

## 46–60 W DC/DC Power Modules 24 V Input Series

- Efficiency typ 84% at 5 V and full load
- Low profile 11.0 mm (0.43 in.)
- 1,500 V dc isolation voltage (duals = 1,000 V dc)
- 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 2000 I series of low profile DC/DC Power Modules are intended as distributed power sources in decentralized +24 V DC power systems. They can be used as on-board distributed power modules, or serve as building blocks for more centralized power boards. The PKG series of DC/DC power modules provide up to 60W of output power utilizing the standard EriPower™ PKA/PKE pin-out, with an even smaller footprint, and a power density of 20 W/cu.in. The high efficiency makes it possible to operate over a wide temperature range without any extra heat-sinks. At forced convection cooling >200 lfm (1 m/s), the PKG units can deliver full power without heatsinks up to +60°C ambient. With derated output power it can also operate in temperature controlled

environments with free convection cooling. By adding external heatsinking, the temperature range can be extended even further. Thanks to their peak power capability, the PKG series is ideal for applications where max power is only required during short durations e.g. in disc drives.

The PKG series use ceramic substrates 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.*

# General

## Absolute Maximum Ratings

Characteristics		min	max	Unit
T <sub>C</sub>	Case temperature @ max output power	-45	+100	°C
T <sub>S</sub>	Storage temperature	-55	+125	°C
V <sub>I</sub>	Input voltage	-0.5	+40	V dc
V <sub>ISO</sub>	Isolation voltage (input to output test voltage)	Singel output 1,500 dual output 1,000		V dc
V <sub>RC</sub>	Remote control voltage pin 1	-10	+10	V dc
V <sub>adj</sub>	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<sub>C</sub> < T<sub>C</sub> max

Characteristics		Conditions	min	typ	max	Unit
V <sub>I</sub>	Input voltage range <sup>1)</sup>		18	36		V
V <sub>Ioff</sub>	Turn-off input voltage	(See Operating Information)		16		V
V <sub>Ion</sub>	Turn-on input voltage	(See Operating Information)		17		V
r <sub>Irush</sub>	Equivalent inrush current resistance			10		mΩ
C <sub>I</sub>	Input capacitance			3.6		μF
P <sub>Ii</sub>	Input idling power	I <sub>O</sub> =0, T <sub>C</sub> = -30...+90°C		1.0	2.0	W
P <sub>RC</sub>	Input stand-by current	V <sub>I</sub> = 26 V, T <sub>C</sub> = +25°C RC connected to pin 4		1.0		W

## Environmental Characteristics

Characteristics	Test procedure & conditions		
Vibration (Sinusoidal)	IEC 68-2-6 F <sub>C</sub>	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 <sub>d</sub>	Frequency Acceleration Spectral density Duration Reproducibility	10...500 Hz 0.5 g <sup>2</sup> /Hz 10 min in 3 directions medium (IEC 62-2-36)
Shock (Half sinus)	IEC 68-2-27 E <sub>a</sub>	Peak acceleration Shock duration	200 g 3 ms
Temperature change	IEC 68-2-14 N <sub>a</sub>	Temperature Number of cycles	-40°C to +125°C 100
Accelerated damp heat	IEC 68-2-3 C <sub>a</sub> with bias	Temperature Humidity Duration	85°C 85% RH 1000 hours
Solder resistability	IEC 68-2-20 T <sub>b</sub> 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 2000 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 PKG 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<sub>C</sub>max when in operation. They are intended to be supplied by isolated secondary circuitry and shall be installed in compliance with the requirements of the ultimate application. If connected to a 24 V DC power system reinforced insulation must be provided in the power supply that isolates the input from the ac mains. The isolation in the DC/DC power module is an operational insulation in accordance with EN 60 950. 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.

The isolation voltage is a galvanic isolation and is verified in an electric strength test. Test voltage (V<sub>ISO</sub>) 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.

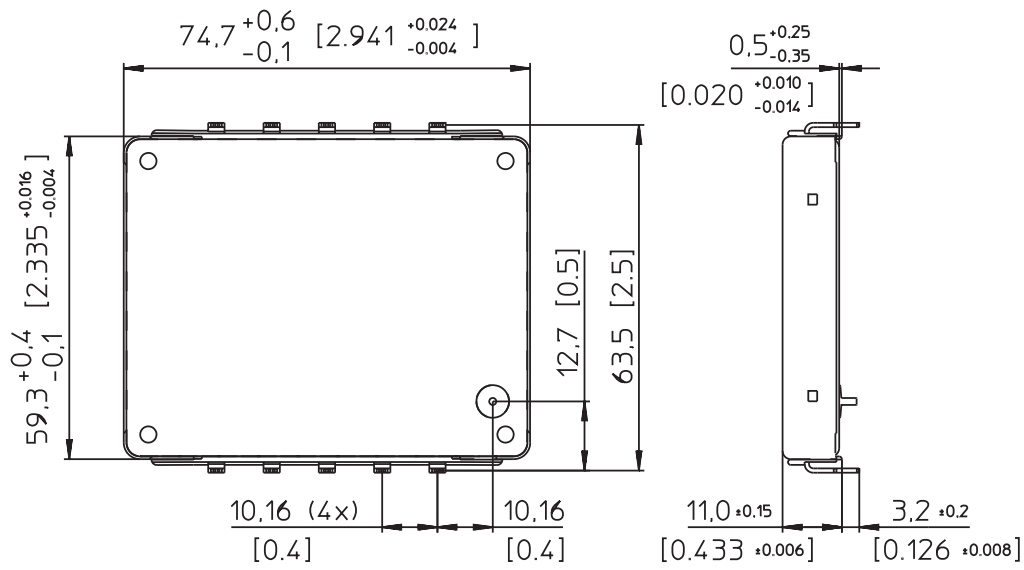
The capacitor between input and output has a value of 4.7 nF (duals = 22 nF) and the leakage current is less than 1μA @ 26 Vdc.

