NATIVE-DISCOVERY

ONE SLOT CHASSIS WITH MTCA FUNCTIONALITY

DESIGNED BY N.A.T. GMBH

TECHNICAL REFERENCE MANUAL V1.0

HW REVISION 1.0

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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-Discovery's** functional capabilities.

Preface

General information about this document

Introduction

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

Quick Start

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

Hardware

Details on the **NATIVE-Discovery's** most important components and interfaces

Operation

Information on start-up sequence and options for temperature management

Specifications and Compliances

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

Document's History

Revision record

Note:

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

2. INTRODUCTION

The **NATIVE-Discovery** is a one slot MTCA.0 chassis AMC box with minimum MTCA infrastructure including cooling as well as basic management and switching functionality. The system is powered by an external power supply.

The chassis can accommodate one single- or double-width, mid- or fullsize AMC. All AMC ports and a debug interface are routed towards the rear panel of the box, so they are accessible externally.

As the **NATIVE-Discovery** aims amongst others on testing and development applications, it offers sliding covers on top and bottom to access top and bottom side of the AMC's PCB.

Moreover, the **NATIVE-Discovery** is a good choice for applications which request the operation of just a single AMC and make minor demands on management and switching functionality, or redundancy.

The following figure shows the **NATIVE-Discovery**, populated with a single-width full-size AMC and filler panel, with open and closed sliding cover.

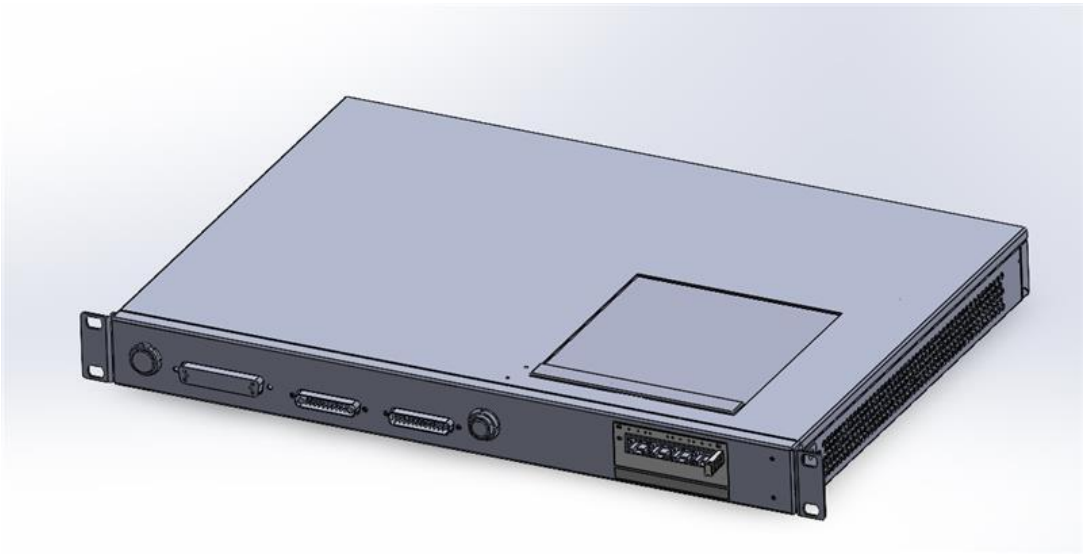
Figure 1 – Front View, open and closed sliding cover

Figure 2 – Rear View, open sliding cover

For special demands, the **NATIVE-Discovery** can be integrated in another chassis. In this case, the core of the **NATIVE-Discovery** (without enclosure) is mounted inside a customized chassis.

The CAD-sketch below shows this option in combination with a 1U 19" chassis.

Figure 3 – Example for custom-specific integration of the NATIVE-Discovery



2.1. Main Features

Table 1 – Technical Data

Form Factor	
	• W 206mm x H 46mm x D 312mm (+ appr. 5mm for rear connectors) • designed for one single- or double-width, mid- or full-size AMC • standalone operation or integration in customized chassis
Management & Switching	
Processing Resources	• Atmel ATxmega128 • Marvel 88E6320 Ethernet Switch
Firmware	• Microcontroller Firmware for MTCA environment simulation
Power Supply	
	• External 240W Power Supply / Input Voltage: 18-36V • Internal onboard 24V
Cooling Units	
	• Integrated fan unit with five fans and 120W cooling power for AMC • Airflow direction: right to left
Front Panel	
	• Slot for single- or double-width AMC with mid-/ full-sized front panel • Depending on the form factor, the use of filler panel(s) is mandatory
Rear Panel	

