Technical Specification

PIM 4710 series Power Interface Modules Input 36-75V, Output up to 20A / 780-1080 W	28701-BMR 455 40 Rev.B December 2016

Key Features

- Industry standard Quarter-brick 57.9 x 36.8 x 20.3 mm (2.28 x 1.45 x 0.80 in)
- 780 W at 39 Vin, 960 W at 48 Vin, 1080 W at 54 Vin
- High efficiency, typ. 98.8% at 780 W
- 15 A output current at 86°C, 2 m/s (300 LFM) airflow
- Low EMI design for CISPR Class B
- Monitoring via I^2C
- 2000 Vdc input to management power output isolation
- Optimized for ATCA applications and PICMG 3.7 (up to 800 W input power)
- Basic insulation according to IEC 62368-1
- MTBF 2.66 Mh

General Characteristics

- Dual input power feeds and enable
- Input transient suppression (IEC & ANSI standards)
- Reverse polarity protection
- Input under voltage shutdown
- Over temperature protection
- Output current protection
- A/B Feed loss alarm
- Inrush protection and hot swap functionality
- Hold-up charge and management
- 3.3 V / up to 7 A management power output
- Highly automated manufacturing ensures quality
- ISO 9001/14001 certified supplier

Safety Approvals

Design for Environment

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

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PIM 4710 series Power Interface Modules Input 36-75V, Output up to 20A / 780-1080 W	28701-BMR 455 40 Rev.B December 2016 © Ericsson AB

Ordering Information

Product program	Output
PIM 4610	16 A & 3.3V, 3.6 A (7 A)
PIM 4710	20 A & 3.3V, 3.6 A (7 A)

Product number and Packaging

PIM 4X10 $n_1n_2n_3n_4$				
Options	n_1	n_2	n_3	n_4
Mounting	o			
Function		o		
Lead length			o	
Delivery package				o

Options	Description	
n_1	P	Through hole
n_2	D DA DG DAG	Standard config. PMBus Limited I^2C (Industry standard) PMBus and Power good pin Limited I^2C and Power good pin
n_3	LA LB	3.69 mm 4.57 mm
n_4	/B	Soft tray*

Example: A through-hole mounted, PMBus logic, 3.69 mm pin length product with tray packaging would be PIM 4710 PDLA.

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

General Information

Reliability

The failure rate (λ) and mean time between failures (MTBF= $1/\lambda$) is calculated at max output power and an operating ambient temperature (T_A) of +40°C. Ericsson Power Modules uses Telcordia SR-332 Issue 2 Method 1 to calculate the mean steady-state failure rate and standard deviation (σ).

Telcordia SR-332 Issue 2 also provides techniques to estimate the upper confidence levels of failure rates based on the mean and standard deviation.

Mean steady-state failure rate, λ	Std. deviation, σ
377 nFailures/h	15.6 nFailures/h

MTBF (mean value) for the PIM 4x10 series = 2.66 Mh.
MTBF at 90% confidence level = 2.53 Mh

Compatibility with RoHS requirements

The products are compatible with the relevant clauses and requirements of the RoHS directive 2011/65/EU and have a maximum concentration value of 0.1% by weight in homogeneous materials for lead, mercury, hexavalent chromium, PBB and PBDE and of 0.01% by weight in homogeneous materials for cadmium.

Exemptions in the RoHS directive utilized in Ericsson Power Modules products are found in the Statement of Compliance document.

Ericsson Power Modules fulfills and will continuously fulfill all its obligations under regulation (EC) No 1907/2006 concerning the registration, evaluation, authorization and restriction of chemicals (REACH) as they enter into force and is through product materials declarations preparing for the obligations to communicate information on substances in the products.

Quality Statement

The products are designed and manufactured in an industrial environment where quality systems and methods like ISO 9000, Six Sigma, and SPC are intensively in use to boost the continuous improvements strategy. Infant mortality or early failures in the products are screened out and they are subjected to an ATE-based final test. Conservative design rules, design reviews and product qualifications, plus the high competence of an engaged work force, contribute to the high quality of the products.

Warranty

Warranty period and conditions are defined in Ericsson Power Modules General Terms and Conditions of Sale.

Limitation of Liability

Ericsson Power Modules does not make any other warranties, expressed or implied including any warranty of merchantability or fitness for a particular purpose (including, but not limited to, use in life support applications, where malfunctions of product can cause injury to a person's health or life).

Safety Specification

General information

PIM 4610 and PIM 4710 are designed in accordance with the safety standards IEC 62368-1, EN 62368-1 and UL 62368-1, *Audio/video, information and communication technology equipment - Part 1: Safety requirements* IEC/EN/UL 62368-1 contains requirements to prevent injury or damage due to the following hazards:

- Electrical shock
- Energy hazards
- Fire
- Mechanical and heat hazards
- Radiation hazards
- Chemical hazards

On-board DC/DC converters, Power interface modules and DC/DC regulators are defined as component power supplies. As components they cannot fully comply with the provisions of any safety requirements without “conditions of acceptability”. Clearance between conductors and between conductive parts of the component power supply and conductors on the board in the final product must meet the applicable safety requirements. Certain conditions of acceptability apply for component power supplies with limited stand-off (see Mechanical Information for further information). It is the responsibility of the installer to ensure that the final product housing these components complies with the requirements of all applicable safety standards and regulations for the final product.

Component power supplies for general use shall comply with the requirements in IEC/EN/UL 62368-1 or IEC/EN/UL 60950-1. Product related standards, e.g. IEEE 802.3af *Power over Ethernet*, and ETS-300132-2 *Power interface at the input to telecom equipment, operated by direct current (dc)* are based on IEC/EN/UL 60950-1 with regards to safety.

Safety Certification

PIM 4610 and PIM 4710 are UL 62368-1 recognized and certified in accordance with EN 62368-1. The flammability rating for all construction parts of the products meet requirements for V-0 class material according to IEC 60695-11-10, *Fire hazard testing, test flames* – 50 W horizontal and vertical flame test methods.

PIM 4610 and PIM 4710 meet all requirements for basic insulation according to IEC/EN/UL 62368-1:

- between input and management power output
- between input and shelf ground
- between management power output and shelf ground

The conditions of acceptability are described in the following sub document: 1/09830-BMR 455 40

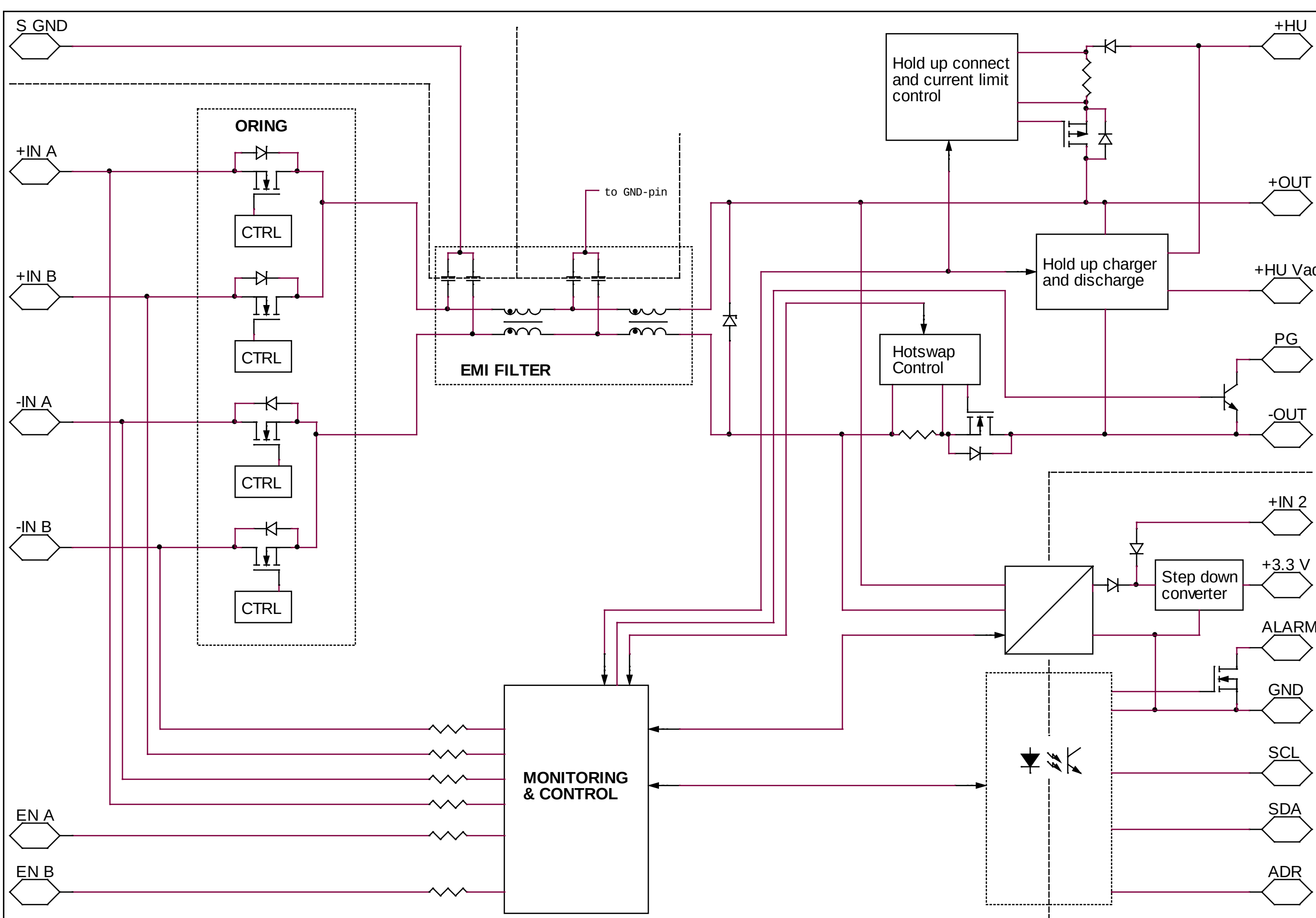
Absolute Maximum Ratings

Characteristics		min	typ	max	Unit
T_{P2}	Operating Temperature (see Thermal Consideration section)	-40		+105	°C
T_S	Storage temperature	-40		+125	°C
V_I	Input voltage	-75		75	V
V_I	Input voltage, reverse polarity. See Note 1.			75	V
V_I	Input voltage transient ANSI T1.315-2001 (R2006)			100	V
V_I	Common mode surge pulses (1.2/50 µs) IEC 61000-4-5			500	V
V_{ISO}	Isolation voltage, shelf ground to main unit			2000	Vdc
	Isolation voltage, shelf ground to management power			2000	
	Isolation voltage, main unit to management power			2000	
V_{HU}	Hold up capacitor voltage			100	V
C_{HU}	Hold up capacitor capacitance			6600	µF
V_{IN2}	External supply voltage			16	V
I_{ALARM}	Alarm sink current			135	mA
V_{ALARM}	Alarm open drain voltage			100	V
I_{PG}	Power good sink current			100	mA
V_{PG}	Power good, open collector voltage			120	V
V_{SCL}, V_{SDA}	SCL and SDA voltage	-0.5		6	V

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

Note 1: The voltage between +IN A and +IN B must be less than 100 V and the voltage between -IN A and -IN B must be less than 120 V.

Fundamental Circuit Diagram



Main Unit (Output 1), Electrical Specification

PIM 4610 / PIM 4710

T_{P1} = -40 to 90 ºC, V_I = 36 to 72 V, C_{O1} = 470 µF/38 mΩ electrolytic + 15 µF ceramic,
C_{O2} = 2 x 100 µF ceramic (see Note 5), unless otherwise specified under Conditions.
Typical values given at: T_{P1} = +25 °C, V_I = 53 V, max I_{O1}, I_{O2} = 3.6 A, unless otherwise specified under Conditions.

Characteristics		Conditions		min	typ	max	Unit
V_I	Input voltage range			36	53	72	V
$V_{I\ A/B\ off}$	Turn-off threshold voltage	Decreasing feed A and B voltage		32	33		V
$V_{I\ A/B\ on}$	Turn-on threshold voltage	Increasing feed A or B voltage			35	36	V
$I_{EN\ A/B}$	Enable input current				120	200	µA
C_I	Internal input capacitance	V_I = 0V			40		µF
η	Efficiency	P_{O1} = 600 W, I_{O2} = 0 A	PIM 4610		98.8		%
		I_{O1} = 16 A, I_{O2} = 0 A			98.5		
		I_{O1} = 16 A, I_{O2} = 3.6 A			98.2		
		P_{O1} = 780 W, I_{O2} = 0 A	PIM 4710		98.8		
		I_{O1} = 20 A, I_{O2} = 0 A			98.5		
		I_{O1} = 20 A, I_{O2} = 3.6 A			98.2		
Pd	Power Dissipation	I_{O1} = 16 A, I_{O2} = 3.6 A	PIM 4610		16	21	W
		I_{O1} = 20 A, I_{O2} = 3.6 A	PIM 4710		20	27	
P_{li}	Input idling power	V_I = 53 V, I_{O1} = I_{O2} = 0 A			1.8		W
I_{UVLO}	Input standby current	$V_I < V_{I\ A/B\ off}$				24	mA
t_r	Ramp-up time (from 10−90 % of V_{Oi})	I_{O1} = I_{O2} = 0 A.	PIM 4610		70		ms
			PIM 4710		45		
t_s	Start-up time (from V_I connection to 90 % of V_{Oi})		PIM 4610		250	435	ms
			PIM 4710		225	360	
I_{O1}	Output current	see Note 2	PIM 4610	0		16	A
			PIM 4710	0		20	
I_{lim}	Current limit threshold	T_{P1} < max T_{P1}	PIM 4610		20	20.5	A
			PIM 4710		24.5	25	
I^2t	E-Fuse rating	$I_{O1} > I_{lim}$				100	A^2s
I_{sc}	Short circuit current	T_{P1} = 25 ºC, see Note 3			0.1		A
C_{O1}	Recommended Capacitive Load	T_{P1} = 25 ºC, see Note 4		100		600	µF
I_{PK}	Inrush current transient	T_{P1} = 25 ºC				7	A

Note 2: No load allowed at start-up, see Hot Swap Functionality section

Note 3: Average current, hiccup mode over current protection

Note 4: See Hold Up Event Voltage section

Note 5: The stated value is the rated capacitance. With 3.3 V bias applied and with the particular frequency and amplitude of the ripple voltage the capacitance of the ceramic capacitors is approximately 50% lower than the rated value.

