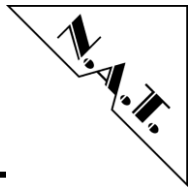
NAT-PM-DC420
NAT-PM-DC840
NAT-PM-DC600LV
MTCA Power Module
Technical Reference Manual V1.8
HW Revision 1.4-1.7



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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.

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

Table 1: List of used abbreviations

Abbreviation	Description
AMC	Advanced Mezzanine Card
CPU	Central Processing Unit
CU	Cooling Unit
DC	Direct Current
EMI	Electromagnetic Interference
EMMC	Enhanced MMC
HPM	Hardware Platform Management
IPMB	Intelligent Platform Management Bus
LED	Light Emitting Diode
µTCA/MTCA	Micro Telecommunications Computing Architecture
MCH	µTCA/MTCA Carrier Hub
MMC	Module Management Controller
PM	Power Module
SMP	Shared Management Power

1 Introduction

The **NAT-PM-DC420/840/600LV** are high density, high-efficiency power modules (PM) for MicroTCA applications. Supplying up to 840W makes it the market's most efficient PM to run today's complex communication systems that use latest processor generations with large memory capacity and an increased number of Advanced Mezzanine Cards (AMC).

The **NAT-PM-DC420/840/600LV** is ideally suited to run latest high availability MicroTCA systems with fast CPUs and large memory arrays where power feeding is crucial and therefore requiring high-performance electrical power modules. It provides payload and management power for up to 12 Advanced Mezzanine Cards (AMCs), 2 Cooling Units (CUs) and 2 MicroTCA carrier Hub (MCH) modules.

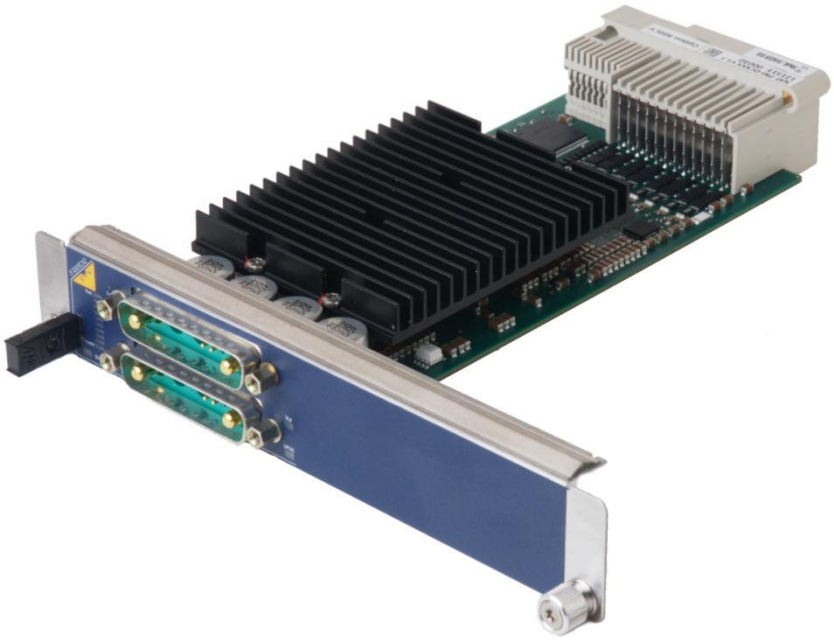
The **NAT-PM-DC420/840** offers power conversion from two -48VDC input sources to 16 independent 12V channels for payload power and 3.3V for management power. It supplies backup power for other power modules (Shared Management Power, SMP) within the system.

The **NAT-PM-600LV** is sourced from a primary supply of 24V.

The following figure shows a photo of the **NAT-PM-DC420/840**.

