

Features

ICE Technology*

- 115°C Maximum Case Temperature
- -40°C Minimum Temp.
- Built-in FCC/EN55022 Class B Filter
- 2:1 Wide Input Voltage Range
- 50 Watts Output Power
- Ribbed or Baseplate Case Styles
- Min. Efficiency 86%
- 3kVDC Isolation
- Low Quiescent Current

Description

The RPP50 series 2:1 input range DC/DC converters are ideal for high end industrial applications and COTS Military applications where a very wide operating temperature range of -45°C to +120°C is required. Although the case size is very compact, the converter contains a built-in filter EN55022 Class B / FCC Level B without the need for any external components. The RPP50 is available in two case styles: the ribbed case for active cooling and the baseplate case for high vibration, bulkhead-mounting or for passive heatsink cooling applications. They are UL-60950-1 certified.

Selection Guide 24V and 48V Input Types

Part Number	Input Range VDC	Output Voltage VDC	Output Current A	Input ⁽¹⁾ Current mA	Efficiency ⁽²⁾ (Typ.)
RPP50-243.3S	18-36	3.3	15	58/2405	86%
RPP50-2405S	18-36	5	10	60/2315	89%
RPP50-2412S	18-36	12	4.16	18/2370	87%
RPP50-2415S	18-36	15	3.33	18/2315	88%
RPP50-2424S	18-36	24	2.10	18/2315	88%
RPP50-483.3S	36-75	3.3	15	42/1177	87%
RPP50-4805S	36-75	5	10	37/1140	89%
RPP50-4812S	36-75	12	4.16	11/1165	87%
RPP50-4815S	36-75	15	3.33	11/1141	88%
RPP50-4824S	36-75	24	2.10	11/1141	88%

** add suffix for case options

SUFFIX INFORMATION

none = Standard Ribbed Case
-B = Baseplate Case

For other CTRL logic (-1), case style (-F) or low temperature options (-L, -M, -T) please contact RECOM for availability.

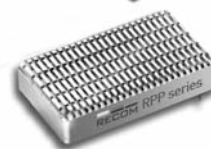
POWERLINE+

DC/DC-Converter

with 3 year Warranty

RECOM

50 Watt 2:1 Single Output



UL-60950-1 Certified
E224736

RPP50-S

* ICE Technology

ICE (Innovation in Converter Excellence) uses state-of-the-art techniques to minimise internal power dissipation and to increase the internal temperature limits to extend the ambient operating temperature range to the maximum. Refer to Application Notes

Specifications (typical at nominal input and 25°C unless otherwise noted)

Input Voltage Range	24V nominal input	18-36VDC
	48V nominal input	36-75VDC
Under Voltage Lockout	24V input	DC-DC ON (min.) 17.5VDC
		DC-DC OFF (max.) 17VDC
	48V input	DC-DC ON (min.) 35VDC
		DC-DC OFF (max.) 34VDC
Input Filter	Common Mode EMC Filter	
Input Surge Voltage (100 ms max.)	24V Input	50VDC
	48V Input	100VDC
Input Reflected Ripple	nominal Vin and full load	300mA _{p-p}
Start Up Time	nominal Vin and constant resistor load	20ms typ., 50ms max.
Remote ON/OFF ⁽³⁾	Logic High	Open or 3.0V < Vr < 5.5V
	Logic Low	Short or 0V < Vr < 1.2V
Remote OFF input current	Nominal input	2mA typ.
Output Voltage Accuracy	10% Load and nominal Vin	±1%
Voltage Adjustability		±10%
Minimum Load		0%
Line Regulation	low line, high line at full load	±0.3%
Load Regulation	10% to 100% full load	±0.5%
Ripple and Noise (20MHz bandwidth limited) (measured with 1µF capacitor across output)	3.3V, 5V	60mV _{p-p} typ.
	All others	40mV _{p-p} typ.
Temperature Coefficient		±0.04%/°C max.
Transient Response	25% load step change	200µs
Over Load Protection	% of full load at nominal Vin	120% typ.
Short Circuit Protection	Hiccup, automatic recovery	
Output Over Voltage Protection (refer to block diagram in Application Notes)	Converter shutdown if Vout > Vout nominal + 20%	
Isolation Voltage	Rated at 2250VDC/1 minute, Flash tested at 3000VDC/1 second	
Isolation Resistance	10MΩ min.	
Isolation Capacitance (refer to block diagram in Application Notes)	3000pF max.	
Operating Frequency	260kHz ± 40kHz Maximum	
Case Temperature	+115°C	
Storage Temperature Range	-55°C to +125°C	
Over Temperature Protection (refer to block diagram in Application Notes)	internal thermistor	
RPP50 Operating Temperature Range	Ambient, Free Convection	-40°C to see Calculation (Note 7)
Thermal Impedance (Natural convection)	Ribbed Case: Vertical	7.3°C/Watt
	Ribbed Case: Horizontal	10°C/Watt
Relative Humidity	5% to 95% RH	
Case Material ⁽⁶⁾	Aluminium	
Potting Material	Silicone (UL94-V0)	
Weight	Ribbed Case	39g
	Baseplate Case	43g
Packing Quantity	Ribbed Case	4 pcs per Tube
	Baseplate Case	Single packed

