NATIVE-R2

2U 19" RACK-MOUNTED MTCA.4 CHASSIS

DESIGNED BY N.A.T. GMBH

TECHNICAL REFERENCE MANUAL V1.1

HW REVISION 1.X

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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 **NATIVE-R2's** technical features and functional capabilities.

Preface

General information about this document

Introduction

Abstract on the **NATIVE-R2's** main functionality and application field

Quick Start

Important information and mandatory requirements to be considered before operating the **NATIVE-R2** for the first time

Chassis Design

Detailed information on the overall design features and detailed description of the individual parts

Cooling Unit

Description of the Cooling Unit and the related parts

Specifications and Compliances

Detailed list of specifications, abbreviations, datasheets of components referred to in this document; and standards the **NATIVE-R2** complies to

Document's History

Revision record

Note:

It is assumed, that the **NATIVE-R2** is handled by qualified personnel only!

2. INTRODUCTION

The **NATIVE-R2** is a compact 2U MTCA.4 chassis with PCIe x8 support. Thus, it is ideally suited for applications with high connectivity requirements, such as high energy physics, industrial automation, machine vision, test and measurement, and telecom edge, access and aggregation equipment.

The **NATIVE-R2** can accommodate six horizontally mounted double-width AMC modules (five mid-size and one full-size) and up to five Rear Transition Modules (µRTM) in double mid-size form factor.

> ***Info:*** What is a Rear Transition Module (RTM)?
>
> An RTM is an optional expansion towards the rear side of the chassis e.g., to increase the number of interfaces, add storage capacity or processing power etc. without populating a further slot from the front side.
>
> A µRTM is connected to its mating AMC via the Zone3-Connector, just like the MCH-RTM is linked to its mating MCH.
>
> An eRTM on the other hand can be operated independently from a front side module and is plugged directly into the LLRF-Backplane with a Zone2-Connector.

With an optional JSM Card Conversion Kit, a JTAG switch module (JSM) can be installed from the rear side.

Optional support for White Rabbit – an Ethernet extension protocol – provides sub-nanosecond accuracy synchronization, particularly useful for the high energy physics community and radio telescopy.

> ***Info:*** What is White Rabbit?
>
> The White Rabbit Project is a Bridged Local Area Network with VLANs (IEEE 802.1Q) that uses Ethernet (IEEE 802.3) to interconnect switches and nodes, and the Precision Time Protocol (PTP, IEEE 1588-2008) to synchronise them.

This enables to build a compact, multi-purpose computing system for a variety of applications by integrating cost-effective AMCs.

Table 1 – Technical Data

Form Factor	
	• Width: 440mm (with mounting brackets – 19") • Depth: 378mm (approx. – without front handle Cooling Unit) • Height: 88.25mm (2U) • Weight: 10kg
Slots (max. Configuration)	
	• 6x AMC – 5 double mid-size + 1 double full-size • 5x µRTM – double mid-size • 1x MCH with RTM – double full-size • 1x Power Module – double full-size • 1x JTAG Switch Module – single mid-size • 1x Cooling Unit (hot-swappable)
Backplane	
	• x16 PCIe to COMExpress module Type 6 (MCH-RTM) • PCIe x8 or 2x PCIe x4 on port 4 to 11 • GbE on port 0 and 1 to every slot • SATA/SAS on port 2 and 3 • Local high-speed connections on ports 12 to 15 • Optional White Rabbit on ports 17 to 20 driven by optional White Rabbit Clock Module on the **NAT-MCH-PHYS80** • JSM (JTAG to AMC) connections to each slot • All CLKs supported
Cooling Unit	
	• Right-to-left configuration: four push-pull fans, each fan rated at 100 CFM (171 m^3/h) • Capable of cooling up to 1000 W depending on AMCs used and assembly positions • Individual-controlled fan speed • Inserted from the front, air flow from right to left • Fully managed via cooling management module • Monitored fan power for early failure detection • Air filter removed detection
Optional Components	
	• Power Module: **NAT-PM-AC600D/-AC1000** or any MTCA compliant power module • Carrier Hub: **NAT-MCH-M4/-PHYS/-PHYS80** or any MTCA compliant carrier hub
Compliance	
	• Conducted and Radiated Emissions: EN55022 Class B • UL 900 Class 2 • UL Class 94HF-1 • UL 94V-0 • Telecordia NEBS GR-78-Core • Telecordia NEBS GR-63-Core • PICMG AMC.0 R2.0 • PICMG AMC.1 R2.0 • PICMG MTCA.0 R1.0 • PICMG MTCA.4 R1.0 • PICMG MTCA4.1

Environmental	
Operating Environment	• +5°C to +50°C • Humidity: 5% – 85%, non-condensing
Storage Environment	• -20°C to +70°C • Humidity: 5% – 85%, non-condensing
Order Codes	
NATIVE-R2 -NWR-RL	• non White Rabbit support • Cooling Unit airflow right to left side
NATIVE-R2 -WR-RL	• White Rabbit support • Cooling Unit airflow right to left side
NATIVE-R2 -NWR-FL	• non White Rabbit support • Cooling Unit airflow front to left side
NATIVE-R2 -WR-FL	• White Rabbit support • Cooling Unit airflow front to left side

3. QUICK START

To ensure proper functioning of the **NATIVE-R2** 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 inserting modules into the **NATIVE-R2**.

