MTCA.4 RF Backplane Option: Features and Management

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RF Signal Distribution in Multichannel Control Systems

- Multichannel systems with RF front end usually require distribution of tens precise LO / CLK / REF signals to RTM or AMC cards.

- Distribution must be realized with impedance controlled lines and coax connectors.

- Tens of cables hanging in front of the crate makes system maintenance really difficult.

- Cable management is a fundamental problem for many applications.
RF Backplane Option

Facilitates the hiding of the „internal” RF/CLK connections inside the crate
AMC-RTM Pair – Side View

AMC Backplane

FRONT

REAR

Zone 3

AMC

RTM
AMC-RTM Pair – RF Backplane Location

Abbreviation **uRFB - uTCA RF B**ackplane

In general: RTM Backplane

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**AMC**

**RTM**

- ADF Connector
- Multipin RF Coaxial Connector

**AMC Backplane**

**RTM Backplane**

**FRONT**

**REAR**

Zone 3

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AMC-RTM Pair – RF Backplane Connectors

Abbreviation uRFB - uTCA RF Backplane
In general: RTM Backplane

ERMET ZD, 3x10 diff. pairs
Radiall Coaxipack 2 6-pin, 6GHz RF connectors
Advantages of the RF Backplane Concept

System with signals distributed outside the crate

- Improved cable management
- Higher reliability
- Space reduction
Slots, eRTMs and Rear Power Supply Modules

Up to 4 extended RTMs (eRTM)

1 or 2 Rear Power Supply Modules

Rear View

Cooling Unit

Zone 3 Area

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

Cooling Unit

15 14 13 12 11 10 9 8 7 6 5 4 3 2 1

Zone 3 Area

eRTM15 eRTM eRTM uRTM uRTM uRTM uRTM uRTM uRTM uRTM uRTM uRTM uRTM uRTM MCH-RTM eRTM/Rear Power Module Rear Power Module

Up to 4 extended RTMs (eRTM)

1 or 2 Rear Power Supply Modules
uRFB – Final Concept Highlights

- **Fully compatible to the standard.** No mechanical collision with standard RTM boards. Supported by crate manufacturers.

- **Hot swap functionality for RF signals.** IPMI extension for uRFB worked out with N.A.T.

- uRFB is passive. All intelligence in modules -> great flexibility for users.

- Developed a concept of extended RTM (eRTM) boards.

- **Redundant high performance rear power supply** for analog applications.
eRTMs

- Offer system designers additional space (note that eRTMs are wider (6HE) than uRTMs (4HE))
- Designers can use 2 or even 3 slots for one module if necessary
  - eRTMs can be used for applications requiring significant space for components like filters or precise temperature stabilization
- uRFB provides management, power supply and data links for eRTMs
- Slot 15 was designated an RF signal entry. See DRTM-LOG1300 talk by T. Rohlev as an example input board design
uRFB Management and Power Supply

- Management by MCH-RTM in slot #-1
- MCH to MCH-RTM interface via Zone 3
- Standard (AMC) management „mirrored” to the RTM side: reduced development cost and time
- eRTM and uRTM FRUs with information about connectivity and power supply
- Rear PM can supply $4 \times +12V$ to eRTMs and $12x +/− 7V$ to uRTMs
- uRTM can use $+/-7V$ from uRFB or standard $+12V$ from AMC
- **Economic use case**: power supply for eRTM in slot #15 from MCH-RTM (no Rear PM) but limited to max 25W
Simplified Block Diagram of uRFB Designed for XFEL LLRF System

- 27 RF signals (optimized for 1.3 GHz but can work up to 6 GHz)
- 22 CLK signals
- „Analog” power supply: +/-7 V for RTMs and +12 V for eRTMs
- Management and communication
Project Status: Tested uRFB PCB Prototype, Developed eRTM Templates and Boards, Fixed Crate Extensions

eRTM15 test board

uRTM test board
Project Status: Automated Teststand

- Measurements in laboratory and in the crate filled with digital boards

- No detectable signal spectrum degradation – in 9kHz – 6 GHz range (no spectral lines at level above instrument noise floor of -75 dBm)

- Excellent isolation from digital side of the MTCA crate

Table I: Measurement Results of The Attenuation and Reflection Coefficients of the uRFB at Frequency 1.300 GHz for REF and CAL and 1.354 GHz for LO Lines

| Slot | $A_{REF}$ [dB] | $|\Gamma_{REF}|$ [dB] | $A_{LO}$ [dB] | $|\Gamma_{LO}|$ [dB] | $A_{CAL}$ [dB] | $|\Gamma_{CAL}|$ [dB] |
|------|----------------|-------------------|-------------|----------------|---------------|----------------|
| 4    | 3.4            | -16.2             | 3.5         | -16.5          | 3.1           | -18.5          |
| 5    | 2.8            | -15.4             | 3.3         | -16.8          | 4.3           | -18.2          |
| 6    | 3.3            | -15.6             | 4.7         | -17.1          | 3.2           | -19.0          |
| 7    | 2.3            | -15.4             | 2.6         | -16.2          | 2.6           | -17.9          |
| 8    | 2.1            | -15.2             | 2.9         | -16.7          | 4.1           | -17.6          |
| 9    | 3.4            | -15.1             | 3.4         | -16.7          | 3.3           | -18.3          |
| 10   | 1.5            | -15.4             | 2.3         | -16.7          | 2.0           | -18.0          |
| 11   | 1.4            | -15.5             | 2.5         | -16.8          | 1.9           | -18.4          |
| 12   | 1.9            | -15.2             | 1.2         | -16.7          | 2.6           | -18.4          |
Summary

- Compact solution integrated with the crate
- No collision with standard MTCA cards
- Reduces number of cable connections and improves reliability and maintainability
- Hot-swap for RF signals up to 6 GHz
- High-performance +/-V managed power supplies for RTMs
- eRTMs to increase number and size of modules
- Developed and tested successfully
- Management and power supply under development
- Extensive performance tests prepared
- Plan to introduce the RTM Backplane concept to PICMG
Thank you for attention!