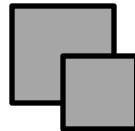




中国科学院高能物理研究所
INSTITUTE OF HIGH ENERGY PHYSICS



Module Management Controller(MMC) of MTCA.4 with open source evaluation

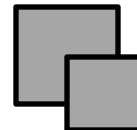
Han Sheng,Gan Nan,Ma Xinpeng,Lu Chenyan,Peng Yongyi,Li Jingyi

LINAC Group,Accelerator Division
Institute of High Energy Physics, Chinese Academy of Sciences

2021.8.25
The 2nd MTCA/ATCA Workshop for Research and Industry



1. Introduction



- **Modules of MTCA.4 System**

- Power Module 1~4

- Cooling Unit 1~2

- MicroTCA Carrier Hub(MCH) 1~2

- Advanced Mezzanine Card(AMC)** 0~12

- Rear Transition Module(RTM) 0~12

- **MCH: Management and Communication**

- MCH ↔ PM/CU: IPMB_0

- MCH ↔ AMC: IPMB_L

- **Module Management Controller(MMC) of AMC**

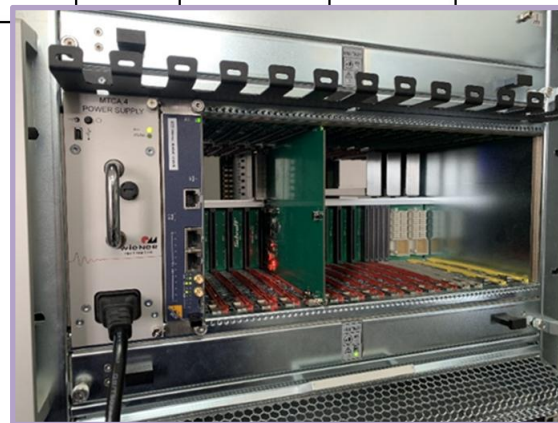
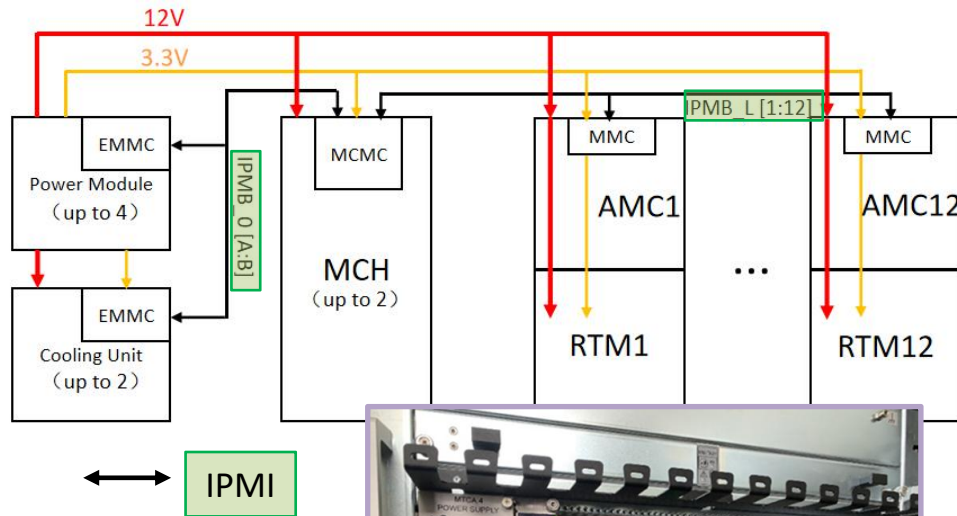
- Power on/off switch

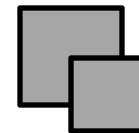
- Operating voltage/current/ temperature monitoring

- Malfunction restart

- **Main Goal**

- a **universal** and **modular** MMC solution





1. Introduction

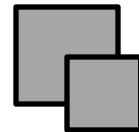
Organization	MCU	Introduction
DESY	ATxmega128	Commercial*; used in Euro XFEL
N.A.T.	ATxmega128	Commercial; Germany
Warsaw University of Technology	LPC1764	Open Source; Design for LNLS
CoreIPM	LPC2000/2300	Open Source
COSYLAB	LPC2136	Commercial; Germany

MCU	Framework	Bit Width	CPU Freq	Flash	SRAM	IO	ADC	Clock	IIC
LPC1764	Cortex-M3	32bit	100MHz	512kB	64kB	70	8×12bit	yes	3
ATxmega128	AVRxmega	8bit	32MHz	128kB	8kB	53	8×10bit	no	1