Interfaces	• AMC Ports 0/1: 2x 1GbE via RJ45
	• AMC Ports 2/3: 2x SAS/SATA via Dual Port SATA Connector including SSD power
	• AMC Ports 4-7 / 8-11: 8 lanes with 10G per lane to QSFP-DD for PCIe Gen3 or 40G Ethernet
	• AMC Ports 12-15 / 17-20: 8 lanes with 10G per lane to QSFP-DD for PCIe Gen3 or 40G Ethernet
	• TCLK 1-4: single-ended TCLK A-D via SMA
	• UART interface via USB Type A
	• LEDs for:
	  • Power / Fan Status
	  • Temperature
	  • AMC Status

Compliance	
	• PICMG AMC.0 Rev. 2.0 • PICMG µTCA.0 Rev. 3 • CE, RoHS • EN55032:2015, EN 55024:2010+A1:2015, EN IEC 62368-1:2020 + A11:2020
Environmental	
Ambient Temperature	• 0°C to +45°C (long term)* • 0°C to +55°C (short term)*
Humidity	• 5% to 85%, non-condensing

Please note: These values are only valid with **closed housing** and **managed cooling** functionality! During operation with open sliding cover(s) and/or in Unmanaged Mode, the board temperature must be **supervised** by the user **manually**!

3. QUICK START

To ensure proper functioning of the **NATIVE-Discovery** during its usual lifetime, take the following precautions before handling the shelf.

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 AMC-Edge-Connectors to ensure proper contact when inserting the modules into the **NATIVE-Discovery**.

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

3.2. Mechanical Requirements

Despite its compact design the **NATIVE-Discovery** compliant to the open standards MTCA.0 and AMC.0. Therefore, every standard-compliant AMC module can be integrated.

Before installing or uninstalling an AMC, read the Installation Guide and the User's Manual of the module.

Check all 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 don't switch off the power.

Ensure that the module is connected to the **NATIVE-Discovery** with the connector completely inserted.

If the device is installed in an enclosed rack or chassis, ensure that the system has adequate ventilation.

Maintain ambient airflow to ensure normal operation. If the airflow is blocked or restricted, or if the intake air is too warm, an over temperature condition can occur.

Ensure that cables from other equipment do not obstruct the airflow through the shelf. Depending on the AMC form factor, the use of a filler panel, which prevents fan air from escaping out of the front of an open slot, is mandatory.

The **NATIVE-Discovery** is intended to be grounded. Ensure that the shelf ground terminals are connected to Protective Earth of the building.

3.3. Voltage Requirements

3.3.1. Power supply

The **NATIVE-Discovery** consumes up to 240W via an external power supply at an input voltage range from 18-36VDC via the rear panel.

Alternatively, power can also be provided via an onboard power connector. This option may be useful in case the **NATIVE-Discovery** is integrated in a customized chassis.

