Application Note

Mobile Fronthaul Tests

CPRI/OBSAI Testing

MT1000A Network Master Pro

MU100010A 10G Multirate Module
MU100011A 100G Multirate Module

MT1100A Network Master Flex

MU110010A 10G Multirate Module
MU110011A 100G Multirate Module
MU110013A 40/100G Advanced Module

The rapid spread of smartphones and tablets together with many new Cloud services in the last decade have led to explosive growth in mobile data traffic. Operators are supporting mobile data traffic growth by increasing the bandwidth of mobile communications networks. This has been an important driver for a complete change in mobile communications systems with the adoption of the Centralized-Radio Access Networks (C-RAN), sometimes called Cloud-Radio Access Networks. Another important driver for operators has been reducing network running costs.

Using C-RAN, the mobile fronthaul is configured with centralized Base Band Units (BBU) controlling multiple, distributed Remote Radio Head (RRH) units at antenna sites. BBUs and RRHs are connected via general-purpose interfaces, most commonly the Common Public Radio Interface (CPRI), or in some cases the Open Base Station Architecture Initiative (OBSAI).

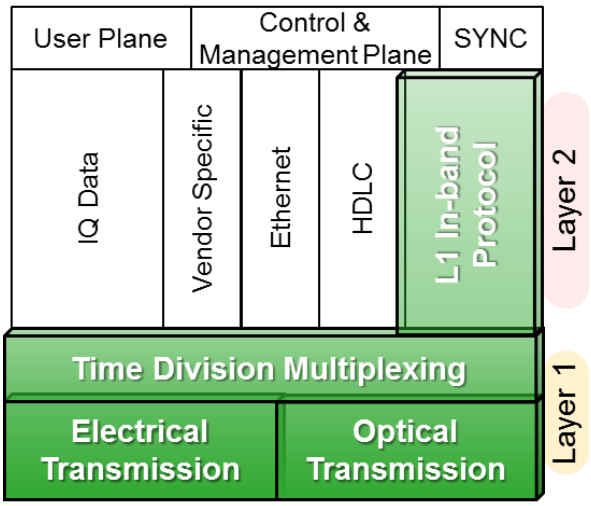
Construction of mobile networks using eCPRI (Ethernet CPRI) has started recently.

Introduction

Removing BBUs from antenna sites reduces operators' costs for renting space and power to the equipment at the antenna site, etc. However, locating BBUs some distance from RRHs requires a reliable connection, which is provided by C-RAN.

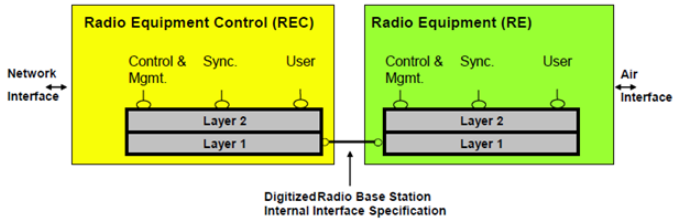
The CPRI running over C-RAN has two main layers:

- Layer 1: Provides physical transport
- Layer 2: Has several areas; the L1 In-band Protocol area is important in Layer 2. Understanding the L1 In-band Protocol area allows the operator to troubleshoot alarms and errors

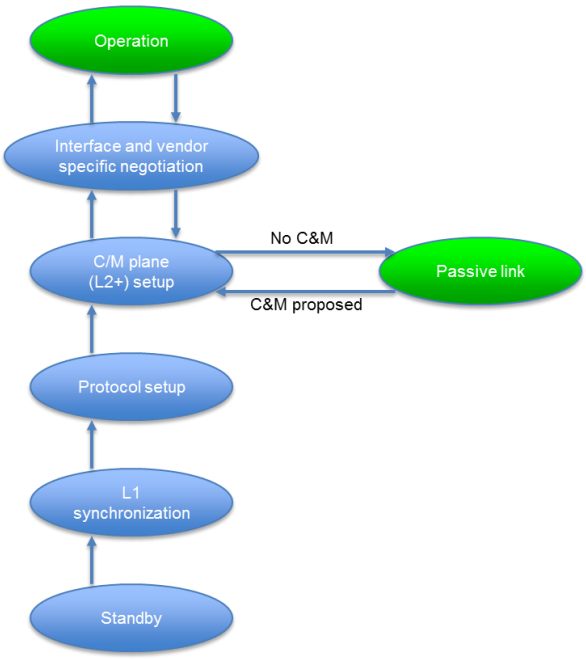


CPRI Specification V7.0 defines the sequence of actions to be performed by two devices connected via a CPRI link. When both devices are in the Operation state or in the Passive Link state, the link is in normal operation. This is shown in Figure 30: Start-up states and transitions in the CPRI specification. This document uses a simplified version of the start-up process.