* open with Non-Disclosure Agreement



2. MMC Hardware



- **Design Principles**

- MTCA.4 standard board shape

- Use less panel area

- Three I²C buses: communicating with MCH, monitoring devices on AMC and RTM

- **Functional Requirements**

- Display Operating Status

- Power on/off Management

- Hot Swap

- Temperature Monitoring

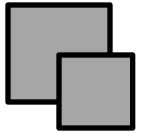
- Voltage and Current Monitoring

- **Design a demo board, reference:**

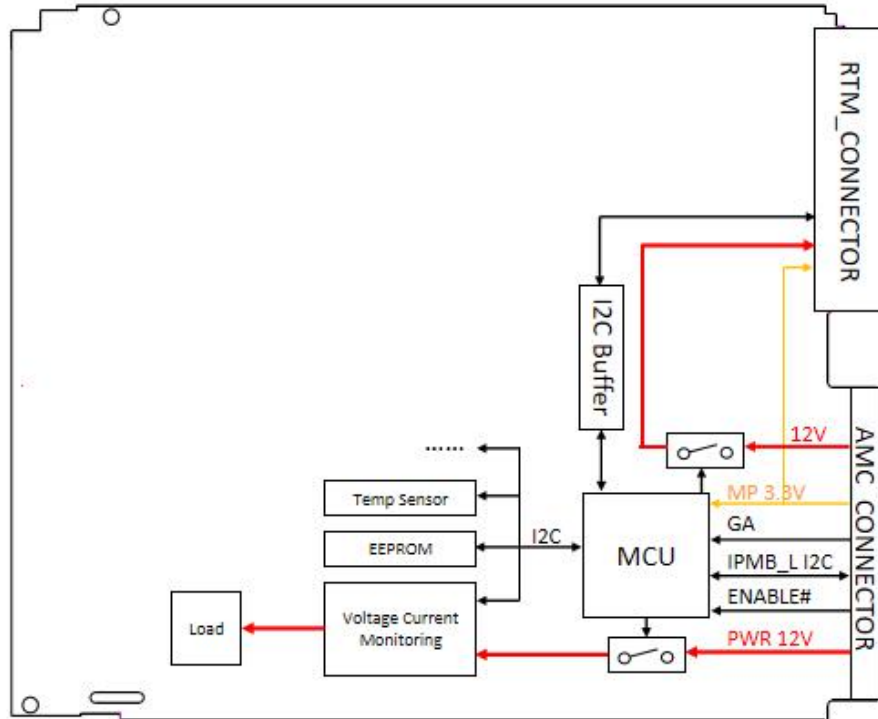
- <https://github.com/Inls-dig/openMMC>

- <https://ohwr.org/project/afck>





2. MMC Hardware



- **MMC Hardware Structures and Functions**

- **MCU:** LPC1764

- **1. Power on Switch: AMC Connector**

PS0# PS1#: located at the two ends of the AMC connector, detect AMC insertion status

