

M212 Master Clock System



Brandywine's M212 Master Clock System 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 GPS 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 GPS reference based upon the inherent stability of the MCM oscillator, providing hardening against possible GPS spoofing.

Available input reference selections include GNSS (both commercial GNSS and SAASM GPS receivers are supported), IRIG-B, and Have Quick/1PPS. In addition, an MCM may be synchronized to up to 2 other M212 chassis using a fiber optic crosslink, this provides additional resiliency for the M212 time and frequency references.

The base oscillator in the M212 is a high quality Temperature Compensated Crystal oscillator, but the M212 optionally 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 modules include NTP, low-phase-noise frequency, time code modules such as IRIG A, B, G, H, and NASA 36, BCD, PPS, PPM, Have Quick, serial data (RS232/422) as well as optical crosslink.

The M212 status and control is via front panel display for basic configuration and status, a secure web browser, and via 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

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

- GPS
- IRIG B
- IRIG B + 1PPS
- Have Quick +1PPS
- 1PPS (requires manual time entry)
- Crosslink A
- Crosslink B
- NTP peer to peer
- RS232/422 NMEA GGA (requires serial port OSM)

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

Propagation delay compensation

Input	± 1 ns -100ms in 1ns steps all inputs
Outputs	$\pm 0 - 1$ ms in 5ns steps

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	
RFC2818	

Alarm Relay

- Dry Contact Closure 100mA
- Audible Buzzer Alarm

¹ Requires firmware upgrade

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

Environmental

Power

AC Supply

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

DC Supply

Voltage 18-36VDC or 36-72 VDC
Connector Barrier Terminal Block

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 -15 to 55degC
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.

Available output formats per connector

- 1 PPS and 1PPM
- HaveQuick
- IRIG A, B, E, G, H
- XR3, 2137

Specifications:

Pulse-per-second/minute

Signal Format Per ICD-GPS-060B
1PPS Rate 1 pulse per second
1PPM Rate 1 pulse per minute
Rising Edge On Time
Rise Time<20ns
Fall time <100ns
Pulse Width 20 μs ±5% default.
Amplitude 10V ±10% into 50Ω
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 ±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 ±1V
Space (logical 0) -2.5V ±1V
Output condition when TFOM<7 only
Connector Type 3 Pin (Consult factory)

IRIG Time Code Output

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

2137 Time code Output

Signal Format 2137
Carrier 1kHz modulated
Modulation ratio 10:3 ±10%
Amplitude 5V_{p-p} ±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 ±5%
Output condition when TFOM<7 only

Propagation delay compensation

Applicability All 4 outputs individually
Range ± 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-

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locked to the MCM oscillator which must be OCXO, CSAC, or a Rubidium oscillator

Specifications:

Waveform	Sinusoid
Amplitude	13 ±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	Sinusoid
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	Sinusoid
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

BCD Time Code Output OSM

The BCD time code OSM provides 4 BCD time code outputs. The OSM buffers and distributes a BCD signal

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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

T1/E1 OSM

The T1/E1 OSM provides 16 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

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. GPS) 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
Range ²	2000m 9/125um cable

1 PPS Distribution Module

The 1PPS Distribution Module provides 4 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

² Consult Factory for longer range or multimode

Octal Distribution Module

The Octal Distribution Module provides up to 8 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

Have Quick Distribution Module

The Have Quick Distribution Module provides 4 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

Modulated Time Code Distribution Module

The Modulated Time Code Distribution Module provides 4 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	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

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Ordering Information

Part number	Description	Includes
036600301	Base Unit Commercial M212 Base Unit - AC	GNSS receiver, Antenna, 100'cable, TCXO oscillator, 90-265 VAC power
036600319	M212 Base Unit – 24DC	GNSS receiver, Antenna, 100'cable, TCXO oscillator, 18-36 VDC power
036600320	M212 Base Unit – 48DC	GNSS receiver, Antenna, 100'cable, TCXO oscillator, 18-36 VDC power
036600321	Base Unit Military M212M Base Unit - AC	SAASM L1/L2 receiver, Antenna, 100'cable, TCXO oscillator, 90-265 VAC power
036600322	M212M Base Unit – 24DC	SAASM L1/L2 receiver, Antenna, 100'cable, TCXO oscillator, 18-36 VDC power
036600323	M212M Base Unit – 48DC	SAASM L1/L2 receiver, Antenna, 100'cable, TCXO oscillator, 18-36 VDC power
	Oscillator Options	
036600313	OCXO	Replaces standard TCXO with OCXO
036600316	Standard Rubidium	Replaces standard TCXO with Rubidium Oscillator
036600324	High Perf Rub	Replaces standard TCXO with High Performance Rubidium Oscillator
036600317	CSAC	Replaces standard TCXO with CSAC
	Output Signal Modules	
036600303	Universal Timing Module 2x Triad, 2x BNC Connectors	
036600304	Universal Timing Module 4x Triad Connectors	
036600305	Universal Timing Module 4x BNC Connectors	
036600312	Low Phase Noise 10MHz	
036600311	Low Phase Noise 5MHz	
036600306	NTP Server	
036600308	PTP Grandmaster	2 ea 10/100/1000BaseT, 512 clients
036600325	EP- PTP Grandmaster	2 ea 10GBEe, 1024 clients
036600309	T1/E1 Output	16 outputs (DB62F connector)
002206495	36" breakout cable	Adapts DB62F connector to breakout panel
002600302	Breakout Panel	1U Rack mount with 16 RJ45 connectors
002600326	Optical Crosslink OSM	2 Port single mode optical cable
036600307	Octal Serial Output	8 outputs (DB62F connector)
002206496	36" breakout cable	Adapts DB62F connector to breakout panel
002600303	Breakout Panel	1U Rack mount with 8 RJ45 connectors
003660310	1PPS Distribution Module	4 outputs, BNC connectors
036600318	Have Quick Output Module	4 outputs, BNC connectors
036600314	BCD Output Module	4 outputs, Triad connectors
036600315	Modulated Time Code Module	4 outputs, BNC connectors
	Service/Support Contract-12	12months priority tech support, firmware upgrades
	Service/Support Contract-24	24months priority tech support, firmware upgrades
	Service/Support Contract-36	36months priority tech support, firmware upgrades
	Service/Support Contract-48	48months priority tech support, firmware upgrades