6.6–10 W DC/DC Power Modules
48 V Input Series

- *SMD and through-hole versions with ultra low component height <8.5 mm (0.335 in.)*
- *83% efficiency (typ at 5V)*
- *1,500 Vdc isolation voltage*
- *Switching frequency syncronization*
- *MTBF >4.9 million hours at +55°C case temperature (+40°C ambient)*
- *Low EMI measured according to CISPR 22 and FCC part 15J*

Patents
US: D357901 DE: M94022763

The MacroDens™ 10W PKF 4000A I series true component level on-board DC/DC power modules are intended as distributed power sources in decentralized –48 and –60V DC power systems. Utilization of thick film technology and a high degree of silicon integration has made it possible to achieve a MTBF of more than 4.9 million hours. The high reliability and the very low height of these DC/DC power modules makes them particularly suited for Information Technology and Telecom (IT&T) applications, with board spacing down to 15 mm or 0.6 in.
The over-moulded rugged design also makes them suitable for other demanding industrial applications.

They are optimized for free convection cooling and have an operational ambient temperature range in compliance with present and future application needs, including non temperature controlled environments. The mechanical design offers the choice of surface mount or through-hole versions, delivered in ready-to-use tubes,trays or tape & reel package, and compatibility with semi and fully aqueous cleaning processes. The PKF series is manufactured in highly automated production lines using SMT, laser trimming, 100% burn-in and ATE final inspection.
Since 1991, Ericsson Components AB is an ISO 9001 certified supplier.

ERICSSON

General

Absolute Maximum Ratings

Characteristics		min	max	Unit
T_C	Case temperature at full output power	–45	+100	°C
T_S	Storage temperature	–55	+125	°C
V_I	Continuous input voltage[1)]	–0.5	+75	V dc
V_{ISO}	Isolation voltage (input to output test voltage)	1,500		V dc
V_{tr}	Transient input energy		0.01	Ws
V_{RC}	Remote control voltage pin 10, 11 ref. to pin 17	–5	+16	V dc
V_{adj}	Output adjust voltage pin 8, 9 ref. to pin 17	–5	+40	V dc

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 of Output data or Electrical Characteristics. If exposed to stress above these limits, function and performance may degrade in an unspecified manner.

Input $T_C < T_{Cmax}$ unless otherwise specified

Characteristics		Conditions	min	typ	max	Unit
V_I	Input voltage range[1)2)]		38		72	V
V_{Ioff}	Turn-off input voltage	See typical characteristics	30.0	34.5	36.0	V
V_{Ion}	Turn-on input voltage	See typical characteristics		36.5	38.0	V
C_I	Input capacitance			1.4		µF
P_{Ii}	Input idling power	I_O=0, T_C=–30…+95°C	(V_I=53V) (V_I=66V)		310 310	mW
P_{RC}	Input stand-by power	T_C=–30…+95°C, RC connected to pin 17	(V_I=53V) (V_I=66V)	30 45		mW

1) The input voltage range 38…72 V dc meets the European Telecom Standard prETS 300 132-2 Nominal input voltage range in 48 V and 60 V dc power systems, –40.5…–57.0 V and –50.0…–72.0 V respectively. At input voltages exceeding 72 V (abnormal voltage) the power loss will be higher than at normal input voltage and T_C must be limited to max +95 °C. Absolute max continuous input voltage is 75 V dc. Output characteristics will be marginally affected at input voltages exceeding 72 V.

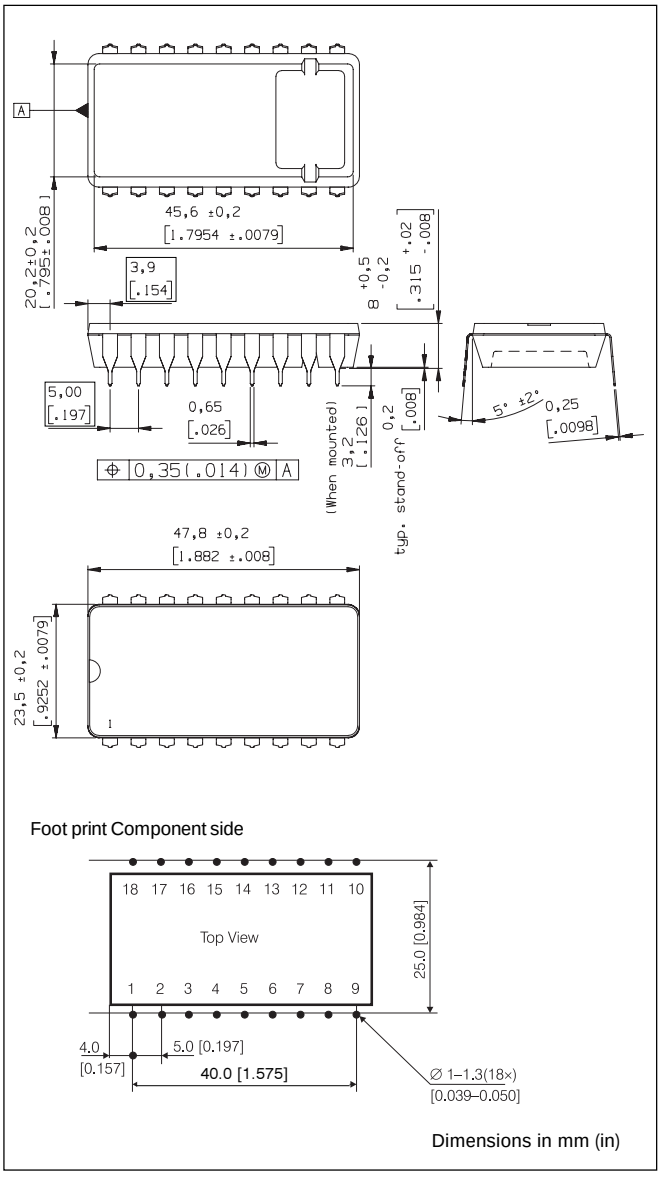
2) The power modules will operate down to ≤36 V, when V_I decreases, but will turn on at V_I ≤38 V, when V_I increases (see also Operating information).