Specifications (typical at nominal input and 25°C unless otherwise noted)

Safety Standards	certified UL-60950-1, 1st Edition	
Thermal Cycling	complies with MIL-STD-810F	
Vibration	10-55Hz, 12G, 30 Min. along X, Y and Z	
Conducted Emissions	EN55022	Class B
Radiated Emissions	EN55022	Class B
ESD	EN61000-4-2	Perf. Criteria B
Radiated Immunity	EN61000-4-3	Perf. Criteria A
Fast Transient ⁽⁴⁾	EN61000-4-4	Perf. Criteria B
Surge ⁽⁴⁾	EN61000-4-5	Perf. Criteria B
Conducted Immunity	EN61000-4-6	Perf. Criteria A
MTBF calculated according to BELLCORE TR-NWT-000332 ⁽⁵⁾	1989 x 10 ³ hours	

Notes :

1. Typical values at nominal input voltage and no load/full load.
2. Typical values at nominal input voltage and full load.
3. The ON/OFF pin voltage is referenced to negative input. The pin is pulled high internally.
ON/OFF control is standard with positive logic: e.g. RPP50-4805S.
Positive logic: 0 = OFF, 1 = ON. The converter will be ON if the CTRL is left open.
4. Requires an external 100µF low ESR capacitor to meet EN61000-4-4 and EN61000-4-5
5. Case I: 50% Stress, Temperature at 50°C (Ground Benign).
6. To ensure a good all-round electrical contact, the baseplate is pressed firmly into place within the aluminium housing. The hydraulic press can leave tooling marks and deformations to both the housing and baseplate. The case is anodised aluminium, so there will be natural variations in the case colour and the aluminium is not scratch resistant. Any resultant marks, scratches and colour variations are cosmetic only and do not affect the operation or performance of the converters.

7. Example:

$$R_{th\text{case-ambient}} = 7.3^{\circ}\text{C/W (vertical)}$$

$$R_{th\text{case-ambient}} = 11^{\circ}\text{C/W (horizontal)}$$

$$R_{th\text{case-ambient}} = \frac{T_{\text{case}} - T_{\text{ambient}}}{P_{\text{dissipation}}}$$

$$P_{\text{dissipation}} = P_{\text{in}} - P_{\text{out}} = \frac{P_{\text{out}}}{\eta} - P_{\text{out}}$$

T_{case} = Case Temperature

T_{ambient} = Environment Temperature

$P_{\text{dissipation}}$ = Internal losses

P_{in} = Input Power

P_{out} = Output Power

η = Efficiency under given Operating Conditions

$R_{th\text{case-ambient}}$ = Thermal Impedance

$$P_{\text{dissipation}} = P_{\text{in}} - P_{\text{out}} = \frac{P_{\text{out}}}{\eta} - P_{\text{out}}$$

Practical Example:

Take the RPP50-4805SW with 90% load. What is the maximum ambient operating temperature? Use converter vertical in application.