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

3.2. Mechanical Requirements

For operation, the **NATIVE-R2** requires a Cooling Unit (included), an MCH, and at least one Power Module (separate order item).

Before installing or uninstalling modules in the **NATIVE-R2**, read the Installation Guide, the User's Manual, and/or Technical Reference Manual of the modules.

Important: Particular attention may be required for the mounting procedure of RTMs!

Check all installed boards and modules for steps that must be taken before turning on or off the power. After taking those steps, turn on or off the power if necessary.

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

Ensure that all modules are connected to the **NATIVE-R2** with the connector completely inserted.

3.3. Voltage Requirements

3.3.1. Power supply

The power consumption of the **NATIVE-R2** depends on the number and variants of installed Power Modules and AMCs.

3.3.2. Hot-Swap

The **NATIVE-R2** supports hot-swapping, which means that hot-swap-capable modules can be inserted or extracted during normal system operation without affecting other modules.

Make sure to follow the procedure ***exactly*** to prevent the module or the system from damage!

Insertion of a hot-swap-capable Module

- Ensure the module supports hot-swapping
- Ensure that the hot-swap-handle of the module is in "unlock"-position (pulled out)
- Push the module carefully into the dedicated connector 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 IPMI-Controller of the **NATIVE-R2** backplane detects the board
- If the information provided by the module is valid, the **NATIVE-R2** backplane enables payload power 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
- The IPMI-Controller of the **NATIVE-R2** backplane disables payload power
- The HS-LED turns solid on
- Pull the module carefully out of the **NATIVE-R2**

4. CHASSIS DESIGN

The **NATIVE-R2** features a standard backplane according to the MTCA.4.1 specification, providing space for a further assembly of an RF Backplane.

A Cooling Unit is located on the right side of the **NATIVE-R2**. Details are described in chapter 5 Cooling Unit.

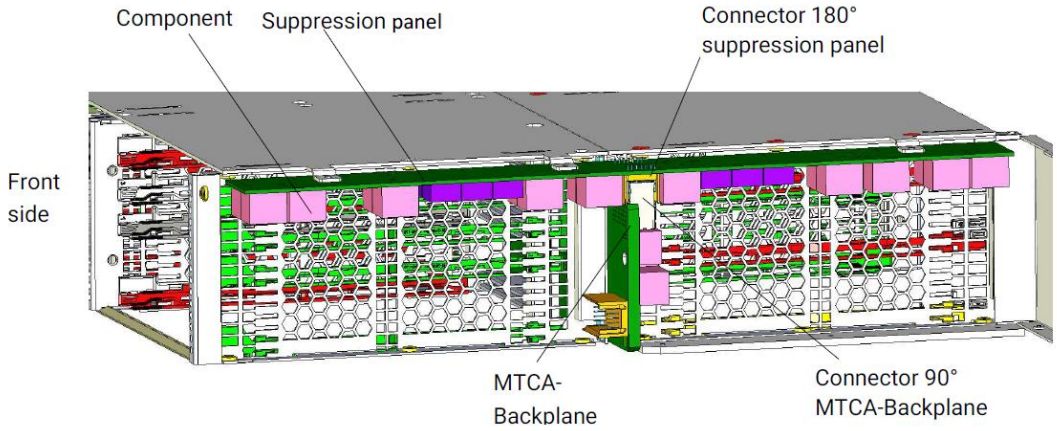
The assembly rooms for the AMC- and RTM-modules, also for the MCH, JSM, and PM are arranged horizontally, and provide the option to accommodate these modules as described in the following paragraphs.

The configuration of the card cages provides the option to fix all double-sized modules with screws. Single-sized modules can be mounted by using splitting kits.

By means of a JSM conversion kit, the **NATIVE-R2** can be modified to operate a JTAG Switch Module. For details, please refer to chapter 4.3 JSM Card Conversion.

Due to limited assembly space on the Backplane, an additional PCB for ripple current suppression connects to the backplane from the top side. The components on the panel are placed in this way that the resistance of the air flow is minimized. In the mounted position of the panel, the components are directed to the bottom side of the chassis.

Figure 1 – Ripple Current Suppression Panel



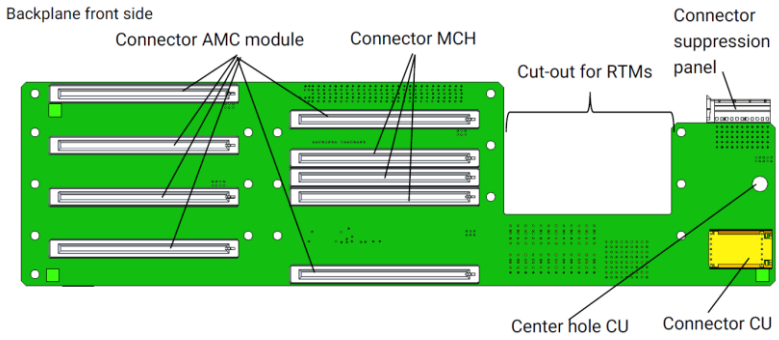
An M6 earthing stud for an external earthing connection is mounted on the rear panel.