Management Power(MP): 3.3V

ENABLE#: reset MCU

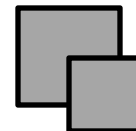
GA[0,1,2]: Geographic Address

IPMB_L(SCL_L, SDA_L): I²C bus; communicate with MCH

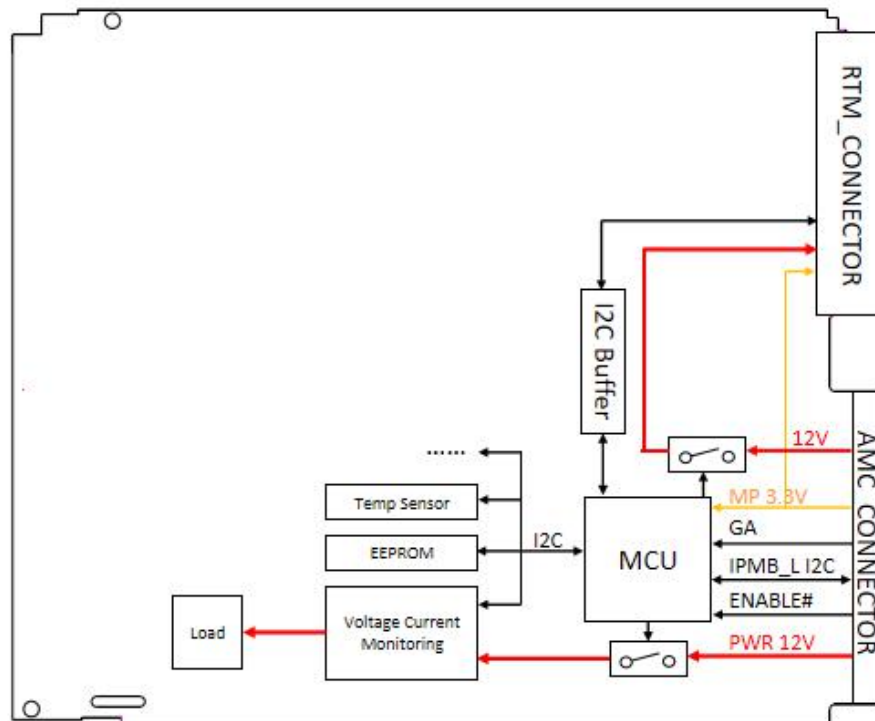
Payload Power(PWR): 12V



2. MMC Hardware

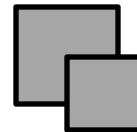


- **MMC Hardware Structures and Functions**
 - **2. Hot Swap:** a mechanical lock switch
 - **3. Running Status:** LED
blue (hot plug state)
red / green (power state)
 - **4. Temperature, Voltage and Current Monitoring:** INA220





