January 16, 2018 Project No. 1668031-1000-L03

North Kent Wind 1
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PHASE 3B: OPERATIONAL VIBRATION MONITORING PROGRAM
DATA COLLECTION AND MANAGEMENT
NORTH KENT WIND 1 PROJECT
CHATHAM-KENT, ONTARIO

This letter summarizes the second of two parts of the Phase 3 work plan to carry out vibration monitoring during operation of wind turbines within the North Kent Wind 1 facility (Project). As with previous vibration monitoring, this work plan is developed as part of Section H1 of the Renewable Energy Approval (REA) 5272-A9FHRL issued by the Ontario Ministry of the Environment and Climate Change (MOECC). This monitoring plan shall commence after the NK1 wind Project Commercial Operation Date following the commissioning period.

To facilitate approvals and address design aspects of the foundations and construction scheduling, the Phase 3 work plan has been separated into two components:

- Phase 3A: Instrumentation Design
- Phase 3B: Monitoring Program

Phase 3A, previously submitted and approved, identified the various instruments that will be installed as part of this work plan. This letter provides Phase 3B details related to the methods and frequency of collection and management of vibration monitoring data along with reporting.

Vibration data will be collected from the instruments identified in the Phase 3A work plan. These instruments are located on the turbine foundations at turbines T23, T41, T51 and T42. In addition, new well casings (termed “mock wells” since they will not be used for water supply) will be installed at the T23, T41, T51 sites. As described in the Phase 3A work plan, these well casings will be used as a means of collecting vibration measurements as a direct comparison to conditions that could be experienced by the similar privately-owned well casings in the Project area. Accelerometers will be installed on the well casings near the ground surface, similar to the instrumentation used for the construction phase vibration monitoring (Phase 2), and into the bedrock at the bottom of the mock wells. Additional information related to equipment and software for Phase 3B components are attached to this work plan.

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Data Collection and Management

During initial implementation of the Phase 3 data collection program, data will be collected from the mock well instruments using either an eight-channel Crystal Instruments (CI) Spider 80X data logger or two four-channel CI Spider 20 data loggers per mock well which will sample the accelerometers and thermocouples at a rate of 250 Hz. These data loggers will be powered by solar cells and the batteries, data loggers, accelerometers and top of mock well casings will all be enclosed within a steel protective box that will be locked.

Initially, data from the mock well instruments will be collected using the self-contained memory modules that permit up to 5 days of data storage. Data will be stored in 10 minute file increments (i.e., 10 minute blocks of data collected at 250 Hz) to assist with reducing data loss risks from power or equipment outages. Golder staff will periodically visit the mock well locations, check equipment performance, down-load data to Golder computers and the data will be subsequently stored on Golder's fully-backed up network server systems (see attached information). This approach allows collection of mock well data in the event of a well interference complaint prior to implementation of the remote data logging and reporting systems.

For long-term monitoring of the turbine-mounted and mock well instruments, and to minimize labour requirements, all data loggers will be connected to the solar power and remote communications (cellular modem) components of a Larson Davis EPS044/NMS044 Noise Monitoring System. Long-term data collection will only use the CI Spider 80X data loggers that are powered by external batteries (to reduce concerns regarding summer-time overheating of batteries in portable systems) with recharging via a dedicated solar power system for each data logger. These systems are being custom built and factory tested for the long-term implementation plan. The steel protective boxes will also be insulated, vented and cooled during summer months using a separate ultra-quiet, low-vibration computer fan and solar power system.

Long-term data collection will be managed by a joint data acquisition and reporting system comprised of Crystal Instruments EDM Dynamic Signal Analyzer (DSA) software and Golder's proprietary internet-based GIDIE instrumentation data management systems (see attached information). The core elements of the GIDIE system, identified for the MOECC as the Central Data Management System, were developed more than 20 years ago and used successfully for nearly 3 years as part of the long-term MOECC water well monitoring program (see attached information). Since then, the system has been updated for system security, hardware and user interfaces, but the core functionality and transparency of data acquisition and storage remain. This system has been used for major projects in Ontario and worldwide, including for government agencies and Crown corporations such as Metrolinx, the Toronto Transit Commission, Niagara Parks Commission and Ontario Power Generation. A copy of a third-party review of Golder's data management systems is attached for additional information.

Both data management and software systems will be configured to send/receive data on a set schedule (e.g., daily, hourly) that, if project requirements dictate, can be adjusted. The data acquisition systems will also be programmed to frequently query the data loggers throughout each day simply for functionality as a means to indicate whether the data logging systems are operational. An automated system will alert appropriate Golder staff if problems with the data logging (i.e., no response) are detected. Data will be collected in raw form such as acceleration and temperature (or voltage) with time. The EDM DSA software will be used to process the accelerometer data to velocity and GIDIE will collect all data streams. Once data is received, it will be loaded and processed via GIDIE. Alerts, alarms and "out of range" triggers will be immediately initiated on the processing of the data. GIDIE stores a copy of all raw data received from data loggers within the Golder IDMS infrastructure along with any data processed by EDM DSA or GIDIE (GIDIE can also include mathematical functions such as calibration constants, logical operations and direct algebraic transformations). All data stored on the Golder IDMS

infrastructure has data changes backed up every 4 hours, complete backups daily and off-site backup every 3 days.

While this work plan includes appropriate steps for reducing the chances of data loss, risks of data loss remain, as with any field instrumentation program where such loss may result from factors such as: unanticipated weather events (e.g., lightning strikes), equipment damage (e.g., farm equipment collision), equipment tampering, equipment theft, equipment or power failure. As noted in the Phase 3A operational vibration monitoring work plan, contingency plans have been identified to address equipment failures. If, during the course of monitoring program implementation, the data alarms (as described above) identify issues, the Project will be notified along with an appropriate course of action to resume data collection as soon as practicable.

Data Analysis and Reporting

Transient vibration sources occurring at relatively random intervals, such as traffic on the nearby roads and movements of farm equipment, could adversely affect appropriate evaluation of subsurface vibration data unless these conditions are planned for in advance. Vibrations associated with turbine operations are expected to differ from the transient pile driving vibrations measured during construction and exhibit longer duration, more regular and sinusoidal characteristics with magnitudes and frequencies being variable based on wind direction, wind speeds, turbine tower responses and other factors. To reduce the potential for comparatively short-duration and random transient vibrations to adversely and inappropriately obscure longer duration turbine-generated vibrations the following approach will be used:

- acceleration and time history data will be preserved for each of the 10 minute data blocks (as defined above);
- velocity will be calculated for 1 second intervals of data using the conventional fast Fourier transform methods as defined in previous work for this project and the EDM software and retained to provide a velocity time history for the 10 minute data blocks;
- average velocity values for 10 minute periods will be calculated for the full 10 minute data file as the basis for data reporting to correspond with use of the 10 minute average average wind speeds in the International Electrotechnical Commission *"International Standard IEC 61400-1, Wind Turbines, Part 1: Design Requirements"* and the World Meteorological Organization (WMO) *"Guide to Meteorological Instruments and Methods of Observation, WMO-No. 8"*; and
- a signal analysis will also be completed for the entire 10 minute data file.

If a well complaint is reported to the Project or MOECC at any time during the program once the mock well instruments are in place, data from the mock well instruments will be analyzed to provide the maximum and average particle velocity values for the 1 second and 10 minute data blocks for each of the instruments (surface and subsurface) for each of the three mock wells for either:

- the 10 minute time period during which the maximum power was generated for the turbines nearest the mock wells;
- the 10 minute period during which the maximum 10 minute average wind speed occurred; or
- any 10 minute period during which the turbine emergency brake(s) were applied.

Images representing the acceleration and velocity time histories will be provided if and as appropriate to illustrate the effects, if any, of transient sources on the output.

The conditions identified above should be representative of the worst conditions experienced during any given day with respect to vibration generation and this information will be evaluated for the day before, the day of and the day after the complaint was reported or the date specified within the complaint on which the well conditions were observed. Golder assumes that the 10 minute period for which the maximum power or maximum average wind speed occurred will be defined and provided to Golder by others for the day before, the day of and the day after the complaint/condition was reported. These data will be compared to subsurface vibration data gathered prior to operation of the turbines as background conditions.

During the course of long-term vibration monitoring, data will also be collected from the instruments installed on the turbine foundations at T23, T41 and T51 and on the tower and subsurface instruments at T42. Implementation of the long-term remote monitoring of the turbine structures themselves will require installation and testing of some instrumentation components once the turbines are in operation.