Figure 1: NAT-PM-DC420/840

Figure 2: NAT-PM-DC600LV (double width face plate shown)



2 Overview

2.1 Major Features

- input power protection
- input isolation
- inrush control
- input OR-ing
- EMI input filtering
- holdup circuit
- high efficiency power conversion
- optical load indicator
- power management for 16 power channels
- backup power for other PM (SMP)
- support for N+1, 2+2 redundancy and load sharing

2.2 Block Diagram

The following figures show the block diagrams of the **NAT-PM-DC420/840** and **NAT-PM-DC600LV**.

Figure 3: NAT-PM-DC420/840 – Block Diagram

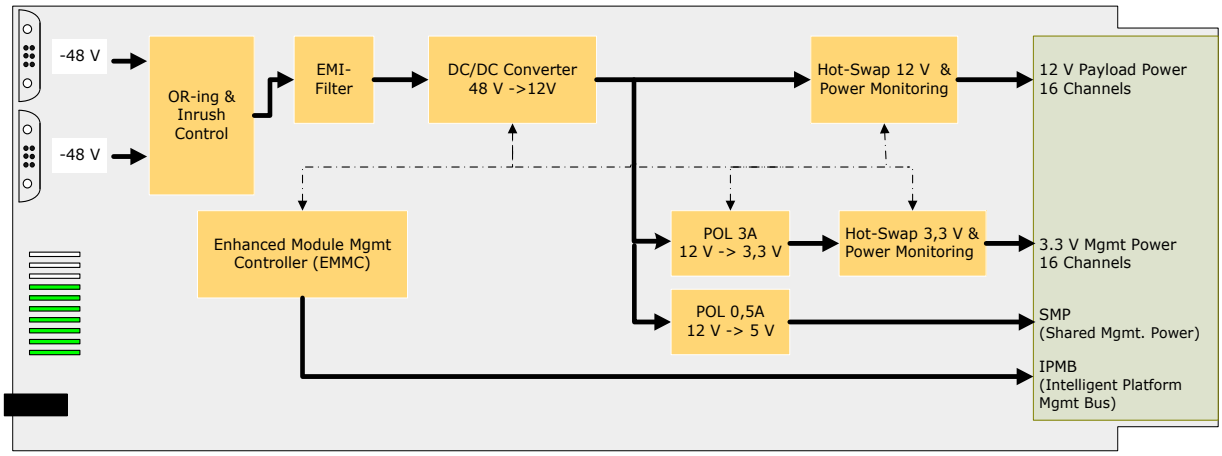
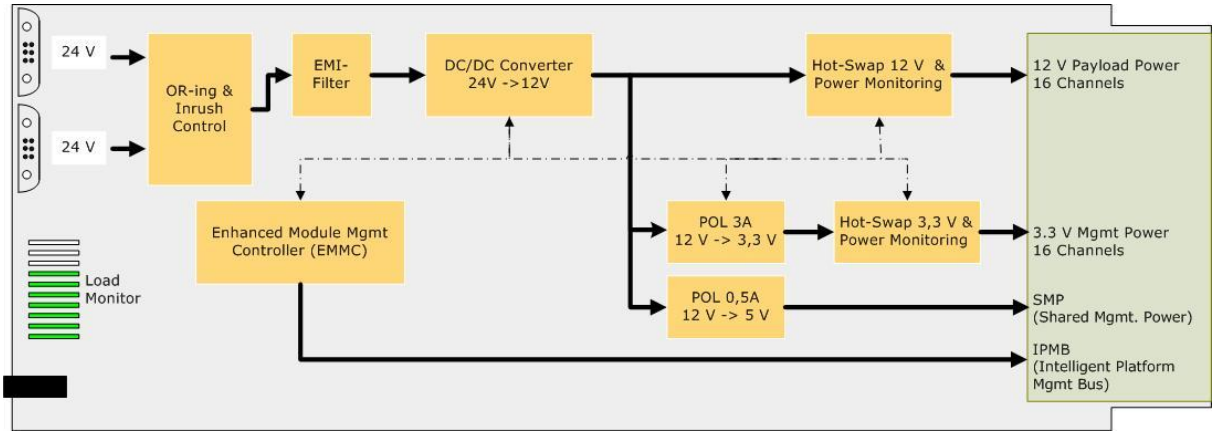


Figure 4: NAT-PM-DC600LV – Block Diagram



3 Board Features

3.1 EMMC

The **NAT-PM-DC420/840/600LV** 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-PM-DC420/840** 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 root cause failure.