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

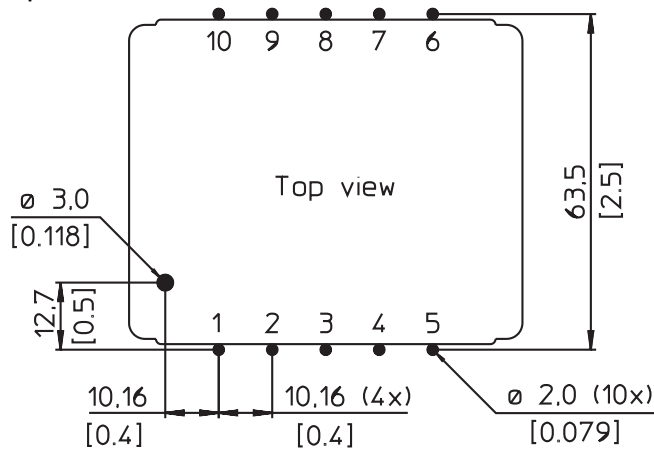
### Note:

<sup>1)</sup> The input voltage range 19...36 V meets the requirements for Normal input voltage range in 24 V DC power systems, 20...30 V. At input voltages exceeding 36 V (abnormal voltage) the power loss will be higher than at normal input voltage and T<sub>C</sub> must be limited to max +90°C. Absolute max continuous input voltage is 40 V dc. Output characteristics will be marginally affected at 18 V (see also Turn-off Input Voltage).

## 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.
2	TOA	Turn-on/off input voltage adjust (see Operating information).
3	-In	Negative input. Connected to case.
4	+In	Positive 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 <sub>adj</sub>	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 DC/DC power module is determined by thermal conduction in the connected pins and thermal convection from the substrate via the case.

The two-parameter model characterize 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 power module mounted on a printed board assembly (PBA).

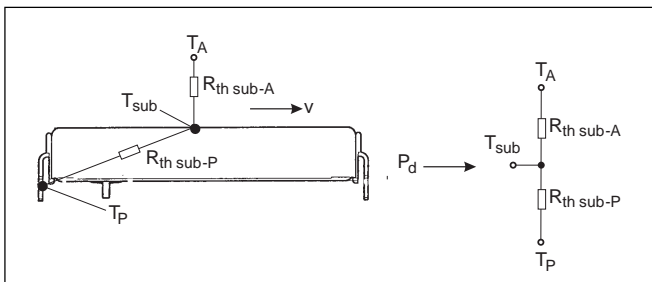
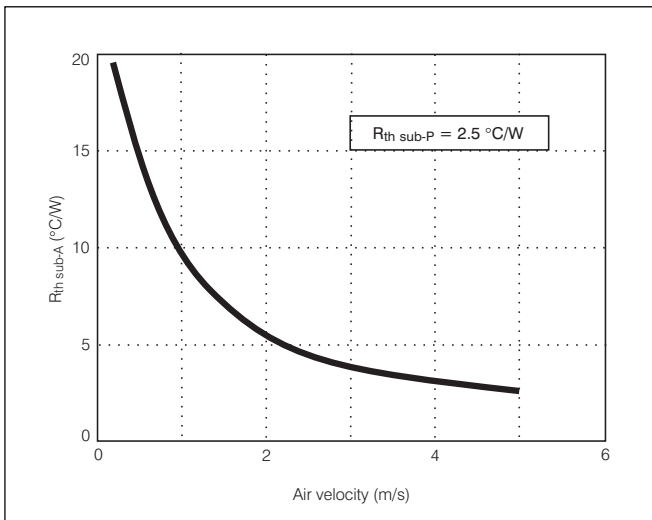
Note that the thermal resistance between the substrate and the air,  $R_{th\ sub-A}$  is strongly dependent on the air velocity.

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

Where:

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

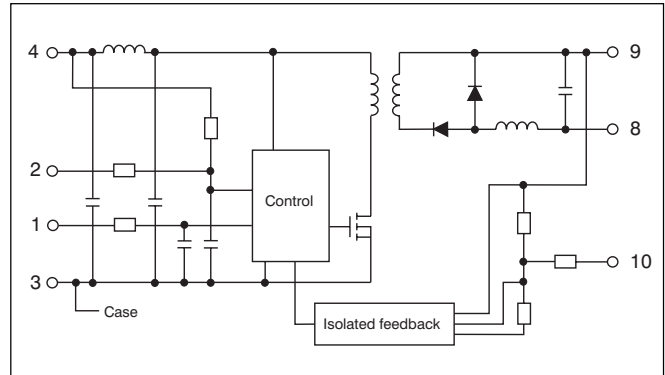
The PKG DC/DC power modules have an internal over temperature protection circuit. If the case temperature exceeds  $\text{min } +115^\circ\text{C}$  the power module will go into OTP-mode. As long as the case temperature exceeds  $\text{min } +115^\circ\text{C}$  the power module will operate in OTP-mode.

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  $\text{min } +115^\circ\text{C}$ .