Once final testing of the fully remote data collection system is completed, anticipated to occur approximately one month after the Project Commercial Operation Date, GIDIE will be used as a web-based portal for on-going data reporting. Remote access will be granted to specified Project users with appropriate clearance for viewing data in near “real-time” conditions. At a pre-arranged time and date, Golder will host a brief presentation on use of the GIDIE system for observing on-going data collection to those individuals selected by the Project as authorized users.

At this time, remote reporting via the GIDIE internet portal is anticipated to include the following:

- Well casing velocities at mock wells T23, T41 and T51;
- Velocities measured by in-rock instruments at mock wells T23, T41 and T51; and
- Velocities measured by in-rock instrument in at least one subsurface location at T42.

These parameters are considered indicative of the deep ground vibration responses to turbine operations. As monitoring progresses, data from instruments mounted on the turbine structure components as defined in the Phase 3A instrumentation program may also be included in the remote reporting tools.

All data will be evaluated over the course of the first 6 months of collection to identify, to the extent practicable, relationships that may exist between wind velocities, turbine operations (all turbines on, all off, some on and some off, etc.), tower responses, foundation responses, bedrock responses near the T42 turbine and responses measured by the well casing (surface) and in-rock instruments at the mock wells. This six month period for development of relationships among these various measurements will be essential to capture the effects of natural wind speed and operational variables on overall response patterns and to devote an appropriate level of effort to examining signal to noise ratio variables and other influences on the overall vibration environment. At the conclusion of the six month monitoring period a report will be prepared summarizing:

- historical system data noting peaks, data anomalies and graphical presentations of typical response patterns;
- system performance issues, if any;
- implementation of contingency plans, if needed;

- interpretation of the data with respect to the effects of the turbine operations on subsurface ground vibration magnitudes, frequencies and distances to receptors with operation and meteorological data provided to Golder by the Project as appropriate; and
- recommendations related to future reporting frequencies and changes to the monitoring program if any should be identified.

During the remaining 30 months of the monitoring program, update reports will be prepared annually, documenting any changes, following the information content as defined above.

We trust that this Phase 3B operational vibration monitoring program is sufficient to permit start of the work. Further, we expect that the program, as identified above, should be sufficiently flexible to allow adaptation to concerns if and as they may be identified with respect to on-line data reporting, the frequency of reporting of more detailed analyses or if other monitoring criteria are subsequently developed.

Yours truly,

GOLDER ASSOCIATES LTD.

Storer J. Boone, Ph.D., P.Eng.
Principal

SJB/MEB/cr

CC: J. Vaidyan, Samsung
Jody Law, Pattern Energy

Attachments: IM Security
EDM DSA Software Specifications 6.1
Gidie
Spider 80X Specification 6.1
Spider 80Xi Specification 1.1
Project Profile - Provincial Groundwater Monitoring Network

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Tracking Number		Question/Request	Response	Additional Information
	RISK ASSESSMENT	A. Risk Assessment and Treatment		
A.1	Risk Assessment Program	Is there a risk assessment program that has been approved by management, communicated to appropriate constituents and an owner to maintain and review the program? If so, does it include:	Yes	Charlie Voss, Global Head of Risk heads up Golder's Risk Management Function. Information Security Risks are captured as part of this process.
A.1.1	Conducted in last 12 months	A risk assessment, conducted within the last 12 months?	Yes	Yes, Risk Assessment is an ongoing process with monthly review.
	SECURITY POLICY	B. Security Policy		
B.1	Approved Security Policy	Is there an information security policy that has been approved by management, communicated to appropriate constituents and an owner to maintain and review the policy? If so, does the policy contain:	Yes	Our information security policy and procedures were published in 2014 and align to the ISO27000 Standard framework for information security. These have been incorporated into our Integrated management system.
B.1.3	Awareness Training/Education	Security awareness training/education?	Yes	Infosec awareness is delivered by the Information Security Office and incorporates both general awareness and specific training for roles.
	ORGANIZATION SECURITY	C. Organizational Security		
C.1	Security initiatives	Is there an information security function responsible for security initiatives within the organization? If so, does it include:	Yes	This is the Information Security Office
C.1.6	Review incidents	Review and monitor information security / privacy incidents or events?	Yes	The Information Security Office has established Incident Management procedures which can be invoked in the event of an incident. This process includes monitoring.
	ASSET MANAGEMENT	D. Asset Management		
D.2.1	Asset classification policy	Is there an information asset classification policy or program that has been approved by management, communicated to appropriate constituents and an owner to maintain and review the policy?	Yes	Asset Management, including classification forms part of our information security procedures.
	HUMAN RESOURCE SECURITY	E. Human Resource Security		
E.2	Background screening	Is a background screening performed prior to allowing constituent access to Scoped Systems and Data? If so, does it include:	Yes	Background Checking is in place for specific roles within the organisation with access to sensitive data.
E.2.1	Criminal	Criminal?	No	Criminal background checks can be done upon request.
E.3	New hire agreements	Are new hires required to sign any agreements upon hire? If so, does it include:	Yes	
E.3.2	Code of Conduct / Ethics	Code of Conduct / Ethics?	Yes	
E.4	Security awareness training program	Is there a security awareness training program? If so, does it include:	Yes	Security Awareness is made available to all employees, including videos, articles and guidance.
E.4.1	Security policies, procedures and processes	Security policies, procedures and processes?	Yes	
	PHYSICAL AND ENVIRONMENTAL CONTROLS	F. Physical and Environmental Security		
F.1	Physical security program	Is there a physical security program?	Yes	
F.2		Do the Scoped Systems and Data reside in a data center? If yes, are the following controls in place:	Yes	Rogers Data Center
F.2.13	Data centre access	Is access to the data center restricted and logs kept of all access?	Yes	
	COMMUNICATIONS AND OPERATIONS	G. Communications and Operations Management		
G.1	Operating procedures utilized	Are Management approved operating procedures utilized? If so, are they:	Yes	These are included within our Information Security Procedures.
G.1.1	Documented, maintained, and made available	Documented, maintained, and made available to all users?	Yes	
G.3	Application development performed	Is application development performed? If so, is:	Yes	
G.3.1	Development and test separate from production	Development, test, and staging environment separate from the production environment? If so how are they separated:	Yes	
G.3.1.0.1	Logically	Logically?	Yes	
G.3.1.0.2	Physically	Physically?	No	Dev / test / staging sit on separate Virtual Appliances, typically within the same host.
G.3.1.0.3	No segregation	No segregation?	N/A	
G.4	Third party vendors	Do Subcontractors have access to Scoped Systems and Data? (backup vendors, service providers, equipment support maintenance, software maintenance vendors, data recovery vendors, etc.)? If yes, is there:	No	
G.10	Wireless networking technology used	Is wireless networking technology used? Is so, is there:	Yes	Guest wireless access is completely separated from the corporate network.
G.10.4	Strong encryption	Encrypted using strong encryption (WPA2 or higher)?	No	No – WPA only
G.10.7	VA, scans or pen tests	Are vulnerability assessments, scans or penetration tests on internal or external networks performed at least annually? If yes, are they:	No	Tests are performed but unsure how often wireless is tested.
G.10.7.1	performed by trained personnel	Performed by trained and experienced personnel?	N/A	
G.10.8	External network connections	Are there external network connections (Internet, extranet, etc.)? If yes, is there:	Yes	
G.10.8.1	security and hardening stds	Security and hardening standards for network devices (baseline configuration, patching, passwords, access control)?	Yes	Technical Security Baselines for core infrastructure have been developed by the Information Security Office.