$$\text{Eff}_{\text{min}} = 89\% @ V_{\text{nom}}$$

$$P_{\text{out}} = 50\text{W}$$

$$P_{\text{outapp}} = 50 \times 0.9 = 45\text{W}$$

$$P_{\text{dissipation}} = \frac{P_{\text{out}}}{\eta} - P_{\text{out}}$$

$$\eta = \sim 90\% \text{ (from Eff vs Load Graph)}$$

$$P_{\text{dissipation}} = \frac{45}{0.9} - 45 = 5\text{W}$$

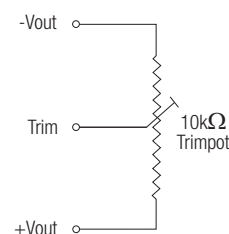
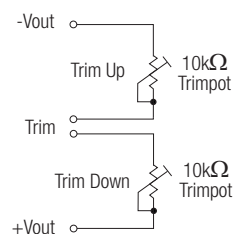
$$R_{th} = \frac{T_{\text{casemax}} - T_{\text{ambient}}}{P_{\text{dissipation}}} \rightarrow 7.3^{\circ}\text{C/W} = \frac{115^{\circ}\text{C} - T_{\text{ambient}}}{5\text{W}}$$

$$T_{\text{ambient}} = 78.5^{\circ}\text{C}$$

Typical Characteristics

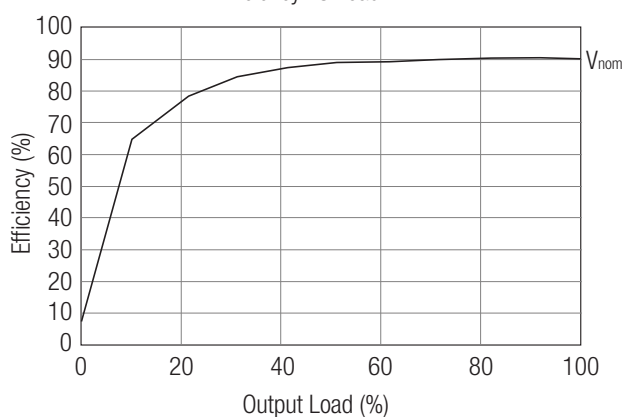
External Output Trimming

Refer to Application Notes for suggested Resistor Values



RPP50-4805S

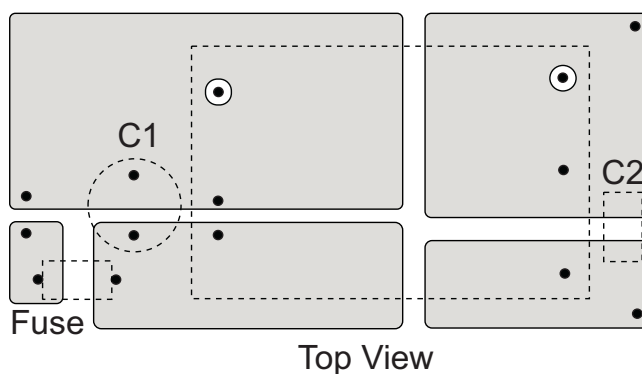
