Optic Nodes
1 GHz GX2 High Density Headend Optics
1 GHz SG4000 Segmentable Optical Node
1 GHz BT Amplifier
1 GHz SSP System Passive
1 GHz MB Amplifier
1 GHz BLE Amplifier
1 GHz FFT Tap

Broadband Access Networks Product Portfolio
Enabling Network Convergence and Seamless Mobility
TX/RX PLATFORM
Optical Broadband Transmission Platform

- High Module Density
  - 16 application modules in 4 rack-unit chassis
    - With Quad Return Receiver module, 64 receivers in 4RU
- Universal Platform
  - Full compliment of optic and RF modules available for GX2 to ease ordering/inventory and training
- Leading 1310nm and 1550nm Performance
  - Motorola’s traditional strength in 1310nm and 1550nm technology
- Intelligence
  - Every module contains high-performance microprocessor enabling a highly integrated design and smarter functionality.

Quick-Swap Module Configuration when exchanging modules
Optical Broadband Transmission Platform

- 4U Rack Mount Chassis
- Up to 16 Single-Wide Application Modules
- Control Module
- 1 or 2 AC or DC PS modules

- 2U Rack Mount Chassis
- Up to 3 Application Modules
- Control Module
- 1 AC Integrated Power Supply
- Integrated display
OMNISTAR GX2
SHELF DISPLAY ON HINGED DOOR (OPTIONAL)

CONTROL MODULE W/ ETHERNET

FIBER CONNECTOR

CONFIGURABLE BACKPLANE WITH BLIND-MATE RF CONNECTORS

POWER MODULES W/ FANS

FIELD REPLACEABLE FANS (on modules)

TYPICAL TX
Select Modules

GX2-LM1000E

- 1310nm Broadcast Tx
- 47MHz to 1 GHz
- 2-15dBm
- 2 RF Test Points
- Automatic Gain Control AGC
- Anti-clipping circuitry

GX2-RX200BX2

- Dual Return Receiver
- 2 independent receivers
- RF output is 34-52 dBmV
- Integrated Gain Control

GX2-EM1000

- 1550nm Broadcast Tx
- Proprietary amplitude modulation technique
- Advanced optical linearization

GX2-OA100B

- Erbium-Doped Fiber Amp
- Optical Output Powers: +13, +16, +18, +20, +22, +21x2
- 3 Operating Modes
- Flat gain in red band

GX2-DM1000

- DWDM Narrowcast Tx
- 40 ITU wavelengths available
- High output power: +10 dBm

GX2-RX200X4

- Quad Return Receiver
- 4 independent receivers
- Highest density in the industry (16 RX/RU) - provides up to 64 independent optical return path signals in a 4RU GX2 chassis
- Expanded optical input level range (-18dBm to +2dBm) supports additional return path combining and splitting
- Two mid-stage gain control modes:
  - AGC based on optical input level
  - Manual Gain Control
- Muting feature enables redundancy for each independent receiver; No external RF Switch Module required
- Communication between redundant receiver modules uses standard Ethernet cross-over cable
Key Features:
- 1GHz Operating Bandwidth (47-1002 MHz)
- Low RF Input Level: +17dBmV
- Link distances up to 100km
- Automatic Gain Control
- RoHS compliant
- PON version with +20dBm SBS Threshold
- Leading performance: Performance for 65km link

<table>
<thead>
<tr>
<th>Test Load</th>
<th>Carrier to Noise Ratio</th>
<th>Composite Second Order</th>
<th>Composite Triple Beat</th>
<th>Cross Modulation</th>
</tr>
</thead>
<tbody>
<tr>
<td>79 analog</td>
<td>53.5 dB Min.</td>
<td>-66 dBC Max.</td>
<td>-66 dBC Max.</td>
<td>-56 dB Max.</td>
</tr>
<tr>
<td>79 analog + 320 MHz Digital</td>
<td>52.5 dB Min.</td>
<td>-66 dBC Max.</td>
<td>-66 dBC Max.</td>
<td>-59 dB Max.</td>
</tr>
<tr>
<td>79 analog + 450 MHz Digital</td>
<td>52.0 dB Min.</td>
<td>-66 dBC Max.</td>
<td>-66 dBC Max.</td>
<td>-59 dB Max.</td>
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</tbody>
</table>
• Increases downstream services by up to 5x over a single fiber and enables 1GHz operating bandwidth
• Mitigates Raman crosstalk and enable links up to 25km though an innovative, exclusive RF conditioning technique ("Magic Box")
• Utilizes standard ITU CWDM wavelengths in 1.3um window
• Offers simplicity and ease of use through Motorola’s GX2 platform
• Is Operationally friendly – minimal set-up, equipment is interchangeable and interoperable with existing nodes
GX2-LC1000E Transmitters

