30−60 W DC/DC Power Modules
48 V Input Series

- *Efficiency typ 86% (5 V) at full load*
- *Low profile 11.0 mm (0.43 in.)*
- *1,500 V dc isolation voltage (duals = 1,000 Vdc)*
- *MTBF >200 years at +75 °C case temperature*
- *Rugged mechanical design and efficient thermal management, max +100 °C case temperature*
- *EMI measured according to EN 55 022 and FCC part 15J*

The PKG series of DC/DC Power Modules are members of the EriPower™ range of low profile DC/DC converters for distributed power architectures in 48/60 VDC power systems. They provide up to 60W in single and dual output versions. Utilizing the standard EriPower™ PKA/PKE pin-out with an even smaller footprint, the power density is 20 W/cu.in. The PKG units can be used as on-board distributed power modules, or serve as building blocks for more centralized power boards. The high efficiency makes it possible to operate over a wide temperature range without any extra heatsinks. At forced convection cooling >200 lfm (1 m/s), the PKG units can deliver full power without heatsinks up to +65°C ambient. With derated output power it can also operate in temperature controlled environments with non-forced convection cooling. By adding external heatsinking, the temperature range can be extended even further. Thanks to its peak power capa-bility, the PKG series is ideal for applications where max power is only required during short durations e.g. in disc drives. The PKG series uses ceramic sub-strates with plated copper in order to achieve good thermal management, low voltage drops, and a high efficiency. These products are manufactured using highly automated manufacturing lines with a world-class quality commitment and a five-year warranty. Ericsson Microelectronics AB has been an ISO 9001 certified supplier since 1991. *For a complete product program please reference the back cover.*

ERICSSON

General

Absolute Maximum Ratings

Characteristics		min	max	Unit
T_C	Case temperature @ max output power	−45	+100	°C
T_S	Storage temperature	−55	+125	°C
V_I	Input voltage	−0.5	+80	V dc
V_{ISO}	Isolation voltage (input to output test voltage) single output / dual output	1,500 1,000		V dc
V_{RC}	Remote control voltage pin 1	−10	+10	V dc
V_{adj}	Output adjust voltage pin 10	−10	+10	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 $T_C < T_{C\,max}$

Characteristics		Conditions	min	typ	max	Unit
V_I	Input voltage range[1)]		38		72	V
V_{Ioff}	Turn-off input voltage	(See Operating Information)		32		V
V_{Ion}	Turn-on input voltage	(See Operating Information)		33		V
r_{Irush}	Equivalent inrush current resistance			30		mΩ
C_I	Input capacitance			1.8		µF
P_{Ii}	Input idling power	I_O=0, T_C= −30...+90°C		1.5	2.0	W
P_{RC}	Input stand-by current	V_I = 53 V, T_C = +25 °C RC connected to pin 4		1.0		W

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 100
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
Resistance to cleaning solvents	IEC 68-2-45 XA Method 1	Water Isopropyl alcohol Terpens Method	+55 ±5°C +35 ±5°C +35 ±5°C with rubbing

Safety

The PKG 4000 I Series DC/DC power modules are designed in accordance with EN 60 950 *Safety of information technology equipment including electrical business equipment* and certified by SEMKO. The isolation is an operational insulation in accordance with EN 60 950.

The PKG DC/DC 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 is intended to be supplied by isolated secondary circuitry and shall be installed in compliance with the requirements of the ultimate application. When the supply to the DC/DC power module meets all the requirements for SELV (<60Vdc), the output is considered to remain within SELV limits (level 3). If connected to a 60 V DC power system reinforced insulation must be provided in the power supply that isolates the input from the ac 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 isolation voltage is a galvanic isolation and is verified in an electric strength test. Test voltage between input and output and between case and output is 1,500 V dc (duals = 1,000 V dc) for 60 s. In production the test duration may be decreased to 1 s.

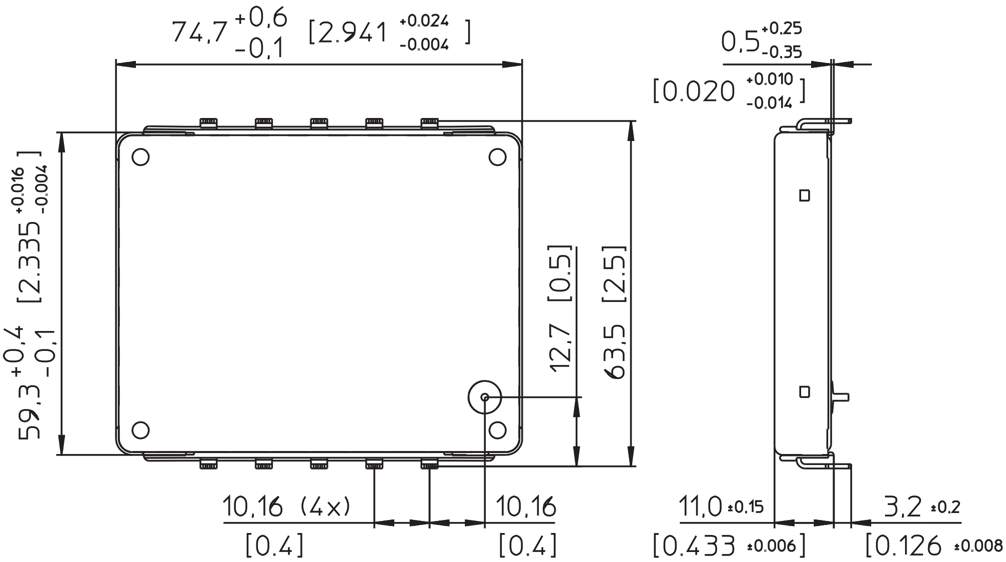
The capacitor between input and output has a value of 4.7 nF (duals = 22 nF) and the leakage current is less than 1µA @ 50 Vdc.

Flammability ratings of the terminal support and internal plastic construction details meets UL 94V-0.

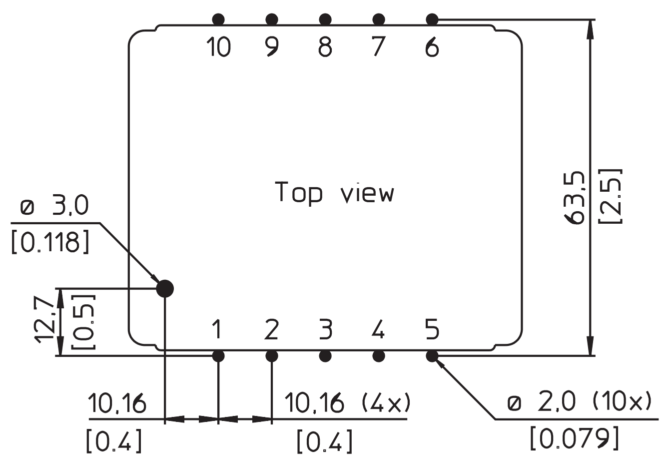
Note:

1)The input voltage range 38...72 V meets the requirements in the European Telecom Standard prETS 300 132-2 for Normal 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 +90 °C. Absolute max continuous input voltage is 80 V dc. Output characteristics will be marginally affected at input voltages exceeding 72 V.

Mechanical Data



Foot print Component side



Dimensions in mm (in)

Connections

Pin	Designation	Function
1	RC	Remote control. To turn-on and turn-off the output and to set the turn-off input voltage threshold.
2	TOA	Turn-off input voltage adjust (see Operating information).
3	+In	Positive input. Connected to case.
4	−In	Negative input.
5	NC	Not connected.
6	−Out 2	Negative output 2.
7	+Out 2	Positive output 2.
8	−Out 1	Negative output 1.
9	+Out 1	Positive output 1.
10	V_{adj}	Output voltage adjust.

Weight

Maximum 75 g (2.66 oz).

Case

Blue anodized aluminium casing with embedded tin plated copper pins.

Thermal Data

Two-parameter model

Power dissipation is generated in the components mounted on the ceramic substrate. The thermal properties of the PKG power module is determined by thermal conduction in the connected pins and thermal convection from the substrate via the case.

The two-parameter model characterizes the thermal properties of the PKG power module and the equation below can be used for thermal design purposes if detailed information is needed. The values are given for a module mounted on a printed board assembly (PBA).

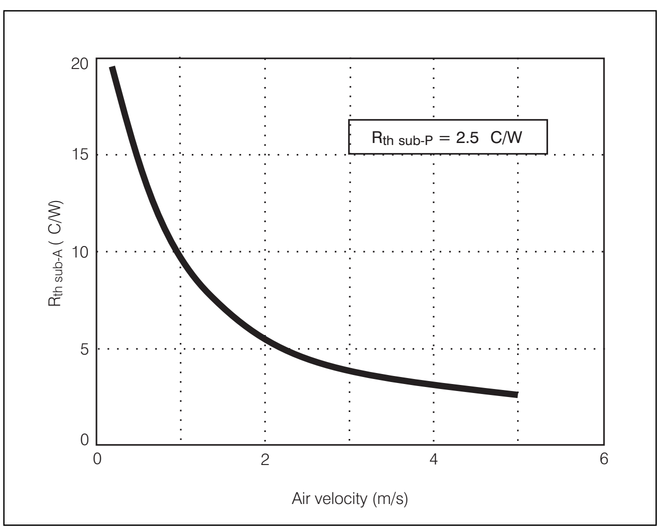
Note that the thermal resistance between the substrate and the air, $R_{th\ sub\text{-}A}$ is strongly dependent on the air velocity.