Environmental Characteristics

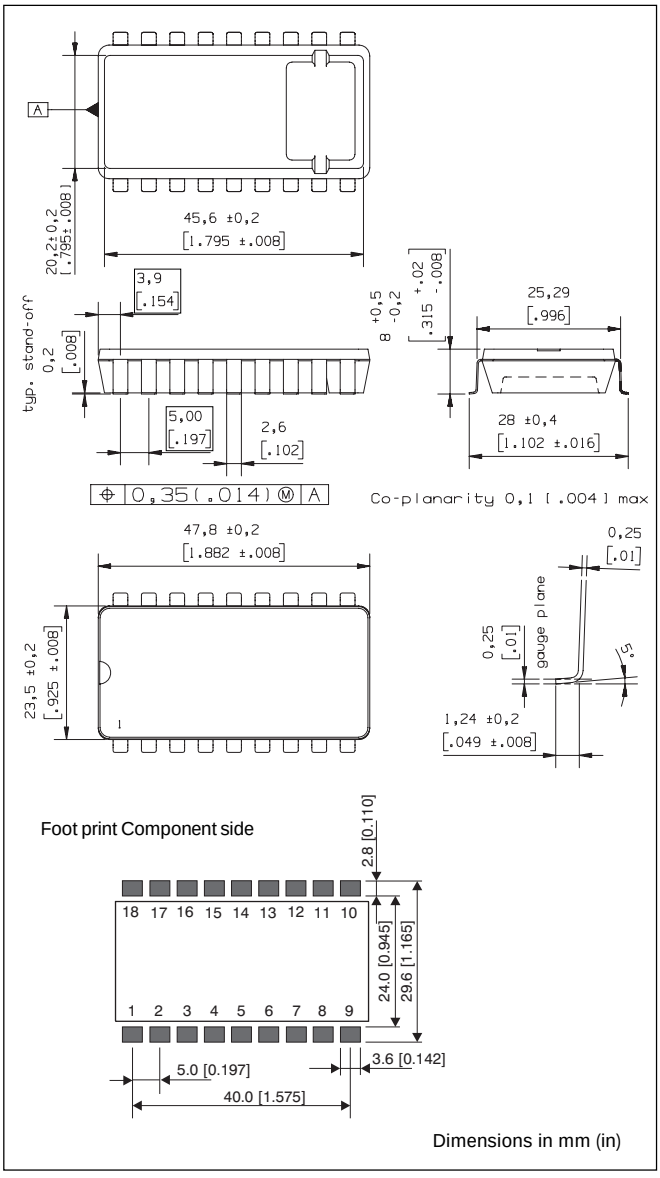
Characteristics	Test procedure & conditions		
Vibration (Sinusoidal)	IEC 68-2-6 F_c	Frequency Amplitude Acceleration Number of cycles	10…500 Hz 0.75 mm 10 g 10 in each axis
Random vibration	IEC 68-2-34 E_d	Frequency Acceleration density spectrum Duration Reproducability	10…500 Hz 0.5 g^2/Hz 10 min in 3 directions medium (IEC 62-2-36)
Shock (Half sinus)	IEC 68-2-27 E_a	Peak acceleration Shock duration	200 g 3 ms
Temperature change	IEC 68-2-14 N_a	Temperature Number of cycles	–40°C…+125°C 500
Damp heat	IEC 68-2-3 C_a	Temperature Duration	40°C 56 days
Accelerated damp heat	IEC 68-2-3 C_a with bias	Temperature Humidity Duration	85°C 85% RH 1000 hours
Solder resistability	IEC 68-2-20 T_b 1A	Temperature, solder Duration	260°C 10…13 s
Aggressive environment	IEC 68-2-11 K_a	Duration Temperature Concentration	96 h 35°C 5 %
	IEC 68-2-42 K_c	Duration Temperature Humidity Concentration	504 h 25°C 75% RH 25 ppm
	IEC 68-2-43 K_d	Duration Temperature Humidity Concentration	96 h 25°C 75% RH 12 ppm

Mechanical Data

Through-hole version



Surface-mount version



Connections

Pin	Designation	Function
1	Out 1	Output 1. Positive voltage ref. to Rtn.
2	Rtn	Output return.
3–6	NC	Not connected. Galvanically isolated from other pins.
7	Sync	Synchronization input.
8	V_{adj}	Output voltage adjust. To set typical output voltage (V_{Oi}) connect pin 8 to pin 9.
9	NOR	Connection of Nominal Output voltage Resistor. (See Operating Information, Output Voltage Adjust).
10	TOA	Turn-on/off input voltage adjust (V_{Ion}/V_{Ioff}). Used to decrease the turn-on/off input voltage threshold.
11	RC	Remote control and turn-on/off input voltage adjust. Used to turn-on and turn-off output and to set the turn-on/off input voltage threshold.
12–16	NC	Not connected. Galvanically isolated from other pins.
17	– In	Negative input.
18	+ In	Positive input.

Weight

Maximum 20 g (0.71 oz).

Case

The case consists of semiconductor grade epoxy with embedded pins.

Coefficient of thermal expansion (CTE) is typ. 15 ppm/°C.

Connection Pins

Base material is copper (Cu), first plating is nickel (Ni) and second (outer) plating is palladium (Pd).

Thermal Data

Two-parametermodel

These data gives a more precise description of the thermal characteristics to be used for thermal calculations.

Thermally the power module can be considered as a component and the case temperature can be used to characterize the properties. The thermal data for a power module with the substrate in contact with the case can be described with two thermal resistances. One from case to ambient air and one from case to PB (Printed circuit Board).

The thermal characteristics temperature can be calculated from the following formula:

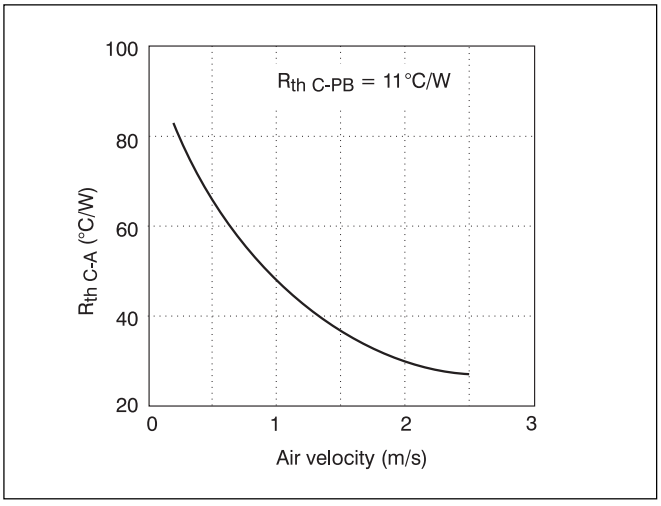
$T_{PB} = (T_C - T_A) \times (R_{th\ C-PB} + R_{th\ C-A}) / R_{th\ C-A} - P_d \times R_{th\ C-PB} + T_A$

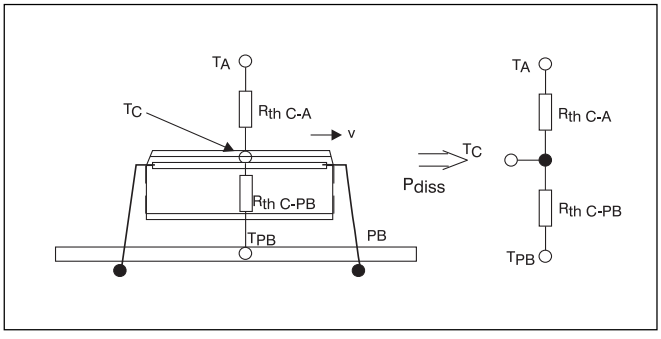
Where:

P_d:	dissipated power, calculated as $P_O \times (l/\eta - 1)$
T_C:	max average case temperature
T_A:	ambient air temperature at the lower side of the power module
T_{PB}:	temperature in the PB between the PKF connection pins
$R_{th\ C-PB}$:	thermal resistance from case to PB under the power module
$R_{th\ C-A}$:	thermal resistance from case to ambient air
v:	velocity of ambient air

$R_{th\ C-PB}$ is constant and $R_{th\ C-A}$ is dependent on the air velocity.

Free convection is equal to an air velocity of approx. 0.2 – 0.3 m/s. See figure below.