Hold up, Electrical Specification

PIM 4610 / PIM 4710

T_{P1} = -40 to 90 ºC, V_I = 36 to 72 V, C_{O1} = 470 µF/38 mΩ electrolytic + 15 µF ceramic,
C_{O2} = 2 x 100 µF ceramic (see Note 5), unless otherwise specified under Conditions.
Typical values given at: T_{P1} = +25 °C, V_I = 53 V, max I_{O1}, I_{O2} = 3.6 A, unless otherwise specified under Conditions.

Characteristics		Conditions		min	typ	max	Unit
C_{HU}	Hold up capacitance	See Hold Up Safe Operating Area				6600	µF
f_{HU}	Hold up generator switching frequency				500		kHz
V_{HU}	Hold up capacitor voltage adjust range			40		95	V
t_{HU}	Hold up time	C_{HU} = 3340 µF, V_{HU} = 75 V, P_{O1} = 600 W, I_{O2} = 3.6 A			10		ms
V_{HU_TRIG}	Input / output voltage threshold for hold up event				36.8		V
V_{HU_OVP}	Hold up over voltage protection				100		V
I_{HU}	Hold up charger current	V_{HU} = 75 V			10		mA
	Hold up charger short circuit current				80		mA
	Hold up dump current	$V_{HU} > V_{O1}$	PIM 4610		50		A
			PIM 4710		80		A

Alarm and Power Good, Electrical Specification

T_{P1} = -40 to 90 ºC, V_I = 36 to 72 V, C_{O1} = 470 µF/38 mΩ electrolytic + 15 µF ceramic,
C_{O2} = 2 x 100 µF ceramic (see Note 5), unless otherwise specified under Conditions.
Typical values given at: T_{P1} = +25 °C, V_I = 53 V, max I_{O1}, I_{O2} = 3.6 A, unless otherwise specified under Conditions.

Characteristics		Conditions	min	typ	max	Unit
V_I	Input voltage alarm threshold	Normal conditions, increasing feed A and B voltages		38.4		V
		Fault conditions, decreasing feed A or B voltages		36.9		V
V_{ALARM_OL}	Alarm low level output voltage	I_{ALARM} = 20 mA. Referenced to GND.			0.4	V
I_{ALARM_OH}	Alarm high level output current	V_{ALARM} = 5.0 V. Referenced to GND.			10	µA
V_{PG_OL}	Power good low level output voltage	I_{PG} = 8 mA. Referenced to -OUT.			0.4	V
I_{PG_OH}	Power good high level output current	V_{PG} = 5.0 V. Referenced to -OUT.			10	µA

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Management Power (Output 2), Electrical Specification

PIM 4610 / PIM 4710

T_{P3} = -40 to 90 ºC, V_I = 36 to 72 V, C_{O1} = 470 µF/38 mΩ electrolytic + 15 µF ceramic,
C_{O2} = 2 x 100 µF ceramic (see Note 5), unless otherwise specified under Conditions.
Typical values given at: T_{P3} = +25 °C, V_I = 53 V, max I_{O1}, I_{O2} = 3.6 A, unless otherwise specified under Conditions.

Characteristics		Conditions	min	typ	max	Unit
$V_{I\ A/B\ off}$	Turn-off threshold voltage	Decreasing feed A and B voltage	32	33		V
$V_{I\ A/B\ on}$	Turn-on threshold voltage	Increasing feed A or B voltage		35	36	V
V_{IN2}	External supply voltage		9	12	13.2	V
η	Efficiency	No external supply, I_{O1} = 0 A, I_{O2} = 3.6 A, see Note 6		71.9		%
		V_{IN2} = 12 V, I_{O1} = 0 A, I_{O2} = 3.6 A, see Note 7		88.9		
		V_{IN2} = 12 V, I_{O1} = 0 A, I_{O2} = 7 A, see Note 7		85.2		
P_d	Power Dissipation	No external supply, I_{O1} = 0 A, I_{O2} = 3.6 A, see Note 6		4.7	5.9	W
		V_{IN2} = 12 V, I_{O1} = 0 A, I_{O2} = 3.6 A, see Note 7		1.5	1.7	
		V_{IN2} = 12 V, I_{O1} = 0 A, I_{O2} = 7 A, see Note 7		4.0	4.9	
V_{Oi}	Output voltage initial setting and accuracy	T_{P1} = +25 °C, V_I = 53 V, I_{O2} = 1.8 A	3.27	3.33	3.38	V
V_O	Output voltage tolerance band	no external supply, I_{O2} = 0 to 3.6 A or V_{IN2} = 9 to 13.2 V, I_{O2} = 0 to 7 A	3.2		3.4	V
	Idling voltage	I_{O2} = 0 A	3.27	3.33	3.4	V
	Line regulation	V_I = 36 to 72 V, I_{O2} = 3.6 A		1		mV
	Load regulation	V_I = 53 V, no external supply, I_{O2} = 0...3.6 A		11		mV
		V_I = 53 V, V_{IN2} = 12 V, I_{O2} = 0...7 A		15		
V_{tr}	Load transient voltage deviation	V_I = 53 V, no external supply, Load step I_{O2} = 0.75-2.25-0.75 A, di/dt = 1 A/µs, C_{O2} = 6 x 100 µF ceramic, see Note 5		±75		mV
		V_I = 53 V, V_{IN2} = 12 V, Load step I_{O2} = 1.75-5.25-1.75 A, di/dt = 1 A/µs, C_{O2} = 470 µF/10 mΩ OS-CON + 4 x 100 µF ceramic, see Note 5		±100		
t_{tr}	Load transient recovery time			75		µs
t_r	Ramp-up time (from 10-90 % of V_{Oi})			3		ms
t_s	Start-up time (from V_I connection to 90 % of V_{Oi})			70		ms
I_O	Output current	Continuous output current, without external supply	0		3.6	A
		Continuous output current, with external supply	0		7	
I_{lim}	Current limit threshold	T_{P3} < max T_{P3}, no external supply		4.5	5.5	A
		T_{P3} < max T_{P3}, V_{IN2} = 12 V		10	11.5	
I_{sc}	Short circuit current	T_{P3} = 25 ºC		10	12.5	A
C_{O2}	Recommended Capacitive Load		100		4700	µF
V_{Oac}	Output ripple & noise	See Output ripple & noise section, I_O = 3.6 A		6		mV_{p-p}
f_s	Switching frequency	First stage		510		kHz
		Second stage		480		

Note 6: Idling losses in main unit are included

Note 7: Idling losses in main unit are not included

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Functional Description

PIM 4610, PIM 4710

T_{P1} = -40 to 90 ºC, V_I = 36 to 72 V, C_{O1} = 470 µF/38 mΩ electrolytic + 15 µF ceramic, C_{O2} = 2 x 100 µF ceramic (see Note 5), unless otherwise specified under Conditions.
Typical values given at: T_{P1} = +25 °C, V_I = 53 V, max I_{O1}, I_{O2} = 3.6 A, unless otherwise specified under Conditions.

Characteristics		Comments		min	typ	max	Unit
PMBus monitoring accuracy							
READ_VIN MFR_READ_VINA MFR_READ_VINB	OR'ed input voltage Feed A input voltage Feed B input voltage	V_I = 36 V to 75 V		-1.5	±0.25	1.5	%
		V_I = 0 V to 36 V		-0.5		0.5	V
READ_VCAP	Hold up capacitor voltage	V_{HU} = 50 V to 95 V		-3	±1	3	%
READ_IIN READ_IOUT	OR'ed input current Output 1 current	I_{O1} = 0 A to 16 A I_{O2} = 0 A to 3.6 A	PIM 4610	-0.3	±0.1	0.3	A
		I_{O1} = 0 A to 20 A I_{O2} = 0 A to 3.6 A	PIM 4710	-0.4	±0.1	0.4	A
READ_PIN	Input power	P_I = 300 W to 600 W	PIM 4610	-3.5	±1	3.5	%
		P_I = 0 W to 300 W	PIM 4610	-11	±3	11	W
		P_I = 390 W to 780 W	PIM 4710	-3.5	±1	3.5	%
		P_I = 0 W to 390 W	PIM 4710	-14	±4	14	W
READ_TEMPERATURE_1	P3 temperature	T_{P3} = 25 to 90 ºC		-5	±3	5	ºC
Fault Protection Characteristics							
UVLO, input under voltage lockout	Delay				100		ms
OCP, over current protection	Fault response time	I_{O1} = 25 A			95		ms
		I_{O1} = 32 A			2		ms
OTP, over temperature protection, position P2	Trip limit				105		°C
	Hysteresis				10		°C
	Fault response time					1	s

Logic Input/Output Characteristics			min	typ	max	Unit
PMBus frequency			10		400	kHz
Logic input low (V_{IL})	SCL, SDA				0.96	V
Logic input high (V_{IH})	SCL, SDA		2.38			V
Logic output low (V_{OL})	SCL, SDA				0.4	V
Setup time, SMBus			460			ns
Hold time, SMBus			210			ns
Bus free time (T_{BUF})	Note 8	After read access	1.3			µs
		After write access	30			µs

Note 8: It is recommended that a PMBus master reads back written data for verification.

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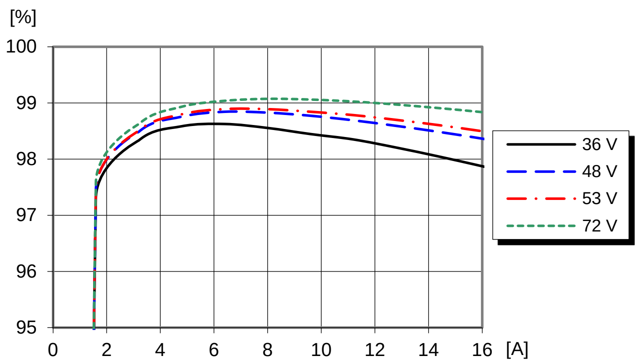
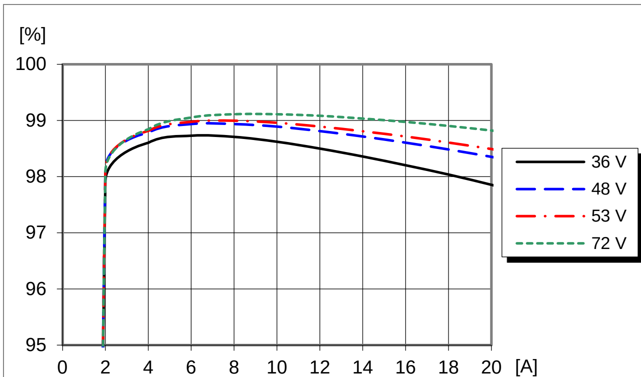
Main Unit (Output 1), Typical Characteristics

Efficiency (PIM 4610)



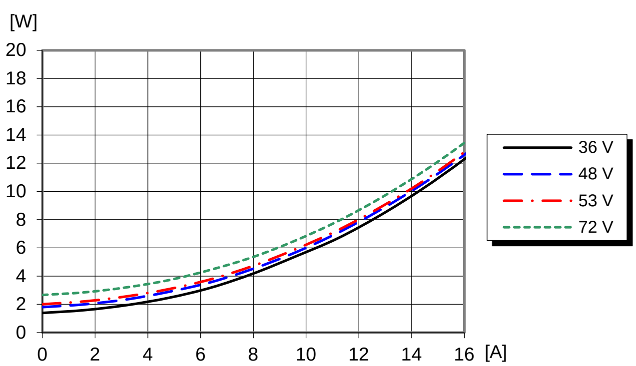
Efficiency vs. load current and input voltage at T_{P1} = +25 °C
I_{O2} = 0 A

Efficiency (PIM 4710)



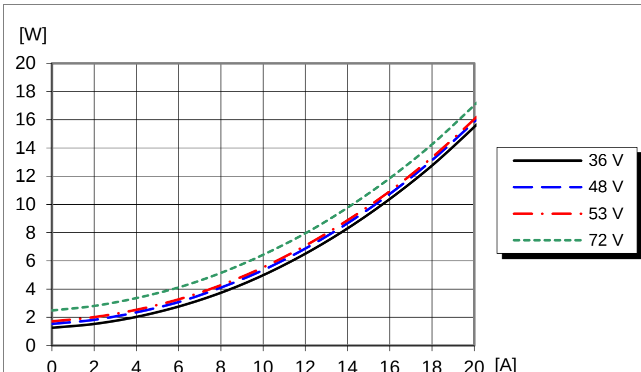
Efficiency vs. load current and input voltage at T_{P1} = +25 °C
I_{O2} = 0 A

Power Dissipation (PIM 4610)



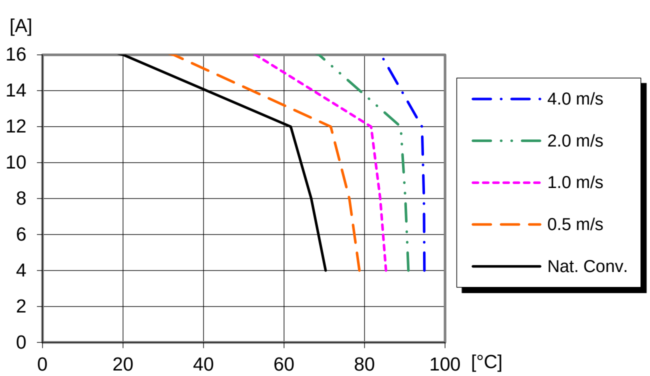
Dissipated power vs. load current and input voltage at
T_{P1} = +25 °C, I_{O2} = 0 A

Power Dissipation (PIM 4710)



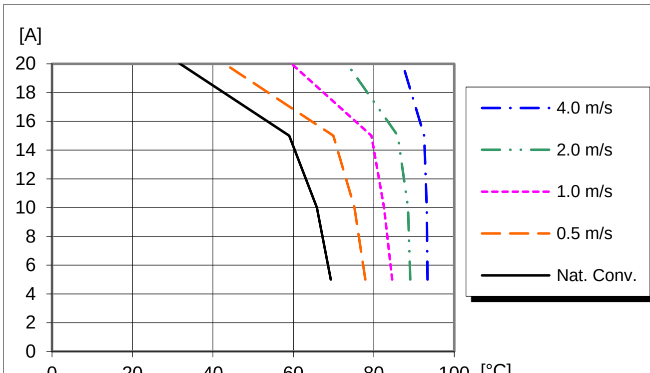
Dissipated power vs. load current and input voltage at
T_{P1} = +25 °C, I_{O2} = 0 A

Output Current Derating, no external supply (PIM 4610)



Available load current vs. ambient air temperature and airflow at
V_I = 53 V, I_{O2} = 1.8 A. See Thermal Consideration section.

