Non-Contact Technologies LLC

NSMS *echo*V and *fusion*V Product Specification Sheet

Overview:

The "V" series Tip Timing Data Acquisition Modules from Non-Contact Technologies, LLC (NCT) provide up to eight (8) channels of Tip Timing (NSMS) data acquisition in a small modular form factor. The *echo*V Tip Timing Data Acquisition Module has inputs for up to eight (8) channels of Tip Timing (NSMS) plus reference 1/rev and time code inputs, all in a package that can be installed near the sensors. The NCT *echo*V can automatically acquire data when connected to optical spot or beam interrupt sensors. The NCT *fusion*V Tip Timing/Tip Clearance Data Acquisition Module includes all the features of the *echo*V and additionally provides Tip Clearance data when interfaced to a combined tip timing/tip clearance capable sensor.

The *echo*$^{+}$V and *fusion*$^{+}$V eight (8) channel modules have the advanced capability of automating the tip timing and tip clearance measurement for all tip timing sensors using digital processing techniques, requiring little or no operator input.

NCT's "V" series modules are designed to allow installation wherever the user needs them, either in a conditioned control/data room or in the tough environment near the test article, to simplify interconnect infrastructure. If optical sensors are used, the acquisition modules can be installed alongside the laser light sources and optical detectors, which must be installed near the test article. The modular design allows large channel counts by interfacing multiple 8 channel modules together through a high-speed network switch connected to data acquisition computers.

Data from all modules are routed into data acquisition PCs, processed, and displayed on multiple monitors for near-real time monitoring of blade vibrations and clearances (*fusion*V series only) using the *echo*View software. Data is recorded continuously at user defined intervals and can be retrieved later by the *echo*Process post-processing software for detailed analysis, report generation and plots. Data can also be exported in text or CSV format for simplifying import into MatLab, Python, or other data analysis tools.

Features:

NCT *echo*V or *fusion*V 8 Channel Tip Timing/Tip Clearance Data Acquisition Modules have the following features:

1. 13" (330mm) x 9.1" (231mm) x 5.9" (149mm) aluminum chassis with heat sinks
2. 110VAC – 230VAC standard (other power sources optional)
3. Operating Temperature Range: 0ºC (32ºF) - 40ºC (104ºF) (Extended Temperature Ranges Available Upon Request)
4. Flexible clock speed of 20 to 400 MHz (2.5-50 nS tip timing resolution)
5. Up to 8 fully differential or single ended sensor inputs
    a. Signal range of +/-15V
    b. Custom termination impedance (if required)
    c. Nominal 4 MHz analog signal bandwidth (other analog bandwidths are available if required)
6. Analog signal conditioning with auto-gain control, fixed 4th Order Lowpass Active Filter and user adjustable gain, offset, and trigger/qualifier set points.
7. Multiple digital trigger modes can be selected by the user:
    a. Leading Edge
    b. Trailing Edge
    c. Leading and Trailing Edge
    d. Zero Crossing
    e. Percent Peak Trailing Edge
    f. Automatic Percent Peak Leading Edge/Trailing Edge (optional upgrade to *echo*$^{+}$V or *fusion*$^{+}$V - the most user-friendly acquisition mode and takes the expert out of the loop)
8. Data can be acquired with or without a 1/rev (1/rev required if blade indexing is desired)
9. Up to 2 fully differential 1/rev signal inputs or single ended inputs with custom termination and a signal range of +/-15V
    a. Auto Gain Control feature that maintains the 1/rev signal at a constant peak-to-peak voltage level
    b. Multi-tooth tachometer signal input available upon request
10. Time stamping of each revolution of data using an IRIG B standard (amplitude modulated or DC Level Shift input) (Precision Time Protocol (PTP) available if requested)
11. Up to 16 additional analog data channels sampled at low speed and time stamped with each revolution of tip timing data
12. Communication to the module is via 100mbps Ethernet
13. Individual blade Tip Clearance and overall clearance measurement (*fusion*V or *fusion*$^{+}$V only)
    a. Compatible with capacitive, eddy current, or multi-channel optical sensors

