

## **NATIVE-R2A**

### **2U 19" RACK-MOUNTED MTCA.4 CHASSIS**

**DESIGNED BY N.A.T. GMBH**

**TECHNICAL REFERENCE MANUAL V1.0**

**HW REVISION 1.X**



## TABLE OF CONTENTS

<b>1.</b>	<b>PREFACE .....</b>	<b>6</b>
<b>1.1.</b>	<b>Disclaimer .....</b>	<b>6</b>
<b>1.2.</b>	<b>About This Document .....</b>	<b>7</b>
<b>2.</b>	<b>INTRODUCTION .....</b>	<b>8</b>
<b>3.</b>	<b>QUICK START .....</b>	<b>11</b>
<b>3.1.</b>	<b>Unpacking .....</b>	<b>11</b>
<b>3.2.</b>	<b>Mechanical Requirements.....</b>	<b>11</b>
<b>3.3.</b>	<b>Voltage Requirements.....</b>	<b>11</b>
<b>3.3.1.</b>	<b>POWER SUPPLY .....</b>	<b>11</b>
<b>3.3.2.</b>	<b>HOT-SWAP .....</b>	<b>12</b>
<b>4.</b>	<b>CHASSIS DESIGN .....</b>	<b>13</b>
<b>4.1.</b>	<b>Front Side Assembly .....</b>	<b>14</b>
<b>4.2.</b>	<b>Rear Side Assembly.....</b>	<b>15</b>
<b>4.3.</b>	<b>Backplane Topology .....</b>	<b>17</b>
<b>5.</b>	<b>COOLING UNIT .....</b>	<b>18</b>
<b>5.1.</b>	<b>Fans.....</b>	<b>20</b>
<b>5.2.</b>	<b>Air Filter .....</b>	<b>21</b>
<b>6.</b>	<b>SPECIFICATION AND COMPLIANCES .....</b>	<b>22</b>
<b>6.1.</b>	<b>Mechanical Specification .....</b>	<b>22</b>
<b>6.2.</b>	<b>MTBF.....</b>	<b>22</b>
<b>6.3.</b>	<b>Internal Reference Documentation .....</b>	<b>23</b>
<b>6.4.</b>	<b>External Reference Documentation .....</b>	<b>23</b>
<b>6.5.</b>	<b>Standards Compliance.....</b>	<b>23</b>
<b>6.6.</b>	<b>Compliance to RoHS Directive .....</b>	<b>23</b>
<b>6.7.</b>	<b>Compliance to WEEE Directive .....</b>	<b>23</b>
<b>6.8.</b>	<b>Compliance to EMC Directive .....</b>	<b>24</b>



6.9.	Compliance to REACH .....	24
6.10.	Abbreviation List.....	25
7.	DOCUMENT'S HISTORY.....	26



LIST OF TABLES

Table 1 – Technical Data ..... 9

Table 2 – Cooling Unit Connector..... 19

Table 3 – Fans: Technical Data..... 20

Table 4 – Air Filter: Technical Data ..... 21

Table 5 – Mechanical Dimensions..... 22

Table 6 – Abbreviation List..... 25

Table 7 – Document’s History ..... 26



### LIST OF FIGURES

Figure 1 – Ripple Current Suppression Panel .....	13
Figure 2 – Front Slot Assignment .....	14
Figure 3 – Backplane Front View .....	14
Figure 4 – Backplane Position in Chassis Front View.....	14
Figure 5 – Rear Slot Assignment .....	15
Figure 6 – Backplane Rear View .....	15
Figure 7 – Backplane Position in Chassis Rear View.....	15
Figure 8 – Backplane Side View .....	16
Figure 9 – Backplane Top View .....	16
Figure 10 – Backplane Topology .....	17
Figure 11 – Airflow Configuration .....	18
Figure 12 – Cooling Unit: Fans and Air Filter.....	19
Figure 13 – Fans: PWM Duty Cycle and Operating Voltage Range.....	20
Figure 14 – MTBF Calculations.....	22



## 1. PREFACE

### 1.1. Disclaimer

The following documentation, compiled by N.A.T. GmbH (henceforth called N.A.T.), represents the current status of the product's development. The documentation is updated on a regular basis. Any changes which might ensue, including those necessitated by updated specifications, are considered in the latest version of this documentation. N.A.T. is under no obligation to notify any person, organization, or institution of such changes or to make these changes public in any other way.