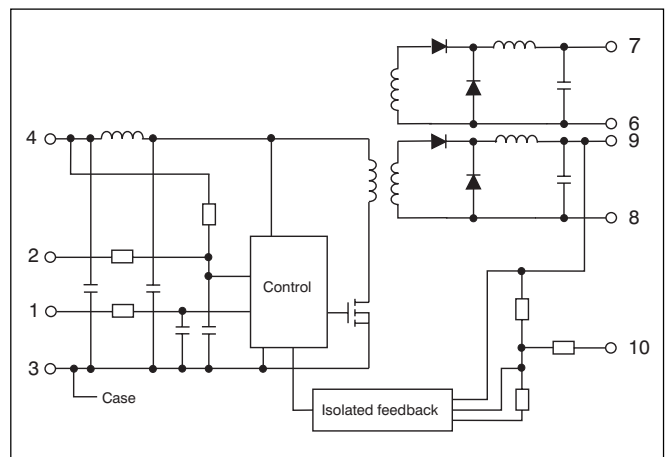
# Electrical Data

## Fundamental circuit diagrams

### Single output



### Dual output



# PKG 2410 PI

$T_C = -30 \dots +90^\circ\text{C}$ ,  $V_I = 19 \dots 36\text{ V}$  unless otherwise specified.

## Output

Characteristics		Conditions		Output 1			Unit	
				min	typ	max		
$V_{O_i}$	Output voltage initial setting and accuracy	$T_C = +25^\circ\text{C}$ , $I_O = I_{O\text{max}}$ , $V_I = 26\text{ V}$		3.28	3.30	3.32	V	
	Output adjust range <sup>1)</sup>			2.40		3.65	V	
$V_O$	Output voltage tolerance band	Long term drift included	$I_O = 0.1 \dots 1.0 \times I_{O\text{max}}$	3.10		3.40	V	
	Idling voltage	$I_O = 0\text{ A}$				4.0	V	
	Line regulation	$I_O = I_{O\text{max}}$			10		mV	
	Load regulation	$I_O = 0.1 \dots 1.0 \times I_{O\text{max}}$ , $V_I = 26\text{ V}$			35		mV	
$t_{tr}$	Load transient recovery time	$I_O = 0.1 \dots 1.0 \times I_{O\text{max}}$ , $V_I = 26\text{ V}$ load step = $0.5 \times I_{O\text{max}}$			100	150	$\mu\text{s}$	
$V_{tr}$	Load transient voltage				+200			mV
					-300			mV
$T_{\text{coeff}}$	Temperature coefficient <sup>2)</sup>	$I_O = I_{O\text{max}}$ , $T_C < T_{C\text{max}}$		see PKG 2410 Temperature characteristics				
$t_r$	Ramp-up time	$I_O = 0.1 \dots 1.0 \times I_{O\text{max}}$	$0.1 \dots 0.9 \times V_O$		10	15	ms	
$t_s$	Start-up time		From $V_I$ connection to $V_O = 0.9 \times V_{O_i}$		15		ms	
$I_O$	Output current			0		14	A	
$P_{O\text{max}}$	Max output power <sup>3)</sup>	Calculated value			46		W	
$I_{\text{lim}}$	Current limiting threshold	$T_C < T_{C\text{max}}$		14.4			A	
$I_{\text{sc}}$	Short circuit current	$V_O = 0.2 \dots 0.5\text{ V}$ , $T_A = 25^\circ\text{C}$			18		A	
$V_{O\text{ac}}$	Output ripple & noise	$I_O = I_{O\text{max}}$	20 Hz ... 5 MHz		60	100	mV <sub>p-p</sub>	
			0.60 ... 30 MHz			70	dB $\mu\text{V}$	
SVR	Supply voltage rejection (ac)	$f = 100\text{ Hz}$ sine wave, $1\text{ V}_{p-p}$ , $V_I = 26\text{ V}$ ( $\text{SVR} = 20 \log(1 \text{ V}_{p-p} / V_{O\text{p-p}})$ )		45			dB	
OVP	Over voltage protection	$I_O > 0.1 \times I_{O\text{max}}$			4		V	

<sup>1)</sup> See Operating information.

<sup>2)</sup> Temperature coefficient is positive at low temperatures and negative at high temperatures.

<sup>3)</sup> See also Typical Characteristics, Power derating.

## Miscellaneous

Characteristics		Conditions	min	typ	max	Unit
$\eta$	Efficiency	$I_O = I_{O\text{max}}$ , $V_I = 26\text{ V}$		79.5		%
$P_d$	Power dissipation	$I_O = I_{O\text{max}}$ , $V_I = 26\text{ V}$		12		W

# PKG 2611 PI

$T_C = -30 \dots +90^\circ\text{C}$ ,  $V_I = 19 \dots 36\text{ V}$  unless otherwise specified.

## Output

Characteristics		Conditions		Output 1			Unit
				min	typ	max	
$V_{O_i}$	Output voltage initial setting and accuracy	$T_C = +25^\circ\text{C}$ , $I_O = I_{O\text{max}}$ , $V_I = 26\text{ V}$		5.12	5.15	5.18	V
	Output adjust range <sup>1)</sup>			4.60		5.60	V
$V_O$	Output voltage tolerance band	Long term drift included	$I_O = 0.1 \dots 1.0 \times I_{O\text{max}}$	5.05		5.25	V
	Idling voltage	$I_O = 0\text{ A}$				5.80	V
	Line regulation	$I_O = I_{O\text{max}}$			10		mV
	Load regulation	$I_O = 0.1 \dots 1.0 \times I_{O\text{max}}$ , $V_I = 26\text{ V}$			30		mV
$t_{tr}$	Load transient recovery time	$I_O = 0.1 \dots 1.0 \times I_{O\text{max}}$ , $V_I = 26\text{ V}$ load step = $0.5 \times I_{O\text{max}}$			100	150	$\mu\text{s}$
$V_{tr}$	Load transient voltage			+350			mV
				-500			mV
$T_{\text{coeff}}$	Temperature coefficient <sup>2)</sup>	$I_O = I_{O\text{max}}$ , $T_C < T_{C\text{max}}$		see PKG 2611 Temperature characteristics			
$t_r$	Ramp-up time	$I_O = 0.1 \dots 1.0 \times I_{O\text{max}}$	$0.1 \dots 0.9 \times V_O$		10	15	ms
$t_s$	Start-up time		From $V_I$ connection to $V_O = 0.9 \times V_{O_i}$		20		ms
$I_O$	Output current			0		12	A
$P_{O\text{max}}$	Max output power <sup>3)</sup>	Calculated value			60		W
$I_{\text{lim}}$	Current limiting threshold	$T_C < T_{C\text{max}}$		12.1			A
$I_{\text{sc}}$	Short circuit current	$V_O = 0.2 \dots 0.5\text{ V}$ , $T_A = 25^\circ\text{C}$			17		A
$V_{O\text{ac}}$	Output ripple & noise	$I_O = I_{O\text{max}}$	20 Hz...5 MHz		50	100	mV <sub>p-p</sub>
			0.60...30 MHz			80	dB $\mu\text{V}$
SVR	Supply voltage rejection (ac)	$f = 100\text{ Hz}$ sine wave, 1 V <sub>p-p</sub> , $V_I = 26\text{ V}$ ( $\text{SVR} = 20 \log(1 \text{ V}_{p-p}/V_{O\text{p-p}})$ )		50			dB
OVP	Over voltage protection	$I_O > 0.1 \times I_{O\text{max}}$			6		V