3.3.2. Hot-Swap

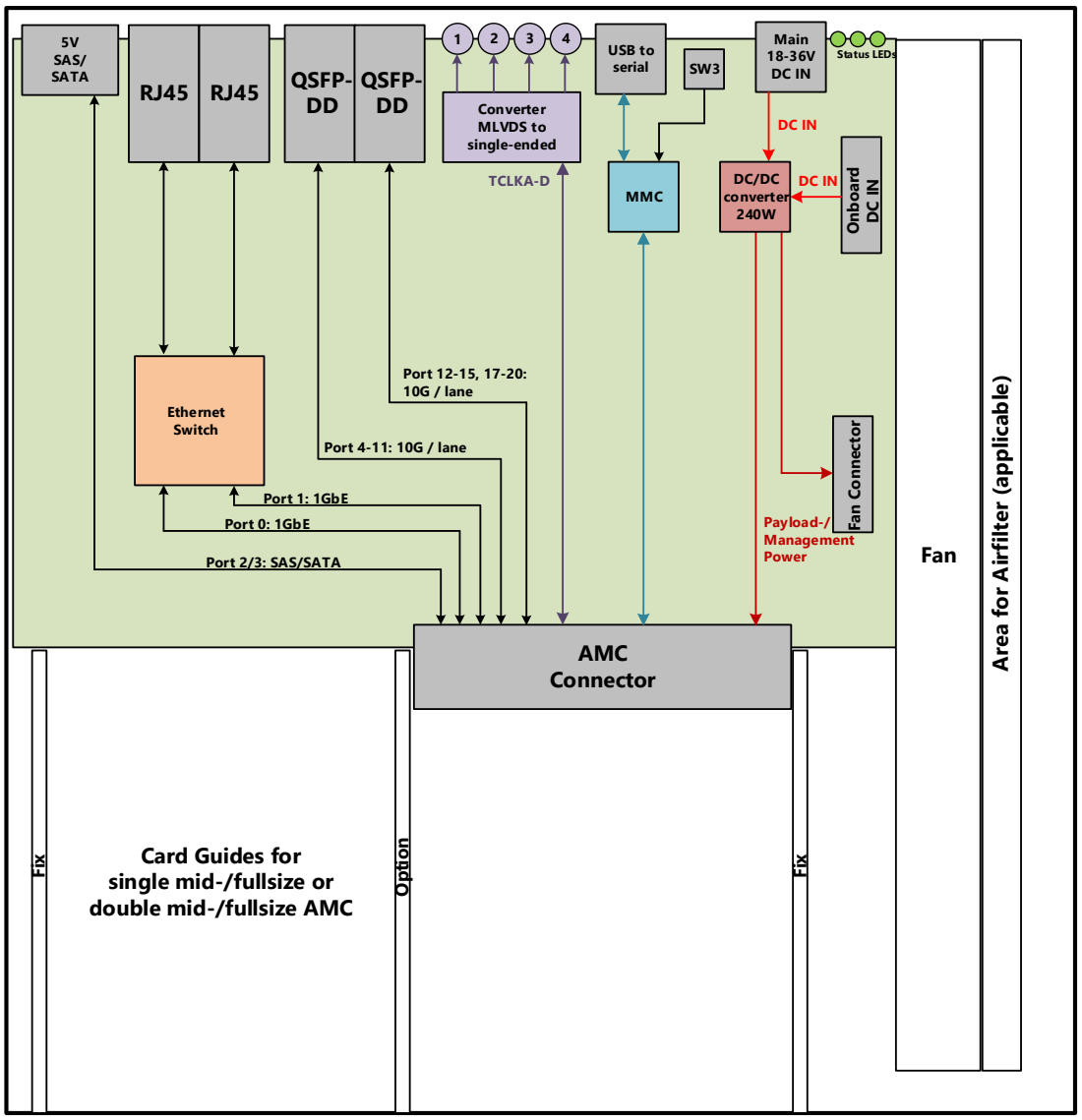
With the current prototype version, the **NATIVE-Discovery** supports Hot-Swap-Functionality if operating in managed mode.

In unmanaged mode, before inserting or extracting an AMC, the system must be shut down completely to prevent damage.

4. HARDWARE

The following diagram shows the main components of the **NATIVE-Discovery**.

Figure 4 – Block Diagram



4.1. Rear Panel LEDs and Connectors

The **NATIVE-Discovery** rear panel features several status LEDs; the behaviour is described in the table below.

Figure 5 – Rear Panel

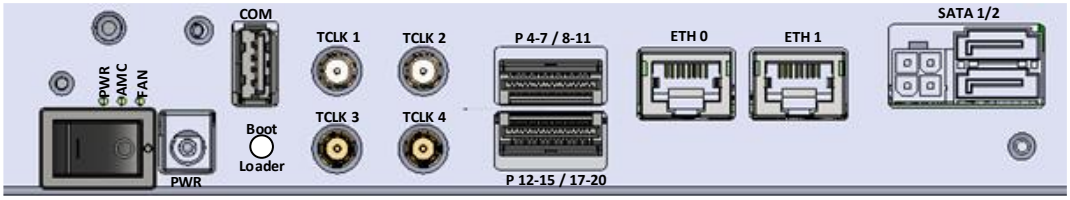


Table 2 – LED Functionality

LED	Colour	Behaviour	Function
PWR	RGB	tbd	Reflects system power status
AMC	RGB	tbd	Reflects AMC Status
FAN	RGB	tbd	Reflects Fan Status

LED functionality is under development; the description will be detailed with the following hardware version.

