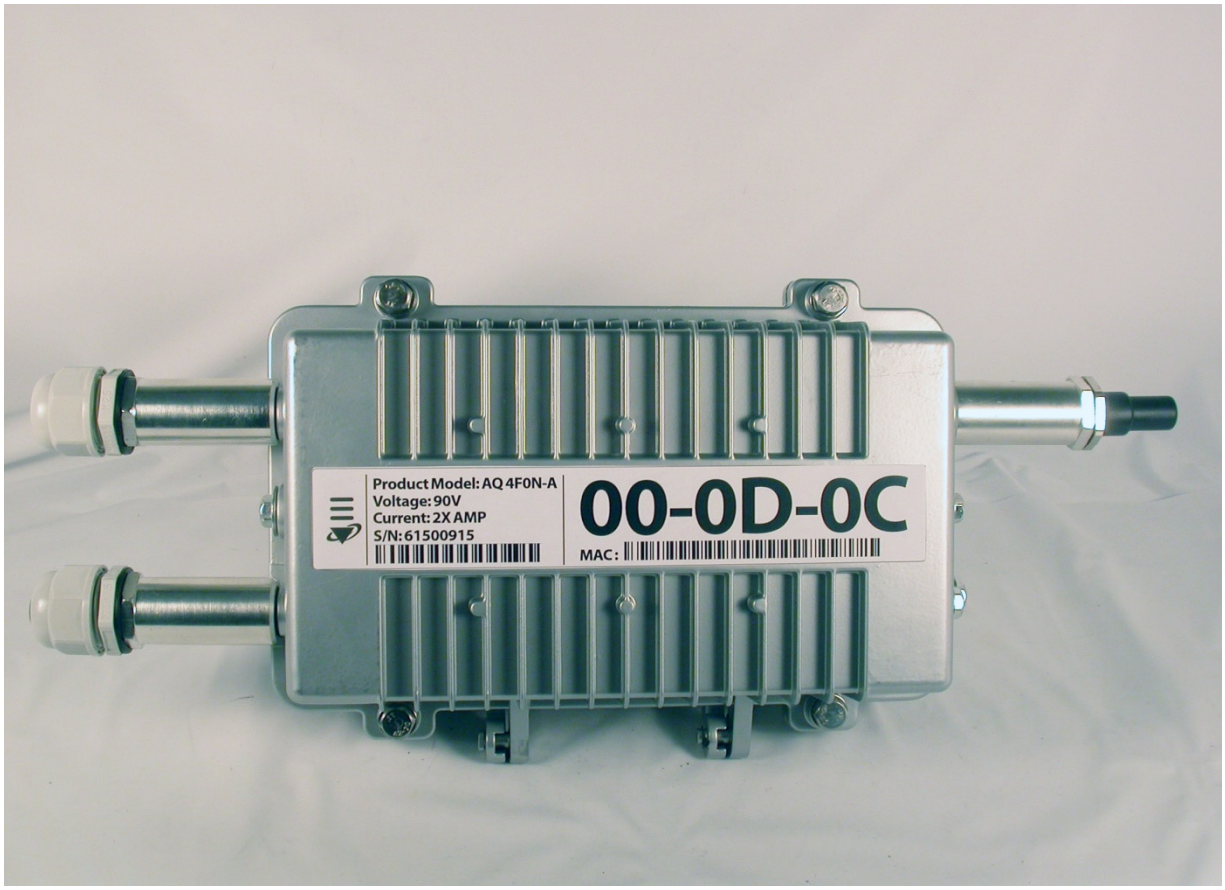
AQ4 Series DOCSIS® 3.1
3rd generation
Mobile Backhaul and Business Services

AQ4 Highlights

The AQ4 series Rugged Cable Modem is DOCSIS® 3.1 and EuroDOCSIS™ 3.1 compliant and is weatherproof and specially designed for installations where temperatures can be extreme, uncontrolled, and typical of the outside plant in an HFC cable network. This cable modem is designed to withstand electrical over-voltages and surges commonly experienced in HFC network outside plant. It is also designed to withstand high powered LTE cells at close proximity. It eliminates LTE frequencies getting into the HFC network. It has an optional built in MEF Compliant Carrier Ethernet Demarcation Device.