<sup>1)</sup> See Operating information.

<sup>2)</sup> Temperature coefficient is positive at low temperatures and negative at high temperatures.

<sup>3)</sup> See also Typical Characteristics, Power derating.

## Miscellaneous

Characteristics		Conditions		min	typ	max	Unit
$\eta$	Efficiency	$I_O = I_{O\text{max}}$ , $V_I = 26\text{ V}$			84		%
$P_d$	Power dissipation	$I_O = I_{O\text{max}}$ , $V_I = 26\text{ V}$			11.5		W

# PKG 2623 PI

$T_C = -30...+90^\circ\text{C}$ ,  $V_I = 19...36\text{ V}$  unless otherwise specified.  $I_{O1\text{ nom}} = 2.5\text{ A}$ ,  $I_{O2\text{ nom}} = 2.5\text{ A}$ .

## Output

Characteristics		Conditions		Output 1			Output 2			Unit		
				min	typ	max	min	typ	max			
$V_{O1}$	Output voltage initial setting and accuracy	$T_C = +25^\circ\text{C}$ , $I_O = 2.5\text{ A}$ , $V_I = 26\text{ V}$		11.98	12.10	12.22	11.98	12.10	12.22	V		
	Output adjust range <sup>1)</sup>			8.50		13.20		8.50		13.20		V
$V_O$	Output voltage tolerance band	Long term drift included	$I_O = 0.1...1.0 \times I_{O\text{ nom}}$ $I_{O1} = I_{O2}$	11.70		12.50		11.70		12.60		V
	Idling voltage	$I_O = 0\text{ A}$		12.95			20			V		
	Line regulation	$I_O = I_{O\text{ nom}}$	$V_I = 19...36\text{ V}$	10						mV		
	Load regulation	$I_{O1} = 0.1...1.0 \times I_{O1\text{ nom}}$ , $I_{O2} = I_{O2\text{ nom}}$ , $V_I = 26\text{ V}$		10						mV		
$t_{\text{tr}}$	Load transient recovery time	$I_O = 0.1...1.0 \times I_{O\text{ nom}}$ , $V_I = 26\text{ V}$ load step = $0.5 \times I_{O\text{ nom}}$ , $I_{O1} = I_{O2}$		100			100			$\mu\text{s}$		
$V_{\text{tr}}$	Load transient voltage			+500			+500			mV		
		-850			-850			mV				
$T_{\text{coeff}}$	Temperature coefficient <sup>2)</sup>	$I_O = I_{O\text{ nom}}$ , $T_C < T_{C\text{ max}}$		see PKG 2623 Temperature characteristics								
$t_r$	Ramp-up time	$I_O = 0.1...1.0 \times I_{O\text{ nom}}$	$0.1...0.9 \times V_O$	15		15				ms		
$t_s$	Start-up time		From $V_I$ connection to $V_O = 0.9 \times V_{O1}$		25		25				ms	
$I_O$	Output current			0		4.0		0		4.0		A
$P_{O\text{ max}}$	Max total output power <sup>3)</sup>	Calculated value		60						W		
$I_{\text{lim}}$	Current limiting threshold	$T_C < T_{C\text{ max}}$		min $1.05 \times P_{O\text{ max}}$ <sup>4)</sup>								
$I_{\text{sc}}$	Short circuit current	$V_O = 0.2...0.5\text{ V}$ , $T_A = 25^\circ\text{C}$ , $R_{\text{SC}} > 0.1\Omega$		6		6				A		
$V_{O\text{ ac}}$	Output ripple & noise	$I_O = I_{O\text{ nom}}$	20 Hz... 5 MHz	60		150		60		150		mV <sub>p-p</sub>
			0.60...30 MHz	75		75						dB $\mu\text{V}$
SVR	Supply voltage rejection (ac)	$f = 100\text{ Hz}$ sine wave, $1\text{ V}_{p-p}$ , $V_I = 26\text{ V}$ (SVR = $20 \log(1 \text{ V}_{p-p}/V_{O\text{ p-p}})$ )		43			43			dB		
OVP	Over voltage protection	$I_O > 0.1 \times I_{O\text{ max}}$		15						V		

<sup>1)</sup> See Operating information.

<sup>2)</sup> Temperature coefficient is positive at low temperatures and negative at high temperatures.

<sup>3)</sup> See also Typical Characteristics, Power derating.