G.10.8.1.1	regular review of network devices	Regular review and/or monitoring of network devices for continued compliance to security requirements?	Yes	
G.10.8.2	devices configured to prevent comms from unapproved networks	Are network devices configured to prevent communications from unapproved networks?	Yes	
G.10.8.3	devices deny access by default	Do network devices deny all access by default?	Yes	All network devices are provisioned based on permissions within our Active Directory. Access is denied unless those privaliges are applied.
G.10.8.4	process for access across devices	A process to request, approve, log, and review access to networks across network devices?	No	
G.10.8.5	network traffic logged	Network traffic logged to support forensics? If yes, do logs contain:	No	
G.10.8.5.6	log failure alert	In the event of a network device audit log failure, does the network device generate an alert and prevent further connections?	No	
G.10.8.5.7	audit log overwrite disabled	Is the overwriting of audit logs disabled?	No	
G.10.8.6	network device security patches	Are security patches reviewed and applied to network devices?	Yes	
G.10.8.7	device install approval process	Is there an approval process prior to installing a network device?	Yes	
G.10.8.8	ports approval process	Is there an approval process for the ports allowed through the network devices?	Yes	
G.10.8.9	network segments isolated	Are critical network segments isolated?	Yes	
G.10.8.10	unauth devices connecting to network	Is there a process to prevent unauthorized devices from physically connecting to the internal network?	No	Would need Active Directory credentials to complete operations but no Network Access Control is in place.
G.10.8.11	content filtering proxy	Are internal systems required to pass through a content filtering proxy prior to accessing the Internet?	No	
G.10.8.12	extranet connections	Is there an approval process to allow extranet connections?	Yes	
G.10.8.13	Insecure protocols (telnet)	Are insecure protocols (telnet) used to access network devices?	No	
G.10.8.14	diagnostic ports	Is access to diagnostic or maintenance ports on network devices restricted?	Yes	
G.10.8.15	remote access network segment	Is there a separate network segment or endpoints for remote access?	Yes	
G.10.8.16	firewall rules reviewed	Are firewall rules and network access control lists regularly reviewed?	Yes	
G.10.8.17	DMZ	Is there a DMZ environment within the network that transmits, processes or stores Scoped Systems and Data? If yes, is it:	Yes	
G.10.8.18	IDS/IPS deployed	Is Intrusion Detection/Prevention System employed in all network zones? If yes, does it include:	No	Host based IDS is in place, however no Network IDS is currently in place.
G.12	Data sent electronically or physically	Is Scoped Data sent or received electronically or via physical media? If so, is there:	Yes	
G.12.1	External transport encryption	Encryption in transit while outside the network?	Yes	
	ACCESS CONTROL	H. Access Control		
H.1	Electronic systems access scoped systems and data	Are electronic systems used to transmit, process or store Scoped Systems and Data?	Yes	
H.1.1	Owned, approved, and educated access control policy	Is there an access control policy that has been approved by management, communicated to appropriate constituents and an owner to maintain and review the policy?	Yes	Incorporated into the Information Security procedures.
H.3	Application development performed permitting developers to:	Is application development performed? If so, are developers permitted to:	Yes	
H.3.1	Access production environments	Access production environments, including read only access?	Yes	
	INFORMATION SYSTEMS	I. Information Systems Acquisition Development & Maintenance		
I.1	Business information systems	Are business information systems used to transmit, process or store Scoped Systems and Data? If so, are:	Yes	
I.1.1	Security requirements documented	Security requirements documented?	Yes	Incorporated in to the Information Security procedures.
I.3	Systems and applications patched	Are systems and applications patched? If so, does the process include:	Yes	
I.3.5	Third party alerts	Are third party alert services used to keep up to date with the latest vulnerabilities?	Yes	
I.4	Web site interfaces	Is a web site supported, hosted or maintained that has access to Scoped Systems and Data? If so, are these controls in place:	Yes	
I.4.3	Follow best practices or security guidelines	Web applications configured to follow best practices or security guidelines (OWASP)?	Yes	
	INCIDENT MANAGEMENT	J. Incident Event and Communications Management		
J.1	Incident Management program	Is there an Incident Management program?	Yes	
	DISASTER RECOVERY	K. Business Continuity and Disaster Recovery		
K.1	Business continuity policy	Is there a documented policy for business continuity and disaster recovery that has been approved by management, communicated to appropriate constituents and an owner to maintain and review the policy?	Yes	Incorporated into the Information Security procedures.
	COMPLIANCE	L. Compliance		
L.1	Issues are identified, tracked and resolved	Is there an internal audit, risk management or compliance department with responsibility for identifying and tracking resolution of outstanding regulatory issues?	Yes	

	MOBILE	M.Mobile		
M.1	Mobile Devices	Are mobile devices able to access Scoped Systems and Data	Yes	
M.1.18.3	Mobile SDLC	Is there a mobile software development lifecycle (SDLC) process? If yes, does it include:	N/A	As a website, the system is accessible by mobile devices with internet capability, but no mobile-specific application is being developed for this version.
	PRIVACY	P.Privacy		
P.1	Who handles privacy compliance	Is there a dedicated person (or group) responsible for privacy compliance? If yes, provide name and phone number. If no, explain reason.	No	No Data Privacy Officer in place, however some requirements are incorporated into the Information Security Office responsibilities under the control of our CISO, Paul Beswick +447456541613
P.4	Frequency of Privacy awareness training	Is there formal privacy awareness training for employees, contractors, volunteers (and other parties, as appropriate)? If yes, provide frequency and scope. If no, explain reason.	Yes	Training available as part of the information security office T&A programme.
P.7	Collected directly from individuals	Is personal information collected directly from individuals as a service to the client? If yes, describe the information collected.	N/A	The only information collected when creating a new user is their work email address.
P.7.4	Client notice is given before the collection	If personal information is collected directly from individuals as a service to the client, are individuals from whom personal information is collected provided with appropriate notice? If yes, describe. If no, explain reason.	N/A	

CRYSTAL INSTRUMENTS

EDM DYNAMIC SIGNAL ANALYZER (DSA)
SOFTWARE SPECIFICATIONS (v6.1)

WWW.CRYSTALINSTRUMENTS.COM

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INTRODUCTION

EDM (Engineering Data Management) is a PC-based software program designed for real-time data management and processing. This easy to use, Windows native software manages the communication between the PC and all Crystal Instruments hardware platforms. Real-time processing functions include basic FFT, FRF, transient capture, octave filter, user-defined digital filter, sound level meter, order analysis, automated alarm limit in both time and frequency domain, and throughput recording. Various time and frequency signals can be played back or post-processed. EDM includes a user interface in multiple languages. Template based report functions provide testing results in seconds. Reports are conveniently generated in Microsoft Office 2007 files, LibreOffice files, and PDF files.

Test Management

Tests are managed through a MSSQL Server database. Signal files, test setup, and UUT (machine) information are stored in the database. The user can search the previous tests using keywords, time, or date information. The database may be installed on local computer or a server on LAN.

Spider Hardware System Management

A Spider system consists of one or more Spider front-ends. The user constructs the system by combining Spider front-ends on the same LAN. The software validates and displays hardware attributes of each Spider front-end.

User Management and Access Code Control

The administrator can edit access privileges of other users. Each Spider front-end has its own access control code to prevent unauthorized access.

Black Box Mode: Running Without PC

A supported front-end can operate in Black Box mode which allows it to acquire data without a PC. In this mode, a PC is used only to configure the system before the test and then to download the data after the test is complete. During the test, the front-end can be operated according to a preset schedule or from a variety of external devices, such a Wi-Fi enabled PDA or iPad. For hardware with version 7.3 and higher, up to 8 tests can be uploaded and stored on each front-end.

Self-Test

Verifies the condition of the input and output channels using a precise internal signal source. Test validates that the input channels are within the manufacturer's tolerances.

Engineering Units

The user selects the preferred physical quantity at the user interface level with corresponding Engineering Units (EU). Transducer sensitivity (mV/EU) can be set for each input channel. Typical physical quantities include acceleration, velocity, displacement, force, strain, torque, temperature, voltage, angle, phase, resistance, tacho speed, pressure, voltage, time, frequency, angular velocity, current, sound pressure, and mass.

Measurement Data Storage

- Data Format: compliant with ASAM-ODS hierarchy and structure
- Data Precision: data saved in 32 bit (4 byte) words with single floating point precision
- Signal Data Structure: all signals are combined and saved into one file per each save command executed

Export Data File Formats

- ASAM-ODS XML: ASAM Open Data Source binary format (default, recommended)
- UFF ASCII: ASCII format of UFF files
- UFF Binary: binary format of UFF files
- ASCII: User-defined format with selectable attributes.
- Excel CSV: Comma Separated Value, CSV, can be opened directly in Microsoft Excel
- MATLAB: *.mat binary format can be opened and analyzed using MATLAB
- .WAV: sound wave files

Import Data File Formats

ASAM-ODS XML, UFF ASCII, UFF Binary, ASCII, Excel CSV, SIG

Languages

English, Russian, Japanese, Simplified and Traditional Chinese are available. Languages can be switched without reinstalling software.

Report

Testing reports are directly created in the Open XML format that can be read by Microsoft Word or many open source Office tools. Reports can also be created in Microsoft word (.doc / .docx) formats as well as PDF format. Fields and attributes are customizable. Logo and report layout preview are provided.

3D Signals (Waterfall and Colormap Display)

3D signal waterfall displays are available for block signals in all types of tests. 3D signals can be plotted with reference to Time or RPM (when tachometer input is available). User customizable trace number and reference axis settings are available for both Time and RPM reference axes.