In the CPRI, a BBU is called REC, and an RRH is called RE.



(Figure 1 in CPRI Specification V7.0)



Extract from Figure 30 in CPRI Specification V7.0: Start-up states and transitions

CPRI and OBSAI Bit Rates

CPRI bit rates are referred to as "Option #". There are now 11 options, according to CPRI Specification V7.0:

Option	Bit Rate (Mbps)	Line Code
1	614.4	8B/10B
2	1,228.8	8B/10B
3	2,457.6	8B/10B
4	3,072.0	8B/10B
5	4,915.2	8B/10B
6	6,144.0	8B/10B
7	9,830.4	8B/10B
7A*	8,110.08	64B/66B
8	10,137.6	64B/66B
9	12,165.1	64B/66B
10	24,330.2	64B/66B

*7A is intended for intra-REC and intra-RE electrical interface use only.

4 OBSAI bit rates are defined:

Bit Rate (Mbps)	Line Code
768	8B/10B
1,536	8B/10B
3,072	8B/10B
6,144	8B/10B

Applications

During recent CPRI installations, many operators have found that up to 80% of CPRI turn-up issues occur in the lowest layers. Therefore, during installation, it is essential to confirm that the RRH/RE can communicate to ground even when the BBU/REC has not yet been installed. This includes:

- Confirming the RRH/RE can connect to the Passive Link state as per the CPRI standard. (See the figure above: "Extract from Figure 30 in CPRI Specification V7.0: Start-up states and transitions".)
- Confirming that connection including the HDLC layer within the Layer-2 network is connecting correctly to the C&M Plane.

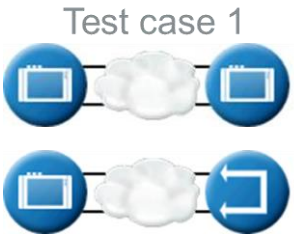
When these two are functioning correctly, the first phase (often considered the most important and most expensive) can be confirmed before installing the BBU/REC at the second phase.

CPRI/OBSAI Test Cases

Test case 1

In this case, the physical line between REC(s) and RE(s) is tested during the installation phase, before connection of the actual network equipment (RECs and REs) The line can be optical, carried over a radio link or microwave link or the line can be CPRI over OTN. In any case, the instrument is connected via the optical interface to the link.

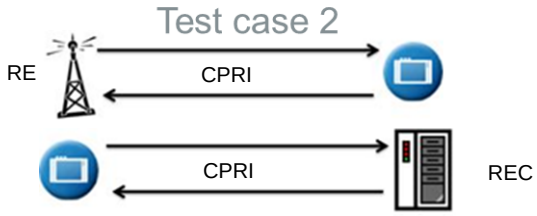
- Terminate both sides of the transmission line. Typical tests in this case are:
  - BER test (Framed or unframed). One side could be in loopback.
  - Delay measurement with one side in loopback.



Test case 2

In this case, the network equipment (RECs and REs) are tested during the installation phase.

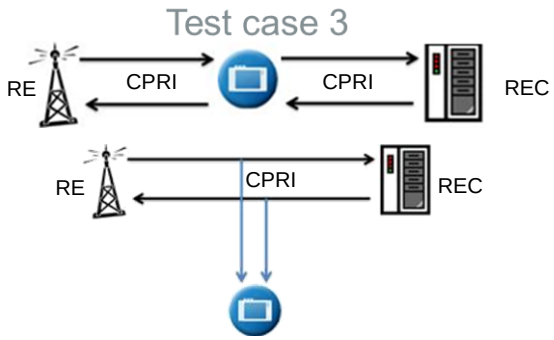
- Connect to the actual equipment. Typical tests in this case are:
  - Frequency measurement
  - Monitor control word K30.7 (indicates error in 8B/10B line code) and monitor 8B/10B Line Code Violations (LCV) (CPRI option 1-7 only)
  - Equipment behavior check:
    - Check that the equipment can reach the "Passive Link" state
    - Check the equipment behaviour when alarms are generated



Test case 3

In this case, the C-RAN behavior is tested during the installation phase or later for in-service troubleshooting of the system.