2. MMC Hardware



- **RTM Hardware Structures**

- **I²C Extender:** PCA9554

- **Hot Swap switch**

- **LED**

- **EEPROM**

- **Temperature Sensors**

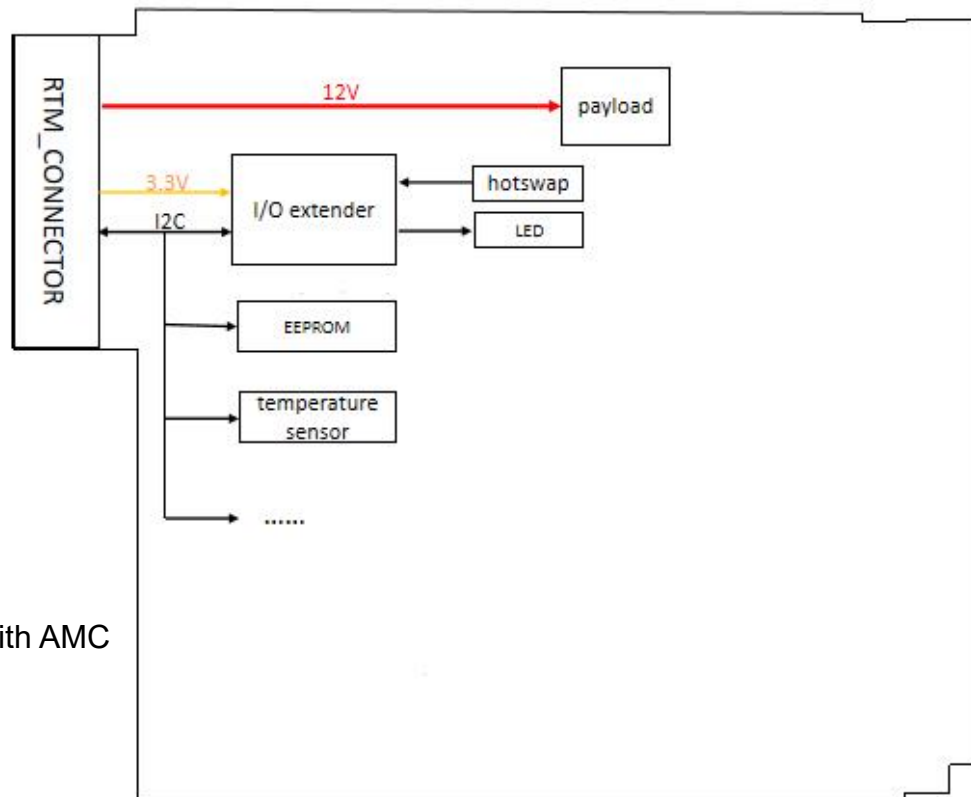
- **RTM Connector**

- PS#:** detect RTM insertion status

- RTM-I²C(SCL, SDA):** communicates with AMC

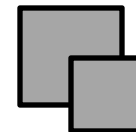
- Management Power(MP):** 3.3V

- Payload Power(PWR):** 12V

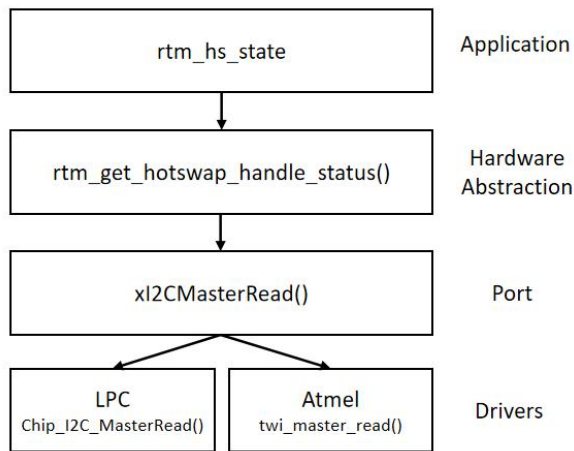




3. MMC Software



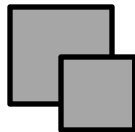
- **OpenMMC of WUT**
 - **Driver:** directly access and control the MCU
 - **Port:** defines general functions for hardware program to invoke
 - **Hardware Abstraction Level(HAL):** all functions of the peripheral hardware, IPMI communication protocol management
 - **Applications:** deciding actions based on hardware information



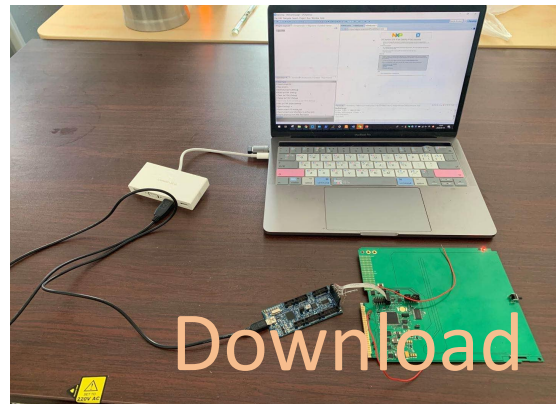
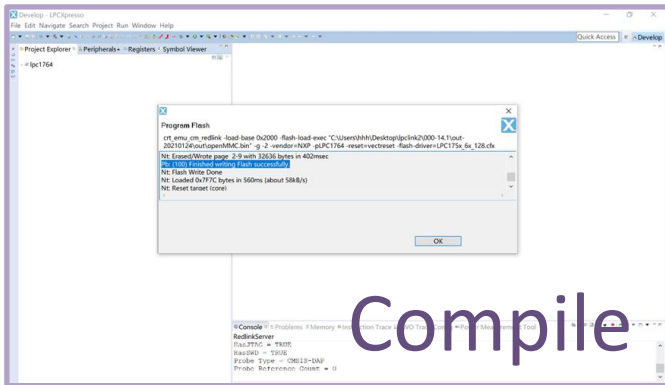
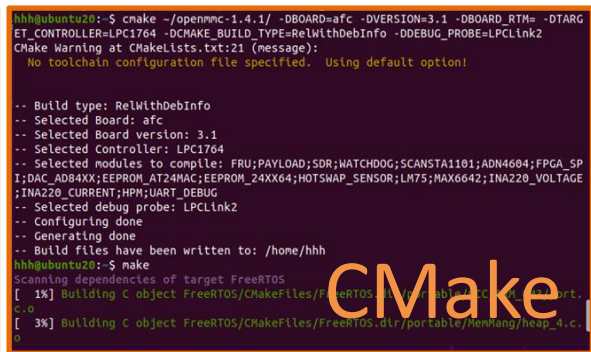
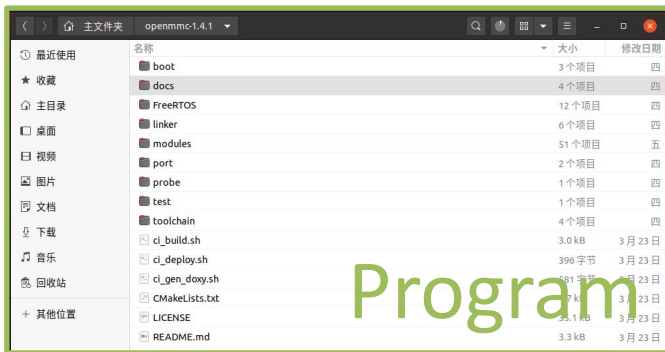
- **Functions implemented**
 - Display Operating Status of AMC and RTM
 - Power on/off Management and Hot Swap of AMC
 - Temperature Monitoring
 - Voltage and Current Monitoring
- **Modification**
 - **RTM Hot Swap**
 - Hot Swap Switch pushed in: Payload Power turn ON
 - pulled out: Payload Power turn OFF



