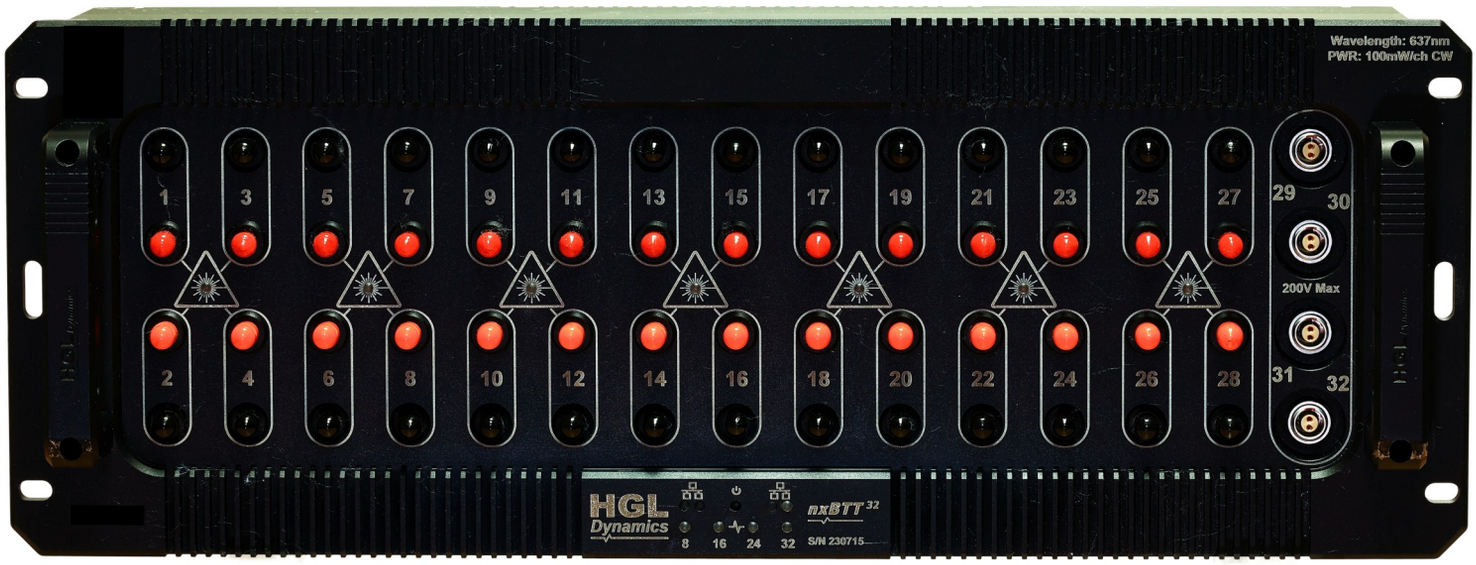
Lightning$^{32\text{-}BTT}$/NxBTT^{32}

32 Channel Blade Tip Timing Acquisition System

HGL Dynamics



Connect | Condition | Acquire

Key Features

- 28 Laser / Photodiode Channels (0.1 - 100mW)
- 4 Voltage / Tacho / IRIG Channels (50mV - 200V pk)
- 16/-bit 10MHz ADC per channel
- 10 Gigabit Ethernet Connectivity
- Conduction Cooled, Milled Unibody Chassis
- Modular Architecture, Scalable to >128 Channels
- Multi-unit Synchronisation (GPS, IRIG, LVDS, IEEE-1588)
- 9-36V dc & PoE++ Power Options
- Environmentally Sealed to DO160H standards

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Introduction

Lightning is a series of rugged 12, 16, 24, and 32 channel data acquisition modules designed to provide a world class, highly flexible solution for high-speed data measurement. The Lightning$^{xx\text{-}BTT}$ members of the family provide a range of specialised Front-End modules which include 10, 12 or 28 paired laser and photo diode channels intended primarily for Blade Tip Timing applications. Each module includes 0, 2, or 4 additional Voltage channels which can be used for general or tacho inputs.

