Technical Specification

PKE 8000A series Direct Converters Input 9-75 V, Output up to 3.3 A / 40 W	2/ 28701- BMR 712 Rev. A October 2018
	© Flex

Key Features

- Industry standard case dimensions
  50.8 x 25.4 x 11.9 mm (2 x 1 x 0.47 in)
- High Efficiency up to 91%
- 2250 Vdc input to output isolation
- Meets functional insulation and safety requirements according to IEC/UL 62368

General Characteristics

- Output over voltage protection
- Input under voltage shutdown
- Over temperature protection
- Output short-circuit protection
- Remote control
- Output voltage adjust function

Safety Approvals

Design for Environment

RoHS compatible

Meets requirements in high-temperature lead-free soldering processes.

Contents

Ordering Information

Product program	Output
PKE 8413A PI	12V, 3.33A / 40 W

Product number and Packaging

PKE84XXX n_1n_2		
Options	n_1	n_2
Mounting	o	
Remote Control logic		o

Options	Description	
n_1	PI	Through hole
n_2		Negative
	P	Positive

General Information

Reliability

The failure rate (λ) and mean time between failures (MTBF= 1/λ) is calculated at max output power and an operating ambient temperature (T_A) of +25°C. Flex uses Telcordia SR-332 Issue 3 Method 1 to calculate the mean steady-state failure rate and standard deviation (σ).

Telcordia SR-332 Issue 3 also provides techniques to estimate the upper confidence levels of failure rates based on the mean and standard deviation.

Mean steady-state failure rate, λ	Std.deviation, σ
1548.10 nFailures/h	619.75 nFailures/h

MTBF (mean value) for the PKE 8000A series = 645 Kh.
MTBF at 90% confidence level = 420 Kh

Compatibility with RoHS requirements

The products are compatible with the relevant clauses and requirements of the RoHS directive 2011/65/EU and have a maximum concentration value of 0.1% by weight in homogeneous materials for lead, mercury, hexavalent chromium, PBB and PBDE and of 0.01% by weight in homogeneous materials for cadmium.
Exemptions in the RoHS directive utilized in Flex products are found in the Statement of Compliance document.

Flex fulfills and will continuously fulfill all its obligations under regulation (EC) No 1907/2006 concerning the registration, evaluation, authorization and restriction of chemicals (REACH) as they enter into force and is through product materials declarations preparing for the obligations to communicate information on substances in the products.

Quality Statement

The products are designed and manufactured in an industrial environment where quality systems and methods like ISO 9000, Six Sigma, and SPC are intensively in use to boost the continuous improvements strategy. Infant mortality or early failures in the products are screened out and they are subjected to an ATE-based final test. Conservative design rules, design reviews and product qualifications, plus the high competence of an engaged work force, contribute to the high quality of the products.

Warranty

Warranty period and conditions are defined in Flex General Terms and Conditions of Sale.

Limitation of Liability

Flex does not make any other warranties, expressed or implied including any warranty of merchantability or fitness for a particular purpose (including, but not limited to, use in life support applications, where malfunctions of product can cause injury to a person's health or life).

© Flex 2018

Safety Specification

General information

PKE 8413A series products are designed in accordance with the safety standards IEC 62368-1 and UL 62368-1, *Audio/video, information and communication technology equipment - Part 1: Safety requirements*
IEC/UL 62368-1 contains requirements to prevent injury or damage due to the following hazards:

- Electrical shock
- Energy hazards
- Fire
- Mechanical and heat hazards
- Radiation hazards
- Chemical hazards

On-board DC/DC converters are defined as component power supplies. As components they cannot fully comply with the provisions of any safety requirements without "conditions of acceptability". Clearance between conductors and between conductive parts of the component power supply and conductors on the board in the final product must meet the applicable safety requirements. Certain conditions of acceptability apply for component power supplies with limited stand-off (see Mechanical Information for further information). It is the responsibility of the installer to ensure that the final product housing these components complies with the requirements of all applicable safety standards and regulations for the final product.

Component power supplies for general use shall comply with the requirements in IEC/UL 62368-1 or IEC/UL 60950-1. Product related standards, e.g. IEEE 802.3af *Power over Ethernet*, and ETS-300132-2 *Power interface at the input to telecom equipment, operated by direct current (dc)* are based on IEC/UL 60950-1 with regards to safety.

Safety Certification

PKE 8413A series products are UL 62368-1 recognized. The flammability rating for all construction parts of the products meet requirements for V-0 class material according to IEC 60695-11-10, *Fire hazard testing, test flames* – 50 W horizontal and vertical flame test methods.