3. MMC Software

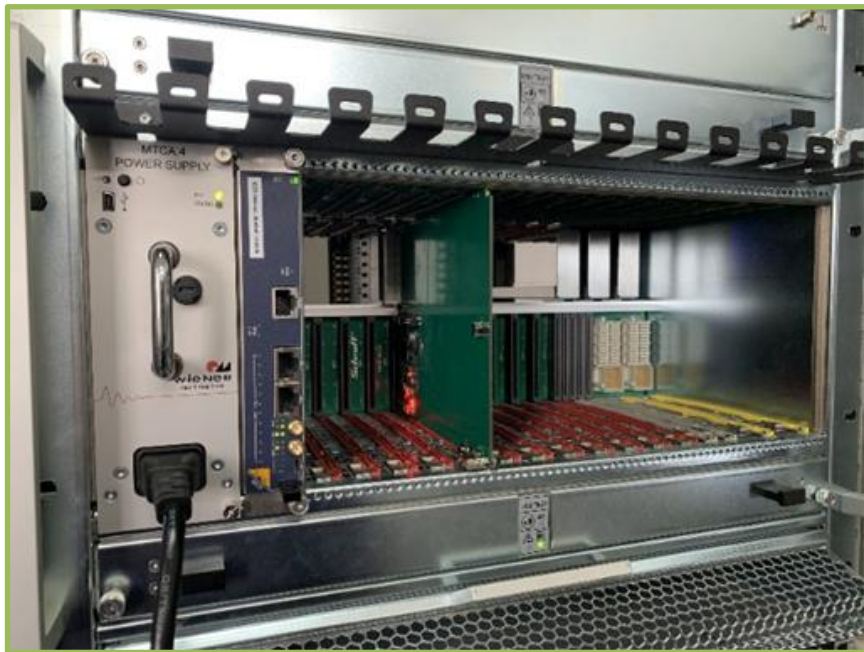
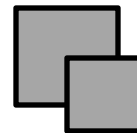


- **Software Download Process**
- **Configure Environment**
 - Operating System: Ubuntu20
 - Software: CMake
 - gcc-arm-none-eabi
 - LPCXpresso
- **Compile**
 - generate the binary code
- **Download**
 - LPC-Link2





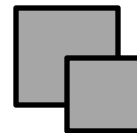
4. Test



Chassis: nVent
Power Module: Wiener
MCH: NAT
RTM: Struck
Load: an air fin



4. Test



1. AMC inserted into chassis

Bule LED: ON

Management Power: ON

2. Hot Swap Switch inserted into chassis

Bule LED: BLINK

MCU is communicating with the MCH

3. air fan starts to work

Bule LED: OFF

Payload power: ON

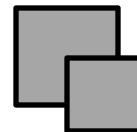
4. Hot Swap Switch pulled out

Bule LED: BLINK then ON

Payload power: OFF

FRU Information:

FRU	Device	State	Name
0	MCH	M4	NAT-MCH-CM
3	mcmc1	M4	NAT-MCH-MCMC
11	AMC7	M4	MMC
40	CU1	M4	Schroff uTCA CU
41	CU2	M4	Schroff uTCA CU
51	PM2	M4	PM-AC1000
60	Clock1	M4	MCH-Clock
61	HubMod1	M4	MCH-PCIE
96	AMC7-RTM	M4	MMC-RTM