- Maximum traces in a 3D signal: 500
- Reference Axis: Time, RPM1, RPM2, RPM1_Up, RPM1_Down, RPM2_Up, RPM2_Down
- Minimum time resolution: 10 ms
- Minimum RPM Resolution: 10
- Maximum 3D plots (8 enabled channels) with maximum traces: 32 per module

Digital I/O Interface

Each Spider-81 front-end has 8 isolated digital inputs and 8 isolated digital outputs (Spider-81B/80X/80Xi has 4 of each), corresponding to the pins on the Digital I/O connector, which is used to send and receive low level electrical signals to and from other devices to coordinate their operation during a test.

Configurable Actions for Digital Inputs: start test, flash screen, beep, create report, capture screen, send socket message, send emails, set digital output signals, start recording, stop recording, save signals in the list, reset average, top the test, limit check on, limit check off

Configurable Digital Input and Output: each isolated pin is configurable to be used as a digital input or output. This flexibility allows users to change the number of digital inputs or outputs according to their application. (Available for Spider-80X/80Xi only.)

Output Pulse Types: High-Low, Low-High and variations

Test Sequence

Create a list of tests and run them sequentially. Test sequences

can be initiated and controlled by a user command, digital input event, or Windows socket message.

Send Emails and IM as Event-Actions
The ability to send emails or instant messages as custom actions in response to a system or user event. Content of emails can be customized.

Remote Operation Communication using Socket Messages
Communicate with and control Spider systems remotely with Window socket messages. Socket messages also allow communication with other hardware, such as temperature chambers. Please refer to the Socket Message document for detailed specifications.

System Failure Protection
Power Loss Emergency Shutdown: When a power loss is detected, the system will save all test data into non-volatile flash memory and safely shut down.

Ethernet Connection Loss Detection: When a network loss is detected, the system can be configured to either save all data and ramp down the test or continue running the test in Black Box mode.

Input Channels
- Location ID: labels the physical point of UUTs or machines. Location ID is used to name signals.
- Level Display: bar graph displays the input level of each channel with 4 grids. Automatic IEPE sensor detection.
- Sensitivity: user-defined with engineering unit and input sensitivity setting
- Input Types: AC/DC, differential or single-ended, IEPE, Charge coupling
- Integration/Differentiation: when acceleration is selected as the measurement physical quantity, integration or double integration can be applied to obtain velocity or displacement quantity. When velocity is selected as the measurement quantity, integration or differentiation can be applied to obtain displacement or acceleration.
- Digital High-Pass Filter: user-defined cutoff frequency

Event-Action Rules
The software can be controlled based on user commands or a sequence of events and user defined rules of actions. For example, a trigger can be set as an event, save signals can be set as an action caused by this event. The user can insert multiple events into a run schedule.

Event Type: system generated events or user-defined events: connection lost, triggered, user-stop, channel overload, output maximum, limit exceeded, average number reached, download complete

Actions: flash screen, beep, create report, capture screen, digital output (user defined pin), start recording, stop recording, save signals, reset average, send email, send message to other program, stop the test, limit check on, limit check off

Output Channels
The output channels provide signal sources and generate user determined waveforms. Multiple output channels may generate signals independently or simultaneously. The Spider-80X/80Xi is equipped with two output channels but only one is enabled. An option (DSA-30) is available to enable the second output.

Output Types: Sine, Triangle, Square, White noise, Pink noise, DC, Chirp, Swept sine, Arbitrary waveform, Shaped random, Playback

Arbitrary Waveform: Outputs a user defined time signal of up to 1 giga points in length at a sampling frequency of 1 KHz. User defined file in ASCII format can also be imported.

Shaped Random: Outputs a random noise signal with a user defined frequency shape. Power spectrum data, in various file formats, can be imported, modified, and used as the spectrum profile. An imported or user defined profile can be created/modified by creating/editing or deleting the breakpoints. Refer to import file formats for signals of available file formats.

Playback: Outputs a time recording file which can be selected by the user. Recording file formats of ASAM-ODS XML, CI-ODS, ASCII, Excel CSV are supported. Supports recording files up to the maximum available memory on Spider flash.

RPM Measurement
Tachometer channels are available to take RPM measurements while performing order tracking, FFT analysis or acoustic analysis. In addition, RPM time trace recording or RPM time stream recording can be done on the same channels. The new hardware versions (Spider-80X version 7.5 and above, and Spider-80Xi) have output channels that act as dedicated tachometer channels. The older version of hardware including the Spider-81 can use any of the input channels as the dedicated tachometer channels.

Strain Measurement
As an integrated function into the DSA mode, strain can be measured with the Spider-80SG hardware. Full, half and quarter bridge configurations are compatible. The advantage of this integrated design is that FFT spectral analysis can be run along with strain measurement simultaneously.

Shunt Calibration consists of three convenient steps. 1. Locating the shunt resistor 2. Measure the input 3. Finalize calibration. The software allows the user to switch the location of the shunt resistor between available bridge legs.

Offset-Nulling function makes the bridge-balancing process easy. It can be done with Shunt calibration simultaneously in one step, resulting in a balanced and calibrated strain gage.

Remote Sensing function makes long-distance measurement possible. This function allows the user to locate the UUT further away from the Spider-80SG and measure strain with the same accuracy.

Test Parameters: several test parameters are included in the channel table including strain gage type, excitation voltage, gain factor, Poisson ratio etc. which could be set and configured as necessary.

Review Mode
Review Mode is used to recall multiple saved signals in a user-defined format. When signals are saved to a PC, the parameters (such as level, RMS, elapsed time) of the test are also saved to the same file. The signals, along with the test parameters and run log values, are viewable under Review Mode. Reports including selected runs may be generated in Review Mode.

Timer Control (Only Available on the Spider-20/20E)
The timer setting function for the Spider-20/20E allows the user to set up a time to automatically to turn on/off the device. For long term data monitoring and acquisition, it extends the acquisition time of the Spider-20/20E by turning the device off when acquisition is not required.

PREMIUM FFT SPECTRAL ANALYSIS (DSA-10)

- The FFT Spectral Analysis provides comprehensive data acquisition and FFT analysis. ***Acquisition Mode*** controls how the data is acquired block-by-block and processed with the signal analyzer functions. These time blocks can be either gap-free, overlapped, or with gaps, depending on the acquisition mode selection. ***Sampling Rate*** can be set directly from the control panel. 54 sampling rate stages are available and can be changed without stopping data acquisition. 3D waterfall processing allows the data to be acquired and processed in real time with either RPM or time as additional axis. Output has a dozen signal source types to excite the testing articles.

Frequency Signal Analyzer Functions

- Maximum Input Channels in a System: 512
- Transient Time Block Size: up to 256,000 points for 1 channel per Spider front-end, up to 16,000 points for all channels.
- FFT Block Sizes: 256 –32,768 for up to 128 channels, 256 –65,536 for 1 channel per Spider front-end, up to 16384 for 512 channels
- FFT Spectral Lines: 100–14,400 for all input channels, 100 –28,800 for 1 channel per Spider front-end
- Data Window Functions: Hanning, Hamming, Flattop, Uniform, Kaiser-Bessel, Blackman, Force, Exponential, Force-Exponential
- Averaging: exponential, linear, peak hold
- Time Trace: RMS, Peak, RPM (if enabled) vs. Time
- Spectrum Types: linear spectrum, auto power spectrum, frequency response function, coherence, cross power spectrum, phase spectrum
- PC FRF Function: H1, H2, H3 and Hv
- Auto Spectrum Type and Scaling: linear spectrum with peak or RMS scaling, power spectrum or power spectrum density with RMS scaling (Spectrum Units: EUpk, EUrms, EUrms2, EU2/Hz, EU2•s/Hz), sqrt(EU2•s/Hz))
- APS view: as FFT or Octave of 1/1, 1/3, 1/6, 1/12, 1/24
- Overlap: free-run, 25%, 50%, 75% or 90%
- Correlation Functions: auto and cross correlation functions
- Display of complex spectrum: bode plot, Nyquist plot
- Resonance search and report for FRF signals: Includes automatic calculation of user customizable resonance peaks, saving peak values and creating reports on any FRF signals.

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Real-Time Processing Performance
Real-Time Spectral Bandwidth: 46 kHz when all inputs are enabled for full spectral analysis (except octave analysis and sound level meter)

Acquisition Mode

- Mode Selection: free-run, continuous after trigger, single shot with trigger, single shot without trigger, auto-arm trigger, manual-arm trigger
- Trigger Conditions: trigger source > high level (rising edge); trigger source < low level (falling edge); low level < trigger source < high level; trigger source > high level OR trigger source < low level (bi-polar)
- Trigger Delay: ±100% of block size
- Trigger Setup Display: a special display view is created for trigger setup. User selects the acquisition mode, trigger source, trigger level, trigger delay, and trigger condition
- Trigger Run-Time Display: in manual arm-mode, a smaller window will pop up for the user to accept or reject the transient captured signals. Only accepted signals are averaged into the spectra.