Cable Modem Features

- Designed for DOCSIS® & EURODOCSIS™ specifications
- Network Monitoring - Embedded Spectrum Analyzer
- For D3.1, 32x8 channels and 2x2 OFDM bonded channels
- Support for BSOD and L2VPN
- Support switching between Transparent Bridge mode and Router mode (OpenWRT) through a software switch
- Dual PAD (US & DS) system
- Adjustable DS slope with Cable Simulator module
- Specialized Ethernet Receptacle that reduces RF interference
- Watchdog module that monitors Cable Modem health and resets unit when problem is detected. This reduces truck rolls.
- Strand, wall, pedestal, mast, pole and vault mounting. Optional brackets are available
- Up to two (2) filtered 10/100/1000 BASE-T auto sensing / auto-MDIX Ethernet ports

- Power over Ethernet (up to IEEE802.3bt) Gigabit interface for attached Ethernet devices with remote power recycle option
- Maximum power available on PoE ports is 120Watts shared on 2 Ethernet ports. Capability of limiting and locking PoE power to IEEE802.3at at factory
- HFC cable powered, 42 to 100 VAC
- Maximum power consumption scenarios (using 100meters Ethernet cable):
    - CM only: 23.1 Watts
    - CM + 1 port IEEE802.3at: 57.8 Watts
    - CM + 2 ports IEEE802.3at: 93.1 Watts
    - CM + 1 port IEEE802.3at + 1 port IEEE802.3bt: 163.7 Watts
- Temperature Hardened and weather proof IP-67 rated housing.
- Optional GNSS Receiver for geo-location purpose
- Optional Ethernet Demarcation Device (EDD NID)
- Optional strand mount brackets for horizontal or vertical mounting

Electroline Specific and Unique Features

1. Superior Radio Frequency Interference (RFI) Isolation: over 130dB

1.1. Ethernet RFI Enhanced Port: A special patented design that filters noise coming from Small Cells and getting inside the AQ housing, and thus into the HFC network.

1.2. Ethernet termination: a shielded Ethernet cable is terminated inside the Ethernet receptacle and the proper grounding of the Ethernet cable shield.

1.3. Specific design to isolate the different sections of the outdoor housing from each other in order to reduce or eliminate the interference between each other. These sections are the Power Supply, HFC plant RF and the Ethernet.

2. **Electroline Intelligence (EI) for our Cable Modem: Reduce truck rolls.** Electroline has implemented many levels of protection to ensure that the Cable Modem remains functional in case of a failure. These EI system will reduce maintenance and truck rolls. There are 5-tiers EI:

    2.1. A Firmware Watchdog system designed to reboot the CM engine if an internal error is detected.

    2.2. A Hardware Watchdog system that will reset the complete CM. With the help of a special Chipset added to the CM, the Electroline EI code running in the CM will monitor the health of the CM and reset the CM if it finds any malfunctions.

    2.3. An SNMP watchdog. The EI in the CM is set to reset the CM if there are no SNMP activity detected during a certain period of configured time.

    2.4. An RF watchdog: The EI code in the CM will reset the CM if it becomes offline after a certain configured time.

    2.5. An RF scanning watchdog: The EI code in the CM will reset the CM if after 5 DS scanning cycles no DOCSIS carrier is found

3. Ruggedized Architecture: Our ruggedized product is among the leaders in the industry

3.1. Industrial Components used: Most critical parts used on the CM are rated for Industrial specifications

3.2. Specialized RF Front End: Modularized Diplexer for future band-split changes; Separate PADs to adjust power levels (attenuation) on downstream and upstream direction; Adjustable downstream slope (Cable Simulator); Downstream Test Point (TP 20 dB).