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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-R2a's** technical features and functional capabilities.

### ***Preface***

General information about this document

### ***Introduction***

Abstract on the **NATIVE-R2a's** main functionality and application field

### ***Quick Start***

Important information and mandatory requirements to be considered before operating the **NATIVE-R2a** 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-R2a** complies to

### ***Document's History***

Revision record

### **Note:**

It is assumed, that the **NATIVE-R2a** is handled by qualified personnel only!



## 2. INTRODUCTION

The **NATIVE-R2a** 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-R2a** can accommodate six horizontally mounted double-width AMC modules (five mid-size and one full-size). Moreover, it features up to five  $\mu$ RTM in double mid-size form factor and yet another slot for a sixth  $\mu$ RTM in double full-size form factor.

**Info:** What is a Rear Transition Module (RTM)?

In general, 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  $\mu$ RTM 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.

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



**Table 1 – Technical Data**

<b>Form Factor</b>	
	<ul style="list-style-type: none"> <li>Width: 482.60mm (with mounting brackets – 19")</li> <li>Depth: 379.10mm (approx. – without front handle Cooling Unit)</li> <li>Height: 88.25mm (2U)</li> <li>Weight: 10kg</li> </ul>
<b>Slots (max. Configuration)</b>	
	<ul style="list-style-type: none"> <li>6x AMC – 5 double mid-size + 1 double full-size</li> <li>5x <math>\mu</math>RTM – double mid-size + 1x <math>\mu</math>RTM – double full-size</li> <li>1x MCH – double full-size</li> <li>1x Power Module – double full-size</li> <li>1x Cooling Unit (hot-swappable)</li> </ul>
<b>Backplane</b>	
	<ul style="list-style-type: none"> <li>AMC Ports 0/1: GbE to every slot</li> <li>AMC Ports 2/3: SATA/SAS</li> <li>AMC Ports 4-11: PCIe x8 or 2x PCIe x4</li> <li>AMC Ports 12-15: Local high-speed connections</li> <li>AMC Ports 17-20: tbd</li> <li>JSM (JTAG to AMC) connections to each slot*</li> <li>All CLKs supported</li> </ul>
<b>Cooling Unit</b>	
	<ul style="list-style-type: none"> <li>Four push fans, each fan rated at 100 CFM (171 m<sup>3</sup>/h)</li> <li>Capable of cooling up to 600W @ <math>dT_{max}=10K</math> / 1000W @ <math>dT_{max}=16K</math> depending on used AMCs and assembly positions</li> <li>Individual-controlled fan speed</li> <li>Inserted from the front, air flow from right to left</li> <li>Fully managed via cooling management module</li> <li>Monitored fan power for early failure detection</li> <li>Air filter removed detection</li> </ul>
<b>Optional Components</b>	
	<ul style="list-style-type: none"> <li>Power Module: <b>NAT-PM-AC600D/-AC1000</b> or any MTCA compliant power module</li> <li>Carrier Hub: <b>NAT-MCH-M4/-PHYS/-PHYS80</b> or any MTCA compliant carrier hub</li> </ul>
<b>Compliance</b>	
	<ul style="list-style-type: none"> <li>Conducted and Radiated Emissions: EN55022 Class B</li> <li>UL 900 Class 2</li> <li>UL Class 94HF-1</li> <li>UL 94V-0</li> <li>Telecordia NEBS GR-78-Core</li> <li>Telecordia NEBS GR-63-Core</li> <li>PICMG AMC.0 R2.0</li> <li>PICMG AMC.1 R2.0</li> <li>PICMG MTCA.0 R1.0</li> <li>PICMG MTCA.4 R1.0</li> <li>PICMG MTCA4.1</li> </ul>



Environmental	
<b>Operating Environment</b>	<ul style="list-style-type: none"> <li>+5°C to +50°C</li> <li>Humidity: 5% – 85%, non-condensing</li> </ul>
<b>Storage Environment</b>	<ul style="list-style-type: none"> <li>-20°C to +70°C</li> <li>Humidity: 5% – 85%, non-condensing</li> </ul>
Order Code	
<b>NATIVE-R2a</b>	<ul style="list-style-type: none"> <li>2U 19" MTCA.4 Chassis – 5 double mid-size AMC, 1 double full-size AMC, 1 double full-size MCH, 1 double full-size Power Module, 5 rear slots for double mid-size RTMs, 1 slot for double full-size RTM</li> </ul>

**\*Please note:** The **NATIVE-R2a** backplane is prepared for installing a dedicated JSM module from the rear side. This option is available on request only, please contact N.A.T. for details.

