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 multiple 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 by a passive backplane bus built into the systems chassis. Outputs 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, IRIG B, Have Quick**

Flight Qualified HPTS (front panel connections)

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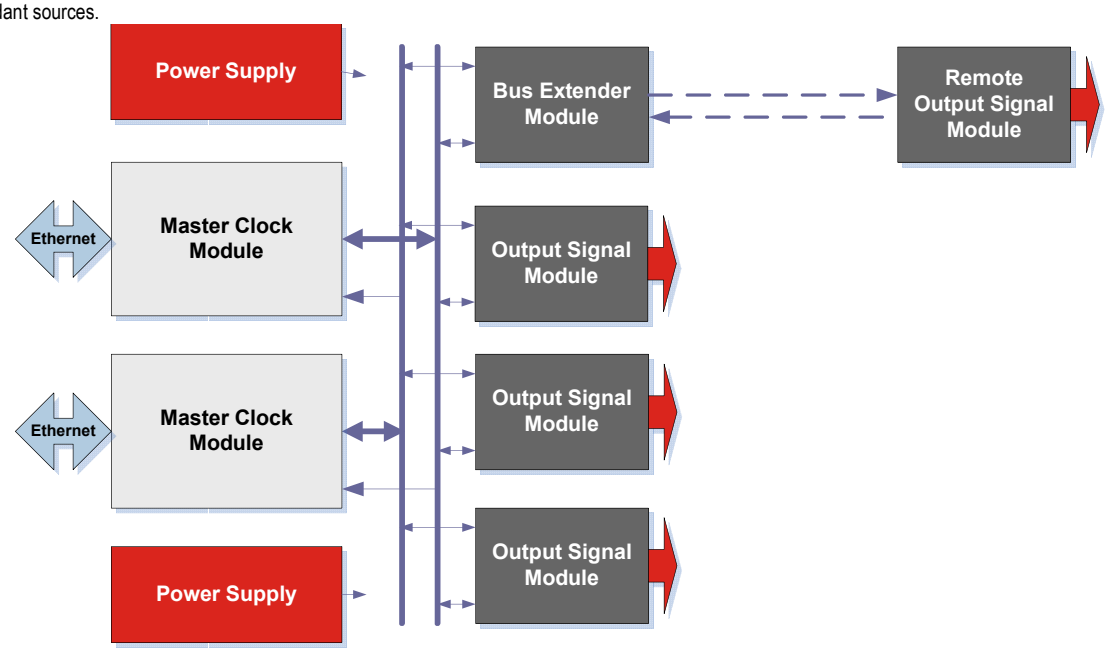
HPTS Architecture

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 databus 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

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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	Synchronization Sources
External Cesium	GPS (C/A) Code (opt)
Internal Rubidium	SA-ASM GPS P/(Y) Code – (opt)
Internal OCXO	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

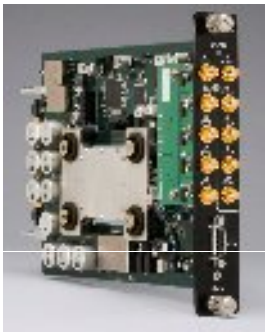
- Voltage 18-32 V, or 36-72V 120W max
- Power Quality: MIL-STD-704F compliant
- Connector: MIL-C-38999 type

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 (1PPS)
Harmonic Distortion: <-40dBc
Phase Noise: at 10 MHz

Offset Freq. (Hz)	Phase Noise (dBc/Hz) *With/without vibration*
10^0	≤ -85 -90dBc
10^1	≤ -100 -120dBc
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 (subject to change without notice)

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	12.06" behind rack (Airborne version)
	13.12" behind rack (Ground/Naval version)

Weight

<25 lb typical

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/EMC

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

External RS232 I/O: Per ICD-GPS-153

Type: 12 Channel continuous tracking

Simultaneous L_1 and L_2 dual frequency GPS signal reception

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.)

41 dB Jammer/Signal while tracking

24 dB Jammer/Signal during initial acquisition

Key Loading Interface

KYK-13, KOI-18

DS101, DS102

Red and Black Key capable

Other Products from brandywine communications

- Modular Time and Frequency TFD8000 System
- Precision Time System Model PTS-SAASM
- NFS220 Networked Frequency Standard
- Network Time Servers
- SYNNCCLOCK family of bus level products for all major computer busses
- Distribution Amplifiers

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

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