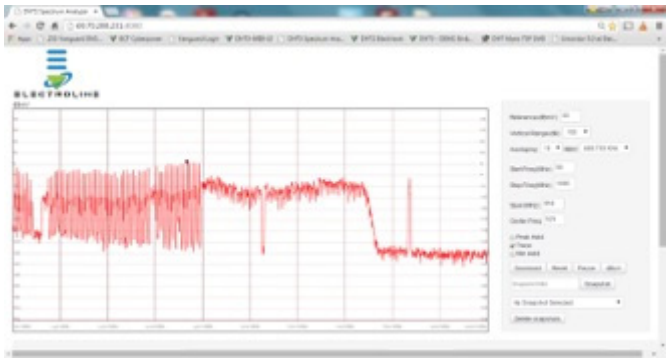
3.3. Troubleshooting Tool: A special Electroline developed integrated spectrum analyzer with a precision of 1 dB at typical temperatures; temperature sensor integrated in CM to compensate the values reported by different temperature readings.

3.4. Individually calibrated with specific calibration points for improved accuracy.

3.5. Temperature hardened: Tested at -40 to 60 degrees Celsius.

3.6. Water/Dust Ingress Protection Rating: IP-67 rated.

3.7. MSO OPEX optimized: Through the EI implemented in the CM and its ability not only to self reset, but also remotely control the power on any attached CPE device on its PoE ports.

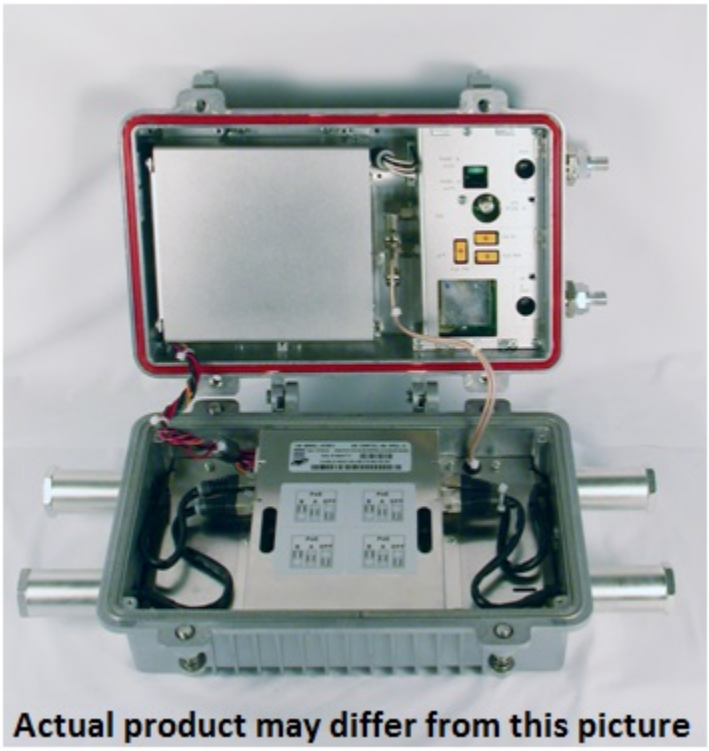


4. Customer Service Level Agreement (SLA) requirements and Business Services support:

4.1. Integrated Carrier Ethernet Demarcation Device (EDD) that is MEF CE2.0 compliant. This device is able to provide IEEE and ITU standards based loop-back testing and performance monitoring that are requested by MNOs. (RFC 2544, ITU-T Y.174 and Y.1731)

4.2. Business Services over DOCSIS® (BSoD) support. Capability to map different SLAs on specified Layer 2 DOCSIS® Tunnels (L2VPN) based on packet differentiating factors. These factors are:

- 4.2.1. VLAN Tags (IEEE802.1q)
- 4.2.2. IP addresses
- 4.2.3. IP Differentiated Services Code Points (DSCP)
- 4.2.4. UDP/TCP port numbers



5. Modular and Scalable architecture: A customer focused product

5.1. DOCSIS® 3.0 or 3.1 Cable Modem.

5.2. Scalable design with options for 1-port, 2-ports and 4-ports PoE+ interfaces.

5.3. Factory configuration option for an integrated Carrier Wi-Fi radio module within the housing: Exists today with centrally managed Wireless controllers.