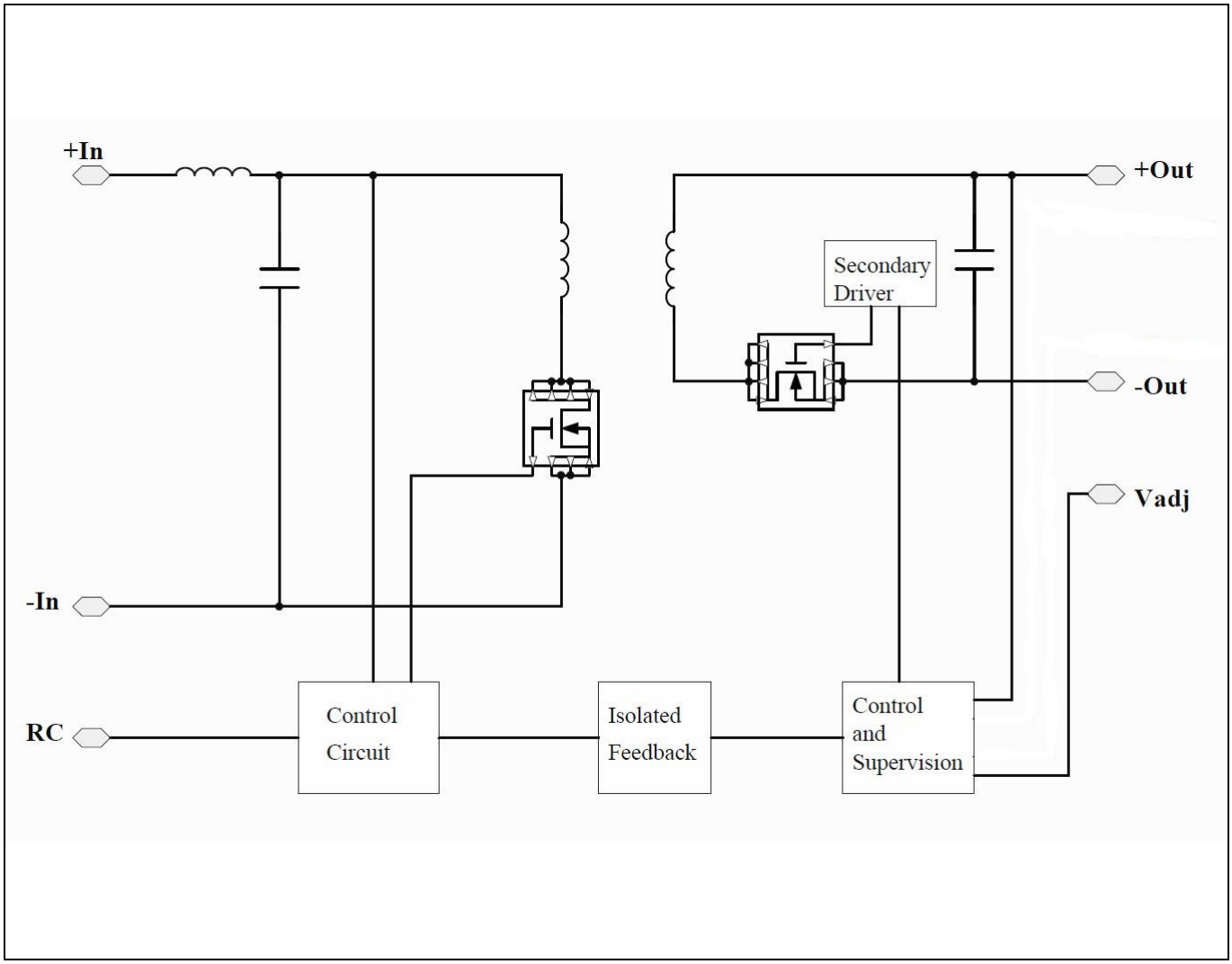
PKE 8413A series products meet all the requirements for functional insulation according to IEC/UL 62368-1.

Absolute Maximum Ratings

Characteristics		min	typ	max	Unit
T_{P1}	Operating Temperature (see Thermal Consideration section)	-40		+115	°C
T_S	Storage temperature	-55		+125	°C
V_I	Input voltage	9		75	V
V_{iso}	Isolation voltage (input to output test voltage)			2250	Vdc
V_{tr}	Input voltage transient (Tp 100 ms)			+80	V
V_{RC}	Remote Control pin voltage	-0.3		+10	V

Stresses above those listed under Absolute Maximum Ratings may cause permanent damage to the device. This is a stress rating only; functional operation of the device at these or any other conditions above those indicated in the Electrical Specification section of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Fundamental Circuit Diagram



Electrical Specification
12 V, 3.33 A / 40 W

PKE 8413A PIP

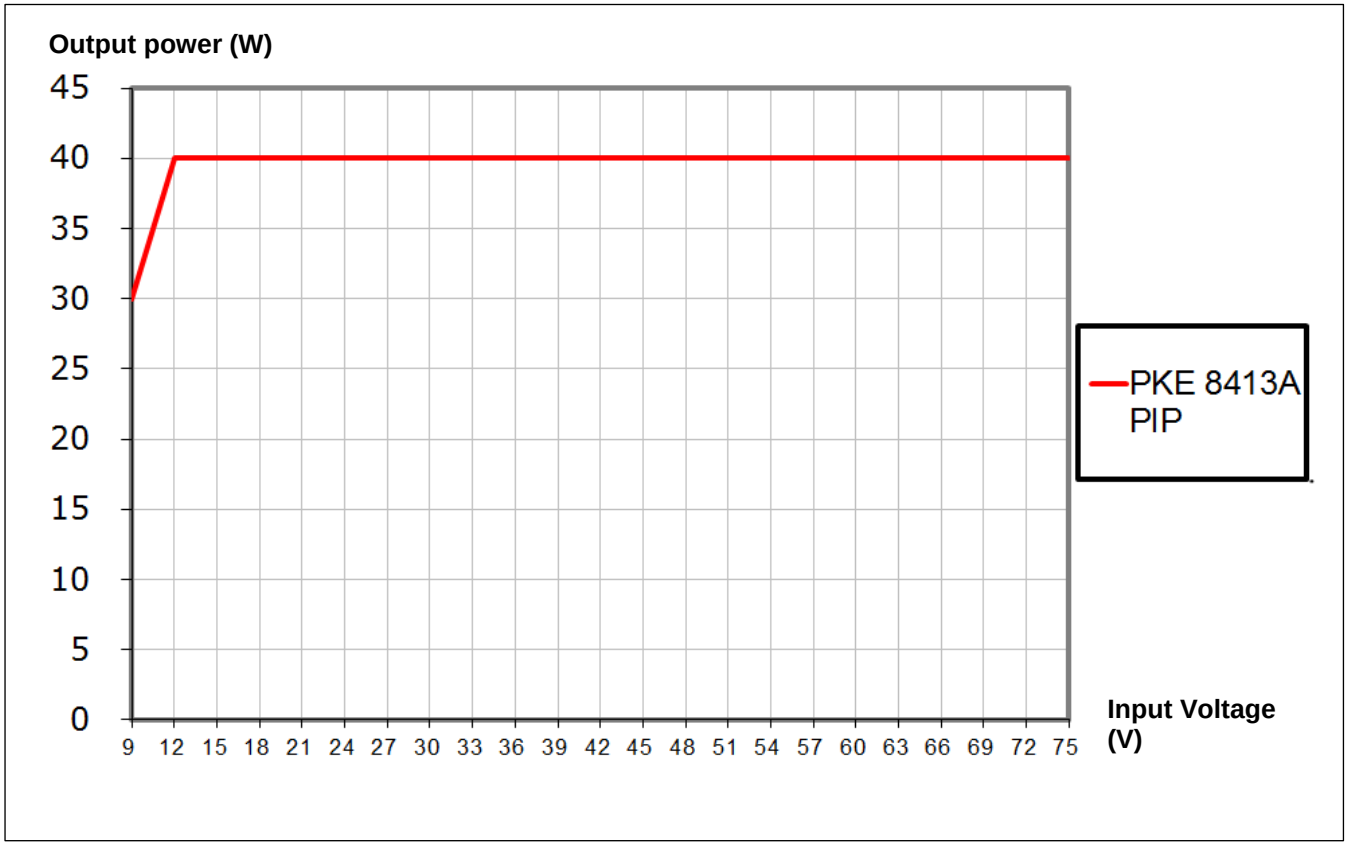
Typical values given at: T_{P1} = +25°C, V_I = 48 V_I max I_O, unless otherwise specified under Conditions.
220 µF external electrolytic capacitors were added across the input of the products.

