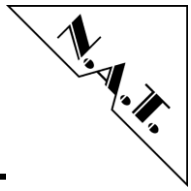
NAT-RPM-AC600
MTCA4.1 Rear Power Module
Technical Reference Manual V1.1



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Note:

The release of the Hardware Manual is related to a certain HW board revision given in the document title. For HW revisions earlier than the one given in the document title please contact N.A.T. for the corresponding older Hardware Manual release.

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Conventions

If not otherwise specified, addresses and memory maps are written in hexadecimal notation, identified by *0x*.

The following table gives a list of the abbreviations used in this document.

Table 1: List of used abbreviations

Abbreviation	Description
AC	Alternating Current
AMC	Advanced Mezzanine Card
CPU	Central Processing Unit
CU	Cooling Unit
EMI	Electromagnetic Interference
EMMC	Enhanced MMC
eRTM	Extended RTM
HPM	Hardware Platform Management
IPMB	Intelligent Platform Management Bus
IPMI	Intelligent Platform Management Interface
LED	Light Emitting Diode
µRTM	MicroTCA Rear Transition Module
µTCA/MTCA	Micro Telecommunications Computing Architecture
MCH	µTCA/MTCA Carrier Hub
MMC	Module Management Controller
PFC	Power Factor Correction
PM	Power Module
RPM	Rear Power Module
SMP	Shared Management Power
RTM	Rear Transition Module (eRTM, µRTM)
#	Active low signal

1 Introduction

The **NAT-RPM-AC600** (Rear Power Module RPM) is a power distribution and management board for MTCA.4.1 applications. Its development was made mandatory by the market's intention to use rear transition modules (uRTMs and eRTMs) which are not covered by the MTCA.4 specification and which differ in form factor and application from the standard MTCA power modules. The RPMs are specified in detail by the MTCA4.1 standard.

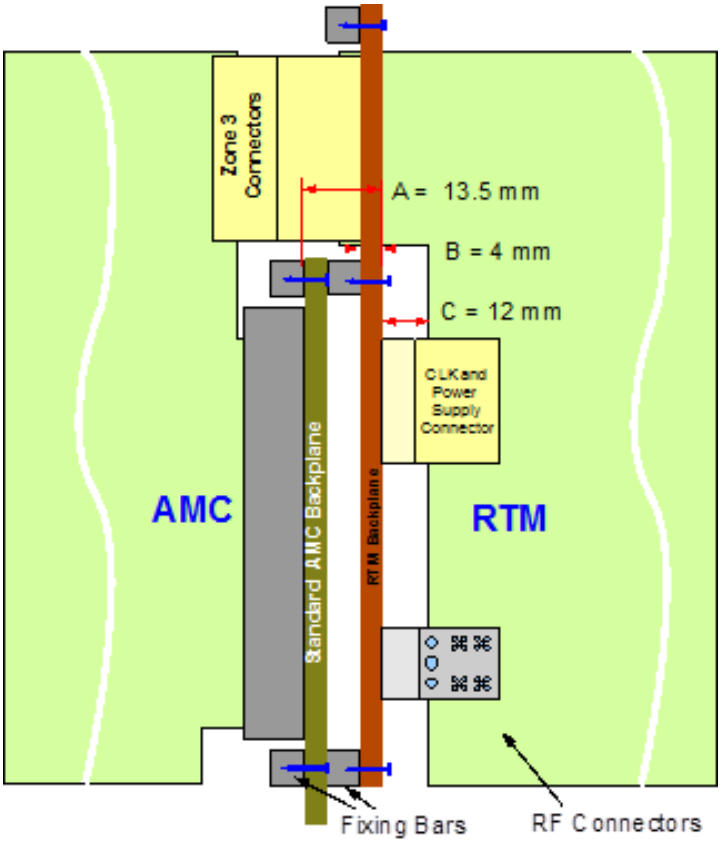
The **NAT-RPM-AC600** provides Management and Payload Power for up three eRTMs and a positive (VV+) and negative supply (VV-) for up to twelve uRTMs in a MicroTCA.4 chassis equipped with an RF-Backplane. The VV+ and VV- voltages are adjustable in a wide range.

