High Performance Timing System (HPTS)

Land/Naval HPTS (rear panel connections)

Brandywine's High Performance Timing System (HPTS) is an industry-leading dual redundant modular system designed to provide time and frequency references for various military platforms. This modular system comprises a single rack mounted chassis, into which a number of modules are inserted to provide the required functionality.

The HPTS receives a basic input reference from a GPS receiver, or external source and, in turn supplies a variety of time and frequency signals in a wide variety of available formats.

The HPTS is a ruggedized system specified to provide full performance over a wide range of environmental conditions.

A unique design feature of the HPTS enables it to distribute time reference signals over a wide area, while providing automatic compensation for propagation delays.

The HPTS has been designed from the outset as a "network centric" product. All features and functions can be monitored and controlled by means of an Ethernet interface.

Two Master Clock Modules (MCM), each utilizing a rubidium or ovenized quartz oscillator, are used to provide redundant time base information for synchronization and system operation.

The subsystem components are connected to a backplane bus built into the systems chassis. Output signals are a variety of low voltage analog and digital type signals such as 10MHz, 1PPS, Have Quick and IRIG Time Code.

Key HPTS Features

- **Modular Timing System**
- **Flexible**
- **Upgradeable**
- **Redundant**
- **Hot Swappable Modules**
- **High Accuracy**
- **Network-Centric**
- **Rugged**
- **Environmentally Qualified**
- **Automatic Propagation Delay Compensation**
- **Flexible input reference – GPS, Have Quick, IRIG B**

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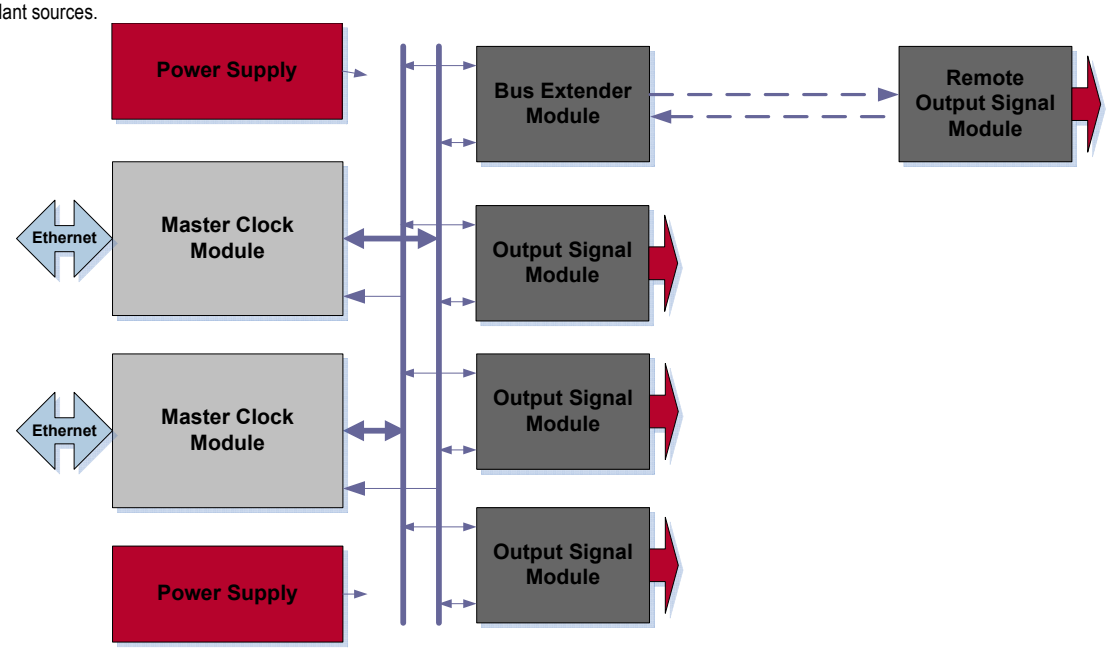
HPTS Architecture

The HPTS provides an integrated redundant timing system, based on a dedicated high speed backplane that allows time and frequency signals to be distributed and switched between redundant sources.



The HPTS is powered by two independent Power Supply Modules (PSM), each of which can power the entire system. The timing references are generated by independent Master Clock Modules (MCM). Each MCM generates a bi-directional, synchronous data bus signal that is fed to each slot on a passive backplane. The data bus signal contains time of day and control information that can used to generate any required time or frequency output. Output signals are generated by means of output signal modules (OSM) Each OSM monitors both data buses, and will select one MCM based on both availability and/or embedded signaling messages, so that all OSM's use the same MCM as a source. Each MCM monitors the data bus signal from the alternate, and if the off-line module detects that the on-line MCM has failed, it will force all OSM's to switch.