Characteristics		Conditions	min	typ	max	Unit
V_I	Input voltage range		9		75	V
V_{Ioff}	Turn-off input voltage	Decreasing input voltage		7.5		V
V_{Ion}	Turn-on input voltage	Increasing input voltage		8.5		V
IOVP	Input over voltage protection			77.5	80	V
C_I	Internal input capacitance			12		µF
P_O	Output power	Note 2	0		40	W
η	Efficiency	50% of max I_O, V_I = 12 V		91		%
		max I_O, V_I = 12 V		88		
		50% of max I_O, V_I = 24 V		91		
		max I_O, V_I = 24 V		90		
		50% of max I_O, V_I = 48 V		89		
		max I_O, V_I = 48 V		91		
P_d	Power Dissipation	max I_O		6		W
P_{li}	Input idling power	I_O = 0 A, V_I = 48 V		0.5		W
f_s	Switching frequency	0-100 % of max I_O,	198	220	242	kHz

V_{Oi}	Output voltage initial setting and accuracy	T_{P1} = +25°C, V_I = 48 V, I_O = 3.33 A	11.88	12	12.12	V
V_O	Output adjust range		10.8		13.2	V
	Output voltage tolerance band	0-100 % of max I_O	11.856		12.144	V
	Idling voltage	I_O = 0 A	11.856		12.144	V
	Line regulation	max I_O			120	mV
	Load regulation	V_I = 48 V, 0-100 % of max I_O			120	mV
V_{tr}	Load transient voltage deviation	V_I = 48 V, Load step 50-75-50% of max I_O, di/dt = 1 A/µs		± 200		mV
t_{tr}	Load transient recovery time			500		µs
t_r	Ramp-up time (from 10−90% of V_{Oi})	10-100% of max I_O, T_{P1} = 25ºC, V_I = 48 V		20		ms
t_s	Start-up time (from V_I connection to 90% of V_{Oi})			24		ms
t_f	V_I shut-down fall time (from V_I off to 10% of V_O)	max I_O		200		us
t_{RC}	RC start-up time	max I_O		12		ms
I_O	Output current		0		3.33	A
I_{lim}	Current limit threshold	T_{P1} < max T_{P1}	4		6.66	A
I_{sc}	Short circuit current	T_{P1} = 25ºC		0.32		A
C_{out}	Recommended Capacitive Load	T_{P1} = 25ºC	0		1500	µF
V_{Oac}	Output ripple & noise	See ripple & noise section, V_{Oi}, max I_O, see Note 1			150	mVp-p
OVP	Output over voltage protection	T_{P1} = +25°C, V_I = 48 V, 10-100% of max I_O		15		V

Note 1: Measured with 0.1µF ceramic and 10 µF tantalum capacitors cross to output.

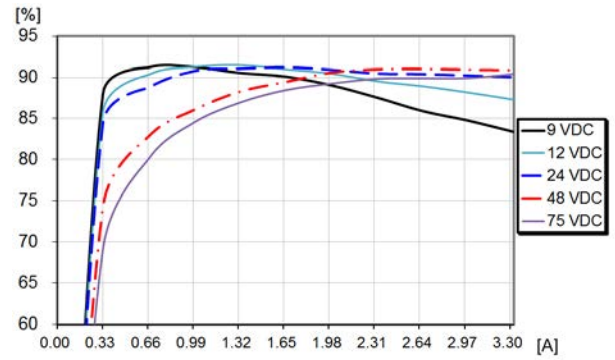
Note 2: PKE 8413A Power Derating Curve



Typical Characteristics
12 V, 3.33 A / 40 W

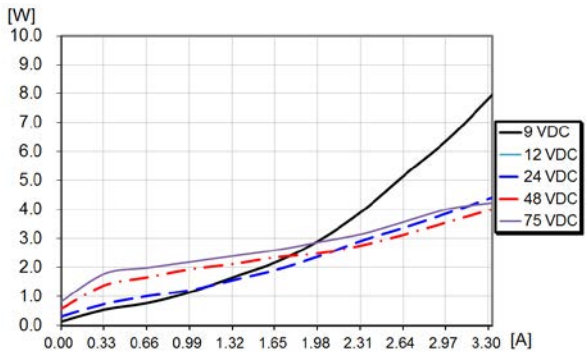
PKE 8413A PIP

Efficiency



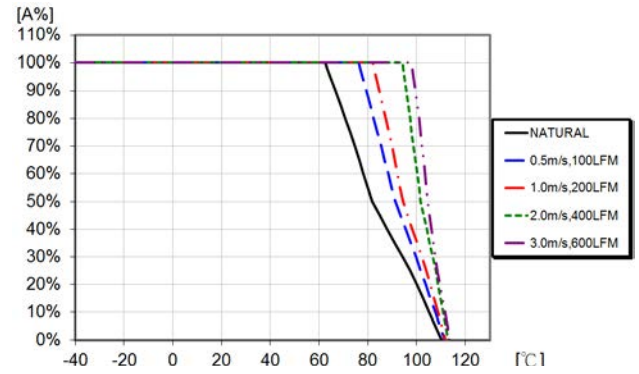
Efficiency vs. load current and input voltage at +25°C.

