50 W DC/DC power module 48 V input series

Contents

Key Features

- Regulated dual outputs
- Efficiency >90% (3.3V) from 30% to full load
- Low profile 8.5 mm (0.335 in.)
- 1,500 Vdc isolation voltage
- MTBF >200 years at +75°C case temperature
- Full power up to +80°C ambient at 1 m/s airflow
- Complete, no extra filters or heatsinks required

The PKN 4000 I series of DC/DC power modules are intended to be used as distributed power sources in decentralized 48/60 VDC power systems. The PKN series use a ceramic substrate with thickfilm technology and a high degree of silicon integration. That together with the electrical design using synchronous rectification gives good thermal management, high reliability and high efficiency. The high efficiency, makes it possible to operate over a wide temperature range without a heatsink. At forced convection cooling >200 lfm (1 m/s), the PKN units can deliver full power up to +80°C ambient temperature.

The high reliability and the low profile of the PKN series makes them particularly suited for Information Technology and Telecom (IT&T) applications with board spacing down to 15 mm (0.6 in.).

These products are manufactured using highly automated manufacturing lines with a world-class quality commitment.

Ericsson Power Modules is an ISO 9001/14001 certified supplier.

Product Program

V_I	V_O/I_O max		P_O max	Ordering No.	Comment
	Output 1	Output 2			
48/60 V	3.3 V /15 A	2.5 V / 6 A	50W	PKN 4520 API	
48/60 V	3.3 V /15 A	1.8 V / 8 A	50W	PKN 4520 BPI	
48/60 V	3.3 V /15 A	1.5 V / 8 A	50W	PKN 4520 BPIOA	

For more information about the complete product program, please refer to our website: www.ericsson.com/powermodules

Quality Statement

The PKN 4000I DC/DC converters are designed and manufactured in an industrial environment where quality systems and methods like ISO 9000, 6σ (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 our products.

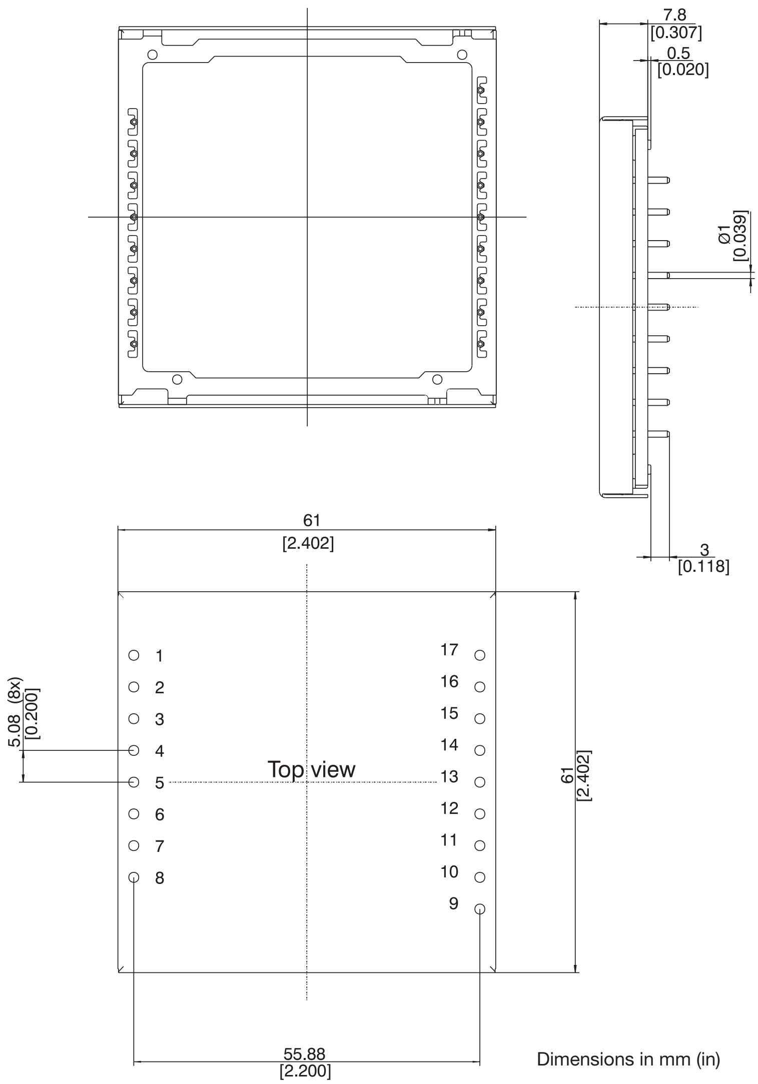
Reliability

Meantime between failure (MTBF) is calculated to >1.7 million hours at full output power and a case temperature of +75°C (T_A =+40°C), using the Ericsson failure rate data system. The Ericsson failure rate data system is based on field failure rates and is continously updated. The data corresponds to actual failure rates of conponent used in Information Technology and Telecom equipment in temperature controlled environments (T_A =-5…+65°C). The data is considered to have a confidence level of 90%. For more information see Design Note 002.

Limitation of Liability

Ericsson Power Modules 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).