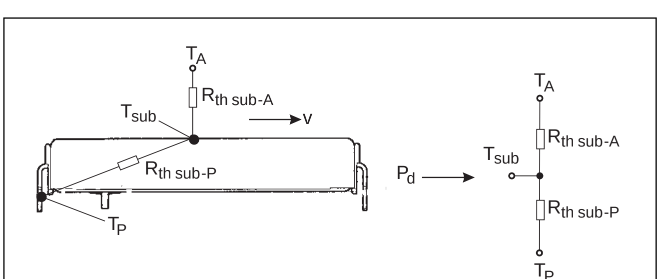
$$T_{sub} = P_d \times R_{th\ sub\text{-}P} \times R_{th\ sub\text{-}A}/(R_{th\ sub\text{-}P} + R_{th\ sub\text{-}A}) + (T_P - T_A) \times R_{th\ sub\text{-}A}/(R_{th\ sub\text{-}P} + R_{th\ sub\text{-}A}) + T_A$$

Where:

P_d : dissipated power, calculated as $P_O \times (1/\eta\text{-}1)$
T_{sub} : max average substrate temperature, $\approx T_{C max}$
T_A : ambient air temperature at the lower side of the power module
T_P : average pin temperature at the PB solder joint
$R_{th\ sub\text{-}P}$: thermal resistance from T_{sub} to the pins
$R_{th\ sub\text{-}A}$: thermal resistance from T_{sub} to T_A
v : velocity of ambient air.

Air velocity in free convection is 0.2–0.3 m/s (40-60 lfm).





Over Temperature Protection (OTP)

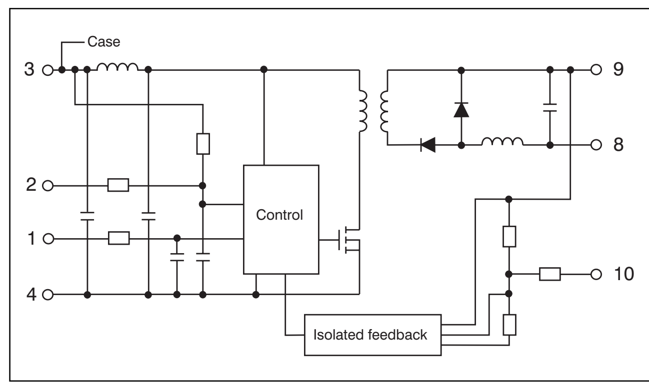
The PKG DC/DC power modules have an internal over temperature protection circuit. If the case temperature exceeds min +115 °C the power module will go in to OTP-mode. As long as the case temperature exceeds min +115 °C the power module will operate in OTP-mode.

During OTP-mode the output voltage pulsates between zero and nominal output voltage, which reduces the power loss inside the power module. The PKG DC/DC power module will automatically resume normal operation when the temperature decreases below min +115 °C.

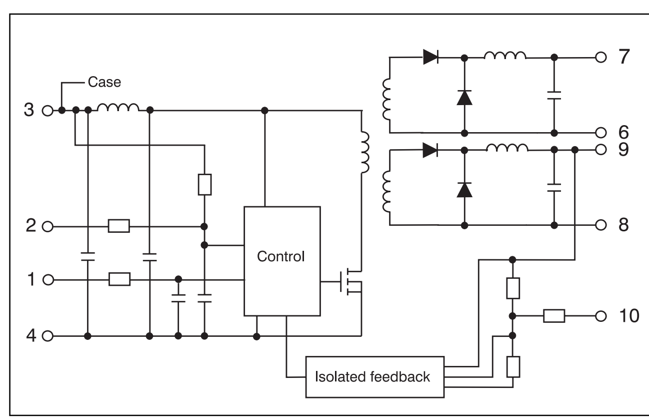
Electrical Data

Fundamental circuit diagrams

Single output



Dual output



PKG 4310 PI

T_C = –30…+90°C, V_I = 38 ...72V unless otherwise specified.

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 = 14.5 A, V_I = 53 V		2.07	2.10	2.13	V
	Output adjust range[1]			1.90		2.30	V
V_O	Output voltage tolerance band	Long term drift included	I_O = 0.1 …1.0 × $I_{O max}$	2.03		2.17	V
	Idling voltage	I_O = 0 A				3.5	V
	Line regulation	I_O = $I_{O max}$	V_I = 38…60 V		2		mV
			V_I = 50…72 V		2		
	Load regulation	I_O = 0.1 …1.0 × $I_{O max}$, V_I = 53 V			30		mV
t_{tr}	Load transient recovery time	I_O = 0.1 … 1.0 × $I_{O max}$, V_I = 53 V load step = 0.5× $I_{O max}$			100		µs
V_{tr}	Load transient voltage				+130		mV
					–210		mV
T_{coeff}	Temperature coefficient[2]	I_O = $I_{O max}$, T_C < $T_{C max}$		see PKG 4310 PI Temperature characteristics			
t_r	Ramp-up time	I_O = 0.1…1.0 × $I_{O max}$ V_I = 53 V	0.1 …0.9 × V_O		10		ms
t_s	Start-up time		From V_I connection to V_O = 0.9 × V_{Oi}		30		ms
I_O	Output current			0		14.5	A
$P_{O max}$	Max output power[3]	Calculated value			30		W
I_{lim}	Current limiting threshold	T_C < $T_{C max}$		16.2			A
I_{sc}	Short circuit current	V_O = 0.2… 0.5V, T_A = 25°C			18		A
$V_{O ac}$	Output ripple	I_O = $I_{O max}$	20 Hz…5 MHz		60	100	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}/$V_{O p-p}$))		56			dB
OVP	Over voltage protection	I_O > 0.1 × $I_{O max}$			2.6		V

1) See Operating information.
2) Temperature coefficient is positive at low temperatures and negative at high temperatures.
3) See also Typical Characteristics, Power derating.

Miscellaneous

Characteristics		Conditions	min	typ	max	Unit
η	Efficiency	I_O = $I_{O max}$, V_I = 53 V		75		%
P_d	Power dissipation	I_O = $I_{O max}$, V_I = 53 V		10		W

PKG 4319 PI

T_C = –30…+90°C, V_I = 38 ...72V unless otherwise specified.

Output

Characteristics		Conditions		Output 1			Unit
				min	typ	max	
V_{Oi}	Output voltage initial setting and accuracy	T_C = +25°C, I_O = 15 A, V_I = 53 V		2.49	2.51	2.53	V
	Output adjust range[1]			2.25		2.75	V
V_O	Output voltage tolerance band	Long term drift included	I_O = 0.1 …1.0 × $I_{O max}$	2.43		2.57	V
	Idling voltage	I_O = 0 A				3.0	V
	Line regulation	I_O = $I_{O max}$	V_I = 38…60 V		5		mV
			V_I = 50…72 V		5		mV
	Load regulation	I_O = 0.1 …1.0 × $I_{O max}$, V_I = 53 V			20		mV
t_{tr}	Load transient recovery time	I_O = 0.1 … 1.0 × $I_{O max}$, V_I = 53 V load step = 0.5× $I_{O max}$			100		µs
V_{tr}	Load transient voltage				+250		mV
					–500		mV
T_{coeff}	Temperature coefficient[2]	I_O = $I_{O max}$, T_C < $T_{C max}$			see PKG 4319 PI Temperature characteristics		
t_r	Ramp-up time	I_O = 0.1…1.0 × $I_{O max}$ V_I = 53 V	0.1 …0.9 × V_O		30		ms
t_s	Start-up time		From V_I connection to V_O = 0.9 × V_{Oi}		60		ms
I_O	Output current			0		15	A
$P_{O max}$	Max output power[3]	Calculated value			38		W
I_{lim}	Current limiting threshold	T_C < $T_{C max}$		15.3			A
I_{sc}	Short circuit current	V_O = 0.2 … 0.5 V, T_A = 25°C, R_{SC} > 25 mΩ			22		A
$V_{O ac}$	Output ripple	I_O = $I_{O max}$	20 Hz…5 MHz		60	100	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}/$V_{O p-p}$))		47			dB
OVP	Over voltage protection	I_O > 0.1 × $I_{O max}$			3.5		V

1) See Operating information.
2) Temperature coefficient is positive at low temperatures and negative at high temperatures.
3) See also Typical Characteristics, Power derating.