Math Functions Applied to the Signals

- RMS: apply RMS estimation to an input data stream and generate a continuous output time stream
- Peak: extract the peak or peak-peak value over a period of time and generate a time stream
- Includes long time PC recording for the Peak and RMS time streams.
- Math Modules: abs, +, -, *, /, square, square-root, log, and offset scale.
- Offset Scale: apply a multiplier gain and an offset to any input data stream and generate the output stream continuously

STANDARD FFT SPECTRAL ANALYSIS (DSA-10-C04)

This option is the same as Premium FFT Spectral Analysis (DSA-10) with following limitations:

- FFT lines up to 3200
- No 3D waterfall display
- No Tacho and RPM measurement
- Output is not enabled

OCTAVE ANALYSIS AND SOUND LEVEL METERS (SLM) (DSA-11)

Both Octave filter and Sound Level Meters are implemented based on high precision real-time filters. FFT Spectral Analysis, Octave Analysis, and Sound Level Meter analysis can be executed at the same time.

Octave Filter Analysis

- Maximum Input Channels in a System: 512
- Standards: conforms to ANSI std. S1.11:2004, Order 3 Type 1-D and IEC 61260-1995
- Filter Implementation: real-time digital filters
- Frequency Weighting: A, C, Z comply with IEC 61672-2002 class 1. B complies with IEC 60651-1979 type 0.
- Octave Fractional Resolution: 1/1, 1/3, 1/6, 1/12
- Frequency Range (Band centers):
  1/1 Octave: 0.125 Hz to 16 kHz, up to 18 filters on each of all 8 channels
  1/3 Octave: 0.1 Hz to 20 kHz, up to 53 filters on each of all 8 channels
  1/6 Octave: 0.1 Hz to 20 kHz, up to 107 filters on each of all 8 channels
  1/12 Octave: 0.1 Hz to 20 kHz, up to 213 filters on each of all 8 channels
  1/24 Octave: 0.1 Hz to 20 kHz, up to 424 filters on each of all 8 channels
- Midband Frequencies: base 10 complies with ANSI std. S1.11:2004 Annex A
- Average Type: linear, exponential, peak hold, time linear, time exponential
- Time Weighting: fast, slow, impulse
- Accuracy: < 0.2 dB (1 second stable average, single tone at band center)
- Dynamic Range: from typical noise floor to maximum level for a pure tone signal at 1 kHz:-23 – 111 dB (1/3 Octave, 2 second stable average) per ANSI S1.11:2004

Sound Level Meter Analysis

- Maximum Input Channels in a System: 512
- Standards: conforms to IEC 61672-1 2002
- Filter Implementation: real-time digital filters
- Frequency Weighting: A, C, Z comply with IEC 61672-2002 class 1. B complies with IEC 60651-1979 type 0
- Time Weighting: fast, slow, impulse (complies with IEC 61672-2002)
- Average Time Interval: from 0.125 seconds to 24 hours. Unique moving linear averaging method allows independent setting averaging time interval and time trace update rate.
- Linear Operating Range: 110 dB
- Inherent Noise: A: -10 dB or less, B: -13 dB or less, C: 1 dB or less, Z: 16 dB or less
- Measurement Range: A: 0 to 110 dB, B: 0 to 110 dB, C: 5 to 110 dB, Z: 20 to 110 dB
- Measurement Types: time-weighted sound level (L), time-averaged sound level (L_{eq}), sound exposure level (L_E), peak sound level (L_{peak}), peak C sound level (L_{Cpeak}), maximum time-weighted sound level (L_{max}), minimum time-weighted sound level (L_{min}), maximum time-averaged sound level (L_{eq-max}), minimum time-averaged sound level (L_{eqmin}), statistical sound level (L_N) and statistical sound level distribution (dB Histogram).

	Time Weighting	Frequency Weightings			
		Z	A	B	C
Time-Weighted Sound Level (L)	**F (Fast)**	L_{ZF}	L_{AF}	L_{BF}	L_{CF}
	S (Slow)	L_{ZS}	L_{AS}	L_{BS}	L_{CS}
	I (Impulse)	L_{ZI}	L_{AI}	L_{BI}	L_{CI}
	User-Defined	L_{ZU}	L_{AU}	L_{BU}	L_{CU}
Time-Averaged Sound Level (L_{eq})		L_{eq}	L_{Aeq}	L_{Beq}	L_{Ceq}
Sound Exposure Level (L_E)		L_{ZE}	L_{AE}	L_{BE}	L_{CE}
Statistical Level (L_N)		L_1	L_5	L_{50}	L_{95}
Peak Sound Level		L_{peak}		L_{CPeak}	

- Measure Time Control: free run, user-defined
- Decay Time Constant for F and S time-weighted Sound Levels: 34.7 dB/s (by standard, >25 dB/s) and 4.34 dB/s (by standard, between 3.4 – 5.3 dB/s)

Signal Type

- Octave analysis: time trace, octave spectrum,
- Sound Level Meter: SLM time trace, analysis result, dB histogram

REAL-TIME ORDER TRACKING AND ORDER ANALYSIS (DSA-12)

Real-time Order tracking and Order Analysis is available across all Spider hardware systems manufactured by Crystal Instruments. The Spider-80X/80Xi hardware has a special capability and is equipped with two tacho channels in addition to the 8 analog inputs. Developed and based on a precise tachometer measurement of rotating speed, the Order Tracking option uses fast digital re-sampling at the rotating speed and a proprietary DFT method to acquire any required fractional orders of interest at a fast slew rate. The following measurements are made in the Order Tracking option: raw time streams, real-time order tracks and order spectra and constant band frequency spectra.

- Maximum Input Channels in a System: 512
- Maximum Tachometer channels: 2

Real-Time Order Tracks and Order Spectra

Real-Time Order Tracks are the frequency amplitude signals graphed against the RPM variable. Multiple order tracks are measured, displayed, and saved. Order Spectra are auto power spectra that are normalized to orders.

All Order Tracks can have the optional phase which is phase measurement relative to the tachometer signals as reference. Order tracks with phase can be displayed as Bode, Polar, or Nyquist plots.

Order tracks and Order Spectra can use the one of the tachometer channels' RPM as reference.

- Maximum Input Channels in a System: 512
- Max Order Tracks: 16 on each front-end
- Max Order of Interest: 200
- Maximum Tachometer Channels for RPM Measurement: 2
- Maximum Reference Tachometer signals for Order Analysis: 1
- Order Tracks Scaling: linear spectrum with peak or RMS scaling, or power spectrum with RMS scaling
- Spectrum Units: EU_{pk}, EU_{rms}, EU_{rms}^2
- Tracking RPM Range: 1 – 300,000 RPM (0.016 Hz – 5 kHz)
- RPM Resolution: 10 – 10,000 RPM
- Minimum Delta Order of Order Spectrum: 0.025
- Maximum Delta Order of Order Spectrum: 1
- Acquisition Mode: Free Run, Run Up, Run Down, Run Up and Down, Run Down and Up

Constant Band Frequency Spectra

Constant band frequency spectrum displays the auto power spectrum of the selected fixed band of frequencies and is computed using the FFT analysis within the fixed band of interest.

- FFT Block Sizes: 256 to 4,096 for 8 channels, up to 2048 for 512 channels
- Data Window Functions: Hanning, Hamming, Flat-top, Kaiser-Bessel, Blackman
- Auto Power Spectrum Type and Scaling: linear spectrum with peak or RMS scaling, power spectrum or power spectrum density with RMS scaling (Spectrum Units: EU_{pk}, EU_{rms}, EU_{rms}^2, EU^2/Hz, $EU^2 \cdot s/Hz$)
- RPM Range: 1 – 300,000 RPM (0.016 Hz – 5 kHz)
- RPM Resolution: 10 – 10,000 RPM
- Average Mode: linear, exponential, peak hold
- Acquisition Mode: free run, run up, run down
- Fixed Band RPM Spectra: user definable band range. The instrument calculates the total power within the fixed band versus RPM. Spectrum Units, EU_{rms}, EU_{rms}^2.

Tachometer Processing

Two tachometer channels are available. Either of them or both of them can be simultaneously utilized to calculate the RPM of each respective tachometer channel.

The user has the option to view original time signal for the Tachometer 1 and RPM trace for both tachometer channels. One of the tachometer channels can be used for generating order tracks and order spectrum.