Mechanical Information



Dimensions in mm (in)

Connections

Pin	Designation	Function
1	LO	Local on/off. Turns the module off immediately after LO pin is connected to positive input pin.
2	RC	Remote Control. Turns the module off immediately after RC pin is connected to negative input pin.
3-5	NC	Not Connected
6	- In	Negative input
7	+ In	Positive input
8	No pin	-
9	V_{adj} Out 2	Output 2 voltage adjust
10-11	+ Out 2	Output 2
12-14	Rtn	Return
15-16	+ Out 1	Output 1
17	V_{adj} Out 1	Output 1 voltage adjust

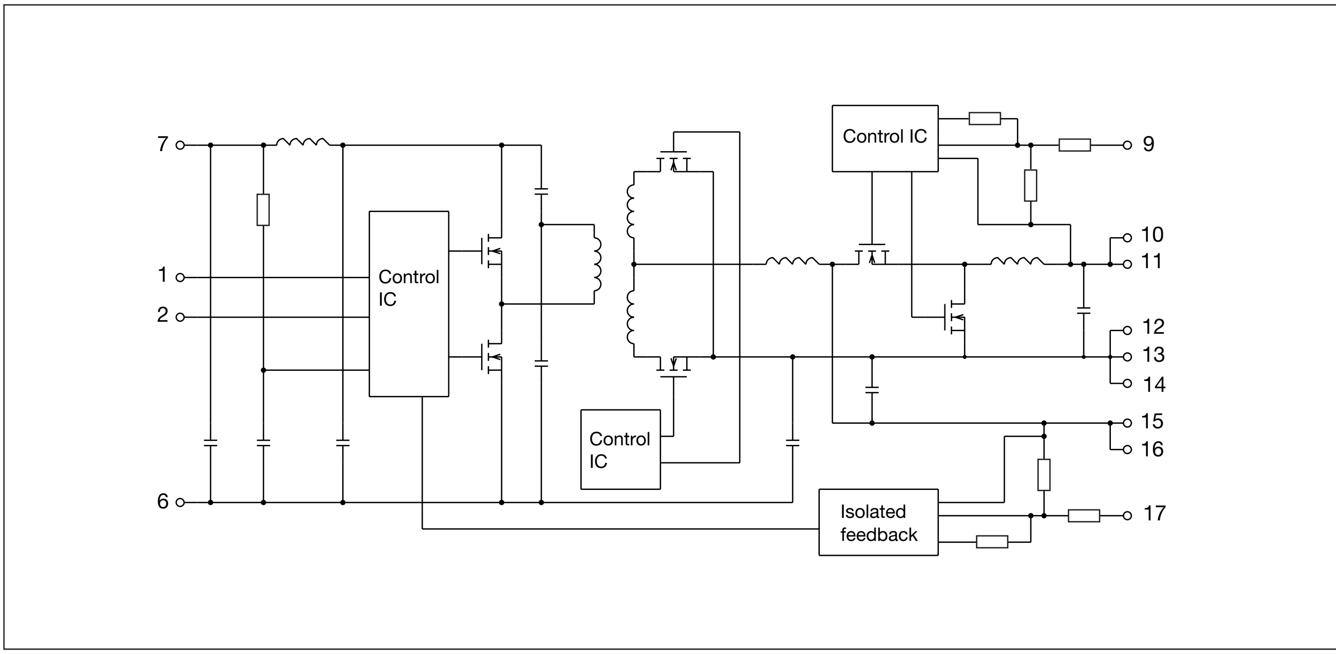
Weight

Maximum 45 g (1.58 oz).

Case

Plastic coated aluminium casing with tin plated brass pins.

Fundamental Circuit Diagram



Safety Specification

General information.

Ericsson Power Modules DC/DC converters and DC/DC regulators are designed in accordance with safety standards IEC/EN/UL 60 950, *Safety of Information Technology Equipment.*

IEC/EN/UL60950 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”. 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 Directives for the final product.

Component power supplies for general use should comply with the requirements in IEC60950, EN60950 and UL60950 “Safety of information technology equipment”.

There are other more product related standards, e.g. IEC61204-7 “Safety standard for power supplies", IEEE802.3af “Ethernet LAN/MAN Data terminal equipment power”, and ETS300132-2 “Power supply interface at the input to telecommunications equipment; part 2: DC”, but all of these standards are based on IEC/EN/UL60950 with regards to safety.

Ericsson Power Modules DC/DC converters and DC/DC regulators are UL 60 950 recognized and certified in accordance with EN 60 950.

The flammability rating for all construction parts of the products meets UL 94V-0.

The products should be installed in the end-use equipment, in accordance with the requirements of the ultimate application. Normally the output of the DC/DC converter is considered as SELV (Safety Extra Low Voltage) and the input source must be isolated by minimum Double or Reinforced Insulation from the primary circuit (AC mains) in accordance with IEC/EN/UL 60 950.

Isolated DC/DC converters.

It is recommended that a fast blow fuse with a rating twice the maximum input current per selected product be used 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 in the input filter or in the DC/DC converter that imposes a short circuit on the input source, this fuse will provide the following functions:

- Isolate the faulty DC/DC converter 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.

The galvanic isolation is verified in an electric strength test. The test voltage (V_{ISO}) between input and output is 1500 Vdc or 2250 Vdc for 60 seconds (refer to product specification). Leakage current is less than 1µA at nominal input voltage.

24 V dc systems.

The input voltage to the DC/DC converter is SELV (Safety Extra Low Voltage) and the output remains SELV under normal and abnormal operating conditions.

48 and 60 V dc systems.

If the input voltage to Ericsson Power Modules DC/DC converter is 75 V dc or less, then the output remains SELV (Safety Extra Low Voltage) under normal and abnormal operating conditions.

Single fault testing in the input power supply circuit should be performed with the DC/DC converter connected to demonstrate that the input voltage does not exceed 75 V dc.

If the input power source circuit is a DC power system, the source may be treated as a TNV2 circuit and testing has demonstrated compliance with SELV limits and isolation requirements equivalent to Basic Insulation in accordance with IEC/EN/UL 60 950.