Additional items available:

Sensors

1. NCT Tip Timing/Tip Clearance Optical Unlensed (0.010" (0.254mm) to 0.125" (3.175mm)) working distance)
    a. 15 to 20 feet (4.5 to 6.0 m) in total length typical or custom length
    b. All fiber connectors are ST or SMA905 (unless otherwise specified)
    c. Receive fibers are electrically isolated
    d. Probe cable is protected by metal BX (armored cable)
    e. Standard probe tip size: 0.093" (2.36mm) diameter with a 0.1875" (4.76mm) step, overall length 1.00" (25.4mm) (dimensions can be customized)
    f. Temperature up to 725 degrees F (385 deg. C) uncooled (Higher temperatures can be obtained with special construction of the probe tip and/or with cooling)
2. Other sensors such as lensed optical sensors, capacitive sensors, and eddy current sensors are available from Third Party Vendors. Please inquire.

NCT *opto*V 8 Channel Laser/Detector Module

1. 13" (330mm) x 9.1" (231mm) x 5.9" (149mm) aluminum chassis with heat sinks
2. 110VAC – 230VAC Standard (other power sources optional)
3. Operating Temperature Range: 0ºC (32ºF) - 40ºC (104ºF) (Extended Temperature Ranges Available Upon Request)

4. 8 channels of lasers and detectors per module with 2 spare lasers (up to 2 spare detectors available upon request)
5. Typical laser wavelength of 808nm (other wavelengths available if required such as 405nm for hot sections) with a max output power of 30 mW (higher optical output powers available if required)
6. Peak detector sensitivity at 808nm with a typical analog bandwidth of 4 MHz (other analog bandwidths are available if required)
7. All fiber connectors are typically ST or SMA905 but can be customer defined based on sensor fiber connectors
8. Detector signals interface directly to *echo*V or *fusion*V
9. Module is environmentally protected and should be purged with GN2 or filtered shop air.
10. Water is required to cool the lasers.
11. Interactive software to control laser power and monitor laser current and temperature

***echo*View Real-time Monitoring Software**

1. Multi-threaded software with interactive software oscilloscope to adjust gain, trigger modes, and Trigger/Qualifier thresholds
2. Real-time processes with multi-window displays for processing/visualizing:
    a. Probe health and data quality checks
    b. Blade Stack with limit checking
    c. Analog data plots
    d. All Blades Waterfall with Probe Differences
    e. Flutter or non-integral (non-synchronous) vibration with limit checking and Campbell Diagram
    f. Integral (synchronous) vibration data with limit checking and Campbell Diagram
    g. Data is corrected for extra and missing blades
    h. Data continuously streamed to storage media and during user defined data points

***echo*Process Post-Processing Software**

1. Software package compatible with NCT native data files and the Industry Standard data file formats as defined by ANSI/ISA 107.1-2013 (other data formats as required)
2. Probe health check performed upon opening data file
3. Auto time stamp correlation between all probes selected to be processed
4. Blade stack display with auto-correlation between probes
    a. Blade stack data saved to *.csv files
5. Spike rejection filtering to remove random noise spikes
6. Low pass or high pass filtering of data with user selectable cutoff
7. Interactive selection of zero regions with option to load a template from a *.csv file
8. Probe difference waterfall to view probe differences based on Engine Order input
9. Analog data plotting and long-term trending versus processed tip timing data
10. Non-integral data processing with waterfall, max amplitude/frequency/speed/nodal diameter, and Campbell Diagram plots for individual blades and system mode responses (Traveling Wave)
    a. Data saved to *.csv files
11. Integral data processing with max amplitude/frequency/speed/phase/damping, and Campbell Diagram plots for individual blades
    a. Sine Wave Analysis Technique (SWAT) – uses multiple probes to curve fit and calculate amplitude/frequency/phase
        i. Auto detect Engine Order available when using SWAT
    b. Single Degree of Freedom (SDOF) – uses a single or difference of two probes to calculate amplitude/frequency/phase
    c. All processed data saved to *.csv files