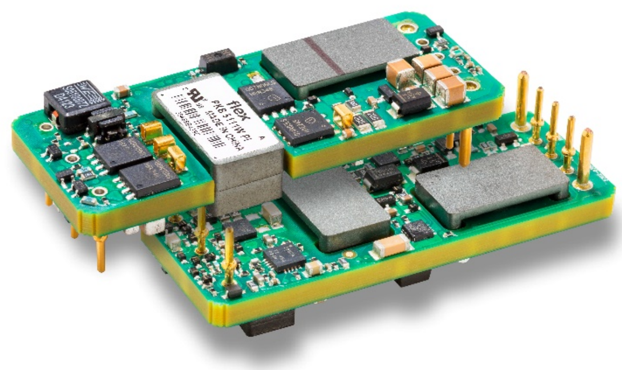
flex

Technical Specification

PKB 5000W series Direct Converters Input 18 - 75 V, Output up to 30 A / 120 W	28701- BMR 709 Rev. C November 2017 © Flex

Key Features

- Industry standard through-hole Eighth-brick 58.4 x 22.9 x 9.91 mm (2.3 x 0.9 x 0.39 in)
- Wide input range of 18-75Vdc
- Up to 120 Watts
- High efficiency, typ. 91.5% at 12 Vout full load
- 2250 Vdc input to output isolation
- Meets basic insulation and safety requirements according to IEC/EN/UL 60950-1
- MTBF 17 Mh



General Characteristics

- Output over voltage protection
- Input under voltage shutdown
- Over temperature protection
- Output short-circuit protection
- Outstanding thermal performance and derating
- Remote sense
- Remote control
- Highly automated manufacturing ensures quality
- ISO 9001/14001 certified supplier

Safety Approvals

c US EU

Pending

Design for Environment

RoHS compatible

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

Contents

PKB 5000W series Direct Converters Input 18 - 75 V, Output up to 30 A / 120 W	28701- BMR 709 Rev. C November 2017
	© Flex

Ordering Information

Product program	Output
PKB 5110W	3.3 V, 30 A / 99 W
PKB 5111W	5 V, 20 A / 100 W
PKB 5113W	12 V, 10 A / 100 W

Product number and Packaging

PKB 5XXXW $n_1n_2n_3n_4$				
Options	n_1	n_2	n_3	n_4
Mounting	o			
Mechanical option		o		
Remote Control logic			o	
Lead length				o

Options	Description	
n_1	PI	Through hole*
n_2	 HS	open frame* baseplate
n_3		negative logic*
n_4		4.8mm*

Example a through-hole mounted, negative logic product with baseplate would be PKB 5110W PIHS.

* Standard variant (i.e. no option selected).

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
58.6 nFailures/h	8.7 nFailures/h

MTBF (mean value) for the PKB-W series = 17 Mh.
MTBF at 90% confidence level = 14 Mh

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 2017

The information and specifications in this technical specification is believed to be correct at the time of publication. However, no liability is accepted for inaccuracies, printing errors or for any consequences thereof. Flex reserves the right to change the contents of this technical specification at any time without prior notice.

Safety Specification

General information

Flex DC/DC converters and DC/DC regulators are designed in accordance with the safety standards IEC 60950-1, EN 60950-1 and UL 60950-1 *Safety of Information Technology Equipment*.

IEC/EN/UL 60950-1 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 and DC/DC regulators 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 and Safety Certificate 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 should comply with the requirements in IEC/EN/UL 60950-1 *Safety of Information Technology Equipment.* 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/EN/UL 60950-1 with regards to safety.

Flex DC/DC converters, Power interface modules and DC/DC regulators are UL 60950-1 recognized and certified in accordance with EN 60950-1. 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.

Isolated DC/DC converters & Power interface modules

The product may provide basic or functional insulation between input and output according to IEC/EN/UL 60950-1 (see Safety Certificate), different conditions shall be met if the output of a basic or a functional insulated product shall be considered as safety extra low voltage (SELV).

For basic insulated products (see Safety Certificate) the output is considered as safety extra low voltage (SELV) if one of the following conditions is met:

- The input source provides supplementary or double or reinforced insulation from the AC mains according to IEC/EN/UL 60950-1.
- The input source provides functional or basic insulation from the AC mains and the product’s output is reliably connected to protective earth according to IEC/EN/UL 60950-1.

For functional insulated products (see Safety Certificate) the output is considered as safety extra low voltage (SELV) if one of the following conditions is met:

- The input source provides double or reinforced insulation from the AC mains according to IEC/EN/UL 60950-1.
- The input source provides basic or supplementary insulation from the AC mains and the product’s output is reliably connected to protective earth according to IEC/EN/UL 60950-1.
- The input source is reliably connected to protective earth and provides basic or supplementary insulation according to IEC/EN/UL 60950-1 and the maximum input source voltage is 60 Vdc.

Galvanic isolation between input and output is verified in an electric strength test and the isolation voltage (V_{iso}) meets the voltage strength requirement for basic insulation according to IEC/EN/UL 60950-1.

It is recommended to use a slow blow fuse at the input of each DC/DC converter. If an input filter is used in the circuit the fuse should be placed in front of the input filter. In the rare event of a component problem that imposes a short circuit on the input source, this fuse will provide the following functions:

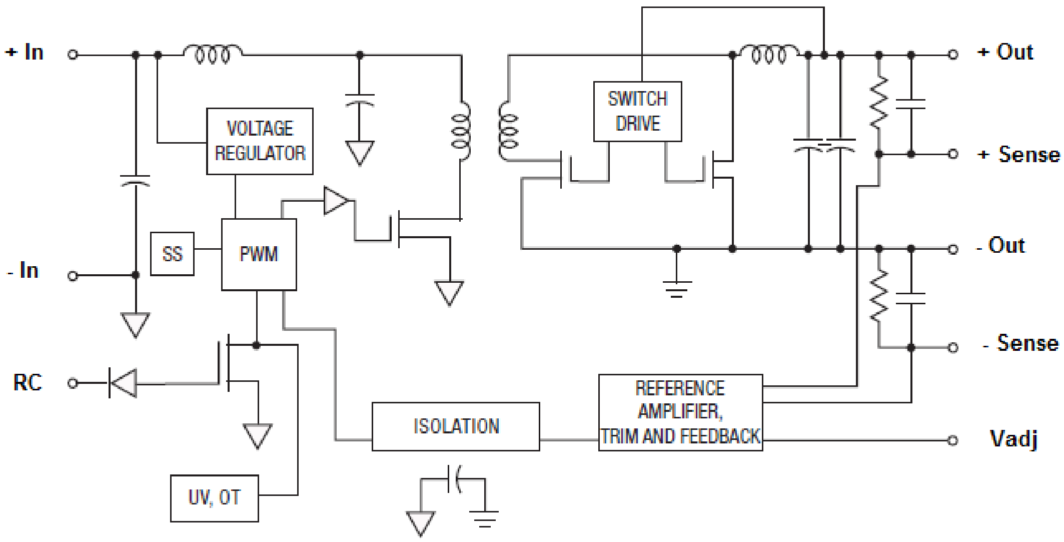
- Isolate the fault from the input power source so as not to affect the operation of other parts of the system
- Protect the distribution wiring from excessive current and power loss thus preventing hazardous overheating

Absolute Maximum Ratings

Characteristics			min	typ	max	Unit
T_{P1}	Operating Temperature (see Thermal Consideration section)		-40		+110	°C
T_S	Storage temperature		-55		+125	°C
V_I	Input voltage		-0.5		+80	V
V_{iso}	Isolation voltage (input to output test voltage)				2250	Vdc
V_{tr}	Input voltage transient (100msec max. duration, operating or non-operating)				100	V
V_{RC}	Remote Control pin voltage (see Operating Information section)	Positive logic option	-0.5		15	V
		Negative logic option	-0.5		15	V

Stress in excess of Absolute Maximum Ratings may cause permanent damage. Absolute Maximum Ratings, sometimes referred to as no destruction limits, are normally tested with one parameter at a time exceeding the limits in the Electrical Specification. If exposed to stress above these limits, function and performance may degrade in an unspecified manner.

Fundamental Circuit Diagram



© Flex

Electrical Specification
3.3 V, 30 A / 99 W

PKB 5110W PI

T_{P1} = -40 to +85ºC, V_I = 18 to 75 V, sense pins connected to output pins unless otherwise specified under Conditions.
Typical values given at: T_{P1} = +25°C, V_I= 48 V_I max I_O, unless otherwise specified under Conditions.
Additional C_{in} = 33 µF, C_{out} = 1 µF + 10 µF. See Operating Information section for selection of capacitor types.