Non-isolated DC/DC regulators.

The input voltage to the DC/DC regulator is SELV (Safety Extra Low Voltage) and the output remains SELV under normal and abnormal operating conditions.

It is recommended that a slow blow fuse with a rating twice the maximum input current per selected product be used at the input of each DC/DC regulator.

PKN 4520 API Output

T_C = –25…+90°C, V_I = 36...75 V unless otherwise specified. $I_{O1\,nom}$ = 10 A, $I_{O2\,nom}$ = 6 A.

	Characteristics	Conditions		Output 1			Output 2			Unit
				min	typ	max	min	typ	max	
V_{Oi}	Output voltage initial setting and accuracy	T_C = +25°C, $I_O = I_{Onom}$, V_I = 53 V		3.28	3.30	3.32	2.48	2.50	2.52	V
	Output adjust range[1]			2.90		3.60	2.00		2.75	V
V_O	Output voltage tolerance band	Long term drift included	I_O = 0.01…1.0 × $I_{O\,nom}$	3.24		3.36	2.45		2.55	V
	Idling voltage	I_O = 0 A		3.23		3.37	2.44		2.56	V
	Line regulation	$I_O = I_{Onom}$	V_I = 36…75 V		2	15		2	15	mV
	Load regulation	$I_{O2} = I_{O2nom}$, V_I = 53 V I_{O1} = 0.01…1.0 × I_{O1nom}			10	25		10	25	mV
		$I_{O1} = I_{O1nom}$, V_I = 53 V I_{O2} = 0.01…1.0 × I_{O2nom}			10	25		10	25	mV
t_{tr}	Load transient recovery time	I_O = 0.01…1.0 × I_{Onom}, V_I = 53 V load step = 0.5× I_{Onom}			100			50		µs
V_{tr}	Load transient voltage				+330			+200		mV
					–330			–200		mV
t_r	Ramp-up time	$I_O = I_{Onom}$	V_O = 0.1…0.9 × V_O		15	45		5	25	ms
t_s	Start-up time	I_O = 0.1…1.0 × I_{Onom} V_I = 53 V	From V_I connection to V_O = 0.9 × V_{Oi}		20	60		15	45	ms
I_O	Output current			0		15	0		6	A
$P_{O\,max}$	Max output power[2]	Calculated value		min 50 - 0.333 × I_O2						W
I_{lim}	Current limiting threshold[1]	$T_C < T_{C\,max}$		min 1.05 × P_Omax						
I_{sc}	Short circuit current	T_C = +25°C, short circuit resistance max 20 mΩ				25			13	A
$V_{O\,ac}$	Output ripple	$I_O = I_{Onom}$	20 Hz…5 MHz		80	100		40	80	mV_{p-p}
SVR	Supply voltage rejection (ac)	f = 100 Hz sine wave, 1 V_{p-p}, V_I = 53 V (SVR = 20 log (1 V_{p-p}/V_{Op-p}))		60			70			dB
OVP	Over voltage protection	V_I = 53 V		3.9	4.1	4.4				V
							4.0	7.5	16.0	%

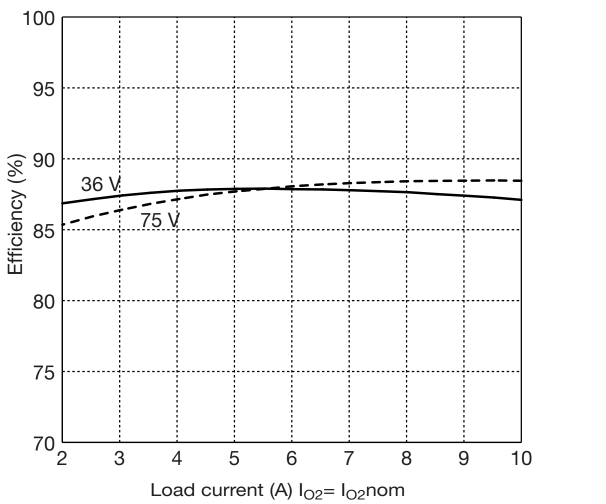
1) See Operating information, Dual output.
2) See also Typical Characteristics, Power derating.

Miscellaneous

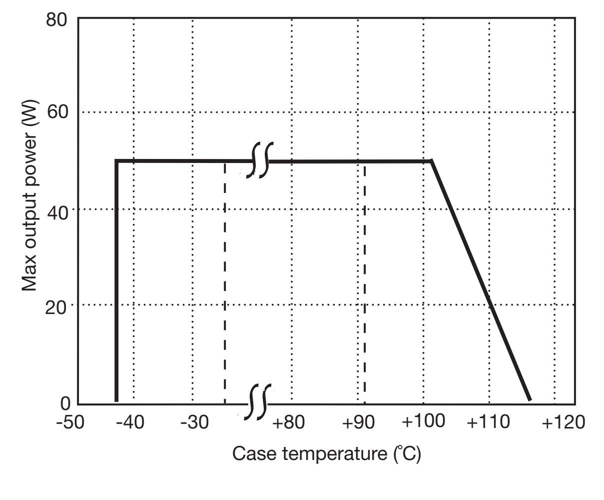
	Characteristics	Conditions	min	typ	max	Unit
η	Efficiency	$I_O = I_{Onom}$, V_I = 53 V	85	89		%
P_d	Power dissipation	$I_O = I_{Onom}$, V_I = 53 V			8.5	W