Miscellaneous

Characteristics		Conditions	min	typ	max	Unit
η	Efficiency	I_O = $I_{O max}$, V_I = 53 V		78		%
P_d	Power dissipation	I_O = $I_{O max}$, V_I = 53 V		10.5		W

PKG 4410 PI

T_C = –30…+90°C, V_I = 38 ...72V unless otherwise specified.

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 = 14 A, V_I = 53 V		3.28	3.30	3.32	V
	Output adjust range[1]			2.80		3.65	V
V_O	Output voltage tolerance band	Long term drift included	I_O = 0.1…1.0 × $I_{O max}$	3.10		3.40	V
	Idling voltage	I_O = 0 A				4.0	V
	Line regulation	I_O = $I_{O max}$	V_I = 38…60 V		3		mV
			V_I = 50…72 V		3		
	Load regulation	I_O = 0.1…1.0 × $I_{O max}$, V_I = 53 V			35		mV
t_{tr}	Load transient recovery time	I_O=0.1 … 1.0 × $I_{O max}$, V_I = 53 V load step = 0.5× $I_{O max}$			100		µs
V_{tr}	Load transient voltage				+200		mV
					–330		mV
T_{coeff}	Temperature coefficient[2]	I_O = $I_{O max}$, T_C < $T_{C max}$		see PKG 4410 PI Temperature characteristics			
t_r	Ramp-up time	I_O = 0.1…1.0 × $I_{O max}$ V_I = 53 V	0.1…0.9 × V_O		10		ms
t_s	Start-up time		From V_I connection to V_O = 0.9 × V_{Oi}		30		ms
I_O	Output current			0		14	A
$P_{O max}$	Max output power[3]	Calculated value			46		W
I_{lim}	Current limiting threshold	T_C < $T_{C max}$		15.4			A
I_{sc}	Short circuit current	V_O = 0.2…0.5 V, T_A = 25°C			18		A
$V_{O ac}$	Output ripple	I_O = $I_{O max}$	20 Hz… 5 MHz		60	100	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}/$V_{O p-p}$))		53			dB
OVP	Over voltage protection	I_O > 0.1 × $I_{O max}$			4		V

1) See Operating information.
2) Temperature coefficient is positive at low temperatures and negative at high temperatures.
3) See also Typical Characteristics, Power derating.

Miscellaneous

Characteristics		Conditions	min	typ	max	Unit
η	Efficiency	I_O = $I_{O max}$, V_I = 53 V		81		%
P_d	Power dissipation	I_O = $I_{O max}$, V_I = 53 V		11		W

PKG 4611 PI

T_C = –30…+90°C, V_I = 38 ...72V unless otherwise specified.

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 = 12 A, V_I = 53 V		5.12	5.15	5.18	V
	Output adjust range[1]			4.65		5.65	V
V_O	Output voltage tolerance band	Long term drift included	I_O = 0.1…1.0 × $I_{O max}$	5.00		5.20	V
	Idling voltage	I_O = 0 A				5.6	V
	Line regulation	I_O = $I_{O max}$	V_I = 38…60 V		5		mV
			V_I = 50…72 V		5		mV
	Load regulation	I_O = 0.1…1.0 × $I_{O max}$, V_I = 53 V			50		mV
t_{tr}	Load transient recovery time	I_O = 0.1…1.0 × $I_{O max}$, V_I = 53 V load step = 0.5× $I_{O max}$			100		µs
V_{tr}	Load transient voltage				+350		mV
					–500		mV
T_{coeff}	Temperature coefficient[2]	I_O = $I_{O max}$, T_C < $T_{C max}$		see PKG 4611 PI Temperature characteristics			
t_r	Ramp-up time	I_O = 0.1…1.0 × $I_{O max}$ V_I = 53 V	0.1…0.9 × V_O		10		ms
t_s	Start-up time		From V_I connection to V_O = 0.9 × V_{Oi}		30		ms
I_O	Output current			0		12	A
$P_{O max}$	Max output power[3]	Calculated value			60		W
I_{lim}	Current limiting threshold	T_C < $T_{C max}$		12.1			A
I_{sc}	Short circuit current	V_O = 0.2…0.5 V, T_A = 25°C			17		A
$V_{O ac}$	Output ripple	I_O = $I_{O max}$	20 Hz… 5 MHz		60	100	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}/$V_{O p-p}$))		50			dB
OVP	Over voltage protection	I_O > 0.1 × $I_{O max}$			6		V

1) See Operating information.
2) Temperature coefficient is positive at low temperatures and negative at high temperatures.
3) See also Typical Characteristics, Power derating.

Miscellaneous

Characteristics		Conditions	min	typ	max	Unit
η	Efficiency	I_O = $I_{O max}$, V_I = 53 V		86		%
P_d	Power dissipation	I_O = $I_{O max}$, V_I = 53 V		10		W

PKG 4617 PIOA

T_C = –30…+90°C, V_I = 38 ...72V unless otherwise specified.

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 = 10A, V_I = 53 V		6.19	6.22	6.25	V
	Output adjust range[1]			5.0		7.7	V
V_O	Output voltage tolerance band	Long term drift included	I_O = 0.1 …1.0 × $I_{O max}$	6.00		6.40	V
	Idling voltage	I_O = 0 A				7.5	V
	Line regulation	I_O = $I_{O max}$	V_I = 38…60 V		5		mV
			V_I = 50…72 V		5		
	Load regulation	I_O = 0.1 …1.0 × $I_{O max}$, V_I = 53 V			50		mV
t_{tr}	Load transient recovery time	I_O=0.1 …1.0 × $I_{O max}$, V_I = 53 V load step = 0.5× $I_{O max}$			100		µs
V_{tr}	Load transient voltage				+200		mV
					–400		mV
T_{coeff}	Temperature coefficient[2]	I_O = $I_{O max}$, T_C < $T_{C max}$		see PKG 4617 PIOA Temperature characteristics			
t_r	Ramp-up time	I_O = 0.1…1.0 × $I_{O max}$ V_I = 53 V	0.1 …0.9 × V_O		15		ms
t_s	Start-up time		From V_I connection to V_O = 0.9 × V_{Oi}		25		ms
I_O	Output current			0		10	A
$P_{O max}$	Max output power[3]	Calculated value			60		W
I_{lim}	Current limiting threshold	T_C < $T_{C max}$		11.6			A
I_{sc}	Short circuit current	V_O = 0.2 …0.5 V, T_A = 25°C			15		A
V_{Oac}	Output ripple	I_O = $I_{O max}$	20 Hz… 5 MHz		60	100	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}/$V_{O p-p}$))		50			dB
OVP	Over voltage protection	I_O > 0.1 × $I_{O max}$			8		V

1) See Operating information.
2) Temperature coefficient is positive at low temperatures and negative at high temperatures.

Miscellaneous

Characteristics		Conditions	min	typ	max	Unit
η	Efficiency	I_O = $I_{O max}$, V_I = 53 V		86		%
P_d	Power dissipation	I_O = $I_{O max}$, V_I = 53 V		10		W

PKG 4428 PI

T_C = –30…+90°C, V_I = 38 ...72V unless otherwise specified. $I_{O1\ nom}$ = 6.0 A, $I_{O2\ nom}$ = 4.0 A.

Output

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, $I_O = I_{O nom}$, V_I = 53 V		3.27	3.30	3.33	5.10	5.27	5.40	V
	Output adjust range[1]			2.90		3.70	4.60		5.90	V
V_O	Output voltage tolerance band	Long term drift included	I_O = 0.2…1.0 × $I_{O nom}$, I_{O1} = 1.5 × I_{O2}	3.10		3.40	4.90		5.40	V
	Idling voltage	I_O = 0 A				4.0			7.0	V
	Line regulation	$I_O = I_{O nom}$	V_I = 38…60 V		5			15		mV
			V_I = 50…72 V		5			15		
	Load regulation	I_{O1} = 0.1 …1.0 × $I_{O1 nom}$, $I_{O2} = I_{O2 nom}$, V_I = 53 V			15					mV
t_{tr}	Load transient recovery time	I_O = 0.1 …1.0 × $I_{O1 nom}$, V_I = 53 V load step = 0.5× $I_{O1 nom}$, $I_{O2} = I_{O2 nom}$			100			100		µs
V_{tr}	Load transient voltage				+150			+150		mV
					–200			–200		mV
T_{coeff}	Temperature coefficient[2]	$I_O = I_{O nom}$, $T_C < T_{C max}$		see PKG 4428 PI Temperature characteristics						
t_r	Ramp-up time	I_O = 0.1…1.0 × $I_{O max}$ V_I = 53 V	0.1 …0.9 × V_O		10			10		ms
t_s	Start-up time		From V_I connection to V_O = 0.9 × V_{Oi}		15			15		ms
I_O	Output current			0		9.6	0[4]		6.4	A
$P_{O max}$	Max total output power[3]	Calculated value		min 40						W
I_{lim}	Current limiting threshold	$T_C < T_{C max}$		min 1.02 × $P_{O max}$[5]						
I_{sc}	Short circuit current	V_O = 0.2… 0.5 V, T_A = 25 °C, R_{SC} > 0.1 Ω			15					A
$V_{O ac}$	Output ripple	$I_O = I_{O nom}$	20 Hz…5 MHz		100	150		100	150	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 $V_{p-p}/V_{O p-p}$))		60			60			dB
OVP	Over voltage protection	I_O > 0.1 × $I_{O max}$			4					V

1) See Operating information.
2) Temperature coefficient is positive at low temperatures and negative at high temperatures.
3) See also Typical Characteristics, Power derating.
4) At full load on output 1 output 2 must have min 0.6 A load.
5) I_{lim} on each output is set by the total load.