### 3. QUICK START

To ensure proper functioning of the **NATIVE-R2a** 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-R2a**.

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

#### 3.2. Mechanical Requirements

For operation, the **NATIVE-R2a** requires a Cooling Unit (included), an MCH, and at least one Power Module (separate order item).

Before installing or uninstalling modules in the **NATIVE-R2a**, 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-R2a** with the connector completely inserted.

#### 3.3. Voltage Requirements

##### 3.3.1. Power supply

The power consumption of the **NATIVE-R2a** depends on the number and variants of installed Power Modules and AMCs.



## 3.3.2. Hot-Swap

The **NATIVE-R2a** 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-R2a** backplane detects the board
- If the information provided by the module is valid, the **NATIVE-R2a** 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-R2a** backplane disables payload power
- The HS-LED turns solid on
- Pull the module carefully out of the **NATIVE-R2a**



### 4. CHASSIS DESIGN

The **NATIVE-R2a** features a standard backplane according to the MTCA.4.1 specification, providing space for a further assembly of an RF Backplane.

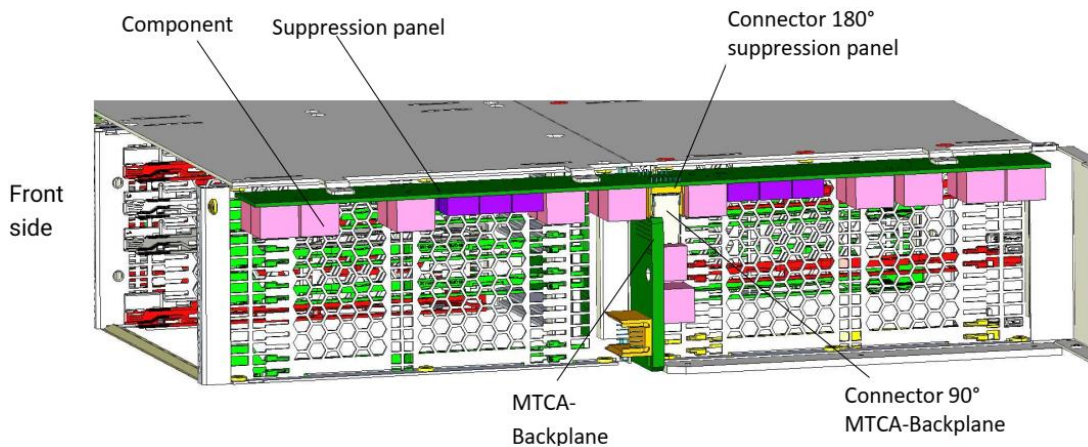
A Cooling Unit is located on the right side of the **NATIVE-R2a**. Details are described in chapter 5 Cooling Unit.

The assembly rooms for the AMC- and RTM-modules, also for the MCH 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.

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.

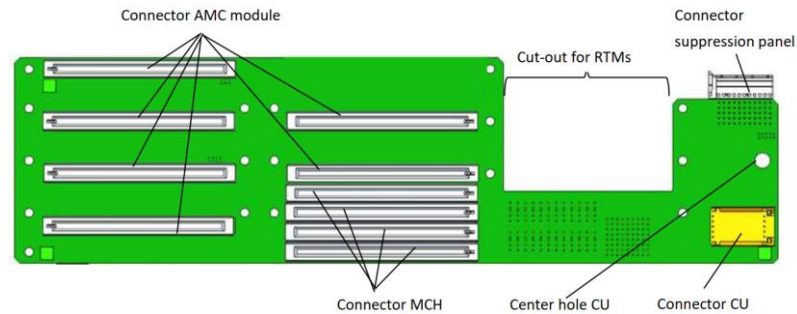
### 4.1. Front Side Assembly

- Up to 5 AMC modules, double mid-size + 1 AMC double full-size
- 1 MCH double full-size
- 1 hot-swappable managed Cooling Unit incl. Air Filter