4.1. Front Side Assembly

- Up to 5 AMC.4 modules, double mid-size
- 1 AMC.0 module, double full-size
- 1 MCH (**NAT-MCH-4, NAT-MCH-PHYS/-PHYS80**, or any MTCA compliant MCH)
- 1 hot-swappable managed Cooling Unit
- Removable air filter

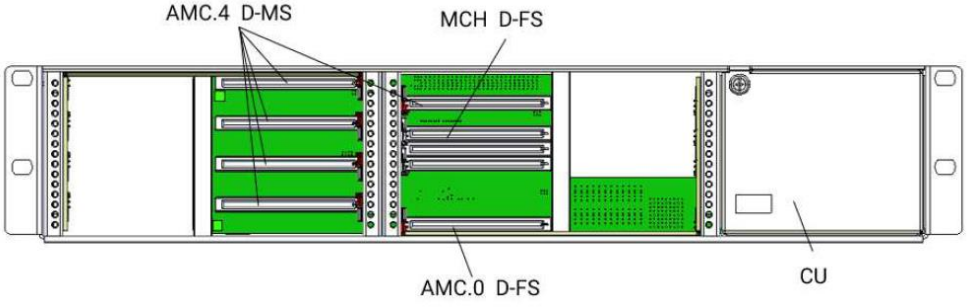
Figure 2 – NATIVE-R2 Front View

Figure 3 – Backplane Front View



As shown below, the Backplane has a smaller size than the chassis, the RTM connections of the AMCs located on the left side are aside the Backplane PCB.

Figure 4 – Backplane Position in Chassis Front View



4.2. Rear Side Assembly

- Up to 5 RTM modules, double mid-size
- 1 AMC.0 module, double full-size
- 1 MCH-RTM (e.g. **NAT-MCH-RTM**), double full-size
- 1 Power Module with up to 1000W (e.g. **NAT-PM-AC600D** or **NAT-PM-AC1000**)
- 1 JSM module, single mid-size (conversion kit required)

Figure 5 – NATIVE-R2 Rear View

Figure 6 – Backplane Rear View

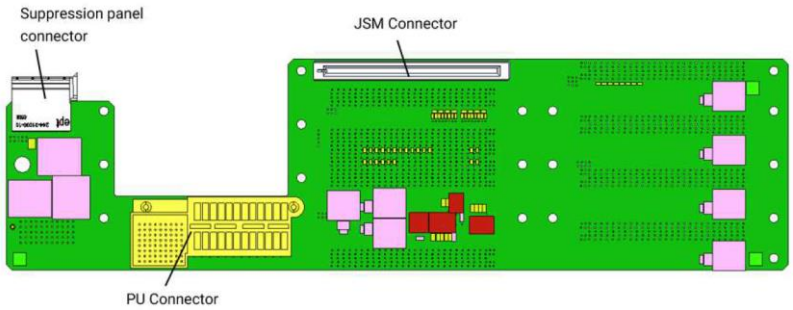
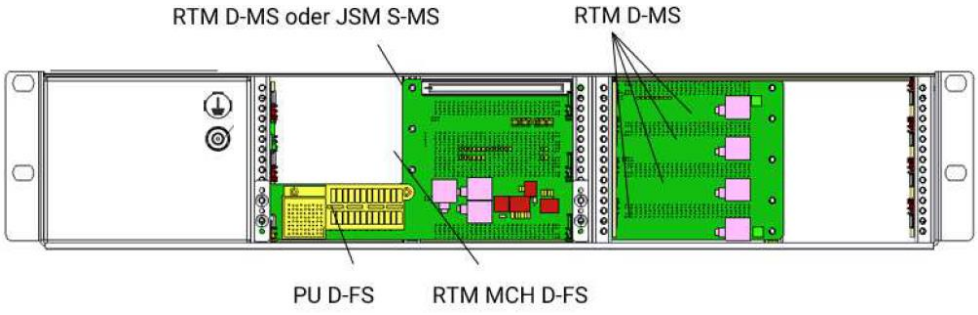


Figure 7 – Backplane Position in Chassis Rear View



Due to the direct connection of the JSM and the Power Module on the Backplane, these two units extend approx. 3.0 – 3.2 mm on the rear side of the chassis. This distance will be compensated by Aluminium blocks with threads, which allow the fixation of the modules. Therefore, the rear assembly in this area is realized like a meander.

Please note: the slot AMC.4 on the top side right allows the assembly of an RTM only under the condition, that no JTAG-module will be used!