Reflow Soldering Information

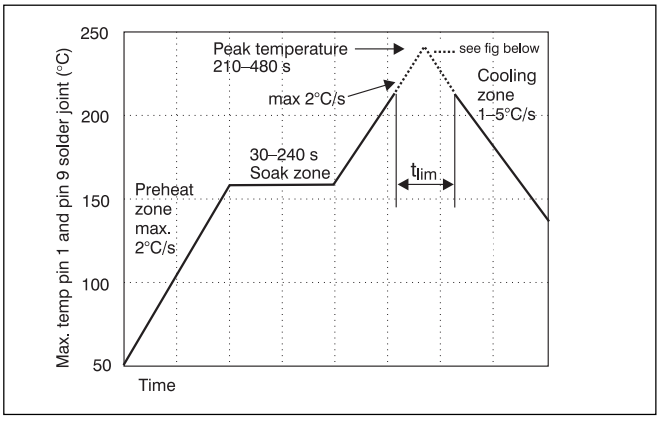
The PKF series of DC/DC power modules are manufactured in surface mount technology. Extra precautions must therefore be taken when reflow soldering the surface mount version. Neglecting the soldering information given below may result in permanent damage or significant degradation of power module performance.

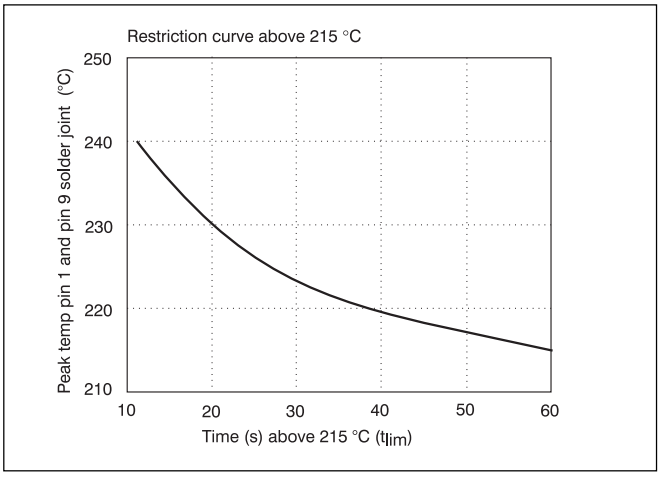
The PKF series can be reflow soldered using IR, Natural Convection, Forced Convection or Combined IR/Convection Technologies. The high thermal mass of the component and its effect on ΔT (°C) means particular attention should be paid to other temperature sensitive components.

IR Reflow technology may require the overall profile time to be extended to approximately 8–10 minutes to ensure an acceptable ΔT. Higher activity flux may be more suitable to overcome the increase in oxidation and to avoid flux burn-up.

The general profile parameters detailed in the diagram, with this extended time to reach peak temperatures, would then be suitable.

Note! These are maximum parameters. Depending on process variations, an appropriate margin must be added.





Palladium plating is used on the terminal pins. A pin temperature (T_p) in excess of the solder fusing temperature (+183°C for Sn/Pb 63/37) for more than 25 seconds and a peak temperature above 195°C, is required to guarantee a reliable solder joint.

Both pin 1 and pin 9 have to be checked.

No responsibility is assumed if these recommendations are not strictly followed.

Preliminary Data Sheet EN/LZT 137 30 R4 ©Ericsson Components AB, April 1999

Safety

The PKF 4000A I series DC/DC power modules are designed in accordance with EN 60 950, *Safety of information technology equipment including electrical business equipment*. SEMKO certificate no. 9814213.

The PKF power modules are recognized by UL and meet the applicable requirements in UL 1950 *Safety of information technology equipment*, the applicable Canadian safety requirements and UL 1012 *Standard for power supplies*.

The DC/DC power module shall be installed in an end-use equipment and considerations should be given to measuring the case temperature to comply with $T_{C max}$ when in operation. Abnormal component tests are conducted with the input protected by an external 15 A fuse. The need for repeating these tests in the end-use appliance shall be considered if installed in a circuit having higher rated devices.

When the supply to the DC/DC power module meets all the requirements for SELV (<60 V dc), the output is considered to remain within SELV limits (level 3). The isolation is an operational insulation in accordance with EN 60 950.

The DC/DC power module is intended to be supplied by isolated secondary circuitry and shall be installed in compliance with the requirements of the ultimate application. If they are connected to a 60 V DC system reinforced insulation must be provided in the power supply that isolates the input from the mains. Single fault testing in the power supply must be performed in combination with the DC/DC power module to demonstrate that the output meets the requirement for SELV. One pole of the input and one pole of the output is to be grounded or both are to be kept floating.

The terminal pins are only intended for connection to mating connectors of internal wiring inside the end-use equipment.

These DC/DC power modules may be used in telephone equipment in accordance with paragraph 34 A.1 of UL 1459 (Standard for Telephone Equipment, second edition).

The galvanic isolation is verified in an electric strength test. Test voltage (V_{ISO}) between input and output is 1,500 V dc for 60 s. In production the test duration may be decreased to 1 s.

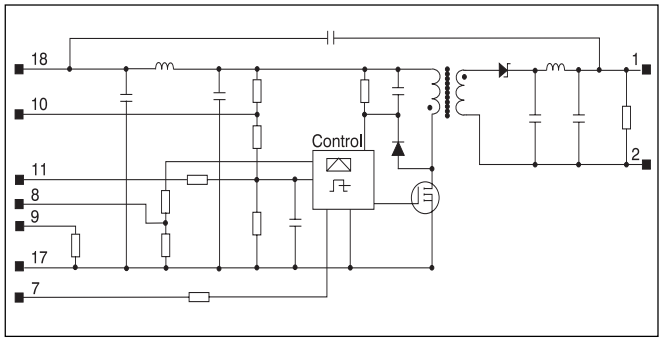
The capacitor between input and output has a value of 1 nF and the leakage current is less than 1µA @ 53 V dc.

The case is designed in non-conductive epoxy. Its flammability rating meets UL 94V-0. The oxygen index is 34%.

Electrical Data

Fundamental circuit diagram

Single output



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T_C = –30…+95°C, V_I = 38 ...72V and pin 8 connected to pin 9.

Output

Characteristics		Conditions		Output 1 min	Output 1 typ	Output 1 max	Unit
V_{Oi}	Output voltage initial setting and accuracy	T_C = +25°C, I_O = 1.5 A, V_I = 53V		3.27	3.30	3.33	V
	Output adjust range[1]			1.7		3.8	V
V_O	Output voltage tolerance band	I_O = 0.1…1.0 × I_{Omax} Long term drift included	T_C = 0…+95°C	3.17		3.42	V
			T_C = –30°C	2.90		3.42	V
	Idling voltage	I_O = 0A			3.80	4.15	V
	Line regulation	I_O =I_{Omax}	V_I = 38…60V		20		mV
			V_I = 50…72V		10		
	Load regulation	I_O = 0.1…1.0 × I_{Omax}, V_I = 53V		50		150	mV
t_{tr}	Load transient recovery time	I_O = 0.1…1.0 × I_{Omax}, V_I = 53V load step = 0.5 × I_{Omax}			150		µs
V_{tr}	Load transient voltage				+200		mV
					–200		mV
T_{coeff}	Temperature coefficient[2]	I_O = I_{Omax}, T_C =+40…+90ºC			–0.6		mV/°C
t_r	Ramp-up time	I_O = I_{Omax}, 0.1…0.9 ×V_O, V_I = 53 V			2		ms
t_s	Start-up time	I_O = 0.1…1.0 × I_{Omax}, V_I = 53V From V_I connection to V_O = 0.9 ×V_{Oi}			5		ms
I_O	Output current			0		2.0	A
P_{Omax}	Max output power[2]	Calculated value		6.6			W
I_{lim}	Current limiting threshold	T_C<T_{Cmax}, V_O = 3.0V		2.35		2.80	A
I_{sc}	Short circuit current	V_O = 0.2…0.5V, T_C=+25°C			3.0		A
V_{Oac}	Output ripple & noise	I_O = I_{Omax}	20 Hz…5 MHz		20	70	mV_{p-p}
			0.6 …50 MHz			80	dBµV
SVR	Supply voltage rejection (ac)	f = 100 Hz sine wave, 1V_{p-p}, V_I = 53V (SVR = 20 log (1 V_{p-p}/V_{Op-p}))			50		dB

[1] See also Operating Information.
[2] See Typical Characteristics.