**Figure 2 – Front Slot Assignment**

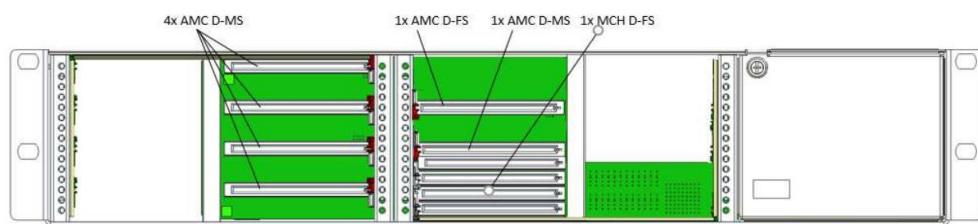
<b>AMC4</b> Double mid-size	<b>AMC6</b> Double full-size
<b>AMC3</b> Double mid-size	<b>AMC5</b> Double mid-size
<b>AMC2</b> Double mid-size	<b>MCH</b> Double full-size
<b>AMC1</b> Double mid-size	

**Figure 3 – Backplane Front View**



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

**Figure 4 – Backplane Position in Chassis Front View**



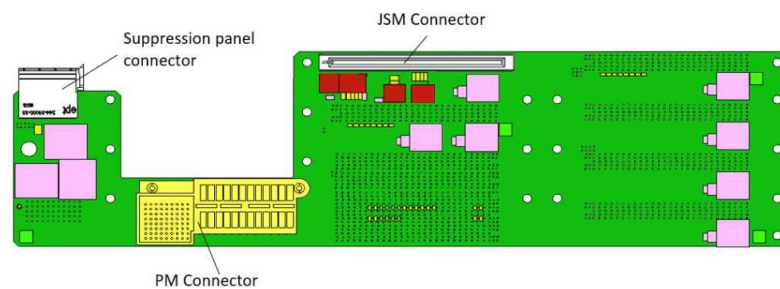
### 4.2. Rear Side Assembly

- Up to 5  $\mu$ RTM modules, double mid-size + 1x  $\mu$ RTM double full-size
- 1 double full-size Power Module

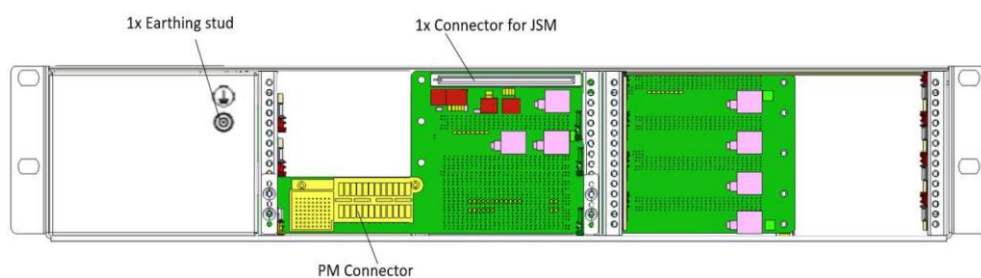
**Figure 5 – Rear Slot Assignment**

<b>RTM6</b> Double full-size	<b>RTM4</b> Double mid-size
<b>RTM5</b> Double mid-size	<b>RTM3</b> Double mid-size
<b>Power Module</b> Double full-size	<b>RTM2</b> Double mid-size
	<b>RTM1</b> Double mid-size