The MicroTCA RTM Backplane (µRTM backplane), e.g. Low Level RF backplane, for MicroRTM cards (µRTM) is a hardware implementation embedded in a MicroTCA4.1 crate. The unit is a passive RTM backplane located behind the AMC backplane and suited for interconnection of high-precision RF and CLK signals and delivery of high-performance managed analog power supply for µRTM and extended RTM (eRTM) modules. The high-frequency signal distribution network was designed to operate in the DC – 6GHz band.

The **NAT-RPM-AC600** offers power conversion from universal line input (85V-265VAC) and feeds up to 16 independent power channels for RTMs It supplies backup power for other power modules (Shared Management Power, SMP) within the system. It is available as double-width, full-size module.

The figure below shows the location of the MicroTCA RTM backplane behind the AMC backplane in a MicroTCA4.1 chassis:

Figure 1: MicroTCA RF-Backplane – Top View

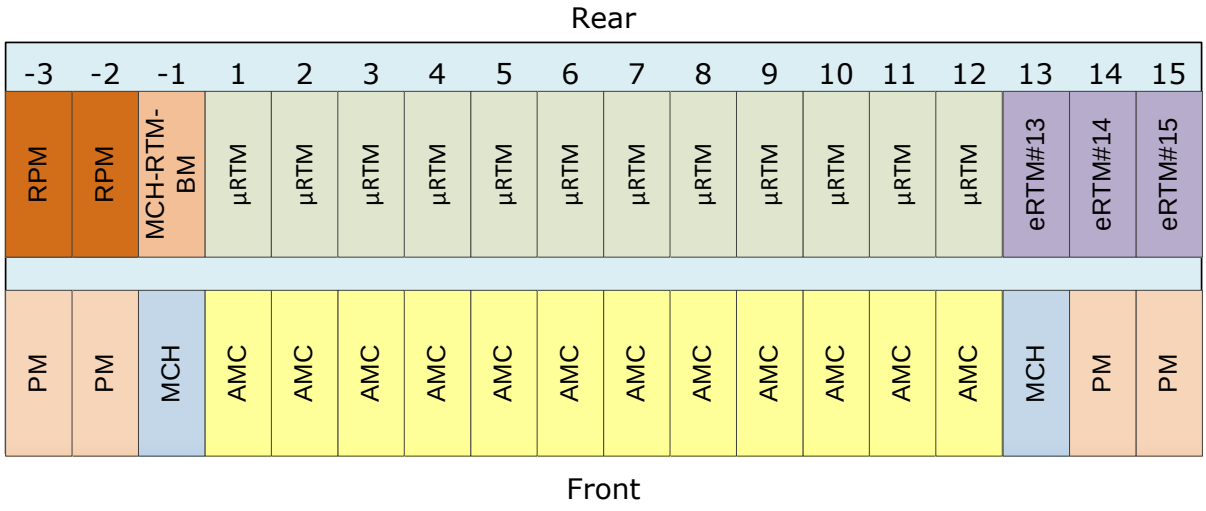


Three types of RTMs are used:

- µRTMs with only a Zone-3 connection to the front AMCs – power supply is provide by the front AMC
- RTMs with a connector to the RTM backplane and optionally a Zone-3 connection to the front AMCs
- Extended RTMs, located behind the Power Modules and the MCHs

The position of these modules is shown in the following figure:

Figure 2: MicroTCA RF-Backplane – Rear View



The following figure shows a photo of the **NAT-RPM-AC600.**

Figure 3: NAT-RPM-AC600

tbd

2 Overview

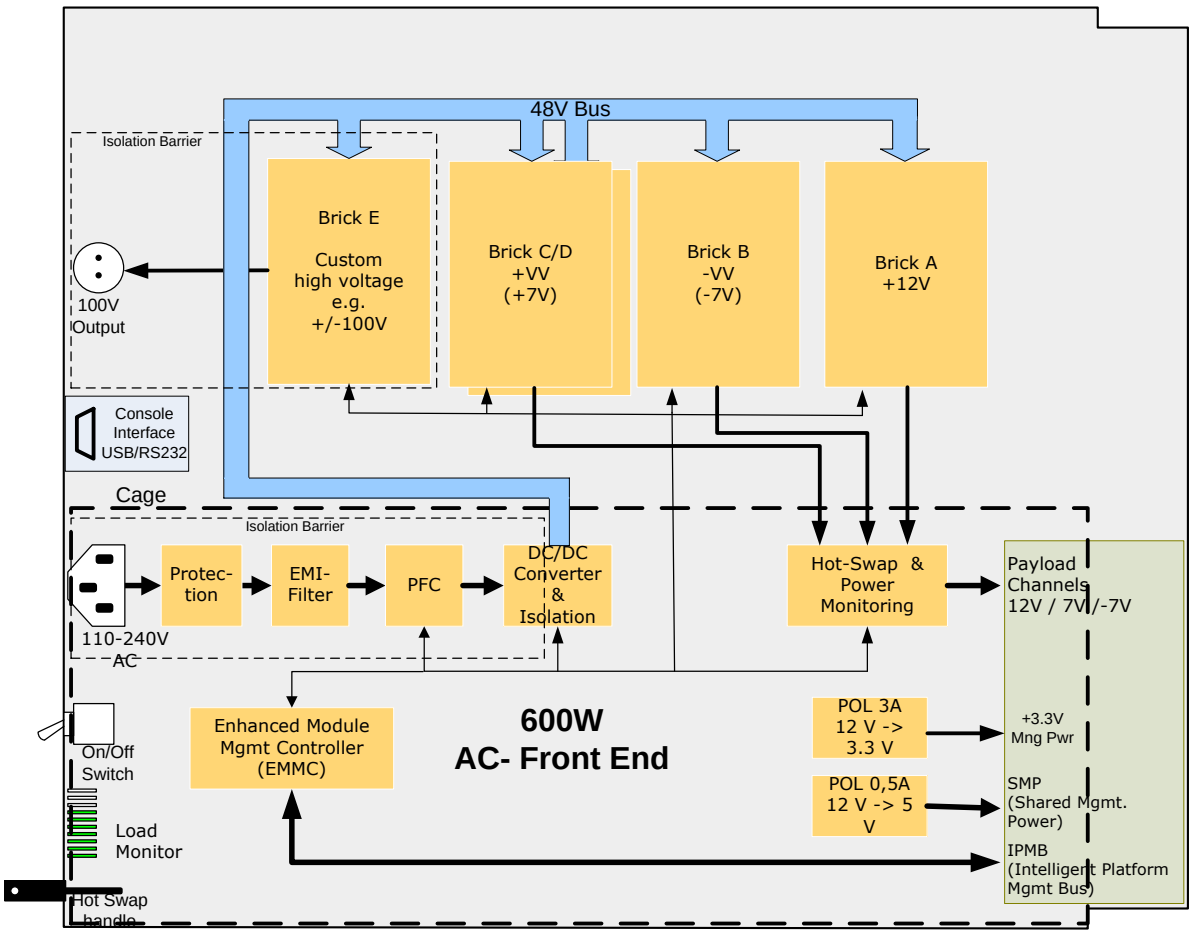
2.1 Major Features

- EMI Filtering providing EN55022 Class A and B compliance
- inrush control
- Power factor correction circuitry (PFC)
- holdup circuit
- high-efficiency power conversion
- load indicator
- power management for 16 power channels
- backup power for second PM (SMP)
- support for N+1, 2+2 redundancy and load sharing
- HPM firmware upgrade support

2.2 Block Diagram

The following figure shows a block diagram of the **NAT-RPM-AC600**.