PKN 4520 API Typical Characteristics

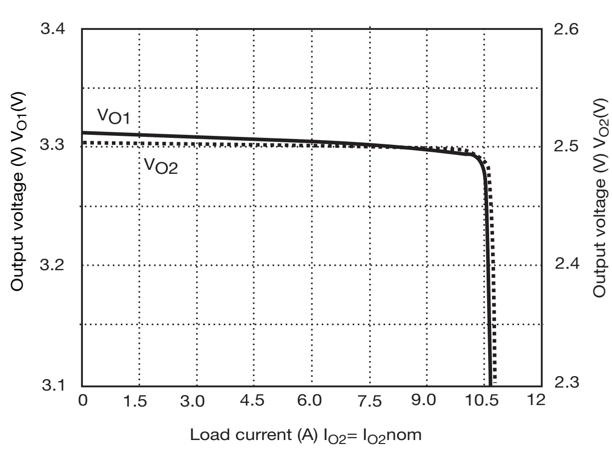
Efficiency (typ)



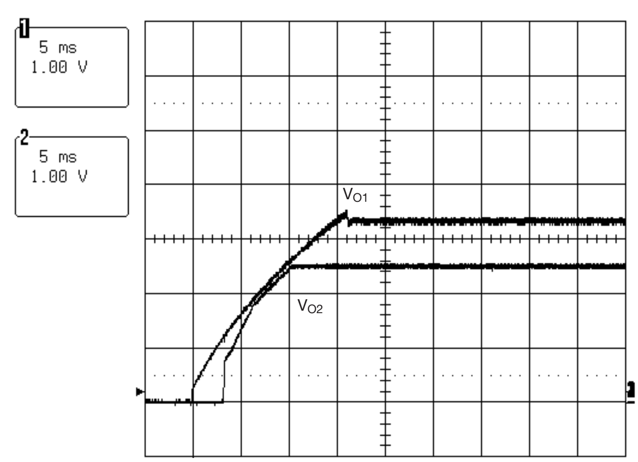
Power Derating



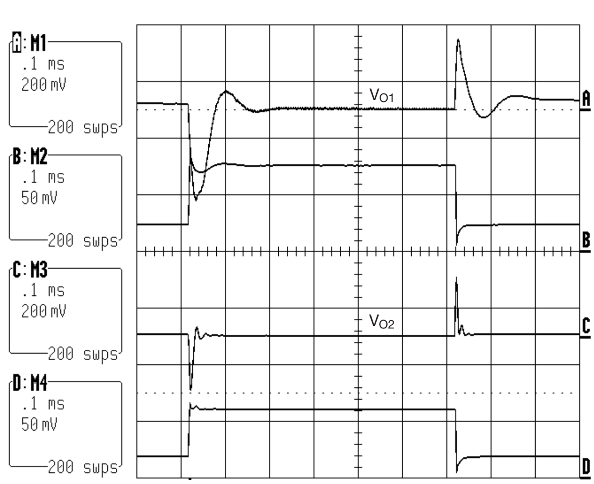
Output Characteristic (typ)



Start up (typ)



Dynamic load response (typ)



Dynamic load response (typ)

A, C. The output voltage deviation is determined by the load transient (dI/dt)

B, D. Load change: $0.25\times I_{Onom}\ldots0.75\times I_{Onom}\ldots0.25\times I_{Onom}$, $dI/dt\approx5A/\mu s$

PKN 4520 BPI Output

T_C = –25…+90°C, V_I = 36...75 V unless otherwise specified. $I_{O1\,nom}$ = 10 A, $I_{O2\,nom}$ = 8 A.

	Characteristics	Conditions		Output 1			Output 2			Unit
				min	typ	max	min	typ	max	
V_{Oi}	Output voltage initial setting and accuracy	T_C = +25°C, I_O = I_{Onom}, V_I = 53 V		3.28	3.30	3.32	1.79	1.80	1.81	V
	Output adjust range[1]			2.90		3.60	1.60		2.00	V
V_O	Output voltage tolerance band	Long term drift included	I_O=0.01…1.0 × $I_{O\,nom}$	3.24		3.36	1.76		1.84	V
	Idling voltage	I_O = 0 A		3.23		3.37	1.75		1.85	V
	Line regulation	I_O = I_{Onom}	V_I = 36…75 V		2	15		2	15	mV
	Load regulation	I_{O2} = I_{O2nom}, V_I = 53 V I_{O1} = 0.01…1.0 × I_{O1nom}			10	25		10	25	mV
		I_{O1} = I_{O1nom}, V_I = 53 V I_{O2} = 0.01…1.0 × I_{O2nom}			10	25		10	25	mV
t_{tr}	Load transient recovery time	I_O=0.01…1.0 × I_{Onom}, V_I = 53 V load step = 0.5× I_{Onom}			100			50		µs
V_{tr}	Load transient voltage				+330			+200		mV
					–330			–200		mV
t_r	Ramp-up time	I_O = I_{Onom}	V_O = 0.1…0.9 × V_O		15	45		5	20	ms
t_s	Start-up time	I_O= 0.1…1.0 × I_{Onom} V_I = 53 V	From V_I connection to V_O = 0.9 × V_{Oi}		20	60		15	35	ms
I_O	Output current			0		15	0		8	A
$P_{O\,max}$	Max output power[2]	Calculated value		min 50 - 0.325× I_O2						W
I_{lim}	Current limiting threshold[1]	T_C < $T_{C\,max}$		min 1.05 × $P_O$max						
I_{sc}	Short circuit current	T_C = +25°C, short circuit resistance max 20 mΩ				25			15	A
$V_{O\,ac}$	Output ripple	I_O=I_{Onom}	20 Hz…5 MHz		100	150		40	80	mV_{p-p}
SVR	Supply voltage rejection (ac)	f = 100 Hz sine wave, 1 V_{p-p}, V_I = 53 V (SVR = 20 log (1 V_{p-p}/V_{Op-p}))		60			70			dB
OVP	Over voltage protection	V_I = 53 V		3.9	4.1	4.4				V
							4.0	7.5	16.0	%