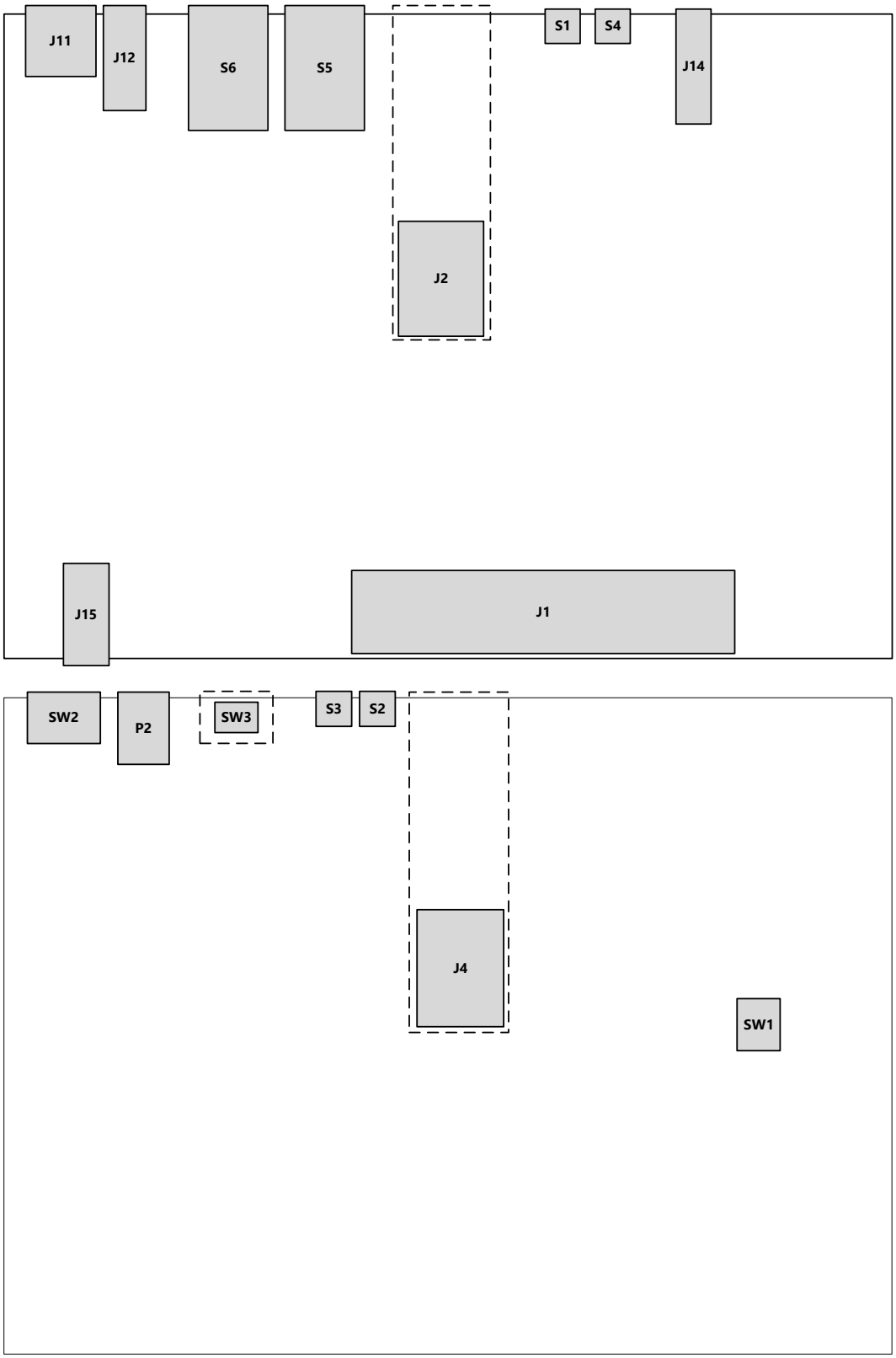
The following table lists the connectors and their functionality. Their location is shown on the diagrams below; the pin assignments of the bold labelled connectors are described in the following paragraphs.

