	All	500			

Stresses above the absolute maximum ratings can cause permanent damage to the device.

FUNCTIONAL SPECIFICATIONS

The following specifications apply over the operating temperature range, under the following conditions TA = +25°C unless otherwise specified

INPUT CHARACTERISTICS

PARAMETER	CONDITIONS	Model	Min.	Typical	Max.	Units
Operating Input Voltage	DC	All	14	72	160	Volts
Input Under-voltage Lockout						
Turn-On Voltage Threshold	DC	All	13.2	13.6	14	Volts
Turn-Off Voltage Threshold	DC	All	11.8	12.2	12.6	Volts
Lockout Hysteresis Voltage	DC	All		1.4		Volts
Maximum Input Current	100% Load, V_{in}= 14V	All		4.6		A
No-Load Input Current	V_{in}=Nominal	Vo=5.0V Vo=12V Vo=24V Vo=48V		5 5 5 8		mA
Inrush Current (I^2t)		All			0.1	A^2s
Input Filter		All	Pi Filter			
Input Reflected Ripple Current	P-P thru 12µH inductor, 5Hz to 20MHz	All		30		mA

OUTPUT CHARACTERISTICS

PARAMETER	CONDITIONS	Device	Min.	Typical	Max.	Units
Output Voltage Set Point	V_{in}=Nominal V_{in}, I_o = I_{o_max}, Tc=25°C DC	Vo=5.0 V Vo=12 V Vo=24 V Vo=48 V	4.95 11.88 23.76 47.52	5 12 24 48	5.05 12.12 24.24 48.48	Volts
Output Voltage Regulation						
Load Regulation	I_o=I_{o_min} to I_{o_max}	All			±0.2	%
Line Regulation	V_{in}=low line to high line	All			±0.2	%
Temperature Coefficient	TC=-40°C to 100°C	All			±0.02	%/°C
Output Voltage Ripple and Noise (5Hz to 20MHz bandwidth)						
Peak-to-Peak	Full load, 10µF tantalum and 1.0uF ceramic capacitors	Vo=5V Vo=12V Vo=24V Vo=48V			100 100 100 100	mV

RMS	Full load, 10µF solid tantalum and 1.0µF ceramic capacitors	Vo=5V Vo=12V Vo=24V Vo=48V			40 40 40 40	mV
Operating Output Current Range		Vo=5V Vo=12V Vo=24V Vo=48V	0 0 0 0		6 4.2 2.1 1.05	A
Output DC Current Limit Inception	Vo = 90% Nominal Output Voltage	All	110	180	220	%
Maximum Output Capacitance	Full resistive load	Vo=5V Vo=12V Vo=24V Vo=48V	0 0 0 0		10000 6800 3300 680	µF

DYNAMIC CHARACTERISTICS

PARAMETER	CONDITIONS	Model	Min.	Typical	Max.	Units
Output Voltage Current Transient						
Step Change in Output Current	75% to 100% of I_{o_max}	All			±5	%
Setting Time (within 1% Vout nominal)	d_i/d_t=0.1A/µs	All			250	µs
Turn-On Delay and Rise Time						
Turn-On Delay Time from On/Off Control	$V_{on/off}$ to 10%V_{o_set}	All		15		ms
Turn-On Delay Time from Input	$V_{in\ min}$ to 10%V_{o_set}	All		15		ms
Output Voltage Rise Time	10%V_{o_set} to 90%V_{o_set}	All		10		ms

EFFICIENCY

PARAMETER	CONDITIONS	Device	Min.	Typical	Max.	Units
Full Load	V_{in}=Nominal V_{in}, Tc=25°C	Vo=5V Vo=12V Vo=24V Vo=48V		83 87 89 89		%
	V_{in}= 110 V, Tc=25°C	Vo=5V		81		
		Vo=12V		86		
		Vo=24V		87		
		Vo=48V		85		

ISOLATION CHARACTERISTICS

PARAMETER	CONDITIONS	Model	Min.	Typical	Max.	Units
Isolation Voltage	1minute; input/output,	All			3000	Volts
	1minute; input/case	All			2500	
	1 minute; output/case	All			500	
Isolation Resistance		All	100			MΩ
Isolation Capacitance	Input/output	All		1000		pF
Isolation Capacitance	Input/case	All		1500		pF
Isolation Capacitance	Output/case			10000		pF

FEATURE CHARACTERISTICS

PARAMETER	CONDITIONS	Model	Min.	Typical	Max.	Units
Switching Frequency		All	215	240	265	KHz
On/Off Control, Positive Remote On/Off logic						
Logic Low (Module Off)	$V_{on/off}$ at $I_{on/off}$=1.0mA	All	0		1.2	V
Logic High (Module On)	$V_{on/off}$ at $I_{on/off}$=0.0uA	All	3.5 or Open Circuit		160	V
On/Off Control, Negative Remote On/Off logic						
Logic High (Module Off)	$V_{on/off}$ at $I_{on/off}$=0.0uA	All	3.5 or Open Circuit		160	V
Logic Low (Module On)	$V_{on/off}$ at $I_{on/off}$=1.0mA	All			1.2	V
On/Off Current (for both remote on/off logic)	$I_{on/off}$ at $V_{on/off}$=0.0V	All		0.4	1	mA
Leakage Current (for both remote on/off logic)	Logic High, $V_{on/off}$=15V	All			30	μA
Off Converter Input Current	Shutdown input idle current	All		3	5	mA
Over-Temperature Shutdown	Aluminum Baseplate Temperature	All		110		°C
Over-Temperature Recovery	Aluminum Baseplate Temperature	All		95		°C

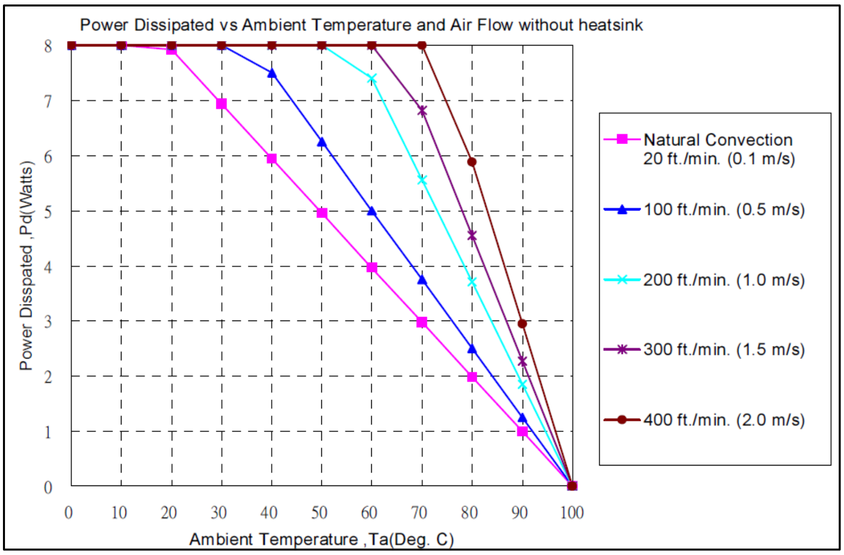
GENERAL SPECIFICATIONS

PARAMETER	NOTES and CONDITIONS	Device	Min.	Typical	Max.	Units
MTBF	I_o=100% of $I_{o\ max}$; T_a=25°C per MIL-HDBK-217F	Vo=5.0V Vo=12V Vo=24V Vo=48V		780 780 780 780		K hours
Weight		All		61.5		grams
Potting Material	UL 94V-0					
Baseplate Material	Aluminum					
Case Material	Plastic, DAP					
Pin Material	Base: Copper – Plating: Nickel with Matte Tin					
Altitude	5000 meters operating Altitude, 12000meters Transport Altitude					
EMI	Meets EN5501, EN55022 & EN50155 with External Input Filter EN55032					
ESD	Meets EN61000-4-2 Level 3 : Air ±8kV Contact ±6kV					
Thermal Shock	MIL-STD-810F					
Radiated Immunity	Meets EN61000-4-3 Level 3: 80~1000MHz, 20 V/m					
Fast Transient	Meets EN61000-4-4 Level 3: On power input port, ±2KV, External Input Capacitor is required					
Surge	Meet EN61000-4-5 Level 4: Line to Earth, ±4KV Line to Line , ±2KV					
Conducted Immunity	Meets EN61000-4-6 Level 3: 0.15 ~ 80MHz, 10 V					
Supply Change Over	Meet EN50155 During a supply break of 30 ms					
Interruptions of Supply Voltage	Meet EN50155 10ms Interruptions					

POWER DERATING

The operating case temperature range of this QBR87 series is -40°C to +100°C. When operating this QBR series, proper derating or cooling is needed. The maximum case temperature under any operating condition should not exceed + 100°C.

Forced Convection Power De-rating without Heat Sink
Example (without heatsink):



AIR FLOW RATE	TYPICAL R_{ca}
Natural Convection 20ft./min. (0.1m/s)	10.1 °C /W
100 ft./min. (0.5m/s)	8.0 °C /W
200 ft./min. (1.0m/s)	5.4 °C /W
300 ft./min. (1.5m/s)	4.4 °C /W
400 ft./min. (2.0m/s)	3.4 °C /W

What is the minimum airflow necessary for a QBR87S12-4.2 operating at nominal line voltage, an output current of 4.2A, and a maximum ambient temperature of 40°C?