All members of the BTT sub-family are intended for use in harsh environmental environments and have been tested to DO160H standards including:

- Altitudes to 60,000ft (20,000m),
- Temperatures ranging from –55 to 80°C (lasers active –10 to +50°C)
- Explosive, sand / dust, salt fog & humidity to 100% RH
- Corrosive fluid environments including lubricants, fuel, solvents etc
- Waterproof to IP65
- Vibration to DO160H Cat R curve C1
- Severe acoustic (160dB+ Mil-Std 810H)

The Lightning$^{32\text{-}BTT}$ (NxBTT32) is the largest member of the family and provides 28 Laser / Photo diode channels and 4 Voltage / Tacho channels. It is intended for use in Test Cell environments close to the vehicle under test, and for civil flight test environments where many channels are required.

The Lightning$^{32\text{-}BTT}$ is supplied as standard with both IEEE-1588 and IRIG A/B support for synchronising with external devices to +/-20ns accuracy. A GPS receiver can be specified as an optional addition.

Multiple power options are provided as standard, including Power over Ethernet (PoE++) to the latest IEEE802.3bt standard (HGL can also supply matching Power Injector units), 9-36V dc and wide range mains via external adaptors (100-250V ac 50/60Hz unit supplied).

Laser powers of 0 to 100mW are fully configurable by software and multiple Physical and ‘Soft’ interlocks (such as Speed, Pressure or Digital I/O) provide the unit with IEC 60825 compliance (together with clear laser safety labelling).

All communications with the unit is achieved via Ethernet through the rear LEMO 8-pin ports and both ports are 10 Gigabit capable and additionally provide a pass-through switch capability for daisy chaining units together. HGL can supply software support from an API through to fully featured measurement systems.

Lightning$^{32\text{-}BTT}$/NxBTT^{32}

32 Channel Blade Tip Timing Acquisition System

HGL Dynamics

Hardware Overview

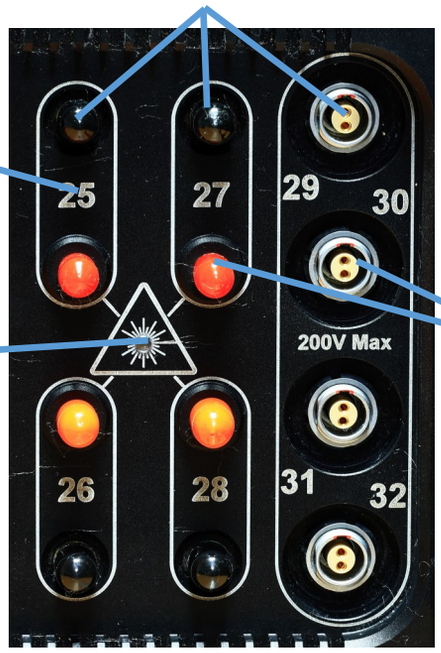
Independent Inputs

Equipped with 32 individual channels
One 10/15MHz SAR ADC per channel.

Laser (Red) / Photo Diode (Black) Pair

100mW capable Laser Diode (637nm)

Photodiode with Optical Filter (635nm +/-10nm)



Laser Power (Safety) Indicator

Green - < 10mW

Amber - 10-100mW

Flashing is enabled but interlocked OFF

Shows maximum level of 4 lasers

Connector Compatibility

Laser / Photo diode - (Optical) SMA

Voltage—2-pin Lemo / BNC

Buffered Analogue Outputs

Buffered outputs from the conditioning electronics (one connector per 8 channels)

Networking

- Command & Control Interface
- 10 Gigabit data streaming
- IEEE-1588 Synchronisation
- PoE++ Power (marked)

Calibration

Lightning facilitates quick on-board correction with the use of standard bench signal generators/multi-meters.

Digital I/O

DIG (Input) - 8 programmable interlocks
ALM (output) - 8 programmable alarms

IRIG (GPS Option) Synchronisation

Dedicated IRIG-A/B input for synchronization with external systems.
Optional GPS input for high precision

Chassis GND

- LEMO 1-pin connector

LVDS Synchronisation

- LVDS (Low Voltage Differential Signalling) Synchronisation Interface
- <10nS Unit to Unit
- 0-200m Unit to Unit cable lengths
- Daisy-Chain, Star or mixed

DC Power

- 9-36V d.c.
- Slave output connectors for additional units

Physical Interlock

- 4-pin LEMO Connector
- Must be inserted for laser power to be applied

Lightning$^{32\text{-}BTT}$/NxBTT^{32}

32 Channel Blade Tip Timing Acquisition System

Principle of Operation

Introduction

The Lightning$^{xx\text{-}BTT}$ Acquisition Front Ends can operate in one of two modes:

Streaming - where raw 10MHz ADC data is transmitted directly from the unit to one (or more) PC Hosts for processing.

