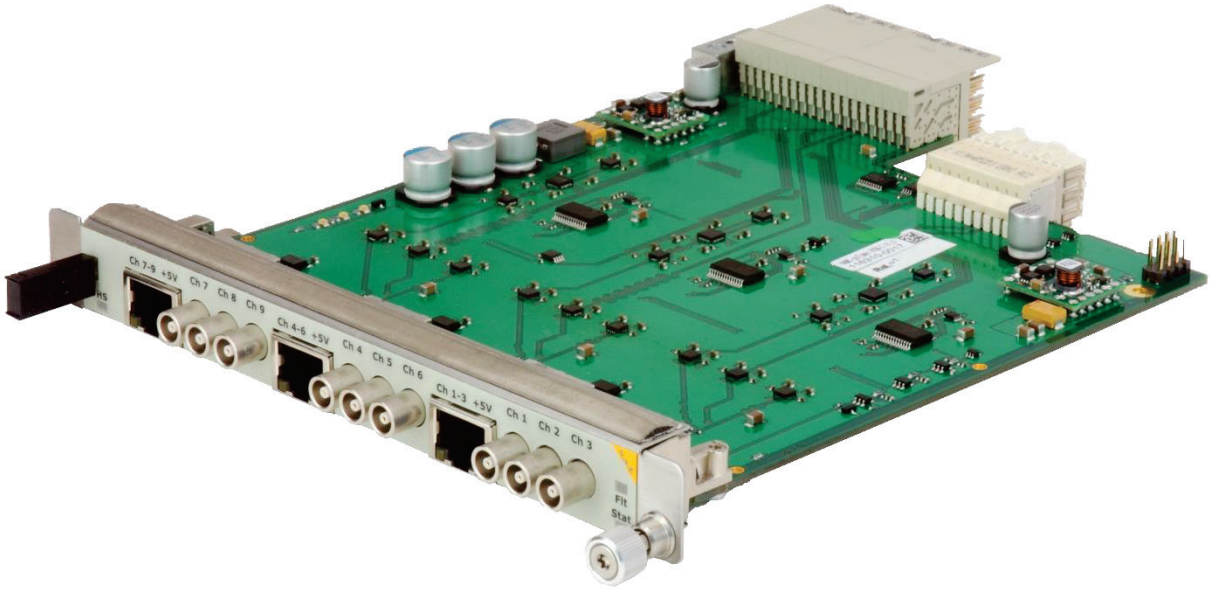
NAMC-PSTIMER-RTM-C

PICOSECOND TIMING RTM MODULE

DESIGNED BY DESY HAMBURG / UNIVERSITY OF STOCKHOLM

OPTIMIZED AND MANUFACTURED BY N.A.T. GMBH



TECHNICAL REFERENCE MANUAL V1.0

HW REVISION 1.1

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1. PREFACE

1.1. Disclaimer

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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.

1.2. About This Document

This document is intended to give an overview on the **NAMC-psTimer-RTM-C's** functional capabilities.

Preface

General information about this document

Introduction

Abstract on the **NAMC-psTimer-RTM-C's** main functionality and application field

Quick Start

Important information and mandatory requirements to be considered before operating the **NAMC-psTimer-RTM-C** for the first time

Functional Description

Detailed information on the individual devices and the **NAMC-psTimer-RTM-C's** main features

Hardware

Description of the connectors, switches, and LEDs located on the **NAMC-psTimer-RTM-C**

Specifications and Compliances

Detailed list of specifications, abbreviations, and datasheets of components referred to in this document and standards, the **NAMC-psTimer-RTM-C** complies to

Document's History

Revision record

Note:

It is assumed, that the **NAMC-psTimer-RTM-C** is handled by qualified personnel only!

2. INTRODUCTION

The **NAMC-psTimer** is an AMC based Fast Timing System with a pico-second stable clock in double width, mid-size AMC format for usage in the MicroTCA.4 architecture. Its main purpose is to output triggers and clock signals, which may be based on local stand-alone configuration, or information provided by a global timing system installation.

The number of output triggers and clock signals can be extended by adding an RTM, e.g. the **NAMC-psTimer-RTM-C** (copper). Triggers, clocks, and data coming from the Zone3 connector of the **NAMC-psTimer** are routed to 9 Lemo connectors at the face plate; three of nine channels offer a 5ps resolution.