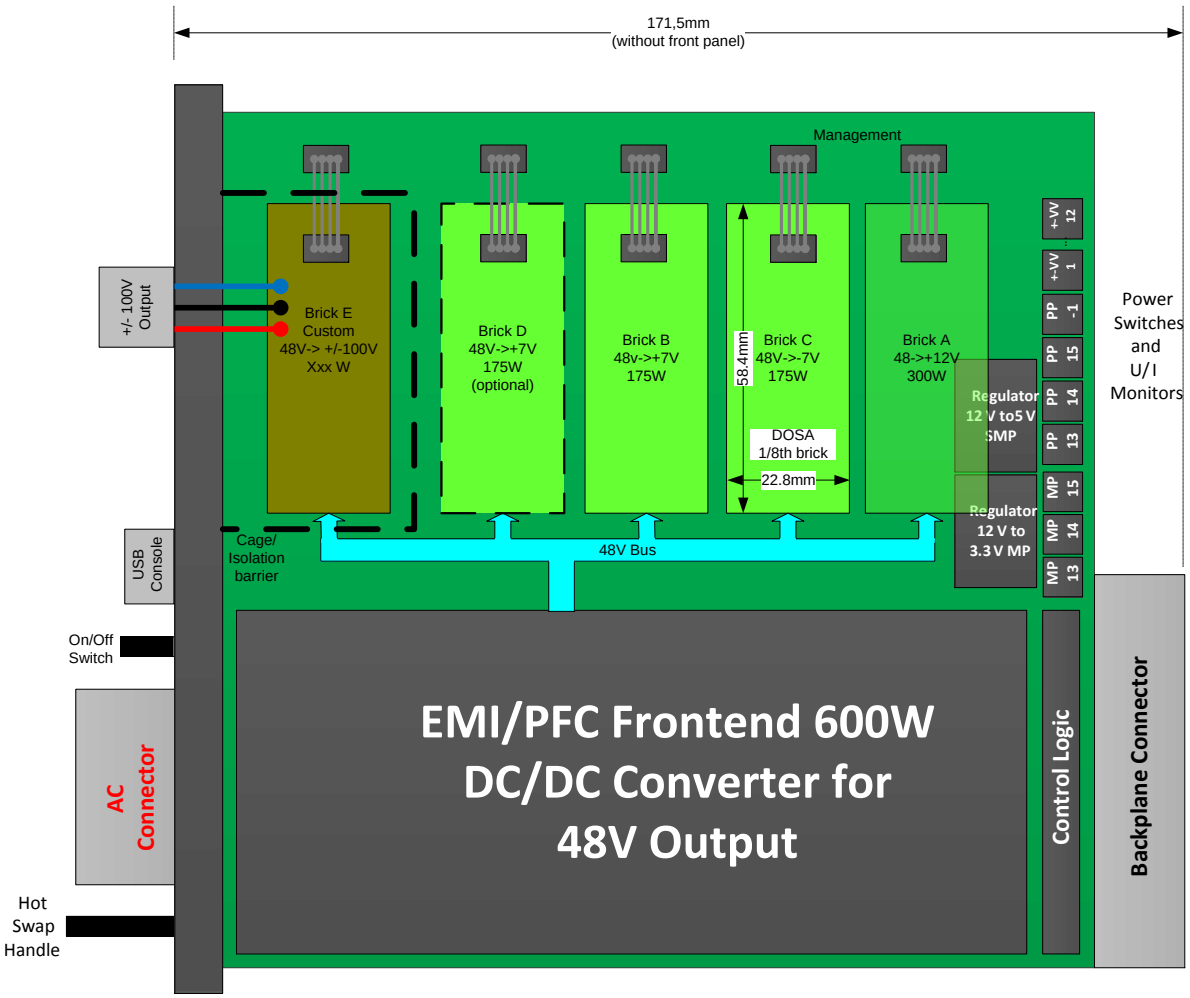
Figure 4: NAT-RPM-AC600 – Block Diagram



2.3 Location Diagram

The position of important components is shown in the following location overview. Depending on the board type it might be that the board does not include all components named in the location diagram.