Solution:
Given:
Vin = 72Vdc, Vo =12Vdc, Io = 4.2A

Determine Power dissipation (Pd):
Pd =Pi-Po=Po(1-η)/η
Pd =12V × 4.2A × (1-0.87)/0.87 = 7.53 Watts

Determine airflow:
Given: Pd = 7.53W and Ta = 40°C

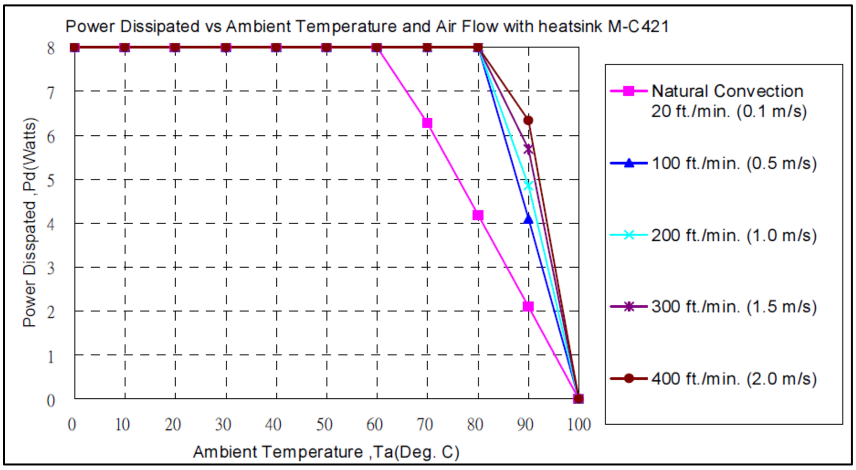
Check Power Derating curve:
Minimum airflow= 200 ft./min.

Verify:
Maximum temperature rise is
ΔT = Pd × Rca = 7.53W × 5.4 = 40.67°C.

Maximum case temperature is
Tc=Ta + ΔT = 80.67°C <100°C.

Where:
The Rca is thermal resistance from case to ambient environment.
Ta is ambient temperature and Tc is case temperature.

Example (with heatsink M-C421)



AIR FLOW RATE	TYPICAL R_{ca}
Natural Convection 20ft./min. (0.1m/s)	4.78 °C/W
100 ft./min. (0.5m/s)	2.44 °C/W
200 ft./min. (1.0m/s)	2.06 °C/W
300 ft./min. (1.5m/s)	1.76 °C/W
400 ft./min. (2.0m/s)	1.58 °C/W

What is the minimum airflow necessary for a QBR87S12-4.2 operating at nominal line voltage, an output current of 4.2A, and a maximum ambient temperature of 80°C?

Solution:

Given:

Vin = 72 V_{dc}, Vo=12V_{dc}, Io=4.2A

Determine Power dissipation (P_d):

Pd =Pi-Po=Po (1-η)/η

Pd = 12 ×4.2 × (1-0.87)/0.87 = 7.53Watts

Determine airflow:

Given: Pd = 7.53W and Ta = 80℃

Check above Power de-rating curve:

Minimum airflow= 100 ft./min

Verify:

Maximum temperature rise is

$\Delta T = P_d \times R_{ca} = 7.53 \times 2.44 = 18.37°C$

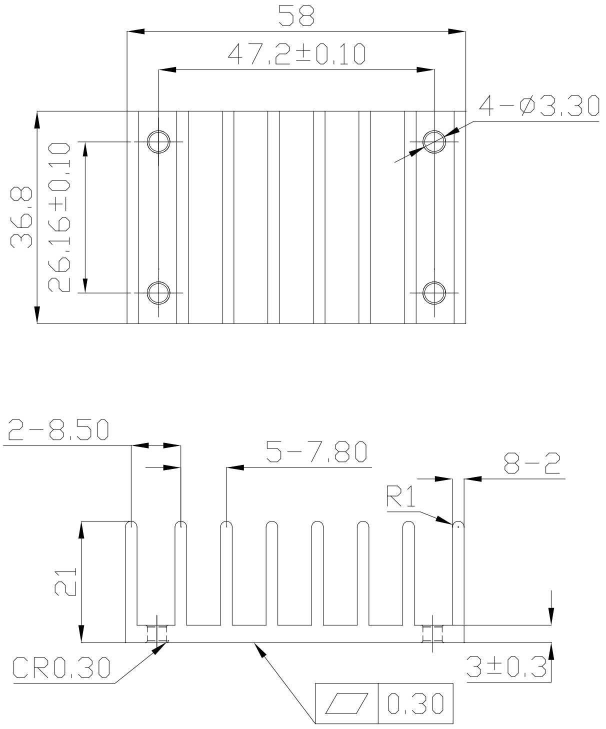
Maximum case temperature is $T_c = T_a + \Delta T = 98.37°C < 100°C$

Where:

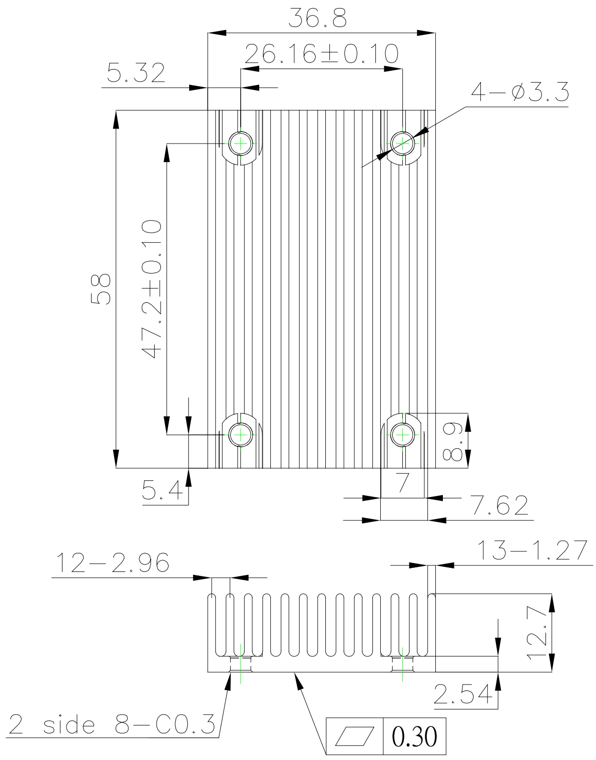
The R_{ca} is thermal resistance from case to ambient environment.

T_a is ambient temperature and T_c is case temperature.

QUARTER BRICK HEAT SINKS:



M-C421 (G6620510201)
Transverse Heat Sink



M-C488 (G6620570202)
Longitudinal Heat Sink

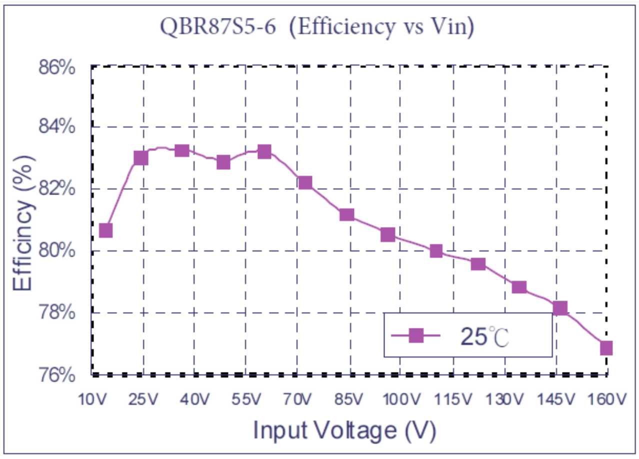
All Dimensions in mm

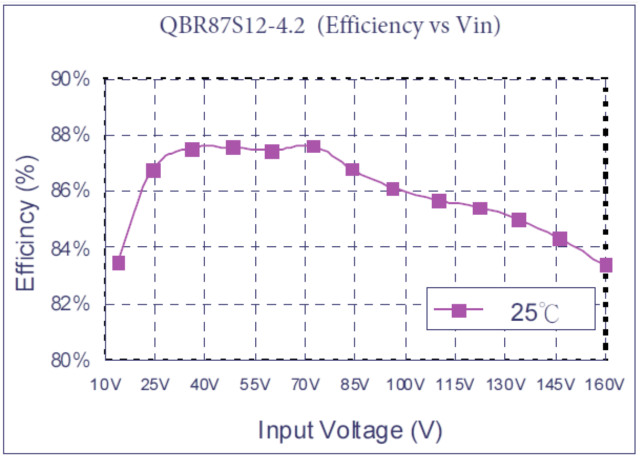
Rca: 4.78°C/W (typ.), At natural convection
2.44°C/W (typ.), At 100LFM
2.06°C/W (typ.), At 200LFM
1.76°C/W (typ.), At 300LFM
1.58°C/W (typ.), At 400LFM