2.1. Basic Functionality

The **NAMC-psTimer** system is designed for large timing systems installations, such as the European XFEL (X-Ray Free Electron Laser) in Hamburg, Germany – please refer to chapter 6.1 Internal Reference Documentation for details – but it can be used in a single stand-alone setup as well.

In addition to the distribution of triggers and clocks, the system is able to distribute data words and tables through its fiber distribution network. A precision 1.3GHz clock with modulated data is used on the fiber links. Receivers can recover both clock and data. Synchronized dividers are used to generate local clocks at the receivers.

2.2. Main Features

Table 1 – Technical Data

Form Factor	
	• Double-width, mid-size RTM with RF-Trigger-Connector to RTM-Backplane
Processing Resources	
Delay Lane	• Microchip SY89297U Programmable Delay
Signal Split	• Microchip SY89833AL LVDS Buffer/Translator
AMC-RTM Interconnect	
	• Trigger signals Trg_0 – Trg_8 • I^2C
RF Backplane Interconnect	
	• RF Trigger OUT
Front Panel	
	• 3x RJ45 • 9x Lemo • Standard MTCA LEDs
Compliance	
	• PICMG µTCA.4 Rev. 1.0
Order Codes	
NAMC-psTimer-RTM-[Option C]	• Copper-based Interface
Environmental	
Operating Environment	• Default: 0°C to +50 °C (with forced cooling) • Humidity: 10% to 90% at +55°C (non-condensing) • Vibrations: sinusoidal , 0.38mm pk from 5Hz to 36Hz, 2g from 36Hz to 2KHz • Shocks: 20g, 11ms, 1⁄2 sine • Altitude: 0 to 5000m
Storage Environment	• Default: -40°C to +85°C • Humidity: 5% to 95% (non-condensing) • Vibrations: sinusoidal , 0.38mm pk from 5Hz to 36Hz, 3g from 36Hz to 2KHz • Shocks: 30g, 11ms, 1⁄2 sine • Altitude: 0 to 15000m

3. QUICK START

To ensure proper functioning of the **NAMC-psTimer-RTM-C** during its usual lifetime, take the following precautions before handling the board.

3.1. Unpacking

Electrostatic discharge, incorrect board installation, and uninstallation can damage circuits or shorten their lifetime. Before touching integrated circuits, ensure to take all required precautions for handling electrostatic devices.

Avoid touching gold contacts of the connectors to ensure proper contact when connecting the **NAMC-psTimer-RTM-C** to its associated AMC and the backplane connector to the RF-Backplane.

Make sure that the board and its attachments are undamaged and complete according to delivery note.

3.2. Mechanical Requirements

As the **NAMC-psTimer-RTM-C** is an extension of the **NAMC-psTimer**, this AMC is mandatory for operation.

Before installing or uninstalling the **NAMC-psTimer-RTM-C**, read the Installation Guide and the User's Manual of the **NAMC-psTimer**, and of the µTCA system the board will be plugged into.

Check all installed boards and modules for steps that you have to take before turning on or off the power. After taking those steps, turn on or off the power if necessary.

Make sure the part to be installed / removed is hot-swap-capable, if you do not switch off the power.

Ensure that the **NAMC-psTimer-RTM-C** is connected to the **NAMC-psTimer** and the RF-Backplane with the connectors completely inserted.

When operating the board in areas of strong electromagnetic radiation, ensure that the module is bolted to the front panel or rack, and shielded by closed housing.

3.3. Voltage Requirements

3.3.1. Power supply

The power supply for the combination of the **NAMC-psTimer** and the **NAMC-psTimer-RTM-C** must meet the following specifications:

+12V / 1A max.

+ 3,3V / 0.05A max.

3.3.2. Hot-Swap

The **NAMC-psTimer-RTM-C** supports hot-swapping, which means that the board can be inserted or extracted during normal system operation without affecting other modules.

Make sure to follow the procedure ***exactly*** to prevent the **NAMC-psTimer-RTM-C** or the system it is plugged into from damage!