Figure 5: NAT-RPM-AC600 – Location Diagram



3 Board Features

3.1 EMMC

The **NAT-RPM-AC600** includes a robust Enhanced Module Management Controller (EMMC) that interfaces the power control functionality via an Intelligent Platform Management Bus (IPMB) to the MicroTCA Carrier Hub (MCH).

3.2 Redundancy and Load Sharing

The **NAT-RPM-AC600** supports redundancy as well as load sharing modes in accordance with the MicroTCA specifications. In case of an input power supply failure the on-board EMMC can be supplied with SMP power by other power modules, so that the System/Carrier Manager is able to analyze the root cause failure.

3.3 LED Indicators

Besides the standard indicator LEDs for hot-swap, failure and heartbeat the **NAT-RPM-AC600** has an unique light bar indicator, showing the total power load of the module on a scale from 0 to 100% in real time.

3.4 Applications

The **NAT-RPM-AC600** is a hot swappable, fully redundant power module. The module's double-width design offers perfect thermal performance and is therefore ideally suited for all air cooled MicroTCA solutions. It supports all redundancy schemes as well as load sharing applications. The power module's software has been developed and debugged using the **NAT-MCH** as a reference tool. It is fully compatible with any cards or modules inserted into a MicroTCA chassis.

Application areas are

- physics instrumentation and test equipment
- commercial-, military-, and telecommunication applications
- automation test equipment
- medical or security tasks
- video on demand services
- industrial machine control and other clustered computing applications

3.5 Sensors

The **NAT-RPM-AC600** features several sensors to capture and monitor the temperature-, voltage-, and current-conditions of the module. Details are shown in the following table.

Table 2: Sensor Overview

Sensor #	Sensor Type	Name	Description
1	Temp	T_CPU	Temperature of CPU
2	Temp	T_XFRM	Temperature of Transformer
3	Temp	T-PSB	Temperature of Bridge Transistors
4	Temp	T-PFC1	Temperature of PFC-Unit
5	Temp	T-REC	Temperature of Rectifier
6	Voltage	VINAC	Input Voltage AC
7	Voltage	VINDC	Input Voltage DC
8	Voltage	12V	12V Monitoring
9	Voltage	3.3V	3.3V Monitoring
10	Voltage	VV+	VV+ Monitoring
11	Voltage	VV-	VV- Monitoring
12	Current	I_Sum	Sum of all Power Channels
13	Current	I_PP01	Power Channel 1 +12V – eRTM15
14	Current	I_PP02	Power Channel 2 +12V – eRTM14
15	Current	I_PP03	Power Channel 3 +12V – eRTM13
16	Current	I_PP04	Power Channel 4 +12V – MCH-RTM
17	Current	I_CH05	Power Channel 5 – VV+01
18	Current	I_CH06	Power Channel 6 – VV+02
19	Current	I_CH07	Power Channel 7 – VV+03
20	Current	I_CH08	Power Channel 8 – VV+04
21	Current	I_CH09	Power Channel 9 – VV+05
22	Current	I_CH10	Power Channel 10 – VV+06
23	Current	I_CH11	Power Channel 11 – VV+07
24	Current	I_CH12	Power Channel 12 – VV+08
25	Current	I_CH13	Power Channel 13 – VV+09
26	Current	I_CH14	Power Channel 14 – VV+10
27	Current	I_CH15	Power Channel 15 – VV+11
28	Current	I_CH16	Power Channel 16 – VV+12
29	Current	I_CH17	Power Channel 16 – VV-01
30	Current	I_CH19	Power Channel 16 – VV-02
31	Current	I_CH19	Power Channel 16 – VV-03
32	Current	I_CH20	Power Channel 16 – VV-04
33	Current	I_CH21	Power Channel 16 – VV-05
34	Current	I_CH22	Power Channel 16 – VV-06
35	Current	I_CH23	Power Channel 16 – VV-07
36	Current	I_CH24	Power Channel 16 – VV-08
37	Current	I_CH25	Power Channel 16 – VV-09
38	Current	I_CH26	Power Channel 16 – VV-10
39	Current	I_CH27	Power Channel 16 – VV-11
40	Current	I_CH28	Power Channel 16 – VV-12