Miscellaneous

Characteristics		Conditions		min	typ	max	Unit
η	Efficiency	I_O = I_{Omax}	V_I = 53V	75	78		%
			V_I = 66V	75	78		
P_d	Power dissipation		V_I = 53V			2.2	W
			V_I = 66V			2.2	

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T_C = –30…+95°C, V_I = 38 ...72V and pin 8 connected to pin 9.

Output

Characteristics		Conditions		Output 1 min	Output 1 typ	Output 1 max	Unit
V_{Oi}	Output voltage initial setting and accuracy	T_C = +25°C, I_O = 2.0 A, V_I = 53V		3.27	3.30	3.33	V
	Output adjust range[1]			1.75		4.08	V
V_O	Output voltage tolerance band	Long term drift included	I_O = 0.1…1.0 × I_{Omax}	3.17		3.43	V
	Idling voltage	I_O = 0A			3.7	4.0	V
	Line regulation	I_O =I_{Omax}	V_I = 38…60V		45		mV
			V_I = 50…72V		10		
	Load regulation	I_O = 0.1…1.0 × I_{Omax}, V_I = 53V			30	170	mV
t_{tr}	Load transient recovery time	I_O = 0.1…1.0 × I_{Omax}, V_I = 53V load step = 0.5 × I_{Omax}			130		µs
V_{tr}	Load transient voltage				+300		mV
					–300		mV
T_{coeff}	Temperature coefficient[2]	I_O = I_{Omax}, T_C =+40…+90ºC			–1.5		mV/°C
t_r	Ramp-up time	I_O = I_{Omax}, 0.1…0.9 ×V_O, V_I = 53 V			3		ms
t_s	Start-up time	I_O = 0.1…1.0 × I_{Omax}, V_I = 53V From V_I connection to V_O = 0.9 ×V_{Oi}			6		ms
I_O	Output current			0		3.0	A
P_{Omax}	Max output power[2]	Calculated value		9.9			W
I_{lim}	Current limiting threshold	T_C<T_{Cmax}, V_O = 3.0V		3.2	3.4	3.7	A
I_{sc}	Short circuit current	V_O = 0.2…0.5V, T_C=+25°C			4.1		A
V_{Oac}	Output ripple & noise	I_O = I_{Omax}	20 Hz…5 MHz		20	50	mV_{p-p}
			0.6 …50 MHz			80	dBµV
SVR	Supply voltage rejection (ac)	f = 100 Hz sine wave, 1V_{p-p}, V_I = 53V (SVR = 20 log (1 V_{p-p}/V_{Op-p}))			60		dB

[1] See also Operating Information.
[2] See Typical Characteristics.

Miscellaneous

Characteristics		Conditions		min	typ	max	Unit
η	Efficiency	I_O = I_{Omax}	V_I = 53 V	75	78		%
			V_I = 66 V	75	78		
P_d	Power dissipation		V_I = 53 V			3.3	W
			V_I = 66 V			3.3	

T_C = –30…+95°C, V_I = 38 ...72V and pin 8 connected to pin 9.

Output

Characteristics		Conditions		Output 1 min	Output 1 typ	Output 1 max	Unit
V_{Oi}	Output voltage initial setting and accuracy	T_C = +25°C, I_O = 1.5 A, V_I = 53V		5.02	5.05	5.08	V
	Output adjust range[1]			4.30		5.80	V
V_O	Output voltage tolerance band	Long term drift included	I_O = 0.1…1.0 × I_{Omax}	4.85		5.25	V
	Idling voltage	I_O = 0A			5.8	6.0	V
	Line regulation	I_O =I_{Omax}	V_I = 38…60V		20		mV
			V_I = 50…72V		6		
	Load regulation	I_O = 0.1…1.0 × I_{Omax}, V_I = 53V		50	80	180	mV
t_{tr}	Load transient recovery time	I_O = 0.1…1.0 × I_{Omax}, V_I = 53V load step = 0.5 × I_{Omax}			200		µs
V_{tr}	Load transient voltage				+200		mV
					–250		mV
T_{coeff}	Temperature coefficient[2]	I_O = I_{Omax}, T_C =+40…+90ºC			–1.3		mV/°C
t_r	Ramp-up time	I_O = I_{Omax}, 0.1…0.9 ×V_O			2		ms
t_s	Start-up time	I_O = 0.1…1.0 × I_{Omax}, V_I = 53V From V_I connection to V_O = 0.9 ×V_{Oi}			5		ms
I_O	Output current			0		2.0	A
P_{Omax}	Max output power[2]	Calculated value		10			W
I_{lim}	Current limiting threshold	T_C<T_{Cmax}, V_O = 4.0V		2.15		2.60	A
I_{sc}	Short circuit current	V_O = 0.2…0.5V, T_C =+25°C			3.0		A
V_{Oac}	Output ripple & noise	I_O = I_{Omax}	20 Hz…5 MHz		20	50	mV_{p-p}
			0.6 …50 MHz			80	dBµV
SVR	Supply voltage rejection (ac)	f = 100 Hz sine wave, $1V_{p-p}$, V_I = 53V (SVR = 20 log (1 V_{p-p}/V_{Op-p}))			50		dB

[1] See also Operating Information.
[2] See Typical Characteristics.

Miscellaneous

Characteristics		Conditions		min	typ	max	Unit
η	Efficiency	I_O = I_{Omax}	V_I = 53 V	80	83		%
			V_I = 66 V	80	81		
P_d	Power dissipation		V_I = 53 V			2.5	W
			V_I = 66 V			2.5	

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Typical Characteristics

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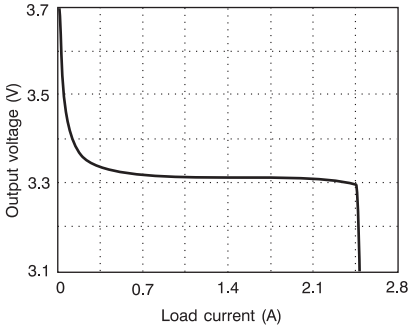
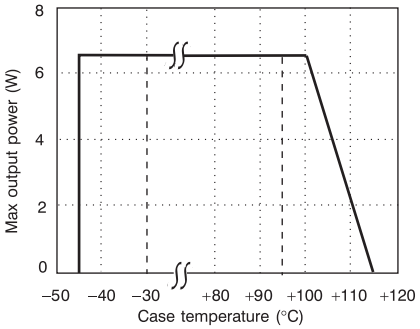
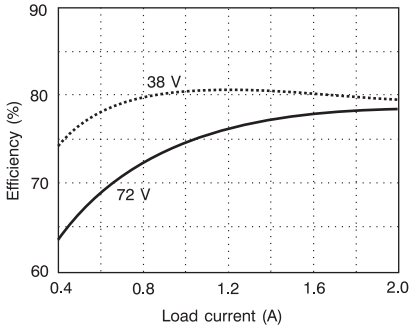
Output characteristic (typ)