Characteristics		Conditions	min	typ	max	Unit
V_I	Input voltage range		18		75	V
V_{Ioff}	Turn-off input voltage	Decreasing input voltage	16.5	17	17.9	V
V_{Ion}	Turn-on input voltage	Increasing input voltage	15.5	16.5	17.5	V
P_O	Output power		0		99.99	W
η	Efficiency	max I_O		89.5		%
		max I_O, V_I = 24 V		90		
P_d	Power Dissipation	max I_O, see Note 1		TBD		W
I_{li}	Input idling current	I_O = 0 A, V_I = 48 V		90		mA
I_{RC}	Input standby current	V_I = 48 V (turned off with RC)		4		mA
f_s	Switching frequency	0-100 % of max I_O, see Note 2	195	215	235	kHz

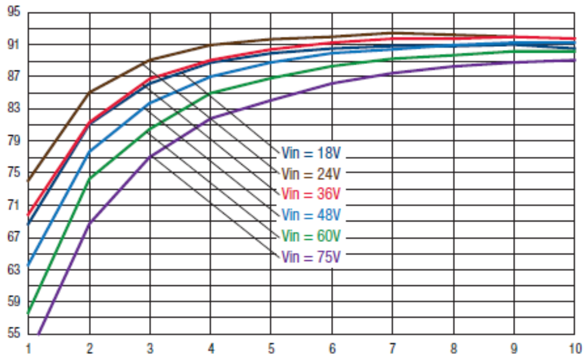
V_{Oi}	Output voltage initial setting and accuracy	T_{P1} = +25°C, V_I = 48 V, I_O = 15 A	3.267	3.3	3.333	V
V_O	Output adjust range	See operating information	2.97		3.63	V
	Output voltage tolerance band	0-100% of max I_O	3.267		3.333	V
	Line regulation	max I_O		±6.6		mV
	Load regulation	V_I = 48 V, 0-100% of max I_O		±6.6		mV
V_{tr}	Load transient voltage deviation	V_I = 48 V, Load step 50-75-50% of max I_O, di/dt = 10 A/µs see Note 3		±500		mV
t_{tr}	Load transient recovery time			50	200	µs
t_s	Start-up time (from V_I connection to 90% of V_{Oi})	0-100% of max I_O		20	30	ms
t_{RC}	RC start-up time	max I_O		10		ms
I_O	Output current		0		30	A
I_{lim}	Current limit threshold	T_{P1} < max T_{P1}	33	35	44	A
I_{sc}	Short circuit current	T_{P1} = 25ºC, see Note 4		5	10	A
C_{out}	Recommended Capacitive Load	T_{P1} = 25ºC, see Note 5	0		10000	µF
V_{Oac}	Output ripple & noise	See ripple & noise section, V_{Oi}		90	125	mVp-p
OVP	Over voltage protection	T_{P1} = +25°C, V_I = 48 V, 0-100% of max I_O		3.8	4.5	V

Note 1: See power dissipation graph
Note 2: See Operating Information section
Note 3: Cout = 1 µF + 10 µF +10000µF
Note 4: RMS current, See Operating Information section.
Note 5: See Operating Information section.

Typical Characteristics
3.3 V, 30 A / 99 W

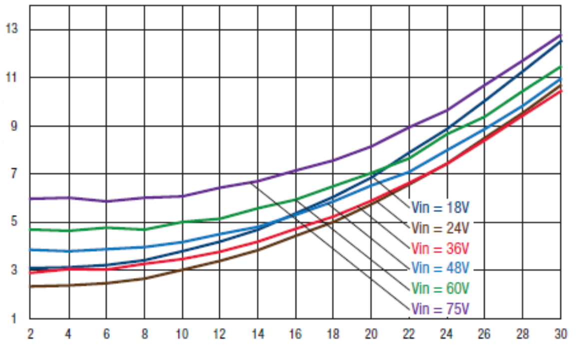
PKB 5110W PI

Efficiency



Efficiency vs. load current and input voltage at T_{P1} = +25°C.

Power Dissipation



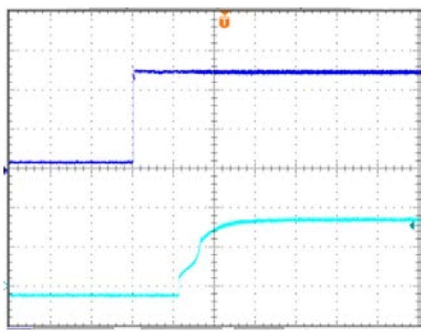
Dissipated power vs. load current and input voltage at T_{P1} = +25°C.

© Flex

Typical Characteristics
3.3 V, 30 A / 99 W

PKB 5110W PI

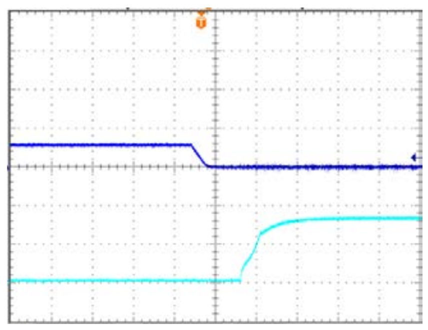
Start-up



Start-up enabled by connecting V_I at:
T_{P1} = +25°C, V_I = 48 V,
I_O = 30 A resistive load.

Top trace: input voltage (20 V/div.).
Bottom trace: output voltage (2 V/div.).
Time scale: (10 ms/div.).

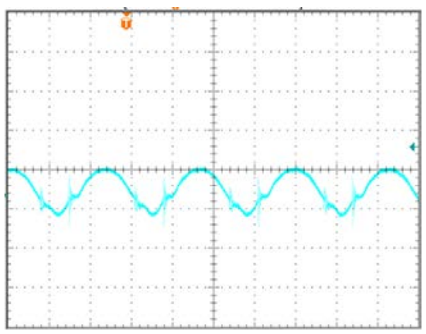
Start-up



Start-up enabled by grounding RC at:
T_{P1} = +25°C, V_I = 48 V
I_O = 30 A resistive load.

Top trace: remote control (5 V/div.).
Bottom trace: output voltage (2 V/div.).
Time scale: (10 ms/div.).

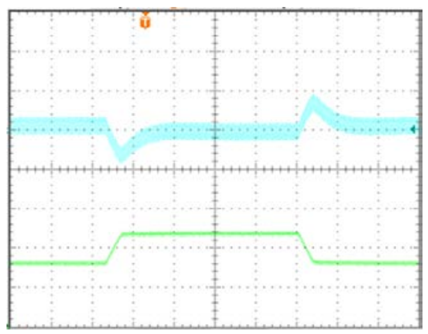
Output Ripple & Noise



Output voltage ripple at:
T_{P1} = +25°C, V_I = 48 V,
I_O = 30 A resistive load.

Trace: output voltage (100 mV/div.).
Time scale: (2 µs/div.).

Output Load Transient Response



Output voltage response to load current step-change (15-22.5-15 A) at:
T_{P1} =+25°C, V_I = 48 V.

Top trace: output voltage (200 mV/div.).
Bottom trace: load current (10A/div.).
Time scale: (0.2 ms/div.).

Output Voltage Adjust (see operating information)

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

Output Voltage Adjust, Decrease:

$$Radj = \left(\frac{16.31}{3.3 - Vo} - 10.2 \right) \text{ k}\Omega$$

Output Voltage Adjust, Increase:

$$Radj = \left(\frac{13.3(Vo - 1.226)}{Vo - 3.3} - 10.2 \right) \text{ k}\Omega$$

Example: Increase 4% => V_o = 3.432 Vdc

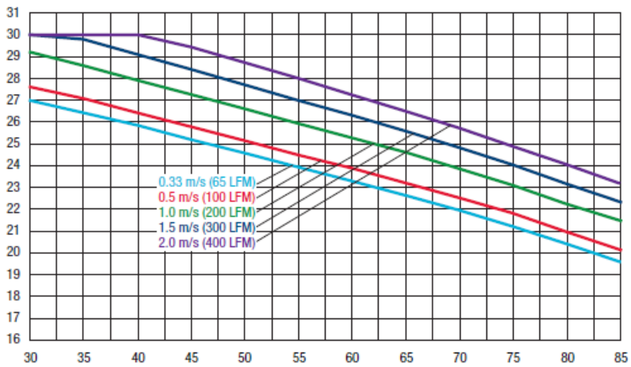
$$\left(\frac{13.3 \times (3.432 - 1.226)}{3.432 - 3.3} - 10.2 \right) \text{ k}\Omega = 212.07 \text{ k}\Omega$$