4 Technical Data

- Maximum power output on +VV (default +7V): 270W
  Please note: the maximum power output that can be generated by one brick is VV x 25A; for +VV=7V this means a maximum power output of 175W. So it is mandatory, that the optional second brick for generating +VV is assembled, to reach the required 270W power output!
- Maximum power output on +12V: 250W
- Maximum power output on –VV (default -7V): 42W
- Support of redundant operation for Management Power, Payload Power and +VV/-VV
- 85VAC-265VAC universal line input
- 600W output power (*)
- support of N+1 and 2+2 redundancy
- 4 power channels of
  - 12V
  - 3.3V
- 12 power channels of
  - VV+
  - VV-
- 88% peak conversion efficiency
- HPM firmware upgrade support
- double-width, full-size (6HP)
- Intelligent Security System
  - output over-voltage and over-temperature-protection
  - input under-voltage-shutdown
  - output short-circuit-protection
  - programmable current limiting threshold per output channel
- Front Panel
  - power input plug
  - On/Off Switch
  - optical load indicator
  - hot swap handle and blue LED
  - health indicator LED
  - heartbeat indicator LED
- Standard Compliance
  - PICMG MicroTCA.4 MicroTCA4.1
  - IPMI v1.5 and v2.0
  - Safety and EMI standard compliance
  - RoHS compliant

(*) guaranteed for AC line input 115VAC-265VAC

5 Hardware

5.1 Front Panel and LEDs

Figure 6: NAT-RPM-AC600 – Front Panel View

Elements of the front panel:

- AC Power Plug
- Hot Swap Handle: AMC.0 compliant hot swap and extraction handle
- On/Off Switch: "On" position is left
- Load Indicator Bar: indicates the overall load of the module in 10% steps
- LEDs:
  - LED HS: MTCA.0 Blue LED
  - LED FTL: red LED indicating the power module is not healthy and thus not able to provide power to the system
  - LED WD:
    - solid green: PM is the startup PM and runs in autonomous mode
    - green blinking: PM is primary and shows the heartbeat from the MCH (managed mode)
    - solid yellow: PM has come up as secondary PM and is not managed
    - yellow blinking. PM is secondary and shows the heartbeat of the MCH (managed mode)
  - LED PFC:
    - Green: PFC stage active
    - red: PFC stage overheat
  - LED 12V:
    - green: power converter stage active
    - Red: power converter stage overheat
  - LED StdBy:
    - Green: power module switched on
    - Yellow: power module switched off, standby

5.2 Connectors

5.2.1 P1: Backplane Power Connector

Table 3: P1: Power Connector Part A – Control Signal and Management Power

Pin	A	B	C	D	E	F	G	H
1	PS_PM#	PM_OK#	PS1_15#	PS1_13#	EN_15#	EN_13#	MP_15	MP_13
2	n.c.	PMP_A#	PS1_2#	PS1_1#	-VV_2	-VV_1	n.c.	n.c.
3	n.c.	PMP_B#	PS1_4#	PS1_3#	-VV_4	-VV_3	n.c.	n.c.
4	n.c.	PMP_C#	PS1_6#	PS1_5#	-VV_6	-VV_5	n.c.	n.c.
5	n.c.	RST_PM_IN#	PS1_8#	PS1_7#	-VV_8	-VV_7	n.c.	n.c.
6	n.c.	RST_PM_A#	PS1_10#	PS1_9#	-VV_10	-VV_9	n.c.	n.c.
7	GA0	RST_PM_B#	PS1_12#	PS1_11#	-VV_12	-VV_11	n.c.	n.c.
8	GA1	RST_PM_C#	PS1_14#	PS1_-2#	EN_14#	EN_-2#	MP_14	MP_-2
9	GA2	SMP	SCL_B	SDA_B	SCL_A	SDA_A	PWR_ON_14	PWR_ON_15