Efficiency VS Load



Recommended PCB Layout

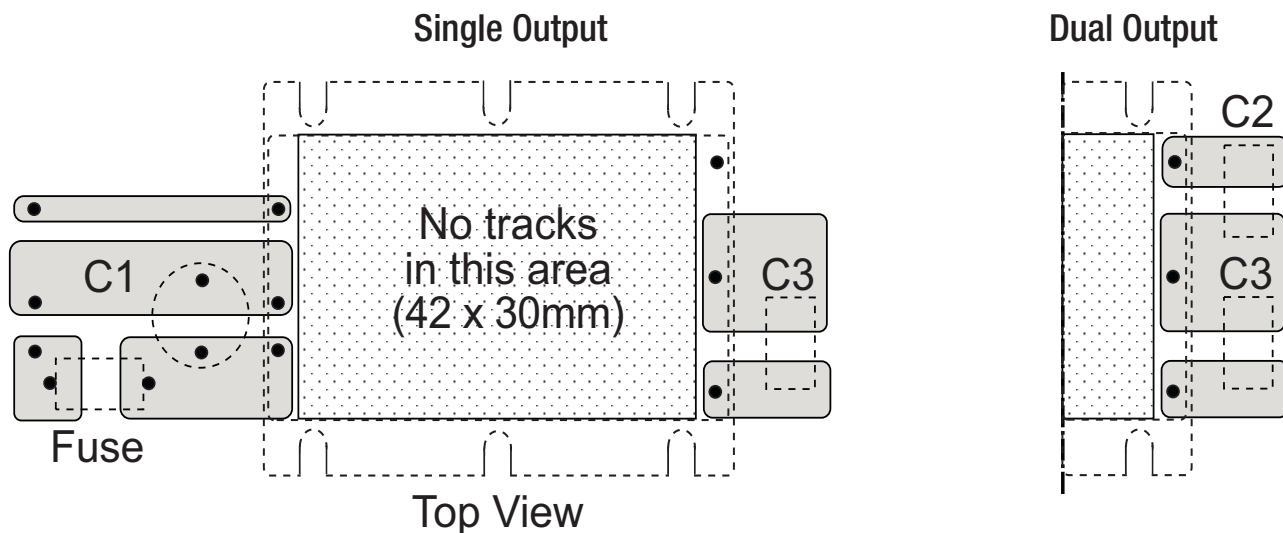
Ribbed Case

Single Output



Recommended PCB Layout

Baseplate Case- suggested PCB layout



Input Fuse is recommended. Recommended fuse rating = double maximum input current, time delay type.

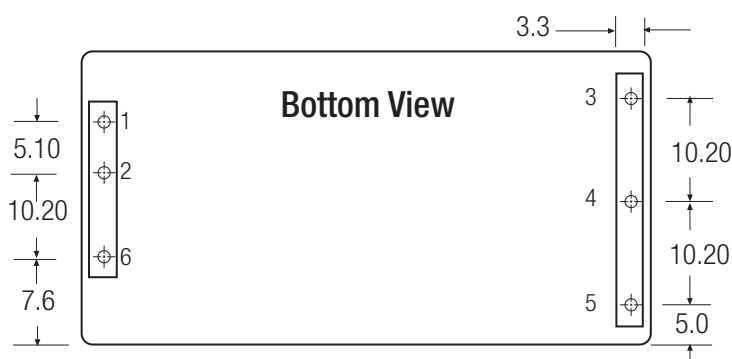
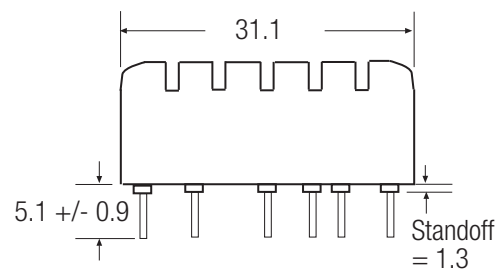
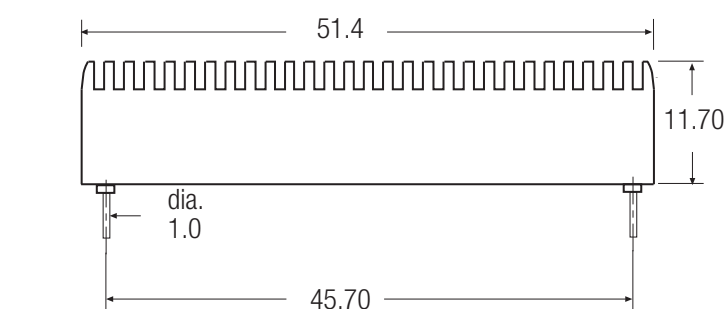
Input Capacitor, C1, is required to meet EN61000 Surge and Fast Transient, otherwise it is not required for normal operation.

Output Capacitors C2/C3 are recommended, but not required for normal operation. Typical capacitor values are 1µF MLCC

To ensure optimum thermal performance, use large areas of copper on the PCB to assist with heat dissipation and mount the converter vertically.

Package Style and Pinning (mm)

Ribbed Case (Standard - no Suffix)