<sup>4)</sup>  $I_{\text{lim}}$  on each output is set by the total load.

## Miscellaneous

Characteristics		Conditions	min	typ	max	Unit
$\eta$	Efficiency	$I_O = I_{O\text{ max}}$ , $V_I = 26\text{ V}$		88		%
$P_d$	Power dissipation	$I_O = I_{O\text{ max}}$ , $V_I = 26\text{ V}$		8.2		W

# PKG 2625 PI

$T_C = -30...+90^\circ\text{C}$ ,  $V_I = 19...36\text{ V}$  unless otherwise specified.  $I_{O1\text{ nom}} = 2.0\text{ A}$ ,  $I_{O2\text{ nom}} = 2.0\text{ A}$ .

## Output

Characteristics		Conditions		Output 1			Output 2			Unit
				min	typ	max	min	typ	max	
$V_{O1}$	Output voltage initial setting and accuracy	$T_C = +25^\circ\text{C}$ , $I_O = 2.5\text{ A}$ , $V_I = 26\text{ V}$		14.90	15.00	15.10	14.90	15.00	15.10	V
	Output adjust range <sup>1)</sup>			10.5		16.5	10.5		16.5	V
$V_O$	Output voltage tolerance band	Long term drift included	$I_O = 0.1...1.0 \times I_{O\text{ nom}}$ $I_{O1} = I_{O2}$	14.20		15.65	14.20		16.10	V
	Idling voltage	$I_O = 0\text{ A}$				17			26	V
	Line regulation	$I_O = I_{O\text{ nom}}$	$V_I = 19...36\text{ V}$	10						mV
	Load regulation	$I_{O1} = 0.1...1.0 \times I_{O1\text{ nom}}$ , $I_{O2} = I_{O2\text{ nom}}$ , $V_I = 26\text{ V}$		10						mV
$t_{\text{tr}}$	Load transient recovery time	$I_O = 0.1...1.0 \times I_{O\text{ nom}}$ , $V_I = 26\text{ V}$ load step = $0.5 \times I_{O\text{ nom}}$ , $I_{O1} = I_{O2}$		100			100			$\mu\text{s}$
$V_{\text{tr}}$	Load transient voltage			+500			+500			mV
				-1000			-1000			mV
$T_{\text{coeff}}$	Temperature coefficient <sup>2)</sup>	$I_O = I_{O\text{ nom}}$ , $T_C < T_{C\text{ max}}$		see PKG 2625 Temperature characteristics						
$t_r$	Ramp-up time	$I_O = 0.1...1.0 \times I_{O\text{ nom}}$	$0.1...0.9 \times V_O$	5			5			ms
$t_s$	Start-up time		From $V_I$ connection to $V_O = 0.9 \times V_{O1}$		15			15		
$I_O$	Output current			0		3.2	0		3.2	A
$P_{O\text{ max}}$	Max total output power <sup>3)</sup>	Calculated value		60						W
$I_{\text{lim}}$	Current limiting threshold	$T_C < T_{C\text{ max}}$		min $1.05 \times P_{O\text{ max}}^4)$						
$I_{\text{sc}}$	Short circuit current	$V_O = 0.2...0.5\text{ V}$ , $T_A = 25^\circ\text{C}$ , $R_{\text{SC}} > 0.1\Omega$		5			5			A
$V_{O\text{ ac}}$	Output ripple & noise	$I_O = I_{O\text{ nom}}$		20 Hz... 5 MHz		60	150	60	150	$\text{mV}_{\text{p-p}}$
				0.60...30 MHz		75		75		$\text{dB}\mu\text{V}$
SVR	Supply voltage rejection (ac)	$f = 100\text{ Hz}$ sine wave, $1\text{ V}_{\text{p-p}}$ , $V_I = 26\text{ V}$ ( $\text{SVR} = 20 \log(1\text{ V}_{\text{p-p}}/V_{O\text{ p-p}})$ )		43			43			dB
OVP	Over voltage protection	$I_O > 0.1 \times I_{O\text{ max}}$		18						V

<sup>1)</sup> See Operating information.

<sup>2)</sup> Temperature coefficient is positive at low temperatures and negative at high temperatures.

<sup>3)</sup> See also Typical Characteristics, Power derating.

<sup>4)</sup>  $I_{\text{lim}}$  on each output is set by the total load.

## Miscellaneous

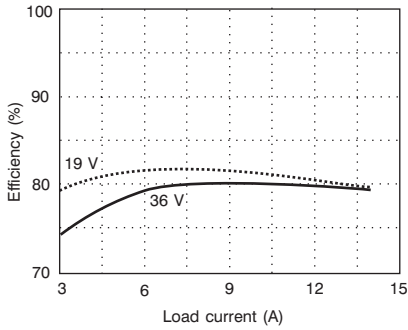
Characteristics		Conditions		min	typ	max	Unit
$\eta$	Efficiency	$I_O = I_{O\text{ max}}$ , $V_I = 26\text{ V}$			88		%
$P_d$	Power dissipation	$I_O = I_{O\text{ max}}$ , $V_I = 26\text{ V}$			8.2		W



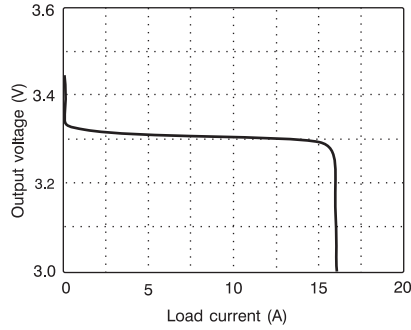
# Typical Characteristics

## PKG 2410 PI

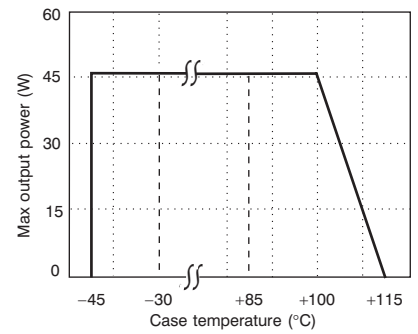
Efficiency (typ)



