

M212 Master Clock System



The M212 Master Clock System, from Brandywine Communications, represents the next generation of modular timing systems. Built as a commercial derivative of the highly successful ruggedized Modular Master Clock, the M212 provides assured timing capabilities using Brandywine's Timewall™ technology.

FEATURES:

- ⊕ Modular design with multiple reference paths built-in for high-availability.
- ⊕ 6 expansion slots for customization and expansion.
- ⊕ Industry-first GNSS integrity checking with Timewall™
- ⊕ Unique optical crosslink architecture for either Master-Slave hierarchical setups or Master-Master crosschecking and failover
- ⊕ LCD display and keypad for basic status and configuration – secure web browser for detailed setup.

At the center of the M212 system is Brandywine's powerful Master Clock Module (MCM). The MCM may be synchronized by a variety of reference sources and uses the selected reference to steer an embedded oscillator, to provide stable and accurate time and frequency for the M212. Multiple references can be prioritized with automatic failover. Uniquely, the MCM's Timewall™ algorithms validate the GNSS reference based upon the inherent stability of the MCM oscillator, providing hardening against possible GNSS spoofing.

Available input reference selections include GNSS (both commercial GNSS and SAASM GPS receivers are supported), IRNSS (both L5 and S band implementations are supported), IRIG-B, and Have Quick/1PPS. In addition, an MCM may be synchronized to up to two other M212 chassis using a fiber optic crosslink, providing additional resiliency for the M212 time and frequency references.

The base oscillator in the M212 is a high quality Temperature Compensated Crystal Oscillator (TCXO), but optionally, the M212 can be ordered with other reference oscillator choices, including Rubidium, Chip Scale Atomic Clock (CSAC) and Ovenized Oscillator (OCXO).

The output signals for the M212 are generated by up to 6 Output Signal Modules (OSM), and are ideal for custom solutions or future expansion. Available outputs include low-phase-noise frequency, time codes such as IRIG A, B, G, H, and NASA 36, pulses including PPS, PPM, Have Quick, serial data (RS232/422) as well as an optical crosslink.

The M212 status and control is via front panel display for basic configuration and status, and via a secure web browser, and SNMPv3. Network protocols also fully support privacy and authentication.

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Typical M212 Chassis Rear View

Master Clock Module

All M212 configurations include a Master Clock Module (MCM), which provides the basic timekeeping and management functions of the M212.

Management Functions

The MCM is accessed either via the front display/keypad, which is typically used to configure one of two Ethernet ports. Typically one port is dedicated to management and control, and the second port is enabled only to support maintenance and upgrades, thus providing physical network security. The M212 includes provision for Information Assurance. All Network connections use both authentication and privacy corresponding to the protocol in use. Only required ports and protocols are enabled.

MCM Reference Inputs

GNSS Receiver (Standard)

Receiver Type	GNSS Multi-constellation (GPS, GLONASS, Galileo ¹ , BeiDou)
Sensitivity	Tracking: -159 dBm Acquisition -147 dBm
Accuracy	15ns (1 σ) (@ -130 dBm)
Connector Type	BNC J8

IRNSS Receiver (Optional)

Receiver Type	GNSS Multi-constellation (GPS, GLONASS, NavIC (L5+S band)
Sensitivity	Tracking: -153 dBm Acquisition: -145 dBm
Accuracy	15ns (1 σ)
Connector Type	BNC J8

SAASM GPS Receiver (optional)

Receiver Type	GB-GRAM Type II
Keyfill cable	5 pin Audio
Keyfill port	DS102
COM Port	DB9-F connector

External 1PPS Input

Signal Format	Per ICD-GPS-060B
Rate	1 pulse per second
Impedance	50 ohm
Connector Type	BNC J6B

External GPS Have Quick T/C Input

Signal Format	Per ICD-GPS-060A, STANAG 4246 HQ2A
Rate	1 frame per second
Impedance	10k Ω
Connector Type	DB9M J5A

External IRIG B Input

Signal Format	IRIG B Per IRIG 200-04
Control Functions	Per IEEE1344
Modulation ratio	2.5:1 to 3.3:1
Amplitude	1 Vp-p to 5Vp-p
Impedance	>600 ohm
Connector Type	DB9M J5A