Output Current Derating, no external supply (PIM 4710)



Available load current vs. ambient air temperature and airflow at
V_I = 53 V, I_{O2} = 1.8 A. See Thermal Consideration section.

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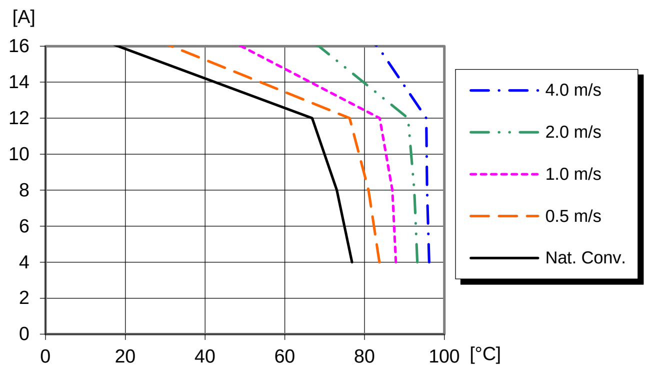
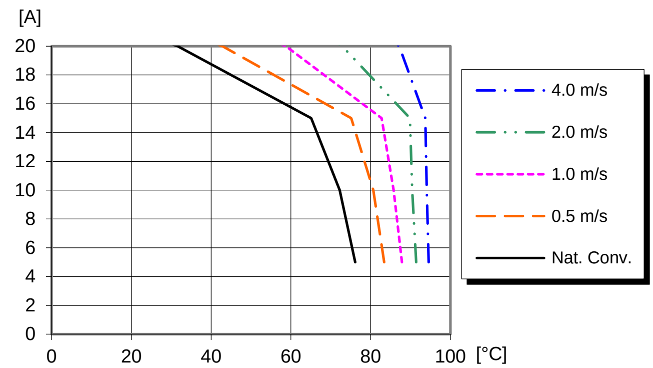
Main Unit (Output 1), Typical Characteristics

Output Current Derating, external 12 V supply (PIM 4610)



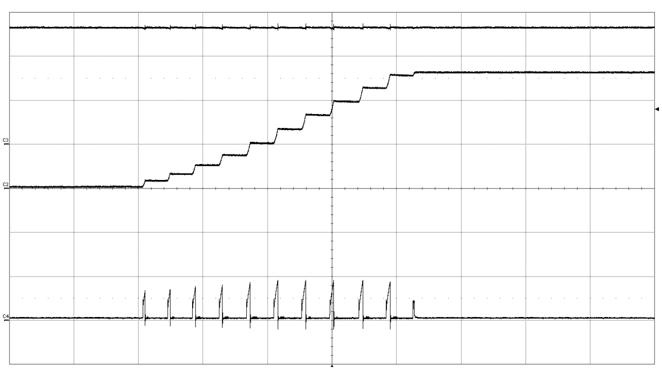
Available load current vs. ambient air temperature and airflow at V_I = 53 V, I_{O2} = 3.5 A. See Thermal Consideration section.

Output Current Derating, external 12 V supply (PIM 4710)



Available load current vs. ambient air temperature and airflow at V_I = 53 V, I_{O2} = 3.5 A. See Thermal Consideration section.

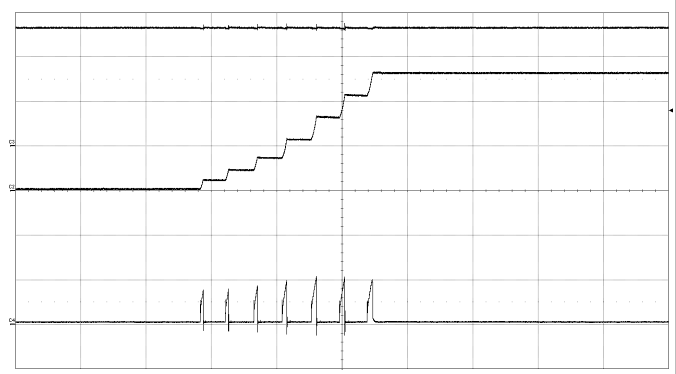
Ramp-up (PIM 4610)



Ramp-up sequence at:
T_{P1} = +25 °C, V_{IA} = 53 V
I_{O1} = 0 A, C_{O1} = 485 µF

Top trace: input voltage (20 V/div.).
Second trace: output 1 voltage (20 V/div.).
Bottom trace: input current (5 A/div.).
Time scale: (20 ms/div.).

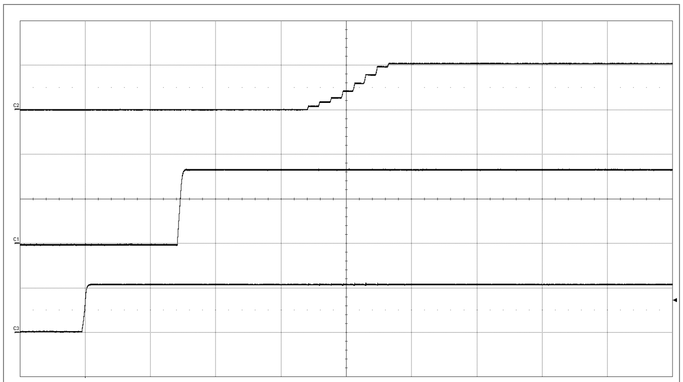
Ramp-up (PIM 4710)



Ramp-up sequence at:
T_{P1} = +25 °C, V_{IA} = 53 V
I_{O1} = 0 A, C_{O1} = 485 µF

Top trace: input voltage (20 V/div.).
Second trace: output 1 voltage (20 V/div.).
Bottom trace: input current (5 A/div.).
Time scale: (20 ms/div.).

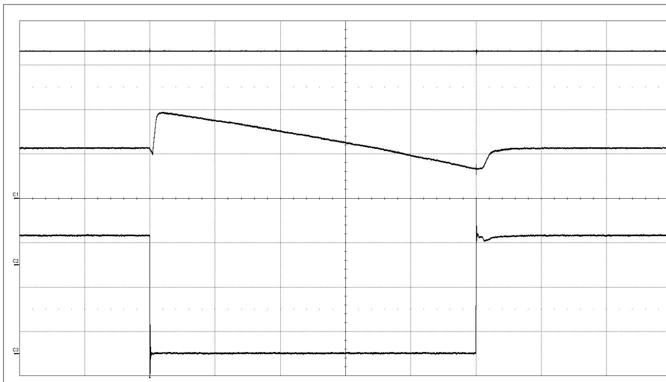
Start-up sequence



Start-up sequence at:
T_{P1} = +25 °C, V_{IA} = 53 V
I_{O1} = 0 A, I_{O2} = 3.6 A

Top trace: output 1 voltage (50V/div)
Second trace: output 2 voltage (2V/div)
Third trace: input A voltage (50V/div)
Time scale: (50 ms/div.).

Hold up performance



10 ms interruption
C_{HU} = 3340 µF, V_{HU} = 75 V,
T_{P1} = +25 °C, P_{O1} = 600 W, C_{O1} = 485 µF, I_{O2} = 3.6 A

Top trace: output 2 voltage (1 V/div.).
Second trace: output 1 voltage (20 V/div.).
Bottom trace: input voltage (20 V/div.).
Time scale: (2 ms/div.).

PIM 4710 series Power Interface Modules Input 36-75V, Output up to 20A / 780-1080 W	28701-BMR 455 40 Rev.B December 2016
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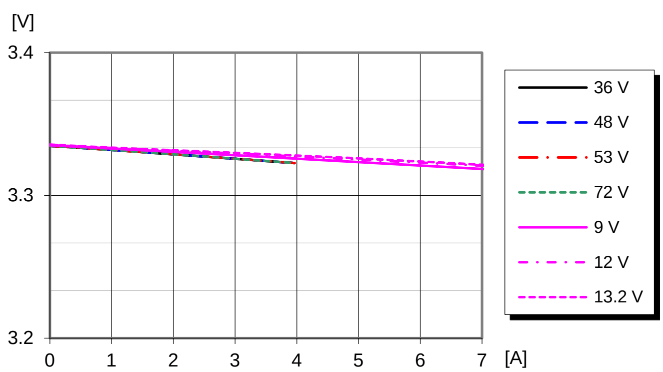
Management Power (Output 2), Typical Characteristics

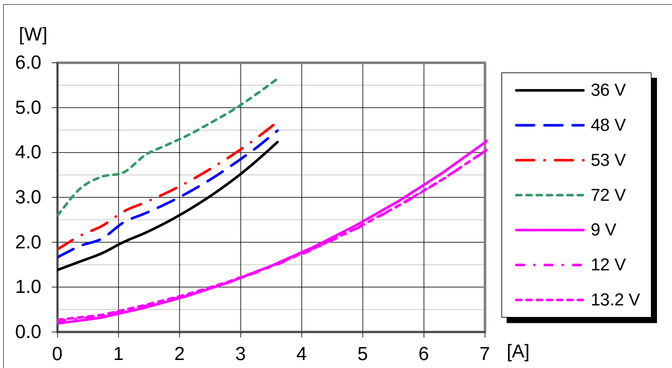
PIM 4610, PIM 4710

Output Characteristics



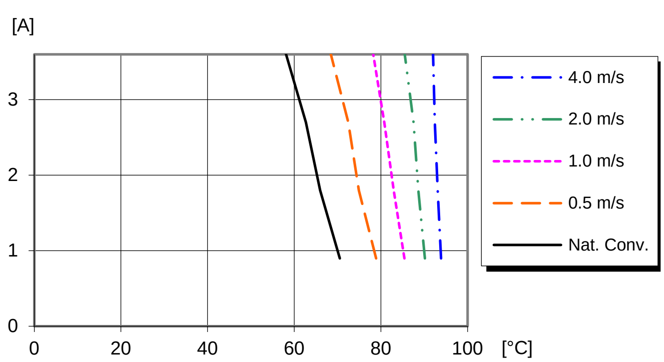
Output 2 voltage vs. load 2 current at:
T_{P1} = +25 °C. I_{O1} = 0 A

Power Dissipation



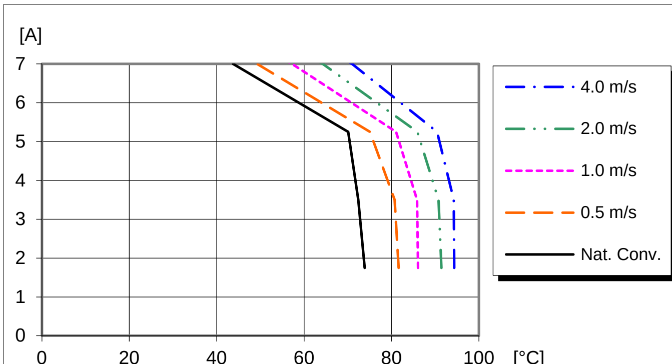
Output 2 voltage vs. load 2 current at:
T_{P1} = +25 °C. I_{O1} = 0 A, V_I = 53 V when external voltage is supplied, no losses in main unit included for the curves when external voltage is supplied,
max continuous I_{O2} = 7 A

Output Current Derating, no external supply



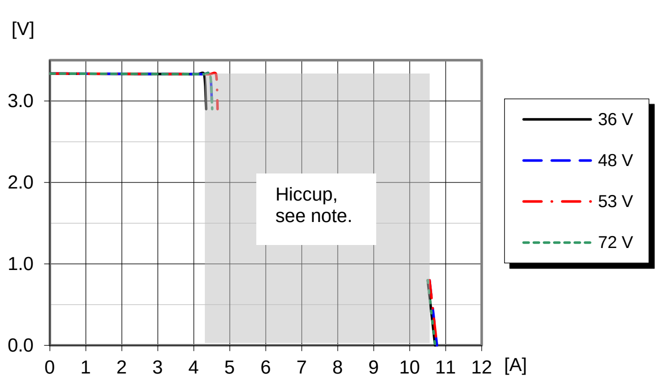
Available load current vs. ambient air temperature and airflow at V_I = 53 V, I_{O1} = 0.5 x max I_{O1}. See Thermal Consideration section.

Output Current Derating, external 12 V supply



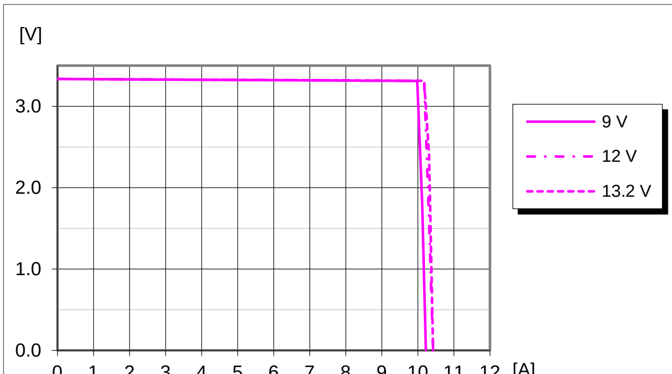
Available load current vs. ambient air temperature and airflow at V_I = 53 V, I_{O1} = 0.5 x max I_{O1}. See Thermal Consideration section.

Output Current Limit Characteristic, no external supply



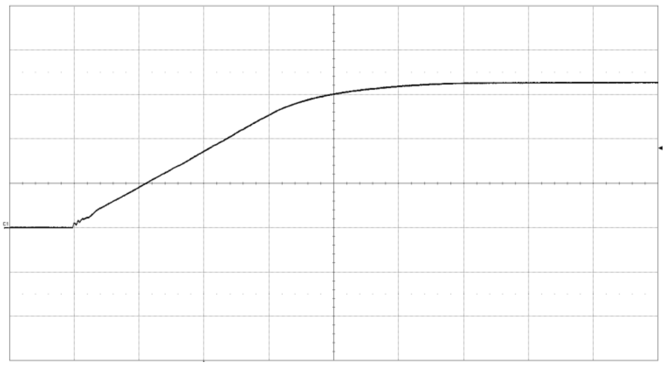
Output 2 voltage vs. load 2 current at: T_{P1} = +25 °C, I_{O1} = 0 A
Note: When Output 2 is supplied from the main input it will hiccup when the current limit is reached. When the output current reaches 10-11 A it will again run continuously.