4. Test

Sensor Information for FRU 11 / AMC7

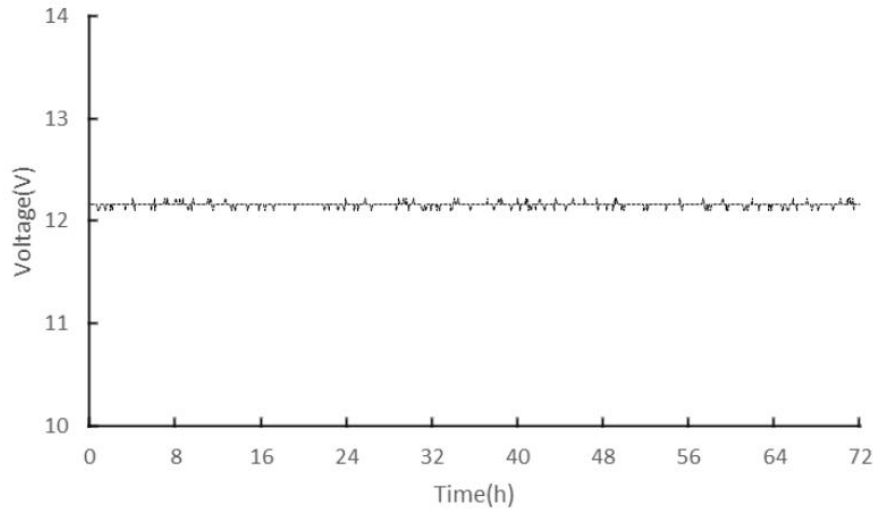
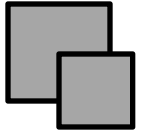
#	SDRType	Sensor Entity	Inst	Value	State	Name
-	MDevLoc		0xc1 0x67			MMC
2	Full	Voltage	0xc1 0x67	12.480 V	ok	AMC 12V
3	Full	Current	0xc1 0x67	0.256 A	ok	AMC 12V Curr
4	Full	Temp	0xc1 0x67	24.5 C	ok	TEMP 1
5	Full	Temp	0xc1 0x67	25.0 C	ok	TEMP 2
6	Full	Temp	0xc1 0x67	24.0 C	ok	TEMP 3
7	Full	Temp	0xc1 0x67	24.5 C	ok	TEMP 4
8	Compact	0xf2	0xc1 0x67	0x01		HOTSWAP AMC
9	Compact	0xf0	0xc1 0x67	0x10		HS 011 AMC7

Sensor Information for FRU 96 / RTM7

#	SDRType	Sensor Entity	Inst	Value	State	Name
-	MDevLoc		0xc0 0x67			MMC-RTM
9	Compact	0xf2	0xc0 0x67	0xa1		HOTSWAP RTM
10	Full	Temp	0xc0 0x67	26.0 C	ok	TEMP RTM
11	Compact	0xf0	0xc0 0x67	0x10		HS 096 RTM7



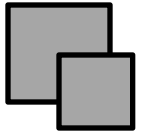
4. Test



- **Voltage Stability Test**
 - **Load:** air fan
 - **Time:** 72 Hours
 - **Average Voltage:** 12.16V
 - **Vpp:** 0.128V
 - **Standard Deviation:** 0.024V

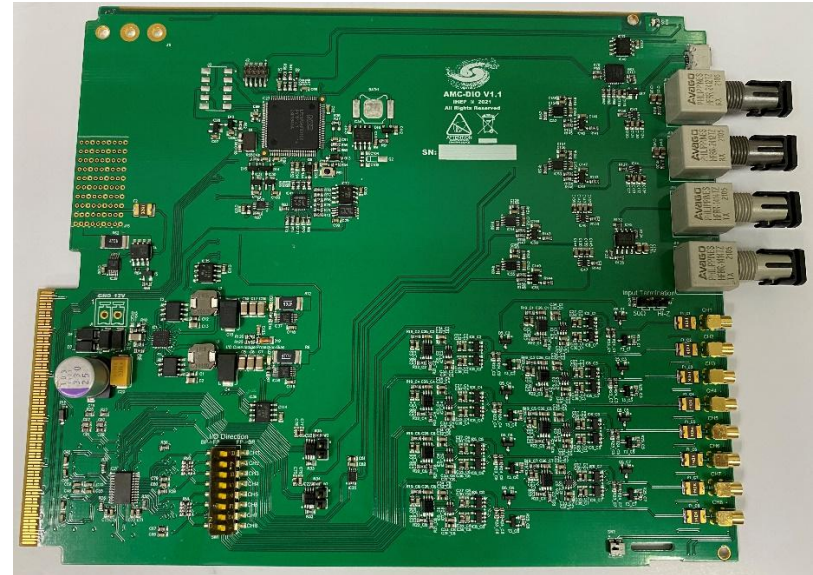


5. Summary



- A set of **universal, modular** MicroTCA.4 standard Module Management Controller (MMC) solution based on OpenMMC

	Status LED	Payload Power on/off Switch	Hot Swap
AMC	√	√	√
RTM	√	√	√
	Temp	Voltage	Current
AMC	√	√	√
RTM	√		



THANKS !