Miscellaneous

Characteristics		Conditions	min	typ	max	Unit
η	Efficiency	$I_O = I_{O nom}$, V_I = 53 V		84		%
P_d	Power dissipation	$I_O = I_{O nom}$, V_I = 53 V		7.6		W

PKG 4623 PI

T_C = –30…+90°C, V_I = 38 ...72V unless otherwise specified. $I_{O1\ nom}$ = 2.5 A, $I_{O2\ nom}$ = 2.5 A.

Output

Characteristics		Conditions		Output 1 min	Output 1 typ	Output 1 max	Output 2 min	Output 2 typ	Output 2 max	Unit
V_{Oi}	Output voltage initial setting and accuracy	T_C = +25°C, $I_O = I_{Onom}$, V_I = 53 V		11.94	12.10	12.26	11.94	12.10	12.26	V
	Output adjust range[1]			10.80		13.20	10.80		13.20	V
V_O	Output voltage tolerance band	Long term drift included	I_O = 0.1 …1.0 × I_{Onom} $I_{O1} = I_{O2}$	11.70		12.50	11.70		12.60	V
	Idling voltage	I_O = 0 A				12.65			20	V
	Line regulation	$I_O = I_{Onom}$	V_I = 38…60 V		10			10		mV
			V_I = 50…72 V		10			10		mV
	Load regulation	I_{O1} = 0.1 …1.0 × I_{O1nom}, $I_{O2} = I_{O2nom}$, V_I = 53 V			20					mV
t_{tr}	Load transient recovery time	I_O = 0.1 …1.0 × I_{Onom}, V_I = 53 V load step = 0.5× I_{Onom}, $I_{O1} = I_{O2}$			100			100		µs
V_{tr}	Load transient voltage				+850			+850		mV
					−850			−850		mV
T_{coeff}	Temperature coefficient[2]	$I_O = I_{Onom}$, $T_C < T_{C\ max}$		see PKG 4623 PI Temperature characteristics						
t_r	Ramp-up time	I_O = 0.1…1.0 × I_{Omax} V_I = 53 V	0.1 …0.9 × V_O		10			10		ms
t_s	Start-up time		From V_I connection to V_O = 0.9 × V_{Oi}		30			30		ms
I_O	Output current			0		4.0	0		4.0	A
$P_{O\ max}$	Max total output power[3]	Calculated value		min 60						W
I_{lim}	Current limiting threshold	$T_C < T_{C\ max}$		min 1.02 × $P_{O\ max}$[4]						
I_{sc}	Short circuit current	V_O = 0.2 …0.5V, T_A = 25°C, R_{SC} > 0.1Ω			7			7		A
V_{Oac}	Output ripple	$I_O = I_{Onom}$	20 Hz… 5 MHz		100	150		100	150	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}))		43			43			dB
OVP	Over voltage protection	I_O > 0.1 × I_{Omax}			14.5					V

1) See Operating information.
2) Temperature coefficient is positive at low temperatures and negative at high temperatures.
3) See also Typical Characteristics, Power derating.
4) I_{lim} on each output is set by the total load.

Miscellaneous

Characteristics		Conditions	min	typ	max	Unit
η	Efficiency	$I_O = I_{Onom}$, V_I = 53 V		89		%
P_d	Power dissipation	$I_O = I_{Onom}$, V_I = 53 V		7.4		W

PKG 4625 PI

T_C = –30…+90°C, V_I = 38 ...72V unless otherwise specified. $I_{O1\ nom}$ = 2.0 A, $I_{O2\ nom}$ = 2.0 A.

Output

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		14.90	15.00	15.10	14.90	15.00	15.10	V
	Output adjust range[1]			12.00		16.50	12.00		16.50	V
V_O	Output voltage tolerance band	Long term drift included	I_O = 0.1…1.0 × I_{Onom} $I_{O1} = I_{O2}$	14.20		15.65	14.20		15.65	V
	Idling voltage	I_O = 0 A				17			26	V
	Line regulation	$I_O = I_{Onom}$	V_I = 38…60 V		15			15		mV
			V_I = 50…72 V		15			15		
	Load regulation	I_{O1} = 0.1…1.0 × I_{O1nom}, $I_{O2} = I_{O2nom}$, V_I = 53 V			50			50		mV
t_{tr}	Load transient recovery time	I_O = 0.1…1.0 × I_{Onom}, V_I = 53 V load step = 0.5× I_{Onom}, $I_{O1} = I_{O2}$			150			150		µs
V_{tr}	Load transient voltage				+750			+750		mV
					–1300			–1300		mV
T_{coeff}	Temperature coefficient[2]	$I_O = I_{Onom}$, $T_C < T_{C\ max}$		see PKG 4625 PI Temperature characteristics						
t_r	Ramp-up time	I_O = 0.1…1.0 × I_{Omax} V_I = 53 V	0.1…0.9 × V_O		10			10		ms
t_s	Start-up time		From V_I connection to V_O = 0.9 × V_{Oi}		15			15		ms
I_O	Output current			0		3.2	0		3.2	A
P_{Omax}	Max total output power[3]	Calculated value		min 60						W
I_{lim}	Current limiting threshold	$T_C < T_{C\ max}$		min 1.02 × $P_{O\ max}$[4]						
I_{sc}	Short circuit current	V_O = 0.2…0.5 V, T_A = 25°C, R_{SC} > 0.1Ω			9			9		A
V_{Oac}	Output ripple	$I_O = I_{Onom}$	20 Hz… 5 MHz		100	150		100	150	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}))		43			43			dB
OVP	Over voltage protection	I_O > 0.1 × I_{Omax}			18					V

1) See Operating information.
2) Temperature coefficient is positive at low temperatures and negative at high temperatures.
3) See also Typical Characteristics, Power derating.
4) I_{lim} on each output is set by the total load.

Miscellaneous

Characteristics		Conditions	min	typ	max	Unit
η	Efficiency	$I_O = I_{Onom}$, V_I = 53 V		89		%
P_d	Power dissipation	$I_O = I_{Onom}$, V_I = 53 V		7.4		W

PKG 4627 PI

T_C = –30…+90°C, V_I = 38 ...72V unless otherwise specified. $I_{O1\ nom}$ = 6.0 A, $I_{O2\ nom}$ = 2.5 A.

Output

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		5.11	5.15	5.19	11.92	12.10	12.28	V
	Output adjust range[1]			4.63		5.67	10.80		13.20	V
V_O	Output voltage tolerance band	Long term drift included	I_O = 0.1 …1.0 × I_{Onom} I_{O1} = 2.4 × I_{O2}	5.00		5.25	11.70		12.60	V
	Idling voltage	I_O = 0 A				5.45			20	V
	Line regulation	$I_O = I_{Onom}$	V_I = 38…60 V		12			25		mV
			V_I = 50…72 V		4			8		
	Load regulation	I_{O1} = 0.1 …1.0 × I_{O1nom}, $I_{O2} = I_{O2nom}$, V_I = 53 V			10					mV
t_{tr}	Load transient recovery time	I_O = 0.1 …1.0 × I_{Onom}, V_I = 53 V load step = 0.5× I_{Onom}			100			100		µs
V_{tr}	Load transient voltage				+350			+850		mV
					−400			−850		mV
T_{coeff}	Temperature coefficient[2]	$I_O = I_{Onom}$, $T_C < T_{C\ max}$		see PKG 4627 PI Temperature characteristics						
t_r	Ramp-up time	I_O = 0.1…1.0 × I_{Omax} V_I = 53 V	0.1 …0.9 × V_O		10			10		ms
t_s	Start-up time		From V_I connection to V_O = 0.9 × V_{Oi}		30			30		ms
I_O	Output current			0		9.0	0		3.0	A
$P_{O\ max}$	Max total output power[3]	Calculated value		min 60						W
I_{lim}	Current limiting threshold	$T_C < T_{C\ max}$		min 1.02 × $P_{O\ max}$[4]						
I_{sc}	Short circuit current	V_O = 0.2 … 0.5 V, T_A = 25 °C, R_{SC} > 0.1 Ω			17			7		A
V_{Oac}	Output ripple	$I_O = I_{Onom}$	20 Hz…5 MHz		100	150		100	150	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}))		43			35			dB
OVP	Over voltage protection	I_O > 0.1 × I_{Omax}			6					V

1) See Operating information.
2) Temperature coefficient is positive at low temperatures and negative at high temperatures.
3) See also Typical Characteristics, Power derating.
4) I_{lim} on each output is set by the total load.