Power Dissipation



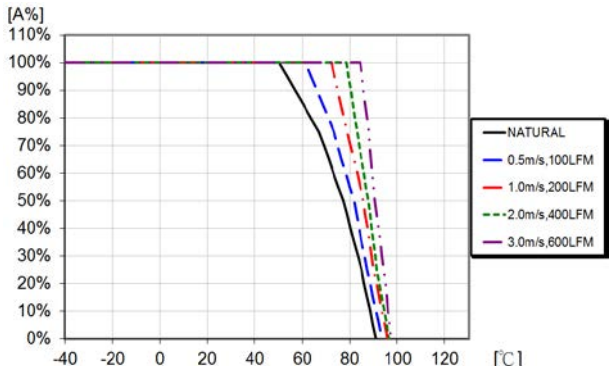
Dissipated power vs. load current and input voltage at +25°C.

Output Current Derating (Vin= 48 V)



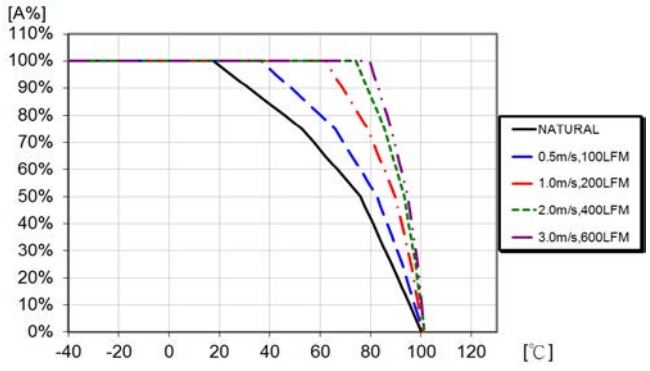
Available load current vs. ambient air temperature and airflow at V_I= 48 V, 100% of max I_O = 3.33 A.
See Thermal Consideration section.

Output Current Derating (Vin= 24V)



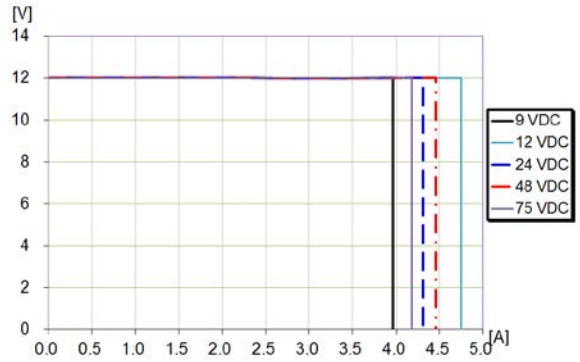
Available load current vs. ambient air temperature and airflow at V_I= 24 V, 100% of max I_O = 3.33 A.
See Thermal Consideration section.

Output Current Derating (Vin= 9 V)



Available load current vs. ambient air temperature and airflow at V_I= 9 V,100% of max I_O = 3.33 A.
See Thermal Consideration section.

Current Limit Characteristics

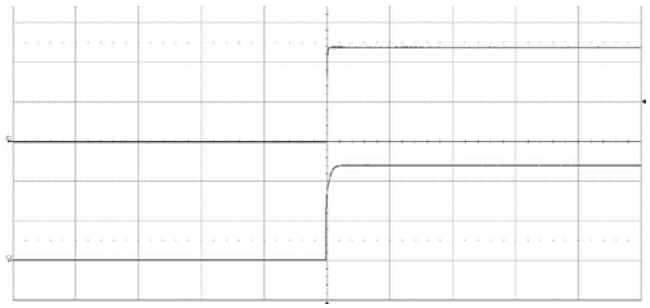


Output voltage vs. load current at I_O > max I_O at +25°C.

Typical Characteristics
12 V, 3.33 A / 40 W

PKE 8413A PIP

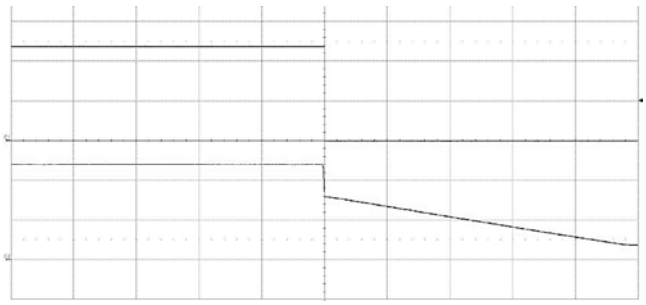
Start-up



Start-up enabled by connecting V_I at:
T_{P1} = +25°C, V_I = 48 V,
I_O = 3.33 A resistive load.

Top trace: output voltage (5 V/div.).
Bottom trace: input voltage (20 V/div).
Time scale: (200 ms/div.).

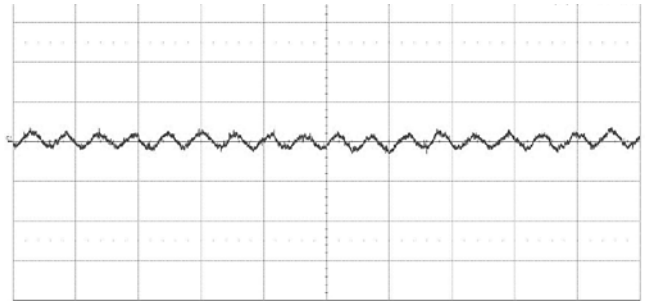
Shut-down



Start-up enabled by connecting V_I at:
T_{P1} = +25°C, V_I = 48 V,
I_O = 3.33 A resistive load.

Top trace: output voltage (5 V/div.).
Bottom trace: input voltage (20 V/div.).
Time scale: (200 ms/div.).