Insertion of a hot-swap-capable Module

- Ensure the module and the AMC / MTCA-System it shall be connected to support hot-swapping
- Ensure that the hot-swap-handle is in "unlock"-position (pulled out)
- Push the **NAMC-psTimer-RTM-C** carefully into the dedicated connector(s), until it is completely inserted
- The blue HS-LED turns solid on
- With pushing the hot-swap-handle to "lock"-position, the HS-LED starts blinking and the AMC detects the board
- If the information provided by the **NAMC-psTimer-RTM-C** is valid, payload power is enabled and the blue HS-LED turns off

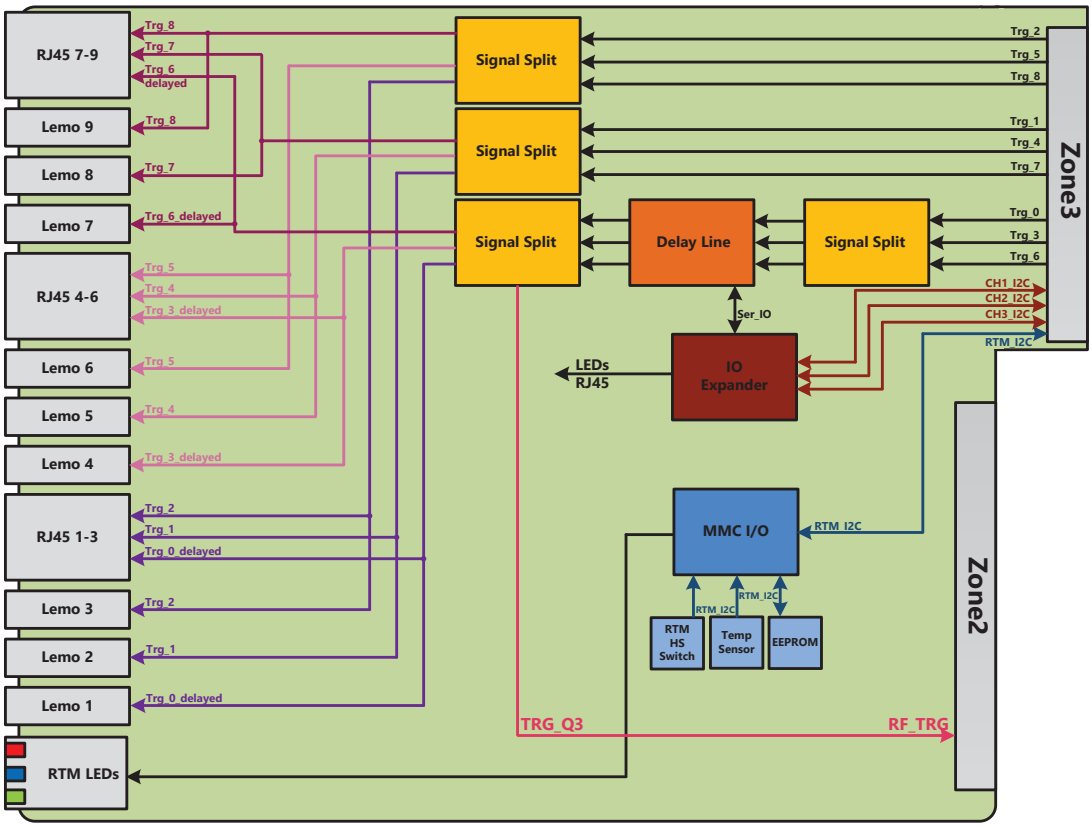
Extraction of a hot-swap-capable Module

- Pull the hot-swap-handle in "unlock"-position
- The blue HS-LED starts blinking
- Payload power is disabled
- The HS-LED turns solid on
- Pull the **NAMC-psTimer-RTM-C** carefully out of the system

4. FUNCTIONAL DESCRIPTION

The **NAMC-psTimer-RTM-C** is an interface extension board of the **NAMC-psTimer**, so main functionality is concentrated on the AMC. Nevertheless, there are functional blocks implemented on the RTM as well, which are shown in the following figure and described in the subsequent paragraphs.

Figure 1 – Block Diagram



4.1. Signal Split

Signal split stages are used to create multiple instances of each signal to allow them to be distributed via single-ended Lemo connectors and differential RJ45 in parallel.

4.2. Delay Line

Delay lines are used to create delayed versions of the signals. Please refer to SY89297U datasheet for details.

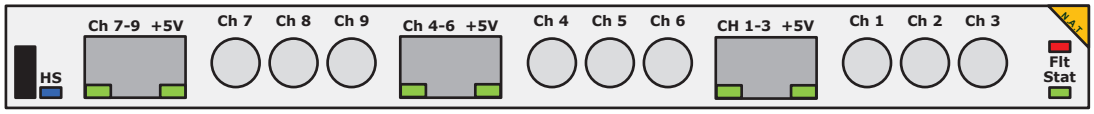
4.3. I/O Expander and MMC

The I^2C I/O Expander is used to allow the MMC on the AMC to detect and manage the RTM.