© Flex

Typical Characteristics
3.3 V, 30 A / 99 W

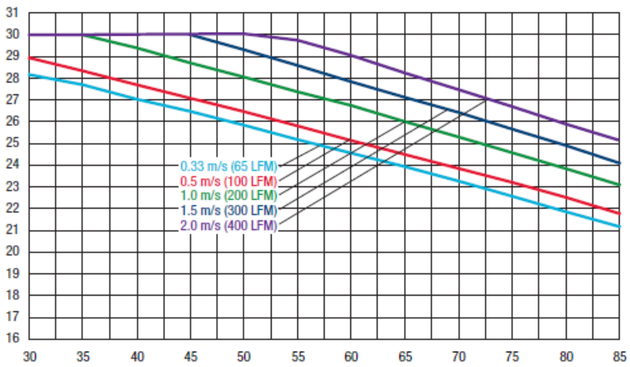
PKB 5110W PI

Output Current Derating – Open frame



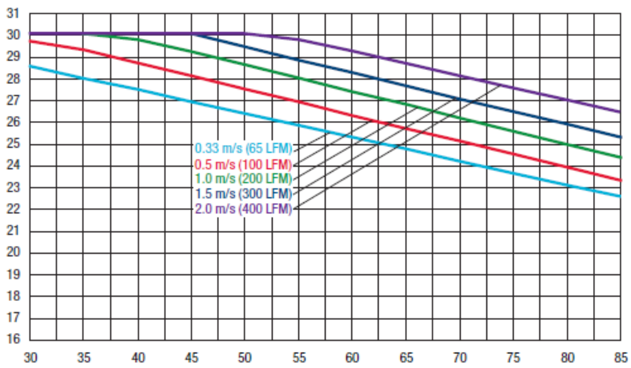
Available load current vs. ambient air temperature and airflow at V_I = 48 V. See Thermal Consideration section.

Output Current Derating – Open frame



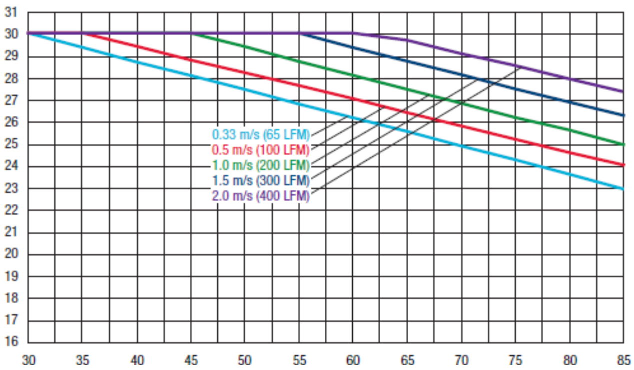
Available load current vs. ambient air temperature and airflow at V_I = 24 V. See Thermal Consideration section.

Output Current Derating – Base plate



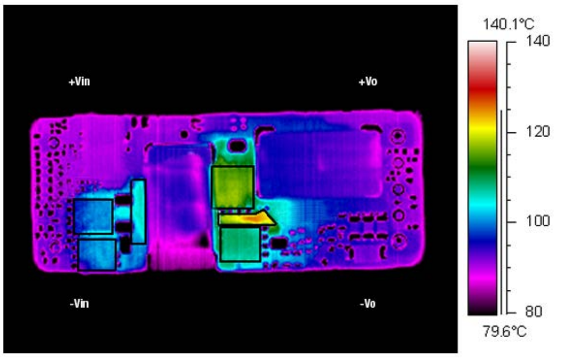
Available load current vs. ambient air temperature and airflow at V_I = 48 V. See Thermal Consideration section.

Output Current Derating – Base plate



Available load current vs. ambient air temperature and airflow at V_I = 24 V. See Thermal Consideration section.

Thermal Hot Spot



Thermal image with hot spot at V_I = 48 V, T_A = +25°C, I_O = 23.5 A. Natural convection is used without forced airflow.

Electrical Specification
5 V, 20 A / 100 W

PKB 5111W PI

T_{P1} = -40 to +85ºC, V_I = 18 to 75 V, sense pins connected to output pins unless otherwise specified under Conditions.
Typical values given at: T_{P1} = +25°C, V_I= 48 V_I max I_O, unless otherwise specified under Conditions.
Additional C_{in} = 33 µF, C_{out} = 1 µF + 10 µF. See Operating Information section for selection of capacitor types.

Characteristics		Conditions	min	typ	max	Unit
V_I	Input voltage range		18		75	V
V_{Ioff}	Turn-off input voltage	Decreasing input voltage	17	17.5	18	V
V_{Ion}	Turn-on input voltage	Increasing input voltage	15.5	16	17.5	V
P_O	Output power		0		100	W
η	Efficiency	max I_O		90.5		%
		max I_O, V_I = 24 V		92		
P_d	Power Dissipation	max I_O, see Note 1		TBD		W
I_{li}	Input idling current	I_O = 0 A, V_I = 48 V		100		mA
I_{RC}	Input standby current	V_I = 48 V (turned off with RC)		5		mA
f_s	Switching frequency	0-100 % of max I_O, see Note 2	200	225	250	kHz

V_{Oi}	Output voltage initial setting and accuracy	T_{P1} = +25°C, V_I = 48 V, I_O = 10 A	4.95	5	5.05	V
V_O	Output adjust range	See operating information	4.5		5.5	V
	Output voltage tolerance band	0-100% of max I_O	4.95		5.05	V
	Line regulation	max I_O		±5		mV
	Load regulation	V_I = 48 V, 0-100% of max I_O		±5		mV
V_{tr}	Load transient voltage deviation	V_I = 48 V, Load step 50-75-50% of max I_O, di/dt = 10 A/µs see Note 3		±450		mV
t_{tr}	Load transient recovery time			100	200	µs
t_s	Start-up time (from V_I connection to 90% of V_{Oi})	0-100% of max I_O		20	30	ms
t_{RC}	RC start-up time	max I_O		20		ms
I_O	Output current		0		20	A
I_{lim}	Current limit threshold	T_{P1} < max T_{P1}	23	27	32	A
I_{sc}	Short circuit current	T_{P1} = 25ºC, see Note 4		1.5	2.5	A
C_{out}	Recommended Capacitive Load	T_{P1} = 25ºC, see Note 5	0		10000	µF
V_{Oac}	Output ripple & noise	See ripple & noise section, V_{Oi}		75	110	mVp-p
OVP	Over voltage protection	T_{P1} = +25°C, V_I = 48 V, 0-100% of max I_O		6.5	7	V

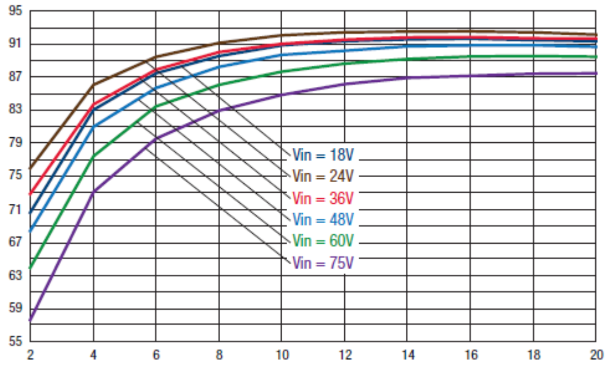
Note 1: See power dissipation graph
Note 2: See Operating Information section
Note 3: Cout = 1 µF + 10 µF +10000µF
Note 4: RMS current, See Operating Information section.
Note 5: See Operating Information section.

© Flex

Typical Characteristics
5 V, 20 A / 100 W

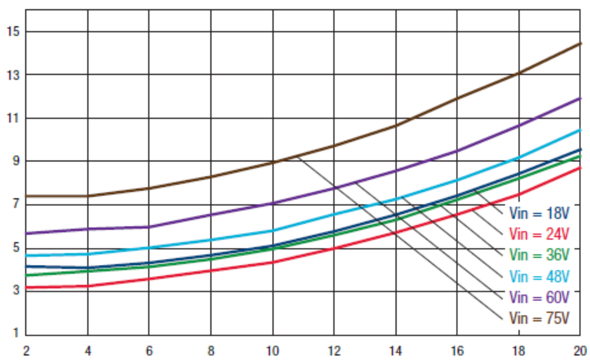
PKB 5111W PI

Efficiency



Efficiency vs. load current and input voltage at T_{P1} = +25°C.

Power Dissipation

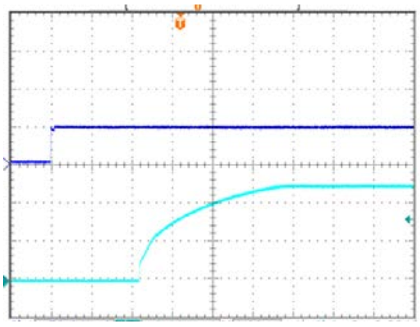


Dissipated power vs. load current and input voltage at T_{P1} = +25°C.