Output Current Limit Characteristic, external supply



Output 2 voltage vs. load 2 current at: T_{P1} = +25 °C, I_{O1} = 0 A

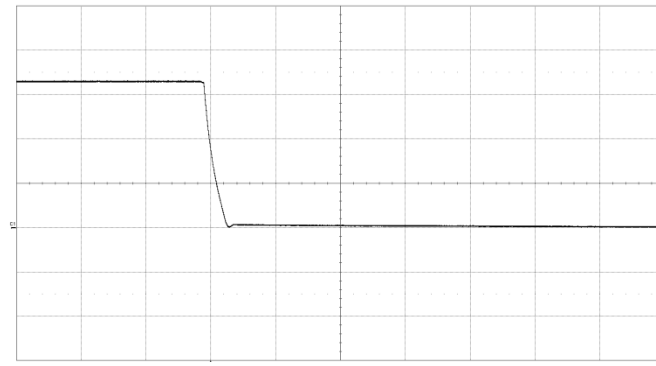
Ramp-up



T_{P1} = +25 °C, V_I = 53 V,
I_{O1} = 0 A, I_{O2} = 3.6 A, C_{O2} = 360 µF

Top trace: output 2 voltage (1 V/div.).
Time scale: (1 ms/div.).

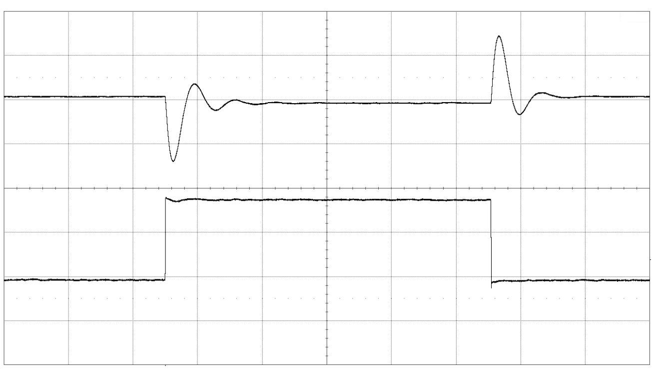
Shut-down



T_{P1} = +25 °C, V_I = 53 V,
I_{O1} = 0 A, I_{O2} = 3.6 A, C_{O2} = 360 µF

Top trace: output 2 voltage (1 V/div.).
Time scale: (1 ms/div.).

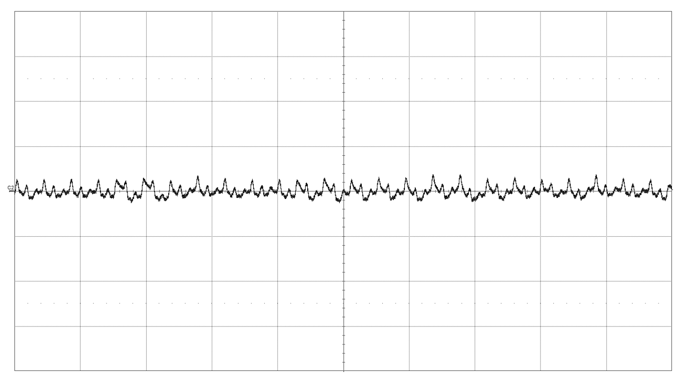
Output Load Transient Response



Output voltage response to load current step-change, output 2 (0.9-2.7-0.9 A)
at: T_{P1} = +25 °C, V_I = 53 V
I_{O1} = 0 A, electronic load,
C_{O2} = 6 x 100 µF (see Note 5)

Top trace: output 2 voltage (50 mV/div.).
Bottom trace: output 2 current (1 A/div.).
Time scale: (0.2 ms/div.).

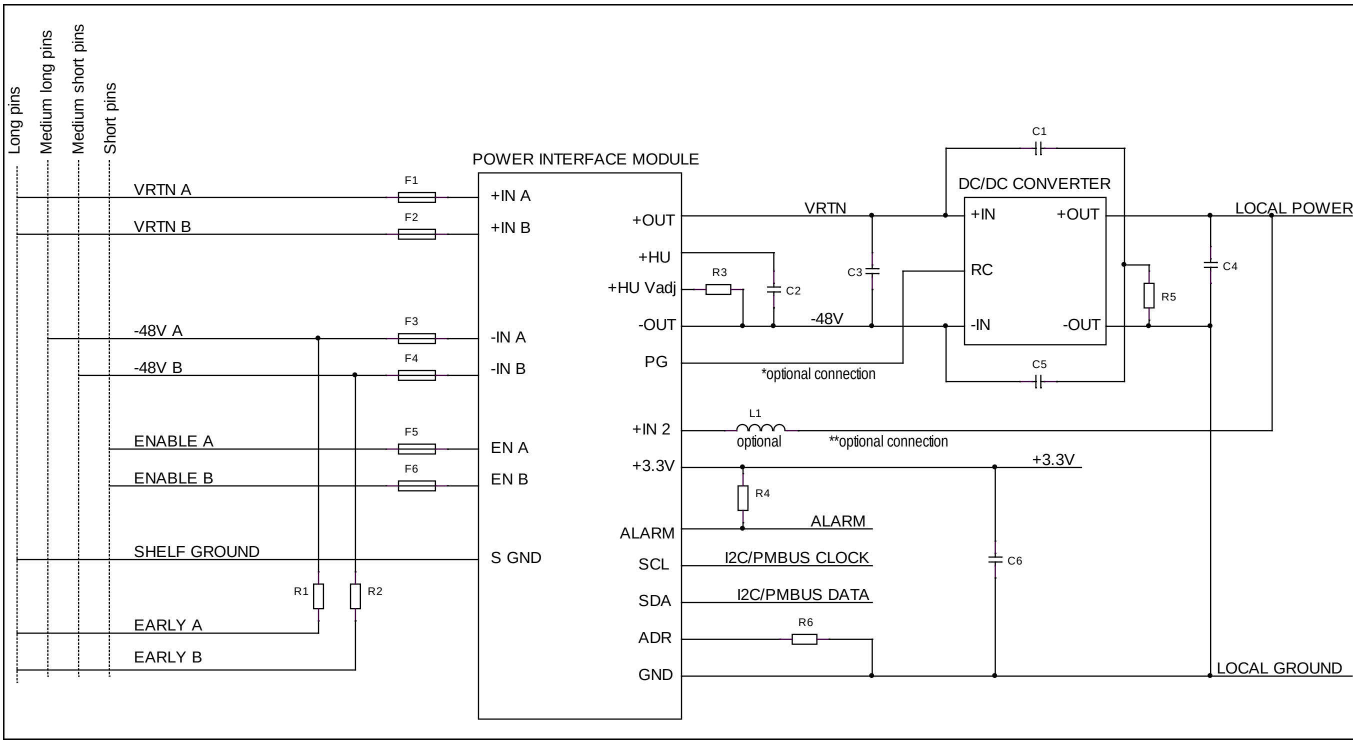
Output 2 Ripple & Noise



Output voltage ripple at:
T_{P1} = +25 °C, V_I = 53 V,
I_{O1} = 0 A, I_{O2} = 3.6 A, resistive load

Output 2 voltage (10 mV/div.).
Time scale: (100 µs/div.).

Typical ATCA Application Circuit



External components
C1, C5 = EMI suppression capacitor (recommended 30 nF)
C2 = hold up capacitor, C_{HU} (max 6600 µF)
C3 = DC/DC converter input capacitor, C_{O1} (see technical specification of the DC/DC converter)
C4 = DC/DC converter output capacitor (see technical specification of the DC/DC converter)
C6 = management power output capacitor, C_{O2} (recommended 360 µF)
F1 = fuse (recommended >25 A)
F2 = fuse (recommended >25 A)
F3 = fuse (recommended >25 A)
F4 = fuse (recommended >25 A)
F5 = fuse (recommended 0.5 A)
F6 = fuse (recommended 0.5 A)
L1 = optional filter inductor (recommended 1 µH to comply with class B when supplying +IN 2 from LOCAL_POWER)
R1, R2 = pre-charge resistor (recommended 50 Ω, max 1 A, max 50 ms)
R3 = hold up voltage adjust resistor, R_{HU} (see Hold Up Capacitor Charge section)
R4 = alarm pull-up resistor (recommended 3.3 kΩ)
R5 = EMI suppression resistor (recommended 0 Ω)
R6 = PMBus Address configuration resistor (see PMBus Addressing section)

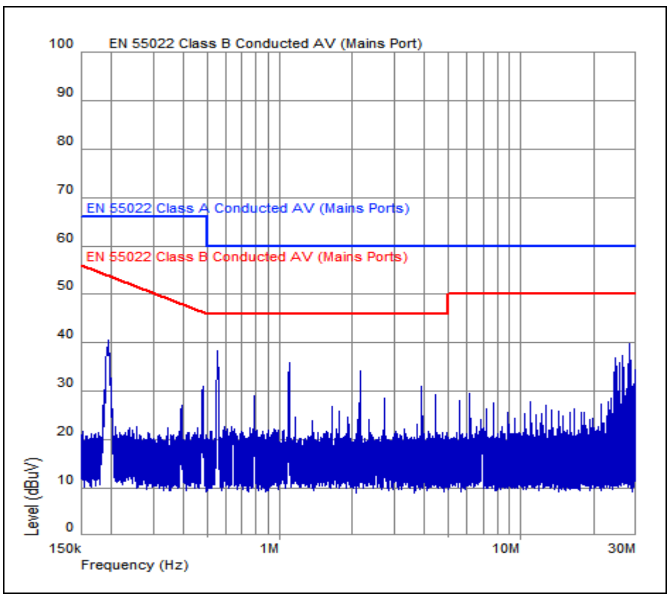
* The RC-pin of the DC/DC Converter may be controlled by an IPM in which case the connection to the PG-pin of the PIM shall be removed. (IPM = Intelligent Platform Management (see ATCA specification PICM 3.7)). The DC/DC must be kept off during start-up to allow the PIM to charge the capacitance, C3.

** The connection between LOCAL_POWER and +IN 2 is optional. With this connection the +3.3 V output can deliver higher current.

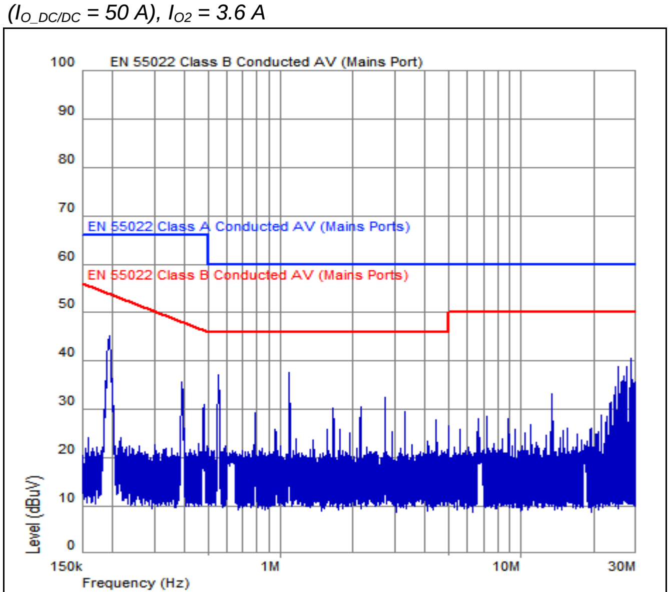
EMC Specification

The product contains an EMI filter which is designed to meet the requirements according to EN 55022, CISPR 22 and FCC part 15J class B (see test set up), when used in conjunction with Ericsson PKM 4613ANH DC/DC converter, PKM 4817NH DC/DC converter and two BMR 456 0004 DC/DC converters in parallel. PIM 4710 and PIM 4610 have the same filter.

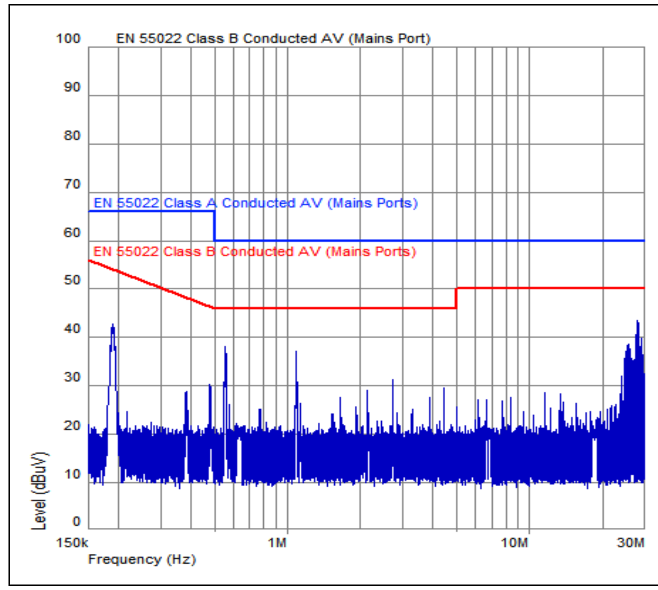
Conducted EMI Input terminal peak value (typ)



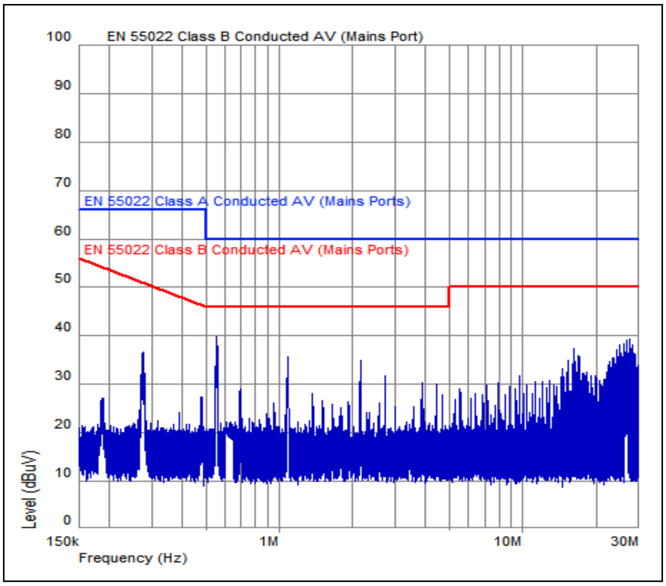
in combination with PKM 4613ANH
V_I = 48 V, C_{O1} = 330 µF electrolytic // 130 µF ceramic, I_{O1} ≈ 13 A ($I_{O\_DC/DC}$ = 50 A), I_{O2} = 3.6 A