AM-MUX-CWDM*
LGX Mux (2λ, 5λ)

MC-MUX-CWDM*
Mini-Cassette Mux module (5λ)

R1U-ECWDM Conditioning Unit
What is Fiber Deep?
Why Fiber Deep?
What is Fiber Deep?

- There is a suite of solutions that enable MSO’s to expand network capacity, deliver higher bandwidth per subscriber and reduce node serving areas
  - Node segmentation
  - Node to hub migration
  - Amplifier to node conversion
  - Multi-wavelength solutions

- Solutions allow customers to maximize valuable fiber resources
  - Fiber reclamation is catalyst for new revenue growth
Amplifier to Node conversions

- Reduced actives in the network provide additional benefits
  - lower operating expenses
  - maximize initial investment

- Minimizes network disruption

- More cost effective than N+0

- Incremental fiber expansion prepares HFC networks for transition to PON
Benefits of Fiber Deep

- Do not cut out
- Rebirth of the Amplifier
- As fiber is pushed deeper, reutilize existing installations
- Where is the “sweet spot” for operators
- Greenfield and Brownfield with GaN technology
Benefits of Fiber Deep Deployment
Amplifier to Node conversions

- New nodes that drop-in to existing amplifier housings locations.
- Allows fiber deep migration with minimal downtime and cost.
- New fiber is need only need from existing node to new satellite node
- Existing coax and power supplies can be used for powering.
- Allows seamless migration to 1 GHz.
Deployment Case of Amp-to-Node

AM-MBR 750 MHz

MBN100 1000 MHz

Fiber Entry Flexibility
• Complements Motorola’s high performance 1310nm Transmitter Family (GX2-LM1000E)
• Offers a cost reduction relative to GX2-LM1000E (~ 20% - 30%)
• Specifies appropriate performance levels for Fiber Deep (N+3 or less) and reduced analog channel loading (N+4 or less)
• Available

<table>
<thead>
<tr>
<th>Key Features</th>
<th>GX2-LM1000S</th>
</tr>
</thead>
<tbody>
<tr>
<td>CNR</td>
<td>51dB</td>
</tr>
<tr>
<td>CSO/CTB/XMOD</td>
<td>63dBC</td>
</tr>
<tr>
<td>Optical Powers</td>
<td>2, 4, 6, 8, 10, 11, 12 dBm</td>
</tr>
<tr>
<td>NC input port</td>
<td>No</td>
</tr>
<tr>
<td>Laser Drive Mon Port</td>
<td>No</td>
</tr>
<tr>
<td>RoHS Compliant</td>
<td>Yes</td>
</tr>
<tr>
<td>Pricing</td>
<td>~ 0.75X (relative to LM1000E)</td>
</tr>
</tbody>
</table>
### Benefit
- Provide up to 8 unique downstream content lineups over a single fiber to segment fiber deep networks
- With Optical Amplification, satisfy link distances up to 40km.

### Key Product Features for EA1000
- Operating Bandwidth: 52-1003 MHz
- Output Power: +6 dBm
- 8 DWDM ITU Wavelengths for Fiber Deep
- Main and Secondary RF Input Ports
- Gain modes: Preset (AGC), Set (AGC), Manual
**GX2-EA1000 Use Cases**

### Fiber Deep: Analog + Digital

![Diagram of Fiber Deep: Analog + Digital](attachment:image)

**Loading:** Analog 79ch, 50-550MHz + Digital 550MHz to 1GHz

**Distance:** 2 to 30km

**Optical Loss:** Up to 7.5 dB @ 1550nm

### Fiber Deep: Digital Only

![Diagram of Fiber Deep: Digital Only](attachment:image)