Use of a single serial data bus between the MCM's and the OSM's allows an OSM to be remotely located and connected by means of a duplex fiber optic cable. A unique feature of the HPTS is that the MCM can measure the round trip timing delay of the timing reference supplied to each OSM. This propagation delay information is included in the data message to the OSM, so that the timing can be advanced to automatically compensate for delays. This allows the HPTS to provide a high accuracy distributed master system.

The system is managed by means of dual 100BaseT Ethernet interfaces. All operating parameters may be set by means of this interface, which uses industry-standard Simple Network Management Protocol (SNMP). The status of both MCM modules and all PSM's and OSM's are monitored by either MCM network interface, or by simplifying device management. Network segregation can also be achieved in each MCM by assigning up to three network addresses to each MCM.

HPTS Benefits

- *Automatic propagation delay compensation provides high accuracy time and frequency at the point of use in a distributed environment*
- *Redundant Time and Frequency Sources provide high availability*
- *Automatic Switchover in the event of failure*
- *"Hitless Switching" of outputs when references switch*
- *Hot Swappable Modules reduce MTTR and increase availability*
- *Network centric design allows remote management in a "lights out'" operating environment*
- *Flexible architecture provides capability growth as new requirements are defined*
- *Low cost of ownership due to commonality of modules*
- *High environmental capability, including low noise reference frequencies under vibration.*
- *Light-weight, front connector packaging available for aircraft applications with full environmental performance*
- *High capacity output signal modules provide efficient use of rack space*

HPTS Applications

The HPTS has been developed to have the flexibility to suit many applications, including:

- *Satellite ground station time and frequency reference*
- *Airborne master clock system to provide time and frequency references to all mission electronics*
- *Shipboard master clock system to provide distributed time and frequency across the entire platform*
- *Test range primary time, frequency and countdown distribution*
- *Military and government secure communications using either C/A code or SA-ASM P(Y) code GPS receivers*
- *Telecommunications network synchronization*
- *Standards and calibration laboratories*

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Available HPTS Modules

The following modules are available or planned for the HPTS. Specific requirements are easily met by customizing modules to suit new applications.

Master Clock Modules

Front Connector Master Clock Module shown

Master clock modules are available in a variety of configurations

Available MCM Oscillators

Oscillator type is specified at time of order
External Cesium
Internal Rubidium
Internal OCXO

Synchronization Sources

GPS (C/A) Code (opt)

SA-ASM GPS P/(Y) Code – (opt)
External Have Quick/1PPS (std)
External IRIG B (std)

MCM External interfaces
- J1 Synchronizing inputs
  - External 1PPS
  - External Have Quick
  - IRIG B 124 with IEEE 1344 extensions
  - GPS Antenna (optional) RS232
  - RS232 console port
    - Monitor operation of HPTS
    - Upload new firmware
  - Connector: MIL-C-38999 type
- J2 Ethernet
  - Type 100 BaseT
  - Protocols: IP, TCP/IP, UDP, DHCP, NTP, SNMP
  - IP addresses: 6 IP addresses are loaded
  - 3 active addresses are determined by which physical HPTS slot MCM is installed in
  - Connector: RJ45 MIL-C-24682 type

MCM controls
- Mode select: Auto/manual

MCM Display
Time display Days thru seconds
Led indicators:
- Power, GPS, IRIG, On-Line, Manual, Holdover, Fault

Power Supply Modules

DC Power Supply Module shown

DC Power supply
Voltage 18-32 V, or 36-72V 120W max
Power Quality: MIL-STD-704F compliant
Connector: MIL-C-38999 type

AC Power supply
Voltage 85-265 VAC, 50 60 Hz, 120W max
Connector: IEC320 or MS 3452W14S-7P

Output Signal Modules

Baseband Reference Frequency Module

Frequencies available: 1,5,10, 64.8, 70, 100 MHz
Level: 13dBm nominal
No. of outputs: 5 sinewave, 5 1PPS from direct division
- Optional 10 sinewave
- 3 RS422 (1,5 or10 MHz only) These are 1PPS signals now

Harmonic Distortion: <-40dBc
Phase Noise: at 10 MHz

Offset Freq. (Hz)	Phase Noise (dBc/Hz)	*With/without vibration*
10^0	≤ -85	-95dBc
10^1	≤ -100	-125dBc
10^2	≤ -130	-140dBc
10^3	≤ -140	-150dBc
10^4	≤ -145	-155dBc

Clock Rate Module

Rates Available: N x 1Hz from 1 Hz through 16.384 MHz
Level: TTL or RS422
No of outputs: 15 total
Rate: All outputs can be independently divided by any integer from the programmed master rate
Connector: SMA, D-SUB, Wire wrap available

Pulse Rate Module

Rates Available: 1PPS (std) through 1kPPS
Level: 10 V from Lo-Z, 10V from 50 ohm, RS422
No of outputs: 12 single ended, 3 RS422
Connector: SMA (single ended), DB9-F (RS-422)