Figure 8 – Backplane Side View

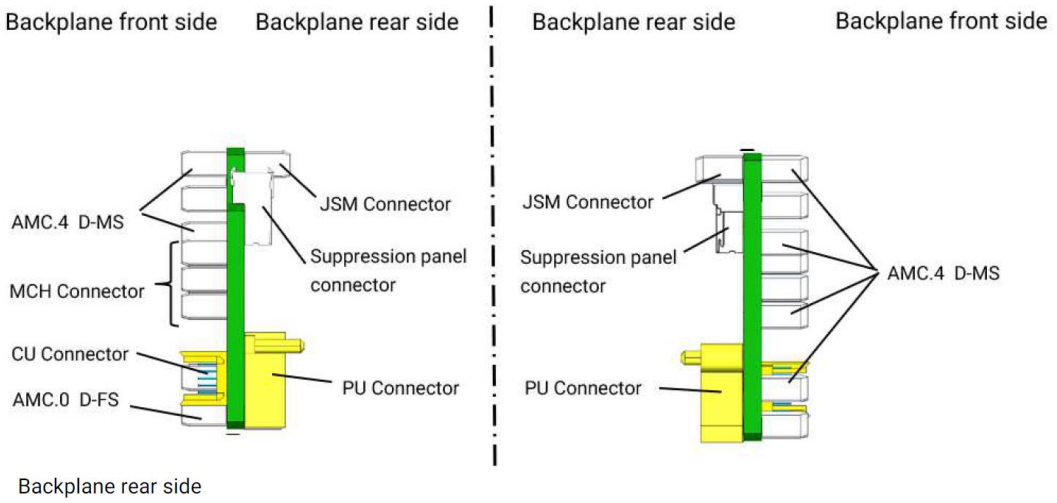
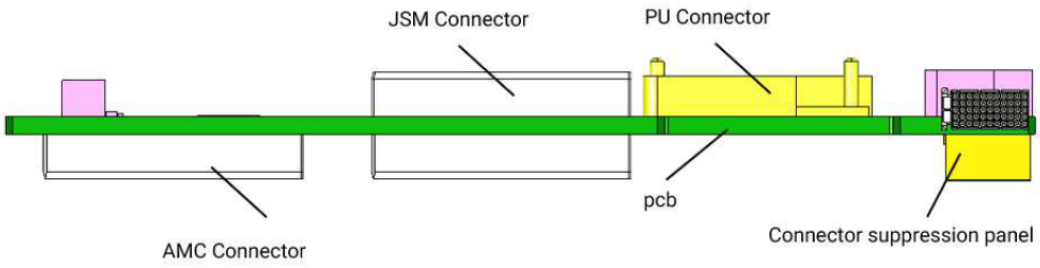


Figure 9 – Backplane Top View



The assembly room on the rear side of the chassis is prepared for the accommodation of one Power Module up to 1000W double full-size and management according to specification MTCA.0. Due to the different mounting positions between the Power Module and the RTMs, the distance of approximately 3.0 mm will be compensated by Al-blocks with threads.

4.3. JSM Card Conversion

The rear card cage of suitable MTCA systems with the respective backplane can be converted to install a JSM module.

All necessary parts are included in a conversion kit, part no. 21890-601. A part list is noted in the table below.

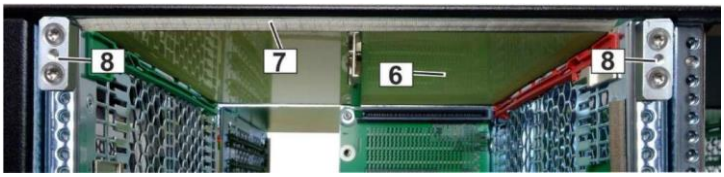
Table 2 – Part List JSM Conversion Kit – Part-No. 21690-601

Quantity	Item
1	• Guide rail, red
1	• Guide rail, green
1	• Splitting kit
1	• EMC gasket 61mm
1	• EMC gasket 147mm
2	• Adapter block 4 HP/5mm
4	• Screws for adapter block
1	• Filler module

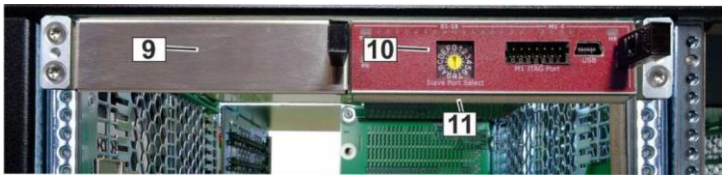
Figure 10 – JSM Card Cage Conversion

1) Remove the EMC gasket (1)
2) Lift the guide rails in the middle (2)
3) Pull out the guide rails to the front (3)

4) Install the new guide rails in the topmost position (4)
5) Install the new EMC gasket (5)



6) Insert the splitting kit (6)
7) Install EMC gasket (7)
8) Install the adapter blocks (8)