Typical Characteristics
5 V, 20 A / 100 W

PKB 5111W PI

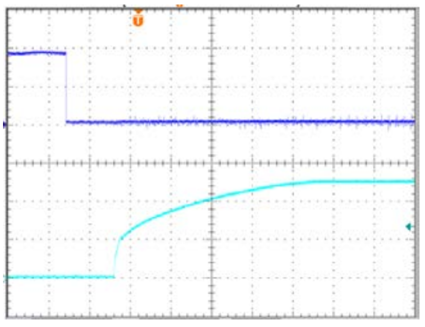
Start-up



Start-up enabled by connecting V_I at:
T_{P1} = +25°C, V_I = 48 V,
I_O = 20 A resistive load.

Top trace: input voltage (50 V/div.).
Bottom trace: output voltage (2 V/div.).
Time scale: (4 ms/div.).

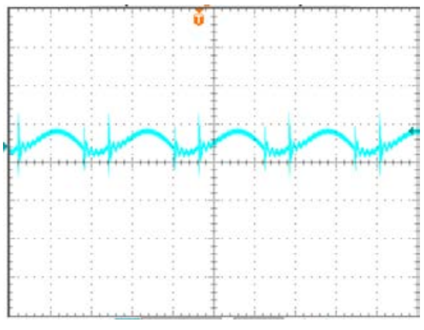
Shut-down



Start-up enabled by grounding RC at:
T_{P1} = +25°C, V_I = 48 V,
I_O = 20 A resistive load.

Top trace: remote control (2 V/div.).
Bottom trace: output voltage (2 V/div.).
Time scale: (4 ms/div.).

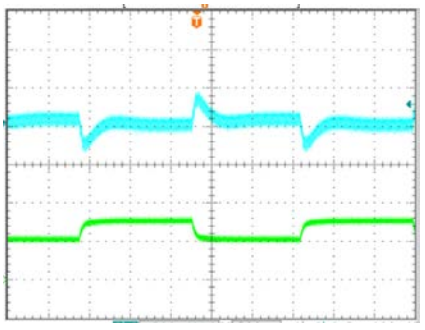
Output Ripple & Noise



Output voltage ripple at:
T_{P1} = +25°C, V_I = 48 V,
I_O = 20 A resistive load.

Trace: output voltage (100 mV/div.).
Time scale: (2 µs/div.).

Output Load Transient Response



Output voltage response to load current step-change (10-15-10 A) at:
T_{P1} =+25°C, V_I = 48 V.

Top trace: output voltage (200 mV/div.).
Bottom trace: load current (10A/div.).
Time scale: (0.2 ms/div.).

Output Voltage Adjust (see operating information)

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

Output Voltage Adjust, Decrease:

$$Radj = \left(\frac{25.01}{5 - Vo} - 10.2\right) \text{ k}\Omega$$

Output Voltage Adjust, Increase:

$$Radj = \left(\frac{20.4(Vo - 1.226)}{Vo - 5} - 10.2\right) \text{ k}\Omega$$

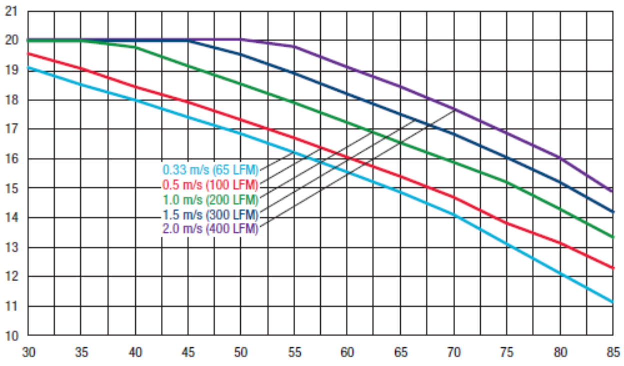
Example: Increase 4% => V_o = 5.2 Vdc

$$\left(\frac{20.4 \times (5.2 - 1.226)}{5.2 - 5} - 10.2\right) \text{ k}\Omega = 395.15 \text{ k}\Omega$$

Typical Characteristics
5 V, 20 A / 100 W

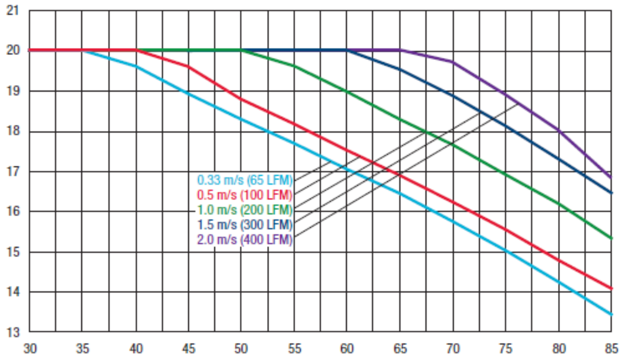
PKB 5111W PI

Output Current Derating – Open frame



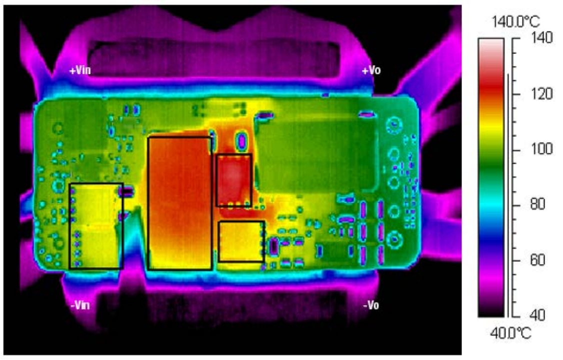
Available load current vs. ambient air temperature and airflow at V_I = 48 V. See Thermal Consideration section.

Output Current Derating – Base plate



Available load current vs. ambient air temperature and airflow at V_I = 48 V. See Thermal Consideration section.

Thermal Hot Spot



Thermal image with hot spot at V_I = 48 V, T_A = +25°C, I_O = 17 A. Natural convection is used without forced airflow.

© Flex

Electrical Specification
12 V, 10 A / 120 W

PKB 5113W PI

T_{P1} = -40 to +85ºC, V_I = 18 to 75 V, sense pins connected to output pins unless otherwise specified under Conditions.
Typical values given at: T_{P1} = +25°C, V_I= 48 V_I max I_O, unless otherwise specified under Conditions.
Additional C_{in} = 33 µF, C_{out} = 1 µF + 10 µF. See Operating Information section for selection of capacitor types.

Characteristics		Conditions	min	typ	max	Unit
V_I	Input voltage range		18		75	V
V_{Ioff}	Turn-off input voltage	Decreasing input voltage	16	16.45	17.5	V
V_{Ion}	Turn-on input voltage	Increasing input voltage	17	17.5	17.9	V
P_O	Output power		0		120	W
η	Efficiency	max I_O		91.5		%
		max I_O, V_I = 24 V		91.5		
P_d	Power Dissipation	max I_O, see Note 1		TBD		W
I_{li}	Input idling current	I_O = 0 A, V_I = 48 V		110		mA
I_{RC}	Input standby current	V_I = 48 V (turned off with RC)		4		mA
f_s	Switching frequency	0-100 % of max I_O, see Note 2	200	220	240	kHz

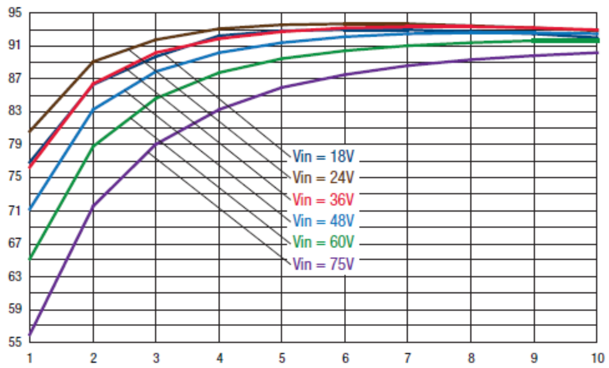
V_{Oi}	Output voltage initial setting and accuracy	T_{P1} = +25°C, V_I = 48 V, I_O = 5 A	11.88	12	12.12	V
V_O	Output adjust range	See operating information	10.8		13.2	V
	Output voltage tolerance band	0-100% of max I_O	11.88		12.12	V
	Line regulation	max I_O		±18		mV
	Load regulation	V_I = 48 V, 0-100% of max I_O		±9		mV
V_{tr}	Load transient voltage deviation	V_I = 48 V, Load step 50-75-50% of max I_O, di/dt = 5 A/µs see Note 3		±650		mV
t_{tr}	Load transient recovery time			100	200	µs
t_s	Start-up time (from V_I connection to 90% of V_{Oi})	0-100% of max I_O		30	40	ms
t_{RC}	RC start-up time	max I_O		20		ms
I_O	Output current		0		10	A
I_{lim}	Current limit threshold	T_{P1} < max T_{P1}	11.5	12.5	14	A
I_{sc}	Short circuit current	T_{P1} = 25ºC, see Note 4		1	2	A
C_{out}	Recommended Capacitive Load	T_{P1} = 25ºC, see Note 5	0		4700	µF
V_{Oac}	Output ripple & noise	See ripple & noise section, V_{Oi}		115	200	mVp-p
OVP	Over voltage protection	T_{P1} = +25°C, V_I = 48 V, 0-100% of max I_O		15	16	V

Note 1: See power dissipation graph
Note 2: See Operating Information section
Note 3: Cout = 1 µF + 10 µF +4700µF
Note 4: RMS current, See Operating Information section.
Note 5: See Operating Information section.