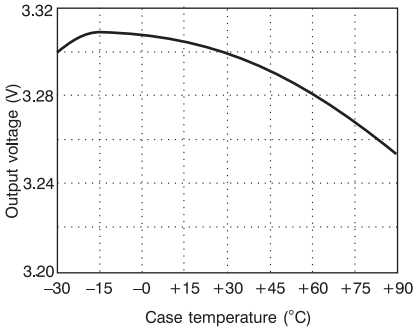
Power derating



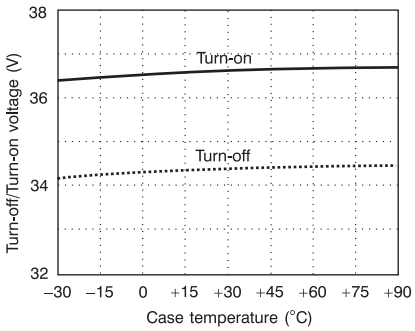
Efficiency (typ) @ T_A = +25°C



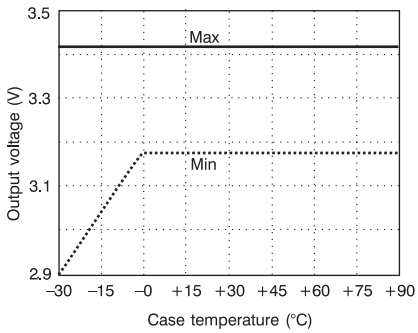
Temperature coefficient



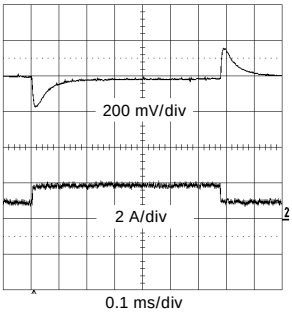
Turn-on/turn-off input voltage



Output voltage band



Dynamic load response (typ) @ +25 °C

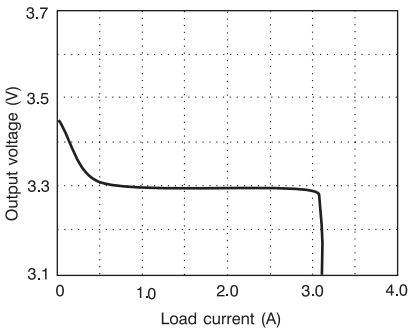


The output voltage deviation is determined by the load transient (dI/dt)

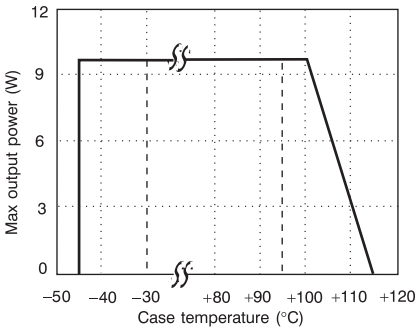
Load change: dI/dt ≈ 4 A/µs

PKF 4910A

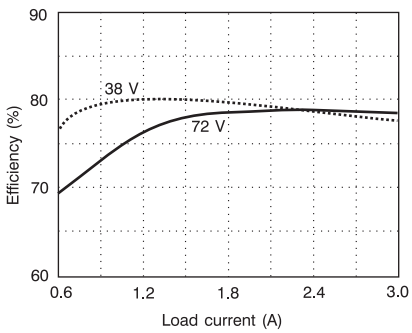
Output characteristic (typ)



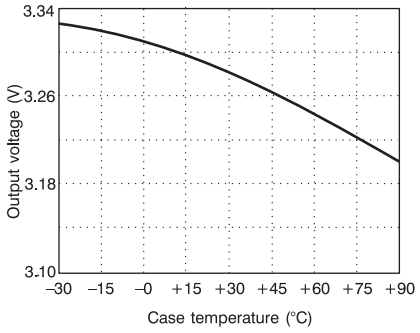
Power derating



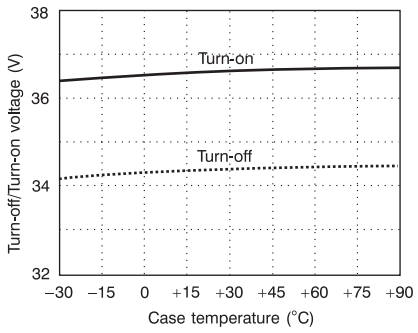
Efficiency (typ) @ T_A = +25°C



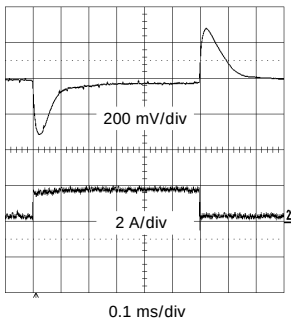
Temperature coefficient



Turn-on/turn-off input voltage



Dynamic load response (typ) @ +25°C

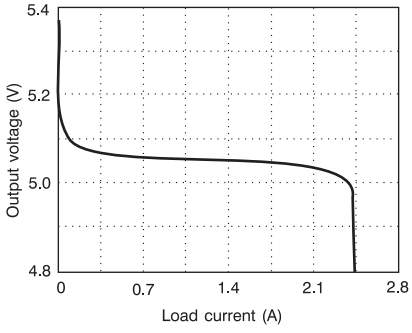


The output voltage deviation is determined by the load transient (dI/dt)

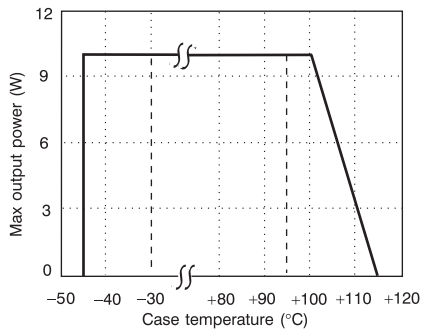
Load change: dI/dt ≈ 4 A/µs

PKF 4111A

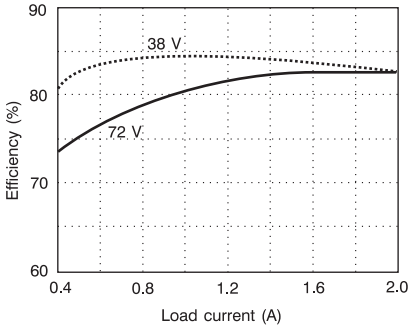
Output characteristic (typ)