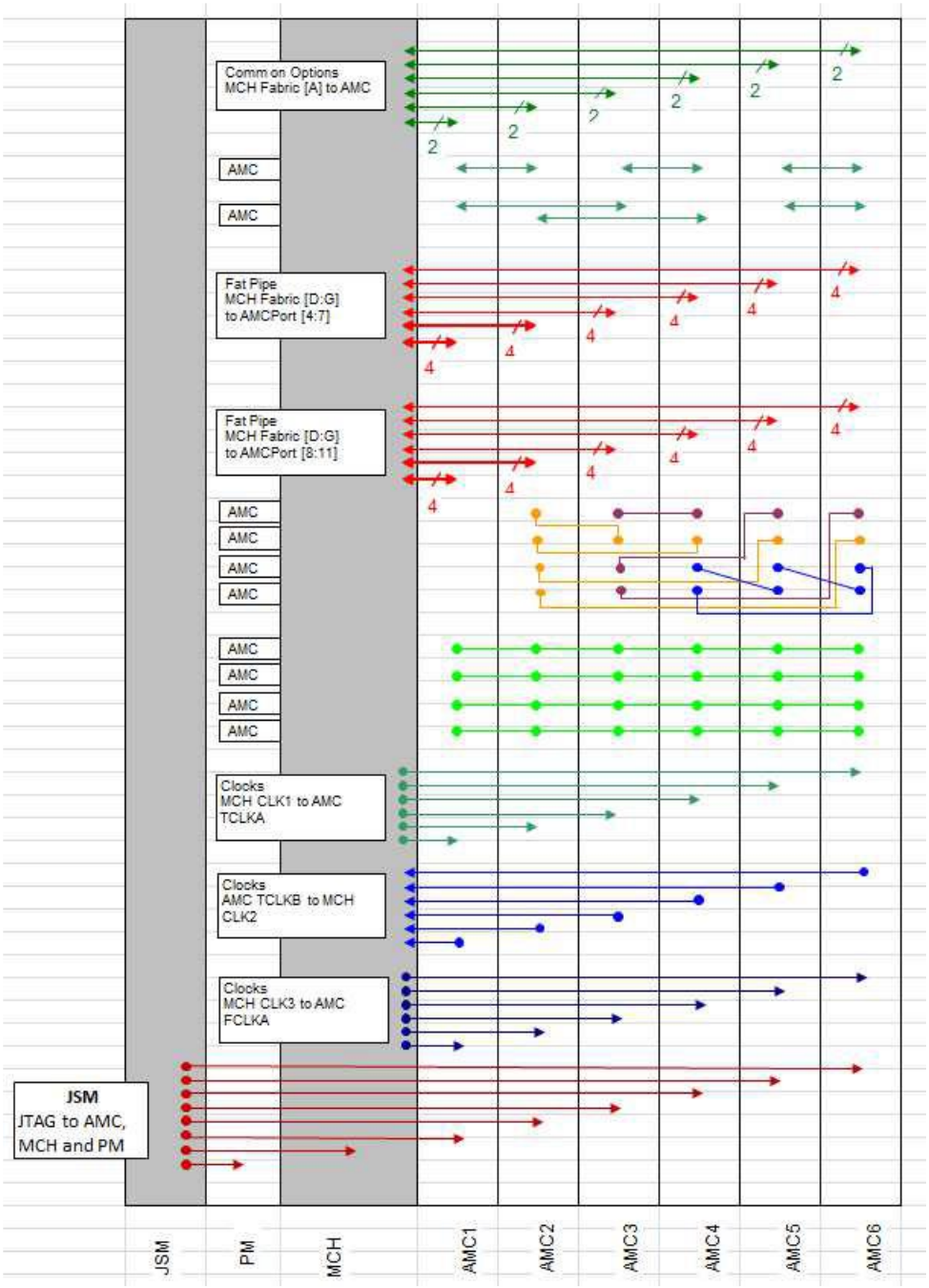


9) Insert filler module
10) Remove the EMC gasket (11) from the JSM module (10) and insert the JSM module

4.4. Backplane Topology

The backplane topology is illustrated in the following figure.

Figure 11 – Backplane Topology



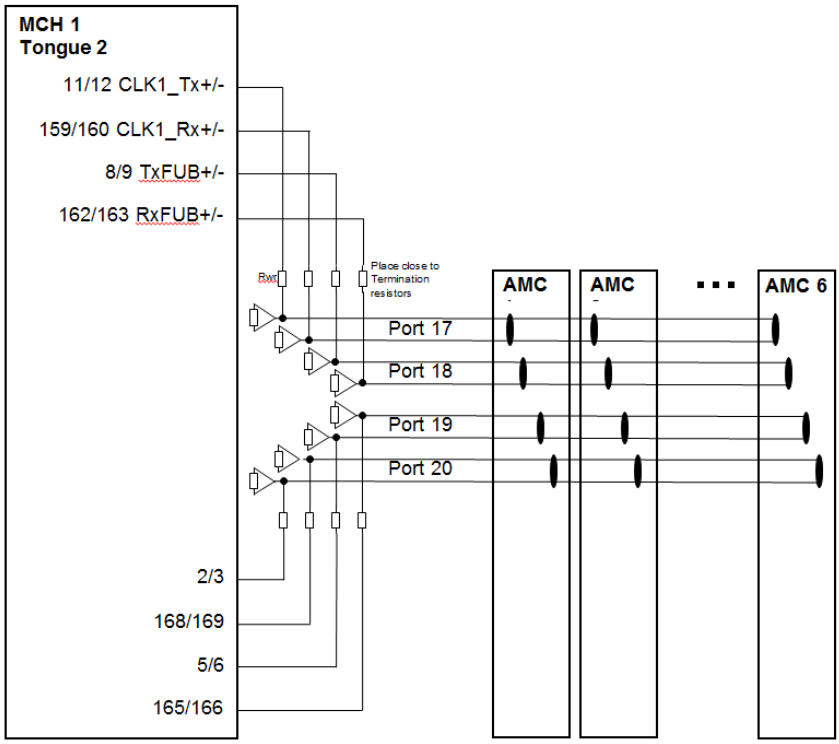
Moreover, the backplane provides the connection for the Cooling Unit (connector type HM40 C11 Pin A/B) and an Air Filter detection.

4.5. Optional White Rabbit Trigger Distribution

The following figure gives an overview of the White Rabbit trigger distribution of the **NATIVE-R2-WR** version used together with **NAT-MCH-PHYS80** and White-Rabbit-Clock module from Creotech.