5.4. Additional features include:

- 5.4.1. Strand, wall, pedestal, pole mounting options.
- 5.4.2. 100% Electroline designed and Cablelabs® certified Cable Modem.

Embedded DOCSIS® & EURODOCSIS 3.1 Cable-Modem Specifications

Upstream		
Frequency Range[1] (edge to edge) Full band: Switchable sub-band:	5-F_{US_MAX} 5-42 (for North America model) 5-65 (for EURO model)	MHz
Output Impedance	75	Ω
Maximum Transmit Level	(Total average power) +65	dBmV
Output Return Loss (across freq. range)	≥ 6	dB
SC-QAM channels		
Signal Type	TDMA, S-CDMA	
Number of Channels	8	max
Modulation Type	QPSK, 8 QAM, 16 QAM, 32 QAM, 64 QAM, and 128 QAM	
Modulation Rate (nominal)	TDMA: 1280, 2560, and 5120 S-CDMA: 1280, 2560, and 5120 Pre-DOCSIS3 operation: TDMA: 160, 320, and 640	KHz
Bandwidth	TDMA: 1600, 3200, and 6400 S-CDMA: 1600, 3200, and 6400 Pre-DOCSIS3 operation: TDMA: 200, 400, and 800	KHz
Minimum Transmit Level	P_{min} = +17 at ≤1280KHz modulation rate P_{min} = +20 at 2560KHz modulation rate P_{min} = +23 at 5120KHz modulation rate	dBmV
OFDMA channels		
Signal Type	OFDMA	
Maximum OFDMA Channel Bandwidth[2]	96	MHz
Minimum OFDMA Occupied Bandwidth	6.4 (for 25 KHz subcarrier spacing) 10 (for 50 KHz subcarrier spacing)	MHz
Number of Independently configurable OFDMA channels	2	
Subcarrier Channel Spacing	25, 50	KHz
FFT Size	50 KHz: 2048 (2K FFT); 1900 Maximum active subcarriers 25 KHz: 4096 (4K FFT); 3800 Maximum active subcarriers	
Sampling Rate	102.4 (96 MHz Block Size)	MHz
FFT Time Duration	40 (25 KHz subcarriers) 20 (50 KHz subcarriers)	µs
Modulation Type	BPSK, QPSK, 8-QAM, 16-QAM, 32-QAM, 64-QAM,128-QAM, 256-QAM, 512-QAM, 1024-QAM, 2048-QAM, 4096-QAM	
Bit Loading	Variable from minislot to minislot. Constant for subcarriers of the same type in the minislot. Support zero valued subcarriers per profile and minislot.	
Pilot Tones	14 data patterns and 2 subslot patterns, minislot subcarrier size and length dependent.	

Notes: (1) F_{US_MAX} determined by external diplexer. Maximum upstream frequency supported by SoC: 204 MHz.
(2) Not including external diplexer bandwidth limitation.