3.3 LED Indicators

Besides the standard indicator LEDs for hot-swap, failure and heartbeat the **NAT-PM-DC420/840/600LV** 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 Sensors

The **NAT-PM-DC420/840/600LV** 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	TBrick-A	Temperature of 48V Converter Brick A
2	Temp	TBrick-B	Temperature of 48V Converter Brick B
3	Temp	T-Base	Temperature of Base Board
4	Voltage	VIN	Input Voltage
5	Voltage	VOUT-A	Output Voltage Channel A
6	Voltage	VOUT-B	Output Voltage Channel B
7	Voltage	12V	12V Monitoring
8	Voltage	3.3V	3.3V Monitoring
9	Current	I-Sum	Sum of all Power Channels
10	Current	Ch01 Current	Power Channel 1 – MCH1
11	Current	Ch02 Current	Power Channel 2 – MCH2
12	Current	Ch03 Current	Power Channel 3 – CU1
13	Current	Ch04 Current	Power Channel 4 – CU2
14	Current	Ch05 Current	Power Channel 5 – AMC1
15	Current	Ch06 Current	Power Channel 6 – AMC2
16	Current	Ch07 Current	Power Channel 7 – AMC3
17	Current	Ch08 Current	Power Channel 8 – AMC4
18	Current	Ch09 Current	Power Channel 9 – AMC5

Sensor #	Sensor Type	Name	Description
19	Current	Ch10 Current	Power Channel 10 – AMC6
20	Current	Ch11 Current	Power Channel 11 – AMC7
21	Current	Ch12 Current	Power Channel 12 – AMC8
22	Current	Ch13 Current	Power Channel 13 – AMC9
23	Current	Ch14 Current	Power Channel 14 – AMC10
24	Current	Ch15 Current	Power Channel 15 – AMC11
25	Current	Ch16 Current	Power Channel 16 – AMC12

3.5 Applications

The **NAT-PM-DC420/840/600LV** is a hot swappable, fully redundant and highly efficient power module. The module's single-width design offers perfect thermal performance and is therefore ideally suited for all air cooled MicroTCA solutions. 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