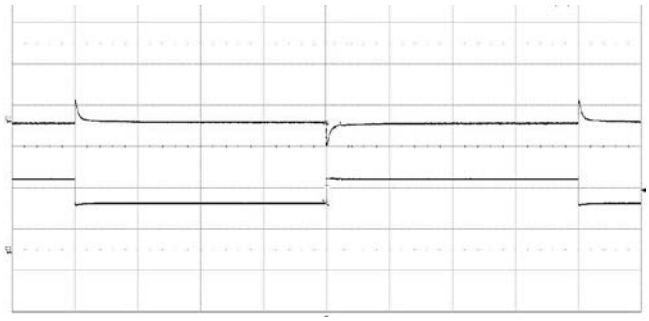
Output Ripple & Noise



Output voltage ripple at:
T_{P1} = +25°C, V_I = 48 V,
I_O = 3.33 A resistive load.

Trace: output voltage (20 mV/div.).
Time scale: (5 µs/div.).

Output Load Transient Response



Output voltage response to load current step-change (1.66-2.49-1.66 A) at:
T_{P1} = +25°C, V_I = 48 V.

Top trace: output voltage (500 mV/div.).
Bottom trace: load current (1 A/div.).
Time scale: (2 ms/div.)

Output Voltage Adjust (TRIM UP/TRIM DOWN)

Output Voltage = 12V

The resistor value for an adjusted output voltage is calculated by using the following equations:

Output Voltage Adjust, Increase:

$$R_{ADJ\_UP} = \left(\frac{3.5998}{\Delta} - 24 \right) \text{k}\Omega$$

Output Voltage Adjust, Decrease:

$$R_{ADJ\_DOWN} = \left(\frac{3.5796}{\Delta} - 31.179 \right) \text{k}\Omega$$

Example:

To trim up the 12 V model by 8% to 12.96V the required external resistor is:

$$R_{ADJ\_UP} = \left(\frac{3.5998}{0.08} - 24 \right) = 21 \text{ k}\Omega$$

Example:

To trim down the 12 V model by 7% to 11.16V the required external resistor is:

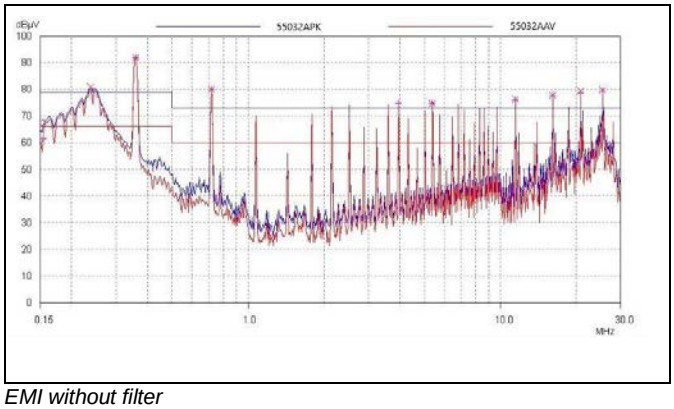
$$R_{ADJ\_DOWN} = \left(\frac{3.5796}{0.07} - 31.179 \right) = 19.96 \text{ k}\Omega$$

See **Output Voltage Adjust (Vadj)** section in page 11 for circuit connection.

EMC Specification

Conducted EMI measured according to EN55032, CISPR 32 and FCC part 15J (see test set-up). See Design Note 009 for further information. The fundamental switching frequency is 220 kHz for PKE 8413A PIP (12 V/ 40 W) at V_I = 48 V and max I_O.

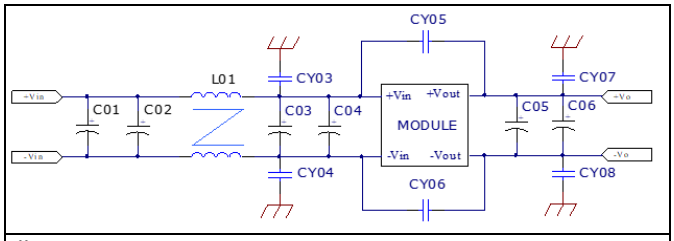
Conducted EMI Input terminal value (typ)



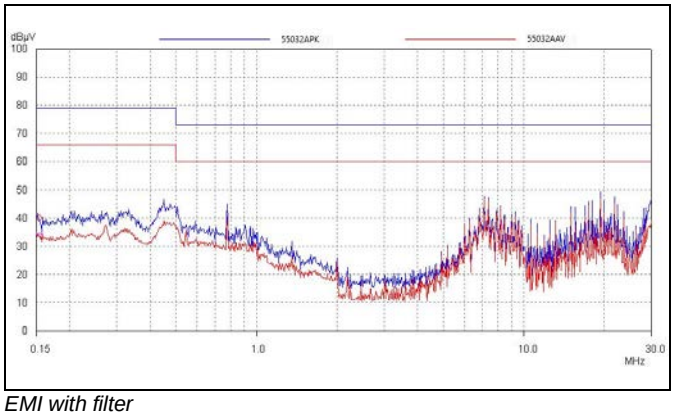
EMI without filter

Optional external filter for class A

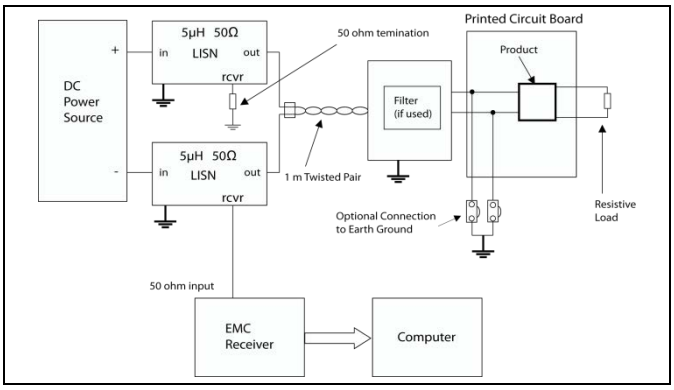
Suggested external input filter in order to meet class A in EN 55032, CISPR 32 and FCC part 15J.