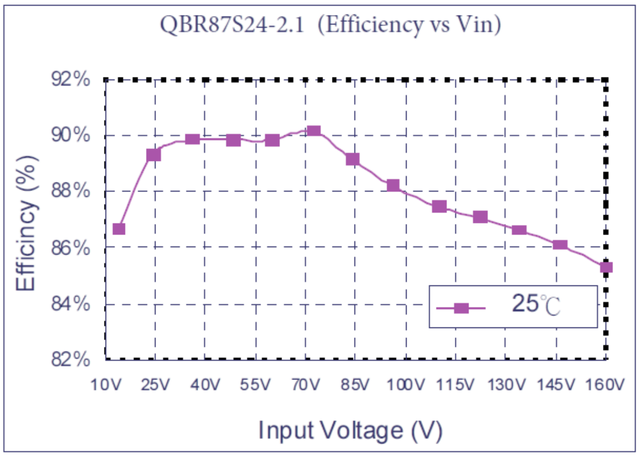
Rca: 5.61°C/W (typ.), At natural convection
4.01°C/W (typ.), At 100LFM
3.39°C/W (typ.), At 200LFM
2.86°C/W (typ.), At 300LFM
2.49°C/W (typ.), At 400LFM

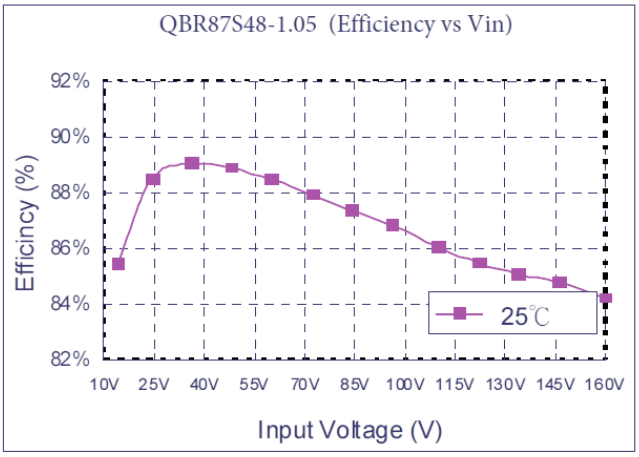
THERMAL PAD: SZ 35.8*56.9*0.25 mm (G6135041041)
SCREW: SMP+SW M3*8L (G75A1300322)

EFFICIENCY vs. LOAD









Operating Temperature Range

This QBR series can be operated over a wide case temperature range of -40°C to + 105°C. Consideration must be given to the derating curves when maximum power is drawn from the converter. The maximum power drawn from open half brick models is influenced by multiple factors, such as:

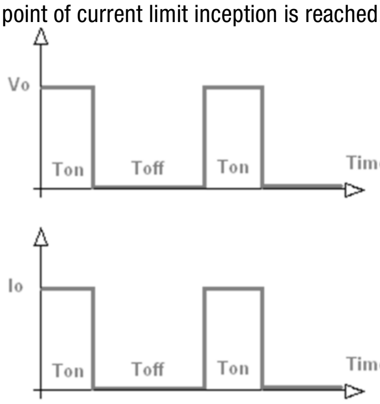
- Input voltage range
- Output load current
- Forced air or natural convection
- Heat Sink

Output Voltage Adjustment

The next page describes in detail how to trim the output voltage with respect to its set point. The output voltage on all models is adjustable within the range of +10% to –20%.

Over Current Protection

All models have internal over current and continuous short circuit protection. Once the fault condition is removed, the unit will operate normally. The converter will go into hiccup mode protection once the point of current limit inception is reached.



Output Overvoltage Protection

The output over voltage protection consists of circuitry that internally limits the output voltage. If more accurate output over voltage protection is required then an external circuit can be used via the remote on/off pin.

Note: Please note that device inside the power supply might fail when voltage more than rate output voltage is applied to output pin. This could happen when the customer tests the over voltage protection of unit.

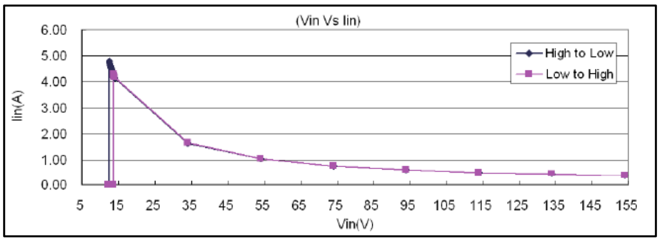
Remote On/Off

This QBR series allows the user to switch the module on and off electronically with the remote on/off feature. All models are available in "positive logic" and "negative logic" (optional) versions. The converter turns on if the remote On/Off pin is high (>3.5Vdc or open circuit). Setting the pin low (<1.2Vdc) will turn the converter off. The signal level of the remote on/off input is defined with respect to ground. If not using the remote on/off pin, leave the pin open (converter will be on). Models with part number suffix "N" are the "negative logic" remote On/Off version. The unit turns off if the remote On/Off pin is high (>3.5Vdc or open circuit). The converter turns on if the On/Off pin input is low (<1.2Vdc). Note that the converter is off by default.

Logic State (Pin 2)	Negative Logic	Positive Logic
Logic Low – Switch Closed	Module on	Module off
Logic High – Switch Open	Module off	Module on

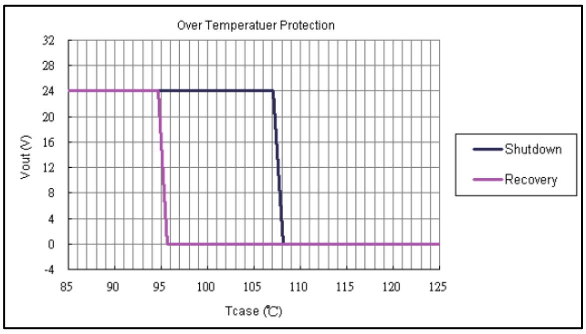
UVLO (Under voltage Lock Out)

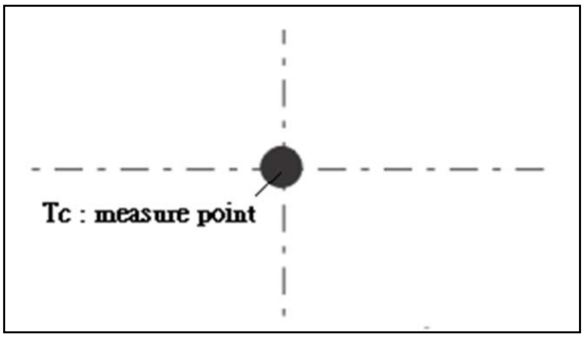
Input under voltage lockout is standard for all QBR units. The unit will shut down when the input voltage drops below a threshold, and the unit will operate when the input voltage goes above the upper threshold.



Over Temperature Protection

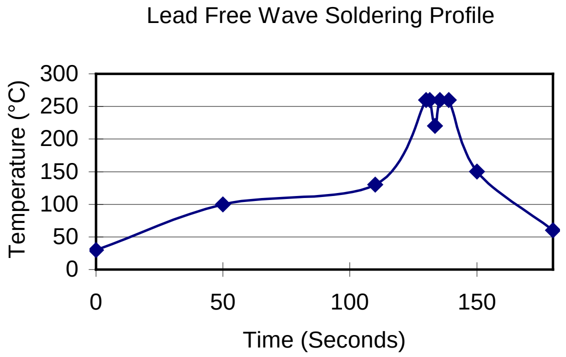
These modules have an over temperature protection circuit to safeguard against thermal damage. Shutdown occurs with the maximum case reference temperature is exceeded. The module will restart when the case temperature falls below over temperature recovery threshold. Please measure case temperature of the center part of aluminum baseplate.



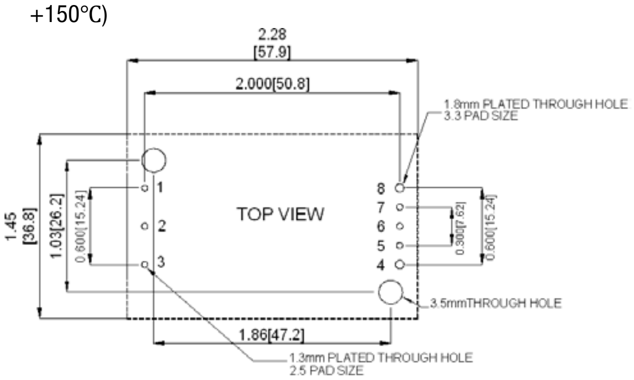


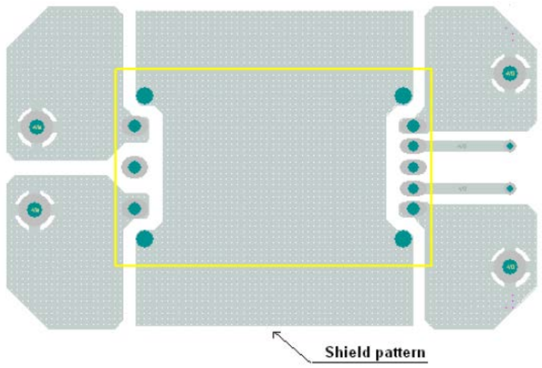
PCB Foot print, Recommended Layout, and Soldering Information

The end user of the converter must ensure that other components and metal in the vicinity of the converter meet the spacing requirements to which the system is approved. Low resistance and low inductance PCB layout traces should be used where possible. Careful consideration must also be given to proper low impedance tracks between power module, input and output grounds. The recommended footprints and soldering profiles are shown in the next two figures



Note：
1. Soldering Materials: Sn/Cu/Ni
2. Ramp up rate during preheat: 1.4 °C/Sec (From+ 50°C to +100°C)
3. Soaking temperature: 0.5 °C/Sec (From +100°C to+ 130°C), 60 ± 20 seconds
4. Peak temperature: +260°C, above+ 250°C 3~6 Seconds
5. Ramp up rate during cooling: -10.0 °C/Sec (From+ 260°C to +150°C)





Convection Requirements for Cooling

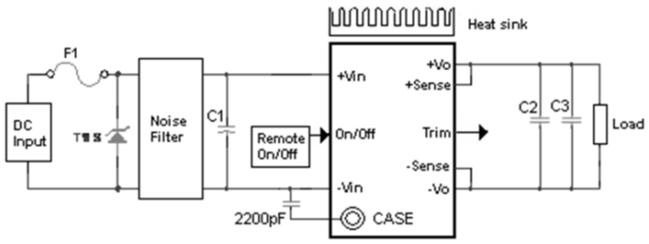
To predict the approximate cooling needed for the Quarter brick module, refer to the power derating curves. These derating curves are approximations of the ambient temperatures and airflows required to keep the power module temperature below its maximum rating. Once the module is assembled in the actual system, the module's temperature should be monitored to ensure it does not exceed +100°C as measured at the center of the top of the case, thus verifying proper cooling.