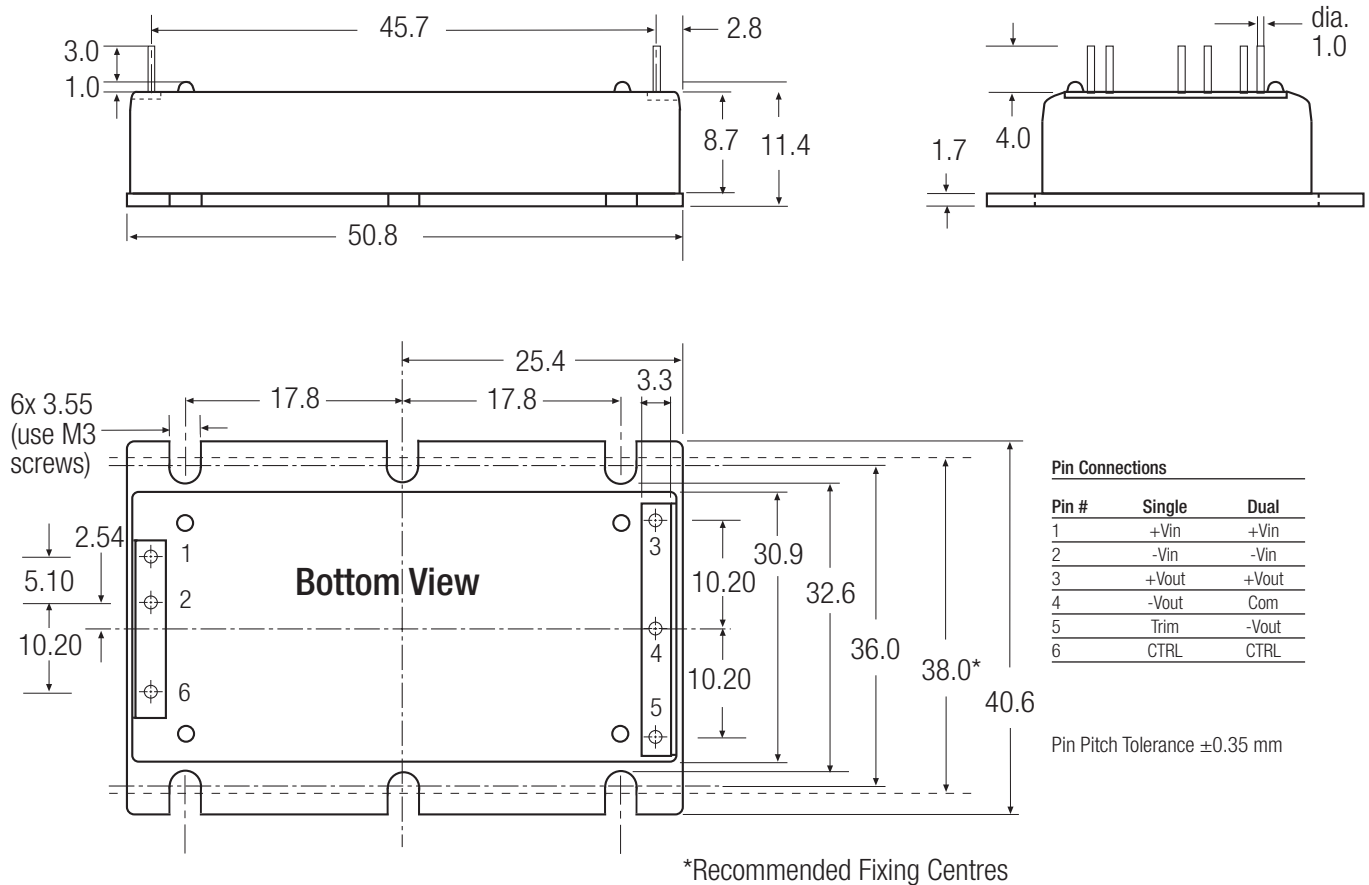
Pin Connections

Pin #	Single	Dual
1	+Vin	+Vin
2	-Vin	-Vin
3	+Vout	+Vout
4	-Vout	Com
5	Trim	-Vout
6	CTRL	CTRL

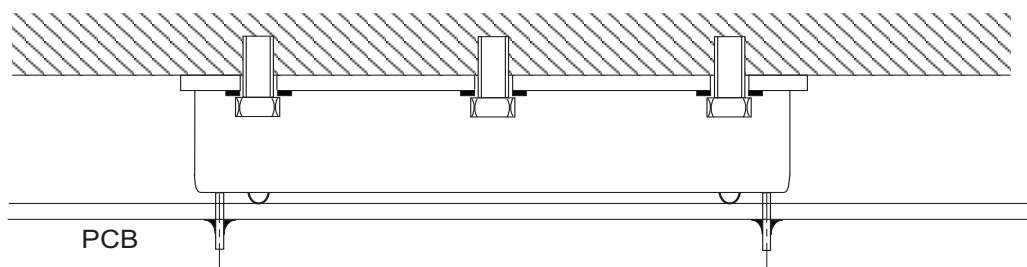
Pin Pitch Tolerance ± 0.35 mm

Typical Characteristics

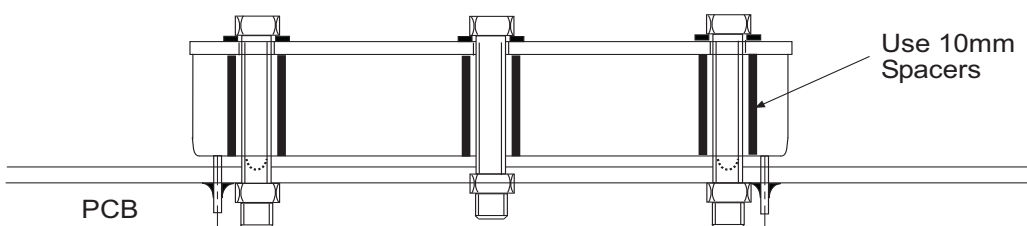
Baseplate Case (-B Suffix)