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

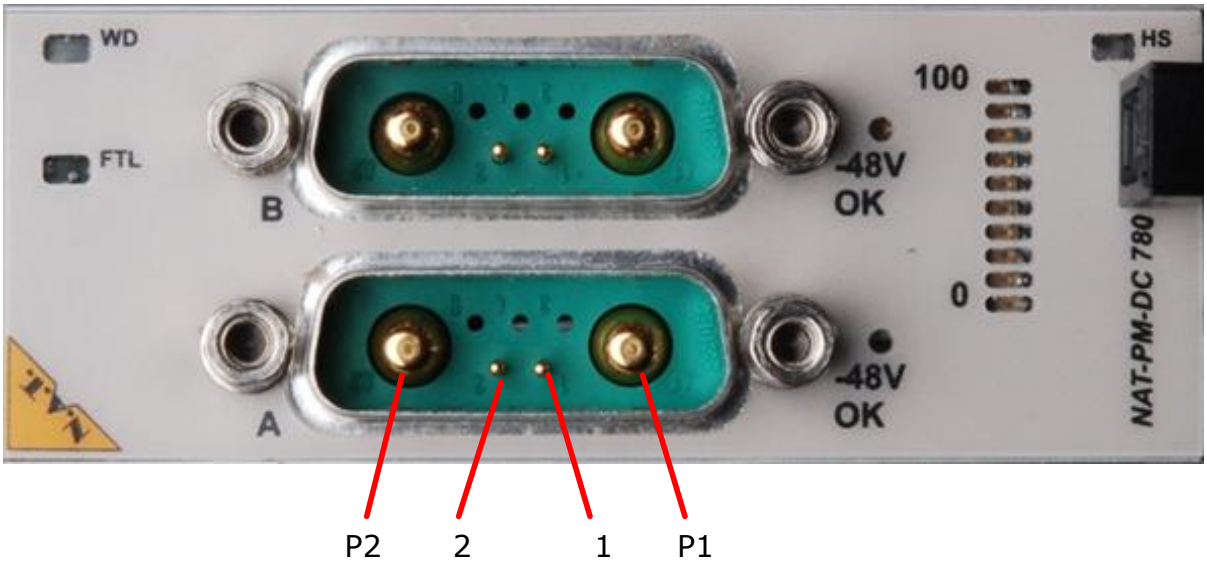
4 Technical Data

- **NAT-PM-DC420**: 420W output power
- **NAT-PM-DC840**: 840W output power
- **NAT-PM-DC600LV**: 600W output power
- support of N+1 and 2+2 redundancy
- 16 channels of
  - 12V
  - 3.3V
- support of
  - 12 AMCs, 2 CUs, 2 MCHs
  - with individual control management and payload power
- dual -48V input
- 95,5% conversion efficiency of converter brick (DC420/840)
- 92% conversion efficiency of converter brick (DC600LV)
- HPM firmware upgrade support
- single-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
- 3.3 V Power supply subsystem
  - max. channel current: 180mA
  - fast trip current limit: 300mA
  - accuracy 3.3V: 5%
  - total ripple voltage (peak-to-peak) Vpp = 30mV (300W total load; measured at AMC with 80W load)
- 12 V Power supply subsystem
  - max. power / channel: 80W
  - 6.6A at 12V
  - fast trip current limit: 8.3A
  - max. inrush current: 19.4A
  - accuracy 12V: 10%
  - total ripple voltage (peak-to-peak) Vpp = 30mV (300W total load; measured at AMC with 80W load)
- Front Panel
  - optical load indicator
  - power input connector A and B
  - hot swap indicator and handle
  - health indicator LED
  - heartbeat indicator LED
- Standard Compliance
  - PICMG MicroTCA.0 R1.0
  - PICMG AMC.0 R2.0
  - IPMI v1.5 and v2.0
  - IEC/EN/UL60950-1 safety standard compliant (SELV)
  - RoHS compliant

5 Hardware

5.1 Front Panel and LEDs – NAT-PM-DC420/DC840

Figure 5: NAT-PM-DC420/840 – Front Panel View

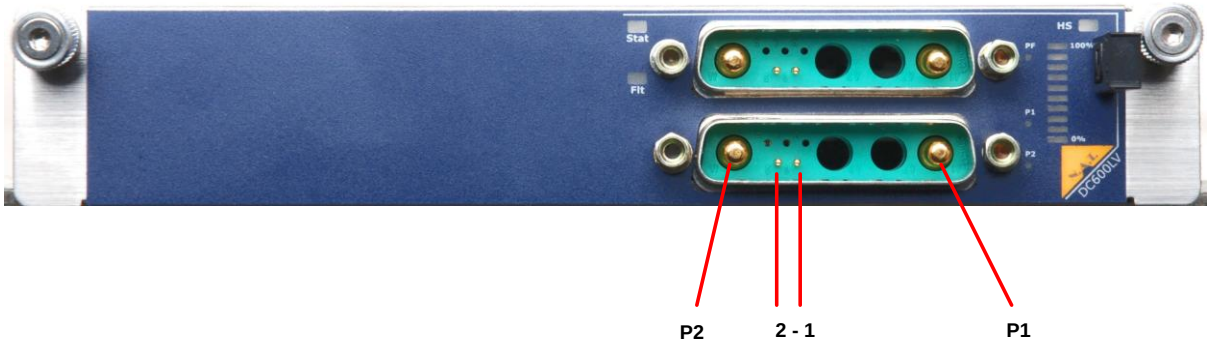


Elements of the front panel:

- Connector A: 7W2 connector type for -48V Input Power Supply
- Connector B: 7W2 connector type for -48V Input Power Supply
- Hot Swap Handle
- LEDs:
  - LED HS: MTCA.0 Hot Swap LED
  - LED FTL: red LED indicating the power module is not healthy and thus not able to provide power to the system
  - LED WD: green LED indicating the heartbeat pulse from the MCH
  - LED -48V A: Input is providing power to the system
  - LED -48V B: Input is providing power to the system
  - LED bar: indicating the actual load on the module in the range 0-100%

5.2 Front Panel Elements NAT-PM-DC600LV

Figure 6: NAt-PM-DC600LV – Front Panel View (double width faceplate shown)



Elements of the front panel:

- Connector A: 9W4 connector type for +24V Input Power Supply
- Connector B: 9W4 connector type for +24 Input Power Supply
- Hot Swap Handle
- LEDs:
  - LED HS: MTCA.0 Hot Swap LED
  - LED FTL: red LED indicating the power module is not healthy and thus not able to provide power to the system
  - LED WD: green LED indicating the heartbeat pulse from the MCH
  - LED PF: red LED indicating input voltage is out of range
  - LED P1: Input A is providing power to the system
  - LED P2: Input B is providing power to the system
  - LED bar: indicating the actual load on the module in the range 0-100%

5.3 Connectors and Switches

5.3.1 NAT_PM-DC420/840 Input Power Connectors A and B

Table 3: Input Power connector A / B

Pin #	Signal	Comment
P1	-48V Return	Input Power (+)
1	Control(*)	Control
2	Control return(*)	Control
P2	-48V	Input Power (-)

(*) Remark: the control and control return pins shall be tied together in the external connector.

5.3.2 NAT_PM-DC600LV Input Power Connectors A and B

Table 4: Input Power connector A / B

Pin #	Signal	Comment
P1	+24V Input	Input Power (+)
1	Control(*)	Control
2	Control return(*)	Control
P2	+24V Return	Input Power (-)

(*) Remark: the control and control return pins shall be tied together in the external connector.

5.3.3 Backplane Power Connector

Table 5: Power Connector Part A – High Power pins

Pin #	Signal	Signal	Pin #
P1	PP_M1	PP_AMC1	P13
P2	PP_CU1	PP_AMC2	P14
P3	PP_CU2	PP_AMC3	P15
P4	GND	PP_AMC4	P16
P5	GND	PP_AMC5	P17
P5	GND	PP_AMC6	P18
P7	GND	PP_AMC7	P19
P8	GND	PP_AMC8	P20
P9	GND	PP_AMC9	P21
P10	GND	PP_AMC10	P22
P11	GND	PP_AMC11	P23
P12	PP_M2	PP_AMC12	P24

Table 6: Power Connector Part B – Control Signal and Management Power

Pin	A	B	C	D	E	F	G	H
1	PS_PM#	PM_OK#	PS1_M1#	PS1_CU1#	EN_M1#	EN_CU1#	MP_M1	MP_CU 1
2	TCK	PMP_A#	PS1_2#	PS1_1#	EN_2#	EN_1#	MP_2	MP_1
3	TMS	PMP_B#	PS1_4#	PS1_3#	EN_4#	EN_3#	MP_4	MP_3
4	TRST#	PMP_C#	PS1_6#	PS1_5#	EN_6#	EN_5#	MP_6	MP_5
5	TDO	RST_PM_IN#	PS1_8#	PS1_7#	EN_8#	EN_7#	MP_8	MP_7
6	TDI	RST_PM_A#	PS1_10#	PS1_9#	EN_10#	EN_9#	MP_10	MP_9
7	GA0	RST_PM_B#	PS1_12#	PS1_11#	EN_12#	EN_11#	MP_12	MP_11
8	GA1	RST_PM_C#	PS1_M2#	PS1_CU2#	EN_M2#	EN_CU2#	MP_M2	MP_CU 2
9	GA2	SMP	SCL_B	SDA_B	SCL_A	SDA_A	PWR_ON_M2	PWR_ON_M1