**Loading:** Only - Digital 50MHz to 1GHz, 256 QAM

**Distance:** 2 to 40km

**Optical Loss:** Up to 10 dB @ 1550nm
- 60 dBmV Node Outputs – Full Digital
- Seamless Bandwidth upgrades
- Ideal for N+0, N+1
- Better ESD “Silicon like”
- 22% CAPEX reductions
- 18% OPEX reductions
  - Based on N+2 estimates

SG4000

- **Silicon**
  - 55 dBmV @ 870 MHz

- **GaAs**
  - 55 dBmV @ 1 GHz

- **E-GaAs**
  - 58 dBmV @ 1 GHz

- **GaN**
  - 60 dBmV @ 1 GHz
**SG4000 Fiber Deep Continuum**

Supporting past, present and future architectures

- **HFC**
- **1 GHz**
- **HUB**
- **1550 Overlay**

**Business Services**

- **Ethernet**
- **RFoG**
- **CablePON**
- Analog CWDM 2mW DFBT
  - 16 wavelengths
  - 5-85 MHz supports “N” Split
    - higher RF BW than Aurora digital return
  - NODE-CWDM-* enables single fiber operation ITU
  - 40 ITU wavelengths
- Digital 2X TDM 8 dBm ITU
  - 40 ITU wavelengths
  - 5-65 MHz
  - Lower cost CWDM & 1310 versions
- Analog DWDM 8 dBm
  - 5-200 MHz Split
  - NODE-DWDM-* enables single fiber solution
• Advanced modules to enable advanced network architecture migration
• SG4-OA* Optical Amplifier
  – Extends the reach of optical signals
  – High-power 13, 16 and 19 dBm EDFA’s
  – Gain-flattened for optimum DWDM performance
• SG4-OSW Optical Switch
  – Latching optical switch
  – Provides route redundancy
  – Automatic or manual switching
Advanced modules to enable advanced network architecture migration

- **SG4-OA* Optical Amplifier**
  - Extends the reach of optical signals
  - High-power 13, 16 and 19 dBm EDFA’s

- **SG4-OSW Optical Switch**
  - Provides route redundancy
  - Automatic or manual switching
- Enables RF regeneration in the node for RFOG and fiber deep architectures.
  - High sensitivity input to achieve higher return link budgets
  - Enables greater fiber and wavelength aggregation
  - Status monitoring through the LL-SG4-DOCSIS transponder
Serve multiple RFoG groups over 1 or 2 fibers
- Up to 256 subscribers served (versus 32 subs for direct feed)
- Optical amplification in the node allows 1X64 splitters
- Multiple return path signals are RF combined or optically combined

Increases link distance to 35km or longer (versus 20km maximum for direct feed)
Updated Optical Passives
Supporting multi-wavelength deployments

- Phase 1 project initiated to standardize optical passives for nodes and Headend LGX

- Included
  - Couplers, WDM, CWDM, E-CWDM, DWDM, RFoG, N1U, OBS, AMUX, BMUX

- Key Improvements
  - Includes all wavelength windows
    - Wider E-CWDM 1310 band
  - Reduce Insertion losses
    - Increased link budgets
  - Standard, smaller cassettes to fit inside new nodes
  - Common fiber bulkhead connector
  - Standard 2 mm jacketing
- Low cost 4 output node 1 GHz
- Easily converts existing amplifier location to a node
- 55 dBmV output @ 1 GHz with -3 dBm input
- MBN transmitters
- DOCSIS Status Monitoring
- 2x RTN Segmentation
- FWD / RTN Redundancy
- Low cost 4 output node 1 GHz
- 55 dBmV output @ 1 GHz with -3 dBm input
- MBN DRT transmitters
- DOCSIS Status Monitoring
- 2x RTN Segmentation
- FWD / RTN Redundancy
- N split (85 MHz) solution for SG2000
- 2 output node
- Easily converts existing amplifier location to a node
- Full EPACK and Lid swap – utilizing existing MB base
- 55 dBmV output @ 1 GHz with -3 dBm input
- CWDM / DWDM return path transmitters
- DOCSIS Status Monitoring
- Modular Power Supply
**MBN200**