Baseplate Case Fixing - Mounting onto Heatsink/Bulkhead



Baseplate Case Fixing - Anti Vibration Mounting onto PCB



POWERLINE+ Application Notes

DC/DC-Converter

ICE Technology

ICE Technology

I.C.E Technology

ICE (Innovation in Converter Excellence) Technology uses a combination of techniques to minimise internal heat dissipation and maximise the heat transfer to ambient to create a new converter series which offers high end performance at a price which is significantly lower than conventional specialist converters.

The exact details of this technology must remain secret, but the following brief resume describes the main features of this technological breakthrough:

Minimising internal heat dissipation

The difference between the input power and the output power is the internal power dissipation which generates heat within the converter.

If the converter is inefficient at converting power, then adding external heat sinks, base-plates or fans are remedies that cure the symptoms rather than address the illness.

First and foremost, the converter must have the highest possible efficiency over the entire input voltage range and load conditions. Most power converters are designed to be most efficient at 25°C, full load and nominal input voltage and thus offer a compromise performance when lightly loaded or operated at the maximum ambient temperature.

ICE Technology uses state-of-the-art techniques to improve power conversion efficiency by approximately 2% compared to standard converters. A two per cent improvement may not sound much, but the difference between a converter with 88% efficiency and one with 90% efficiency is a 17% reduction in the dissipated power. In addition, when lightly loaded, the converters enter a power saving mode and draw only a few milliamps from the supply.

Maximising heat transfer

The rate of heat transfer between a hot body and its cooler surroundings is given by Fourier's Law:

$$q = -k \cdot \Delta T$$

where

q = rate of heat transfer

k = thermal conductivity

and ΔT = temperature difference

If k can be made larger, then the rate of heat transfer can still match or exceed the rate of heat generation at lower temperature differences ΔT and the converter will have an extended operating temperature range.

Techniques to improve thermal conductivity

ICE Technology splits the thermal conductivity problem into two areas and attacks each area separately using different techniques.

Firstly, the internal heat transfer to the case is maximised by a combination of novel converter construction and clever thermal design.

ICE converters use a construction where the hottest components (the switching FET, the transformer and the synchronous rectification FETs) are placed closest to the case wall. This method of construction makes the manufacture of the converter more difficult, but this lack of compromise reduces greatly the internal thermal impedance.

Secondly, the rate of transfer of heat to the surroundings is improved by a novel case construction which incorporates a built-in heat sink. The case is also made from thick aircraft grade aluminium rather than thin nickel-plated copper to provide a better thermal junction between the case and the high thermal conductivity silicone potting material used inside the converter.

Maximising high temperature performance

The final technique used in the construction of ICE Technology converters is to use high temperature internal components. The maximum operating temperature of a converter is dependent on the lowest maximum permissible operating temperature of any the components used. If the capacitors are rated up to +85°C and the FETs are rated at +160°C, then the limiting factor is the capacitor temperature of +85°C.

The temperature of the ferrite core used in the transformer is also an important limiting factor. If the transformer core temperature exceeds the Curie temperature of the ferrite, then the transformer rapidly loses performance.

ICE Technology converter uses high temperature grade components to permit a case temperature of +115°C maximum. This allows operation at up to +85°C ambient without the need for fans to blow air over the converter.



Electromagnetic Compatibility

Although high temperature performance is a significant feature of ICE Technology design, it does not end there.

ICE Technology also addresses the need for electromagnetic compatibility by incorporating a built-in EN55022 Class B grade filter inside the converter. The converter has been designed from the ground up to meet EMC requirements rather than a conventional design process where first the converter is optimised for performance and then an external filter is added to combat the conducted interference.

By including the filter on the main PCB of the converter, the track path lengths and impedances between the filter and the noise-generating components are reduced to the minimum and consequently smaller value filter components can be used that fit into the compact case dimensions of the Powerline+ converters without compromising on filter performance.