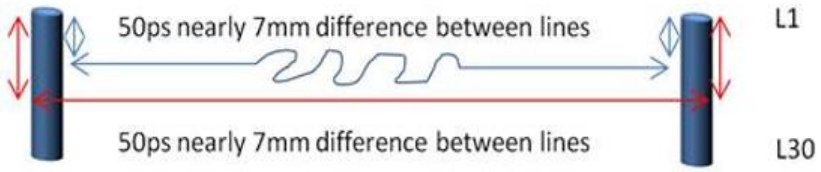
Note: each line in the drawing represents one differential pair.

Figure 12 – White Rabbit Trigger Distribution



To minimize the differences of the signal transmission time of the White Rabbit Signals as much as possible, all clock signals must be trimmed on 50ps between each other. This means a difference of the track length of approx. 7.5mm (TCLKA, TCLKB). The FCLKA-Clocks can be routed as usual.

Figure 13 – Routing of Clock Signals



5. COOLING UNIT

The **NATIVE-R2** is equipped with one Cooling Unit owning four fans, with each fan rated at 100 CFM (171 m^3/h), which results in a total of 400 CFM (684 m^3/h).

The Cooling Unit is realized as a tray to be inserted from the front side. It is equipped with one cooling management module (EMMC), which is used for the communication to the Carrier Manager (MCH) via IPMB-0 and controls the fan speed.

Figure 14 – Cooling Unit: Fans and Air Filter NATIVE-R2

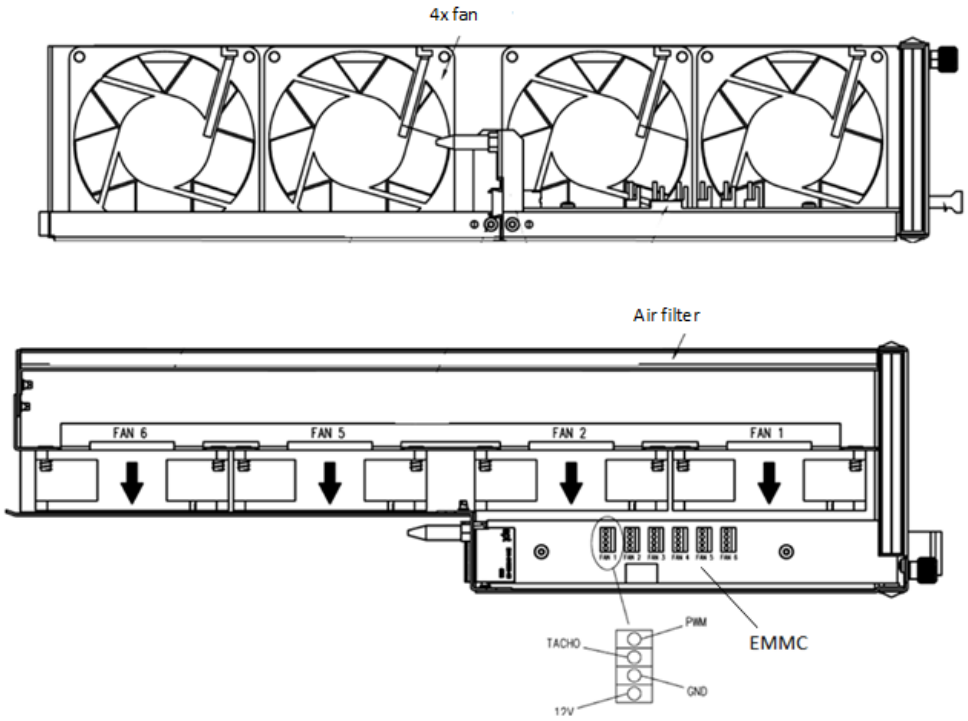


Table 3 – Cooling Unit Connector

Pin	A	B	C	D	E
1	+12V	+12V	+12V	+12V	+12V
2	+12V	+12V	+12V	+12V	+12V
3	+12V_1	+12V_1	+12V_1	+12V_1	+12V_1
4	+12V_1	+12V_1	+12V_2	+12V_2	+12V_2
5	+12V_2	+12V_2	+12V_2	+12V_2	+12V_2
6	PGND	PGND	PGND	PGND	PGND
7	JTAG_TCK	JTAG_TMS	JTAG_TRST#	JTAG_TDO	JTAG_TDI
8	PGND	PGND	PGND	PGND	PGND
9	PRESENT	E_IPMB_SCL_A	E_IPMB_SDA_A	E_IPMB_SCL_B	E_IPMB_SDA_B
10	GA0	GA1	GA2	3V3_MP	GND
11	SCL	SDA	ENABLE	AIRFILTER _PRESENT	GND

As shown in the following figure, the air inlet is on the right side, outlet on the left side of the **NATIVE-R2** chassis.