Tachometer/Output Channels

User has the option to use one or two tachometer channels. At

least one tachometer channel must be configured. An unused tachometer channel can be used as an output channel (Spider-80X/80Xi only).

Limiting and Alarms (Included with DSA -24)
Limits can be set up on order tracks, order spectra, constant band frequency spectra and RPM Signals to trigger the desired functionality when the signals go beyond or below a preset value. (Only input channels on the master front-end support this function.)

SWEEP SINE FRF (DSA-13)

Sweep Sine FRF is a tool with manual control to the sine output while the system displays various time signals and frequency spectra. Random excitation can be enabled as a checkup function. Tracking filters are applied to each input channel to extract the signals at sweeping frequency. When the close-loop option is enabled, the Sweep Sine FRF is essentially a limited sine controller with more manual control functions.

- Frequency Range: 2 Hz to 5,000 Hz
- Sweeping Rate: Log (Oct/Min): 0.001 to 120; Log (Dec/Min): 0.001 to 40; Linear (Hz/Sec): 0.001 to 120
- Sweep Rate Control: Oct/Min, Hz/Sec, Dec/Min, Sweeps/Min, Sweep Duration/Sweeps
- Spectrum Display Resolution: 256 to 4096
- Tracking Filters: Proportional: 7% – 100%; Fixed (Hz): 1 – 500 Hz
- Frequency Resolution: as fine as 0.000001 Hz

REAL-TIME SINE REDUCTION (DSA-14)

The real-time sine reduction function offers a solution to extend the number of measurement channels of a vibration controller system in a swept sine test. When a Spider dynamic measurement system is running in the Sine Reduction Mode while an independent vibration controller controls a shaker, the Sine Reduction application will calculate all time and frequency spectra as those available in the controller. This function requires a COLA signal from the vibration controller system for instantaneous frequency, phase detection, and spectrum analysis.

Analysis Parameters:
- Maximum Input Channels in a System: 512
- Frequency Range: up to 46 kHz analysis frequency range of the COLA signal
- Spectrum Display Resolution: 256 to 4096
- Measurement Strategy: tracking filter, RMS, Mean, Peak (Multiple strategy allowed to each channel signal)
- Tracking Filters: Proportional: 7%-100%; Fixed (Hz): 1-500Hz
- Frequency Resolution: as fine as 0.001 Hz
- Sweep Type: Log, Linear

Measured Signals and Display Status:
Measured Signals: input time stream, auto power spectra for all channels, transmissibility signals are in complex format with real and imaginary parts

Block Signals: block time signals are used to display time waveform or the history of acceleration peak, velocity peak or displacement peak-peak
Display Windows: signal plot window, signal value window, digital I/O view window, runlog window, large numerical value display window, channel status window

Status Display on Control Panel: current frequency and total elapsed time

Runlog: a test log continuously records real-time status changes and user commands. Maximum number of runlog entries is 1024

Included features:
COLA Input: Any channel on the master front-end may be set as COLA channel. Software tracks the frequency of the signal from COLA input and calculates the required spectra.

Data Recorder Function for Sine Reduction: Continuously record all input signals during measurements. Typical continuous recording time: 4 hours for 4 input channels with frequency range 2000 Hz with 4 GB flash memory installed.

Input Abort/Alarm Limiting: Limiting is applied to monitor channels. Available limiting types are abort and alarm limit. Limiting profiles may be edited by the amplitudes and frequencies of breakpoints.

TIME WAVEFORM RECORDING (DSA-20)

The Spider front-end can perform long time waveform recording during real-time data processing. Data is saved to either the internal flash memory or continuously to an external Spider-NAS. The data recording speed is independent of the number of channels. Recording on a High Channel Count system in Black Box mode is supported.

- Maximum Input Channels in a System: 512

Maximum Data Recording Rate:
- Single front-end system: all channels can continuously record simultaneously at a maximum rate of 102.4 kHz.

- ***Multiple Front-end System:***
  Record to flash: up to 81.92 kHz for 512 channels
  Record to Spider-NAS: up to 81.92 kHz for 512 channels

Typical Continuous Recording Time: 4 hours for 4 input channels with a frequency range of 2,000 Hz and with 4 GB flash memory installed. If the Spider-NAS is installed, for a 250 GB disk, the typical recording time is: 4660 hours for 4 channels at 1 kHz/ch; 3 hours for a system with 64 inputs at 102.4 kHz/ch.

Begin Recording on: Manually start recording by pushing buttons (default); When measurement starts; When input signal is triggered according to trigger condition; When digital input is received from input #; When limit exceeded; When time status exceeds the limit

Stop Recording on: When digital input is received from input #; When limit exceeded; When time status exceeds the limit

Recording Duration: user specified, or until stopped by user; repeat # can be specified per defined event

("begin recording when input signal is triggered" currently available only on the 8 channels of master front-end)

AUTOMATED SCHEDULE AND LIMITING TEST (DSA-24)

The automated limit test function allows the Spider front-end to conduct automated limit checking for time or frequency signals. The function is supported in both PC tethered mode and Black Box mode. Limiting signals are designed using the EDM software on a host PC. There are four elements in a limiting test;

signals being tested, upper or lower limits applied, testing schedule, and testing log.

- Maximum Input Channels in a System: 512, up to 8 channels with limiting
- Test Signals: time block signals, auto spectrum, frequency response function, octave spectrum
- Limit Signals: user defined upper or low limit signals. For spectra signal, the spectrum type will also be assigned. Limit signals will be bound to testing signals. Maximum segments of each limit signal: 64; Maximum number of limit signals: 64.
- Limit Editor: breakpoint table, Envelope of imported signal
- Testing Schedule: automatically control the test duration and automates the operation. Multiple testing schedules can be developed and one is executed at a time. Testing schedule event entries: loop/end-loop, run duration, hold, limit check on, limit check off, start recording, stop recording, save signals, turn signal source on and turn signal source off, user defined entries.
- Testing Log and Summary Report: a log file is automatically created for each run of the schedule to record up to 1024 major events. A summary report is provided for the limiting check status for the last scheduled run.
- Limit Check Alarm Events: beep, screen flashing, add event to testing log, send message to host PC, save signals, and send emails or text messages
- User Defined Event Strings: the user can define the message strings of each alarm event. The message strings can be displayed in the runlog, EDM Cloud user interface, and the report.

REAL-TIME DIGITAL FILTERS (DSA-25)

Real-time digital filters are applied in the data conditioning phase. The user designs the filter model with a graphic design tool provided and uploads the filter design parameters to the front-end for real time calculation. The graphic design tool draws the filter performance in vertical axis with the dB unit and horizontal axis in relative frequency.

Maximum Input Channels in a System: 512

Filter Design Display (in EDM): user enters cutoff frequencies, criteria of attenuation, ripple, and filter orders. The design tool provides the frequency response of the filter in a graphic format.

FIR Filter Using Window Method: FIR filter designed based on data window applied to the sinc function. Data window types: Hanning, Hamming, Flattop, Uniform, Kaiser-Bessel, and Blackman. The user selects one of low-pass, high-pass, band-pass or band-stop types; sets one or two cutoff frequencies either relative to sampling rate or in fixed value; and sets the filter length between 3 and 127 (number of FIR taps).

FIR Filter Using Remez Method: The Remez FIR Filter design block implements the Parks-McClellan algorithm to design and apply a linear-phase filter with an arbitrary multiband magnitude response. The user selects low-pass, high-pass, band-pass or band-stop types; sets one or two cutoff frequencies either relative to sampling rate or in fixed value; and sets the filter length between 4 and 127 (number of FIR taps).

IIR Filters: Butterworth, Chebyshev I, and Elliptic. The user selects one of the filter types, selects low-pass, high-pass, band-pass or band-stop types; sets one or two cutoff frequencies either relative to sampling rate or in fixed value; and sets the filter length between 2 and 21.

SHOCK RESPONSE SPECTRUM (SRS) ANALYSIS (DSA-27)

Compute the SRS for all channels using maxi-max, maximum negative, and maximum positive analysis techniques. Reference profile is available.

- Maximum Input Channels in a System: 512
- Filter Implementation: real-time digital filters that simulate single Degree-of-Freedom system.
- Octave Fractional Resolution: 1/1, 1/3, 1/6, 1/12, 1/24, 1/48
- Filter Damping Ratio (1/2Q): set by percentage 0.01 – 100%
- Filter Center Frequencies: controlled by low frequency, high frequency and reference frequency
- SRS Spectrum Type: maximum positive, maximum negative, maxi-max.