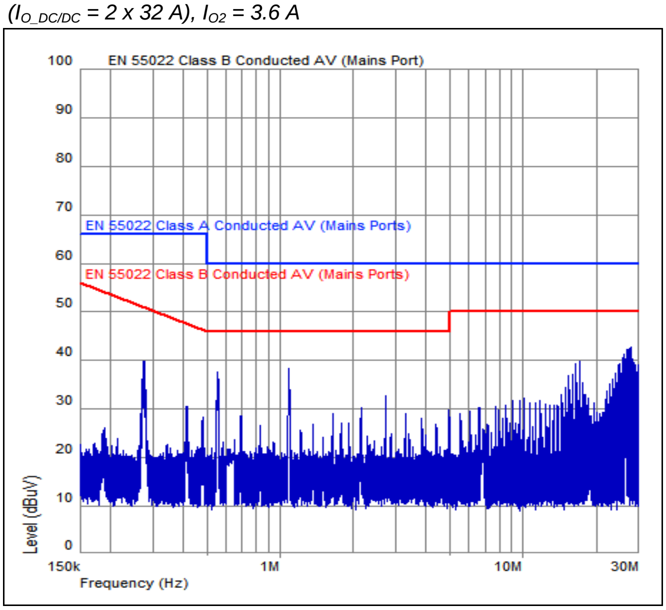
in combination with PKM 4613ANH
V_I = 60 V, C_{O1} = 330 µF electrolytic // 130 µF ceramic, I_{O1} ≈ 10.5 A ($I_{O\_DC/DC}$ = 50 A), I_{O2} = 3.6 A



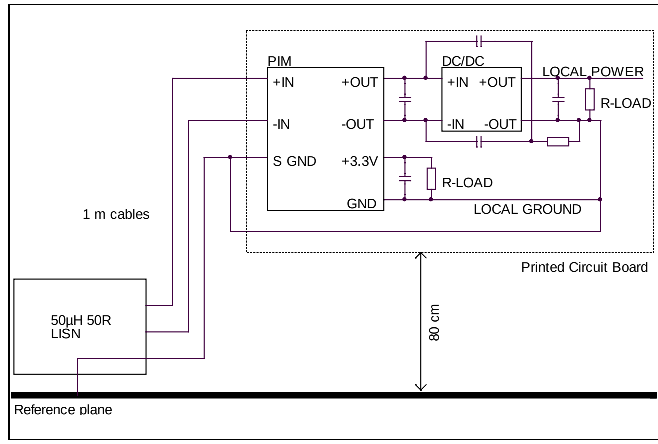
in combination with PKM 4817NH
V_I = 53 V, C_{O1} = 330 µF electrolytic // 130 µF ceramic, I_{O1} ≈ 17 A ($I_{O\_DC/DC}$ ≈ 75 A), I_{O2} = 3.6 A



in combination with 2 x BMR 456 0004
V_I = 48 V, C_{O1} = 470 µF electrolytic // 30 µF ceramic, I_{O1} ≈ 17 A ($I_{O\_DC/DC}$ = 2 x 32 A), I_{O2} = 3.6 A



in combination with 2 x BMR 456 0004
V_I = 60 V, C_{O1} = 470 µF electrolytic // 30 µF ceramic, I_{O1} ≈ 14 A ($I_{O\_DC/DC}$ = 2 x 32 A), I_{O2} = 3.6 A



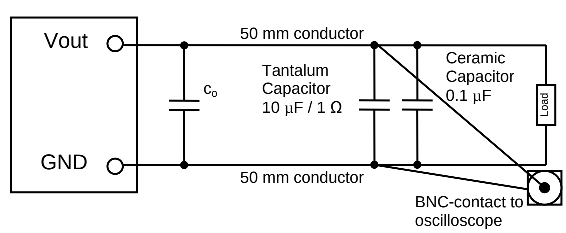
Conducted EMI Test set-up.

Layout recommendations

The radiated EMI performance of the product will depend on the PCB layout and ground layer design. It is also important to consider the stand-off of the product.
A ground layer will increase the stray capacitance in the PCB and improve the high frequency EMC performance. For more information, see the technical specification of the downstream DC/DC converter.

Output Ripple and Noise

Output ripple and noise are measured according to figure below. A 50 mm conductor works as a small inductor forming together with the two capacitances a damped filter.



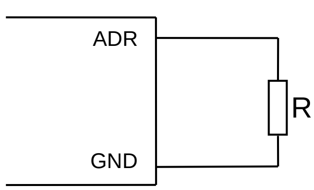
Output ripple and noise test set-up.

I^{2}C / PMBus Interface

This product provides an I^{2}C/PMBus digital interface that enables the user to monitor the input and hold up voltages, output current and device temperature. The product is available in a PMBus-version (PD-suffix) and an I2C-version (PDA-suffix). The product can be used with any standard two-wire I^{2}C or SMBus host device. In addition, the PMBus-version of the module is compatible with PMBus version 1.2. The product supports bus clock frequencies from 10 to 400 kHz. External pull-up resistors must be added to the I^{2}C/PMBus.

I^{2}C / PMBus Addressing

The I^{2}C / PMBus address should be configured with a resistor connected between ADR (pin 10) and GND (pin 13), as shown in the figure below. Recommended resistor values for hard-wiring I^{2}C / PMBus addresses are shown in the table. 1% tolerance resistors are required.



Schematic of connection of address resistor.

I^{2}C Address	R (Ω)
2Fh	open
2Eh	100 000
2Dh	40 200
2Ch	20 000
2Bh	10 000
2Ah	4 020
29h	2 000
28h	short

The user can configure up to 8 unique PMBus addresses.

PMBus-version (PD-suffix)

The product is PMBus compliant. A detailed description of each command is provided in the appendix at the end of this specification.

The Ericsson Power Designer software suite can be used to configure and monitor this product via the PMBus interface. For more information, please contact your local Ericsson sales representative.

Monitoring via PMBus

It is possible to continuously monitor a wide variety of parameters through the PMBus interface. These include, but are not limited to, the parameters listed in the table below.

Parameter	PMBus Command
Input voltage	READ_VIN
Total input current	READ_IIN
Output 1 current	READ_IOUT
Hold up capacitor voltage	READ_VCAP
Total input power	READ_PIN
Controller temperature	READ_TEMPERATURE_1
Feed A Input voltage	MFR_READ_VINA
Feed B Input voltage	MFR_READ_VINB

Monitoring Faults

Fault conditions can be monitored by reading a number of status commands.

Fault & Warning Status	PMBus Command
Overview, Power Good	STATUS_WORD STATUS_BYTE
Output voltage level	STATUS_VOUT
Output current level	STATUS_IOUT
Input voltage level	STATUS_INPUT
Temperature level	STATUS_TEMPERATURE
PMBus communication	STATUS_CML
Miscellaneous	STATUS_MFR_SPECIFIC

I^2C-version (PDA-suffix)

Monitoring via I^2C

Via the I^2C interface five analog measurements and six status bits can be read. The 8-bit values read via I^2C must be multiplied by the scaling factors to get the measurement value. For the temperature reading an offset of 50 °C must be subtracted after multiplying with the scaling factor.

Designation	Data pointer	Description	Scaling factor
StatusBits	1Eh	See table StatusBits	Bit field
HU_CAP	1Fh	Hold-up capacitor voltage	0.398 V/bit
-48V_Current	21h	Output1 current	0.094 A/bit
-48V_A	22h	Feed A input voltage	0.325 V/bit
-48V_B	23h	Feed B input voltage	0.325 V/bit
Temperature	28h	Module temperature	1.961 °C/bit - 50 °C

StatusBits

A read only register that displays current status.

Designation	Bit	Function
ENABLE_A	0	Enable A signal state. 0 = Disabled. 1 = Enabled.
ENABLE_B	1	Enable B signal state. 0 = Disabled. 1 = Enabled.
ALARM	2	Alarm signal state. 0 = Feed loss alarm ceased. 1 = Feed loss alarm raised.
N/A	3	Reserved
HOLDUP	4	Hold up switch state. 0 = Hold up Capacitor is not connected to Output 1. 1 = Hold up Capacitor is connected to Output 1.
HOTSWAP	5	Hot swap switch state. 0 = Switch is off. Output 1 is off. 1 = Switch is on. Output 1 is on.
VOUT_LOW	6	Output 1 Under-Voltage Alarm. 0 = Output voltage is below threshold. 1 = Output voltage is above threshold.
N/A	7	Reserved

I^2C Protocol

To read data through the I^2C interface the Data pointer must first be written.

S	Address	Wr	A	Data pointer	A	P

(shaded) From master to slave

(blank) From slave to master

S START condition

P STOP condition

A Acknowledge / No acknowledge

If more bytes are written after the Data pointer they will be discarded but the Data pointer will be advanced the number of bytes written.

After the Data pointer has been written data can be read.

S	Address	Rd	A	$Data_i$	A	$Data_{i+1}$	A	…

…………	$Data_{i+n}$	A	P

The first byte read will be the value referenced by the Data pointer. Several bytes may be read in one access. For each byte read the Data pointer will be incremented. Reading from an undefined location returns 00h.

The Data pointer is initiated to 00h at power-on and does not overflow when it reaches FFh.
A write may end with a repeat START followed by a read.

Operating information

Input Voltage

The input voltage range 36 to 72 Vdc meets the requirements of the European Telecom Standard ETS 300 132-2 for normal input voltage range in -48 and -60 Vdc systems, -40.5 to -57.0 V and -50.0 to -72 V respectively.

Input Enable

The product has two Enable inputs which shall be connected to feed A and feed B supply of the backplane. The enable pins of the ATCA board are the last to be connected during board insertion and the first to be disconnected during board exertion. The product is switched off until one enable input is connected to the supply (EN A connected to +IN A or EN B connected to +IN B).

A/B Feed OR'ing

Four MOSFETs provide OR'ing of the input feeds. If a short is detected on one of the feeds a control circuit will detect reverse current and quickly turn the MOSFETs off. This feature will also protect the product against reverse polarity of up to 75 V. At high load operation the MOSFETs are operated at a low Rdson condition and at zero load they are turned off.

A/B Feed Alarm

The input feeds A and B are monitored. In case of a feed loss the alarm pin will indicate a fault condition which is provided by an opto isolated signal. Under normal conditions the ALARM output goes low (low resistance to GND) and in case of a feed loss the ALARM output goes open drain (high voltage with a pull-up).

Management Power

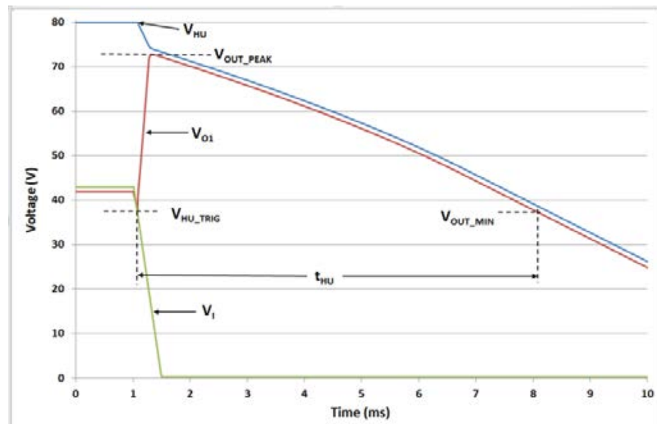
The product provides one isolated DC output, 3.3 V referred to GND. The management power is available as soon as the input voltage level is within 36 V to 72 V. The output is short circuit protected. In a short circuit condition the 3.3 V output will operate in a constant current mode. A 360 µF ceramic capacitor on the 3.3 V output is recommended to reduce switching noise and improve transient characteristics. Management power will be on for max 100 ms after enable A and B have dropped below enable turn-off threshold voltage.

Hot Swap Functionality

The hot swap function is designed to control the inrush current to the downstream DC/DC converter. The level and duration of the inrush current complies with the PICMG 3.7 ATCA base specification Inrush transient specifications.
Note: The hot swap circuit limits the output 1 current during start up. Hence, output 1 cannot be loaded before its external filter capacitor has been charged.

Hold Up Function

If the voltage on both feed A and B falls below V_{HU_TRIG} (default 36.8 V) or if the output voltage (V_{O1}) falls below the same threshold a hold up event will be triggered.



Hold Up Event

During the hold up event the external hold up capacitor C_{HU} will be connected across the output capacitor C_{O1} by a current limiter switch. During the first phase of the event the output capacitor will be charged with current from the hold up capacitor until the voltage of the two capacitors evens out (at V_{OUT_PEAK}). During the second phase of the event the two capacitors together works as an energy reservoir to provide power to downstream consumers.
If hold up is not used pin 17 and 19 can be left open.

Hold Up Voltage and Capacitor Selection

Expressions used in this section:

$\mathbf{V_{HU}}$ = Hold up capacitor charge voltage
$\mathbf{C_{HU}}$ = External hold up capacitor capacitance
$\mathbf{C_{O1}}$ = External capacitance on output 1
$\mathbf{P_{OUT}}$ = Total output power on output 1 and 2
$\mathbf{t_{HU}}$ = Hold up time
$\mathbf{V_{HU\_TRIG}}$ = This is the input/output voltage threshold that triggers the hold up event.
$\mathbf{V_{OUT\_PEAK}}$ = This is the highest voltage that the downstream consumers will be exposed to during a hold up event.
$\mathbf{V_{OUT\_MIN}}$ = This is the minimum voltage that the downstream consumers need.
$\mathbf{V_{O1\_MAX}}$ = This is the highest possible voltage on output 1 when the hold up event starts. Since a hold up event can be triggered either by low voltage on input or output this voltage can be as low as V_{HU_TRIG} or as high as the highest normal operating voltage on feed A and B.

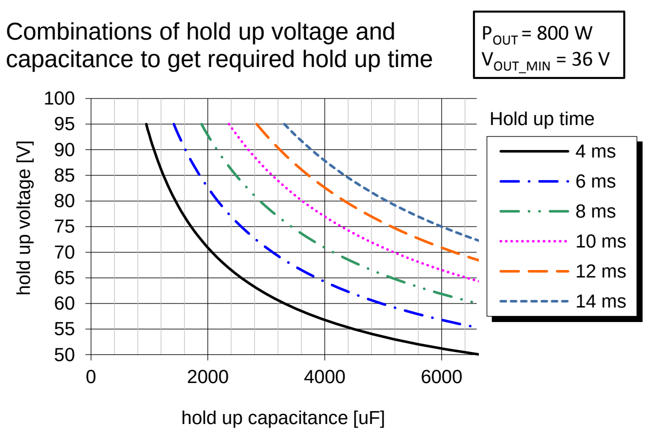
PIM 4710 series Power Interface Modules Input 36-75V, Output up to 20A / 780-1080 W	28701-BMR 455 40 Rev.B December 2016 © Ericsson AB

Hold up voltage and capacitor selection:

The hold up time is roughly proportional to the square of V_{HU}. A high V_{HU} voltage will result in a smaller hold up capacitor. Start by selecting a preliminary value for V_{HU} that is the same or a few Volts higher than the maximum allowed voltage for the downstream consumers.