**Figure 6 – Backplane Rear View**

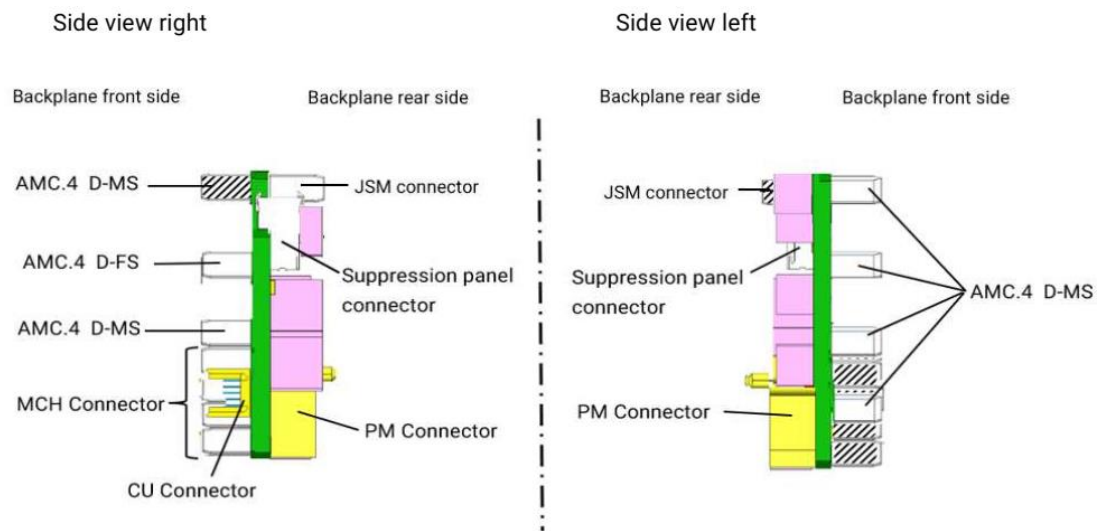


**Figure 7 – Backplane Position in Chassis Rear View**

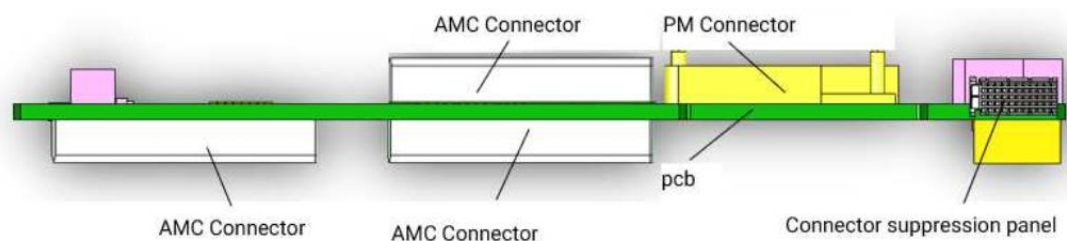


In contrast to the RTMs, which are directly connected to their counter parts, the Power Module is plugged into the Backplane. Thus, this unit extends approx. 3.0 – 3.2 mm on the rear side of the chassis. This distance will be compensated by Aluminium blocks with threads, which allow the fixation of the module and create a meander-like optic of the rear assembly area.