SPIDER INSTRUMENT CALIBRATION SOFTWARE (SPIDER-CAL)

The front-end is calibrated at the factory prior to shipping and should be recalibrated annually by a factory authorized calibration service. EDM has an optional stand-alone Front-End Calibration Tool (FECT) that is operable by either the user or a calibration specialist. Calibration data is stored inside of the Spider front-end.

FECT Functions: The calibration software calibrates the signal source and adjusts the DC and AC gains and offset. It also calibrates the input channels at all coupling types and adjusts the DC and AC error. The report includes the model number, text for the calibration meter, and the calibration operator's name. The report is viewed or printed from the host PC. For more detail, refer to the FECT spec document.

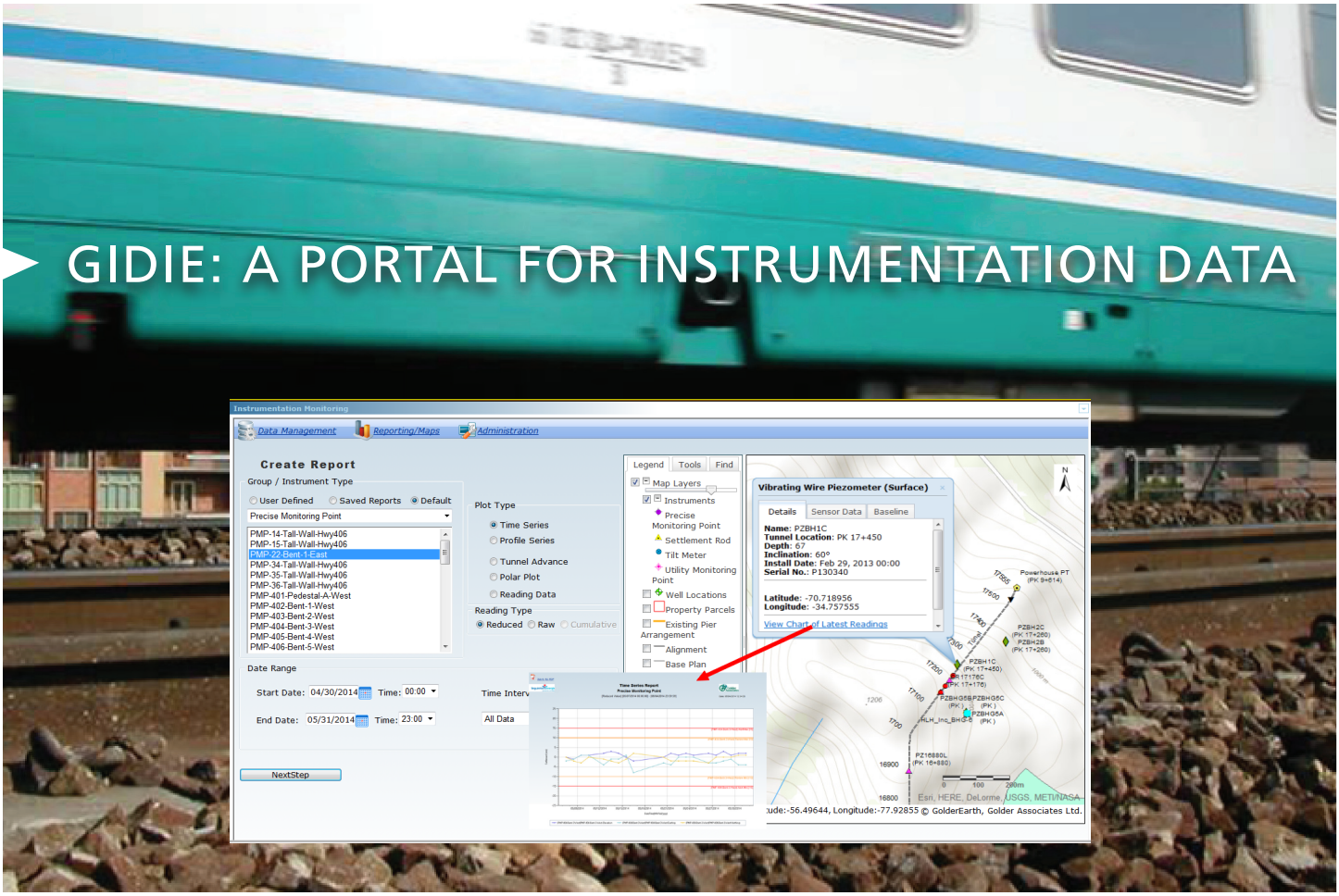
PC REQUIREMENTS FOR EDM SOFTWARE

- Operating System Support: Windows XP SP3 or higher
- Operating System Type: 32-bit or 64-bit
- Minimum Processor Speed: 1.5 GHz Dual-Core x86
- Minimum RAM: 4 GB
- Minimum Free Space: 10 GB

Recommended System Requirements for Spider Systems Over 16 Channels:

- Operating System Type: 64-bit
- Processor: Intel Core i7, 2.0 GHz or Higher
- RAM: 8G DDR3 1600
- PC storage: SSD

GIDIE: A PORTAL FOR INSTRUMENTATION DATA



The Golder Instrumentation Data Interpretation and Evaluation (GIDIE) solution provides a fully integrated system for the monitoring and management of remote instrumentation via a web portal. Data from virtually any type of instrumentation – geotechnical, topographic, meteorological – can be efficiently monitored in near-real time from anywhere in the world and managed to ensure effective monitoring of a project's field operations by technical and business stakeholders with varying needs.

BENEFITS

- Enables remote access to instrumentation data from anywhere in the world, at any time, via web portal.
- The compiled outputs or streams from one or more instrumentation packages, networks, or types can be viewed simultaneously.
- Data is provided in near-real time, to allow rapid responses to developing issues.
- Supports most of the instruments commonly used in geotechnical engineering, construction monitoring, and to monitor ground/structural movement.
- Broad and easily configurable accommodation of all instrument data outputs, regardless of parameters monitored, periodicity, or upload process (i.e., batch or streaming).
- Flexible viewing and reporting formats, via standard options or easily configured custom templates.
- Flexible viewing options: from raw data feeds to compiled trend charts generated at user-defined intervals combining one or more parameters of interest.
- Integrated alerting thresholds and automation allowing for structured responses to variance situations reflected in incoming data.
- Integrated GIS utility allows spatial tracking of instrument location or progress.
- Solution supports five levels of secure access, allowing varying levels of control and access to data and reporting.
- Multi-language capability supports varied international project teams.
- Significant time savings achieved in data compilation, analysis, and batch reporting.
- Robust system back-end, using an industry-standard database platform.
- Flexible data export/output capabilities to integrate with external management systems.
- GIDIE can be hosted on a client's system, or on a Golder-managed server, eliminating infrastructure costs and supporting a flexible range of 'software-as-a-service' (SaaS) options.

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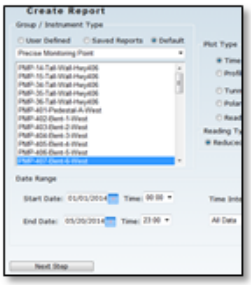
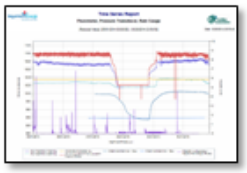
DEMONSTRATED CAPABILITY

In developing GIDIE, Golder applied the experience of 50 years of ground engineering consulting practice, gained through the successful delivery of thousands of projects worldwide in partnerships with a wide variety of clients, stakeholders, regulators, specialized service providers, researchers, and others.

We understand the real-world challenges associated with designing, implementing, and managing instrumentation.





FEATURES

WEB-BASED

GIDIE is web-based, supported by a robust database back-end allowing access from any computer connected to the internet. Security is built into the system as a multi-user, multi-tiered model.

CONFIGURABLE

GIDIE's remote automation capability allows straightforward setup and configuration of the components used to collect data. Once connected (via modem/wireless telemetry, internet, or WAN/LAN), data is output to the GIDIE server which manages storage, retrieval and upload to user-defined scheduling. Configuration flexibility between instrumentation, data collection and GIDIE is maximized to allow a hands-free, automated environment.

INDUSTRY-STANDARD MONITORING INSTRUMENTS

Standard instrumentation types supported include: strain gauges, extensometers, piezometers, pressure cells, jointmeters, inclinometers, electrolevels, and survey/total station. The current state of instrumentation technology allows straightforward accommodation of additional specialized instrumentation types, including those used in vibration monitoring, tunnel advance monitoring, meteorological, and alternative energy applications.