Figure 15 – Airflow Configuration

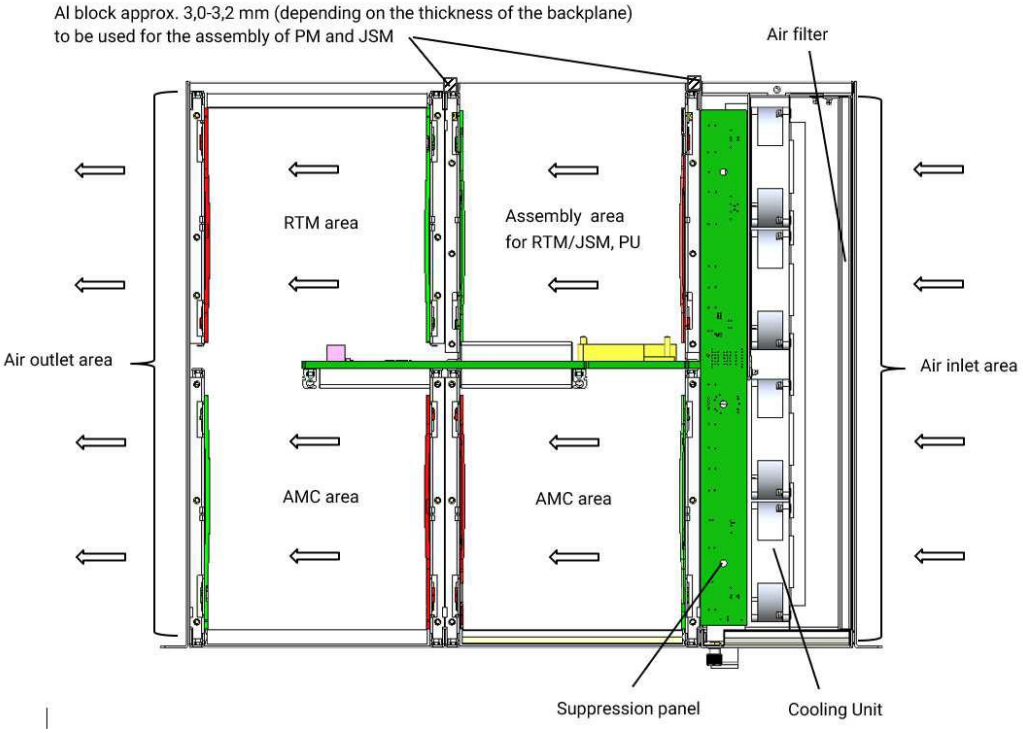


Table 4 – Calculation of Air Volume

Parameter	Value
Heat Dissipation	P_V = max. 1000W
Air constant	F = 3.3 m^3K/wh
Temperature Difference	dT = 10K (internal) or 15 K (ambient)

$$V = \frac{(f * P_V)}{dT}$$

Air Volume @ dT = 10K => V = 330 m^3/h

Air Volume @ dT = 15K => V = 220 m^3/h

Please note: The calculated numbers are only values for orientation. Higher flow resistances must be considered due to different assembly positions and options.

5.1. Fans

Figure 16 – Fans: PWM Duty Cycle and Operating Voltage Range

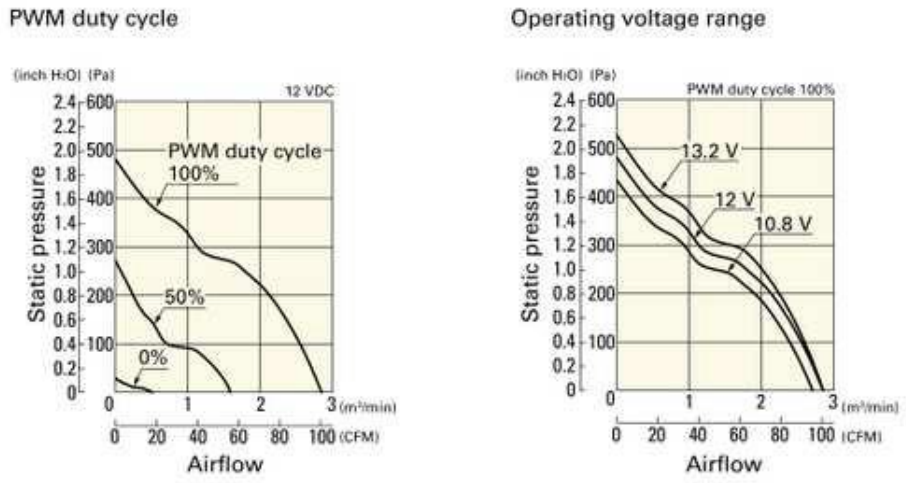


Table 5 – Fans: Technical Data

Parameter	Value
Nominal Voltage	12 VDC
Voltage Range	10.8 – 13.2 VDC
Fan Speed (max)	10,400 rpm ± 10%
Power Consumption	7.2 W
Ambient Operation Temperature	-20..+70°C
Ambient Storage Temperature	-30..+70°C
Air Flow	100 cfm / 171 m^3/h
Noise Level	60 db(A)
Service Life Time L10 at 40°C	70.000 h
Dimensions	80 x 80x 38 mm
Weight	ca. 220 g

5.2. Air Filter

The Air Filter is part of the Cooling Unit.