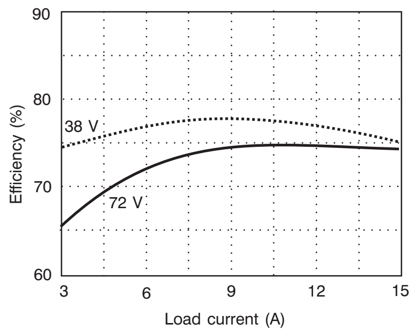
Miscellaneous

Characteristics		Conditions	min	typ	max	Unit
η	Efficiency	$I_O = I_{Onom}$, V_I = 53 V		88		%
P_d	Power dissipation	$I_O = I_{Onom}$, V_I = 53 V		8		W

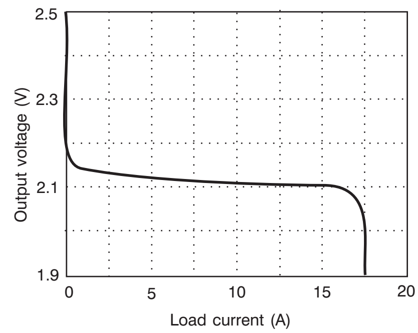
Typical Characteristics

PKG 4310 PI

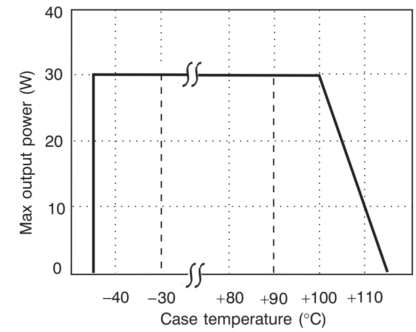
Efficiency (typ)



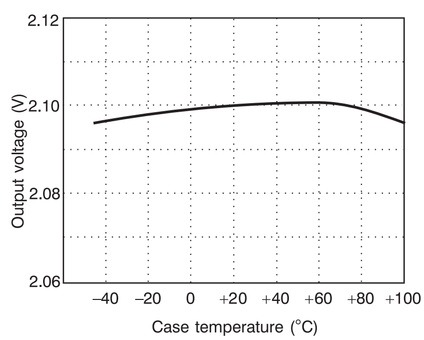
Output characteristic (typ)



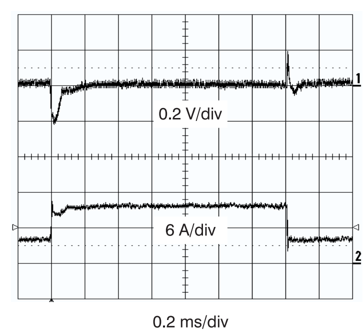
Power derating



Temperature characteristics



Dynamic load response (typ)

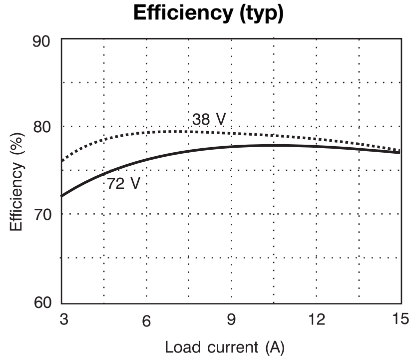


1. Maximum deviation $\Delta V_O < 0.1 \times V_{Oi}$
   Recover time t_r<100 µs
   The output voltage deviation is determined by the load transient (dI/dt)

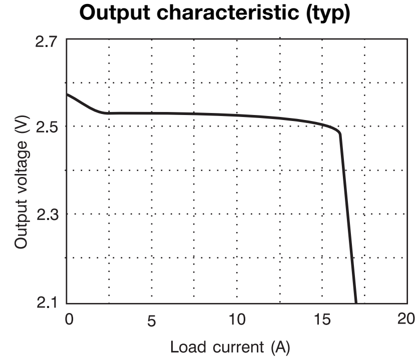
2. Load change:
   $0.25 \times I_{Onom} \ldots 0.75 \times I_{Onom} \ldots 0.25 \times I_{Onom}$
   dI/dt ≈ 5 A/µs

PKG 4319 PI

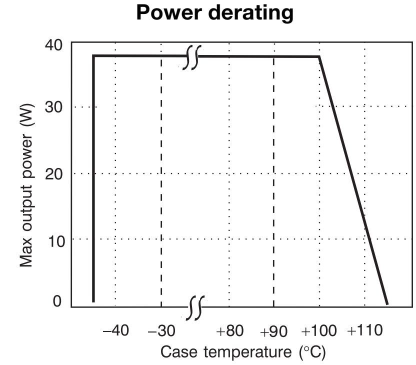
Efficiency (typ)



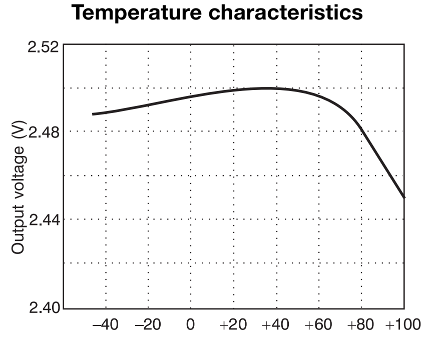
Output characteristic (typ)



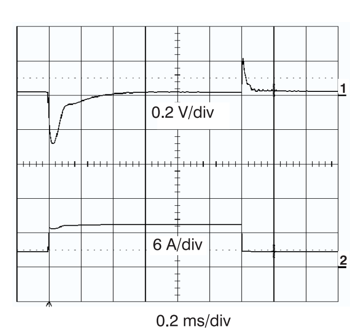
Power derating



Temperature characteristics



Dynamic load response (typ)

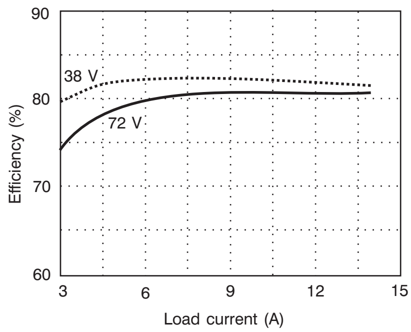


1. Maximum deviation $\Delta V_O < 0.1 \times V_{Oi}$
   Recover time t_r<100 µs
   The output voltage deviation is determined by the load transient (dI/dt)

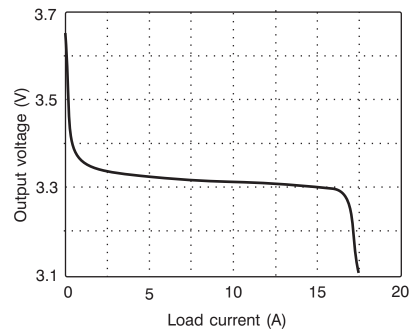
2. Load change:
   $0.25 \times I_{Onom} \ldots 0.75 \times I_{Onom} \ldots 0.25 \times I_{Onom}$
   dI/dt ≈ 5 A/µs

PKG 4410 PI

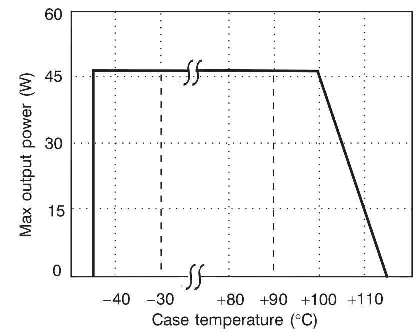
Efficiency (typ)



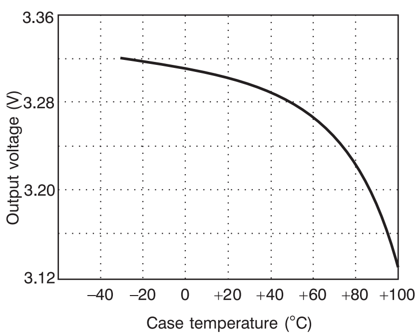
Output characteristic (typ)



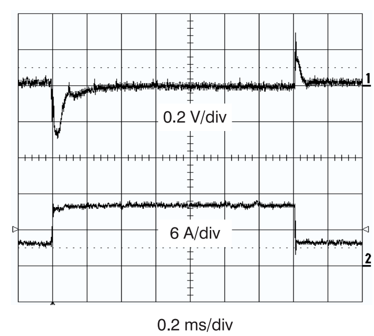
Power derating



Temperature characteristics



Dynamic load response (typ)