Safety and Protection

ICE Technology converters are fully protected from output short circuits, overload, output over-voltage and over-temperature. In addition, they feature under-voltage lockout that will automatically disable the converter if the input voltage falls below the minimum level.

The output is current limited which means that temporary overloads can occur without the converter shutting down. When overloaded, the output voltage will decrease to keep the maximum power constant. For the 40W and 50W converters, if the overload is too high, the converter will go into hiccup short circuit protection mode. In this mode, the converter will attempt to reconnect power every 10-20 milliseconds.

Output overvoltage protection is monitored by a separate and independent feedback circuit and an internal thermistor sensor is used to protect the converter against overheating.

Powerline Plus Output Trim Tables



Output Voltage Trimming:

Single output Powerline Plus converters offer the feature of trimming the output voltage over a certain range around the nominal value by using external trim resistors.

No general equation can be given for calculating the trim resistors, but the

following trimtables give typical values for choosing these trimming resistors.

If voltages between the given trim points are required, extrapolate between the two nearest given values to work out the resistor required or use a variable resistor to set the output voltage.

RPPxx-xx3.3S (all types)

Trim up	1	2	3	4	5	6	7	8	9	10	%
Vout =	3,333	3,366	3,399	3,432	3,465	3,498	3,531	3,564	3,597	3,63	Volts
R _U =	72.8	34.4	21.2	14.4	9.9	7.2	5.3	3.88	2.74	1.84	KOhms
Trim down	1	2	3	4	5	6	7	8	9	10	%
Vout =	3,267	3,234	3,201	3,168	3,135	3,102	3,069	3,036	3,003	2,97	Volts
R _D =	101.3	36.2	21.0	13.65	9.2	6.0	4.12	2.56	1.34	0.87	KOhms

RPPxx-xx05S (all types)

Trim up	1	2	3	4	5	6	7	8	9	10	%
Vout =	5,05	5,1	5,15	5,2	5,25	5,3	5,35	5,4	5,45	5,5	Volts
R _U =	109.7	51	31.2	20.3	14.2	9.87	7.1	5.0	3.38	2.08	KOhms
Trim down	1	2	3	4	5	6	7	8	9	10	%
Vout =	4,95	4,9	4,85	4,8	4,75	4,7	4,65	4,6	4,55	4,5	Volts
R _D =	127.6	55.8	33.0	20.2	14.2	9.46	5.97	3.6	1.77	0.28	KOhms

RPPxx-xx12S (all types)

Trim up	1	2	3	4	5	6	7	8	9	10	%
Vout =	12,12	12,24	12,36	12,48	12,6	12,72	12,84	12,96	13,08	13,2	Volts
R _U =	270	120	70	45.2	30.1	19.8	12.8	7.52	3.31	0	KOhms
Trim down	1	2	3	4	5	6	7	8	9	10	%
Vout =	11,88	11,76	11,64	11,52	11,4	11,28	11,16	11,04	10,92	10,8	Volts
R _D =	270	120	70	45.2	30.1	19.8	12.8	7.52	3.31	0	KOhms

RPPxx-xx15S (all types)

Trim up	1	2	3	4	5	6	7	8	9	10	%
Vout =	15,15	15,3	15,45	15,6	15,75	15,9	16,05	16,2	16,35	16,5	Volts
R _U =	337	150	87	56.2	37.5	24.7	16	9.4	4.16	0	KOhms
Trim down	1	2	3	4	5	6	7	8	9	10	%
Vout =	14,85	14,7	14,55	14,4	14,25	14,1	13,95	13,8	13,65	13,5	Volts
R _D =	337	150	87	56.2	37.5	24.7	16	9.4	4.16	0	KOhms