Signal Reference Selection Menu

Up to 5 references may be selected and prioritized for the list below

- GNSS/IRNSS/SAASM
- IRIG B
- IRIG B + 1PPS
- Have Quick +1PPS
- 1PPS (requires manual time entry)
- Crosslink A
- Crosslink B
- NTP peer to peer

MCM Outputs

The MCM has a basic set of outputs available directly, without requiring additional modules

- Have Quick
- IRIG B DCLS + IEEE1344 CF
- 10 MHz sine wave
- RS232/RS422 Time of Day Output

¹ Requires firmware upgrade

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Status and Control

No of ports 2
 Port Type 10/100BaseT Ethernet
 Protocols Supported SNMP v3 RFC 3411, 3418
 NTP v4 RFC 5905 (IP v4, IP v6)
 HTTPS RFC2818

Alarm Relay
 Audible Buzzer Alarm

Oscillator Options

The M212 may be configured with one of three types of oscillator, depending upon price/performance desired. This option must be specified at time of order

		Rubidium	CSAC	OCXO	TCXO (std)
Time Locked	Accuracy Holdover 10 days	<5ns 2σ <10μs	<10ns 2σ <100μs	<12ns 2σ <500μs	<15ns 2σ <10ms
Frequency Locked	Accuracy Holdover	<1E-12 <2E-11/mo	<2E-12 <3E-13/mo	<1E-12 <3E-8/yr	
Temperature	- 0 to 50°C	<1E-10	<5E-10	<2E-9	
Reference Error	Detection Sensitivity	<2E-10	<1E-9	<1E-8	<10E-6

Environmental

Power

AC Supply Voltage 90-265 VAC 50/60 Hz. 100W Maximum

Physical

Length (depth) 20.00"
 Width 17.00" Chassis Width
 19.00" Front Panel Width
 Height 1.72" 1U chassis
 Weight 10 lbs

Temperature

Air Temperature -20°C to +55°C
 Altitude Conditions -1500 ft to +11,000 ft

Shock and Vibration

Operating Shock MIL-STD 810F 20g/11ms
 Bench Handling Shock MIL-STD 810F
 Vibration MIL-STD-167-1
 Structure-borne Noise MIL-STD-740-2

EMC

FCC Part 15, Class A
 IEC CISPR 22
 CE

Output Signal Modules

The flexibility of the M212 system is achieved by combining a number of available Output Signal Modules (OSM) to the basic Master Clock Module. Up to 6 OSMs may be installed at the time of order to extend the capacity and function of the M212.

Universal Output Signal Module

The Universal OSM provides the ultimate in flexibility. The Universal OSM has 4 outputs, each of which is user-programmable to a wide variety of time code or pulse outputs. This flexibility ensures that an M212 can be reconfigured as requirements change, and fewer modules are needed in comparison to designs where modules are single function. Each output is individually adjustable for propagation delay, ensuring that for high accuracy synchronization different cable lengths can be accommodated.

Specifications:

Pulse-per-second/minute

1PPS Rate	1 pulse per second
1PPM Rate	1 pulse per minute
Rising Edge	On Time
Rise Time	<10ns
Fall time	<100ns
Pulse Width	20 μ s \pm 5% default.
Amplitude	5V \pm 10% into 50 Ω
Output condition	when TFOM<7 only

Have Quick Time of Day Output

Signal Format	Per ICD-GPS-060A
Rising Edge	On Time
Rise Time	<100ns
1PPS coherence	< 100ns of rising edge
Amplitude	5V \pm 5%
Output condition	when TFOM<7 only

BCD Time Code Output

Signal Format	Per ICD-GPS-060B
Rate	50 bits/sec
1PPS coherence	< 100ns of rising edge
Mark (logical 1)	+2.5V \pm 1V
Space (logical 0)	-2.5V \pm 1V
Output condition	when TFOM<7 only
Connector Type	3 Pin (Consult factory)