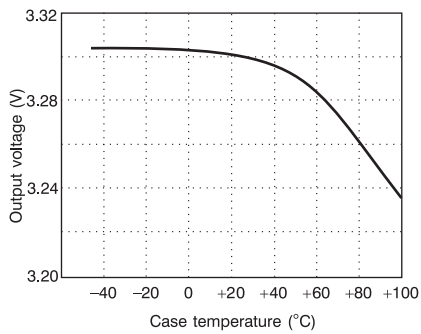
Output characteristic (typ)



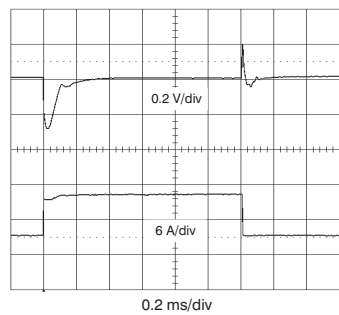
Power derating



Temperature characteristics



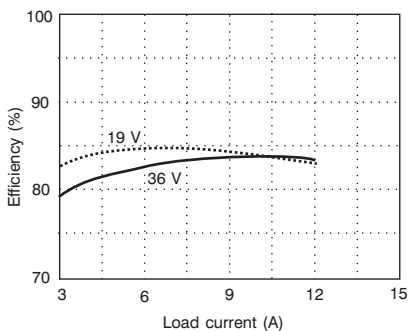
Dynamic load response (typ)



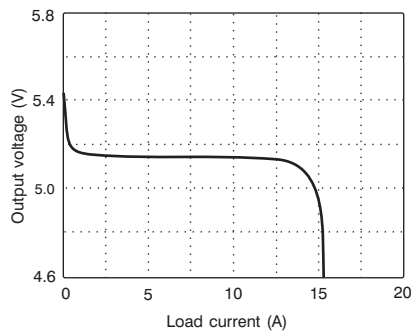
- A. Maximum deviation  $\Delta V_O < 0.1 \times V_{O_i}$   
 Recover time  $t_r < 100 \mu s$   
 The output voltage deviation is determined by the load transient (di/dt)
- B. Load change:  
 $0.25 \times I_{O_{nom}} \dots 0.75 \times I_O \dots 0.25 \times I_{O_{nom}}$   
 $I_{O_{nom}} = I_{O1_{nom}} + I_{O2_{nom}}$   
 $di/dt \approx 5 A/\mu s$

## PKG 2611 PI

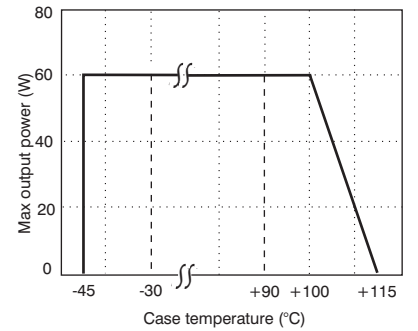
Efficiency (typ)



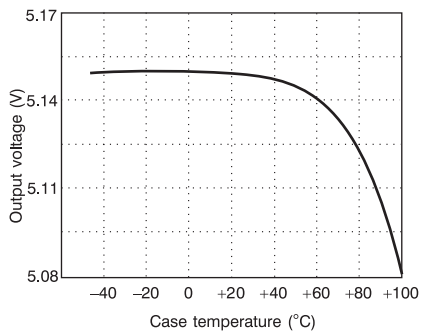
Output characteristic (typ)



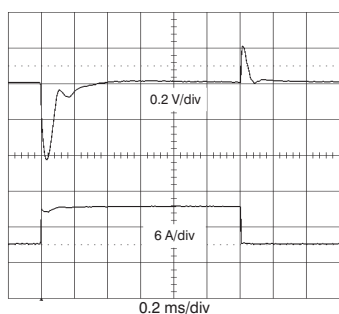
Power derating



Temperature characteristics



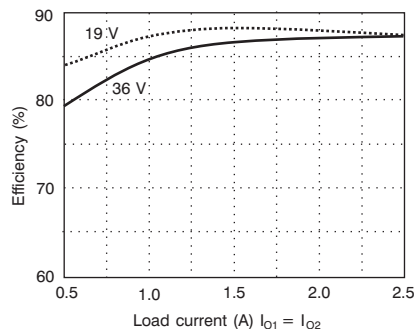
Dynamic load response (typ)



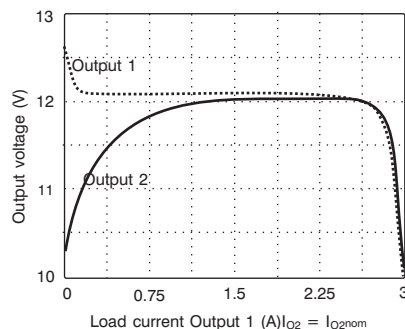
- A. Maximum deviation  $\Delta V_O < 0.1 \times V_{O_i}$   
 Recover time  $t_r < 100 \mu s$   
 The output voltage deviation is determined by the load transient (di/dt)
- B. Load change:  
 $0.25 \times I_{O_{nom}} \dots 0.75 \times I_O \dots 0.25 \times I_{O_{nom}}$   
 $I_{O_{nom}} = I_{O1_{nom}} + I_{O2_{nom}}$   
 $di/dt \approx 5 A/\mu s$