Thermal Considerations

The power module operates in a variety of thermal environments; however, sufficient cooling should be provided to help ensure reliable operation of the unit. Heat is removed by conduction, convection, and radiation to the surrounding environment. The power output of the module should not be allowed to exceed rated power (V_{o_set} x I_{o_max}).

Connection Diagram

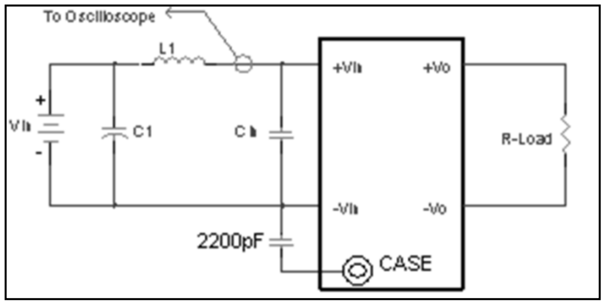
The connection for standard use is shown below. An external input capacitor (C1) 68μF for all models is recommended to reduce input ripple voltage. External output capacitors (C2 = 22μF aluminum, C3 = 1μF ceramic) are recommended for all models to reduce output ripple and noise.



Note:
It is to note that if the impedance of input line is high, C1 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than the temperature of -20 ℃.

External Input Capacitance

The converters must be connected to low AC source impedance. To avoid problems with loop stability source inductance should be low. Also, the input capacitors (Cin) should be placed close to the converter input pins to de-couple distribution inductance. However, the external input capacitors are chosen for suitable ripple handling capability. Low ESR capacitors are good choice. Circuit as shown as below represents typical measurement methods for reflected ripple current. C1 and L1 simulate a typical DC source impedance. The input reflected-ripple current is measured by current probe to oscilloscope with a simulated source Inductance (L1).



Note:
L1: 12μH
C1: 68μF ESR<0.7ohm @100KHz
Cin: 68μF ESR<0.7ohm @100KHz

TEST SET-UP

The basic test set-up to measure parameters such as efficiency and load regulation is shown below. When testing the modules under any transient conditions please ensure that the transient response of the source is sufficient to power the equipment under test.
We can calculate:

- Efficiency
- Load regulation
- Line regulation.

The value of efficiency is defined as:

$$\eta = \frac{V_o \times I_o}{V_{in} \times I_{in}} \times 100\%$$

Where:

V_o is output voltage,
I_o is output current,
V_{in} is input voltage,
I_{in} is input current.

The value of load regulation is defined as:

$$Load.reg = \frac{V_{FL} - V_{NL}}{V_{NL}} \times 100\%$$

Where:

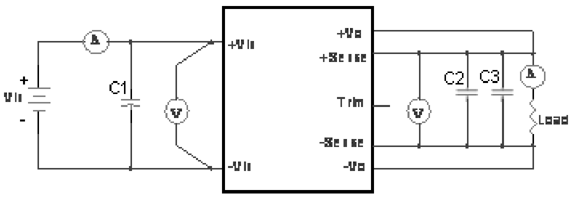
V_{FL} is the output voltage at full load
V_{NL} is the output voltage at no load

The value of line regulation is defined as:

$$Line.reg = \frac{V_{HL} - V_{LL}}{V_{LL}} \times 100\%$$

Where:

V_{HL} is the output voltage of maximum input voltage at full load.
V_{LL} is the output voltage of minimum input voltage at full load.

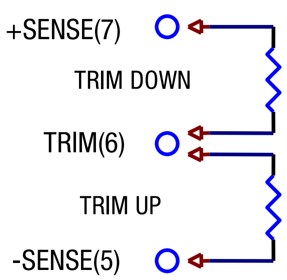


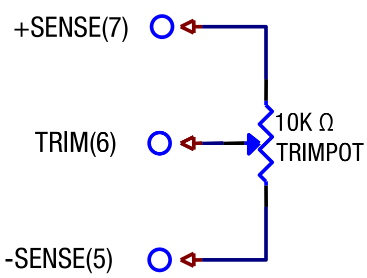
QBR87 Series Test Setup

C1: 68uF/200V ESR<0.7Ω
C2: 1uF/ 1206 ceramic capacitor
C3: 22uF aluminum capacitor.

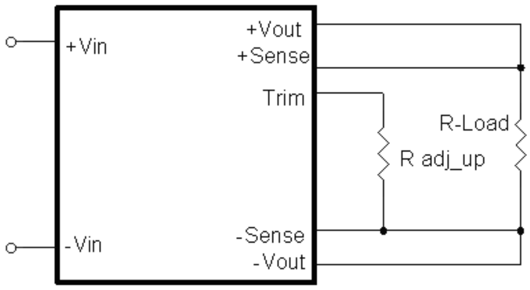
Output Voltage Adjustment

Output may be externally trimmed (-20% to 10%) with a fixed resistor or an external trim pot as shown (optional). Model specific formulas for calculating trim resistors are available upon request as a separate document.

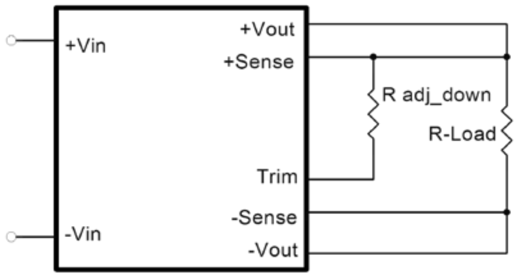




In order to trim the voltage up or down, one needs to connect the trim resistor either between the trim pin and -Vo for trim-up or between trim pin and +Vo for trim-down. The output voltage trim range is -20% to +10%. This is shown:



Trim-up Voltage Setup



Trim-down Voltage Setup

V_{out} (V)	R1 (KΩ)	R2 (KΩ)	R3 (KΩ)	V_r (V)	V_f (V)
5V	3	6.8	2.4	1.24	0.5
12V	9.1	24	5.1	2.5	0.5
24V	20	68	7.5	2.5	0.5
48V	36	82	5.1	2.5	0.5

Trim Resistor Values

The value of Rtrim_up is defined as:

$$R_{trim\_up} = \left(\frac{R_1\left(V_r - V_f\left(\frac{R_2}{R_2 + R_3}\right)\right)}{V_o - V_{o\_nom}}\right) - \frac{R_2 R_3}{R_2 + R_3} \quad (K\Omega)$$

Where:

R_{trim_up} is the external resistor in KΩ.
V_{o_nom} is the nominal output voltage.
V_o is the desired output voltage.
R1, R2, R3 and V_r are internal components.

For example, to trim-up the output voltage of QBR87S12-4.2, 12V output module by 5% to 12.6V, R_{trim_up} is calculated as follows:

$V_o - V_{o\_nom} = 12.6 - 12 = 0.6V$
R1 = 9.1 KΩ, R2 = 24 KΩ, R3 = 5.1KΩ
$V_r = 2.5$ V, $V_f = 0.50$ V

$$R_{trim\_up} = \frac{18.997}{0.6} - 4.206 = 27.45\ (K\Omega)$$

The value of R_{trim_down} defined as:

$$R_{trim\_down} = \frac{R_1 \times (V_o - V_r)}{V_{o\_nom} - V_o} - R_2\ \ (K\Omega)$$

Where:

R_{trim_down} is the external resistor in KΩ.
V_{o_nom} is the nominal output voltage.
V_o is the desired output voltage.
R1, R2, R3 and V_r are internal components.