**Figure 8 – Backplane Side View**



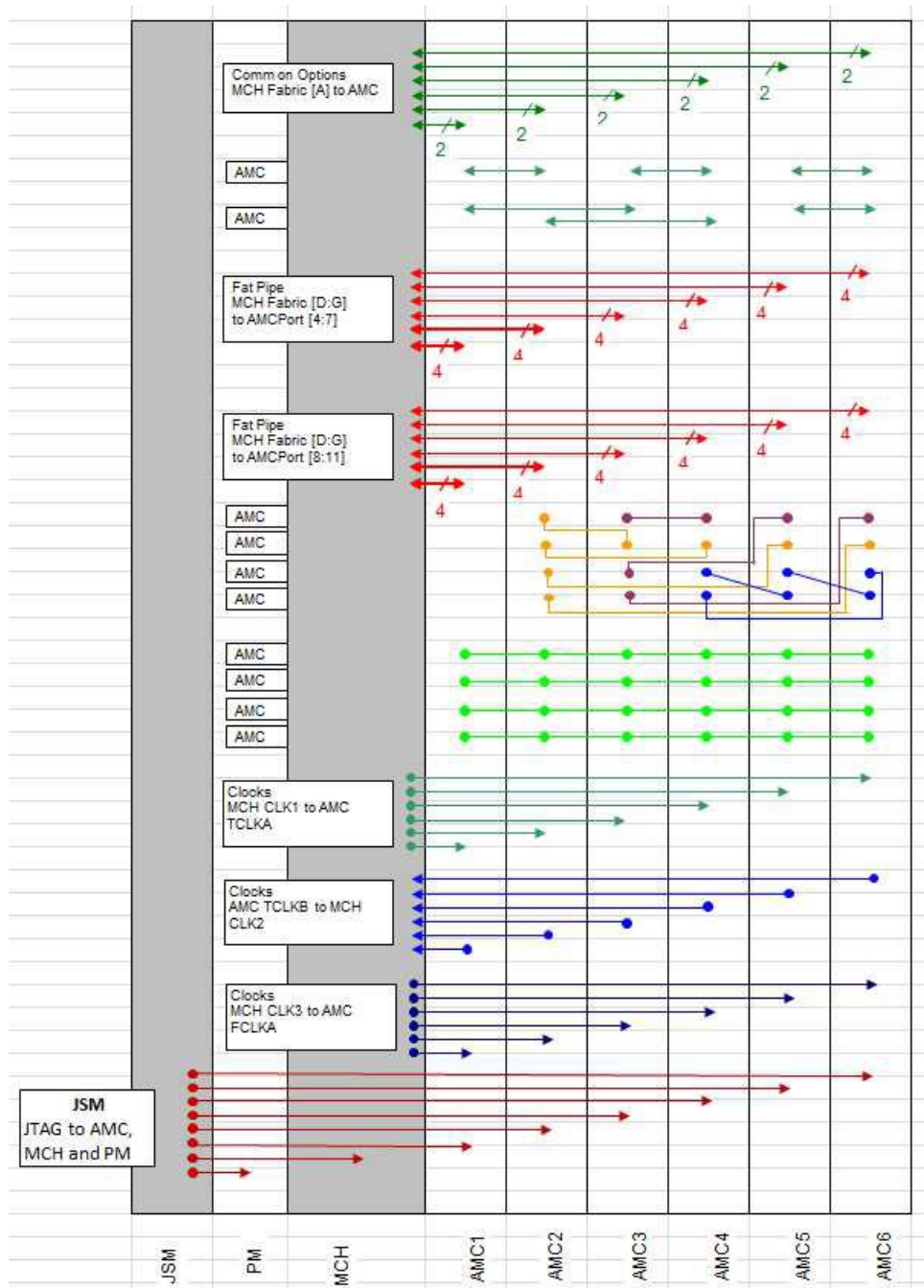
**Figure 9 – Backplane Top View**



### 4.3. Backplane Topology

The backplane topology is illustrated in the following figure.

**Figure 10 – Backplane Topology**



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

### 5. COOLING UNIT

The **NATIVE-R2a** is equipped with one Cooling Unit owning four fans, with each fan rated at 100 CFM (171 m<sup>3</sup>/h), which results in a total of 400 CFM (684 m<sup>3</sup>/h).

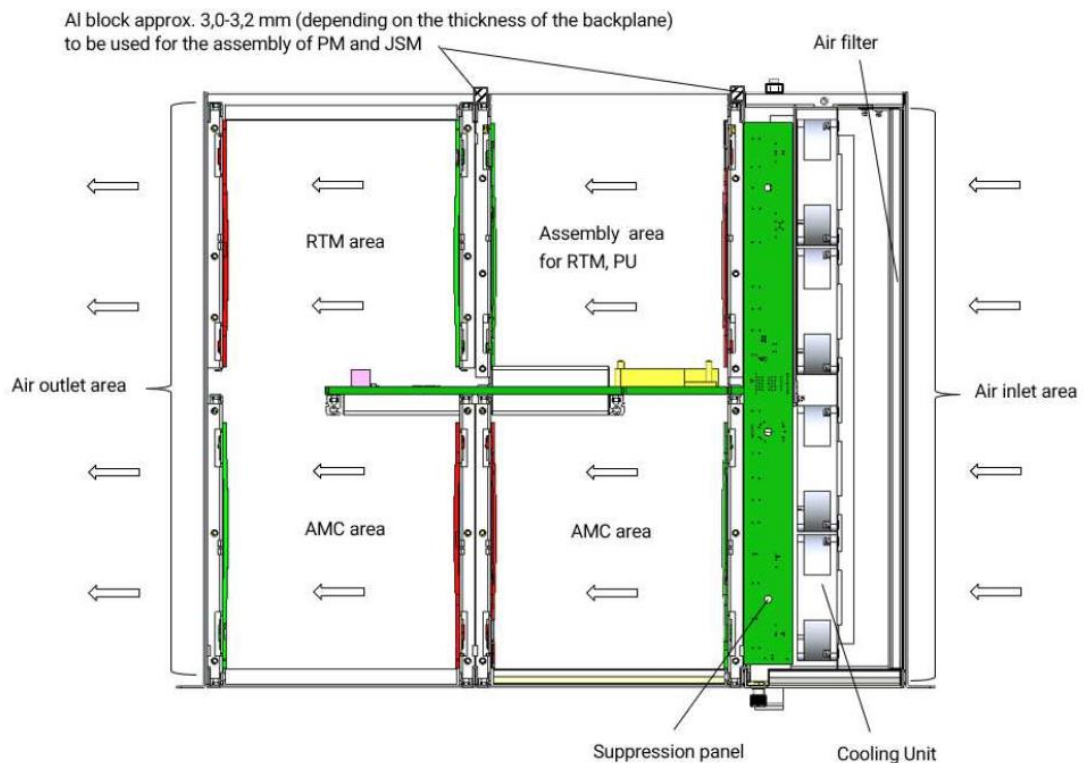
In a typically populated system, the resulting airflow is approx. 140m<sup>3</sup>/h for the AMC- and the RTM-Zone each.