IRIG Time Code Output

Signal Format	B002, B004, B120, B122, B124 (Consult factory for other formats)
Control Functions	B124 per IEEE1344
Rate	1kHz modulated
Modulation ratio	10:3 \pm 10%
Amplitude	5V _{p-p} \pm 20%
Output condition	when TFOM<7 only

2137 Time code Output

Signal Format	2137
Carrier	1kHz modulated
Modulation ratio	10:3 \pm 10%
Amplitude	5V _{p-p} \pm 20%
Output condition	when TFOM<7 only

XR3 Time code Output

Signal Format	XR3
Rising Edge	On Time
Rise Time	<100ns
1PPS coherence	< 100ns of rising edge
Amplitude	5V \pm 5%
Output condition	when TFOM<7 only

Propagation delay compensation

Applicability	All 4 outputs individually
Range	\pm 0 – 1ms in 5ns steps

Low Phase Noise Analog OSM

The Analog Low Phase Noise Module provides 4 low phase noise reference frequency outputs at 5, or 10MHz. The OSM incorporates a clean-up OCXO that is phase-locked to the MCM oscillator which must be OCXO, CSAC, or a Rubidium oscillator.

Specifications:

Waveform	Sinusoidal	
Amplitude	13 \pm 2 dBm/1V _{rms}	
Harmonics	-40dBc	
Non Harmonic	<-80dBc 10k - 500MHz	
Connector Type	Coaxial, BNC	
Accuracy	Locked to MCM oscillator	

Phase Noise dBc/√Hz	10MHz	5MHz
1Hz	-90dBc	-95dBc
10Hz	-120dBc	-125dBc
100Hz	-145dBc	-148dBc
1kHz	-155dBc	-155dBc
10kHz	-158dBc	-158dBc

5MHz Output OSM

The 5MHz output OSM provides 4 reference frequency outputs at 5 MHz. The OSM buffers and distributes a 5MHz signal that is generated directly on the MCM. The stability and accuracy will reflect those of the selected MCM oscillator.

Specifications:

Waveform	Sinusoidal
Amplitude	13 ±2 dBm/1V _{rms}
Harmonic	-35dBc
Non Harmonic	<-65dBc 10k - 500MHz
Connector Type	Coaxial, BNC
Accuracy	Locked to MCM oscillator
Stability	Same as MCM oscillator

10 MHz Output OSM

The 10MHz output OSM provides 4 reference frequency outputs at 10MHz. The OSM buffers and distributes a 10MHz signal that is generated directly on the MCM. The stability and accuracy will reflect those of the selected MCM oscillator.

Specifications:

Waveform	Sinusoidal
Amplitude	13 ±2 dBm/1V _{rms}
Harmonic	-35dBc
Non Harmonic	<-65dBc 10k - 500MHz
Connector Type	Coaxial, BNC
Accuracy	Locked to MCM oscillator
Stability	Same as MCM oscillator

NTP Server OSM

The NTP Server module enables the Master Clock System to act as an NTP server over an Ethernet network. Designed with security in mind, the NTP server module uses a custom network stack that enables it to ONLY act as an NTP server, and prevent it from being used as a gateway to compromise the entire system.

Specifications:

Signal Format	Ethernet 10/100BaseT
Protocols	NTPv3 RFC1305 NTPv4 RFC 5905
Authentication	MD5, SHA-1
Connector Type	RJ45
No of Outputs	2

PTP Grandmaster OSM

The PTP Server module enables the Master Clock System to act as a Precise Time Protocol (PTP) Grandmaster over an Ethernet network. The PTP OSM is fully compliant with the PTP protocol, and is capable of providing time synchronization for up to 256 clients. Designed with security in mind, the PTP server module uses a custom network stack that enables it to ONLY act as a PTP server, and prevent it from being used as a gateway to compromise the entire system.