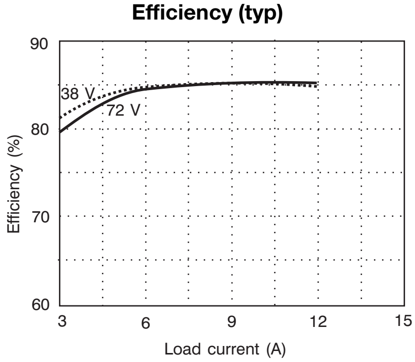


1. Maximum deviation $\Delta V_O < 0.1 \times V_{Oi}$
   Recover time $t_r < 100\ \mu s$
   The output voltage deviation is determined by the load transient (dI/dt)

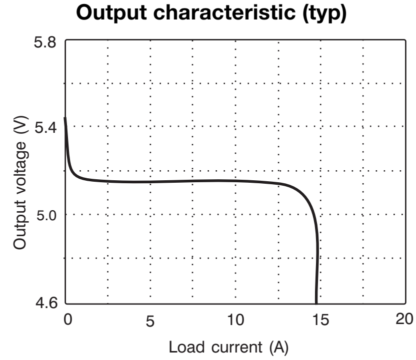
2. Load change:
   $0.25 \times I_{O nom} \ldots 0.75 \times I_{O nom} \ldots 0.25 \times I_{O nom}$
   $dI/dt \approx 5\ A/\mu s$

PKG 4611 PI

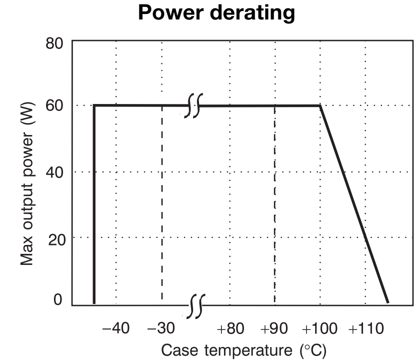
Efficiency (typ)



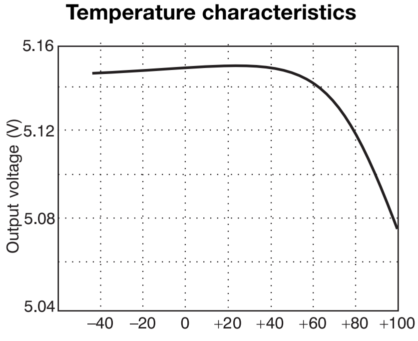
Output characteristic (typ)



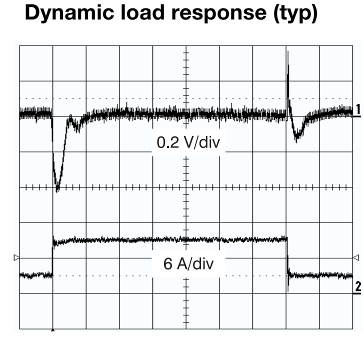
Power derating



Temperature characteristics



Dynamic load response (typ)

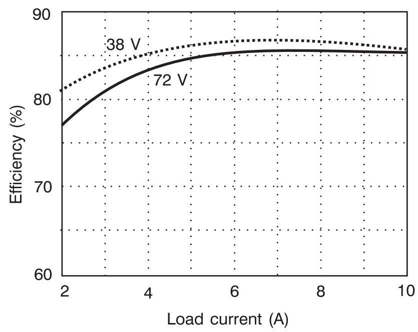


1. Maximum deviation $\Delta V_O < 0.1 \times V_{Oi}$
   Recover time $t_r < 100\ \mu s$
   The output voltage deviation is determined by the load transient (dI/dt)

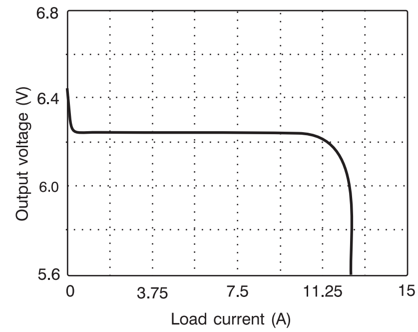
2. Load change:
   $0.25 \times I_{O nom} \ldots 0.75 \times I_{O nom} \ldots 0.25 \times I_{O nom}$
   $dI/dt \approx 5\ A/\mu s$

PKG 4617 PIOA

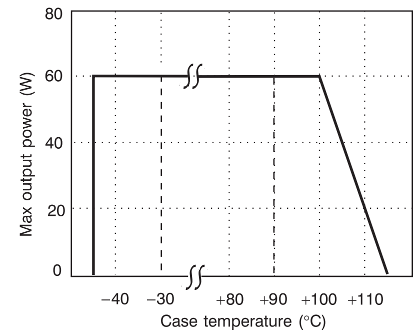
Efficiency (typ)



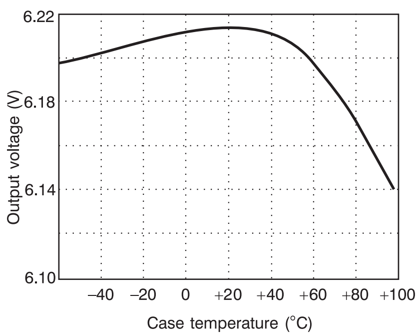
Output characteristic (typ)



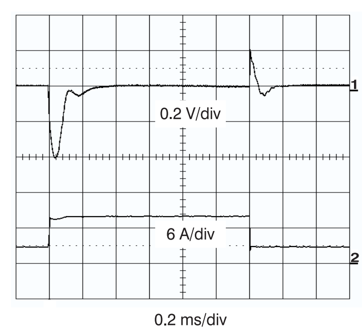
Power derating



Temperature characteristics



Dynamic load response (typ)

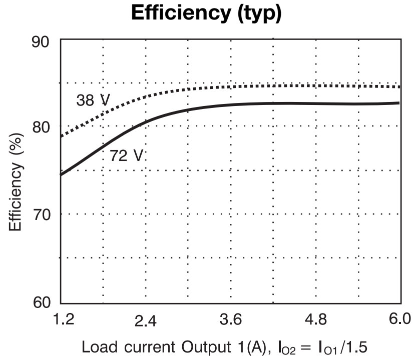


1. Maximum deviation $\Delta V_O < 0.1 \times V_{Oi}$
   Recover time t_r<100 µs
   The output voltage deviation is determined by the load transient (dI/dt)

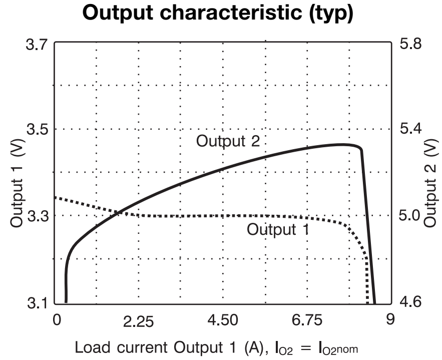
2. Load change:
   $0.25 \times I_{Onom} \ldots 0.75 \times I_{Onom} \ldots 0.25 \times I_{Onom}$
   dI/dt ≈ 5 A/µs

PKG 4428 PI

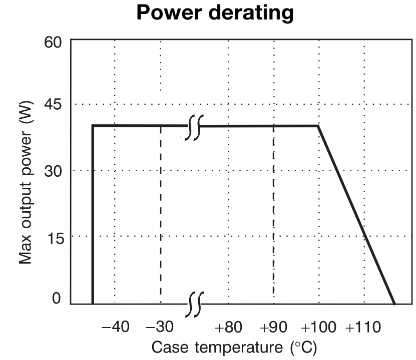
Efficiency (typ)



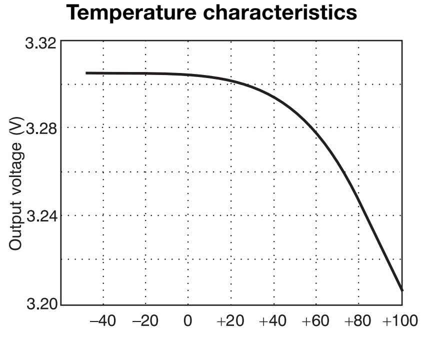
Output characteristic (typ)



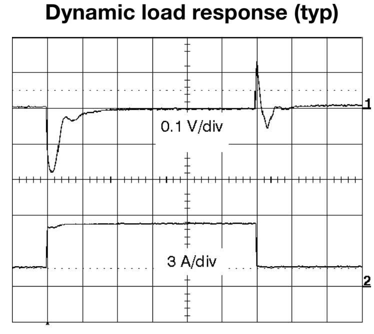
Power derating



Temperature characteristics



Dynamic load response (typ)

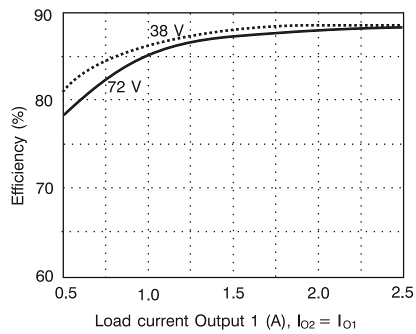


1. Maximum deviation $\Delta V_O < 0.1 \times V_{Oi}$
   Recover time t_r<100 µs
   The output voltage deviation is determined by the load transient (dI/dt)