## PKG 2623 PI

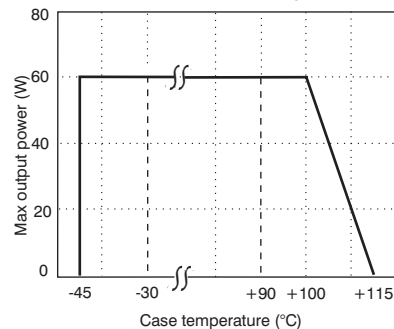
**Efficiency (typ)**



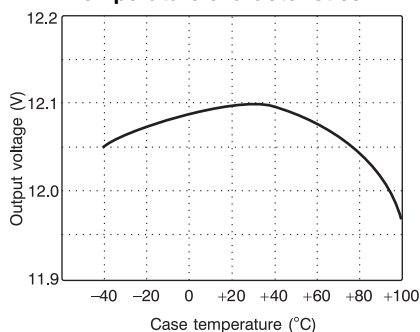
**Output characteristic (typ)**



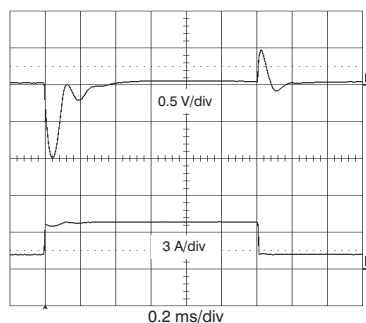
**Power derating**



**Temperature characteristics**



**Dynamic load response (typ)<sup>1)</sup>**



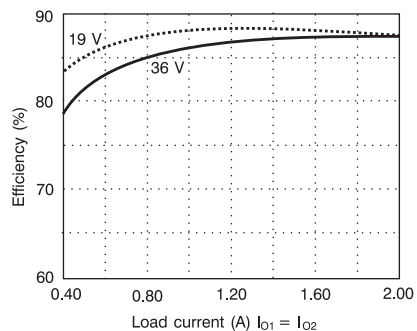
A. Maximum deviation  $\Delta V_O < 0.1 \times V_{O1}$   
Recover time  $t_r < 100 \mu s$   
The output voltage deviation is determined by the load transient (dI/dt)

B. Load change:  
 $0.25 \times I_{O nom} \dots 0.75 \times I_{O} \dots 0.25 \times I_{O nom}$   
 $I_{O nom} = I_{O1 nom} + I_{O2 nom}$   
 $dI/dt \approx 5 A/\mu s$

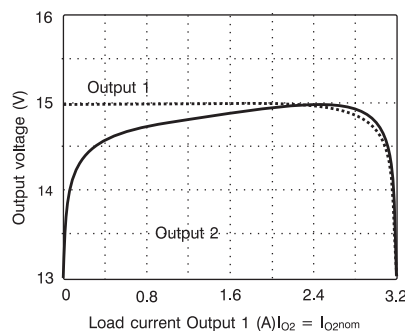
<sup>1)</sup> Outputs paralleled.

## PKG 2625 PI

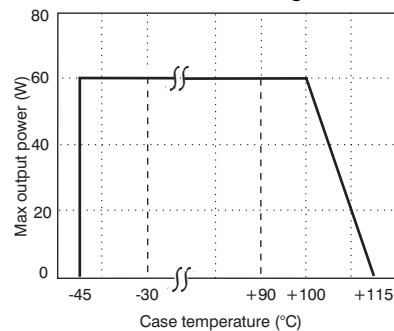
**Efficiency (typ)**



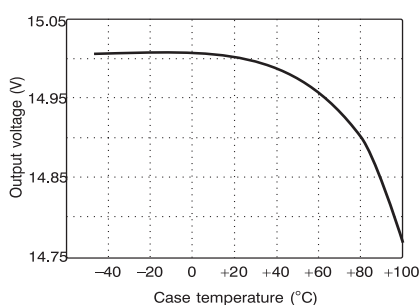
**Output characteristic (typ)**



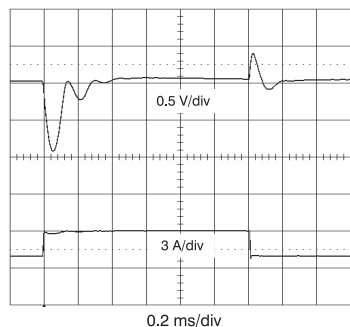
**Power derating**



**Temperature characteristics**



**Dynamic load response (typ)<sup>1)</sup>**



A. Maximum deviation  $\Delta V_O < 0.1 \times V_{O1}$   
Recover time  $t_r < 100 \mu s$   
The output voltage deviation is determined by the load transient (dI/dt)

B. Load change:  
 $0.25 \times I_{O nom} \dots 0.75 \times I_{O} \dots 0.25 \times I_{O nom}$   
 $I_{O nom} = I_{O1 nom} + I_{O2 nom}$   
 $dI/dt \approx 5 A/\mu s$

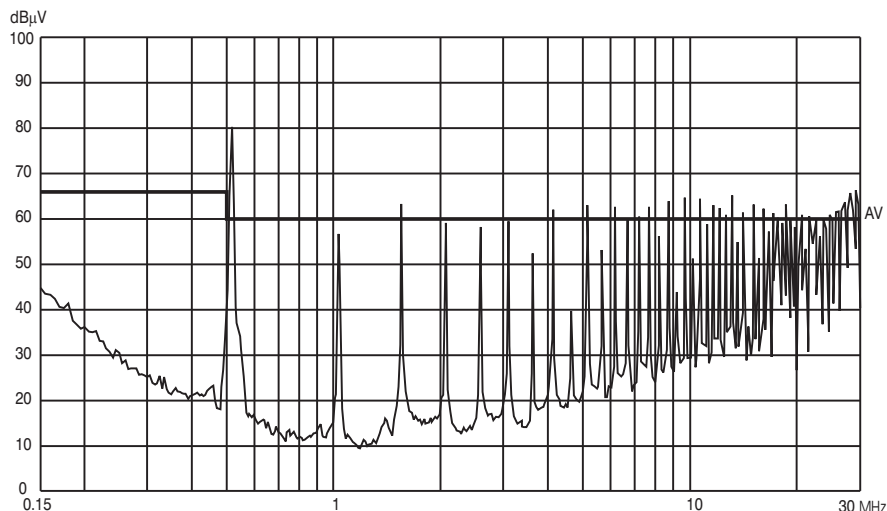
<sup>1)</sup> Outputs paralleled.