PKB 5000W series Direct Converters Input 18 - 75 V, Output up to 30 A / 120 W	28701- BMR 709 Rev. C November 2017
	© Flex

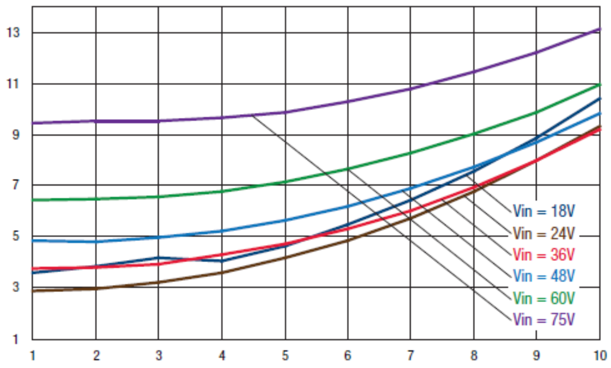
Typical Characteristics **PKB 5113W PI**
12 V, 10 A / 120 W

Efficiency



Efficiency vs. load current and input voltage at T_{P1} = +25°C.

Power Dissipation

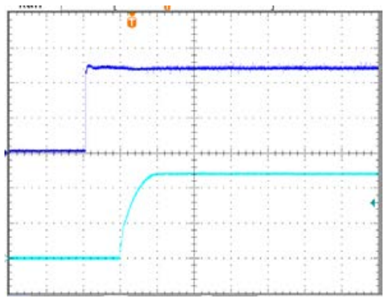


Dissipated power vs. load current and input voltage at T_{P1} = +25°C.

Typical Characteristics
12 V, 10 A / 120 W

PKB 5113W PI

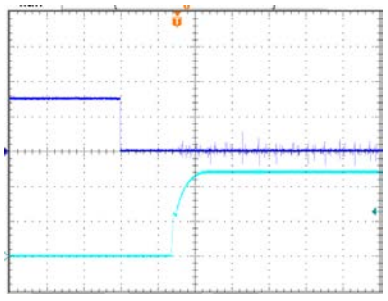
Start-up



Start-up enabled by connecting V_I at:
T_{P1} = +25°C, V_I = 48 V,
I_O = 10 A resistive load.

Top trace: input voltage (20 V/div.).
Bottom trace: output voltage (5 V/div.).
Time scale: (10 ms/div.).

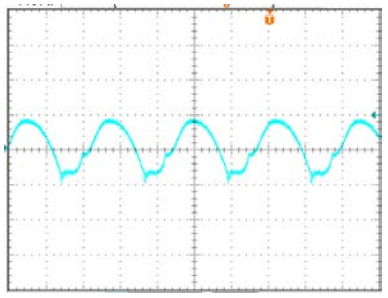
Start-up



Start-up enabled by grounding RC at:
T_{P1} = +25°C, V_I = 48 V
I_O = 10 A resistive load.

Top trace: remote control (2 V/div.).
Bottom trace: output voltage (5 V/div.).
Time scale: (10 ms/div.).

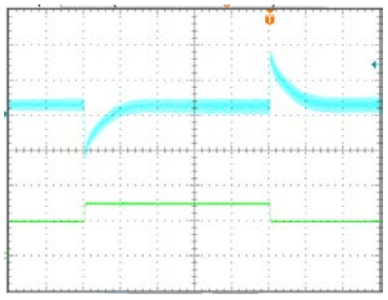
Output Ripple & Noise



Output voltage ripple at:
T_{P1} = +25°C, V_I = 48 V,
I_O = 10 A resistive load.

Trace: output voltage (50 mV/div.).
Time scale: (2 µs/div.).

Output Load Transient Response



Output voltage response to load current step-change (5-7.5-5 A) at:
T_{P1} =+25°C, V_I = 48 V.

Top trace: output voltage (100 mV/div.).
Bottom trace: load current (5A/div.).
Time scale: (2 ms/div.).

Output Voltage Adjust (see operating information)

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

Output Voltage Adjust, Decrease:

$$Radj = \left(\frac{60.45}{12 - Vo} - 10.2 \right) \text{k}\Omega$$

Output Voltage Adjust, Increase:

$$Radj = \left(\frac{49.6(Vo - 1.226)}{Vo - 12} - 10.2 \right) \text{k}\Omega$$

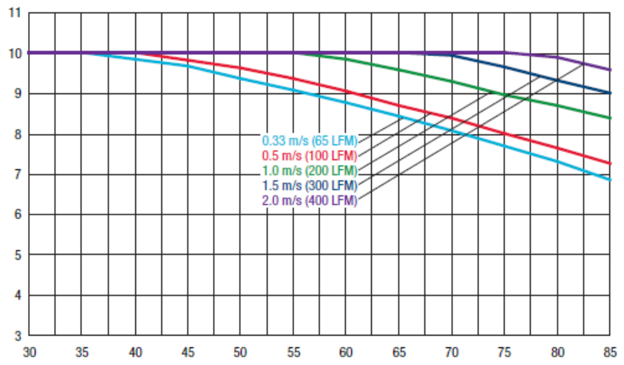
Example: Increase 4% => V_o = 12.48 Vdc

$$\left(\frac{49.6 \times (12.48 - 1.226)}{12.48 - 12} - 10.2 \right) \text{k}\Omega = 1152.7 \text{ k}\Omega$$

Typical Characteristics
12 V, 10 A / 120 W

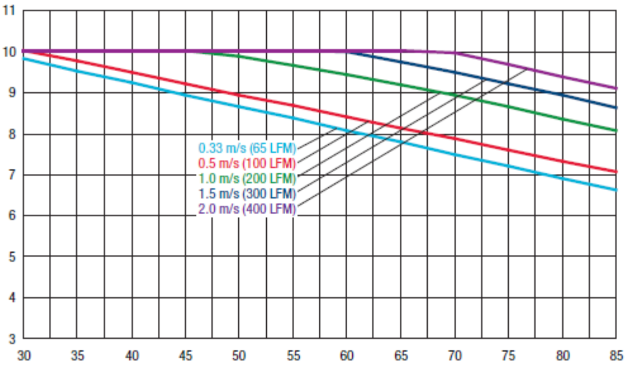
PKB 5113W PI

Output Current Derating – Open frame



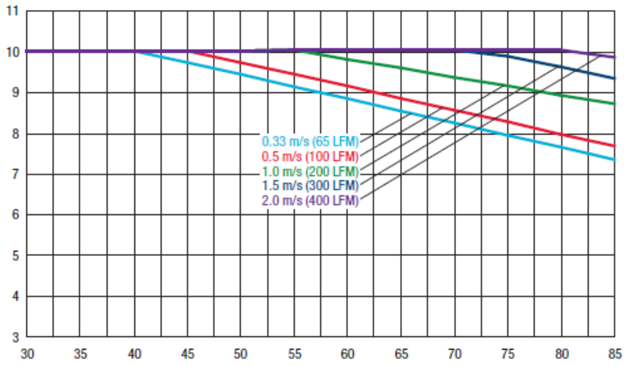
Available load current vs. ambient air temperature and airflow at V_I = 48 V. See Thermal Consideration section.

Output Current Derating – Open frame



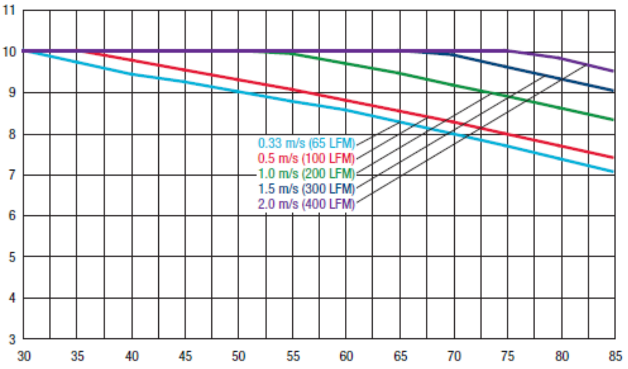
Available load current vs. ambient air temperature and airflow at V_I = 24 V. See Thermal Consideration section.