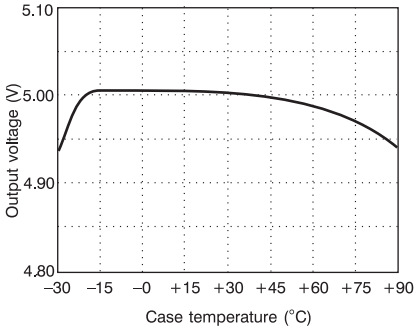
Power derating



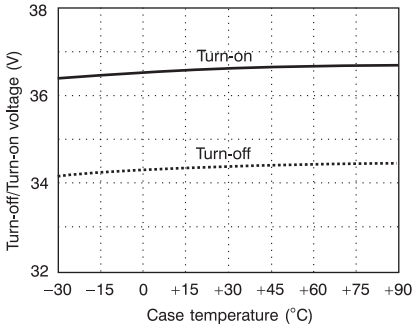
Efficiency (typ) @ T_A = +25°C



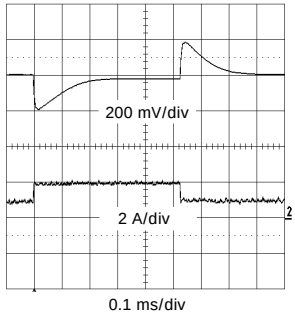
Temperature coefficient



Turn-on/turn-off input voltage



Dynamic load response (typ) @ +25°C



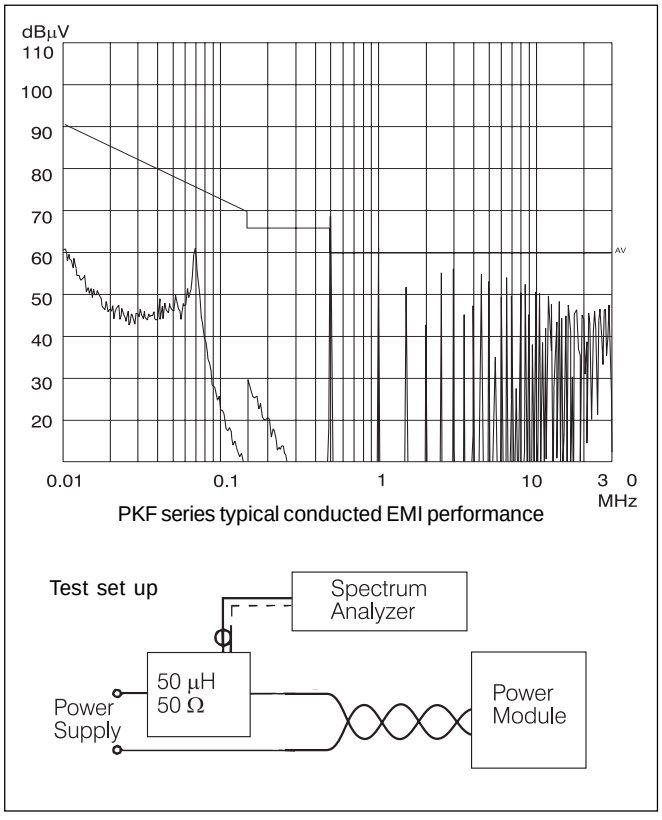
The output voltage deviation is determined by the load transient (dI/dt)

Load change: dI/dt ≈ 4 A/µs

EMC Specifications

The PKF power module is mounted on a double sided Printed circuit Board (PB) with ground plane during EMC measurements.
The fundamental switching frequency is 510 kHz ±5% @
I_O = (0.1…1.0) × I_{Omax}.

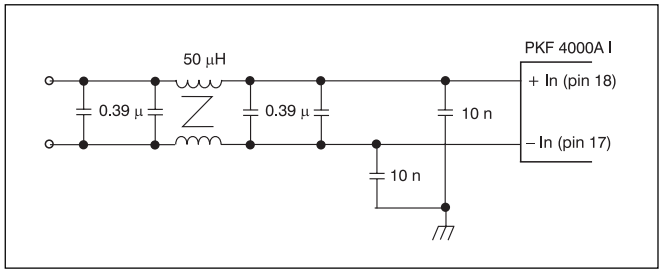
Conducted EMI (input teminals)



PKF series typical conducted EMI performance

External Filter (class B)

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



The low ESR is critical for the result.

Conducted EMS

Electro Magnetic Susceptibility is measured by injection of electrical disturbances on the input terminals. No deviation outside the V_O tolerance band will occur under the following conditions:

Frequency range	Voltage level
0.15...300 MHz	1.0 V_{rms}

The signal is amplitude modulated with 1 kHz/80% and applied in both differential and common mode.

Radiated EMS (Electro-Magnetic Fields)

Radiated EMS is measured according to test methods in IEC Standard publ. 801-3. No deviation outside the V_O tolerance band will occur under the following conditions:

Frequency range	Voltage level
0.01...200 MHz	3 V_{rms}/m
200...1,000 MHz	3 V_{rms}/m
1...12 GHz	10 V_{rms}/m

ESD

Electro Static Discharge is tested according to IEC publ. 801-2. No destruction will occur if the following voltage levels are applied to any of the terminal pins:

Test	Voltage level
Air discharge	±4 kV
Contact discharge	±2 kV

EFT

Electrical Fast Transients on the input terminals could affect the output voltage regulation causing functional errors on the Printed Board Assembly (PBA). The PKF power modules withstand EFT levels of 0.5 kV keeping V_O within the tolerance band and 2.0 kV without destruction. Tested according to IEC publ. 801-4.

Output Ripple & Noise ($V_O$ac)

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

Operating Information

Fuse Considerations

To prevent excessive current from flowing through the input supply line, in the case of a short-circuit across the converter input, and external fuse should be installed in the non-earthed input supply line. We recommend using a fuse rated at approximately 2 to 4 times the value calculated in the formula below:

$$I_{inmax} = \frac{P_{Omax}}{(\eta_{min} \times V_{Imin})}$$

Refer to the fuse manufacturer for further information.

Remote Control (RC)

Turn-on or turn-off can be realized by using the RC-pin. If pin 11 is connected to pin 17 the power modules turns off. Normal operation is achieved if pin 11 is open (NC). To ensure safe turn-off the voltage difference between pin 11 and 17 shall be less than 1.0 V. RC is an TTL open collector compatible output with a sink capacity >300 µA (see fig. 1).

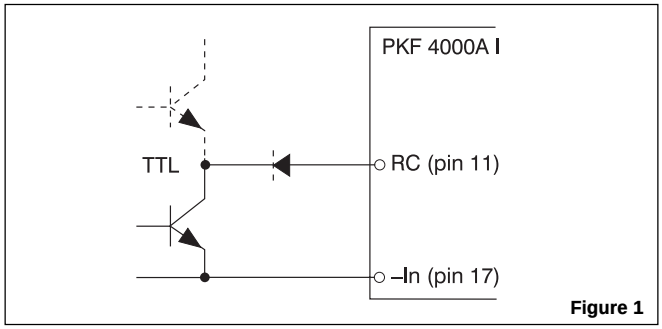


Figure 1

Over Voltage Protection (OVP)

The remote control can also be utilized for OVP by using the external circuitry in figure 2. Resistor values are for 5 V output applications, but can easily be adjusted for other output voltages and the desired OVP level.

