HPTS
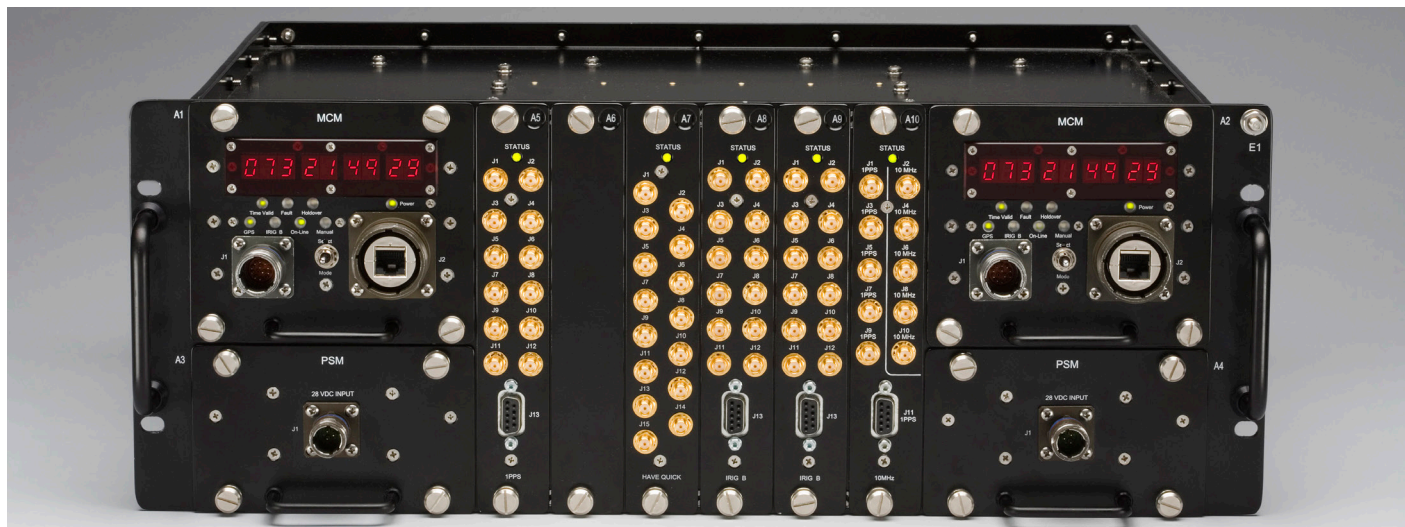## High Performance Timing System

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 rubidi-um or ovenized quartz oscillator, are used to provide re-dundant time base information for synchronization and system operation. The subsystem components are con-nected 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.

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**

Applications
- 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

Key Benefits
- Automatic propagation delay compensation provides high ac-curacy 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

Available Modules

Master Clock Module

Master clock modules are available in a variety of configurations

Available MCM Oscillators	Synchronization Sources
Oscillator type is specified at time of order	GPS (C/A) Code (opt)
External Cesium	SA-ASM GPS P/(Y) Code – (opt)
Internal Rubidium	External Have Quick/1PPS (std)
Internal OCXO	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 Module

DC Power Supply Option

AC Power Supply Option

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 Freqeuncy Reference 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	$\leq$ -85	-95dBc
10^1	$\leq$ -100	-125dBc
10^2	$\leq$ -130	-140dBc
10^3	$\leq$ -140	-150dBc
10^4	$\leq$ -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)

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)

Output Signal Modules

Have Quick Time Code Output Module

Time Code:
   Have Quick II per ICD-GPS-060
Level: >2.5V0-pk into 50 ohm load, TTL compatible
No of outputs:
   15
Connector:
   SMA (single ended)

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)

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

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	
$<1\times10^{-12}$	$<1\times10^{-12}$	when locked to input reference
$<5\times10^{-11}$	$<2\times10^{-10}$	after 24 hr holdover

Short Term Stability
    10 MHz output

1sec	$<1\times10^{-11}$
10 sec	$<1\times10^{-11}$
100 sec	$<1\times10^{-10}$

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

GPS Receiver Options

Standard Positioning Service (SPS) option
    Type: 16 Channel C/A Code
    Frequency: 1575.42 MHz L1 only
    Acquisition Time

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

    WAAS support

Precise Positioning Service (PPS) SA-ASM option[1]
    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 L1 and L2
    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

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1   Note that purchase of a PPS Receiver is restricted to authorized users

Physical

Size	Width	17.00" (fits standard 19" rack per EIA-310-D)
	Height	7.00" 5RU
	Depth	12.00" behind rack
Weight	24 lb. nominal	

Environmental

Temperature:
    Operating: -10 to +50 ºC
        10ºC/hr max rate of change (full accuracy)
        10 ºC/min max rate of change (operating)
    Emergency Operating:
        70ºC 5 minutes without damage
    Non-operating: -40 to +70deg C

Humidity   5 - 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