5. HARDWARE

5.1. Face Plate and LEDs

Figure 2 – Face Plate



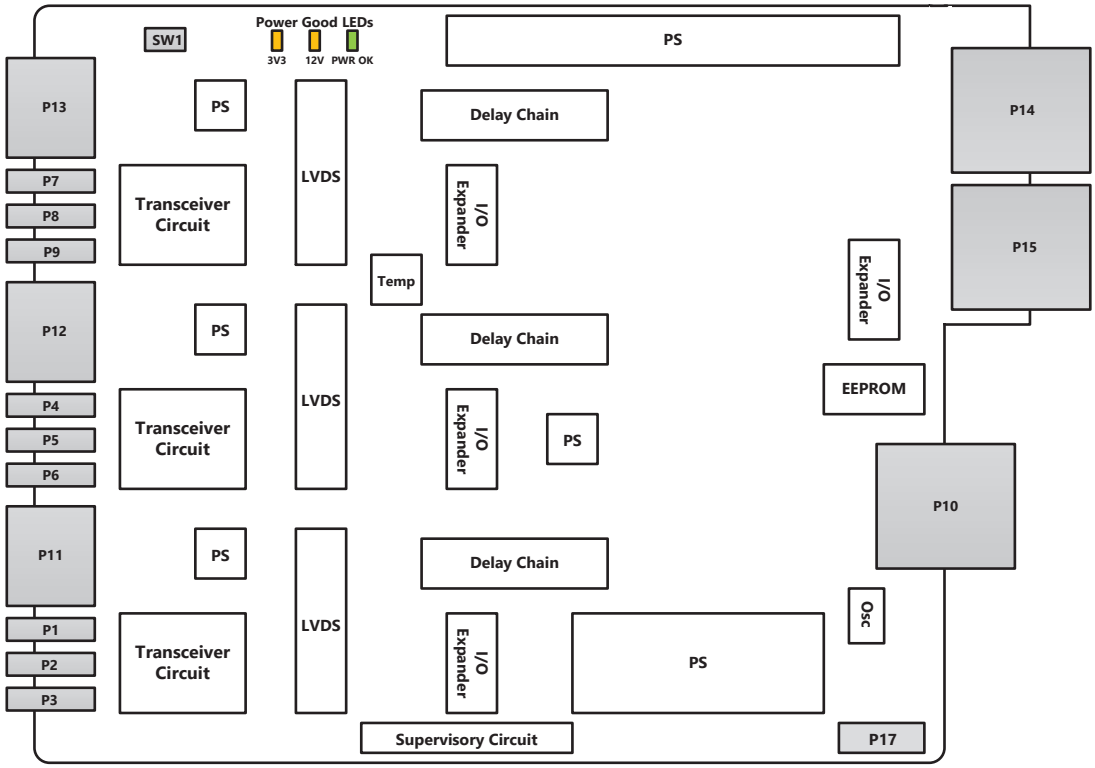
The **NAMC-psTimer-RTM-C** features the standard RTM IPMI LEDs with the blue one indicating the hot-swap-status.

The red Fault Indication LED turns to "On" if the temperature sensor registers a temperature value falling below or exceeding a threshold level. If the temperature returns to normal value, the LED is switched to "Off" again.

Although optically appearing as one LED, the General Purpose LED (Stat) physically consists of two LEDs (green and orange) sharing the same hole in the face plate.

5.2. Component-, Connector-, and Switch-Location

Figure 3 – Location Diagram



Please refer to the following tables to look up the connector pin assignment of the **NAMC-psTimer-RTM-C**.

5.2.2. P1-P9: Lemo Connectors

The **NAMC-psTimer-RTM-C** offers trigger-, clock-, and data-signals in single-ended format via Lemo-Connectors P1-P9.

The signal is routed via the pin, shield is connected to GND.

Figure 4 – P1-P9: Lemo Connectors

Table 2 – P1-P9: Lemo Connectors – Pin Assignment

Connector #	Signal
1	Trg_0_delayed
2	Trg_1
3	Trg_2
4	Trg_3 _delayed
5	Trg_4
6	Trg_5
7	Trg_6_delayed
8	Trg_7
9	Trg_8

5.2.3. P10: RF Trigger Connector (Zone2)

Connector P10 offers access to an optional RF-Backplane.