BTT - where the firmware within the unit performs all the operations required to provide pre-processed tacho and blade passing timestamp information to 1nanosecond resolution with better than +/-2ns error between any two channels on a unit. The data that is sent to the remote host provides a lower rate rich set of crossing points which can be fed into 3rd party Blade Tip Timing Analysis Software for further processing and display.

BTT Mode

Most Blade Tip Timing (BTT) Front End systems determine blade passing events using a high-gain comparator device teamed with 100MHz+ 'digital sampling' to apply a timestamp to the detected edge transitions. Whilst precise, the resolution of such systems is limited to the speed of the comparator and the digital sampling and generally tends to be around 5-10ns.

Lightning$^{xx\text{-}BTT}$ utilises a 10MHz (15MHz option available) 16-bit SAR ADC which provides a high-quality digital representation of the response signal returned from the probes / tacho sensor. Whilst a 10MHz sample rate only provides an intrinsic 100ns resolution, Lightning$^{xx\text{-}BTT}$ employs sophisticated interpolation algorithms on the incoming signals to accurately increase the resolution to +/-1ns to a programmable threshold crossing.

All photodiodes, signal paths and analogue electronics include reactive components that affect the phase of signals travelling through them, and Lightning$^{xx\text{-}BTT}$ is no exception. However, these delays are generally stable and can be calibrated out of the system, this is done in HGL's factory to provide channel to channel errors within +/-2ns across a single unit and from DC to 200kHz blade passing frequency.

Lightning$^{32\text{-}BTT}$ with its 28 optical channels and support for up to 4 tachos can often provide all the optical and tacho inputs required for a BTT test yielding a +/-2ns overall timing accuracy. For larger systems multiple Lightning$^{xx\text{-}BTT}$ units can be used together with synchronisation either by IEEE-1588 (+/-20ns) or HGL's LVDS (characterizable to < +/-5ns unit to unit and deterministic). IEEE-1588 provides the ability to have a more distribute set of BTT units, but reduces the timing accuracy to +/-22ns, whereas with careful setup the HGL LVDS method can maintain sub-5ns accuracy across a system. Additionally Lightning$^{xx\text{-}BTT}$ does not require tachos to be connected to multiple systems, which also reduces measurement uncertainty.

Laser Interlocks

Laser safety is paramount on BTT systems, especially when powers of up to100mW per laser are achievable (Class 3B). Lightning$^{32\text{-}BTT}$ provides multiple Interlock sources including:

- Physical - 4-pin Lemo socket which requires mating plug with shorted pins to allow laser power to be enabled.
- Software - An additional software controlled laser power interlock (can be used in series or parallel depending on model)
- Speed - This is the primary operating interlock and allows individual lasers to be allocated to one tacho. A threshold can be set where the speed must be greater than the threshold for laser power to be enabled.
- Pressure - This is a secondary operating interlock which can be used to gate the Speed Trigger to disable laser power below a specified altitude.
- Digital - A set of 8 TTL lines which can be used to further gate the Speed Trigger to disable / enable laser power.

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HGL Dynamics

Specification

General

Dimensions (W x H x D):	486 x 178 x 110 mm
Weight:	10.6 kg
Supply Voltage:	9-36V V DC PoE++ (IEEE 802.3bt)

Input Configuration

Input Channels:	28 Optical (Laser + Photo) 4 Voltage / Tacho
ADC Type:	SAR
Quantization:	16-bit
Input Ranges:	±100mV, ±1, ±10 & ±100V*
DC Offset:	±0.15 mV
Input Coupling:	AC, DC *
Input Impedance:	>1MΩ
SNR:	>87 dB
Anti-aliasing:	<-90 dB
Sample Rate:	10 MHz (15MHz option)
Frequency Response:	DC to >500 kHz ± 0.05 dB
Dynamic Range:	110 dBFS / √Hz, 87 dB (broadband)
Inter-Channel Δ Phase:	< 1 nS (calibrated)
DC Linearity:	< 0.05%