Table 3 - Connectors

Label on Diagram	Location	Type	Description
J1	Internal	Yamaichi MTCA	AMC Connector
J2	Rear panel	QSFP-DD	AMC Port 4-7 / 8-11: 10G per lane for PCIe Gen3 or 40G Ethernet
J4	Rear Panel	QSFP-DD	AMC Port 12-15 / 17-20: 10G per lane for PCIe Gen3 or 40G Ethernet
J11	Rear Panel	Dual Port SATA	AMC Port 2/3
J12	**Rear Panel**	**Mini ATX**	**5V power supply for external SATA drives**
J14	Rear Panel	USB3.2 Type A	COM / UART interface
J15	**Internal**	**Mini ATX**	**24V DC In**
P2	Rear Panel	Power Connector	Main Power IN 18-36VDC
S1-S4	**Rear Panel**	**4x SMA**	**TCLK 1-4 (TCLK A-D -> single-ended); direction managed by MMC**
S5/S6	Rear Panel	2x RJ45	AMC Port 0/1: Ethernet
SW1	**Internal**	**6x DIP-SW**	**tbd**
SW2	External	Toggle switch	Main Power Switch
SW3	Rear Panel	Push Button	Boot Loader Button

Please note: The boot loader button (SW3) is mounted on the PCB and can be operated via a hole in the rear panel. In case a tool is used, make sure, the material is nonconductive!

Figure 6 – Connector Location Diagrams Top and Bottom



4.1.1. J12: SATA Power Connector

Connector J12 provides an external power supply for SATA drives in Mini-ATX form factor.

Table 4 – J12: SATA Power Connector

Pin #	Signal	Signal	Pin #
1	5V	GND	2
3	GND	12V_PP_B	4

4.1.2. J15: Onboard Power Connector

Connector J15 features an onboard 24VDC power input in Mini-ATX form factor.

Table 5 – J15: Onboard Power Connector

Pin #	Signal	Signal	Pin #
1	24V_IN	GND	2
3	GND	24V_IN	4

4.1.3. S1-S4: Clock IN/OUT

TCLKA-D signals from the AMC are converted from MLVDS to single-ended and vice versa.

The assignment of the clock signals to the label on the rear plate is described in the following table:

Table 6 – S1-S4: Clock Signal Assignment

Clock	Connector	Rear Plate Label
TCLKA	S4	TCLK 1
TCLKB	S3	TCLK 3
TCLKC	S2	TCLK 4
TCLKD	S1	TCLK 2

4.1.4. SW1: DIP Switch

DIP Switch SW1 is reserved for future use.

4.2. Cooling Unit

The **NATIVE-Discovery** features an integrated Cooling Unit with five fans, which can either be controlled by a temperature sensor and managed by the onboard IPMI controller or set manually via console (see chapter 5.1.3 Cooling Modes).

Cold air is taken from the right side and pushed through the system. Thus, a cooling power of 120W for the AMC at an operating temperature of +55°C (short term) is ensured. Please note that this information is valid under optimal conditions only, which includes closed housing and managed fan control. If the fan speed is set manually, the AMC temperature must be supervised by the user!

The fan unit is easily removable for maintenance purposes.

5. OPERATION

Depending on the hardware version, the **NATIVE-Discovery** requires different firmware versions. Make sure to use the appropriate firmware as detailed below.

Please consider, that HW V1.0 - as well as the corresponding firmware version V1.2 – is an engineering release. That means, not all final features are implemented. Fundamental testing took place, but robustness of a final release cannot be guaranteed.

A special cable must be used to access the system's console via the USB interface at the rear plate. This USB to UART adapter cable will be provided by NAT.

5.1. Console

The console is used via USB to UART adapter cable with a baud rate of 115200. The adapter cable must be plugged into the computer with the thicker end. The thinner end shall be plugged into the **NATIVE-Discovery**.

The console provides system information and enables user inputs. A terminal software is required on the computer (e.g. TeraTerm).

The user input is based only on single-key inputs. Key 'h' provides the menu instructions with detailed explanations.

The amount of system information can be controlled by user inputs to select whether debug messages shall be displayed or not. Debug messages are available for AMC development purposes. It is strongly recommended to keep warning and error messages active although they can be also deactivated by user inputs.

The user inputs of the console allow control of the system settings. All system settings are stored in an EEPROM and will be re-used in the next power cycle.

5.1.1. Operation Modes

The operation modes of the **NATIVE-Discovery** including the supported features are shown in the table below.

Important: As the unmanaged mode does not support Hot-Swap functionality, the **NATIVE-Discovery *must*** be switched OFF before inserting or extracting an AMC.
To prevent damage from all components, make sure to insert the AMC completely before activating the **NATIVE-DISCOVERY**.