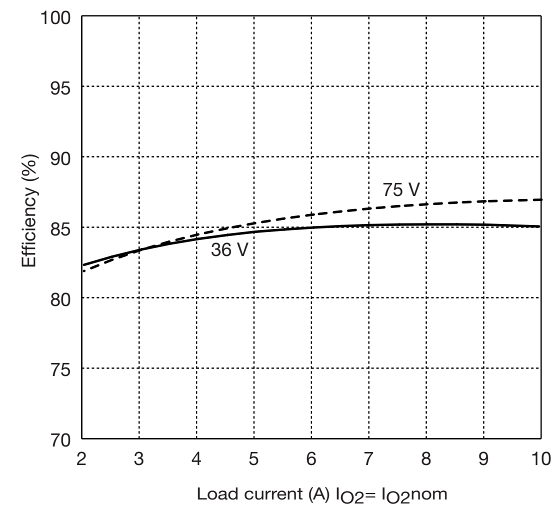
1) See Operating information, Dual output.
2) See also Typical Characteristics, Power derating.

Miscellaneous

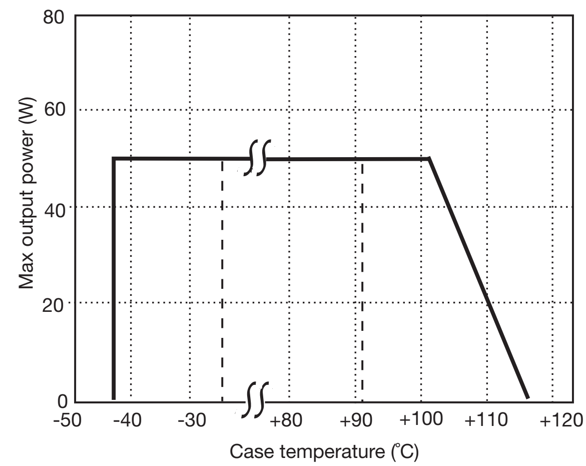
	Characteristics	Conditions	min	typ	max	Unit
η	Efficiency	I_O= I_{Onom}, V_I = 53 V	84	88		%
P_d	Power dissipation	I_O= I_{Onom}, V_I = 53 V			9.0	W

PKN 4520 BPI Typical Characteristics

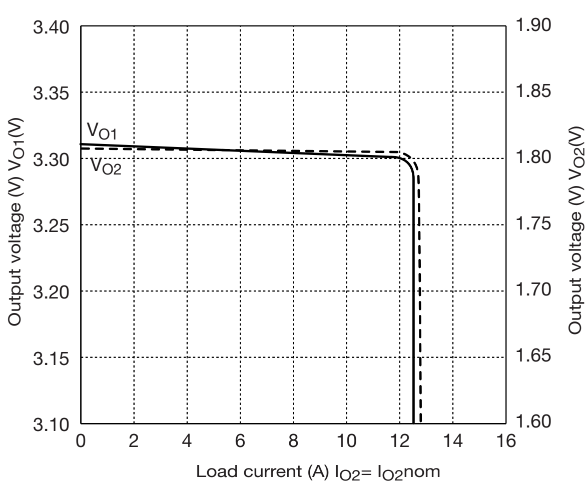
Efficiency (typ)



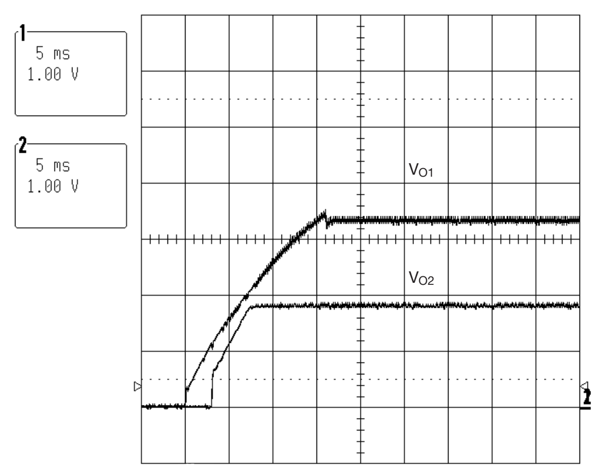
Power Derating



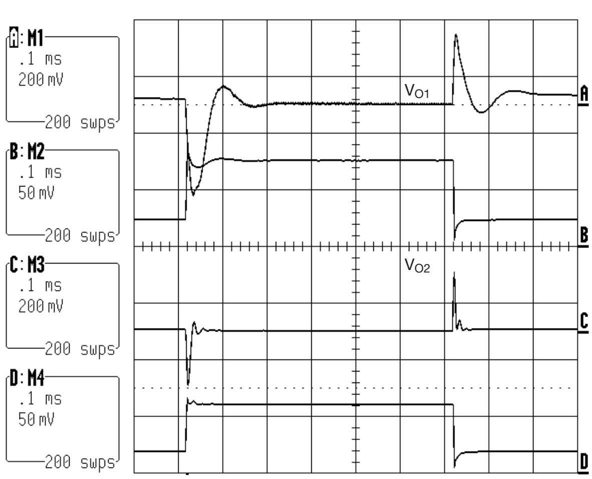
Output Characteristic (typ)



Start up (typ)



Dynamic load response (typ)



Dynamic load response (typ)

A, C. The output voltage deviation is determined by the load transient (dI/dt)

B, D. Load change: $0.25 \times I_{Onom} \ldots 0.75 \times I_{Onom} \ldots 0.25 \times I_{Onom}$, $dI/dt \approx 5A/\mu s$

PKN 4520 BPIOA Output

T_C = –25…+90°C, V_I = 36...75 V unless otherwise specified. $I_{O1\ nom}$ = 10 A, $I_{O2\ nom}$ = 8 A.