- For  $dT_{max}=10K$ , heat dissipation may not exceed **600W**
- For  $dT_{max}=16K$ , heat dissipation may not exceed **1000W**

**Please note:** The calculated airflow / heat dissipation numbers for a standard system are values for orientation only. Higher flow resistances must be considered due to different assembly positions and options.

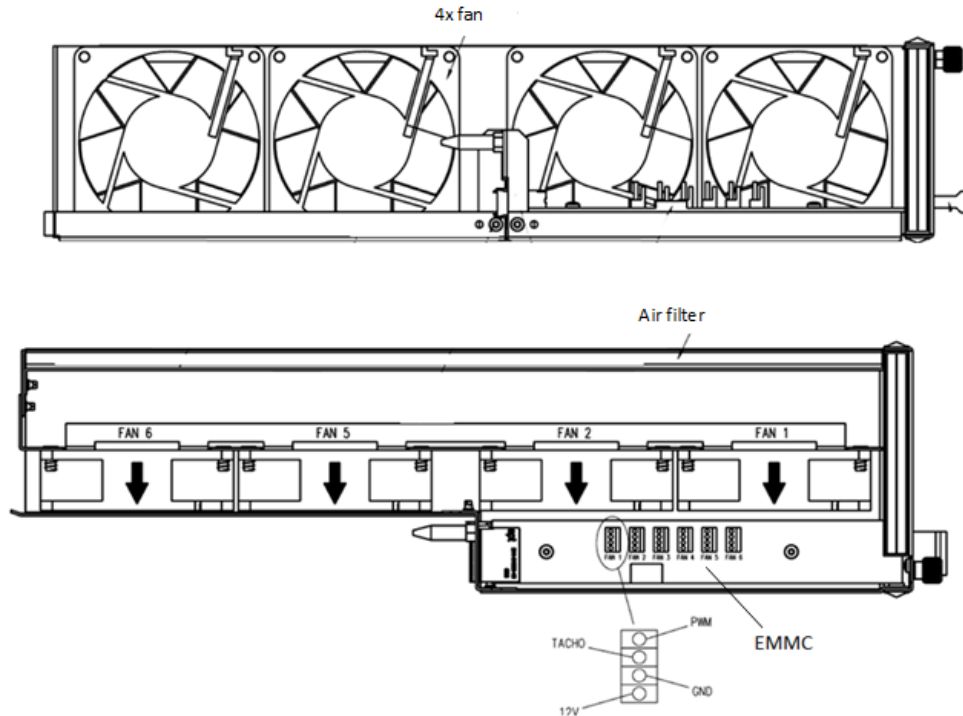
As shown below, air inlet is on the right side, outlet on the left side of the **NATIVE-R2a** chassis.