Figure 5 – P10: RF Trigger Connector

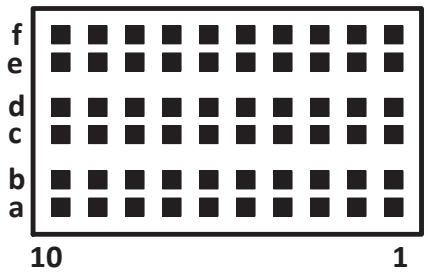


Table 3 – P10: RF Trigger Connector – Pin Assignment

	A	B	AB	C	D	CD	E	F	EF
1	nc	nc	GND	nc	nc	GND	nc	nc	GND
2	nc	nc	GND	nc	nc	GND	nc	nc	GND
3	nc	nc	GND	nc	nc	GND	nc	nc	GND
4	nc	nc	GND	nc	nc	GND	nc	nc	GND
5	Trg1_P	Trg1_N	GND	nc	nc	GND	nc	nc	GND
6	Trg2_P	Trg2_N	GND	nc	nc	GND	nc	nc	GND
7	Trg3_P	Trg3_N	GND	GND	GND	GND	nc	nc	GND
8	GND	GND	GND	GND	GND	GND	nc	nc	GND
9	GND	GND	GND	nc	nc	GND	nc	nc	GND
10	GND	GND	GND	nc	nc	GND	nc	nc	GND

5.2.4. P11 / P12 / P13: RJ45-Connectors

P11, P12, and P13 offer differential outputs of trigger-, clock, and data-signals as well as Power-over-Ethernet (PoE).

Figure 6 – P11-P13: RJ45-Connectors

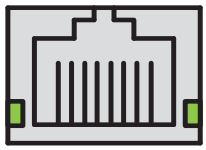


Table 4 – P11: RJ45-Connector – Pin Assignment

Pin #	Signal	Signal	Pin #
1	RJ45_1_D0_P	RJ45_1_D0_N	2
3	VCC5V_1	RJ45_1_D1_P	4
5	RJ45_1_D1_N	GND	6
7	RJ45_1_D2_P	RJ45_1_D2_N	8
9	RJ45_1_LED_1a	RJ45_1_LED_1b	10
11	RJ45_1_LED_2a	RJ45_1_LED_2b	12

Table 5 – P12: RJ45-Connector – Pin Assignment

Pin #	Signal	Signal	Pin #
1	RJ45_2_D0_P	RJ45_2_D0_N	2
3	VCC5V_2	RJ45_2_D1_P	4
5	RJ45_2_D1_N	GND	6
7	RJ45_2_D2_P	RJ45_2_D2_N	8
9	RJ45_2_LED_1a	RJ45_2_LED_1b	10
11	RJ45_2_LED_2a	RJ45_2_LED_2b	12

Table 6 – P13: RJ45-Connector – Pin Assignment

Pin #	Signal	Signal	Pin #
1	RJ45_3_D0_P	RJ45_3_D0_N	2
3	VCC5V_2	RJ45_3_D1_P	4
5	RJ45_3_D1_N	GND	6
7	RJ45_3_D2_P	RJ45_3_D2_N	8
9	RJ45_3_LED_1a	RJ45_3_LED_1b	10
11	RJ45_3_LED_2a	RJ45_3_LED_2b	12

5.2.5. P14 / P15: RTM-Connectors (Zone3)

RTM-Connectors P14 and P15 interface to the **NAMC-psTimer** baseboard.

Figure 7 – P14 / P15: RTM-Connectors

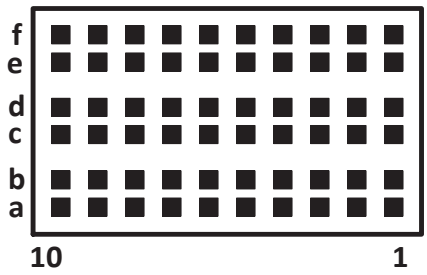


Table 7 – P14: RTM-Connector – Pin Assignment

	A	B	AB	C	D	CD	E	F	EF
1	nc	nc	GND	nc	nc	GND	nc	nc	GND
2	nc	nc	GND	nc	nc	GND	nc	nc	GND
3	INT_Ch2	nc	GND	SDA_Ch2	SCL_Ch2	GND	nc	nc	GND
4	nc	nc	GND	nc	nc	GND	nc	nc	GND
5	nc	nc	GND	nc	nc	GND	nc	nc	GND
6	INT_Ch3	nc	GND	SDA_Ch3	SCL_Ch3	GND	nc	nc	GND
7	nc	nc	GND	nc	nc	GND	nc	nc	GND
8	nc	nc	GND	nc	nc	GND	nc	nc	GND
9	GND	GND	GND	GND	GND	GND	GND	GND	GND
10	nc	nc	GND	nc	nc	GND	nc	nc	GND