For example: to trim-down the output voltage of QBR87S12-4.2, 12V module by 5% to 11.4V, R_{trim_down} is calculated as follows:

$V_{o\_nom} - V_o = 12 - 11.4 = 0.6$ V
R1 = 9.1 KΩ, R2 = 51 KΩ, V_r = 2.5 V

$$R_{trim\_down} = \frac{9.1 \times (11.4 - 2.5)}{0.6} - 24 = 110.98\ \ (K\Omega)$$

The typical value of R_{trim_up}

Vout	5V	12V	24V	48V
Trim Up %	Rtrim_Up (KΩ)			
1%	50.45	154.1	164.0	147.3
2%	24.34	74.95	78.64	71.29
3%	15.63	48.56	50.18	45.93
4%	11.28	35.37	35.94	33.24
5%	8.67	27.45	27.40	25.63
6%	6.93	22.17	21.71	20.56
7%	5.69	18.41	17.64	16.94
8%	4.75	15.58	14.59	14.22
9%	4.03	13.38	12.22	12.10
10%	3.45	11.62	10.32	10.41

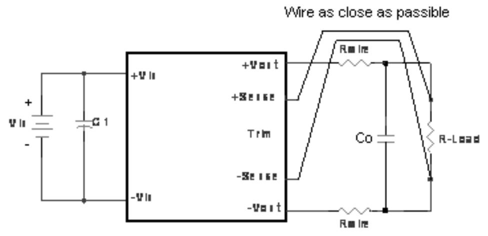
The typical value of R_{trim_down}

Vout	5V	12V	24V	48V
Trim Down %	Rtrim_Down (KΩ)			
1%	215.8	687.3	1703	3294
2%	103.0	327.1	807.8	1588
3%	65.40	207.0	509.2	1019
4%	46.60	147.0	359.9	735.1
5%	35.32	110.9	270.3	564.5
6%	27.80	86.96	210.6	450.7
7%	22.43	69.81	167.9	369.5
8%	18.40	56.95	135.9	308.5
9%	15.27	46.94	111.0	261.1
10%	12.76	38.94	91.16	223.2
11%	10.71	32.39	74.87	192.2
12%	9.00	26.93	61.30	166.3
13%	7.55	22.31	49.82	144.5
14%	6.31	18.35	39.97	125.7
15%	5.24	14.92	31.44	109.5
16%	4.30	11.92	23.97	95.28
17%	3.47	9.277	17.39	82.73
18%	2.73	6.923	11.53	71.58
19%	2.07	4.817	6.298	61.60
20%	1.48	2.921	1.583	52.62

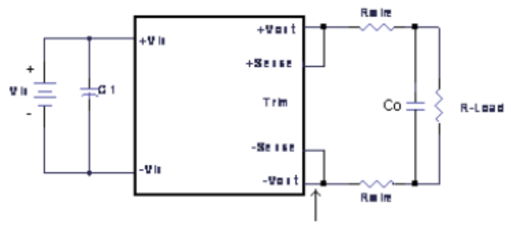
Output Remote Sensing

This QBR series converter has the capability to remotely sense both lines of its output. This feature moves the effective output voltage regulation point from the output of the unit to the point of connection of the remote sense pins. This feature automatically adjusts the real output voltage of the QBR series in order to compensate for voltage drops in distribution and maintain a regulated voltage at the point of load. The remote-sense voltage range is: $[(+V_{out}) - (-V_{out})] - [(+\text{Sense}) - (-\text{Sense})] \leqq 10\%$ of $V_{o\_nominal}$

If the remote sense feature is not to be used, the sense should be connected by twisted-pair wire or shield wire. If the sensing patterns short, heave current flows and the pattern may be damaged. Output voltage might become unstable because of impedance of wiring and load condition when length of wire is exceeding 400mm. This is shown below.



If the remote sense feature is not to be used, the sense pins should be connected locally. The +Sense pin should be connected to the +Vout pin at the module and the -Sense pin should be connected to the -Vout pin at the module. Wire between +Sense and +Vout and between -Sense and –Vout as short as possible. Loop wiring should be avoided. The converter might become unstable by noise coming from poor wiring. This is shown below.



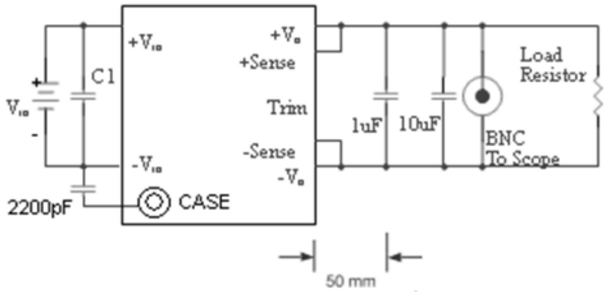
Note:

Although the output voltage can be varied (increased or decreased) by both remote sense and trim, the maximum variation for the output voltage is the larger of the two values not the sum of the values. The output power delivered by the module is defined as the voltage at the output terminals multiplied by the output current. Using remote sense and trim can cause the output voltage to increase and consequently increase the power output of the module if output current remains unchanged. Always ensure that the output power of the module remains at or below the maximum rated power. Also be aware that if $V_{o.set}$ is below nominal value, $P_{out.max}$ will also decrease accordingly because $I_{o.max}$ is an absolute limit. Thus, $P_{out.max} = V_{o.set} \times I_{o.max}$ is also an absolute limit.

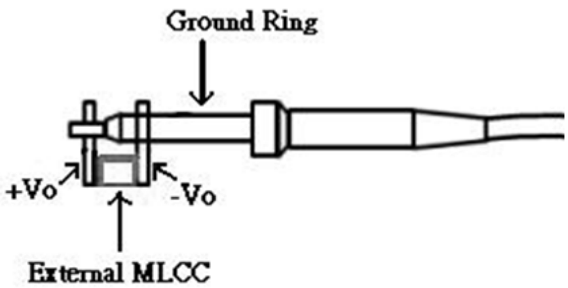
Output Ripple and Noise

Output ripple and noise measured with 10uF aluminum and 1uF ceramic capacitor across output for 48Vout and with 10uF tantalum and 1uF ceramic capacitor for others. A 20 MHz bandwidth oscilloscope is normally used for the measurement.

The conventional ground clip on an oscilloscope probe should never be used in this kind of measurement. This clip, when placed in a field of radiated high frequency energy, acts as an antenna or inductive pickup loop, creating an extraneous voltage that is not part of the output noise of the converter.



Another method is shown in below, in case of coaxial-cable/BNC is not available. The noise pickup is eliminated by pressing scope probe ground ring directly against the -Vout terminal while the tip contacts the +Vout terminal. This makes the shortest possible connection across the output terminals.Output ripple and noise is measured with 10μF tantalum and 1μF ceramic capacitors across the output.

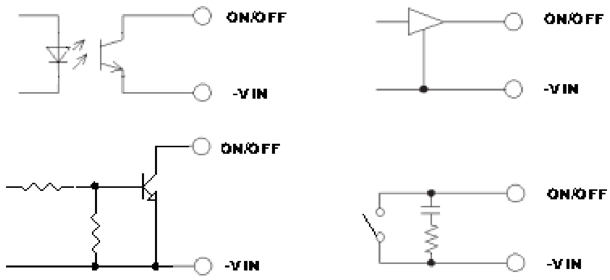


Output Capacitance

This QBR87 series of converters provide unconditional stability with or without external capacitors. For good transient response, low ESR output capacitors should be located close to the point of load. PCB design emphasizes low resistance and inductance tracks in consideration of high current applications. Output capacitors with their associated ESR values have an impact on loop stability and bandwidth. DATEL converters are designed to work with load capacitance to meet the technical specification.

Remote On/Off circuit

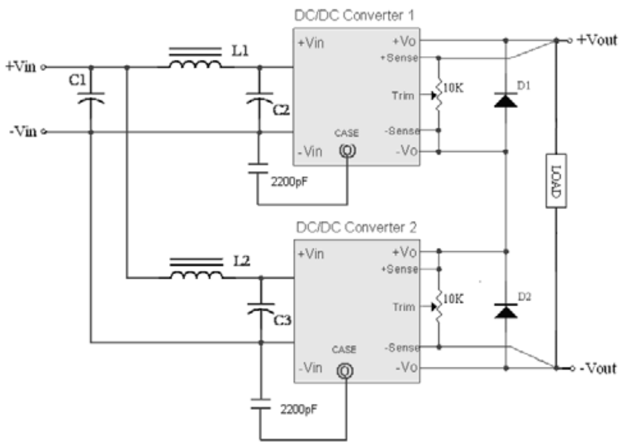
The converter remote On/Off circuit built-in on input side. The ground pin of input side Remote On/Off circuit is –Vin pin. Refer to the below figure for more details. Connection examples see below.



Remote On/Off Connection

Series operation

Series operation is possible by connecting the outputs two or more units. Connection is shown in below. The output current in series connection should be lower than the lowest rate current in each power module.

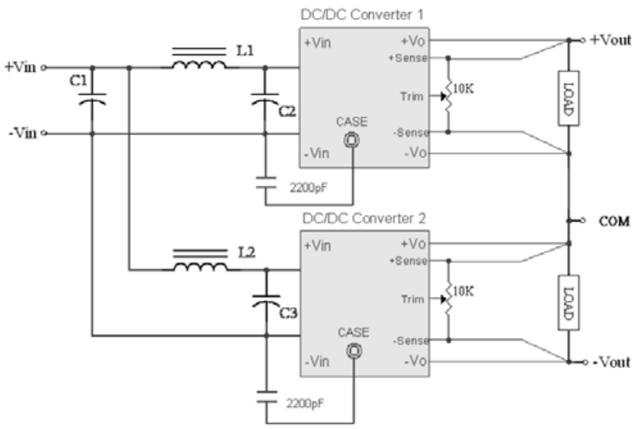


Simple Series Connect Circuit

Where:
L1, L2: 1.0μH
C1, C2, C3: 68μF/200V ESR<0.7Ω

Note:
1. If the impedance of the input line is high, C1, C2, C3 capacitance must be more than above. Use more than two recommended capacitor as above in parallel when ambient temperature becomes lower than -20 °C
2. Recommend sSchottky diode (D1, D2) be connected across the output of each series connected converter, so that if one converter shuts down for any reason, then the output stage won't be thermally

overstressed. Without this external diode, the output stage of the shut-down converter could carry the load current provided by the other series converters, with its MOSFETs conducting through the body diodes. The MOSFETs could then be overstressed and fail. The external diode should be capable of handling the full load current for as long as the application is expected to run with any unit shut down.
Series for ±output operation is possible by connecting the outputs two units, as shown in the schematic below.