Table 4: P1: Power Connector Part B – High Power Pins

Pin #	Signal	Signal	Pin #
P1	PP_15	+VV_1	P13
P2	PP_13	+VV_3	P14
P3	PP_-2	+VV_5	P15
P4	GND	+VV_2	P16
P5	GND	+VV_4	P17
P6	GND	+VV_6	P18
P7	GND	+VV_7	P19
P8	GND	+VV_8	P20
P9	GND	+VV_9	P21
P10	GND	+VV_10	P22
P11	GND	+VV_11	P23
P12	PP_14	+VV_12	P24

5.2.2 SW1: Hot Swap Switch

Switch SW1 is used to support hot swapping of the module. It conforms to PICMG AMC.0.

6 Operation

6.1 Insertion / Power up

After placing the **NAT-RPM-AC600** in a MTCA4.1 Rack the system is powered up as soon as the line power is available and the On/Off switch is placed in the "On" position. As soon as the MCH has taken control over the system, the green WD LED starts to blink. From this time on the power module is under control of the MCH. The MCH is responsible for directing the power module to power up the RTMs in the system.

6.2 Power down / Extraction

The power down / hot swap process is started by pulling the module's hot swap handle. In a non-redundant system the MCH will switch off payload and management power channels for the RTMs. In a redundant system finally the system remains powered by the second power module.
As soon as the power module's blue LED is solid, on the module is ready for extraction.
If the On/Off switch is placed in the "Off" position, system power is cut right away. In redundant systems the system stays active if powered by the second power module.

6.3 Channel Current Limit

According to the MTCA4.1 specification each payload module in a µTCA system has to provide a power budget to the MCH. The MCH communicates this power budget to the power modules.
The **NAT-RPM-AC600** supervises the current for each of the payload channels and turns a power channel off if the measured current exceeds the requested power budget for the respective module. The **NAT-RPM-AC600** can provide a maximum current of 9.2A per channel (= 106W at 11.6V). The current limit can be adjusted in 5% steps down to 2.3A minimum current limit. An additional margin of 5% is added to the requested power budget to compensate for component tolerances and parasitic effects.

6.4 Airflow Requirements

The peak conversion efficiency of the **NAT-RPM-AC600** is 88% or better. When operating under full load this means that still 72W of heat dissipation must be disposed by the airflow.

WARNING

Operating the **NAT-RPM-AC600** under full load of 600W requires a minimum air flow of

5m/sec ≈ 75m^3/h ≈ 50 CFM

The maximum ambient temperature at the power module shall not exceed 50°C.

7 Board Specification

Table 5: NAT-RPM-AC600 Specification

Processor	Atmel xMega	
FPGA	Lattice MACHXO2	
Form Factor	single width, full size	
Front-I/O	AC universal line input plug with fastening notch	
Power consumption	1W standby	
Input Voltage	85VAC-265VC	
AC Line Fuse	8A	
Isolation Input/Output	3KV	
12V	Output Voltage	12.4V primary mode 11.6V secondary mode
	Max. Output Power 12V	20A(***)
	Max. Ripple	70mV(RMS)
	Accuracy	+/-100mV
3.3V	Output Voltage	3.4V
	Max. Output Power	3A(***)
	Max. Ripple	70mV(RMS)
	Accuracy	+/-100mV
VV+	Output Voltage	+6V to +15V configurable
	Max. Output Power	50A(***)
	Max. Ripple	20mV
	Accuracy	+/-100mV(RMS)
VV-	Output Voltage	-6V to -15V configurable
	Max. Output Power	25A(***)
	Max. Ripple	70mV(RMS)
	Accuracy	+/-100mV
Airflow Requirements	5m/sec ≈ 50CFM at full load	
Environmental conditions	Temperature (operating): Temperature (storage): Humidity:	-5°C to +50°C with forced air cooling -40°C to +85°C 10 % to 90 % rh non-condensing
MTBF	4.835270FIT / 204814 hours	MIL217
Standards compliance	AMC and µTCA	PICMG AMC.0 Rev. 2.0 IPMI Specification v2.0 Rev. 1.0 PICMG MTCA4, ;TCA4.1 Rev. 1.0
	Safety	IEC/EN/UL60950-1 safety (**)
	EMI	EN55022 Class A/B (**)

(*) guaranteed for 115VAC-265VAC, below 115VAC input output power is degraded by 1%/Volt
(**) for details please refer to the **NAT-PM-AC600** CE-Report
(***) The **sum** of the output power of ALL channels must not exceed **600W** !