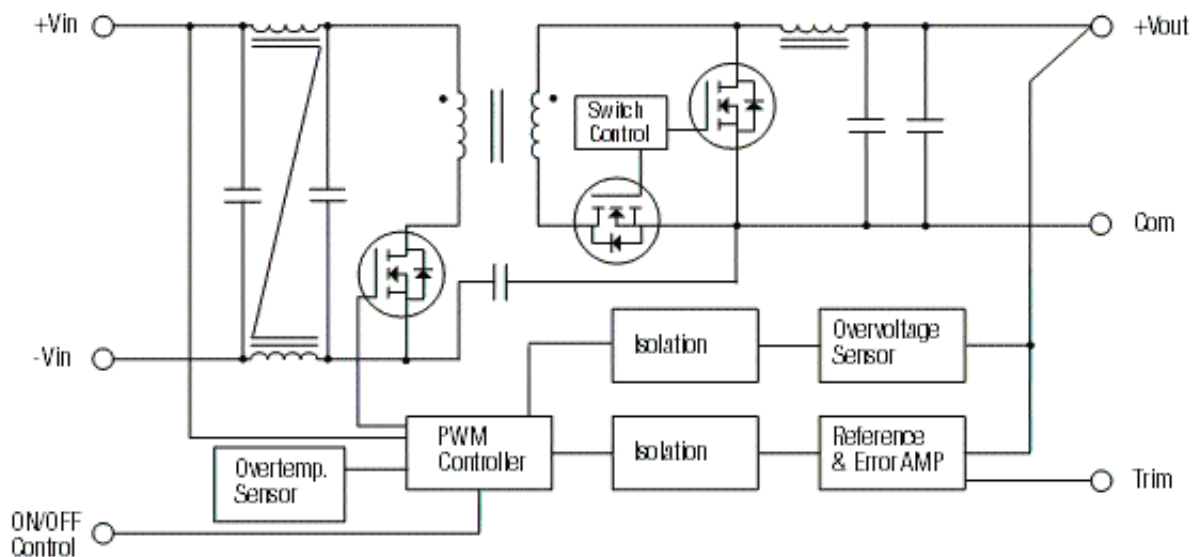
Powerline Plus Output Trim Tables

RPPxx-xx24S (all types)

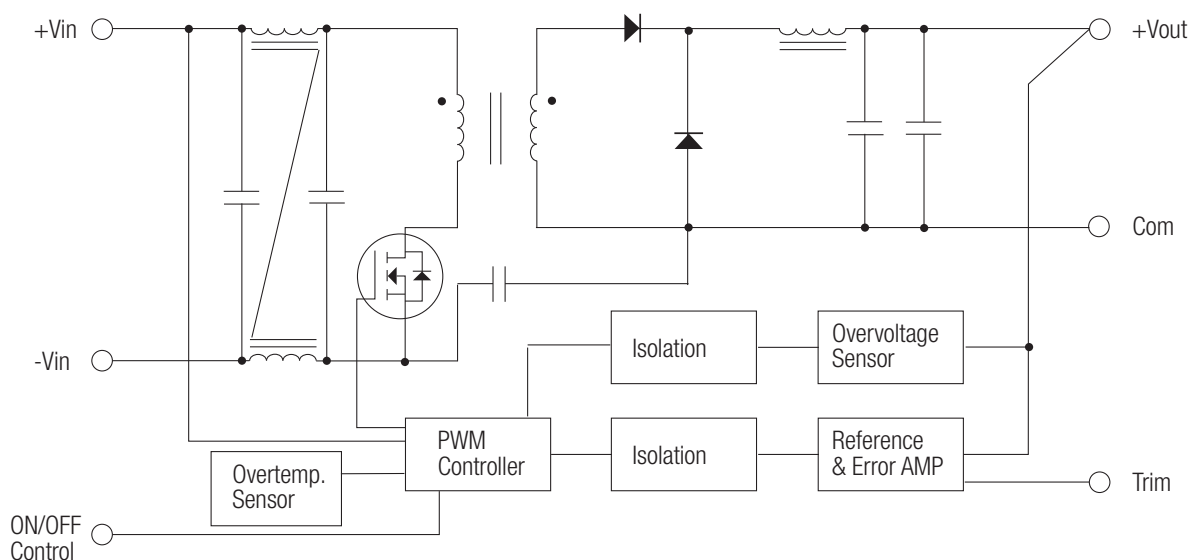
Trim up	1	2	3	4	5	6	7	8	9	10	%
Vout =	24,24	24,48	24,72	24,96	25,20	25,44	24,68	25,92	26,16	26,4	Volts
R _U =	270	120	70	45.2	30.1	19.8	12.8	7.52	3.31	0	KOhms
Trim down	1	2	3	4	5	6	7	8	9	10	%
Vout =	23,76	23,52	23,28	23,04	22,80	22,56	22,32	22,08	21,84	21,6	Volts
R _D =	270	120	70	45.2	30.1	19.8	12.8	7.52	3.31	0	KOhms

Block Diagrams

Single Output - 3.3V and 5V Outputs



Single Output - all other outputs



Block Diagrams

Dual Output