*Software configurable parameter

Other Inputs (using any standard input)

IRIG-A and IRIG-B
Tachometer / Flow meter

Synchronisation

LVDS:	±10 ns
LVDS (max distance)	200 m # (node to node)
IRIG A/B:	±100 ns
IEEE-1588:	±20 ns
GPS (optional)	±50 ns

#If longer distances are require please contact HGL

Accuracy (%full scale)

Voltage:	±0.25%
Optical:	±0.5%
Laser Power:	±0.5%
Speed:	±0.01%

Frequency Response (0-500kHz)

Voltage:	±0.05dB
Optical:	±0.05dB

Time (Blade Passing)

Channel - Channel:	<±2ns
Unit-Unit:	<±10ns
Time Resolution:	1ns

Environmental

Operating Temp.:	-55 to +80 °C
Laser Operating Temp:	-10 to +50 °C
Storage Temp:	-55 to 100°C
Relative Humidity:	0-100% RH

DO160G Certifications

Cat 4.5 (E2)	Temperature
Cat 4.6 (E2)	Altitude
Cat 5 (S2)	Temperature Variation
Cat 6 (C)	Humidity
Cat 7 (E)	Shock
Cat 8 (R/C1)	Vibration
Cat 9 (E)	Explosive
Cat 10 (R)	Waterproofness
Cat 11 (F)	Fluid Susceptibility
Cat 12 (D)	Dust
Cat 13 (F)	Fungus
Cat 14 (T)	Salt Fog
Cat 15 (A)	Magnetic Effect
Cat 16 (A/RI)	Power Input
Cat 17 (A)	Voltage Spike
Cat 18 (Z)	Audio Frequency
Cat 19 (ZC)	Induced Signal
Cat 20 (G & M)	RF Susceptibility
Cat 21 (M)	RF Emission
Cat 24 (A)	Icing
Cat 25 (A)	ESD
Cat 26 (B)	Flammability

MIL STD 810H

Method 515.8	160dB Noise

Communications

Network Interface

Speed:	100, 1000, 10000 Base-T Auto-negotiating
Type:	Copper

Command Interface
HGL UDP Standard

Data Interface

Streaming Mode:	10MHz ADC UDP (per ch with rewind ability)
BTT Mode:	Environmental Data Packets Timestamp (64-bit) Packets (per ch) Snapshot Packets (per ch)

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Software Options

HGL Dynamics provides multiple software platforms for Lightning Acquisition systems; these range from low level Network APIs, Windows® DLL, Single Instrument Applications (Apps), and full Measurement System software. This flexibility allows users to choose the best platform for their particular applications and / or increases the utilisation of the hardware for multiple uses.

External Integration Protocols

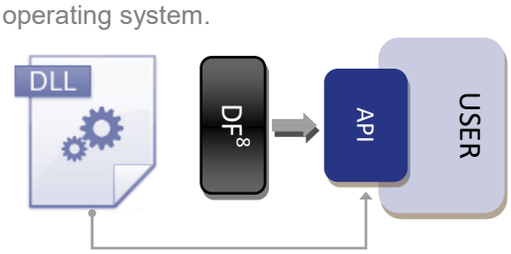
Integrating HGL's software into a third party system has never been easier. HGL Dynamics offers multiple ways to communicate with the Acquisition Software suites. Communication options include DDS subscriber / publisher, OPC client / server and Modbus (over ethernet) client / server.

Network API

All HGL Dynamics hardware modules are Ethernet connected to each other and their host PC(s); a fully documented Programmer's API is available for integrators / customers who wish to access the modules at this level or need to integrate the modules with a non-Windows operating system.