Specifications:

Signal Format	10/100/1000BaseT
Protocols	PTPv2 (IEEE1588-2008)
Resolution	8ns packet timestamp resolution
Accuracy	20ns 3σ (crossover cable)
PTP Profiles	Default, Telecom, Enterprise, Power
Modes	Unicast, Multicast
Connector Type	SFP
Management	Web GUI
No of Outputs	2
Max no of cards	3

Extended Performance PTP Grandmaster OSM

The Extended Performance PTP Server module enables the Master Clock System to act as a Precise Time Protocol (PTP) Grandmaster over an Ethernet network. The PTP OSM is fully compliant with the PTP protocol, and is capable of providing time synchronization to up to 1024 clients. Designed with security in mind, the PTP server module uses a custom network stack that enables it to ONLY act as an NTP server, and prevent it from being used as a gateway to compromise the entire system.

Specifications:

Signal Format	10GbE
Protocols	PTPv2 (IEEE1588-2008)
Resolution	8ns timestamp resolution
Accuracy	20ns 3σ (crossover cable)
PTP Profiles	Default, Telecom, Enterprise, Power
Transmission	Unicast, Multicast
Connector Type	SFP
Management	Web GUI
No of Outputs	2
Max no of cards	2

Optical Crosslink OSM

The Optical Crosslink Module is a unique feature of the M212. When installed, it allows a second M212 to be synchronized as a slave chassis. If both chassis have a primary reference installed (e.g. GNSS) then the two MCM's operate as peers. Peering provides additional redundancy, as well as providing additional references to detect failures.

When a duplex cable is provided, the optical link provides seamless and automatic propagation delay compensation. A security mode allows the optical link to be operated in a single direction from Master to Slave over a single fiber.

Specifications:

Connector Type LC
No of Outputs 2 bi-directional per OSM

Synchronization Accuracy

Phase Measure Accuracy 1ns
End to End Accuracy <5ns synchronization

Optical

Wavelength Single Mode 1300nm
Safety Class 1 CDRH/IEC 825
Range² 2000m 9/125um cable

1 PPS Distribution Module

The 1PPS Distribution Module provides four 1PPS outputs. The OSM buffers and distributes a 1PPS signal that is generated directly on the MCM. The stability and accuracy will be those of the selected MCM. The propagation delay compensation feature is not available on this OSM.

Specifications:

Rising Edge On Time
Rise Time <15ns
Fall time <60ns
Pulse Width 20 μ s \pm 5% default.
Amplitude 10V \pm 10% into 50 Ω
Source impedance link selectable 50 Ω /lowZ

Octal Distribution Module

The Octal Distribution Module provides up to eight RS232 or RS422 output ports that can be used to broadcast a time of day message. All output formats are identical, and selected at the MCM. One channel can be dedicated as an input channel to provide the MCM with a NMEA \$GGA message as an input timing reference. Selection of RS232/422 is available on a per channel using user-installed push on links

Specifications:

No of channels 8
Connector Type 62pin D receptacle
Electrical RS232
RS422/485
Channel selection push on link
Input channel format NMEA \$GGA

Modulated Time Code Distribution Module

The Modulated Time Code Distribution Module provides four AC modulated time code outputs. The OSM buffers and distributes the same time code signal that is generated directly on the MCM. The stability and accuracy will be those of the selected MCM. The propagation delay compensation feature is not available on this OSM.

Specifications:

Time Code Output
Signal Format B120, B122, B124, 2137
(Consult factory for other formats)
Control Functions B124 per IEEE1344
Rate 1kHz modulated
Modulation ratio 10:3 \pm 10%
Amplitude 5V_{p-p} \pm 20%
Load impedance >50ohm

Fiber Optic Time Code Distribution Module

The Fiber Optic Time Code Distribution Module provides two outputs of AC modulated time code over fiber. The OSM buffers and distributes the same time code signal that is generated directly on the MCM. The stability and accuracy will be those of the selected MCM.

Specifications:

Time Code Output
Signal Format B120, B122, B124 2137
(Consult factory for other formats)
Control Functions B124 per IEEE1344
Rate 1kHz modulated
Modulation ratio 10:3 \pm 10%
Connector LC type

Fiber Optic Time Code Input Module

The Fiber Optic Time Code Input Module provides 2 selectable inputs of AC modulated time code. One input is for a fiber input; the second input is for an electrical input. Selection between the two is provided by a rear panel switch. The use of this module allows the standard M212 Modular Master Clock to receive alternative sources of Time Code for synchronization.