5.3.4 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-PM-DC420/840/600LV** in a MTCA Rack the system is powered up as soon as the primary -48V DC power source is available. The cooling units and MCHs are powered up in autonomous mode. 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 further AMCs 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 AMCs, cooling units and the MCH itself. 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.

6.3 Airflow Requirements

All N.A.T. power modules do have very good conversion efficiencies. But when operating under full load this means that still a certain amount of heat dissipation must be disposed by the airflow.

WARNING

Operating the **NAT-PM-DC420/840/600LV** under full load requires a minimum air flow of
3m/sec ≈ 50 CFM
The max. ambient temperature at the power module shall not exceed 60°C.

7 Board Specification

Table 7: NAT-PM-DC420/840 – Specification

Processor	Microchip PIC32	
FPGA	Lattice MACHXO2	
Form Factor	single width, full size	
Front-I/O	DC420/DC840	2x -48V DC Input
	DC600LV	2x +24V DC Input
Power consumption	3.3V 100mA max. (without load)	
Input Voltage	DC420/DC840	-40 to -60V
	DC600LV	+18V to +36V
Isolation Input/Output	1500V	
Safety Standard	SELV	
Output Voltage	12.4V primary mode / 11.6V backup mode	
Max. Output Current 12V	NAT-PM-DC420	35A
	NAT-PM-DC840	70A
	NAT-PM-DC600LV	50A
Max. Output Current 3.3V	3A	
Airflow Requirements	3m/sec ≈ 50CFM at full load	
Environmental conditions	Standard operating temperature: Extended operating temperature: Storage temperature: Humidity:	-5°C to +60°C with forced cooling -40°C to +85°C (on demand) -40°C to +85°C 10 % to 90 % rh non-condensing
Standards compliance	PICMG AMC.0 Rev. 2.0 IPMI Specification v2.0 Rev. 1.0 PICMG µTCA.0 Rev. 1.0 IEC/EN/UL60950-1 safety	

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

[1] Lattice MACHXO2, DS1035 Version 02.4, February 2014
[2] Microchip PIC32MX5xx/6xx/7xx, DS60001156H, March 2013

Appendix B: Document's History

Revision	Date	Description	Author
1.0	20.06.2012	Initial Release	hl
1.1	21.06.2012	Added operating chapter and air flow requirements	hl
1.2	28.02.2013	Added remark concerning dependency of output power on input voltage	hl
1.3	06.05.2013	Added ripple voltage information, minor corrections	te
1.4	15.10.2013	Added reference to **NAT-PM-DC840**	hl
1.5	15.10.2014	Adapted to new layout incl. new arrangement of chapters Changed document's name from "User's Manual" to "Technical Reference Manual" Removed information about **NAT-PM-DC780** due to end of life Updated "List of used abbreviations" Added Figure 1 (photo of the module) Chapter 2: Corrected current value of max. channel current Added chapter 3.5: "Sensors" Added chapter 8: "Statement on Environmental Protection" Added chapter 9: "Known Bugs and Restrictions" Added Appendix A: "Reference Documentation" Minor changes, such as typo correction etc.	Se
	26.02.2015	Clarification of input power labelling	HL
1.6	05.08.2015	Swapped Chapter Sensors and Application Added remark that Output Power adaption has been removed with FW 1.13	HL
1.7	30.09.2015	Removed statement for output power adaption	HL
1.8	14.7.2016	Added reference to NAT-PM-DC600LV	HL