**Forward Segmentation**

- 3 output node
- Top/Bottom Segmentation
- Easily converts existing amplifier location to a node
- Full EPACK and Lid swap – utilizing existing MB base
- 55 dBmV output @ 1 GHz with -3 dBm input
- CWDM / DWDM return path transmitters
- DOCSIS Status Monitoring
- Modular Power Supply
Uses existing GX2-DRR-2X
- DWDM – 40 ITU wavelengths
- CWDM – 16 wavelengths
- 1310 nm
- Double wide module
- Fits into BTN and MBN nodes
- Lower pricing than the SG4
  - SG4 will be readjusted
- Limited Availability June 2010
- Smallest single output node
- Integrated 1 GHz forward optics
  - 46 dBmV @ 550 MHz w/ -3 dBm
  - Maintains original BLE output and performance
- Plug-in return transmitters
  - 1310 or CWDM transmitters
  - WDM for single fiber operation
- 60/90 Volt powering
  - Dedicated power port w/ RF Termination
BLN100 Broadband Line Node

- Power LED
- Integrated optical receiver
- Plug in return transmitter
- Fiber management
SG1000 1 GHz Compact Node

Non-redundant fiber deep node

- Compact, high output node for fiber deep architectures
  - 16.1”(L) x 9.8”(W) x 5.6”(D)
  - Strand or pedestal
- Two high-gain E-GaAs RF outputs
  - Splitter enabled third output
- Straight-forward design simplifies installation & maintenance
**N2U-OA300 High Power Optical Amplifier**

- **Various Ports and Power Levels:**
  - 16 ports @ +21dBm
  - 8 ports @ +18dBm
  - 16 ports @ +10.5dBm

- **Dual DC power supplies or Dual AC power supplies**

- **Option with Integrated WDM ports for RFOG or PON**
  - 1 WDM for every output port
  - Save rack space – Don’t need separate WDM modules
  - Reduce insertion losses compared to discrete WDM’s
Benefits

- Enables longer link distances
- Allows 1:128 split for RFoG in Return-Path
- Allows more RF combining into CMTS port which saves customers $$ on CMTS blades
- High-Density: 64 Return Rx in 4RU

Features

- Very low EINC allows Input power as low as -28dBm
- Receiver Optical Input power
- 5 – 85 MHz Bandwidth
Coexisting Ethernet and Residential Services
SG4-ENET-SW Ethernet Switch Module

Enables new revenue services for operators
- Business Services – ELAN, EPL, EVPL
- Cellular backhaul
- IP backhaul for Wi-Fi Access Points or cameras

Key features
- Aggregates customer Ethernet traffic
  - Saves Headend to node wavelengths – up to 5x savings
  - Combines multiple customers onto wavelength pair to Headend
- Operational simplicity
  - Simplifies Wavelength management for CPE
  - Less expensive CPE optics needed (no CWDM SFPs)
- Leverages installed base of equipment
  - Module fits into SG4 Optical Node
  - Integrates into existing Headend switch
- Standards based implementation
  - SFP optics
  - Interoperable with multi-vendor Headend and CPE Ethernet solutions
  - Passes MEF service traffic
(2) WAN SFP Ports
• Up to 1 Gbps for each port
• Supports LAN, redundancy, or link aggregation

(4) LAN SFP Ports
• Up to 1 Gbps for each port

(2) LAN RJ-45 Ports
• 10/100/1000 Mbps copper ports (RJ-45)
• Enables co-located IP devices

Power
• 11 watts per module
  • Comparable to SG4-R
  • Fully loaded with max. bandwidth
Multiple SG4-ENET-SW Mounting

Two NODE-ENET-SW in 2X2 SG4 Node Shown
Two NODE-ENET-SW in 2X2 SG4 Node Shown
• Deliver MEF certified services to business customer
  • EPL, ELAN, EVPL services
• The CPE device is managed by the operator
  • An “Ethernet service” can be provided to multiple customers
Multiple Fibers Available

No optical muxing required. Simplest and least costly equipment approach.
Optical muxing at the node conserves fiber.
Ethernet Coexists on Upstream HFC Fiber

All existing upstream traffic muxed together with Ethernet. Downstream HFC remains on separate fiber.
Network Management

Console Port
- Provides CLI access
- Provides mechanism to recover from lost passwords and IP addresses
- Not intended for normal unit installation and operation

RJ-45 Ports
- Provides local craft access
- Web, SNMP, and Telnet access

WAN and LAN SFP ports
- Provides in-band network management access
- Web, SNMP, and Telnet access
- Support for multiple trap destinations

Bulk Network Configuration
- Configurable for VLAN, QoS, Redundancy, Scheduling, & Security parameters
- Uses xml file
Questions