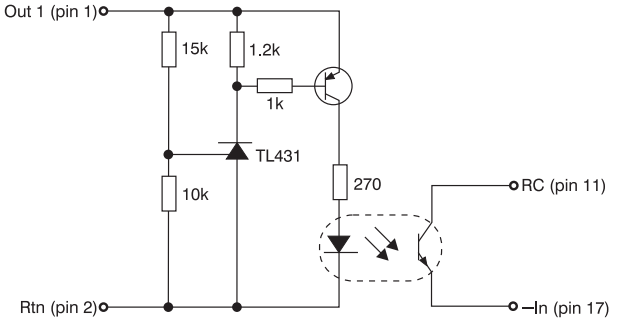


Figure 2

Turn-on/off Input Voltage

The power module monitors the input voltage and will turn on and turn off at predetermined levels set by means of external resistors.

To increase V_{Ion} a resistor should be connected between pin 11 and 17 (see fig. 3).

The resistance is given by the following equation (For V_{Ion}>37 V):

$R_{Ion} = (k_1 - V_{Ion})/(V_{Ion} - k_2)$ kΩ

where k_2 is the typical unadjusted turn-on input voltage (V). V_{Ioff} is the adjusted turn-off input voltage and is determined by $V_{Ion} - V_{Ioff}$ = 2 V (typical value).

To decrease V_{Ion} a resistor should be connected between pin 10 and 11 (see fig. 3). The resistance is given by the following equation (for 34.5 V < V_{Ion} > 36 V:

$R_{Ion} = k_3 \times (V_{Ion} - k_4)/(k_2 - V_{Ion})$ kΩ

k_1	k_2	k_3	k_4	
2780	36.0	49	32.0	PKF 4610A, PKF 4910A
2850	36,5	27	34,5	PKF 4111A*)

*) This formula is valid for PKF 4111A Rev. 2A and above, for prior revision index, please contact the factory.

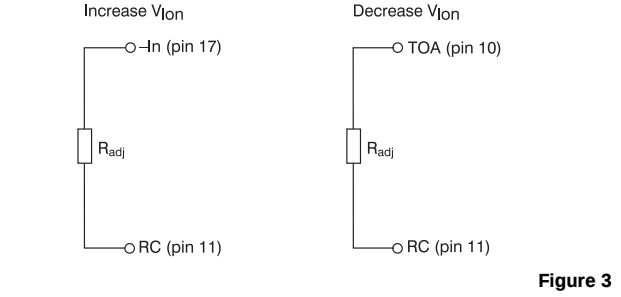


Figure 3

Output Voltage Adjust (V_{adj})

Output voltage, V_O, can be adjusted by using an external resistor or other external circuitry. If other circuitry is used, the slow rate has to be limited to maximum 5 V/ms. If pins 8 and 9 are not connected together the output will decrease to a low value. To increase V_O a resistor should be connected between pin 8/9 and 17, and to decrease V_O a resistor should be connected between pin 8 and 9 (see fig. 4).

Typical required resistor value to increase V_O is given by:

$R_{adj} = k_5 \times (k_6 - V_O)/(V_O - V_{Oi})$ kΩ

where V_O is the desired output voltage,
V_{Oi} is the typical output voltage initial setting

and	k_5=3.18	k_6=3.87	PKF 4610A
	k_5=3.18	k_6=5.85	PKF 4111A
	k_5=4.20	k_6=4.13	PKF 4910A

Typical required resistor value to decrease V_O is given by:

$R_{adj} = k_7 \times (V_{Oi} - V_O)/(V_O - k_8)$ kΩ

where	k_7=17.20	k_8=1.73	PKF 4610A
	k_7=12.50	k_8=4.28	PKF 4111A
	k_7=17.60	k_8=1.75	PKF 4910A

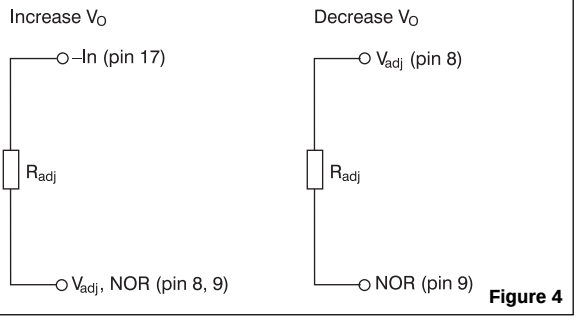


Figure 4

PKF 4910A: The following typical resistor values can be used to adjust the output voltage to 1.8 V or 2.5 V.

Output voltage tolerance band	Rod_{nom} (Ω)	Standard values E24 (Ω)
2.5 V ± 4%	19.4 k	33 k//47 k 1% 200 ppm
1.8 V ± 4%	500 k	1M//1M 1% 200 ppm

PKF 4610A: The following typical resistor values can be used to adjust the output voltage to 1.8 V or 2.5 V. For more information on temperature dependence see fig. 5.

Output voltage tolerance band	Rod_{nom} (Ω)	Standard values E24 (Ω)
2.5 V ± 4%	17.8 k	20 k//160 k 1% 200 ppm
1.8 V ± 4%	360 k	360 k 1% 200 ppm

Max output current vs case temperature for ±4% tolerance band at different output voltages.

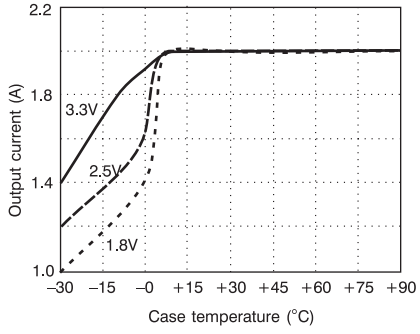


Figure 5

Current Limiting Protection (I_{lim})

The output power is limited at loads above the output current limiting threshold (I_{lim}), specified as a minimum value.

Voltage Margining

For voltage controlled margining e.g. at final test, the following setup can be used. By increasing the control voltage V1 to +10 V the output voltage decreases 5% of V_{Oi}, and by decreasing V1 to –10 V the output voltage increases 5%.

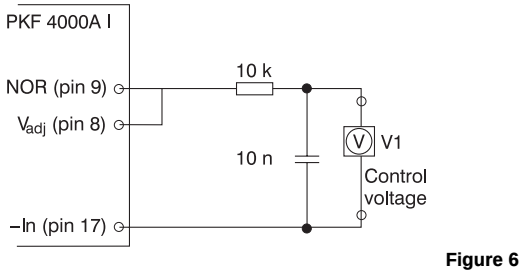


Figure 6

Capacitive Load

The PKF series has no limitation of maximum connected capacitance on the output. The power module may operate in current limiting mode during start-up, affecting the ramp-up and the start-up time. For optimum start performance we recommend a maximum of 100 µF/A of I_O. Connect capacitors at the point of load for best performance.

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 inductance is higher than 10 µH. Their equivalent series resistance together with the capacitance acts as a lossless damping filter. Suitable capacitor values are in the range 10–100 µF.

Synchronization (Sync)

It is possible to synchronize the switching frequency to an external symmetrical clock signal. The input can be driven by an TTL-compatible output and referred to the input pin 17.

Characteristics	min	typ	max	unit
High level	2.2		6.5	V
Threshold level*)	1.2	1.7	2.2	V
Low level	0		0.4	V
Sink current			1.5	mA
Sync. frequency	520		688	kHz

*) Rise time <10ns

Parallel Operation

Paralleling of several converters is easily accomplished by direct connection of the output voltage terminal pins. The load regulation characteristic is specifically designed for optimum paralleling performance. Load sharing between converters will be within ±10%. It is recommended not to exceed $P_O = n \times 0.9 \times P_{Omax}$, where P_{Omax} is the maximum converter output power and n the number of paralleled converters, not to overload any of the converters and thereby decrease the reliability performance.