Use equation 1 or diagram 1 to select a preliminary value for C_{HU}.

Diagram 1:



Equation 1:

$$C_{HU} \geq \frac{2.2 \times P_{OUT} \times t_{HU}}{(V_{HU} - 1.5)^2 - V_{OUT\_MIN}{}^2} \quad [F]$$

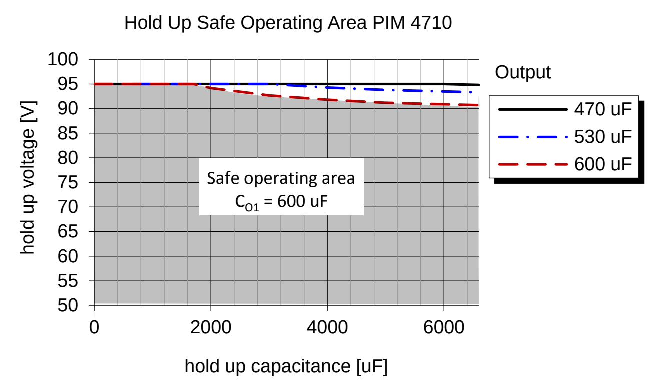
Use equation 2 to verify that the peak voltage (V_{OUT_PEAK}) during the hold up event is lower than the maximum allowed voltage for the downstream consumers.

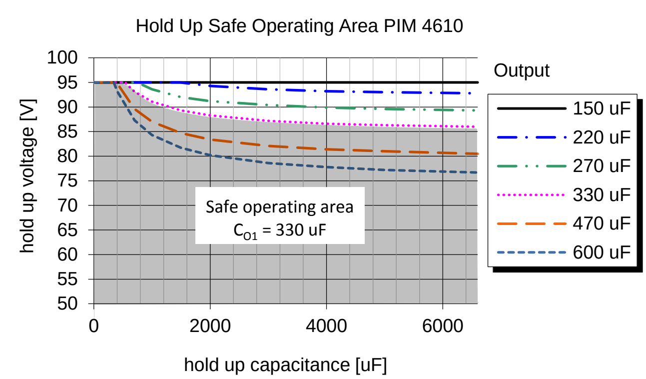
Equation 2:

$$V_{OUT\_PEAK} = V_{O1\_MAX} + (V_{HU} - V_{O1\_MAX}) x \frac{C_{HU}}{C_{HU} + C_{O1}} \quad [V]$$

If the V_{OUT_PEAK} voltage is too high select a lower V_{HU} voltage and reselect C_{HU} with equation 1 or diagram 1.

When V_{OUT_PEAK} voltage is acceptable, verify that the selected combination of values for V_{HU}, C_{HU} and C_{O1} is within the safe operating area (SOA) for the current limiter switch in the hold up circuit. If not, start from beginning and select a lower value for C_{O1} or lower V_{HU} voltage.





Hold Up Safe Operating Area

The current limiter switch in the hold up circuit is protected from over stress by a safe operating area limiting network. If the current limiter switch is operated outside its safe operating area the hold up event will be aborted.

Hold Up Capacitor Charge

An internal DC/DC converter charges the hold up capacitor to a voltage of 40 V – 95 V. The charge level is set by an external resistor.

Resistor connected between +HU Vadj and –OUT for hold up voltages from 50.4 to 95 V:

$$R_{HU} = \frac{480}{V_{HU} - 50.4} - 10 \quad [k\Omega]$$

where V_{HU} is the hold up voltage.

Resistor connected between +HU Vadj and +HU for hold up voltages from 40 to 50.4 V:

$$R_{HU} = \frac{191 \times V_{HU} - 480}{50.4 - V_{HU}} - 10 \quad [k\Omega]$$

No trim resistor results in 50.4 V hold up voltage.

Capacitor Discharge

When the enable inputs are disconnected the hold up and output capacitor will be discharged to less than 60 V within 1 s, conditions: V_{HU} = 75 V, C_{HU} = 6600 µF, V_I = 60 V, C_{O1} = 470 µF.

Over Temperature Protection (OTP)

The product is protected from thermal overload by an internal over temperature shutdown circuit.
When P2 as defined in thermal consideration section exceeds 105 °C the product will shut down. The product will make continuous attempts to start up (non-latching mode) and resume normal operation automatically when the temperature has dropped > 10 °C below the temperature threshold. In an over temperature situation the management power is still available.

Input Transient Over Voltage Protection

The product incorporates a transient voltage protector which will protect the product and the downstream DC/DC converter against over voltage transients exceeding 75 V. The transient voltage protector is rated for 1.5 kW (10/1000 µs) peak pulse power with a breakdown voltage of 83.3 V. The product also handles transients of up to 100 V for 10 µs.

Over Current Protection (OCP)

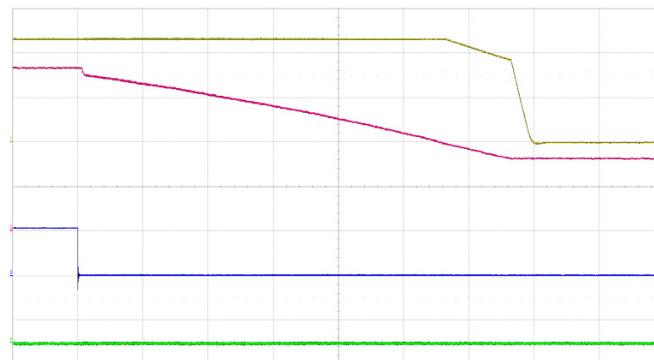
Both the main unit (Output 1) and the management power (Output 2) of the product include current limiting circuitry for protection at continuous overload. The load distribution should be designed for the maximum output short circuit current specified.

The main unit (Output 1) will abruptly be interrupted if the output over current or an internal component overpower thresholds are exceeded for a time longer than the stated fault response time.

The output 2 voltage will decrease towards zero for output currents in excess of max output current. The product will resume normal operation after removal of the overload.

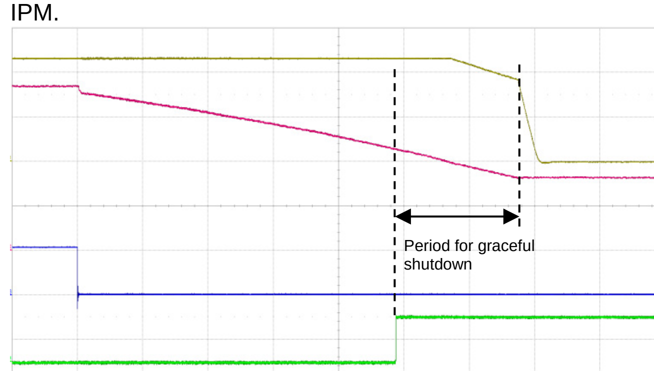
Power Good

The product has a Power Good output that by default is intended to drive the Remote Control-pin of a downstream DC/DC converter, see Typical ATCA Application Circuit. During start-up the Power Good will remain de-asserted while C_{O1} is being charged. When C_{O1} is fully charged it will assert to enable a downstream DC/DC converter. At shut down the Power Good will remain asserted.



Yellow trace: DC/DC output voltage (5 V/div).
Red trace: hold up voltage (20 V/div).
Blue trace: input voltage (50 V/div).
Green trace: Power Good (5 V/div).
Time scale: (2 ms/div).
Shutdown with default configuration for Power Good.

The Power Good output can alternatively be configured to give an advance alert of a potential shutdown. This function can be used by systems that require a graceful shutdown. In this mode the Power Good will typically de-assert before the DC/DC converter has reach its under-voltage lockout. When used in this mode the Power Good shall be connected to an IPM.



Yellow trace: DC/DC output voltage (5 V/div).
Red trace: hold up voltage (20 V/div).
Blue trace: input voltage (50 V/div).
Green trace: Power Good (5 V/div).
Time scale: (2 ms/div).
Shutdown with Power Good in advance alert mode.

To configure the Power Good to the advance alert mode set MFR_PG_DEASSERT_TRIP_LEVEL to a non-zero value. When set to a non-zero value it will define a hold up voltage level at which the Power Good de-asserts. Refer to equation 1 to calculate remaining on-time.

Thermal Consideration

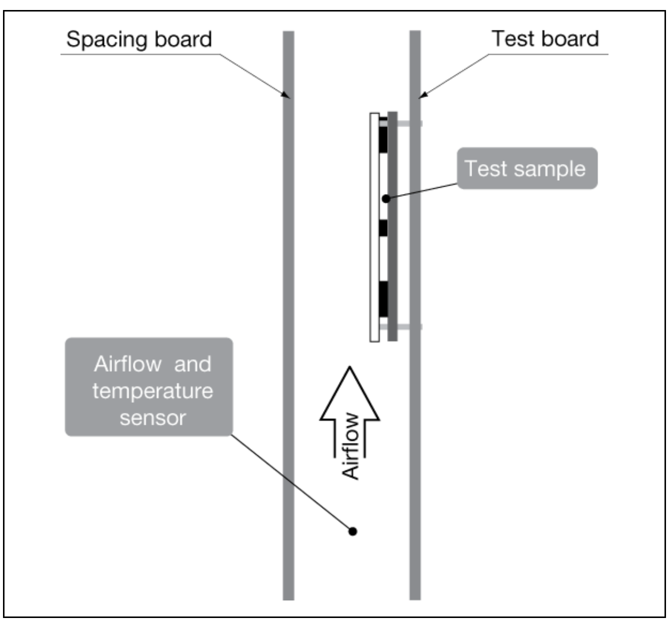
General

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

For products mounted on a PCB without a heat sink attached, cooling is achieved mainly by conduction, from the pins to the host board, and convection, which is dependent on the airflow across the product. Increased airflow enhances the cooling of the product. The Output Current De-rating graph found in the Output section for each model provides the available output current vs. ambient air temperature and air velocity at V_I = 53 V.

A guardband of 5 °C is applied to the maximum recorded component temperatures when calculating output current de-rating curves.

The product is tested on a 254 x 254 mm, 35 µm (1 oz), 16-layer test board mounted vertically in a wind tunnel with a cross-section of 608 x 203 mm.

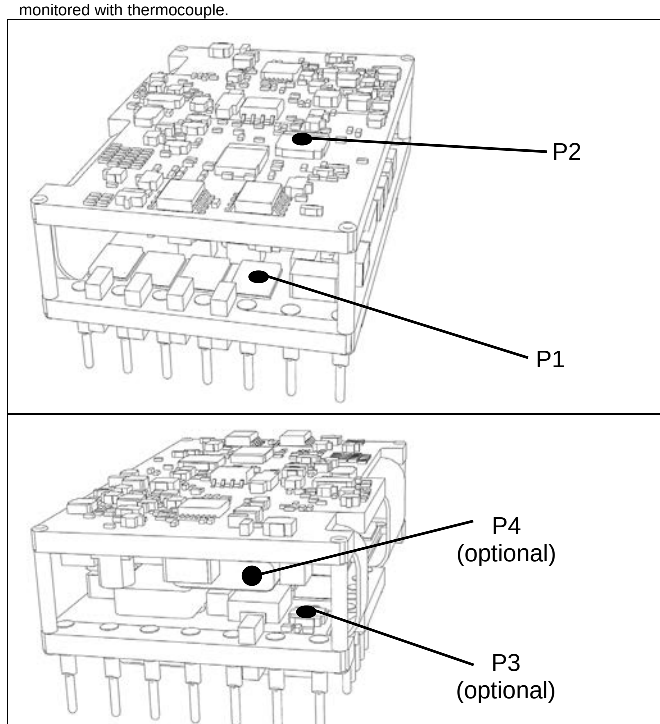


Definition of product operating temperature

The product operating temperature is used to monitor the temperature of the product, and proper thermal conditions can be verified by measuring the temperature at position P1, P2, P3 and P4. The temperature at these positions (T_{P1}, T_{P2}, T_{P3} and T_{P4}) should not exceed the maximum temperature in the table below. Temperature above maximum T_{P1}, T_{P2}, T_{P3} and T_{P4} measured at the reference points P1, P2, P3 and P4 is not allowed and may cause permanent damage. On PIM 4610 position P1 is not populated; use the pad to measure temperature.

Position	Description	Max Temp.
P1	PCB	T_{P1} = 130 °C
P2	Controller	T_{P2} = 105 °C
P3 (Only when I_{O2} > 3.6A)	Buck-IC	T_{P3} = 130 °C
P4*	Transformer	T_{P4} = 100 °C

* The Output Current Derating plots are for functional insulation only. T_{P4} must be monitored if basic insulation is required, a guardband of 10 °C is required according to UL if T_{P4} is monitored with thermocouple.