Important: As the unmanaged mode does not support Temperature Event Evaluation, the user must set the fan speed (see chapter 5.1.3 Cooling Mode) to a sufficient value to prevent damage from all components.
The console does not send temperature warning messages!

Figure 7 – Operation Modes

	Unmanaged Mode	Managed Mode
Management + Payload Power	Activated when PS1 is present	M-State evaluation
Hot-Swap Support	---	✓
Temp Event Evaluation	---	✓
Temperature Warning via Console	---	✓

5.1.2. Clocking

TCLKA-D signals from the AMC are converted from MLVDS to single-ended and vice versa. The directions of the signals can be changed with this setting individually.

5.1.3. Cooling Modes

Two cooling modes are supported by the **NATIVE-Discovery**:

Via console, the Cooling Unit can be controlled by user inputs to increase or decrease fan speed from 30% to 100%. This mode is mandatory if the system operates in Unmanaged Mode.

Via AMC: the AMC can send temperature events to optimize the use of the Cooling Unit. Payload power will be deactivated when temperature becomes non-recoverable. This option is only available in Managed Mode.

Important: In Managed Mode, warnings are displayed on the console, when temperature is getting high independently from the chosen cooling mode.
These warnings will not be available, when the **NATIVE-Discovery** operates in Unmanaged Mode, in this case the temperature must be supervised manually!

5.2. IPMI Communication

IPMI communication is available when the **NATIVE-Discovery** is in Managed Mode. The **NATIVE-Discovery** sends requests to the AMC required for Hot-Swap functionality which include among others:

- Control Blue LED
- Get Device ID
- Get FRU Info

The **NATIVE-Discovery** processes requests from the AMC for the following dedicated events. All other events are currently ignored.

- Hot-Swap handle open or closed
- Temperature events

If IPMI communication gets lost, the system will switch to M-State "COMM LOST". The **NATIVE-Discovery** tries to recover the communication periodically. It is recommended to switch to Unmanaged Mode, when IPMI communication is not working robustly in the system.

5.3. Firmware updates

If firmware updates are required in the future, they can be flashed as following. The procedure varies depending on the operation system used.

Please note: You must disconnect UART console before proceeding.

5.3.1. Windows

- Install avrdude: download avrdude (to C:\avrdude), add this path to environment variables "system variables"
- Download the firmware file (update.hex)
- Connect USB to UART adapter cable to your computer. Ensure that UART console is disconnected.
- Select folder of the firmware file: open Command Window (cmd) or PowerShell in the folder and verify correct AVRdude installation by command avrdude --v
- Find UART device by using the device manager to find the right port COM[*X*] (manual driver installation might be required)
- Switch off the **NATIVE-Discovery**
- Press and hold the boot loader button on the back side of **NATIVE-Discovery** (button is behind a hole on the rear panel close to power-on switch)

- Switch on the **NATIVE-Discovery**
- Execute the following commands (adapt the name of the firmware file and the device name (e.g. *COM8*))
    - avrdude -p ATxmega128A1U -c avr911 -P COM[X] -b 115200 -e -v
    - avrdude -p ATxmega128A1U -c avr911 -P COM[X] -b 115200 -U flash:w:update.hex:i
- Release boot loader button after executing second command. This can take place before the flash process is completed, but the button must be pressed until the flash process starts.
- Switch off the **NATIVE-Discovery**
- Switch on the **NATIVE-Discovery**

5.3.2. Linux

- Install avrdude: sudo apt-get install avrdude
- Download the firmware file (update.hex)
- Connect USB to UART adapter cable to your computer. Ensure that UART console is disconnected.
- Select folder of the firmware file: open Terminal, navigate to the folder, and verify correct AVRdude installation by command avrdude --v
- Find UART device: Linux: Use command ls /dev/. Device name should be visible similar to /dev/ttyUSB0
- Switch off the **NATIVE-Discovery**
- Press and hold the boot loader button on the back side of **NATIVE-Discovery** (button is behind a hole on the rear panel close to power-on switch)
- Switch on the **NATIVE-Discovery**
- Execute the following commands (adapt the name of the firmware file and the device name)
    - avrdude -p ATxmega128A1U -c avr911 -P /dev/ttyUSB0 -b 115200 -e -v
    - avrdude -p ATxmega128A1U -c avr911 -P /dev/ttyUSB0 -b 115200 -U flash:w:update.hex:i
- Release boot loader button after executing second command. This can take place before the flash process is completed, but the button must be pressed until the flash process starts.