Precision load regulation for the PKF 4000A series

PKF 4000A I has a load regulation which allows paralleling of the power modules without external control. If there is a need for tighter voltage regulation, the figure below (fig. 7) shows how to obtain a very exact voltage.

The output voltage is divided by two resistors and compared with a reference voltage. Out 1 integrates the voltage difference and the signal is fed back to output adjust by an opto coupler. Please note:

The operational amplifier must be a single supply in order to operate at the actual output voltage if there are no other voltages available. The opto coupler should have a current gain of 25–200%.

The output voltage is: $U_{out} = U_{ref} \times (R2 + R1)/R2$

Other output voltages and reference voltages may be used. R1 and R2 is calculated from formula above. Please keep the values in the same range as in table below.

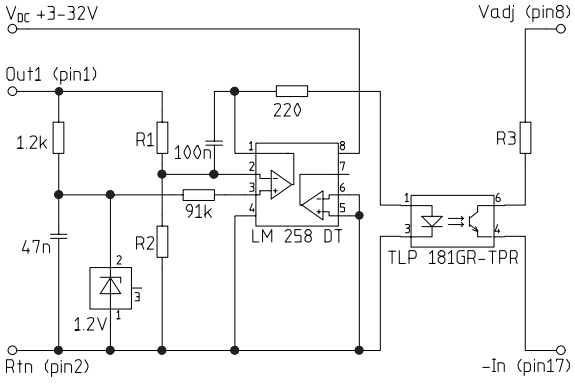


Figure 7

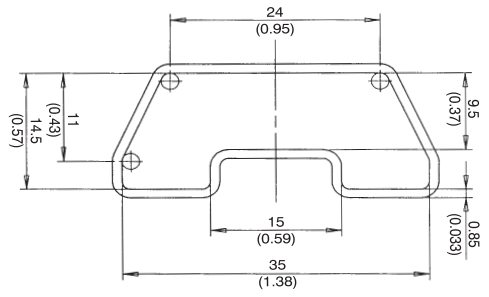
Table for selecting resistor values depending on desired output voltage.

	1.8 V	2.5V	3.3V
R1(Ω)	160 k	200 k	220 k
R2(Ω)	330 k	191 k	130 k
R3(Ω)	21 k	6.8 k	1 k

Delivery Package Information

Tubes

The PKF-series is delivered in tubes (designated by /A) with a length of 500 mm (19.69 in), see fig. 8.



All dimensions in mm (in)

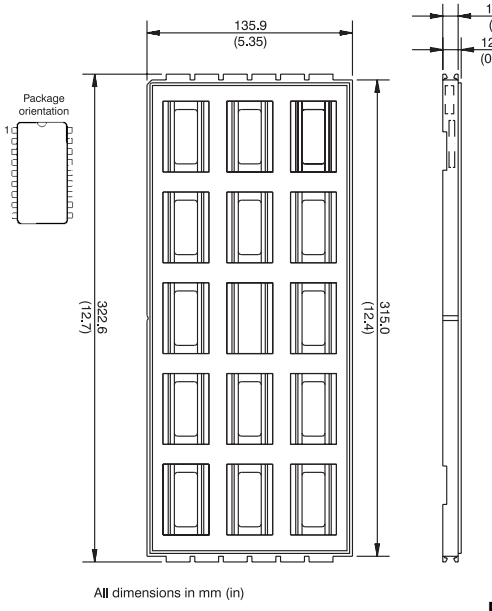
Figure 8

Specification

Material:	Antistatic coated PVC
Max surface resistance:	$10^{11}\Omega/\square$
Color:	Transparent
Capacity:	10 power modules/tube
Weight:	Typ. 60 g
End stops:	Pins

Trays

SMD versions, SI, can be delivered in standard JEDEC trays (designated by /B) on request, see fig. 9. For more information, please contact your local Ericsson sales office.



All dimensions in mm (in)

Figure 9

Specification

Material:	Polypropylene (PP)
Max temperature:	125 ºC
Max surface resistance:	$10^{5}\Omega/\square$
Color:	Black
Capacity:	15 power modules/tray
Stacking pitch:	10.16 mm
Weight:	Typ. 130 g
Min. order quantity:	150 pcs (one box contains 10 full trays)

Tape & Reel

SMD versions, SI, can be delivered in standard tape & reel package (designated by /C) on request, see fig. 10. For more information, please contact your local Ericsson sales office.

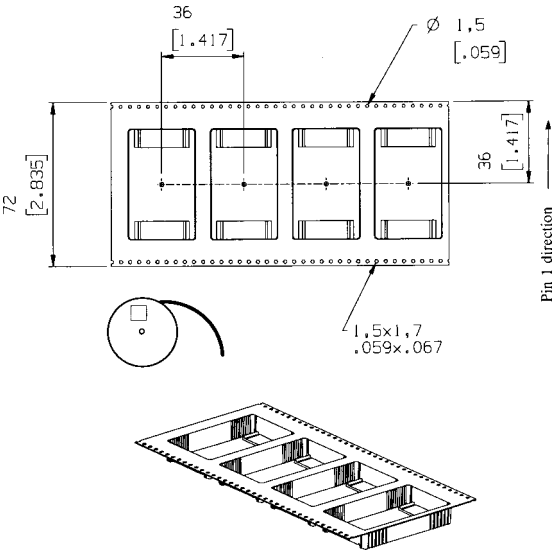


Figure 10

Specification

Tape material:	Conductive polystyrene (PS)
Tape width:	72 mm
Tape pitch:	36 mm
Max surface resistance:	$10^{5}\Omega/\square$
Tape color:	Black
Cover tape color:	Transparent
Reel diameter:	13"
Reel hub diameter:	7"
Reel capacity:	150 pcs
Full reel weight:	Typ. 3.7 kg
Min. order quantity:	300 pcs (one box contains two reels)

Quality

Reliability

Meantime between failure (MTBF) is calculated to >4.9 million hours at full output power and a case temperature of +55°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 continuously updated. The data corresponds to actual failure rates of components 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.

Quality Statement

The products are designed and manufactured in an industrial environment where quality systems and methods like ISO 9000, 6σ and SPC, are intensively in use to boost the continuous improvements strategy. Infant mortality or early failures in the products are screened out by a burn-in procedure and 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.

Warranty

Ericsson Components warrants to the original purchaser or end user that the products conform to this Data Sheet and are free from material and workmanship defects for a period of five (5) years from the date of manufacture, if the product is used within specified conditions and not opened. In case the product is discontinued, claims will be accepted up to three (3) years from the date of the discontinuation. For additional details on this limited warranty please refer to Ericsson Components AB's "General Terms and Conditions of Sales", EKA 950701, or individual contract documents.

Limitation of liability

Ericsson Components 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).

Product Program

V_I	V_O/I_O max	P_O max	Ordering No.*)	
	Output 1		Through-hole	SMD
48/60 V (max 75 Vdc)	3.3 V/2 A 3.3 V/3 A 5 V/2 A	6.6 W 9.9 W 10 W	PKF 4610A PI PKF 4910A PI PKF 4111A PI	PKF 4610A SI PKF 4910A SI PKF 4111A SI

*) See also Delivery Package Information

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3

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Preliminary Data Sheet

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