Filter components:
CY03,CY04：680pF (Y CAP.)+ bead core*2 (RH type)
CY05,CY06：2.2nF (Y CAP.)+ bead core*2 (RH type)
CY07,CY08：100pF (Y CAP.)+ bead core*2 (RH type)
C01、C02、C03、C04、C05、C06：100µF(AL-CAP.)
L01：1.6mH(CM CHOKE)



EMI with filter



Test set-up

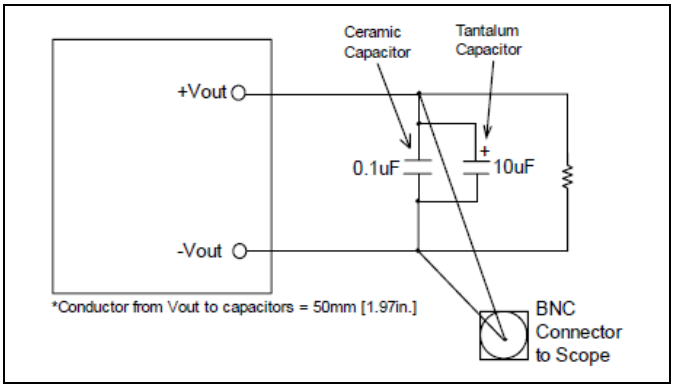
Layout recommendations

The radiated EMI performance of the product will depend on the PWB layout and ground layer design. It is also important to consider the stand-off of the product. If a ground layer is used, it should be connected to the output of the product and the equipment ground or chassis.

A ground layer will increase the stray capacitance in the PWB and improve the high frequency EMC performance.

Output ripple and noise

Output ripple and noise measured according to figure below. See Design Note 022 for detailed information.



Output ripple and noise test setup

Operating information

Input Voltage

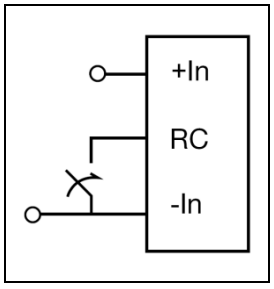
The input voltage range 9 to 75 V_{dc}. At input voltages exceeding 75 V, the power loss will be higher than at normal input voltage and T_{P1} must be limited to absolute max +115°C. The absolute maximum input voltage is 80 V_{dc}.

Short duration transient disturbances can occur on the DC distribution and input of the product when a short circuit fault occurs on the equipment side of a protective device (fuse or circuit breaker). The voltage level, duration and energy of the disturbance are dependant on the particular DC distribution network characteristics and can be sufficient to damage the product unless measures are taken to suppress or absorb this energy. The transient voltage can be limited by capacitors and other energy absorbing devices like zener diodes connected across the positive and negative input conductors at a number of strategic points in the distribution network. The end-user must secure that the transient voltage will not exceed the value stated in the Absolute maximum ratings. ETSI TR 100 283 examines the parameters of DC distribution networks and provides guidelines for controlling the transient and reduce its harmful effect.

Turn-off Input Voltage

The products monitor the input voltage and will turn on and turn off at predetermined levels.
The minimum hysteresis between turn on and turn off input voltage is 1.7 V.

Remote Control (RC)



The products are fitted with a remote control function referenced to the primary negative input connection (-In), with negative and positive logic options available.The RC function allows the product to be turned on/off by an external device like a semiconductor or mechanical switch. The RC pin has an internal pull up resistor to +In.

The external device must provide a minimum required sink current to guarantee a voltage not higher than maximum voltage on the RC pin (see Electrical characteristics table). When the RC pin is left open, the voltage generated on the RC pin is 3 - 5 V.

The standard product is provided with “negative logic” RC and will be on until the RC pin is connected to the -In. To turn off the product, the RC pin should be left open or connected to a voltage higher than 2.5 V referenced to -In. In situations where it is desired to have the product to power up automatically without the need for control signals or a switch, the RC pin can be wired directly to -In.

The second option is “positive logic” remote control, which can be ordered by adding the suffix “P” to the end of the part number. When the RC pin is left open, the product starts up automatically when the input voltage is applied. Turn off is achieved by connecting the RC pin to the -In. The product will restart automatically when this connection is opened.

See Design Note 021 for detailed information.

Input and Output Impedance

The impedance of both the input source and the load will interact with the impedance of the product. It is important that the input source has low characteristic impedance. The products are designed for stable operation without external capacitors connected to the input or output. The performance in some applications can be enhanced by addition of external capacitance as described under External Decoupling Capacitors.

If the input voltage source contains significant inductance, the addition of a 220 µF capacitor across the input of the product will ensure stable operation. The capacitor is not required when powering the product from an input source with an inductance below 10 µH. The minimum required capacitance value depends on the output power and the input voltage. The higher output power the higher input capacitance is needed. Approximately doubled capacitance value is required for a 24 V input voltage source compared to a 48 V input voltage source.

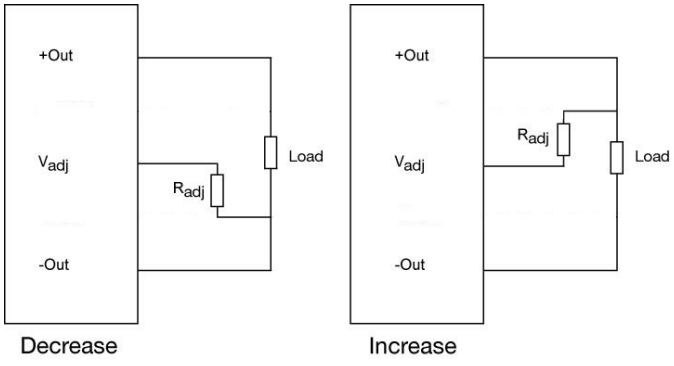
External Decoupling Capacitors

When powering loads with significant dynamic current requirements, the voltage regulation at the point of load can be improved by addition of decoupling capacitors at the load. The most effective technique is to locate low ESR ceramic and electrolytic capacitors as close to the load as possible, using several parallel capacitors to lower the effective ESR. The ceramic capacitors will handle high-frequency dynamic load changes while the electrolytic capacitors are used to handle low frequency dynamic load changes. It is equally important to use low resistance and low inductance PWB layouts and cabling.