- Monitor the actual line between REC (Radio Equipment Control) - (master) and RE (Radio Equipment) - (slave)
  - Utilizing dual port in Pass-through mode or monitor with optical splitters (tabs) on the CPRI link
  - Monitor interactive behaviour of equipment



MT1000A and MT1100A CPRI Wire Line Testing

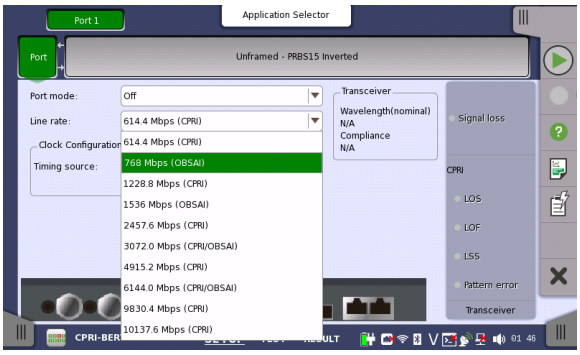
The MT1000A and MT1100A help installers:

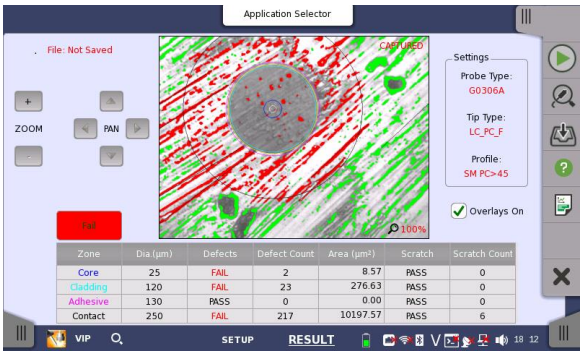
- Confirm the RRH/RE is powered-up correctly
- Confirm the fibers are connected correctly
- Verify that the correct wavelength SFP/SFP+ modules are installed
- Verify that the SFP/SFP+ modules support the rate configured
- Confirm the optical connector condition and cleanliness using the Video Inspection Probe (VIP)
- Confirm the link has no excess loss from the RRH/RE to the BBU/REC (or MT1000A/MT1100A) location – levels at this side can also be measured using the MT1000A/MT1100A
- Confirm the RRH/RE can connect to the lower communications layers, including the C&M channels
  - This is testing up to the Passive state as per the CPRI standard.
  - This is essential because it proves the RRH/RE is working and confirms the communication configuration settings (i.e. line rate, HDLC rate, etc.).
  - This completes testing to confirm the BBU/REC can be installed without issues.
  - Any issue above the Passive state layer is within the proprietary areas of the CPRI protocol.

The MT1000A and MT1100A support CPRI interface rate Option 1 (614.4 Mbps) to Option 8 (10.1376 Gbps). This ensures testing of both current and future CPRI interfaces.
In addition, the MT10001A + MU1000A also supports Option 9 (12.1651 Gbps) and Option 10 (24.3302 Gbps).

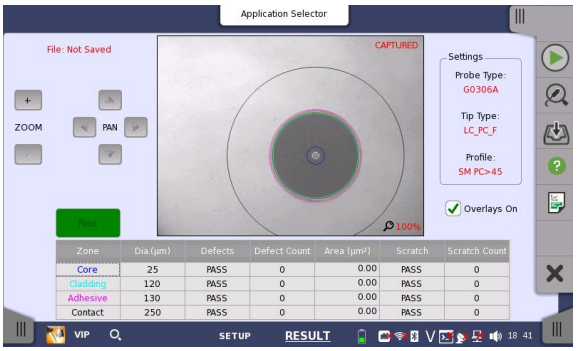
Combining testing at any rate and the ability to exercise the REC (BBU) or RE (RRH) up to the Passive link state (as per the latest CPRI standard) with monitoring in Pass-through mode offers a complete solution for detailed installation and maintenance testing.
Displaying the signal level and bit rate gives first verification of the received-signal condition.

Using the Video Inspection Probe (VIP) to check the fiber endface confirms quality practices are being followed and removes a key point of turn-up failure.