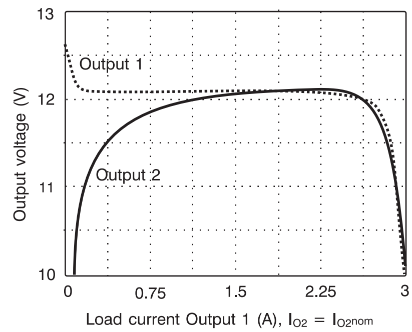
2. Load change:
   $0.25 \times I_{Onom} \ldots 0.75 \times I_{Onom} \ldots 0.25 \times I_{Onom}$
   dI/dt ≈ 5 A/µs

PKG 4623 PI

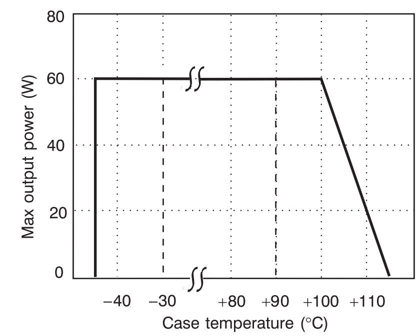
Efficiency (typ)



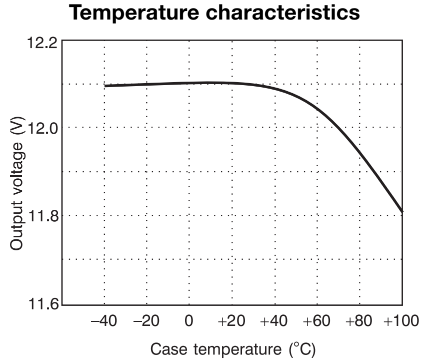
Output characteristic (typ)



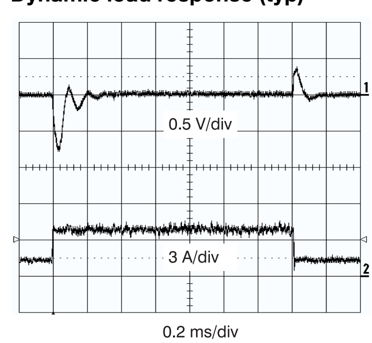
Power derating



Temperature characteristics



Dynamic load response (typ)[1)]

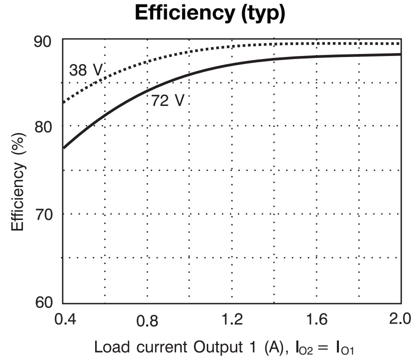


1. Maximum deviation $\Delta V_O < 0.1 \times V_{Oi}$
   Recover time t_r<100 µs
   The output voltage deviation is determined by the load transient (dI/dt)
2. Load change:
   $0.25 \times I_{Onom} \ldots 0.75 \times I_{Onom} \ldots 0.25 \times I_{Onom}$
   dI/dt ≈ 5 A/µs

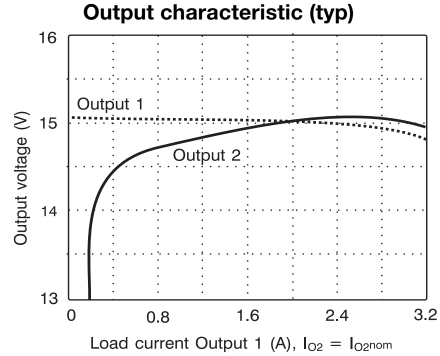
[1)] Outputs paralleled.

PKG 4625 PI

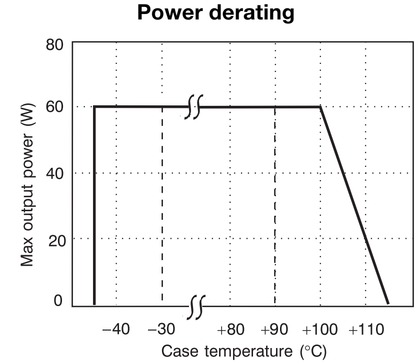
Efficiency (typ)



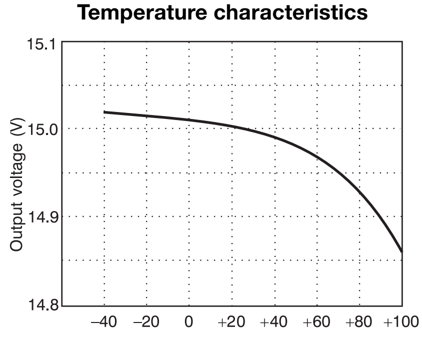
Output characteristic (typ)



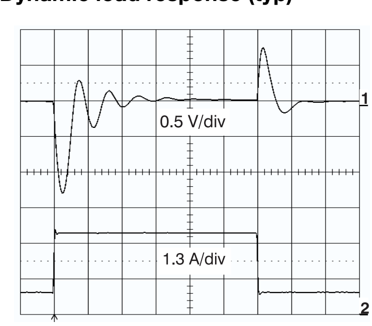
Power derating



Temperature characteristics



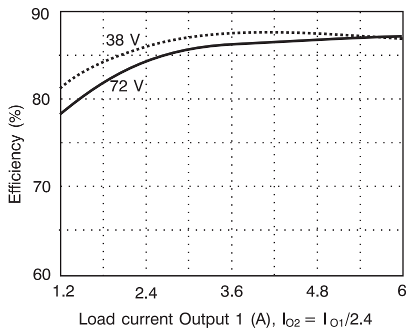
Dynamic load response (typ)[1)]



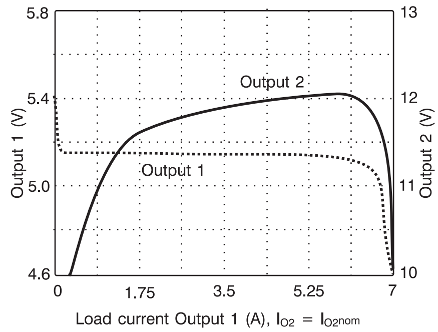
1. Maximum deviation $\Delta V_O < 0.1 \times V_{Oi}$
   The output voltage deviation is determined by the load transient (dI/dt)
2. Load change:
   $0.25 \times I_{Onom} \ldots 0.75 \times I_{Onom} \ldots 0.25 \times I_{Onom}$
   dI/dt ≈ 5 A/µs

[1)] Outputs paralleled.

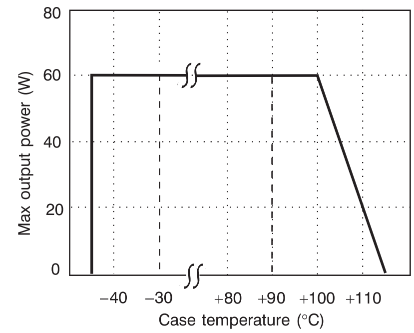
Efficiency (typ)



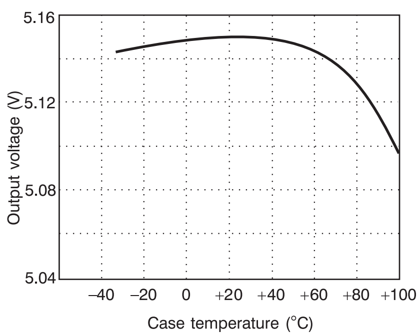
Output characteristic (typ)



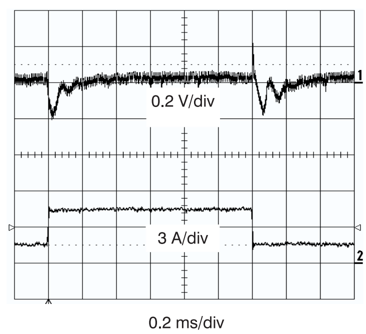
Power derating



Temperature characteristics



Dynamic load response (typ)