Output Current Derating – Base plate



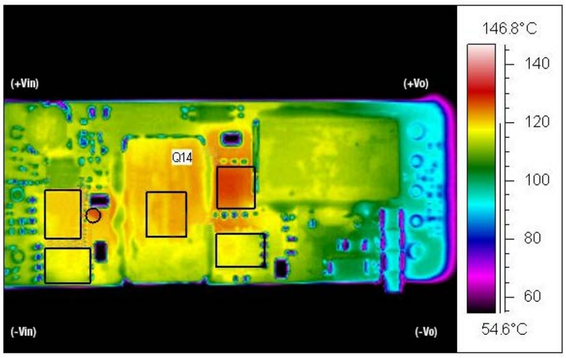
Available load current vs. ambient air temperature and airflow at V_I = 48 V. See Thermal Consideration section.

Output Current Derating – Base plate



Available load current vs. ambient air temperature and airflow at V_I = 24 V. See Thermal Consideration section.

Thermal Hot Spot

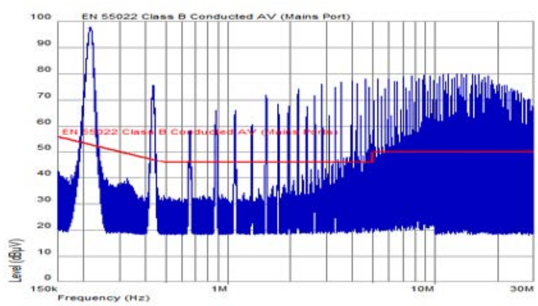


Thermal image with hot spot at V_I = 48 V, T_A = +25°C, I_O = 8.24 A. Natural convection is used without forced airflow.

EMC Specification

Conducted EMI measured according to EN55022, CISPR 22 and FCC part 15J (see test set-up). See Design Note 009 for further information. The fundamental switching frequency is 220 kHz for PKB 5113 WPI at V_I = 48 V and max I_O.

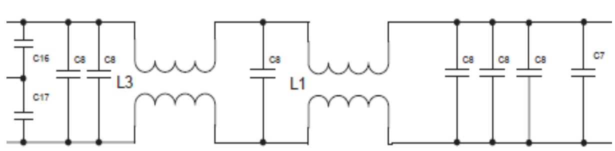
Conducted EMI Input terminal value (typ)



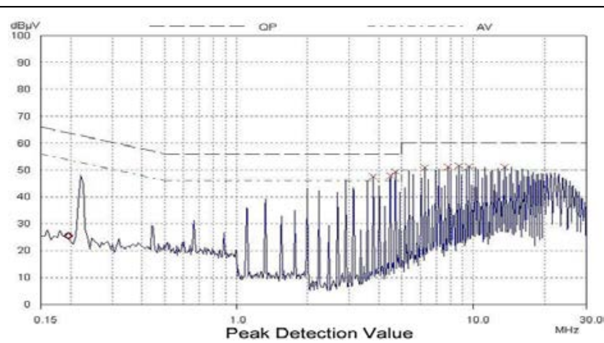
EMI without filter

Optional external filter for class B

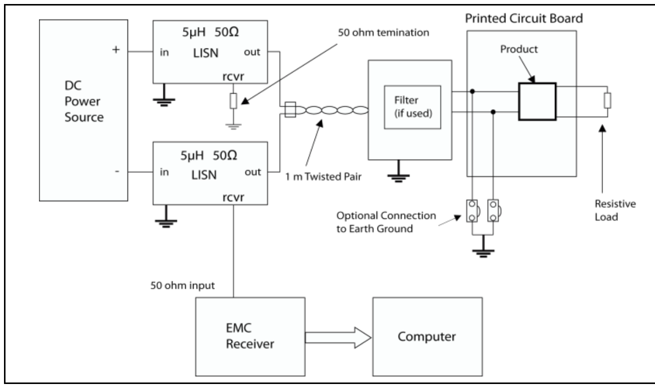
Suggested external input filter in order to meet class B in EN 55022, CISPR 22 and FCC part 15J.



Filter components:
C1,2,8 = 2.2 µF from Murata
C7 = 22 µF, 100V from Panasonic
C16,17 = 0.22 µF
L1 = 1mH, 6A, Pulse PE-62913
L3 = 500 µH,10A, Murata 500 µH,10A, MPS



EMI with filter



Test set-up

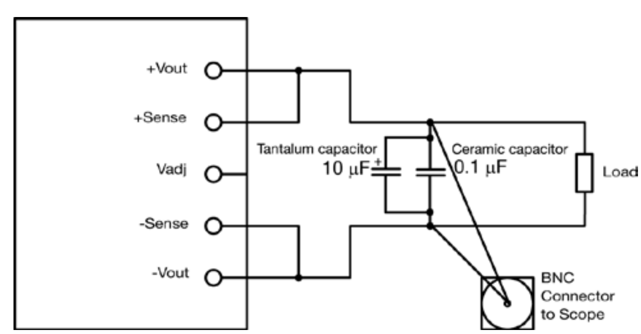
Layout recommendations

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

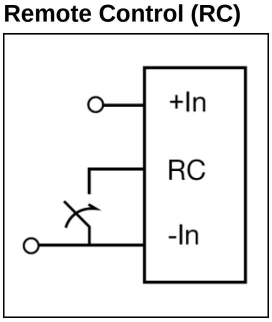
The input voltage range 18 to 75 Vdc meets the requirements of the European Telecom Standard ETS 300 132-2 for normal input voltage range in –48 and –60 Vdc systems, -40.5 to -57.0 V and –50.0 to -72 V respectively.
At input voltages exceeding 75 V, the power loss will be higher than at normal input voltage. The absolute maximum continuous input voltage is 80 Vdc.

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 dependent 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 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 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 – 15 V.

The standard product is provided with “negative logic” RC and will be off 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 3.5 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 22 - 100 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.

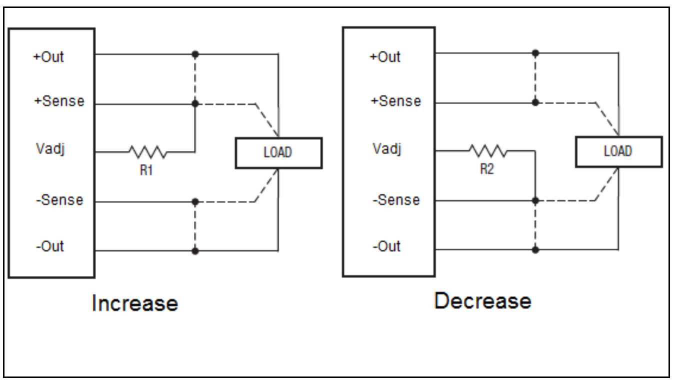
External Decoupling Capacitors

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 Power Modules 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 voltage at the output pins (including any remote sense compensation) must be kept below the threshold of the over voltage protection, (OVP) to prevent the product from shutting down. At increased 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 +Sense 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 –Sense pin.



Remote Sense

The products have remote sense that can be used to compensate for voltage drops between the output and the point of load. The sense traces should be located close to the PWB ground layer to reduce noise susceptibility. The remote sense circuitry will compensate for up to 5% voltage drop between output pins and the point of load.

If the remote sense is not needed +Sense should be connected to +Out and -Sense should be connected to -Out.

Over Temperature Protection (OTP)

The products are protected from thermal overload by an internal over temperature shutdown circuit.
When T_{P1} as defined in thermal consideration section exceeds 140°C the product will shut down. The product will make continuous attempts to start up (non-latching mode) 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 max output current (max I_O). 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.

Pre-bias Start-up

The product has a Pre-bias start up functionality and will not sink current during start up if a pre-bias source is present at the output terminals.