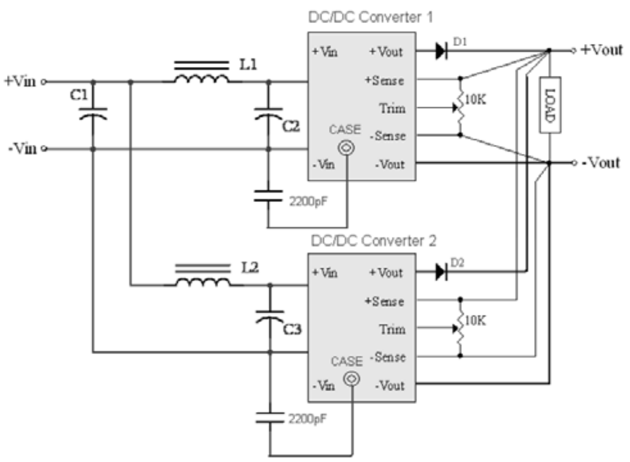


Simple ±Output Connect Circuit

Where:
L1, L2: 1.0μH
C1, C2, C3: 68μF/200V ESR<0.7Ω
Note:
If the impedance of input line is high, C1, C2, C3 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20 ℃

Parallel / Redundant operation

The QBR87 series parallel operation is **not** possible.
Parallel for redundancy operation is possible by connecting the units as shown in the schematic below. The current of each converter become unbalance by a slight difference of the output voltage. Make sure that the output voltage of units of equal value and the output current from each power supply does not exceed the rate current. Suggest use an external potentiometer to adjust output voltage from each power supply.



Simple Redundant Operation Connect Circuit

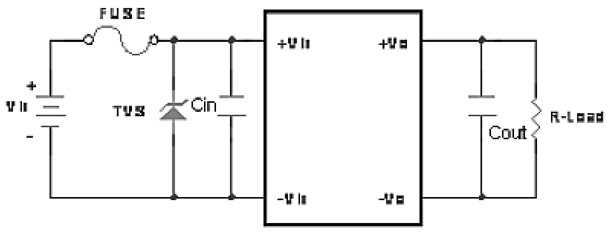
L1, L2: 1.0μH

C1, C2, C3: 68μF/200V ESR<0.7Ω
Note:
If the impedance of input line is high, C1, C2, C3 capacitance must be more than above. Use more than two recommended capacitor above in parallel when ambient temperature becomes lower than -20 ℃

SAFETY and EMC

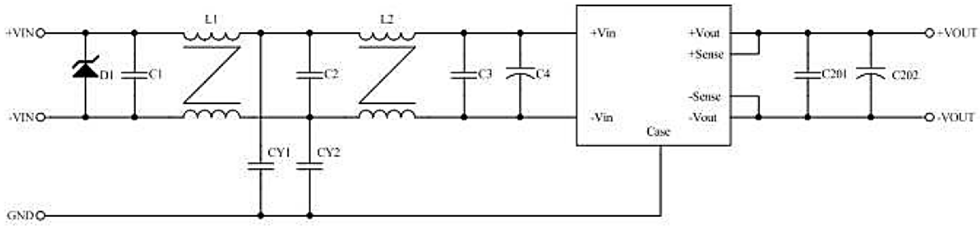
Input Fusing and Safety Considerations

The QBR series converters have no internal fuse. In order to achieve maximum safety and system protection, always use an input line fuse. We recommended a fast acting 6 A for all models. It is recommended that the circuit have a transient voltage suppressor diode (TVS) across the input terminal to protect the unit against surge or spike voltage and input reverse voltage as shown below.



EMC Considerations

EMI Test standard: EN50121-3-2 Conducted & Radiated Emission
Test Condition: Input Voltage: 110Vdc, Output Load: Full Load
(1) EMI meet EN55011 / EN55022 / EN50121-3-2:2006

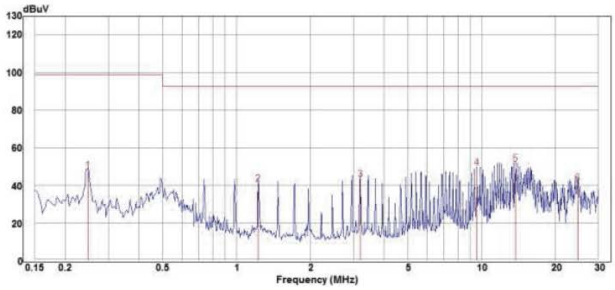


Model No.	C1, C2, C3	C4	C201	C202	CY1, CY2	D1	L1, L2
QBR87S5-6	1μF/250V 1812 Ceramic	1μF/100V KXJ	1μF/100V 1206	22 μF /100V	1500pF	1.5KE180A	5.5 mH
QBR87S12-4.2	1μF/250V 1812 Ceramic	1μF/100V KXJ	1μF/100V 1206	22 μF /100V	1500pF	1.5KE180A	5.5 mH
QBR87S24-2.1	1μF/250V 1812 Ceramic	1μF/100V KXJ	1μF/100V 1206	22 μF /100V	1500pF	1.5KE180A	5.5 mH
QBR87S48-1.05	1μF/250V 1812 Ceramic	1μF/100V KXJ	1μF/100V 1206	22 μF /100V	1500pF	1.5KE180A	5.5 mH

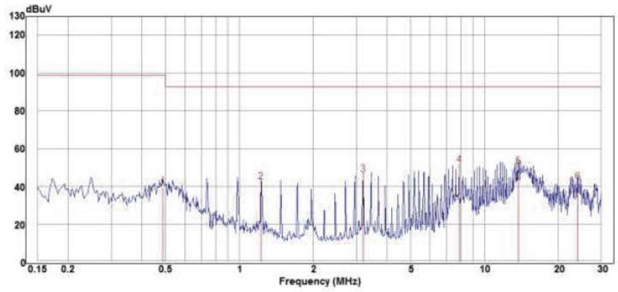
Note: C4 KXJ series UNITED CHEMI-CON, CY1, CY2 MURATA Y1 capacitors, L1, L2 BULL WILL URT24-05055H or equivalent