# EMC Specifications

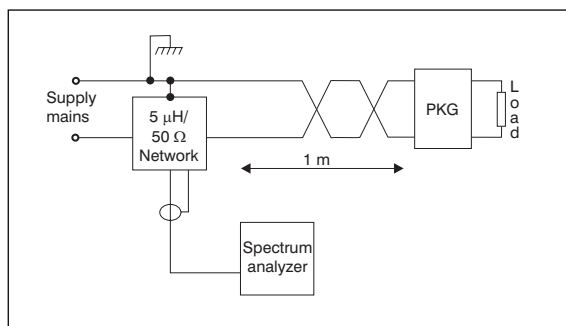
The PKG power module is mounted on a double sided printed circuit board (PB) with ground plane during EMC measurements.

The fundamental switching frequency is  $510 \text{ kHz} \pm 5\%$  @  $V_I = 26 \text{ V}$ ,  $I_O = (0.1 \dots 1.0) \times I_{O \text{ max}}$ .

## Conducted EMI Input terminal value (typ)



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



## 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.  $\pm 5\%$ .

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 ( $V_{Oac}$ )

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 3 the PKG power module turns off. To ensure safe turn-off the voltage difference between pin 1 and 3 shall be less than 1.0 V. RC is TTL open collector compatible (see fig. 1).

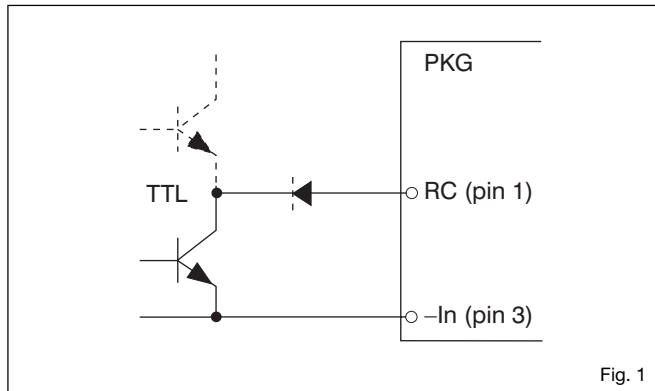


Fig. 1

## 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.)

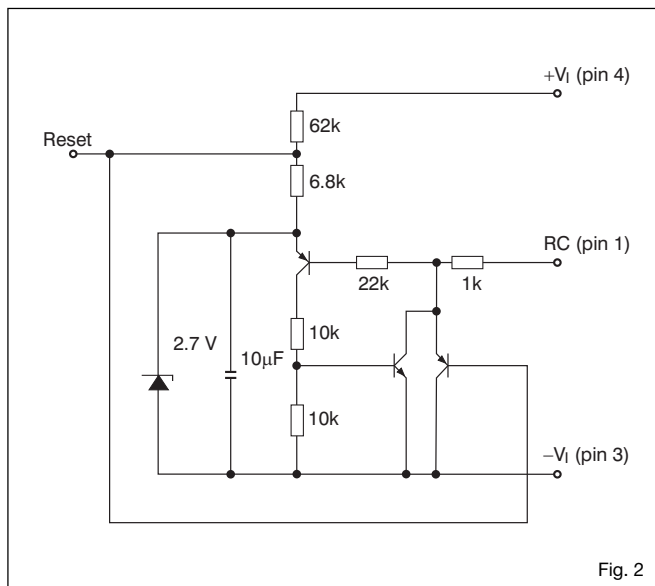


Fig. 2

## Turn-on/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 4. A 0.2 MΩ resistor will decrease the turn-off input voltage approximately 10%.

## Output Voltage Adjust ( $V_{adj}$ )

The output voltage,  $V_O$ , can be adjusted by using an external resistor. A 0.1 MΩ resistor will change  $V_O$  approximately 5%. 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 (- Out 1).

## Maximum Capacitive Load

The PKG 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 performance we recommend maximum 100 µF/A of  $I_O$  for dual outputs. Connect capacitors at the point of load for best performance.

## Parallel Operation

The load regulation characteristic and temperature coefficient 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<sup>2</sup>) 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 power module output power and n the number of paralleled units, not to overload any of them and thereby decrease the reliability performance.

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 continuously updated. The data correspond to actual failure rates of component used in Information Technology and Telecom equipment in temperature controlled environments ( $T_A = -5 \dots +65$ °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, 6 $\sigma$  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 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.

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## Product Program

$V_i$	$V_o/I_o$ max		$P_o$ max	Ordering No.
	Output 1	Output 2		
24 V	3.3 V/14 A <sup>1)</sup> 5 V/12 A <sup>1)</sup> 12 V/4 A 15 V/3.2 A <sup>1)</sup>	12 V/4 A 15 V/3.2 A	46 W 60 W 60 W 60 W	PKG 2410 PI PKG 2611 PI PKG 2623 PI PKG 2625 PI

<sup>1)</sup> Adjustable to 2.5V

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Data Sheet

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