External decoupling capacitors will become part of the product’s control loop. The control loop is optimized for a wide range of external capacitance and the maximum recommended value that could be used without any additional analysis is found in the Electrical specification.
The ESR of the capacitors is a very important parameter. Stable operation is guaranteed with a verified ESR value of >5 mΩ across the output connections.
For further information please contact your local Flex representative.

Output Voltage Adjust (V_{adj})

The products have an Output Voltage Adjust pin (V_{adj}). This pin can be used to adjust the output voltage above or below Output voltage initial setting.
When increasing the output voltage, the output voltage (at the output pins) must be kept below the threshold of the over voltage protection (OVP) to prevent the product from shutting down. When increasing output voltages, the maximum power rating of the product remains the same, and the max output current must be decreased correspondingly.
To increase the voltage, the resistor should be connected between the V_{adj} pin and +Out pin. The resistor value of the Output voltage adjust function is according to information given under the Output section for the respective product.
To decrease the output voltage, the resistor should be connected between the V_{adj} pin and –Out pin.



Over Temperature Protection (OTP)

The products are protected from thermal overload by an internal over temperature shutdown circuit.
When T_{P1} as defined in **Definition of product operating temperature** section exceeds 115°C, the product will shut down. The product will make continuous attempts to start up and resume normal operation automatically when the temperature has dropped >10°C below the temperature threshold.

Over Voltage Protection (OVP)

The products have output over voltage protection that will shut down the product in over voltage conditions. The product will make continuous attempts to start up (non-latching mode) and resume normal operation automatically after removal of the over voltage condition.

Over Current Protection (OCP)

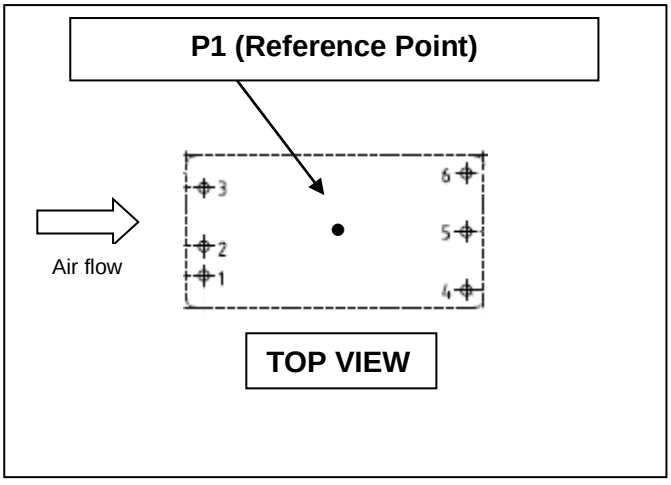
The products include current limiting circuitry for protection at continuous overload. The output voltage will decrease towards zero for output currents in excess of current limt threshold. The product will resume normal operation after removal of the overload. The load distribution should be designed for the maximum output short circuit current specified.

Thermal Consideration

Definition of product operating temperature

The product operating temperatures is used to monitor the temperature of the product, and proper thermal conditions can be verified by measuring the temperature at positions P1. The temperature at this position (T_{P1}) should not exceed the maximum temperatures in the table below. Temperature above maximum T_{P1}, measured at the reference point P1 are not allowed and may cause permanent damage.

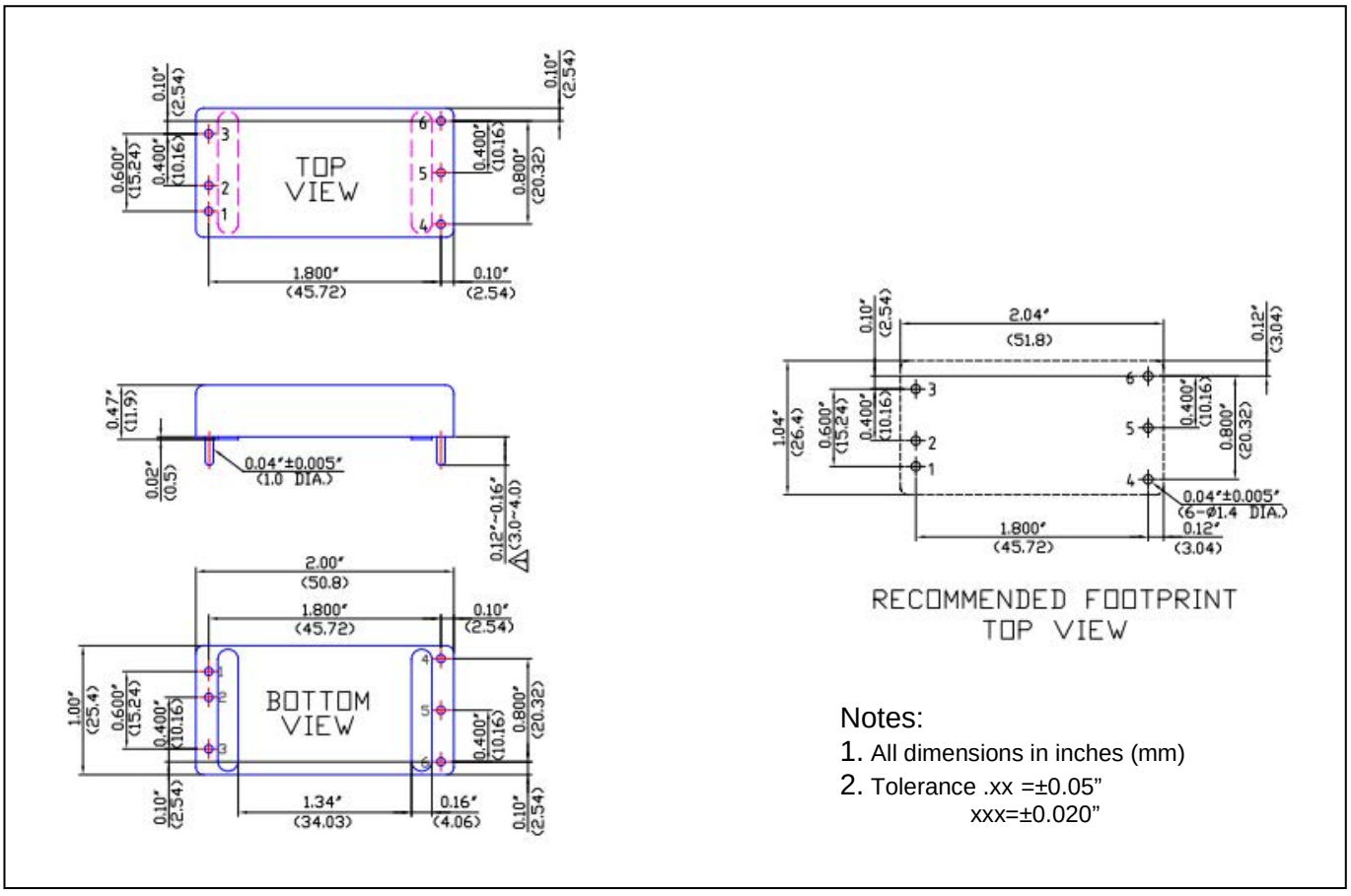
Position	Description	Max Temp.
P1	Reference point	T_{P1}=115º C