Conducted Emission

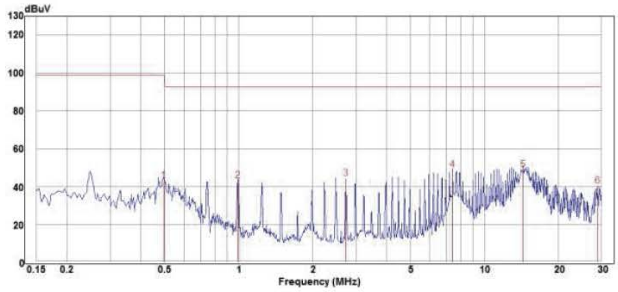
QBR87S5-6 Line



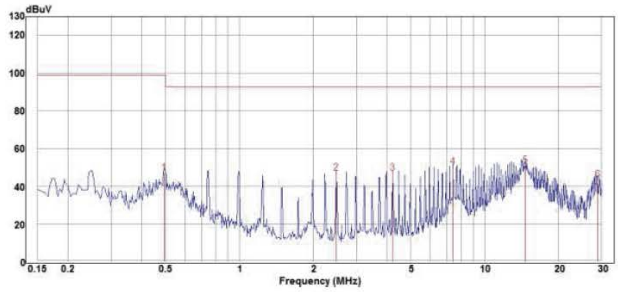
QBR87S5-6 Neutral



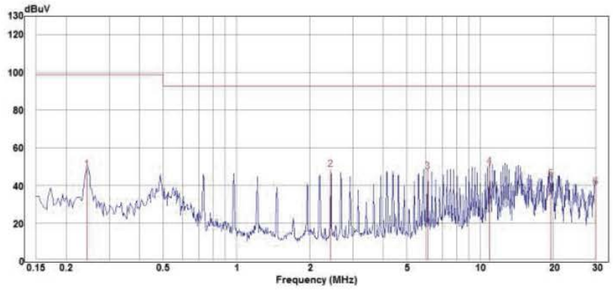
QBR87S12-4.2 Line



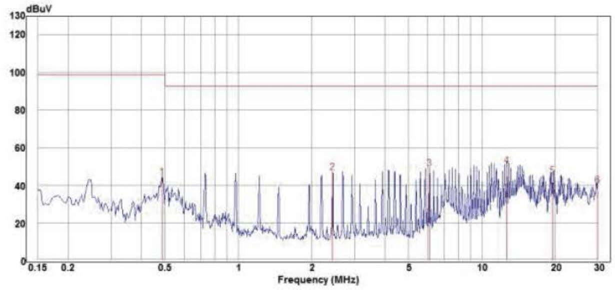
QBR87S12-4.2 Neutral



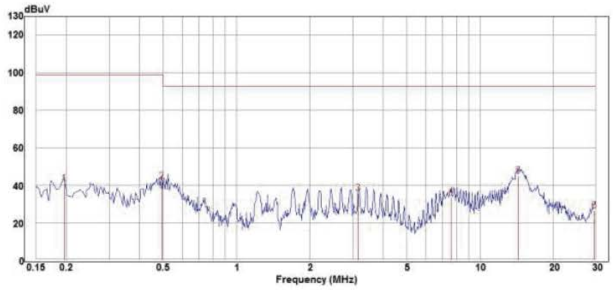
QBR87S24-2.1 Line



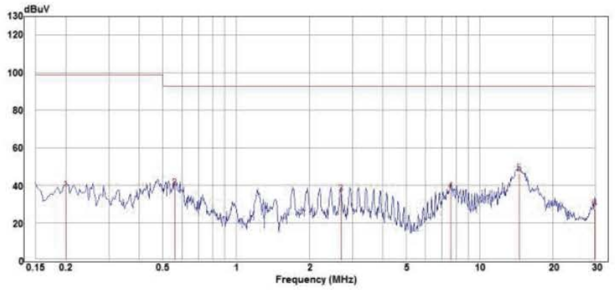
QBR87S24-2.1 Neutral



QBR87S48-1.05 Line

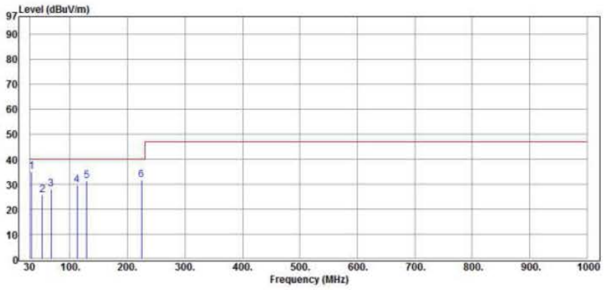


QBR87S48-1.05 Neutral

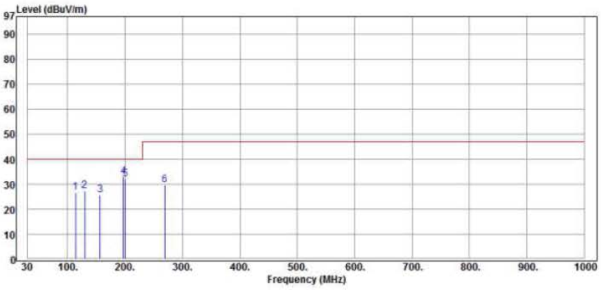


Radiation Emission

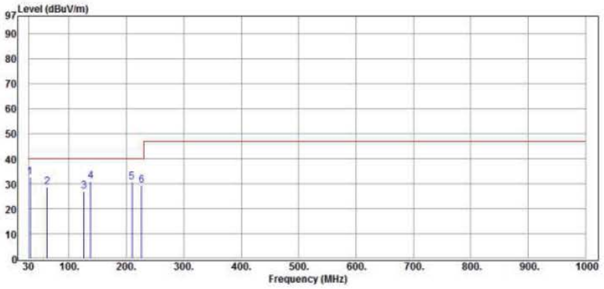
QBR87S5-6 Vertical



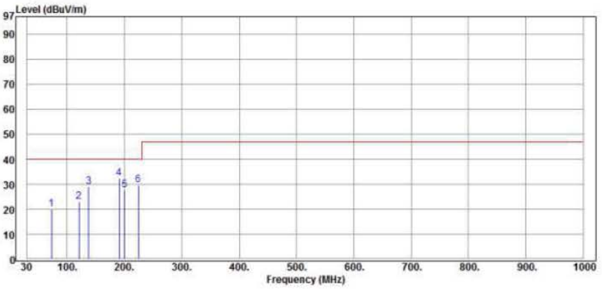
QBR87S5-6 Horizontal



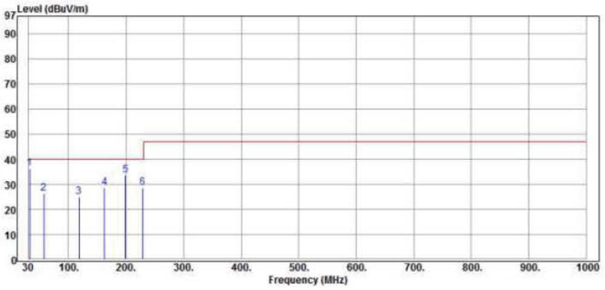
QBR87S12-4.2 Vertical



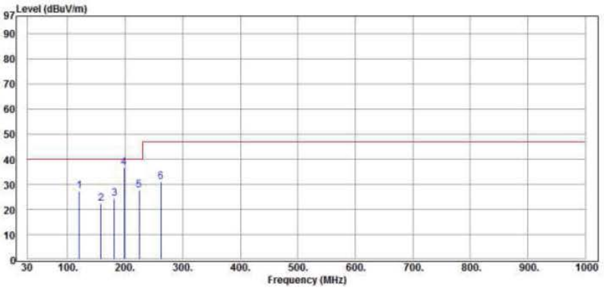
QBR87S12-4.2 Horizontal



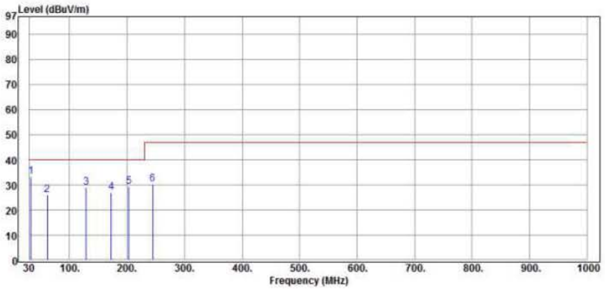
QBR87S24-2.1 Vertical



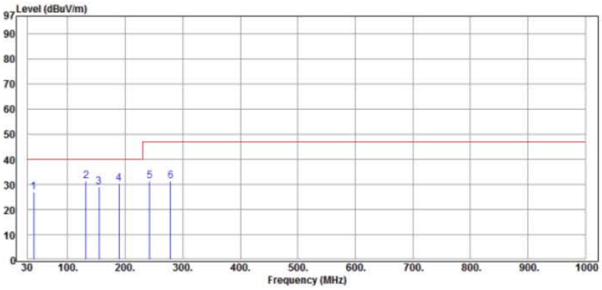
QBR87S24-2.1 Horizontal



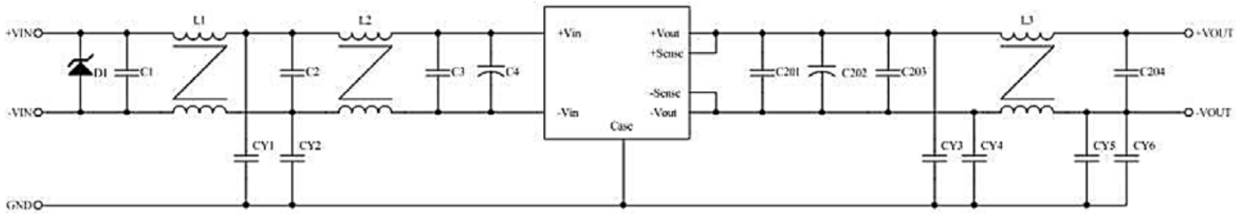
QBR87S48-1.05 Vertical



QBR87S48-1.05 Horizontal



(2) EMI Test standard: meets EN50121-3-2:2015

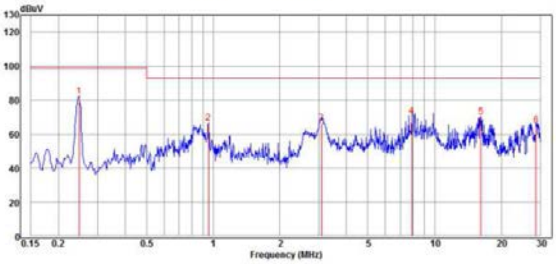


Model No.	C1, C2, C3	C4	C201	C202	C203, C204	CY1, CY2	CY3, CY4, CY5, CY6	D1	L1, L2	L3
QBR87S5-6	1μF/250V	82μF/250V	1μF/100V	22 μF /100V	2.2 μF /100V	1500pF	1.5KE180A	1.5KE180A	5.5 mH	0.4 mH
QBR87S12-4.2	1μF/250V	82μF/250V	1μF/100V	22 μF /100V	2.2 μF /100V	1500pF	1.5KE180A		5.5 mH	0.4 mH
QBR87S24-2.1	1μF/250V	82μF/250V	1μF/100V	22 μF /100V	2.2 μF /100V	1500pF	1.5KE180A		5.5 mH	0.4 mH
QBR87S24-2.1	1μF/250V	82μF/250V	1μF/100V	22 μF /100V	2.2 μF /100V	1500pF	1.5KE180A		5.5 mH	0.4 mH

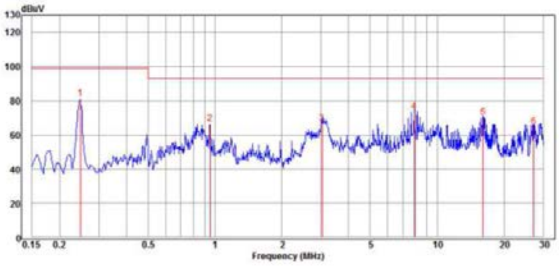
Note: C1, C2, C3 are 1812 Ceramic Capacitors, C4 is UNITED CHEMI-CON KXJ series, C201is a 1206 Ceramic Capacitor, C202 is a solid Aluminum Capacitor, C203 and C204 are 1210 Ceramic Capacitor, CY1, CY2 are MURATA Y1 Capacitors, and L1, L2 are BULL WILL URT24-05055H or equivalent.