**Figure 11 – Airflow Configuration**



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 12 – Cooling Unit: Fans and Air Filter**



**Table 2 – 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

### 5.1. Fans

Figure 13 – Fans: PWM Duty Cycle and Operating Voltage Range

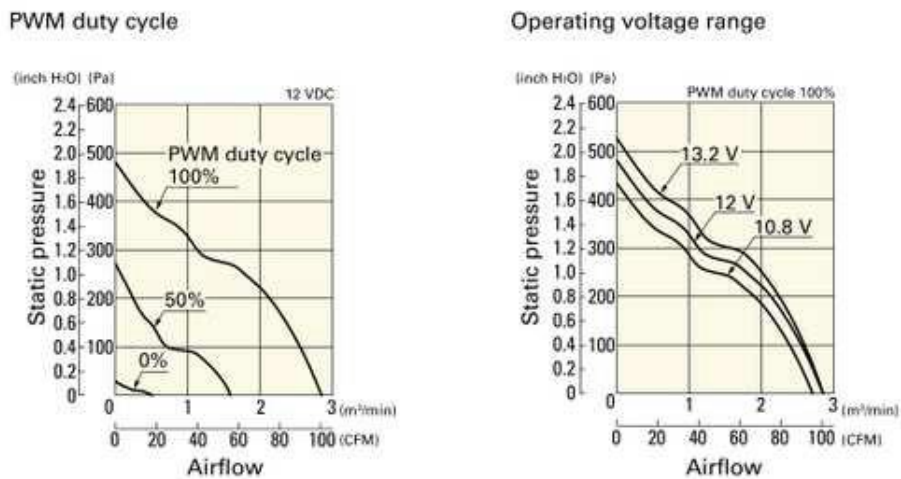


Table 3 – Fans: Technical Data

Parameter	Value
Nominal Voltage	12 VDC
Voltage Range	10.8 – 13.2 VDC
Fan Speed (max)	10,400 rpm $\pm$ 10%
Power Consumption	7.2 W
Ambient Operation Temperature	-20..+70°C
Ambient Storage Temperature	-30..+70°C
Air Flow	100 cfm / 171 m <sup>3</sup> /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 4 – Air Filter: Technical Data**

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



## 6. SPECIFICATION AND COMPLIANCES

### 6.1. Mechanical Specification

Table 5 – Mechanical Dimensions

Parameter	Value
<b>Height:</b>	2U – 88.25mm
<b>Width:</b>	19" – 482.60mm – with mounting brackets
<b>Depth:</b>	379.10mm – approx. – without front handle CU
<b>Weight (only with Cooling Unit):</b>	10.0kg

### 6.2. MTBF

Figure 14 – MTBF Calculations

Telcordia SR-332 Issue 4 (2016)  
 Environmental factor "ground fixed, controlled"  
 40°C mean component environment temperature  
 continuous operation 8760 hours a year  
 Quality factor = Level 2  
 Stress levels: Where applicable, 50% power ratio, current ratio and stress ratio have been used for all piece parts  
 Failure rate of mechanical components is negligible  
 Results at K:\PDSAS\R\_and\_D\1\_Daten\MTBF

**Results:**

		Failure rate [fpmh]	MTBF [hours]	MTBF [years]
1 x 23005522	S-BPL MTCA 2HE 4SL	0,796691		
1 x 23098654	FILTER BOARD	0,043968		
4 x 63995177	FAN 80X38MM 12V	1,458192		
1 x 23098831	MTCA.4 2U W. FIRMW.4 FAN	1,185212		
<b>total</b>		<b>3,484063</b>	<b>287 021</b>	<b>32,76</b>



### 6.3. Internal Reference Documentation

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

### 6.4. External Reference Documentation

- none

### 6.5. 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

### 6.6. Compliance to RoHS Directive

According to RoHS-Directive 2017/2102/EU, the **NATIVE-R2a** 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.

### 6.7. 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 electronic 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.

### 6.8. Compliance to EMC Directive

According to Electromagnetic Compatibility (EMC) Directive 2014/30/EU, the **NATIVE-R2a** 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.

### 6.9. 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.



## 6.10. Abbreviation List

Table 6 – 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 <sup>2</sup> C-Type
IPMI	Intelligent Platform Management Interface
JSM	JTAG Switch Module
JTAG	Joint Test Action Group
LLRF	Low-Level Radio Frequency (Backplane), also $\mu$ RTM-Backplane
$\mu$ RTM	Rear Transition Module connected to its dedicated AMC
$\mu$ TCA/MTCA	Micro Telecommunications Computing Architecture
MCH	MTCA Carrier Hub
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 <b>U</b> nit (height)
VLAN	Virtual Local Area Network



## 7. DOCUMENT'S HISTORY

Table 7 – Document's History

Rev	Date	Description	Author
1.0	23.04.2024	<ul style="list-style-type: none"><li>initial release</li></ul>	Se