Table 6 – Air Filter: Technical Data

Parameter	Value
Filter with Frame	Yes
Filter Material	Quadrafoam (Polyurethan), black or gray
Classifications	UL 900 Class 2 UL Class 94HF-1 Telecordia NEBS GR-78-Core Telecordia NEBS GR-63-Core
Filtration Performance	45 PPI
Frame Material	Polypropylene UL 94V-0, black
Classifications	UL 94V-0

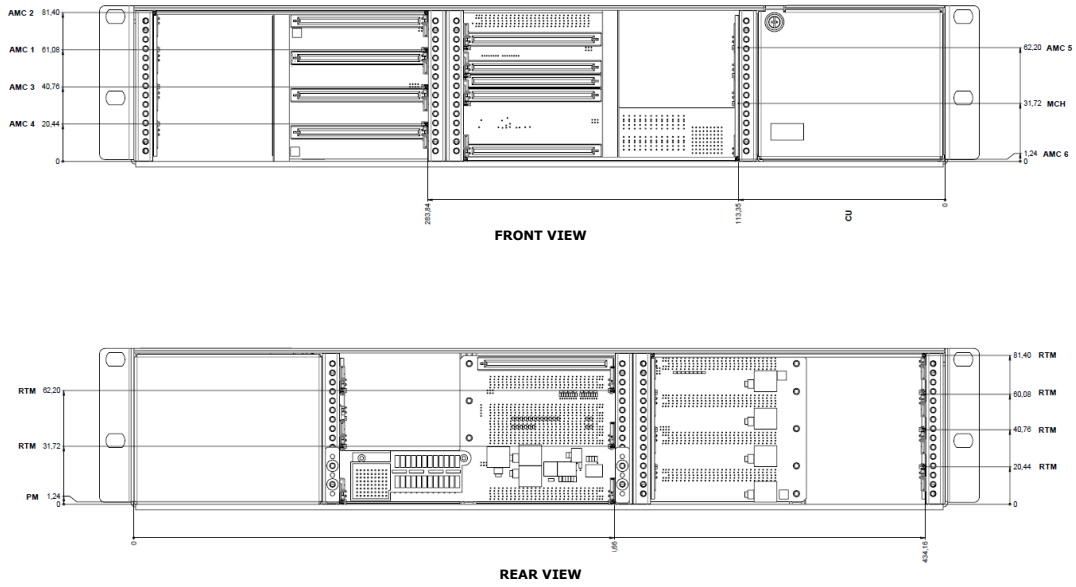
6. SPECIFICATION AND COMPLIANCES

6.1. Mechanical Specification

Table 7 – Mechanical Dimensions

Parameter	Value
Height:	2U – 88.25mm
Width:	19" – 440.00mm – with mounting brackets
Depth:	378mm – approx. – without front handle CU
Weight (only with Cooling Unit):	10.0kg

Figure 17 – Shelf Dimensions



6.2. Internal Reference Documentation

Please find our internal reference documentation on our website by choosing the desired product: https://www.nateurope.com

- **NAT-PM-AC600D**
- **NAT-PM-AC1000**
- **NAT-JSM**
- **NAT-MCH**
- **NAT-MCH-PHYS/-PHYS80**

6.3. External Reference Documentation

- none

6.4. Standards Compliance

- UL 900 Class 2
- UL Class 94HF-1
- UL 94V-0
- Telecordia NEBS GR-78-Core
- Telecordia NEBS GR-63-Core
- PICMG AMC.0 R2.0
- PICMG AMC.1 R2.0
- PICMG MTCA.0 R1.0
- PICMG MTCA.4 R1.0
- PICMG MTCA4.1

6.5. Compliance to RoHS Directive

According to RoHS-Directive 2017/2102/EU, the **NATIVE-R2** complies to EN 50581:2012

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.

6.6. 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.

6.7. Compliance to EMC Directive

According to Electromagnetic Compatibility (EMC) Directive 2014/30/EU, the **NATIVE-R2** complies to

EN55032:2012 +AC :2013 / CISPR32 :2012 +Cor1 :2012 +Cor2 :2012

EN61000-6-2:2005 +AC :2005 / IEC61000-6-2:2005

A 'CE' sign can be found on the product and/or the packing.

6.8. Compliance to REACH

The REACH EU regulation 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 8 – Abbreviation List

Abbreviation	Description
AMC	Advanced Mezzanine Card
CFM	Cubic Feet per Minute
COMex	Computer-on-module Express
CU	Cooling Unit
EMMC	Enhanced Module Management Controller
FCLK	Fabric Clock
FRU	Field Replaceable Unit
GbE	Gigabit Ethernet
HS	Hot Swap
IPMB-0	Dual-redundant A/B local Intelligent Platform Management Bus, I^2C-Type
IPMI	Intelligent Platform Management Interface
JSM	JTAG Switch Module
JTAG	Joint Test Action Group
LLRF	Low-Level Radio Frequency (Backplane), also µRTM-Backplane
µRTM	Rear Transition Module connected to its dedicated AMC
µTCA/MTCA	Micro Telecommunications Computing Architecture
MCH	MTCA Carrier Hub
MCH-RTM	Rear Transition Module connected to its dedicated MCH
PCB	Printed Circuit Board
PCIe	Peripheral Component Interconnect (Express)
PM	Power Module
PTP	Precision Time Protocol
SAS	Serial Attached SCSI
SATA	Serial Advanced Technology Attachment
TCKL	Telecom Clock
U	Rack **U**nit (height)
VLAN	Virtual Local Area Network

7. DOCUMENT'S HISTORY

Table 9 – Document's History

Rev	Date	Description	Author
1.0	18.01.2022	• initial release	Se
1.1	19.10.2022	• complete rework of document; adaption to current layout	se