Conducted Emission Test

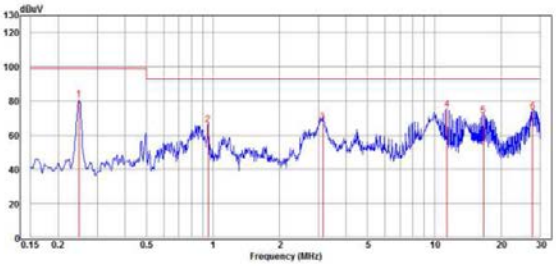
QBR87S5-6 Positive



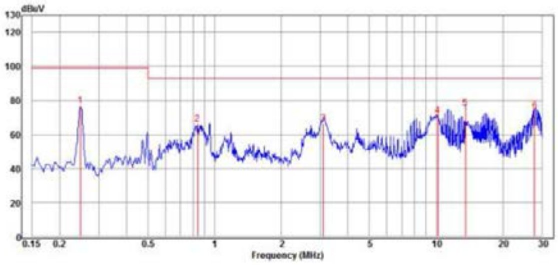
QBR87S5-6 Negative



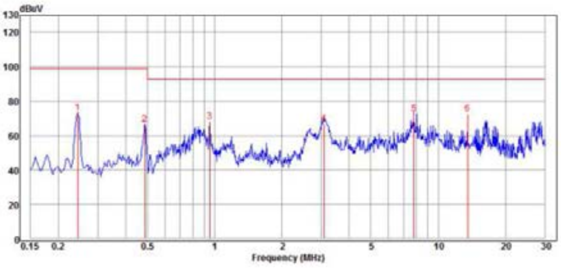
QBR87S12-4.2 Positive



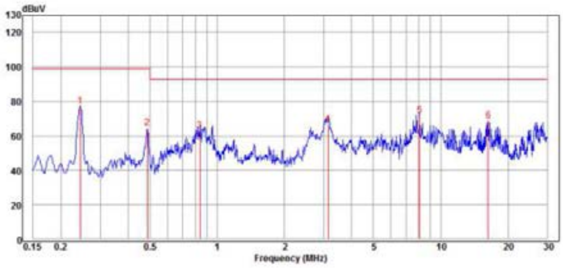
QBR87S12-4.2 Negative



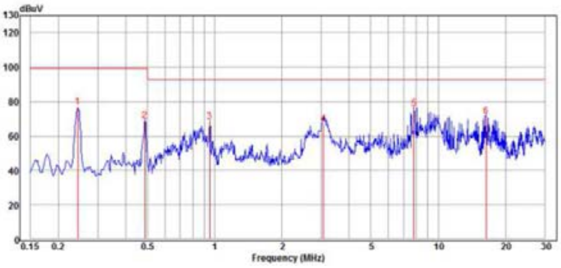
QBR87S24-2.1 Positive



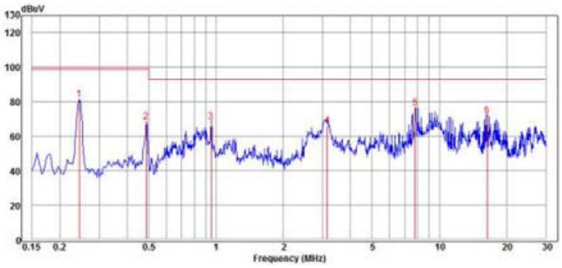
QBR87S24-2.1 Negative



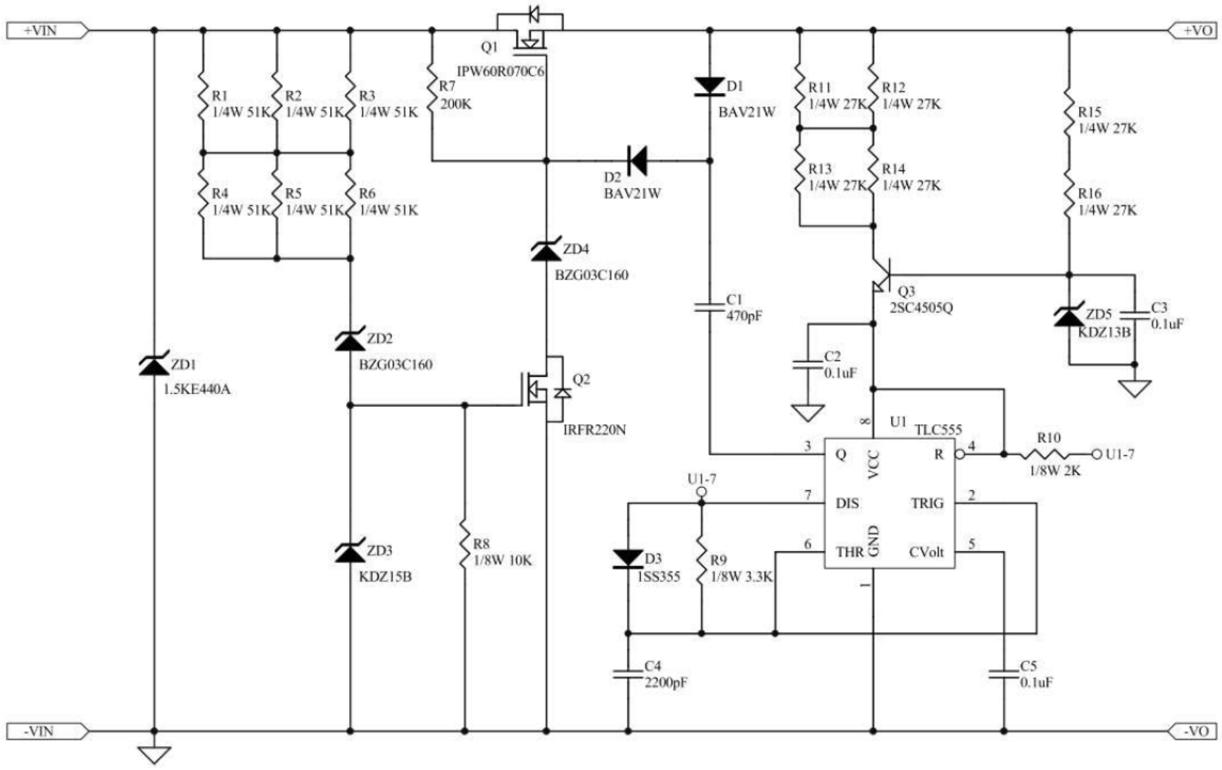
QBR87S48-1.05 Positive



QBR87S48-1.05 Positive

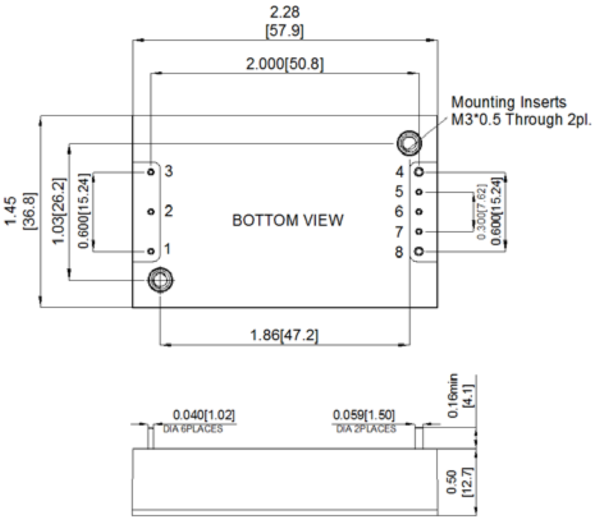


SUGGESTED CONFIGURATION FOR RIA12 SURGE TEST



Note: It is recommended to provide good heat dissipation condition and to use Infineon IPW60R070C6 for Q1 or equivalent

MECHANICAL SPECIFICATIONS



Note: All dimensions are in inches (millimeters). Tolerance: x.xx ±0.02 in. (0.5mm), x.xxx ±0.010 in. (0.25 mm) unless otherwise noted

PIN CONNECTIONS

PIN CONNECTIONS	
PIN	**SINGLE OUTPUT**
1	+ V Input
2	On/Off
3	- V Input
4	-V Output
5	-Sense
6	Trim
7	+ Sense
8	+ V Output

PART NUMBER ORDERING INFORMATION

Family, Form, Factor Package	Nominal Input voltage	Number of Outputs	Voltage Output Volts		Current Output (A)	Options
QBR	87	S	5	—	6	N, M
	(14-160) 87 Volts	S - Single	5 Volts 12 Volts 24 Volts 48 Volts		5 Volts – 6A 12 Volts – 4.2A 24 Volts – 2.1A 48 Volts – 1.05A	*None – Positive ON/OFF Control N – Negative On/Off control M – Clear Mounting Insert

*Note: For proper part ordering, enter optional suffixes in the order listed in table above