Modulated Time Code Module

Time Codes: IRIG B124, IEEE-1344 extensions (std)
Optional IRIG A, E, G
Level: 3Vp-p into 50 ohm load
No of outputs: 12 modulated, 3 DCLS at RS422
Connector: SMA (single ended), DB9-F (RS-422)

Have Quick Time Code Output Module

Time Code: Have Quick II per ICD-GPS-060
Level: >2.5$V_{0\text{-}pk}$ into 50 ohm load, TTL compatible
No of outputs: 15
Connector: SMA (single ended)

Combination Module

This module is often used in conjunction with a remote expansion chassis to provide a limited number of outputs at a remote site. Specifications of each output are as listed above
Outputs:

Time Code:	Have Quick II per ICD-GPS-060
	IRIG B modulated, DCLS (RS422)
Pulse rates	1PPS (qty 4 single ended, qty 1 RS422)
Reference Frequency	10 MHz (qty 4 single ended, qty 1 RS422))

Connector: SMA (single ended) DB9-F (RS-422)

Bus Extender Module

The remote expansion module is used to extend the data bus to a remotely located expansion chassis.
Output: Brandywine proprietary data bus (100Mbit/sec)
Signal Type: Fiber Optic. Multimode (std), single mode (opt)
Connector Type; SC
No of Outputs: 6

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Remote Expansion Chassis

Remote Expansion Chassis is used to power one or more Output Signal Modules. It is a 1U rack mount unit that will accept redundant power supplies, and allows up to 2 modules to be installed.

Specifications

System Accuracy

MCM Timing Accuracy when locked to input reference
- To External Have Quick/1PPS
  - <15ns RMS
- To IRIG B (modulated)
  - <2µsec
- To GPS (calibrated antenna cable delay)
  - <50ns UTC(USNO)

MCM Frequency Accuracy (24 hr avg.)

Rubidium	Ovenized Quartz	
$<1x10^{-12}$	$<1x10^{-12}$	when locked to input reference
$<5x10^{-11}$	$<2x10^{-10}$	after 24 hr holdover

Short Term Stability
- 10 MHz output

1sec	$<1x10^{-11}$
10 sec	$<1x10^{-11}$
100 sec	$<1x10^{-10}$

Output Signal Module Accuracy with respect to MCM

	Main Chassis	Remote Location (<2km)
1PPS	±5ns	±20ns
Have Quick	±5ns	±20ns
IRIG B124	±250ns	±250ns
IRIG B DC	±40ns	±60ns

Physical

Size
- Width 17.00" (fits standard 19" rack per EIA-310-D)
- Height 7.00" 5RU
- Depth 12.00" behind rack (front panel connections)

Weight
- 24 lb nominal

Environmental

Operating Temperature
- -10 to +50 ºC
- 10ºC/hr max rate of change (full accuracy)
- 10ºC/min max rate of change (operating)
- Emergency Operating
- 70 ºC 5 minutes without damage

Non-Operating Temperature
- -40 to +85 ºC

Humidity
- 5% to 95% non condensing

Altitude
- Operating -1500 to +11000 ft
- Non Operating -1500 to +41000ft

Explosive Atmosphere
- MIL-STD-810F, Method 511.4, Procedure I

Shock
- 10g 11ms per MIL-STD-810 Method 516.5, Procedure I
- Bench Handling per MIL-STD-810F, Method 516.5, Procedure VI

Acceleration
- 5g per MIL-STD-810F, Method 513.5, Procedure II

Vibration per MIL-STD-810F
- Operating (Front connector version) $1.3g_{rms}$

Frequency	Power Spectral Density
10 Hz	0.0015
40 Hz	0.0015
2000 Hz	0.0005

- Endurance $4.6g_{rms}$

Fungus
- No fungus nutrient materials

EMI
- MIL-STD-461
- CE101, CE102, CS101, CS115, CS116, RE101, RE102, RS102, RE103

GPS Receiver Options

Standard Positioning Service (SPS) option
- Type: 16 Channel C/A Code
- Frequency: 1575.42 MHz L_1 only
- Acquisition Time

Hot Start	8.4 sec (typ.)
Warm Start	36 sec (typ.)
Cold Start	45 sec (typ.)

- WAAS support

[1]Precise Positioning Service (PPS) SA-ASM option
- Embedded GPS Receiver: GB-GRAM compliant
- Type: 12 Channel continuous tracking
- Code Type: C/A, P(Y) Code
- Frequency: 1575.42 and 1227.6 MHz L_1 and L_2
- Acquisition Time

Hot Start	10 sec (typ.)
Warm Start	90 sec (typ.)
Cold Start	15 min (typ.)

- Key Loading Interface
  - KYK-13, KOI-18
  - DS101, DS102

Red and Black Key capable

[1] Note that purchase of a PPS receiver is restricted to authorized users

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