Downstream		
Frequency Range[1] (edge to edge)	F_{DS_MIN}-1218MHz	MHz
Input Impedance	75	Ω
Total Input Power	< 40	dBmV
Input Return Loss (across freq. range)	≥ 6	dB
SC-QAM channels		
Number of Channels	32	max
Level Range (one channel)	North Am (64 QAM and 256 QAM): -15 to +15 EURO (64 QAM): -17 to +13 EURO (256 QAM): -13 to +17	dBmV
Modulation Type	64 QAM and 256 QAM	
Symbol Rate (nominal)	North Am (64 QAM): 5.056941 North Am (256 QAM): 5.360537 EURO (64 QAM and 256 QAM): 6.952	Msym/s
Bandwidth	North Am (64 QAM/256QAM with α=0.18/0.12): 6 EURO (64 QAM/256QAM with α=0.15): 8	MHz
OFDM channels		
Signal Type	OFDM	
Maximum OFDM Channel Bandwidth	192	MHz
Minimum Contiguous-Modulated OFDM Bandwidth	24	MHz
Number of OFDM channels	2	
Frequency Boundary Assignment Granularity	25 KHz 8K FFT 50 KHz 4K FFT	
Subcarrier Spacing / FFT Duration	25 KHz / 40 µs 50 KHz / 20 µs	
Modulation Type	QPSK, 16-QAM, 64-QAM,128-QAM, 256-QAM, 512-QAM, 1024-QAM, 2048-QAM, 4096-QAM	
Variable Bit Loading	Support with subcarrier granularity Support zero bit loaded subcarriers	
Level Range (24 MHz min occupied BW) Equivalent Power Spectral Density to SC-QAM of -15 dBmV to +15 dBmV per 6MHz.	-9 dBmV/24 MHz to 21 dBmV/24 MHz	
Maximum average power per MHz input to the CM from 54 MHz to 1218 MHz	Let X = Average power of lowest power 24 MHz of modulated spectrum for demodulation Additional Demodulated Bandwidth, B_{DEMOD}: ≤ Min [X - 10*log(24) + 10; 21 - 10*log(24)] Additional Non-Demodulated Bandwidth, $B_{NO\text{-}DEMOD}$: ≤ Min [X - 10*log(24) + 10; 26 - 10*log(24)] For up to 12 MHz of occupied bandwidth (analog, OOB, QAM, OFDM) ≤ Min [X - 10*log(24) + 10; 21 - 10*log(24)] For all remaining bandwidth	dBmV/ MHz

Notes: (1) F_{DS_MIN} determined by external diplexer.

Power Consumption Scenarios

SKU1 = CM only
SKU2 = CM + 1 port IEEE802.3at
SKU3 = CM + 2 ports IEEE802.3at
SKU4 = CM + 1 port IEEE802.3at + CM + 1 port IEEE802.3bt

100 Meter Ethernet cable

Vin 90Vac	SKU1	SKU2	SKU3	SKU4
12V DC power	18	18	18	18
54V DC power	0.5	30	60	120
Total AC Watts	22.2	55.0	88.4	155.0
Total AC Amps	0.44	0.82	1.20	1.97

Short 5 Meter Ethernet cable

Vin 90Vac	SKU1	SKU2	SKU3	SKU4
12V DC power	18	18	18	18
54V DC power	0.5	26	52	98
Total AC Watts	22.2	50.6	79.5	130.6
Total AC Amps	0.44	0.77	1.10	1.69

Vin 60Vac	SKU1	SKU2	SKU3	SKU4
12V DC power	18	18	18	18
54V DC power	0.5	30	60	120
Total AC Watts	22.3	55.8	89.9	158.1
Total AC Amps	0.67	1.24	1.83	3.00

Vin 60Vac	SKU1	SKU2	SKU3	SKU4
12V DC power	18	18	18	18
54V DC power	0.5	26	52	98
Total AC Watts	22.3	51.2	80.8	133.1
Total AC Amps	0.67	1.16	1.67	2.57

Vin 45Vac	SKU1	SKU2	SKU3	SKU4
12V DC power	18	18	18	18
54V DC power	0.5	30	60	120
Total AC Watts	23.1	57.8	93.1	163.7
Total AC Amps	0.92	1.72	2.53	4.14

Vin 45Vac	SKU1	SKU2	SKU3	SKU4
12V DC power	18	18	18	18
54V DC power	0.5	26	52	98
Total AC Watts	23.1	53.1	83.7	137.8
Total AC Amps	0.92	1.61	2.31	3.55

Specifications are subject to change without prior notification.

For more information on our products, please visit: www.electroline.com or call: 800-461-3344