Table 8 – P15: RTM-Connector – Pin Assignment

	A	B	AB	C	D	CD	E	F	EF
1	RTM_12V	RTM_12V	GND	GND	RTM_SDA	GND	nc	nc	GND
2	RTM_12V	RTM_12V	GND	RTM_3V3	RTM_SCL	GND	nc	nc	GND
3	nc	nc	GND	nc	nc	GND	nc	nc	GND
4	nc	nc	GND	nc	nc	GND	nc	nc	GND
5	nc	nc	GND	nc	nc	GND	nc	nc	GND
6	Trg_0_P	Trg_0_N	GND	Trg_1_P	Trg_1_N	GND	Trg_2_P	Trg_2_N	GND
7	Trg_3_P	Trg_3_N	GND	Trg_4_P	Trg_4_N	GND	Trg_5_P	Trg_5_N	GND
8	Trg_6_P	Trg_6_N	GND	Trg_7_P	Trg_7_N	GND	Trg_8_P	Trg_8_N	GND
9	nc	nc	GND	nc	nc	GND	nc	nc	GND
10	INT_Ch1	nc	GND	SDA_CH1	SCL_Ch1	GND	nc	nc	GND

5.2.6. P17: Lab Power Supply

Pin Header P17 offers the option to operate the **NAMC-psTimer-RTM-C** outside a chassis in stand-alone-mode.

Figure 8 – P17: Lab Power Supply

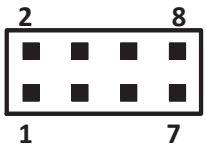


Table 9 – P17: Lab Power Supply – Pin Assignment

Pin #	Signal	Signal	Pin #
1	RTM_12V	GND	2
3	RTM_12V	GND	4
5	RTM_12V	GND	6
7	RTM_12V	GND	8

5.2.7. SW1: Hot Swap Switch

Switch SW1 is used to support Hot-Swapping of the module. It conforms to PICMG AMC.0.

5.2.8. D4 –D6: Power Good LEDs

The on-board LEDs D4-D6 reflect the status of the particular voltage.

LED #	Colour	Indication
D4	Yellow	RTM_3V3 Power Good
D5	Yellow	RTM_12V Power Good
D8	Green	PWR_OK

6. SPECIFICATIONS AND COMPLIANCES

6.1. Internal Reference Documentation

- **NAMC-psTimer, Technical Reference Manual:**
  https://www.nateurope.com/manuals/namc_psTimer_man_hw.pdf
- **XFEL**
  https://www.nateurope.com/documents/SS_High_Energy_Physics.pdf

6.2. External Reference Documentation

- Microchip SY89297U Programmable Delay, Datasheet DS20005835A, 01/2018
- Microchip SY89833AL LVDS Buffer/Translator, Datasheet DS20005608A, 01/2018

6.3. Standards Compliance

- PICMG µTCA.4 Rev. 1.0

6.4. 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, poly-brominated 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. semi-conductor 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.

6.5. 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.

6.6. Compliance to CE Directive

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

6.7. Product Safety

The board complies with EN60950 and UL1950.

6.8. 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.

6.9. Abbreviation List

Table 10 – Abbreviation List

Abbreviation	Description
AMC	Advanced Mezzanine Card
EEPROM	Electrically Erasable PROM
FCLK	Fabric Clock
HS	Hot Swap
I^2C	Inter-Integrated Circuit
I/O	Input/Output
IPMI	Intelligent Platform Management Interface
LVDS	Low Voltage Differential Signaling
µC	Microcontroller
µTCA/MTCA	Micro Telecommunications Computing Architecture
MMC	Module Management Controller
PCI(e)	Peripheral Component Interconnect (Express)
(P)ROM	(Programmable) Read Only Memory
PoE	Power over Ethernet
ps	picosesond
RF	Radio Frequency
RTM	Rear Transition Module
TCKL	Telecom Clock
XFEL	X-Ray Free Electron Laser

7. DOCUMENT'S HISTORY

Table 11 – Document's History

Rev	Date	Description	Author
1.0	26.08.2018	initial release	se
	05.02.2020	Adapted to new layout, reworked all chapters	se
	18.03.2020	Added title photo	se