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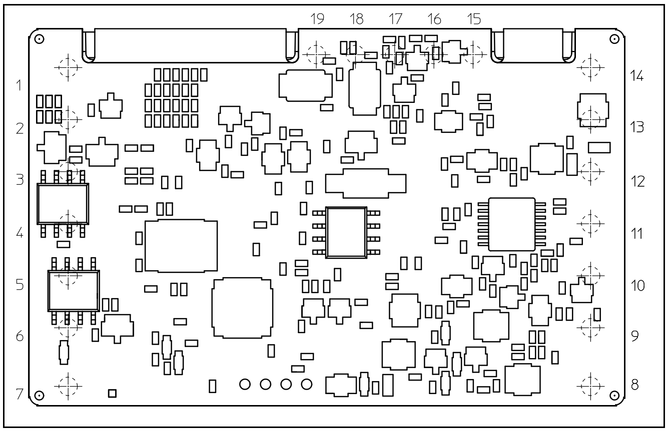
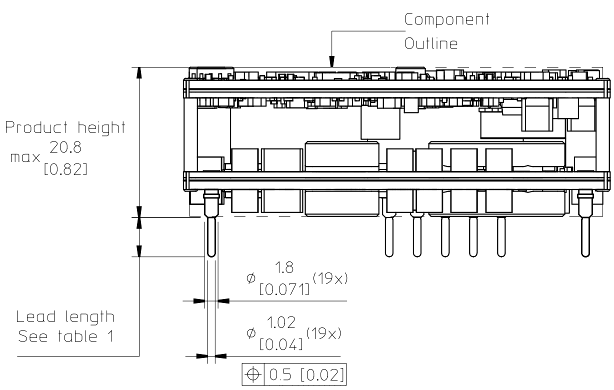
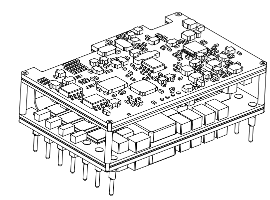
Connections

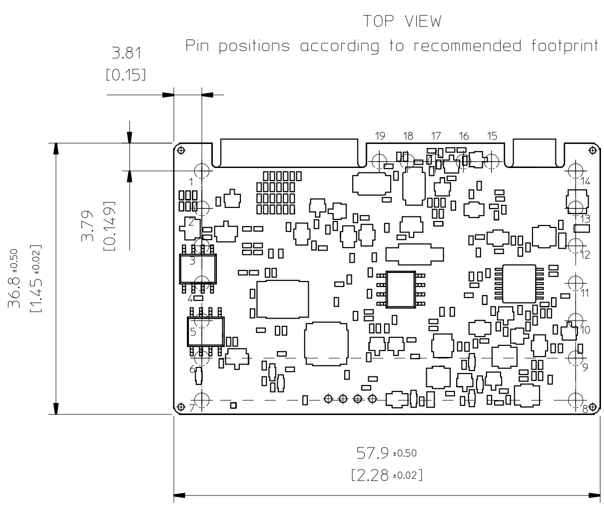


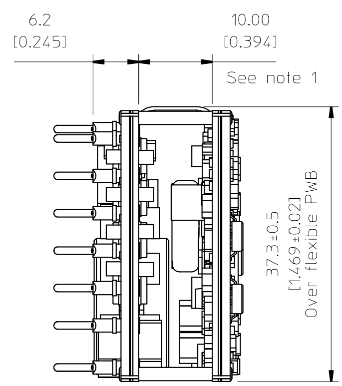
Pin	Designation	Function
1	-IN A	Input A negative feed
2	-IN B	Input B negative feed
3	+IN A	Input A positive feed
4	+IN B	Input B positive feed
5	EN A	Input A enable
6	EN B	Input B enable
7	S GND	Shelf ground
8	+IN 2	External management power supply. May be left open if not needed.
9	+3.3V	Management power, positive output 3.3 V. May be left open if not needed.
10	ADR	I^2C/PMBus address
11	SDA	I^2C/PMBus data
12	SCL	I^2C/PMBus clock
13	GND	Management power, negative output
14	ALARM	Feed loss alarm
15	PG	Power Good
16	-OUT	Main unit, negative output
17	+HU Vadj	Hold up voltage adjust. May be left open if not needed.
18	+OUT	Main unit, positive output
19	+HU	Hold up capacitor bank, positive side. May be left open if not needed.

Mechanical Information









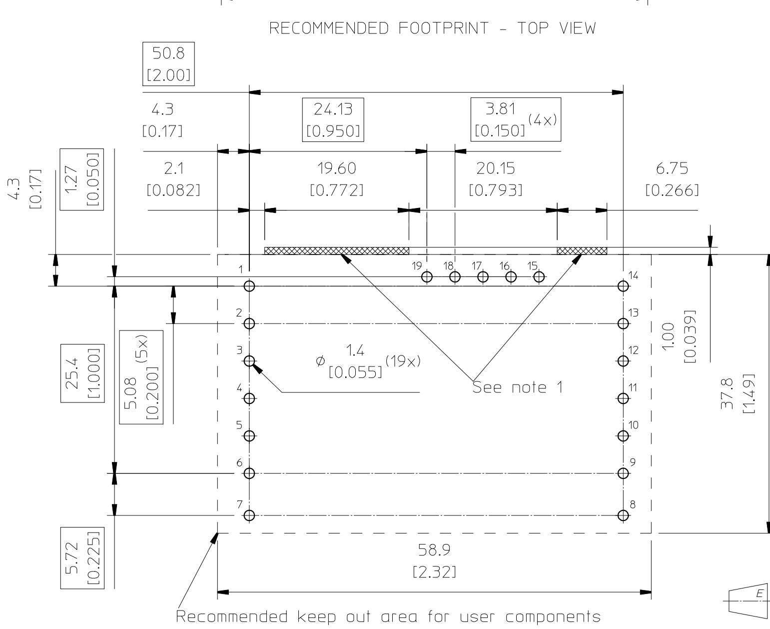


Table 1

Pin option	Lead length
Standard	5.33 [0.21]
LA	3.69 [0.145]
LB	4.57 [0.18]
LC	2.79 [0.11]

Pins:
Material: Copper alloy
Plating: Min 0.1µm Au over 1-3µm Nickel
Pin position 15 is optional

Notes:
1-Keep out areas for component in level with flexible PWB height 6.2-16.2 [0.245-0.638]

Weight: Typical 70 g
All dimensions in mm [inch].
Tolerances unless specified
x.x mm ±0.50 mm [0.02], x.xx mm ±0.25 mm [0.01]
(not applied on footprint or typical values)

Soldering Information - Hole Mounting

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

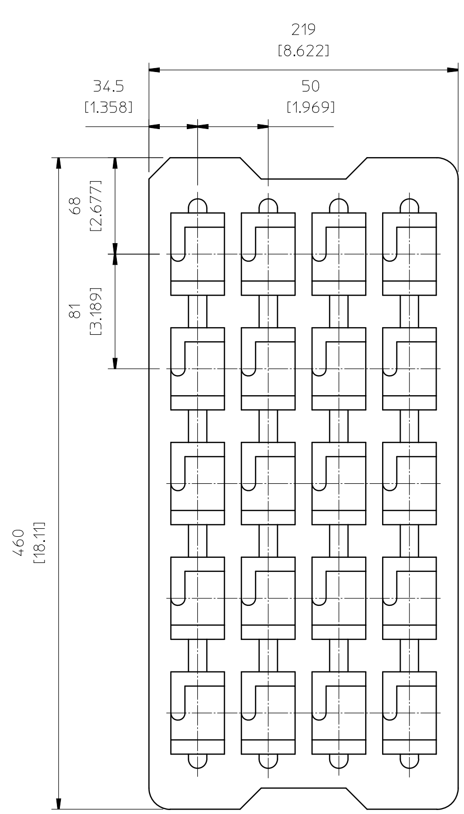
A maximum preheat rate of 4°C/s and maximum preheat temperature of 150°C is suggested. When soldering by hand, care should be taken to avoid direct contact between the hot soldering iron tip and the pins for more than a few seconds in order to prevent overheating.

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

Delivery Package Information

The products are delivered in antistatic trays.

Tray Specifications	
Material	Antistatic PE Foam
Surface resistance	10^5 < Ohm/square < 10^{11}
Bakeability	The trays are not bakeable
Tray thickness	38 mm [1.5 inch]
Box capacity	20 products (1 full tray/box)
Tray weight	63 g empty, 1463 g full tray



Product Qualification Specification

Characteristics			
External visual inspection	IPC-A-610		
Change of temperature (Temperature cycling)	IEC 60068-2-14 Na	Temperature range Number of cycles Dwell/transfer time	-40 to 100°C 1000 15 min/0-1 min
Cold (in operation)	IEC 60068-2-1 Ad	Temperature T_A Duration	-45°C 72 h
Damp heat	IEC 60068-2-67 Cy	Temperature Humidity Duration	85°C 85 % RH 1000 hours
Dry heat	IEC 60068-2-2 Bd	Temperature Duration	125°C 1000 h
Electrostatic discharge susceptibility	IEC 61340-3-1, JESD 22-A114 IEC 61340-3-2, JESD 22-A115	Human body model (HBM) Machine Model (MM)	Class 2, 2000 V Class 3, 200 V
Immersion in cleaning solvents	IEC 60068-2-45 XA, method 2	Water Glycol ether Isopropyl alcohol	55°C 35°C 35°C
Mechanical shock	IEC 60068-2-27 Ea	Peak acceleration Duration	100 g 6 ms
Moisture reflow sensitivity [1]	J-STD-020E	Level 1 (SnPb-eutectic) Level 3 (Pb Free)	225°C 260°C
Operational life test	MIL-STD-202G, method 108A	Duration	1000 h
Resistance to soldering heat [2]	IEC 60068-2-20 Tb, method 1A	Solder temperature Duration	270°C 10-13 s
Robustness of terminations	IEC 60068-2-21 Test Ua1 IEC 60068-2-21 Test Ue1	Through hole mount products Surface mount products	All leads All leads
Solderability	IEC 60068-2-58 test Td [1]	Preconditioning Temperature, SnPb Eutectic Temperature, Pb-free	150°C dry bake 16 h 215°C 235°C
	IEC 60068-2-20 test Ta [2]	Preconditioning Temperature, SnPb Eutectic Temperature, Pb-free	Steam ageing 235°C 245°C
Vibration, broad band random	IEC 60068-2-64 Fh, method 1	Frequency Spectral density Duration	10 to 500 Hz 0.07 g^2/Hz 10 min in each direction

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

Appendix - PMBus Commands

This appendix contains a detailed reference of the PMBus commands supported by the product.

Data Formats

The products make use of a few standardized numerical formats, along with custom data formats. A detailed walkthrough of the above formats is provided in AN304, as well as in sections 7 and 8 of the PMBus Specification Part II. The custom data formats vary depending on the command, and are detailed in the command description.

Standard Commands

The functionality of commands with code 0x00 to 0xCF is usually based on the corresponding command specification provided in the PMBus Standard Specification Part II (see Power System Management Bus Protocol Documents below). However there might be different interpretations of the PMBus Standard Specification or only parts of the Standard Specification applied, thus the detailed command description below should always be consulted.

Forum Websites

The System Management Interface Forum (SMIF)
http://www.powersig.org/
The System Management Interface Forum (SMIF) supports the rapid advancement of an efficient and compatible technology base that promotes power management and systems technology implementations. The SMIF provides a membership path for any company or individual to be active participants in any or all of the various working groups established by the implementer forums.

Power Management Bus Implementers Forum
(PMBUS-IF)
http://pmbus.org/
The PMBus-IF supports the advancement and early adoption of the PMBus protocol for power management. This website offers recent PMBus specification documents, PMBus articles, as well as upcoming PMBus presentations and seminars, PMBus Document Review Board (DRB) meeting notes, and other PMBus related news.

PMBus – Power System Management Bus Protocol Documents

These specification documents may be obtained from the PMBus-IF website described above. These are required reading for complete understanding of the PMBus implementation. This appendix will not re-address all of the details contained within the two PMBus Specification documents.

Specification Part I – General Requirements Transport And Electrical Interface
Includes the general requirements, defines the transport and electrical interface and timing requirements of hard wired signals.

Specification Part II – Command Language
Describes the operation of commands, data formats, fault management and defines the command language used with the PMBus.

SMBus – System Management Bus Documents

System Management Bus Specification, Version 2.0, August 3, 2000
This specification specifies the version of the SMBus on which Revision 1.2 of the PMBus Specification is based. This specification is freely available from the System Management Interface Forum Web site at:
http://www.smbus.org/specs/

PMBus Command Summary and Factory Default Values of Standard Configuration

The factory default values provided in the table below are valid for the Standard configuration. Factory default values for other configurations can be found using the Ericsson Power Designer tool.

Code	Name	Data Format	Factory Default Value Standard Configuration PIM 4610 PD / PIM 4710 PD R1	
0x03	CLEAR_FAULTS	Send Byte		
0x11	STORE_DEFAULT_ALL	Send Byte		
0x12	RESTORE_DEFAULT_ALL	Send Byte		
0x78	STATUS_BYTE	Read Byte		
0x79	STATUS_WORD	Read Word		
0x7A	STATUS_VOUT	R/W Byte		
0x7B	STATUS_IOUT	R/W Byte		
0x7C	STATUS_INPUT	R/W Byte		
0x7D	STATUS_TEMPERATURE	R/W Byte		
0x7E	STATUS_CML	R/W Byte		
0x80	STATUS_MFR_SPECIFIC	R/W Byte		
0x88	READ_VIN	Read Word		
0x89	READ_IIN	Read Word		
0x8A	READ_VCAP	Read Word		
0x8C	READ_IOUT	Read Word		
0x8D	READ_TEMPERATURE_1	Read Word		
0x97	READ_PIN	Read Word		
0x98	PMBUS_REVISION	Read Byte		
0x99	MFR_ID	R/W Block (8)	Unit Specific	
0x9A	MFR_MODEL	R/W Block (18)	Unit Specific	
0x9B	MFR_REVISION	R/W Block (3)	Unit Specific	
0x9C	MFR_LOCATION	R/W Block (3)	Unit Specific	
0x9D	MFR_DATE	R/W Block (6)	Unit Specific	
0x9E	MFR_SERIAL	R/W Block (13)	Unit Specific	
0xD3	MFR_READ_VINA	Read Word		
0xD4	MFR_READ_VINB	Read Word		
0xD5	MFR_STATUS_BITS	Read Byte		
0xE0	MFR_PG_DEASSERT_TRIP_LEVEL	R/W Word	0x0000	0 V
0xE1	MFR_OUT1_START_DELAY	R/W Word	0x0064	100 ms
0xE2	MFR_OUT2_START_DELAY	R/W Word	0x0000	0 ms
0xE3	MFR_CONFIG	R/W Word	0x0001	
0xE4	MFR_HU_TRIG_LEVEL	R/W Word	0x0935	36.8 V
0xE5	MFR_ENABLE_OFF_LEVEL	R/W Word	0x0840	33.0 V
0xE6	MFR_ENABLE_ON_LEVEL	R/W Word	0x08C0	35.0 V
0xE7	MFR_FEED_ALARM_RAISE_LEVEL	R/W Word	0x0939	36.9 V
0xE8	MFR_FEED_ALARM_CEASE_LEVEL	R/W Word	0x0999	38.4 V
0xE9	MFR_VINAP_SLOPE	R/W Word	Unit Specific	
0xEA	MFR_VINA_OFFSET	R/W Word	Unit Specific	
0xEB	MFR_IOUT1_SLOPE	R/W Word	Unit Specific	
0xEC	MFR_IOUT1_OFFSET	R/W Word	Unit Specific	
0xED	MFR_VINAN_SLOPE	R/W Word	Unit Specific	
0xEE	MFR_VINBP_SLOPE	R/W Word	Unit Specific	
0xEF	MFR_VINB_OFFSET	R/W Word	Unit Specific	
0xF0	MFR_VINBN_SLOPE	R/W Word	Unit Specific	
0xFD	MFR_FIRMWARE_DATA	Read Block (20)		

PMBus Command Details

CLEAR_FAULTS (0x03)
Transfer Type: Send Byte
Description: Clears all fault status bits

STORE_DEFAULT_ALL (0x11)
Transfer Type: Send Byte
Description: Commands the device to store its configuration into the Default Store.