	Characteristics	Conditions		Output 1			Output 2			Unit
				min	typ	max	min	typ	max	
V_{Oi}	Output voltage initial setting and accuracy	T_C = +25°C, $I_O = I_{Onom}$, V_I = 53 V		3.28	3.30	3.32	1.49	1.50	1.51	V
	Output adjust range1)			2.90		3.60	1.35		1.65	V
V_O	Output voltage tolerance band	Long term drift included	I_O=0.01…1.0 × $I_{O nom}$	3.24		3.36	1.45		1.55	V
	Idling voltage	I_O = 0 A		3.23		3.37	1.46		1.54	V
	Line regulation	$I_O = I_{Onom}$	V_I = 36…75 V		2	15		2	15	mV
	Load regulation	$I_{O2} = I_{O2nom}$, V_I = 53 V I_{O1} = 0.01…1.0 × I_{O1nom}			10	25		10	25	mV
		$I_{O1} = I_{O1nom}$, V_I = 53 V I_{O2} = 0.01…1.0 × I_{O2nom}			10	25		10	25	mV
t_{tr}	Load transient recovery time	I_O=0.01…1.0 × I_{Onom}, V_I = 53 V load step = 0.5× I_{Onom}				120			80	µs
V_{tr}	Load transient voltage				+300			+200		mV
					–300			–200		mV
t_r	Ramp-up time	$I_O = I_{Onom}$	V_O = 0.1…0.9 × V_O		15	45		5	20	ms
t_s	Start-up time	I_O= 0.1…1.0 × I_{Onom} V_I = 53 V	From V_I connection to V_O = 0.9 × V_{Oi}		20	60		15	35	ms
I_O	Output current			0		15	0		8	A
P_{Omax}	Max output power2)	Calculated value		min 50 - 0.625× I_{O2}						W
I_{lim}	Current limiting threshold1)	$T_C < T_{C\ max}$		min 1.05 × $P_O$max						
I_{sc}	Short circuit current	T_C = +25°C, short circuit resistance max 20 mΩ				25			15	A
V_{Oac}	Output ripple	$I_O = I_{Onom}$	20 Hz…5 MHz		100	150		40	80	mV_{p-p}
SVR	Supply voltage rejection (ac)	f = 100 Hz sine wave, 1 V_{p-p}, V_I = 53 V (SVR = 20 log (1 V_{p-p}/V_{Op-p}))		60			70			dB
OVP	Over voltage protection	V_I = 53 V		3.9	4.1	4.4				V
							4.0	7.5	16.0	%

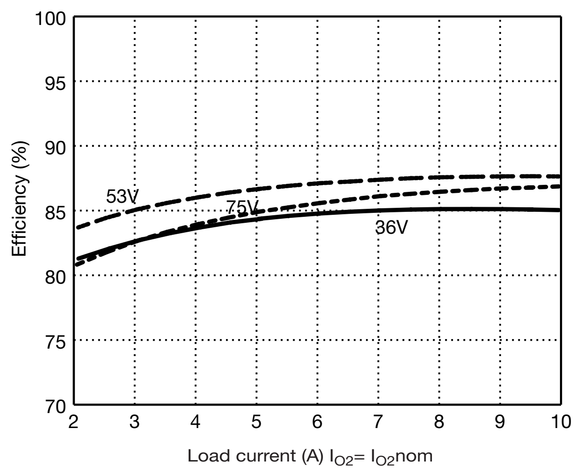
1) See Operating information, Dual output.
2) See also Typical Characteristics, Power derating.

Miscellaneous

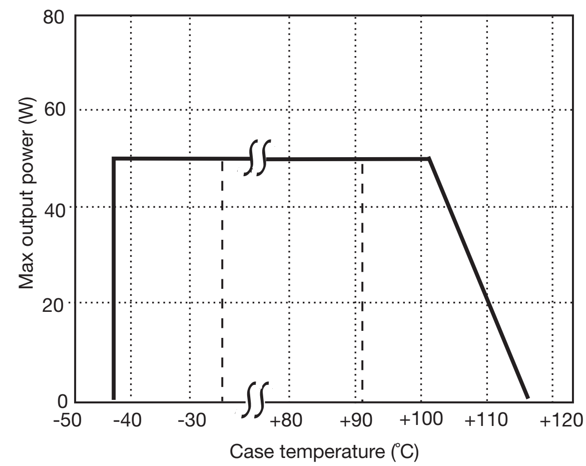
	Characteristics	Conditions	min	typ	max	Unit
η	Efficiency	$I_O = I_{Onom}$, V_I = 53 V	84	87		%
P_d	Power dissipation	$I_O = I_{Onom}$, V_I = 53 V			8.6	W

PKN 4520 BPI Typical Characteristics

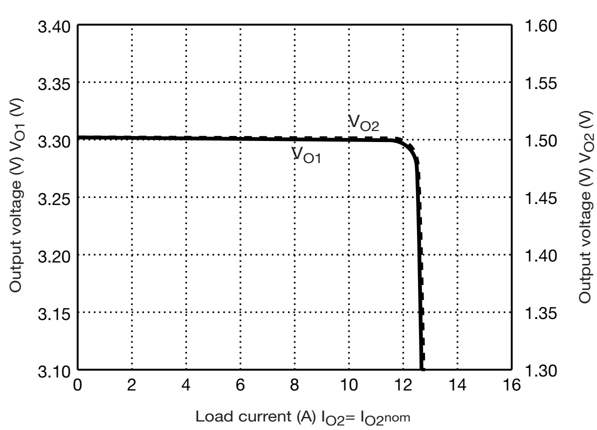
Efficiency (typ)