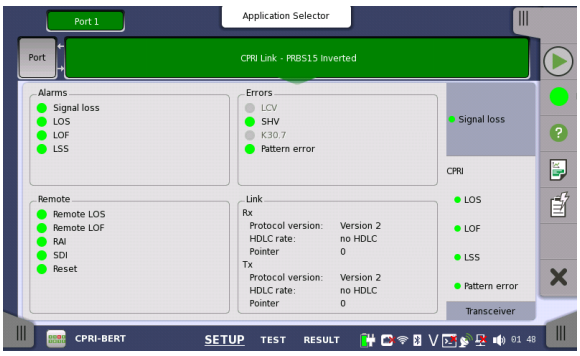


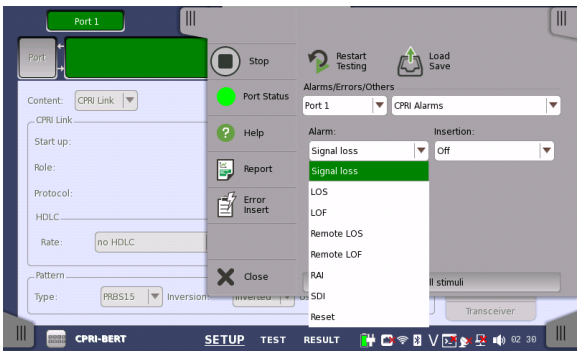


Dirty endface as seen with the VIP.
Using the Table View, you can identify “defects” or “scratches” on the end of the fiber.

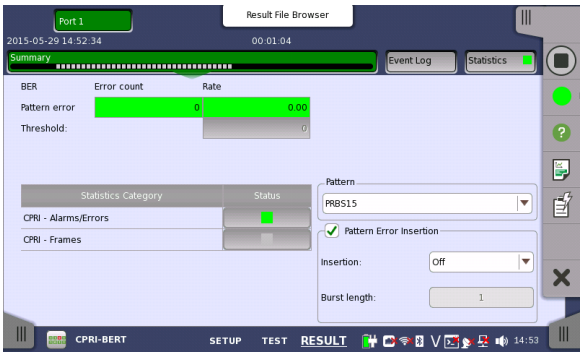


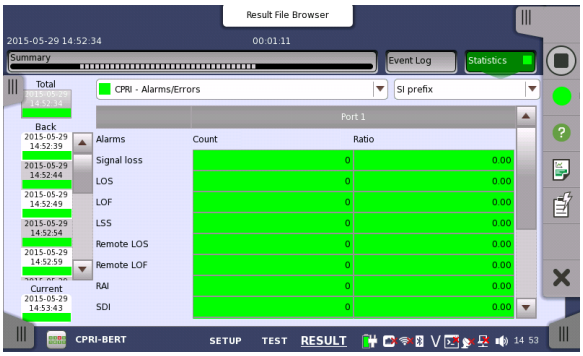
Endface after cleaning as seen with the VIP.
The automatic pass/fail determination is made in accordance with the IEC61300-3-35 standard.





Checking for and inserting Layer-2 Alarms and Errors from the REC (BBU) to the RE (RRH) using the MT1000A and MT1100A ensures that engineers can complete advanced troubleshooting and evaluate the root cause of any issue.





When a test is activated, the MT1000A and MT1100A display valuable results:

- Summary screen with pattern error information and survey of result pages
- Alarms/Errors screen with details of detected CPRI alarms and errors
- CPRI Frames screen with counts of received and sent frames and code words
- Delay screen showing measured Round Trip Delay
- Color coding highlights detected alarms and errors

CPRI over OTN

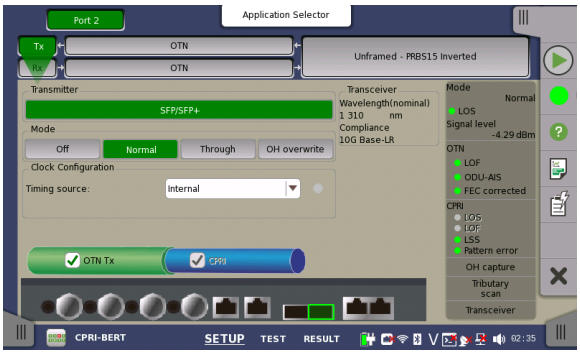
Several vendors are working on CPRI over Optical Transport Network (OTN) solutions supporting transport of the raw radio (CPRI) data from the RE over optical fiber to a centralized location for baseband processing.

- A single location can serve multiple REs.
- This level of consolidation has huge power and cost savings over the distributed approach without impacting network scalability.

OTN supports transport of several protocols over the same fiber, offering OTN operators fault management, performance monitoring, and protection mechanisms coupled with low cost-of-entry and the ability to support current, future, and legacy infrastructure technologies. OTN operators also enjoy the advantage of using the same network-wide management system.

The MT1000A and MT1100A support tests of CPRI over OTN, allowing users to test the latest CPRI implementations.

For more information on OTN please refer to the Anritsu white papers and application notes on OTN.