Microsoft Windows DLL

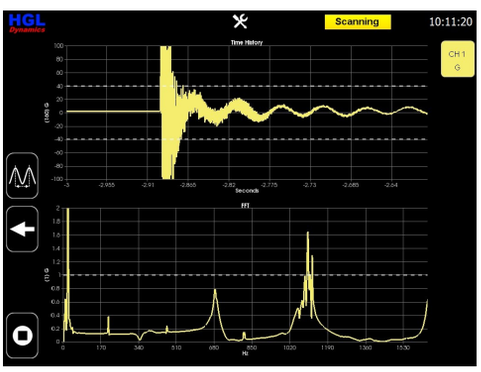
HGL provides (as standard) a Windows DLL with every Hummingbird Acquisition System; for Microsoft Windows users this provides a simpler method to access all the functions of the hardware.



Single Instrument Apps

HGL has developed a number of Single Instrument Apps, primarily for its Firefly system. These apps can be operated on a Lightning and Laptop / PC system equally well. The Apps are intended to provide a family of simple, easy to use applications which turn the Hummingbird into a single instrument, examples include:

- FFT Analyser
- Oscilloscope
- Chart Recorder
- Rotating Machinery Analyser
- Trim Balance
- Power Dip & Rise
  (requires isolation amplifier hardware)



Full Measurement System Software

For the past 15 years, HGL has providing a fully integrated, modular, network distributed Dynamics Measurement System; this software is intended for wide variety of applications and for systems ranging from small portable units to large multi-site systems with hundreds or thousands of channels.

The System comprises four main parts, Acquisition, Monitoring, Analysis and Data Management, and is focused on providing robust, flexible, fixed or mobile operation with ease of use as a primary consideration.

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Software Suites

Data Acquisition - Hawk

HGL's Hawk acquisition software provides everything a user needs to configure, calibrate and acquire data from the acquisition hardware. Full control and feedback of the system is provided by the Hawk GUI Client application; this provides an intuitive instrument-like interface that allows even novice users to operate large channel count systems, even from remote locations.

Real-Time Monitoring - Hawkeye

Hawkeye allows one or more users to monitor the signals being acquired in real-time (<0.1s latency).
Fully customisable displays such as FFTs, Waterfalls, Oscilloscopes, Numerical, Speed and Tracked-orders, Phase, Bode, Orbit, nth Octave etc, provide a rich monitoring environment.
Hawkeye also provides Time, Frequency, Order and Phase domain alarming facilities for all channels simultaneously, with support for many different alarms types per channel. Hawkeye is also client / server based with the 'thin' Hawkeye Client allowing local or remote monitoring (performance dependent on network infrastructure).

Analysis - Aurora

Aurora provides an in-depth analysis tool for acquired data; this is usually required post-test, but can be operated simultaneously with testing if useful. Post-test analysis can pinpoint areas of interest / problems to be further investigated, and for this purpose Aurora provides a range of client / server based tools to analyse, investigate, mine, summarise and report on acquired data.
Multiple users can use Aurora simultaneously, and in common with HGL software portfolio access is via a network connected thin-client (Aurora Client) application, thus allowing both local and (potentially widely) remote users to access data simply and efficiently.

Data Storage & Archiving - Hercules

Prolonged or large-scale data acquisition generates a lot of data, 10's and 100's of TBytes are not unusual for large enterprises. Data is expensive to collect and the functionality to efficiently store and retrieve legacy data is essential for in-service investigations, product development etc.

HGL's Hercules software provides an integrated, low-cost, yet highly scalable and safe data management solution for any sized data acquisition operation. The key to the system's success is support for virtually any common media type (SD cards, HDD/SSDs, LTO tapes etc.) combined with a unique database architecture providing simple, yet highly efficient data storage information, and a client/server architecture which allows data to be managed across multiple remote sites from a single intuitive Graphical User Interface.

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Training

Training

HGL Dynamics offers a wide variety of training workshops and courses. Workshops are conducted at one of our global offices or at the client's site by our training team, all of whom have many years' of industry experience and knowledge.

Typical training courses include: Vibration Fundamentals, Signal Processing, Rotating Machinery, Advanced use of HGL Software and Analysing Large Datasets.

Information

About HGL Dynamics

HGL Dynamics is a world-leading supplier of services and high specification equipment for the integrated capture, monitoring, analysis, storage and management of high bandwidth data.

Purchasing & Availability

The HGL Dynamics Lightning Data Acquisition Module is now available for purchase or lease. Please contact one of our HGL Dynamics offices below for further information or to request a quote.

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