- Switch off the **NATIVE-Discovery**
- Switch on the **NATIVE-Discovery**

5.3.3. MacOS

- Install avrdude: brew install avrdude
- Download the firmware file (update.hex)
- Connect USB to UART adapter cable to your computer. Ensure that UART console is disconnected.
- Select folder of the firmware file: open Terminal, navigate to the folder, and verify correct AVRdude installation by command avrdude --v
- Find UART device: Use command *ls /dev/cu.** Device name should be visible similar to /dev/cu.usbserial-02G8IA29
- Switch off the **NATIVE-Discovery**
- Press and hold the boot loader button on the back side of **NATIVE-Discovery** (button is behind a hole on the rear panel close to power-on switch)
- Switch on the **NATIVE-Discovery**
- Execute the following commands (adapt the name of the firmware file and the device name)
    - avrdude -p ATxmega128A1U -c avr911 -P /dev/cu.usbserial-02G8IA29 -b 115200 -e -v
    - avrdude -p ATxmega128A1U -c avr911 -P /dev/cu.usbserial-02G8IA29 -b 115200 -U flash:w:update.hex:i
- Release boot loader button after executing second command. This can take place before the flash process is completed, but the button must be pressed until the flash process starts.
- Switch off the **NATIVE-Discovery**
- Switch on the **NATIVE-Discovery**

5.4. Known Limitations

- IPMI communication might not be fully robust with all different kinds of AMCs and unexpected behaviours.
- No E-Keying during Hot-Swap process
- Other AMC events than temperature and handle are ignored
- Access to AMC JTAG is not provided via Digilent USB-2-JTAG
- No support for dynamic configuration of various types of QSFP transceivers
- Backside LEDs are not in use

5.5. Open Source Notice

This product includes software licensed under the Apache License, Version 2.0. A copy of the license is available at https://www.apache.org/licenses/LICENSE-2.0.

6. SPECIFICATIONS AND COMPLIANCES

6.1. Internal Reference Documentation

- http://www.nateurope.com

6.2. External Reference Documentation

- Atmel ATxmega128 Microcontroller Datasheet, Rev. 2467XS–AVR–06/11

6.3. Standards Compliance

- PICMG AMC.0 Rev. 2.0/3.0*
- PICMG µTCA.0 Rev. 3
- CE, RoHS
- EN55032:2015, EN 55024:2010+A1:2015, EN IEC 62368-1:2020 + A11:2020

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.

*High Speed Fat Pipes under validation

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. 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.

6.8. Abbreviation List

Table 7 – Abbreviation List

Abbreviation	Description
AC	Alternating Current
AMC	Advanced Mezzanine Card
BIOS	Basic Input/Output System
BMC	Base Management Controller
CLI	Commend Line Interface
CPU	Central Processing Unit
COM	Communication Port
EEPROM	Electrically Erasable Programmable Read Only Memory
eMCH	Embedded MCH
FLASH	Non-Volatile Memory
FRU	Field Replaceable Unit
FTP	File Transfer Protocol
GbE	Gigabit Ethernet
GUI	Graphical User Interface
HS	Hot-Swap
I^2C	Inter-Integrated Circuit
IP	Internet Protocol
IPMB	Intelligent Platform Management Bus
IPMI	Intelligent Platform Management Interface
JRE	Java Runtime Environment
LAN	Local Area Network
µC/MCU	Microcontroller (Unit)
MCH	µTCA Carrier Hub
µTCA	Micro Telecommunications Computing Architecture
OS	Operating System
RMCP	Remote Management Control Protocol
SDR	Sensor Data Repository
SEL	System Event Log
SMS	System Management Software
SNMP	Simple Network Management Protocol
SRAM	Static Random Access Memory
UDP	User Datagram Protocol
VAC	Volt Alternating Current
TCKL	Telecom Clock
USB	Universal Serial Bus

7. DOCUMENT'S HISTORY

Table 8 – Document's History

Rev	Date	Description	Author
0.9	07.07.2025	• Preliminary release according to prototype status	Se
1.0	27.04.2026	• Updated chapter 4 Hardware • Updated chapter 5 Operation	se