8 Statement on Environmental Protection

8.1.1 Compliance to RoHS Directive

Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the "Restriction of the use of certain Hazardous Substances in Electrical and Electronic Equipment" (RoHS) predicts that all electrical and electronic equipment being put on the European market after June 30th, 2006 must contain lead, mercury, hexavalent chromium, polybrominated biphenyls (PBB) and poly-brominated diphenyl ethers (PBDE) and cadmium in maximum concentration values of 0.1% respective 0.01% by weight in homogenous materials only.

As these hazardous substances are currently used with semiconductors, plastics (i.e. semiconductor packages, connectors) and soldering tin any hardware product is affected by the RoHS directive if it does not belong to one of the groups of products exempted from the RoHS directive.

Although many of hardware products of N.A.T. are exempted from the RoHS directive it is a declared policy of N.A.T. to provide all products fully compliant to the RoHS directive as soon as possible. For this purpose since January 31st, 2005 N.A.T. is requesting RoHS compliant deliveries from its suppliers. Special attention and care has been paid to the production cycle, so that wherever and whenever possible RoHS components are used with N.A.T. hardware products already.

8.1.2 Compliance to WEEE Directive

Directive 2002/95/EC of the European Commission on "Waste Electrical and Electronic Equipment" (WEEE) predicts that every manufacturer of electrical and electronical equipment which is put on the European market has to contribute to the reuse, recycling and other forms of recovery of such waste so as to reduce disposal. Moreover this directive refers to the Directive 2002/95/EC of the European Commission on the "Restriction of the use of certain Hazardous Substances in Electrical and Electronic Equipment" (RoHS).

Having its main focus on private persons and households using such electrical and electronic equipment the directive also affects business-to-business relationships. The directive is quite restrictive on how such waste of private persons and households has to be handled by the supplier/manufacturer; however, it allows a greater flexibility in business-to-business relationships. This pays tribute to the fact with industrial use electrical and electronical products are commonly integrated into larger and more complex environments or systems that cannot easily be split up again when it comes to their disposal at the end of their life cycles.

As N.A.T. products are solely sold to industrial customers, by special arrangement at time of purchase the customer agreed to take the responsibility for a WEEE compliant disposal of the used N.A.T. product. Moreover, all N.A.T. products are marked according to the directive with a crossed out bin to indicate that these products within the European Community must not be disposed with regular waste.

If you have any questions on the policy of N.A.T. regarding the Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the "Restriction of the use of certain Hazardous Substances in Electrical and Electronic Equipment" (RoHS) or the Directive 2002/95/EC of the European Commission on "Waste Electrical and Electronic Equipment" (WEEE) please contact N.A.T. by phone or e-mail.

8.1.3 Compliance to CE Directive

Compliance to the CE directive is declared. A 'CE' sign can be found on the PCB.

8.1.4 Product Safety

The board complies with EN60950 and UL1950.

8.1.5 Compliance to REACH

The REACH EU regulation (Regulation (EC) No 1907/2006) is known to N.A.T. GmbH. N.A.T. did not receive information from their European suppliers of substances of very high concern of the ECHA candidate list. Article 7(2) of REACH is notable as no substances are intentionally being released by NAT products and as no hazardous substances are contained. Information remains in effect or will be otherwise stated immediately to our customers.

9 Known Bugs / Restrictions

none

Appendix A: Reference Documentation

Appendix B: Document's History

Revision	Date	Description	Author
1.0	03.11.2014	Initial Release	se
1.1	9.1.2017	Reworked all chapters	hl