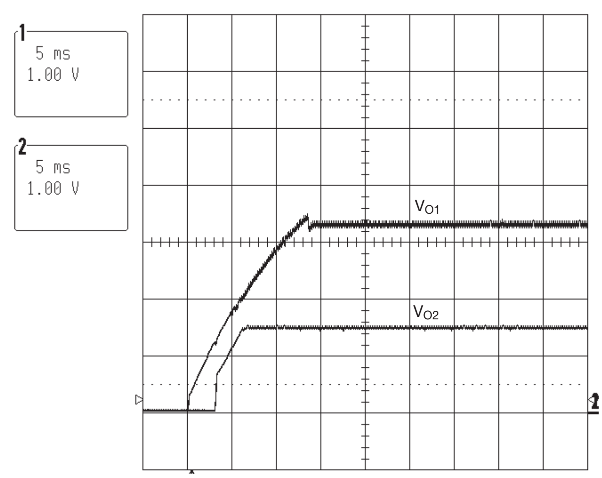
Power Derating



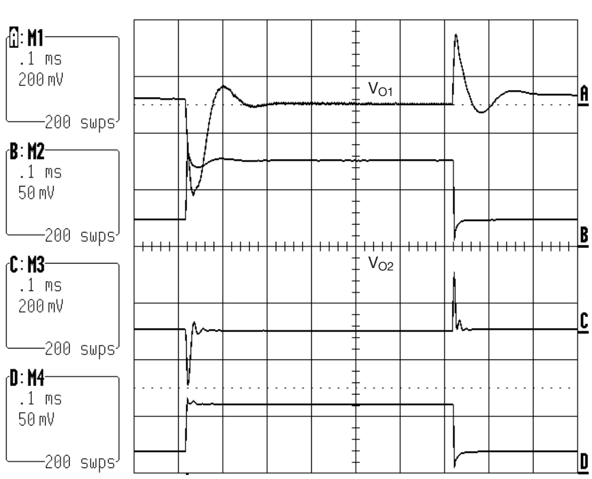
Output Characteristic (typ)



Start up (typ)



Dynamic load response (typ)



Dynamic load response (typ)

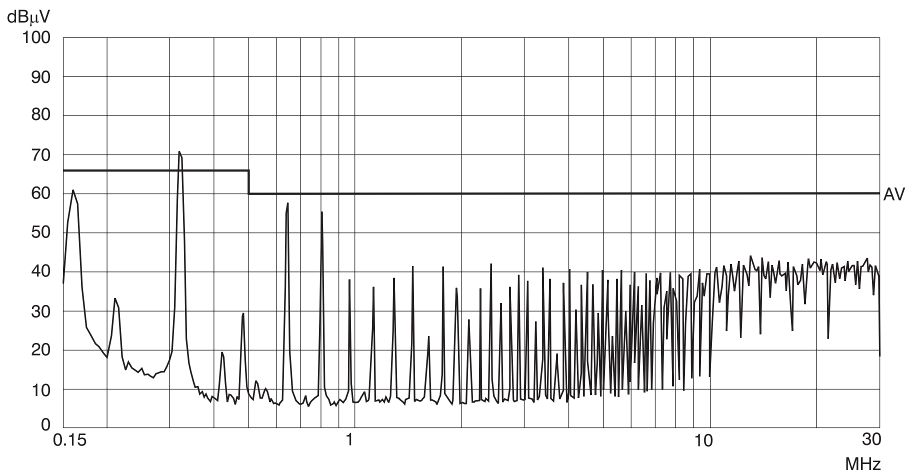
A, C. The output voltage deviation is determined by the load transient (dI/dt)

B, D. Load change: $0.25 \times I_{Onom} \ldots 0.75 \times I_{Onom} \ldots 0.25 \times I_{Onom}$, $dI/dt \approx 5A/\mu s$

EMC Specification

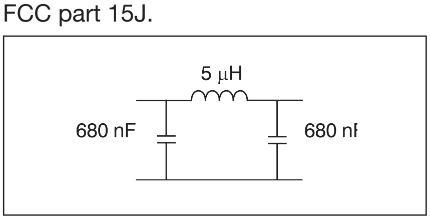
The conducted EMI measurement was performed using a module placed directly on the test bench.
The fundamental switching frequency for PKN single output is 160 kHz ±5% at V_I = 53 V, I_O = (0.1...1.0) × $I_{O\ max}$. For PKN dual it is 160 kHz ±5% on output 1 and 320 kHz ±5% on output 2.