Connections

Pin	Designation	Function
1	+Input	Positive input
2	-Input	Negative input
3	On/Off Control	Remote control
4	+Out	Positive output
5	-Out	Negative output
6	TRIM	Output voltage adjust

Mechanical Information



Notes:
1. All dimensions in inches (mm)
2. Tolerance .xx =±0.05"
   xxx=±0.020"

PIN CONNECTIONS	
PIN NUMBER	PIN FUNCTION
1	+Input
2	-Input
3	On/Off Control
4	+Output
5	-Output
6	Trim

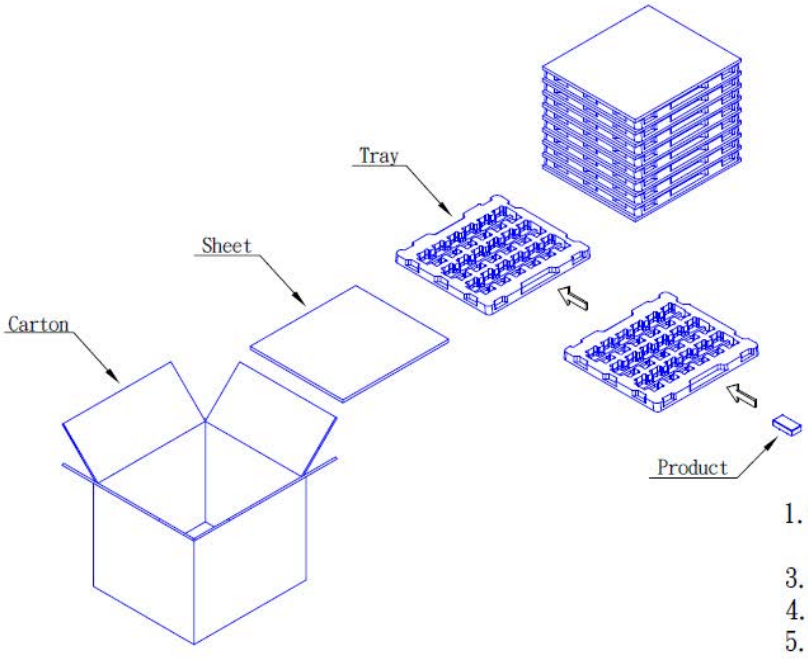
Soldering Information - Hole Mounting

The hole mounted product is intended for plated through hole mounting by wave or manual soldering. The pin temperature is specified to maximum to 270°C for maximum 10 seconds.

A maximum preheat rate of 4°C/s and maximum preheat temperature of 150°C is suggested. When soldering by hand, care should be taken to avoid direct contact between the hot soldering iron tip and the pins for more than a few seconds in order to prevent overheating.

A no-clean flux is recommended to avoid entrapment of cleaning fluids in cavities inside the product or between the product and the host board. The cleaning residues may affect long time reliability and isolation voltage.

Package



1. Q'ty:6*3=18 Pcs/Tray
   18*9=162 Pcs
3. Carton size:299X269X239mm ±6mm
4. Single weight:32g
5. N.W.:5.2Kgs
6. G.W.:7.2Kgs

Product Qualification Specification

Characteristics			
External visual inspection	IPC-A-610		
Change of temperature (Temperature cycling)	IEC 60068-2-14 Na	Temperature range Number of cycles Dwell/transfer time	-55 to 105°C 20 30 min/3 min
Cold (in operation)	IEC 60068-2-1 Ad	Temperature T_A Duration	-45°C 72 h
Damp heat	IEC 60068-2-30	Temperature Humidity Duration	45°C 95 % RH 72 hours
Dry heat	IEC 60068-2-2 Bd	Temperature Duration	125°C 1000 h
Electrostatic discharge susceptibility	IEC 61340-3-1, JESD 22-A114	Human body model (HBM)	Class 2, 2000 V
Immersion in cleaning solvents	IEC 60068-2-45 XA, method 2	Water Glycol ether {Isopropyl alcohol}	55°C 35°C {35°C}
Mechanical shock	IEC 60068-2-27 Ea	Peak acceleration Duration	200 g 6 ms
Moisture reflow sensitivity [1]	J-STD-020E	Level 1 (SnPb-eutectic) Level 3 (Pb Free)	225°C 260°C
Operational life test	MIL-STD-202G, method 108A	Duration	1000 h
Resistance to soldering heat [2]	IEC 60068-2-20 Tb, method 1A	Solder temperature Duration	270°C 10-13 s
Robustness of terminations	IEC 60068-2-21 Test Ua1	Through hole mount products	All leads
Solderability	IEC 60068-2-20 test Ta [1]	Preconditioning Temperature, SnPb Eutectic Temperature, Pb-free	235°C 245°C
Vibration, broad band random	IEC 61373	Frequency RMS acceleration Duration	5 to 150 Hz 5 grms 5 hrs in each direction

Notes
[1] Only for products intended for wave soldering (plated through hole products)