Specifications:

Time Code Input
Signal Format B120, B122, B124 2137
(Consult factory for other formats)
Control Functions B124 per IEEE1344
Rate 1kHz modulated
Input Connector (fiber) LC type
Input Connector (electrical) BNC (female)
Modulation ratio (electrical) 2.5:1 to 3.3:1
Amplitude (electrical) 1 Vp-p to 5Vp-p
Impedance (electrical) >600 ohm

² Consult Factory for longer range or multimode

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T1/E1 OSM

The T1/E1 OSM provides sixteen Framed T1/E1 outputs. Each output may be selected independently. The stability and accuracy will be those of the selected MCM oscillator.

Specifications:

Waveform (T1)	DS1 framed all ones, SF, D4, ESF, SSM support
Waveform (E1)	E1 framed all ones, CRC4 and CAS multiframe SSM support
No of outputs	16
Impedance	software selectable
Standards	ANSI T1.102, T1.403 ITU-T G.703
Short/Long Haul	User programmable
Connector Type	62pin D receptacle
Breakout Panel / Cable	1U Panel / 36" Cable
Breakout connector	RJ45
Accuracy	Locked to MCM oscillator
Stability	Same as MCM oscillator

Have Quick Distribution Module

The Have Quick Distribution Module provides four Have Quick time code outputs. The OSM buffers and distributes a Have Quick signal that is generated directly on the MCM. The stability and accuracy will be those of the selected MCM. The propagation delay compensation feature is not available on this OSM.

Specifications:

Format	ICD-GPS-060A
Signal Format	Per ICD-GPS-060A (Consult factory) STANAG 4430 HQ2A
Rising Edge	On Time
Rise Time	<100ns
1PPS coherence	< 100ns of rising edge
Amplitude	Logic 1 2.4Vmin Logic 0 0.25V max

BCD Time Code Output OSM

The BCD time code OSM provides four BCD time code outputs. The OSM buffers and distributes a BCD signal that is generated directly on the MCM. The stability and accuracy will be those of the selected MCM. The propagation delay compensation feature is not available on this OSM.

Specifications:

Format	ICD-GPS-060B
Signal Format	Per ICD-GPS-060B 40 bits
Rising Edge	On Time
Rise Time	<100ns
1PPS coherence	< 100ns of rising edge
Electrical	Per RS422/485

TIMEWALL™ ASSURED TIMING PROTECTION

TimeWall™ is Brandywine's technology initiative to ensure that every device receiving time of day from a Brandywine time server has the correct time and that the time server is performing multiple crosschecks to ensure that the time of day is correct, even if



GNSS is currently being subjected to jamming or spoofing. With the next generation of information warfare at hand, a determined opponent can use GNSS spoofing to drag a ship off course, disrupt train scheduling, or even cause power outages. Brandywine's unique TimeWall™ protection offers a way to ensure that timing is not disrupted in the event of a spoofing or jamming attack.

Other Modular Timing Systems

The Brandywine Communications family of modular time and frequency systems offer superior performance, a wide range of option choices, and ease of design.

Applications for the modular family include data acquisition and telemetry system support, network synchronization, Video annotation, time stamping, displays for hospitals and public buildings, and military applications. Our modular timing systems are qualified for shipboard, airborne, and land mobile applications.

Modular Master Clock - Ruggedized, secure redundant master clock with touch screen display

HPTS - High Performance Timing System with High Connector Density for Airborne and Land-Based Applications

M212 - Next-generation modular timing system with Timewall™ GPS integrity checking.

M211 - Commercial modular master clock system with support for up to nine option modules

M210 - Commercial modular master clock system with support for three option modules in a 1U Chassis

PRODUCT APPLICATIONS

- ⌚ Satellite Ground Station and Telecommunications
- ⌚ Back Haul Synchronization
- ⌚ Shipboard
- ⌚ Test Ranges
- ⌚ Energy and Utilities
- ⌚ Air Traffic Control, Airports, Railways, and Infrastructure