RESTORE_DEFAULT_ALL (0x12)
Transfer Type: Send Byte
Description: Commands the device to restore its configuration into the Default Store.

STATUS_BYTE (0x78)
Transfer Type: Read Byte
Description: Returns a brief fault/warning status byte.

Bit	Function	Description	Value	Description
4	Iout Overcurrent Fault	An output overcurrent fault has occurred.	0	No fault
			1	Fault
3	Vin Undervoltage Fault	An input undervoltage fault has occurred.	0	No fault
			1	Fault
2	Temperature	A temperature fault or warning has occurred.	0	No fault
			1	Fault
1	Communication/Logic	A communications, memory or logic fault has occurred.	0	No fault
			1	Fault

STATUS_WORD (0x79)
Transfer Type: Read Word
Description: Returns an extended fault/warning status byte.

Bit	Function	Description	Value	Description
15	Vout	An output voltage fault or warning has occurred.	0	No fault
			1	Fault
14	Iout/Pout	An output current or output power fault or warning has occurred.	0	No Fault
			1	Fault
13	Input	An input voltage, input current, or input power fault or warning has occurred.	0	No Fault
			1	Fault
12	Mfr Specific	A manufacturer specific fault or warning has occurred.	0	No Fault
			1	Fault
11	Power-Good	Indicates if output 1 of the PIM is ok and ready to deliver current.	0	Good
			1	Not good
4	Iout Overcurrent Fault	An output overcurrent fault has occurred.	0	No Fault
			1	Fault
3	Vin Undervoltage Fault	An input undervoltage fault has occurred.	0	No Fault
			1	Fault
2	Temperature	A temperature fault or warning has occurred.	0	No Fault
			1	Fault
1	Communication/Logic	A communications, memory or logic fault has occurred.	0	No fault
			1	Fault

STATUS_VOUT (0x7A)
Transfer Type: R/W Byte
Description: Returns Vout-related fault/warning status bits.

Bit	Description	Value	Description
4	Vout Undervoltage Fault.	0	No Fault
		1	Fault

STATUS_IOUT (0x7B)
Transfer Type: R/W Byte
Description: Returns Iout-related fault/warning status bits.

Bit	Description	Value	Description
7	Iout Overcurrent Fault.	0	No Fault
		1	Fault

STATUS_INPUT (0x7C)
Transfer Type: R/W Byte
Description: Returns Vin/Iin-related fault/warning status bits.

Bit	Description	Value	Description
4	Vin Undervoltage Fault.	0	No Fault
		1	Fault

STATUS_TEMPERATURE (0x7D)
Transfer Type: R/W Byte
Description: Returns the temperature-related fault/warning status bits

Bit	Function	Description	Value	Description
7	Overtemperature Fault	Overtemperature Fault. Set when the temperature of the controller (P2) is above 105°C	0	No Fault
			1	Fault
6	Overtemperature Warning	Overtemperature Warning. Set when the temperature of the controller (P2) is above 95°C	0	No Warning
			1	Warning

STATUS_CML (0x7E)
Transfer Type: R/W Byte
Description: Returns Communication/Logic/Memory-related fault/warning status bits.

Bit	Function	Description	Value	Description
7	Invalid Or Unsupported Command Received	Invalid Or Unsupported Command Received.	0	No Invalid Command Received
			1	Invalid Command Received
6	Invalid Or Unsupported Data Received	Invalid Or Unsupported Data Received.	0	No Invalid Data Received
			1	Invalid Data Received
5	Packet Error Check Failed	Packet Error Check Failed.	0	No Failure
			1	Failure
1	Other Communication Fault	A communication fault other than the ones listed in this table has occurred.	0	No Fault
			1	Fault

STATUS_MFR_SPECIFIC (0x80)
Transfer Type: R/W Byte
Description: Returns manufacturer specific status information.

Bit	Function	Description	Value	Description
4	Hold up	Hold up event has occurred.	0	Not Occurred
			1	Occurred
3	Feed B disabled	Feed B disabled. This status bit is set when the feed B voltage drops below the threshold defined by command MFR_ENABLE_OFF_LEVEL or the enable B pin (EN B) is unplugged.	0	Feed B enabled
			1	Feed B disabled
2	Feed A disabled	Feed A disabled. This status bit is set when the feed A voltage drops below the threshold defined by command MFR_ENABLE_OFF_LEVEL or the enable A pin (EN A) is unplugged.	0	Feed A enabled
			1	Feed A disabled

Bit	Function	Description	Value	Description
1	Feed B input under voltage fault	Set when feed B voltage goes below the threshold defined by command MFR_FEED_ALARM_RAISE_LEVEL. Must return above the threshold defined by command MFR_FEED_ALARM_CEASE_LEVEL before it can be cleared.	0	No Fault
			1	Fault
0	Feed A input under voltage fault	Set when feed A voltage goes below the threshold defined by command MFR_FEED_ALARM_RAISE_LEVEL. Must return above the threshold defined by command MFR_FEED_ALARM_CEASE_LEVEL before it can be cleared.	0	No Fault
			1	Fault

READ_VIN (0x88)
Transfer Type: Read Word
Description: Returns the measured input voltage. This is the ORed input voltage and will typically be the highest of feed A and feed B input voltages.

Bit	Description	Format	Unit
15:0	Returns the input voltage reading.	Linear	V

READ_IIN (0x89)
Transfer Type: Read Word
Description: Returns the measured input current.

Bit	Description	Format	Unit
15:0	Returns the input current reading.	Linear	A

READ_VCAP (0x8A)
Transfer Type: Read Word
Description: Returns hold-up capacitor voltage of the module

Bit	Description	Format	Unit
15:0	Returns the hold-up capacitor voltage reading.	Linear	V

READ_IOUT (0x8C)
Transfer Type: Read Word
Description: Returns output current of the module

Bit	Description	Format	Unit
15:0	Returns the output current reading.	Linear	A

READ_TEMPERATURE_1 (0x8D)
Transfer Type: Read Word
Description: Returns the measured temperature (internal).

Bit	Description	Format	Unit
15:0	Returns the measured temperature (internal).	Linear	°C

READ_PIN (0x97)
Transfer Type: Read Word
Description: Returns the measured input power.

Bit	Description	Format	Unit
15:0	Returns the input power reading.	Linear	W

PMBUS_REVISION (0x98)
Transfer Type: Read Byte
Description: PMBus revision 1.2, hard coded

Bit	Function	Description	Value	Function	Description
7:4	Part I Revision	Part I Revision.	0x2	1.2	Part I Revision 1.2.
3:0	Part II Revision	Part II Revision.	0x2	1.2	Part II Revision 1.2.

MFR_ID (0x99)
Transfer Type: R/W Block (8 bytes)
Description: Returns the manufacturer ID String.

Bit	Description	Format
63:0	Maximum of 8 characters.	ASCII fixed length

MFR_MODEL (0x9A)
Transfer Type: R/W Block (18 bytes)
Description: Returns the manufacturer model string.

Bit	Description	Format
143:0	Maximum of 18 characters.	ASCII fixed length

MFR_REVISION (0x9B)
Transfer Type: R/W Block (3 bytes)
Description: Returns the manufacturer revision string.

Bit	Description	Format
23:0	Maximum of 3 characters.	ASCII fixed length

MFR_LOCATION (0x9C)
Transfer Type: R/W Block (3 bytes)
Description: Returns the manufacturer location string.

Bit	Description	Format
23:0	Maximum of 3 characters.	ASCII fixed length

MFR_DATE (0x9D)
Transfer Type: R/W Block (6 bytes)
Description: Returns the manufacturer date at YYMMDD.

Bit	Description	Format
47:0	Maximum of 6 characters.	ASCII fixed length

MFR_SERIAL (0x9E)
Transfer Type: R/W Block (13 bytes)
Description: Returns the manufacturer serial string.

Bit	Description	Format
103:0	Maximum of 13 characters.	ASCII fixed length

MFR_READ_VINA (0xD3)
Transfer Type: Read Word
Description: Returns the measured input voltage on feed A.

Bit	Description	Format	Unit
15:0	Returns the input voltage reading on feed A.	Linear	V

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MFR_READ_VINB (0xD4)
Transfer Type: Read Word
Description: Returns the measured input voltage on feed B.

Bit	Description	Format	Unit
15:0	Returns the input voltage reading on feed B.	Linear	V

MFR_STATUS_BITS (0xD5)
Transfer Type: Read Byte
Description: Status bits.

Bit	Function	Description	Value	Description
6	Output under voltage	Cleared when the output voltage is below the threshold defined by command MFR_HU_TRIG_LEVEL. Set when the output voltage is above the threshold defined by command MFR_HU_TRIG_LEVEL.	0	Raised
			1	Ceased
5	Hot swap switch state	Set when the hot swap switch is on.	0	Off
			1	On
4	Hold-up switch state	Set when the hold-up capacitor is connected to the output.	0	Off
			1	On
2	Feed Alarm	Set when any feed voltage is below the threshold defined by command MFR_FEED_ALARM_RAISE_LEVEL. Cleared when both feed voltages are above the threshold define by command MFR_FEED_ALARM_CEASE_LEVEL.	0	Ceased
			1	Raised
1	Feed B Enable	Cleared when feed B voltage is below the threshold defined by command MFR_ENABLE_OFF_LEVEL or enable B pin is unplugged. Set when feed B voltage is above the threshold defined by command MFR_ENABLE_ON_LEVEL and enable B pin is plugged in.	0	Disabled
			1	Enabled
0	Feed A Enable	Cleared when feed A voltage is below the threshold defined by command MFR_ENABLE_OFF_LEVEL or enable A pin is unplugged. Set when feed A voltage is above the threshold defined by command MFR_ENABLE_ON_LEVEL and enable A pin is plugged in.	0	Disabled
			1	Enabled

MFR_PG_DEASSERT_TRIP_LEVEL (0xE0)
Transfer Type: R/W Word
Description: Configures the functional mode of the Power Good. When set to zero the Power Good will function in its standard mode. When set to a non-zero value the Power Good will function in the shutdown advance alert mode and the value will define a hold up voltage level at which the Power Good de-asserts

Bit	Description	Format	Unit
15:0	DIRECT-format with m = 6400, b = 0 and R = -2. (15.625 mV/LSB).	Direct	V

MFR_OUT1_START_DELAY (0xE1)
Transfer Type: R/W Word
Description: Configures the delay from enable detection to start of output 1.

Bit	Description	Format	Unit
15:0	Configures the delay from enable detection to start of output 1.	Integer Unsigned	ms

MFR_OUT2_START_DELAY (0xE2)
Transfer Type: R/W Word
Description: Configures the delay from enable detection to start of output 2.

Bit	Description	Format	Unit
15:0	Configures the delay from enable detection to start of output 2.	Integer Unsigned	ms

MFR_CONFIG (0xE3)
Transfer Type: R/W Word
Description: Miscellaneous production configuration.

Bit	Description	Format
15:0	Reserved.	Integer Unsigned

MFR_HU_TRIG_LEVEL (0xE4)
Transfer Type: R/W Word
Description: Configures the input and output voltage level at which the hold-up engages.

Bit	Description	Format	Unit
15:0	DIRECT-format with m = 6400, b = 0 and R = -2. (15.625 mV/LSB).	Direct	V

MFR_ENABLE_OFF_LEVEL (0xE5)
Transfer Type: R/W Word
Description: Configures the disable level. When both input voltages are below this threshold the outputs will be turned off.

Bit	Description	Format	Unit
15:0	DIRECT-format with m = 6400, b = 0 and R = -2. (15.625 mV/LSB).	Direct	V

MFR_ENABLE_ON_LEVEL (0xE6)
Transfer Type: R/W Word
Description: Configures the enable level. When any input voltage is above this threshold the outputs will be turned on.

Bit	Description	Format	Unit
15:0	DIRECT-format with m = 6400, b = 0 and R = -2. (15.625 mV/LSB).	Direct	V

MFR_FEED_ALARM_RAISE_LEVEL (0xE7)
Transfer Type: R/W Word
Description: Configures the feed alarm raise level.

Bit	Description	Format	Unit
15:0	DIRECT-format with m = 6400, b = 0 and R = -2. (15.625 mV/LSB).	Direct	V

MFR_FEED_ALARM_CEASE_LEVEL (0xE8)
Transfer Type: R/W Word
Description: Configures the feed alarm cease level.

Bit	Description	Format	Unit
15:0	DIRECT-format with m = 6400, b = 0 and R = -2. (15.625 mV/LSB).	Direct	V

MFR_VINAP_SLOPE (0xE9)
Transfer Type: R/W Word
Description: Calibration data. Feed A input voltage slope positive pin (+IN A).

Bit	Description	Format
15:0	Calibration data. Feed A input voltage slope positive pin (+IN A).	Integer Signed

MFR_VINA_OFFSET (0xEA)
Transfer Type: R/W Word
Description: Calibration data. Feed A input voltage offset.

Bit	Description	Format
15:0	Calibration data. Feed A input voltage offset.	Integer Signed

MFR_IOUT1_SLOPE (0xEB)
Transfer Type: R/W Word
Description: Calibration data. Iout1 slope.

Bit	Description	Format
15:0	Calibration data. Iout1 slope.	Integer Signed

MFR_IOUT1_OFFSET (0xEC)
Transfer Type: R/W Word
Description: Calibration data. Iout1 offset.

Bit	Description	Format
15:0	Calibration data. Iout1 offset.	Integer Signed

MFR_VINAN_SLOPE (0xED)
Transfer Type: R/W Word
Description: Calibration data. Feed A input voltage slope negative pin (-IN A).

Bit	Description	Format
15:0	Calibration data. Feed A input voltage slope negative pin (-IN A).	Integer Signed

MFR_VINBP_SLOPE (0xEE)
Transfer Type: R/W Word
Description: Calibration data. Feed B input voltage slope positive pin (+IN B).

Bit	Description	Format
15:0	Calibration data. Feed B input voltage slope positive pin (+IN B).	Integer Signed

MFR_VINB_OFFSET (0xEF)
Transfer Type: R/W Word
Description: Calibration data. Feed B input voltage offset.

Bit	Description	Format
15:0	Calibration data. Feed B input voltage offset	Integer Signed

MFR_VINBN_SLOPE (0xF0)
Transfer Type: R/W Word
Description: Calibration data. Feed B input voltage slope negative pin (-IN B).

Bit	Description	Format
15:0	Calibration data. Feed B input voltage slope negative pin (-IN B).	Integer Signed

MFR_FIRMWARE_DATA (0xFD)
Transfer Type: Read Block (20 bytes)
Description: Hard coded.

Bit	Description	Format
159:0		ASCII fixed length