PKB 5000W series Direct Converters Input 18 - 75 V, Output up to 30 A / 120 W	28701- BMR 709 Rev. C November 2017
	© Flex

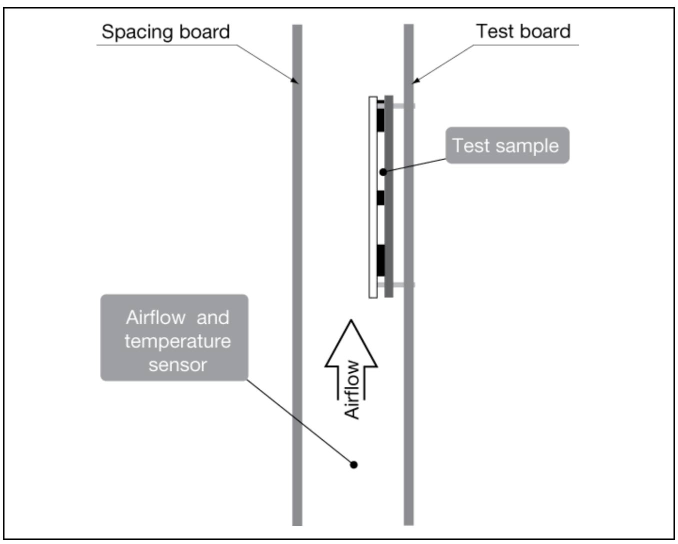
Thermal Consideration

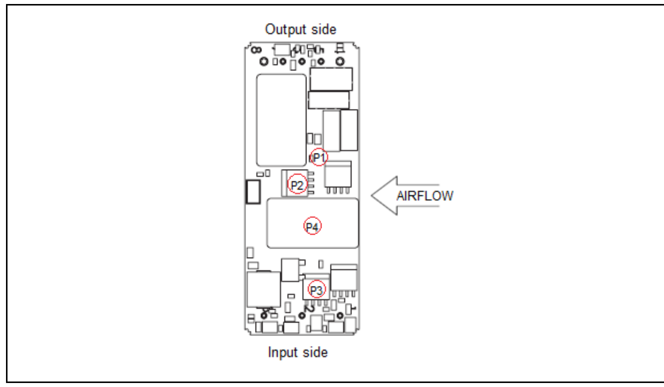
General

The products are designed to operate in different thermal environments and sufficient cooling must be provided to ensure reliable operation.

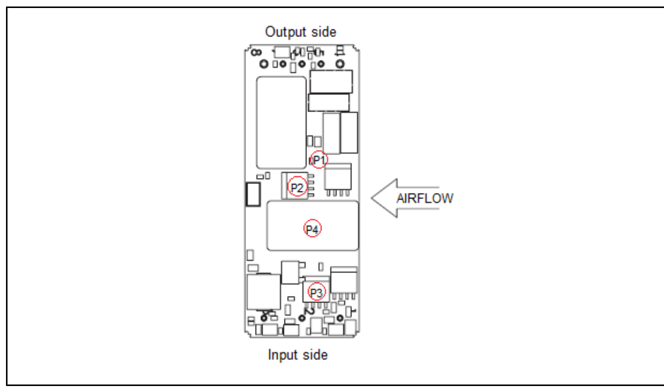
For products mounted on a PWB without a heat sink attached, cooling is achieved mainly by conduction, from the pins to the host board, and convection, which is dependent on the airflow across the product. Increased airflow enhances the cooling of the product. The Output Current Derating graph found in the Output section for each model provides the available output current vs. ambient air temperature and air velocity at V_I = 48 V.

The product is tested on a 10" x 10" test board mounted vertically in a wind tunnel.





Open frame



Base plate

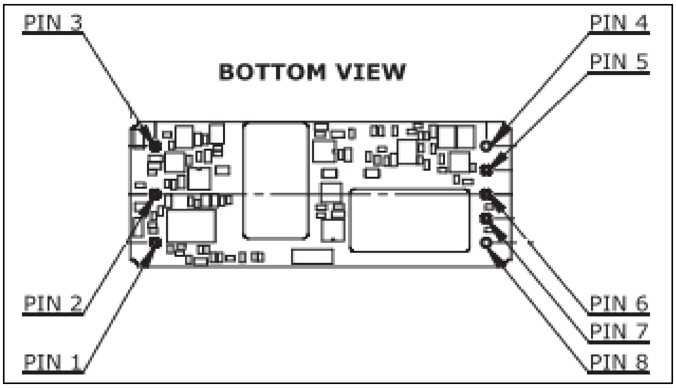
Definition of product operating temperature

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, P2, P3 and P4. The temperature at these positions (T_{P1}, T_{P2}, T_{P3}, T_{P4}) should not exceed the maximum temperatures in the table below. The number of measurement points may vary with different thermal design and topology. Temperatures 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}=110º C
P2	Mosfet case	T_{P2}=120º C
P3	Mosfet case	T_{P3}=120º C
P4	Transformer core	T_{P4}=120º C

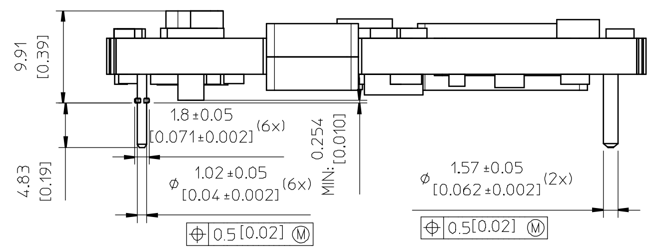
PKB 5000W series Direct Converters Input 18 - 75 V, Output up to 30 A / 120 W	28701- BMR 709 Rev. C November 2017
	© Flex

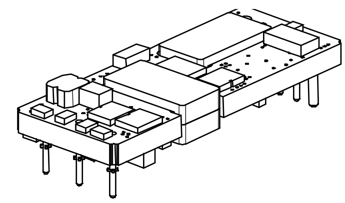
Connections



Pin	Designation	Function
1	+In	Positive input
2	RC	Remote control
3	-In	Negative input
4	-Out	Negative output
5	-Sense	Negative remote sense
6	V_{adj}	Output voltage adjust
7	+Sense	Positive remote sense
8	+Out	Positive output

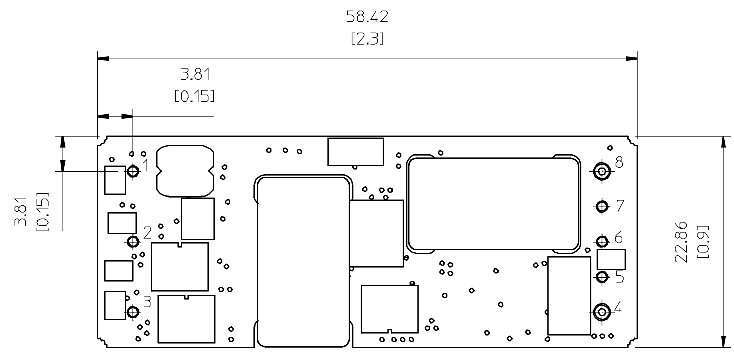
Mechanical Information -Open Frame Version

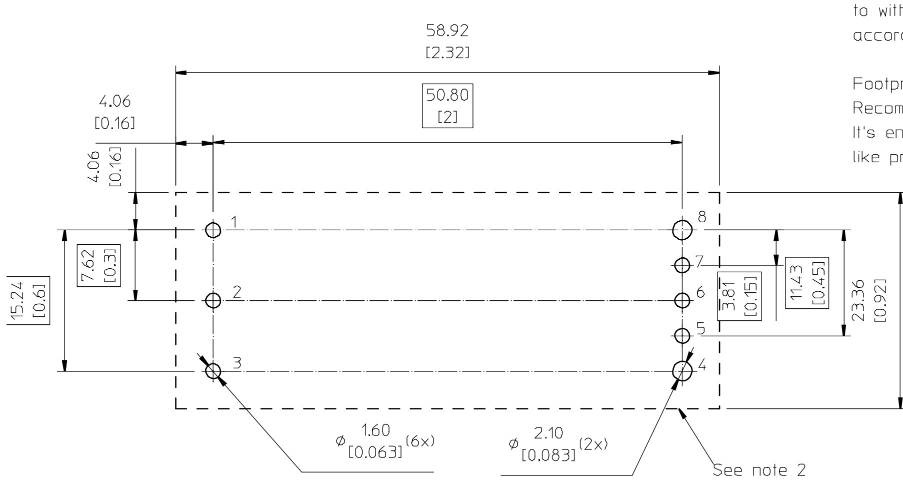




TOP VIEW

Pin postion according to recommended footprint





Note 1

Pins
Pin 1~3, 5~7 Material: C26000, Brass,3/4 Hard
Pin 4,8 Material: C10200 Copper alloy, Full Hard
Plating: Min 5 MICROINCHES Au over 50 MICORINCHES nickel

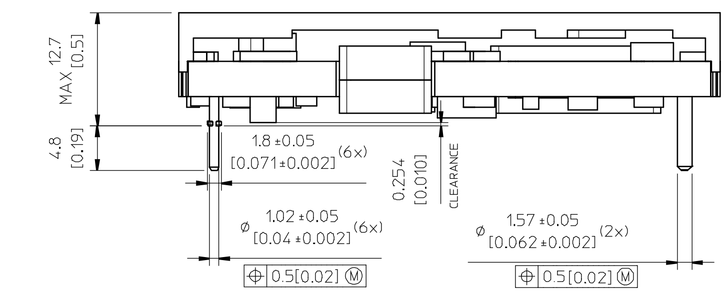
Note 2

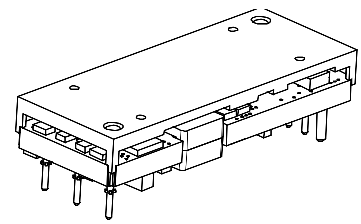
Recommended keep away area for user components to withstand input to output isolation voltage according to absolute maximum ratings.