CPRI/OBSAI Product Features

- CPRI/OBSAI L1 Test
  - Supported bit rates
    - CPRI: 614.4, 1228.8, 2457.6, 3072.0, 4915.2, 6144.0, 9830.4, 10137.6 Mbps
      12.1651 Gbps, 24.3302 Gbps (MU100011A only)
    - OBSAI: 768, 1536, 3072.0, 6144.0 Mbps
  - Clocks: Internal, External (10 MHz), GPS
  - Level measurement (dBm)
  - Bit rate (bps) and deviation (ppm) measurement
  - Alarm/Error detection (Signal Loss, PSL, Pattern Error)
  - Unframed BER measurement
- CPRI L2 Test
  - Link status monitoring
  - Alarm/Error detection (Signal Loss, LOS, LOF, R-LOS, R-LOF, RAI, SDI, Reset, PSL, LCV, INVSH, Pattern Error)
  - Framed BER measurement
  - RTD Measurement (min, avg., max)
- Pass-through monitoring[*1]
- CPRI over OTN[*1]
  - OTN Alarm/Error detection
  - L1 Unframed BER measurement using CPRI client signals
- Fiber endface inspection using VIP (Video Inspection Probe)

*1: 12.1651 and 24.3302 Gbps not supported

Summary

The mobile fronthaul test functions of the Network Master Pro MT1000A and Network Master Flex MT1100A support comprehensive testing and analysis of CPRI and OBSAI technologies. They can identify problems in the mobile fronthaul rapidly, solve issues quickly, reduce system downtime and customer churn, and cut operating costs for mobile operators.
In addition, the MT1000A/MT1100A supports eCPRI and can be used to install and maintain 5G networks.

Ordering Information

MT1000A

Main Frame	
MT1000A	Network Master Pro
Test Module	
MU100010A	10G Multirate Module
MU100011A*	100G Multirate Module
Options	
MU100010A-001	Up to 2.7G Dual Channel
MU100010A-071	CPRI Up to 5G Dual Channel
MU100010A-072	CPRI 6G to 10G Single Channel
MU100010A-073	CPRI 6G to 10G Dual Channel
MU100010A-051	OTN 10G Single Channel
MU100010A-052	OTN 10G Dual Channel
MU100010A-061	ODU Multiplexing
MU100010A-062	ODU Flex
MU100011A-071	CPRI/OBSAI Up to 10G Single Channel
MU100011A-072	CPRI/OBSAI Up to 10G Dual Channel
MU100011A-073	CPRI/OBSAI 12G/25G Single Channel
MU100011A-074	CPRI/OBSAI 12G/25G Dual Channel
MU100011A-075	eCPRI 25G Dual Channel
MU100011A-001	Up to 10G Signal Channel
MU100011A-003	Up to 10G Dual Channel
MU100011A-053	OTN 40G Single Channel
MU100011A-055	OTN 100G Single Channel
MU100011A-062	ODU Flex
MU100011A-063	ODU Multiplexing/Multi Stage
G0306B	Video Inspection Probe
G0382A	Autofocus Video Inspection Probe

*MU100011A requires MT1000A-006

MT1100A

Main Frame	
MT1100A	Network Master Flex
Test Modules	
MU110010A	10G Multirate Module
MU110011A	100G Multirate Module
MU110013A	40/100G Advanced Module
Power Supply Modules	
MU110001A	Power Supply Module AC/DC
MU110002A	High Power Supply Module AC
Options	
MU110010A-001	Up to 2.7G Dual Channel
MU110010A-071	CPRI Up to 5G Dual Channel
MU110010A-072	CPRI 6G to 10G Single Channel
MU110010A-073	CPRI 6G to 10G Dual Channel
MU110011/13A-071	CPRI/OBSAI Up to 10G Single Channel
MU110011A/13A-072	CPRI/OBSAI Up to 10G Dual Channel
MU110010A-051	OTN 10G Single Channel
MU110010A-052	OTN 10G Dual Channel
MU110011A/13A-053	OTN 40G Single Channel
MU110011A/13A-054	OTN 40G Dual Channel
MU110011A/13A-055	OTN 100G Single Channel
MU110013A-056	OTN 100G Dual Channel
MU110010A-061	ODU Multiplexing
MU110010A-062	ODU Flex
MU110011A/13A-061	ODU Multiplexing
MU110011A/13A-062	ODU Flex
MU110011A/13A-063	40G/100G ODU Multi Stage
G0306B	Video Inspection Probe
G0382A	Autofocus Video Inspection Probe

Note: Screenshots in this application note are from the MT1000A. The MT1100A has similar screens.

Anritsu envision : ensure

Specifications are subject to change without notice.

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