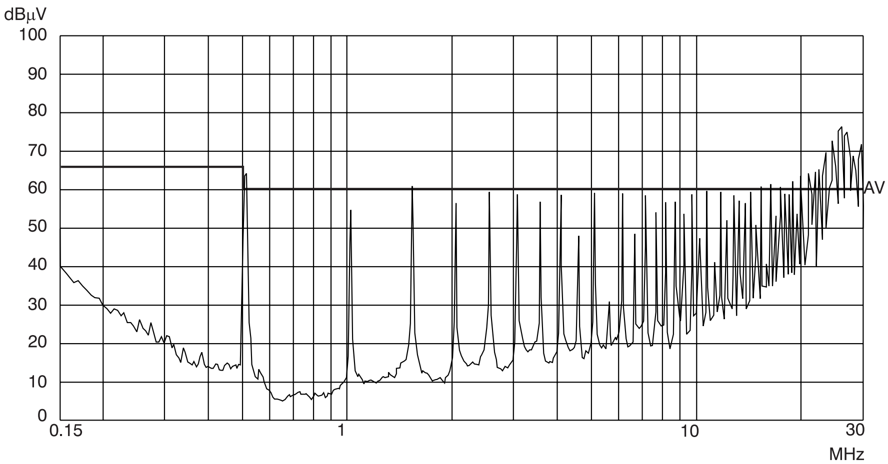
1. Maximum deviation $\Delta V_O < 0.1 \times V_{Oi}$
   Recover time $t_r < 100\ \mu s$
   The output voltage deviation is determined by the load transient (dI/dt)

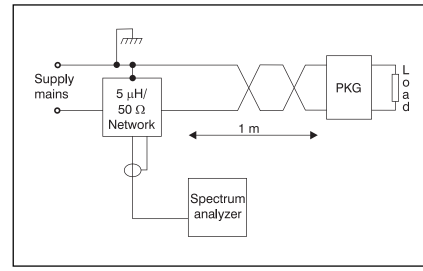
2. Load change:
   $0.25 \times I_{Onom} \ldots 0.75 \times I_{Onom} \ldots 0.25 \times I_{Onom}$
   $dI/dt \approx 5\ A/\mu s$

EMC Specifications

The PKG 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% @ V_I = 53 V, I_O = (0.1...1.0) × $I_{O\ max}$.

Conducted EMI Input terminal value (typ)

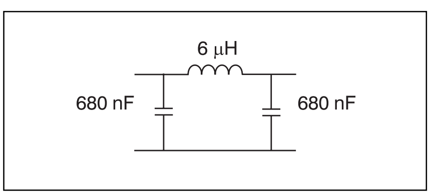




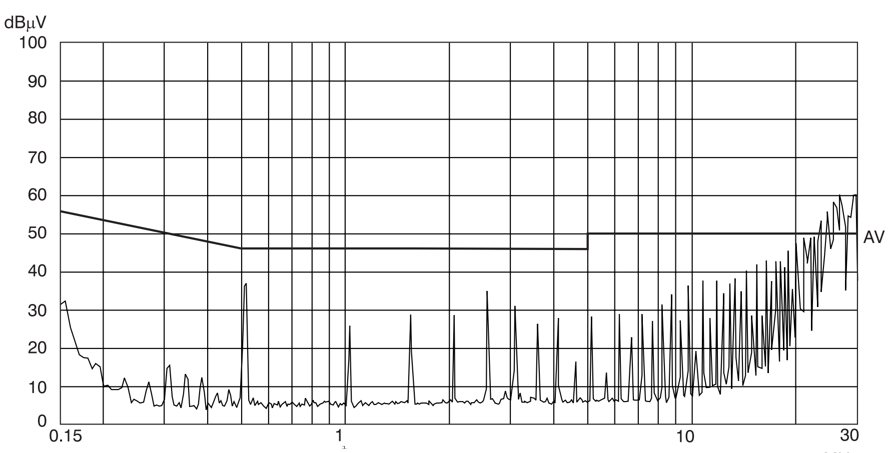
Test Set-up according to CISPR publ. 1A.

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.



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

EFT

Electrical Fast Transients on the input terminals may cause output deviations outside what is tolerated by the electronic circuits, i.e. ±5%.
The PKG 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 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

Remote Control (RC)

Remote turn-on and turn-off can be realized by using the RC-pin. Normal operation is achieved if pin 1 is open (NC). If pin 1 is connected to pin 4 the PKG power module turns off. To ensure safe turn-off the voltage difference between pin 1 and 4 shall be less than 1.0 V. RC is TTL open collector compatible (see fig. 1).

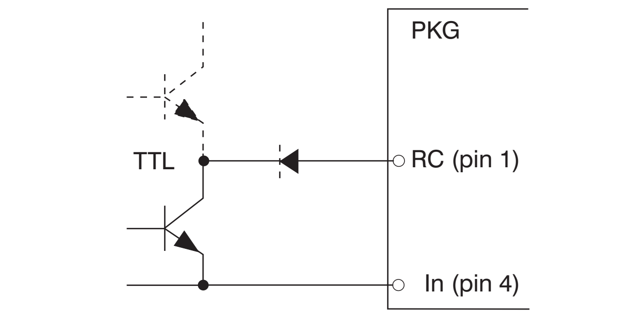


Fig. 1

Over Voltage Protection (OVP)

The PKG series has an internal Over Voltage Protection circuitry. The circuitry will detect over voltage conditions on the output and stop the power module operation. During OVP conditions there are continuous attempts to start up (non-latching mode). If latching mode is preferred an external circuit can be used to change the function and make the output remain in off mode after over voltage detection. (The OVP level can be found in the output data section.)

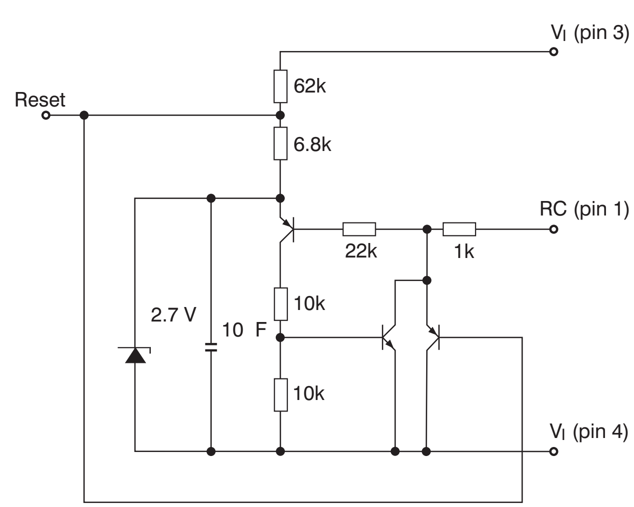


Fig. 2

Turn-off Input Voltage (TOA)

The power module monitors the input voltage and will turn on and turn off at predetermined levels. The levels can be decreased by means of an external resistor connected between pin 2 and pin 3.
A 0.5 MΩ resistor will decrease the turn-off input voltage approximately 10%.

Output Voltage Adjust (V_{adj})

To decrease the output voltage the resistor should be connected between pin 10 and pin 9 (+ Out 1). To increase the output voltage the resistor should be connected between pin 10 and pin 8 (–Out1). Output voltage, V_O, can be adjusted by using an external resistor. A 0.1 MΩ resistor will change V_O approximately 5%.

Maximum Capacitive Load

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

Parallel Operation

The load regulation characteristics and temperature coefficients of the PKG DC/DC Power Modules are designed to allow parallel operation. Paralleling of several modules is easily accomplished by connection of the output voltage terminal pins. The connections should be symmetrical, i.e. the resistance between the output terminal and the common connection point of each module should be equal. Good paralleling performance is achieved if you allow the resistance to be 10 mΩ.
10 mΩ equals 50 mm (2 in) of 35 µm (1 oz/ft^2) copper with a trace width of 2.5 mm (0.1 in).
It is recommended not to exceed $P_O = n \times 0.8 \times P_{O\,max}$, where $P_{O\,max}$ is the maximum converter output power and n the number of paralleled converters, in order to avoid overloading any of the converters and thereby decreasing the reliability.
Paralleling performance may be further improved by voltage matching. Voltage matching is accomplished by using the Output Adjust function and trim the outputs to the same voltage.

Current Limiting Protection

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

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 or output if the source or load inductance is larger 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.

Quality

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 contledenvironments (TA =–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, as well as high competence of an engaged work force, contribute to the high quality of our products.

Warranty

Ericsson Microelectronics 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 we refer to Ericsson Microelectronics AB's "General Terms and Conditions of Sales", or individual contract documents.

Limitation of Liability

Ericsson Microelectronics 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	Output 2		
48/60 V	2.1 V/14.5 A		30 W	PKG 4310 PI
	2.5 V/15 A		38 W	PKG 4319 PI
	3.3 V/14 A		46 W	PKG 4410 PI
	5 V/12 A		60 W	PKG 4611 PI
	6.2 V/10 A		60 W	PKG 4617 PIOA
	3.3 V/9.6 A	5 V/6.4 A	40 W	PKG 4428 PI
	12 V/4 A	12 V/4 A	60 W	PKG 4623 PI
	15 V/3.2 A	15 V/3.2 A	60 W	PKG 4625 PI
	5 V/9 A	12 V/3 A	60 W	PKG 4627 PI

Ericsson Microelectronics
SE-164 81 KISTA, Sweden
Phone: +46 8 757 5000
www.ericsson.com/microelectronics

For local sales contacts, please refer to our website
or call: Int. +46 8 757 4700, Fax: +46 8 757 4776

The latest and most complete information can be found on our website!

Data Sheet

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