Footprint:
Recommended hole dimensions are only for reference
It's end users' decision based on different situations like productions process, substrate thickness,etc

Weight: typical 20 g
All dimensions in mm [inch].
Tolerances unless specified
x.x mm ±0.50 mm [0.02], x.xx mm ±0.25 mm [0.01]
(not applied on footprint or typical values)

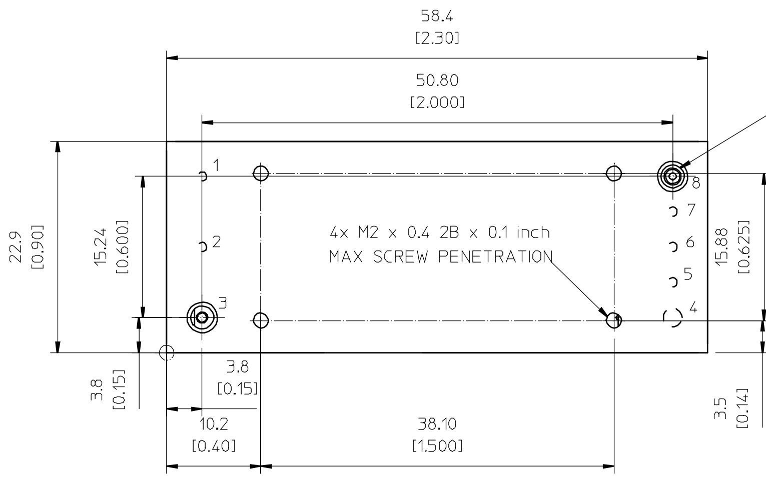
Mechanical Information - Base Plate Version





TOP VIEW

Pin postions according to recommended footprint



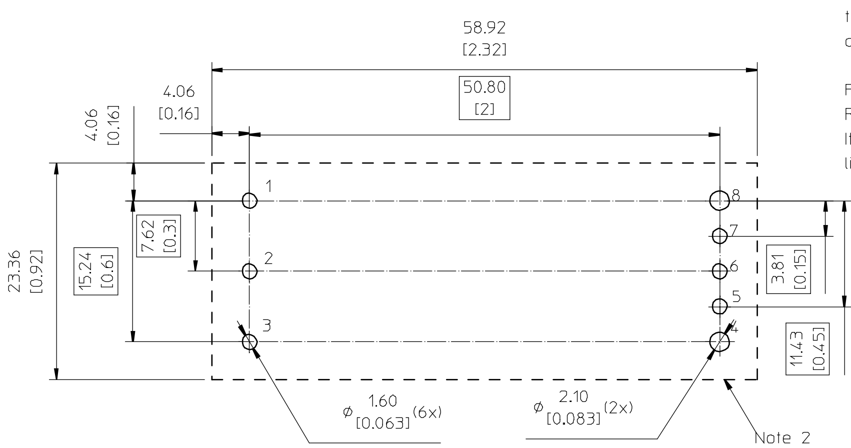
Note 1
Case
Material: Aluminum

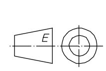
Pins
Pin 1~3, 5~7 Material: C26000 Brass,3/4 Hard
Pin 4,8 Material: C10200 Copper alloy, Full Hard
Plating: Min 5 MICROINCHES Au over 50 MICORINCHES nickel

Note 2

Recommended keep away area for user components to withstand input to output isolation voltage according to absolute maximum ratings.

Footprint:
Recommended hole dimensions are only for reference
It's end users' decision based on different situations like productions process, substrate thickness,etc





Weight: typical 36.5 g
All dimensions in mm [inch].
Tolerances unless specified
x.x mm ±0.5 mm [0.02], x.xx mm ±0.25 mm [0.01]
(not applied on footprint or typical values)

Soldering Information - Hole Mounting

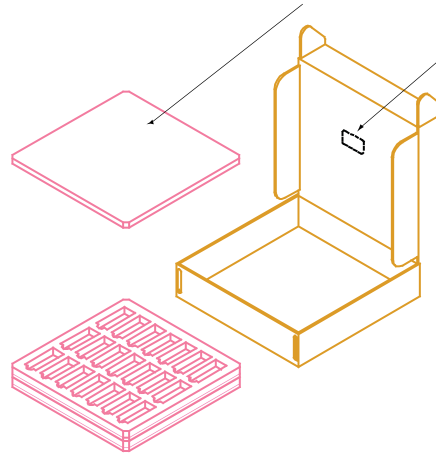
The hole mounted product is intended for plated through hole mounting by wave or manual soldering. The pin temperature is specified to maximum to 270°C for maximum 10 seconds.

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.

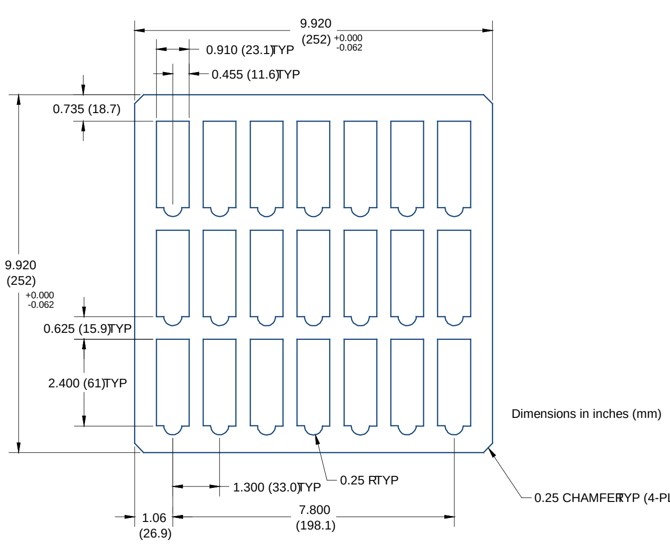
A no-clean flux is recommended to avoid entrapment of cleaning fluids in cavities inside the product or between the product and the host board. The cleaning residues may affect long time reliability and isolation voltage.

Delivery Package Information

The products are delivered in antistatic trays



Tray Specifications	
Material	Antistatic Polyethylene Foam
Surface resistance	10^4 < Ohm/square < 10^{11}
Bakability	The trays are not bakable
Tray thickness	TBD
Box capacity	42 products (2 full trays/box)
Tray weight	TBD



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	-40 to 100°C 1000 15 min/0-1 min
Cold (in operation)	IEC 60068-2-1 Ad	Temperature T_A Duration	-45°C 72 h
Damp heat	IEC 60068-2-67 Cy	Temperature Humidity Duration	85°C 85 % RH 1000 hours
Dry heat	IEC 60068-2-2 Bd	Temperature Duration	125°C 1000 h
Electrostatic discharge susceptibility	IEC 61340-3-1, JESD 22-A114 IEC 61340-3-2, JESD 22-A115	Human body model (HBM) Machine Model (MM)	Class 2, 2000 V Class 3, 200 V
Immersion in cleaning solvents	IEC 60068-2-45 XA, method 2	Water Glycol ether	55°C 35°C
Mechanical shock	IEC 60068-2-27 Ea	Peak acceleration Duration	100 g 6 ms
Moisture reflow sensitivity [1]	J-STD-020C	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 IEC 60068-2-21 Test Ue1	Through hole mount products Surface mount products	All leads All leads
Solderability	IEC 60068-2-58 test Td [1]	Preconditioning Temperature, SnPb Eutectic Temperature, Pb-free	150°C dry bake 16 h 215°C 235°C
	IEC 60068-2-20 test Ta [2]	Preconditioning Temperature, SnPb Eutectic Temperature, Pb-free	Steam ageing 235°C 245°C
Vibration, broad band random	IEC 60068-2-64 Fh, method 1	Frequency Spectral density Duration	10 to 500 Hz 0.07 g^2/Hz 10 min in each direction

Notes
[1] Only for products intended for reflow soldering (surface mount products)
[2] Only for products intended for wave soldering (plated through hole products)