Conducted EMI PKN 4510 PI Input terminal value (typ)

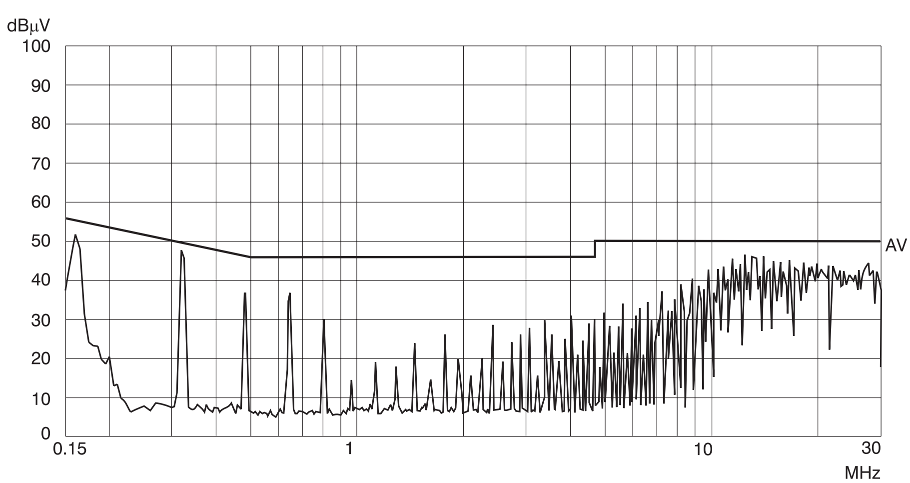


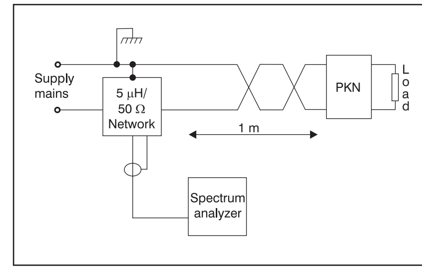
External Filter (class B)

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



The capacitors are of ceramic type. The low ESR is critical for the result.





Test Set-up according to CISPR publ. 1A.

Radiated EMS
(Electro-Magnetic Fields)

Radiated EMS is measured according to test methods in EN/IEC Standard 61000-4-3. No deviation outside the V_O tolerance band will occur under the following conditions:

Frequency range	Voltage level
0.08...1,000 MHz	3 V_{rms}/m

EFT

Electrical Fast Transients on the input terminals may cause output deviations outside what is tolerated by the electronic circuits, i.e. ±5%.
The PKN power module can withstand EFT levels of 0.5 kV keeping V_O within the tolerance band and 2.0 kV without destruction. Tested according to EN/IEC Standard 61000-4-4.

Output Ripple & Noise ($V_O$ac)

Output ripple is measured as the peak to peak voltage of the fundamental switching frequency.

Operating Information

Turn-off Input Voltage

The PKN power module monitors 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 1V where the turn on input voltage is the highest.

Maximum Capacitive Load

The PKN series of converters has no limitation of maximum connected capacitance on the output. Capacitance on the output will affect the ramp-up and the start-up time.

Parallel Operation

PKN can be paralleled for redundancy if external o-ring diodes are used in series with the outputs. It is not recomended to parallel PKN for increased power.

Thermal Data

The PKN DC/DC power module can deliver full power up to +80°C ambient at 1 m/s airflow.

Input and Output Impedance

Both the source impedance of the power feeding and the load impedance will interact with the impedance of the DC/DC power module.
It is most important to have the ratio between L and C as low as possible, i.e. a low characteristic impedance, both at the input and output, as the power modules have a low energy storage capability.
Use an electrolytic capacitor across the input if the source or load inductance is larger than 10 uH. Their equivalent series resistance together with the capacitance acts as a lossless damping filter. Suitable capacitor values are in the range 10–100 µF.

Output Voltage Adjust (V_{adj})

The two outputs can be independently adjusted.
To decrease the voltage on output 1 the resistor should be connected between pin 17 and pin 15–16 (+Out 1). To increase the voltage on output 1 the resistor should be connected between pin 17 and pin 12–14 (Rtn). A 0.1 MΩ resistor will change Vout1 approximately 7%. To decrease the voltage on output 2 the resistor should be connected between pin 9 and pin 10–11
(+Out 2). To increase the voltage on output 2 the resistor should be connected between pin 9 and pin 12–14 (Rtn). A 0.1 MΩ resistor will change Vout2 approximately 5%.

Alarm and control functions

Remote Control (RC)

Turns off the converter when the remote control pin (RC) is connected to the negative input. The converter will stop immediately. To ensure safe turn-off the voltage difference between negative input pin (– In) and the RC pin shall be less than 0.6 V. The converter will restart when the RC pin is released. Normal
is achieved if the RC pin is open (NC).

Local On/Off (LO)

Turns off the converter when the local off pin (LO) is connected to the positive input. The converter will stop immediately. To ensure safe turn-off the voltage difference between positive input pin (+In) and the remote off pin (LO) shall be less than 1.0 V. LO is TTL open collector compatible. The converter will restart when the LO pin is released. Normal operation is achieved if the LO pin is open (NC) or connected to the –In pin. If the LO pin is not used it is recommended to connect it to –In.

Over Voltage Protection (OVP)

Output 1: The over voltage protection function will detect an over voltage on the output and immediately turn off the converter (both output 1 and 2). The OVP is input voltage dependent and has its highest level at approximately V_I = 47.5 V, below that input voltage the output voltage is limited by the maximum duty cycle of the converter. Using the local on/off pin (LO) starts the converter again. The remote control pin (RC) can also be used but the voltage difference between –In pin and the RC pin shall be less than 0.08 V.
Output 2: The over voltage protection function will detect an over voltage on the output and limit the power conversion to output 2.

Over Temperature Protection (OTP)

The PKN DC/DC power modules are protected from thermal over load by an internal over temperature shutdown circuit. When the case temperature exceeds +130°C ±15°C the converter will automatically shut down. If the temperature returns to a normal level normal operation automatically resumes.

Current Limit Protection

Output 1: The total output power is limited by the current limit on output 1.
Output 2: Foldback current limiting when the current exceeds the output 2 current limiting threshold.

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