ERROR REDUCTION

Because GIDIE has the ability to read data files directly from a datalogger without prior manipulation, the likelihood of copy/transcription errors is significantly reduced. Additionally, alerting thresholds can be established to address variances arising from one-time transient events, offering the potential of specialist intervention prior to inputs being incorporated into reporting.

GIS INTEGRATION

GIDIE's integrated GIS component allows the project to be visually accessible, displaying instrumentation icons on a map of the project site linked to the charting/reporting associated with that instrument. This GIS component also supports the display of moving assets, such as the advance of instrumented construction equipment.

REPORTING

One of the key features of GIDIE is that clients are able to define the reports they would like to see, selecting instruments, specifying the readings from those instruments, or defining combinations of readings from various instruments. Clients are able to apply standard documentation formatting to re-usable templates for presentation purposes

APPLICATION

To date, Golder has successfully applied GIDIE on a number of rock engineering, tunneling, environmental and water well monitoring projects, including:

- Construction monitoring on two major Canadian urban subway extension projects
- Ground movement monitoring for a parks commission
- Underground mining bulkhead monitoring for a quarry and exploration company
- Geotechnical tests for an oil refinery in Italy
- Tunnel advance and ground movement monitoring for a major Italian transportation infrastructure project
- Support for a Canadian provincial government groundwater monitoring network

Golder Associates

ENGINEERING EARTH'S DEVELOPMENT, PRESERVING EARTH'S INTEGRITY.

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SPIDER-80X
HARDWARE SPECIFICATIONS (v6.1)

INTRODUCTION

The Spider-80X is a highly modular, truly distributed, scalable dynamic measurement system introduced by Crystal Instruments. It is ideal for a wide range of operations including vibration testing and machine condition monitoring for industries such as automotive, aviation, aerospace, electronics and military. The Spider-80X excels in industries that demand quick and accurate data recording in addition to real-time signal processing.

Multiple Spider front-ends can be combined to form a single high channel system. The Spider system can be arranged with various Spider front-ends and network switches to form different configurations. With multiple Spider-80X front-ends, a Spider system can have up to 64 input channels in a chassis and be chained up to hundreds of channels, with all channels sampled simultaneously. The maximum number of input channels for a Spider-80X system is 512. Multiple Spider front-ends are accurately synchronized through the IEEE 1588v2 protocol, ensuring all measurement channels are on the same time base. Accurate time synchronization results in excellent phase match in the frequency domain between all channels, either on the same Spider front-end or across different front-ends. Channel phase match, even between separate Spider front-ends, is within 1.0 degree at 20 kHz which is suitable for high quality structural and acoustics applications requiring cross channel measurement.

Spider-80X front-ends have voltage, IEPE, and optional charge types of input, which are ideal for shock, vibration, acoustic, or general purpose voltage measurements. Each Spider-80X front-end is equipped with 8 input channels and can accurately measure and record both dynamic and static signals. The mass flash memory can record 8 channels of streaming signals simultaneously at up to 102.4 kHz while computing real-time time and frequency based functions. Two output channels provide various signal output waveforms that are synchronized with the input sampling rate. Two tachometers sharing the connectors with outputs allow the system to measure the rotating pulse signals and conduct order tracking.

The Spider-80X front-ends can be controlled by a host PC or can operate in Black Box mode where a preprogrammed schedule is uploaded to the unit and started manually or based on event triggers. The ability to use any front-end in Black Box mode or in a distributed network system means that the user can place front-ends close to the measurement object, minimizing cable length and decreasing setup time.

The Spider-80X DSA front-end, Spider-80SG strain gage front-end, Spider-NAS storage device and Spider-HUB network switch all have the same physical form factor.

Performance

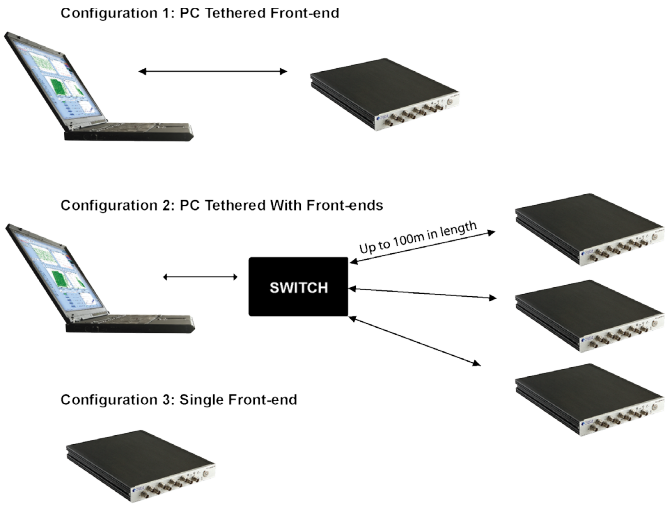
The Spider product line performance is the best in class with the highest dynamic range of any similar product. With patented technology, each measurement channel can detect signals as small as 6 µV and as large as ±20 V. Proprietary hardware technology delivers more than 150 dBFS dynamic range. The extremely high dynamic range eliminates the need for multiple front-end gain settings.

A high-speed floating point DSP manages the data input/output and real-time processing. The Spider-80X is also configured with RAM and onboard flash memory for mass data storage. Special thermal and low power design eliminates the need for a cooling fan.

Typical System Configurations

The Spider hardware platform supports two different software working modes: Black Box mode and PC Tethered mode. When the Spider front-end runs in Black Box mode, the preset projects can be executed based on a user-defined schedule. In PC Tethered mode, the PC is used as a control terminal to access the Spider through an Ethernet network. The Spider can be switched between the two modes. The PC Tethered mode is ideal for applications such as structural testing in a laboratory environment, while Black Box mode is ideal for remote monitoring.

The following figure illustrates some of the different configurations that are possible with the Spider system:



Configuration 1: PC Tethered with One Spider Front-End
One Spider front-end can be directly connected to a PC or to a LAN network through Ethernet. No switch is needed. The PC is used as a control and monitoring terminal via Crystal Instruments' EDM software.

Configuration 2: PC Tethered with Multiple Spider Front-Ends
Multiple Spider front-ends can be connected to make a high channel count system. Multiple switches, such as the SpiderHUB, can be used in cascade to extend the number of front-ends. The PC is used as a control and monitoring terminal via Crystal Instruments' EDM software.

Configuration 3: Black Box Mode with One Spider Front-End
This is the same as Configuration 1 except that the PC is not required during run time. A PC is required to install the Spider Black Box engine to the Spider front-end so it can run without a PC. The PC is only used to configure the Spider and download data files.

Input Channel Specifications
- Input Channels Installed per Front-end: 8
- Connector Type: BNC
- TEDS: IEEE 1451.4 compliant
- Coupling: AC, DC, IEPE (ICP®), and optional Charge (S80X-P44)
- IEPE DC offset Volt and Current: 4.2 mA at 21 V
- Input Type: Differential or Single-Ended
- Input Range: ±20 Vpk
- Input Impedance: 1 MΩ for differential; 500 kΩ for single-end
- Input Protection Voltage: ±220V (For hardware version 7.6.x)
- AC Coupling: analog high-pass filter at 0.3 Hz @ (-3 dB) and 0.7 Hz @ (-0.1 dB)
- A/D Resolutions: 2 x 24-bit (patented dual A/D technology per input channel)
- Anti-Aliasing Filter: analog anti-aliasing filters plus digital decimation technique
- Digital Filter: high-pass filters (user programmable)
- Dynamic Range: 150 dBFS
- Sampling Rate: 0.48 Hz to 102.4 kHz, with 54 stages
- Maximum Bandwidth: 46.08 kHz
- THD: -95 dB (SV sine, DC to 1kHz)
- Amplitude Channel Match (1 kHz, 1V input): 0.02 dB
- Channel Phase Match: < ±1.0 degree up to 20 kHz
- Crosstalk: less than -100 dB
- Frequency Accuracy: 0.00025%
- Common Mode Range: ±20 Vpk
- Amplitude Accuracy (1 kHz, 1V input): ± 0.1%

Tachometer Input Specifications
- Number of Tachometers: 2
- Connector type: BNC
- Configuration: Software configures the port as either output or tacho input
- Input Voltage Range of Rotating Pulses: zero to +/-10Vpk
- Maximum RPM: 300,000

Tacho channel 1 can be used for both pulse counting and order tracking measurement. Tacho channel 2, with 50MHz ultra-high counter resolution, is only used for pulse counting.

Output Channel Specifications
- Channels: 1 or 2 channels
- Connector Type: BNC
- D/A Resolution: 24-bits
- Max Output Frequency: 46 kHz
- Dynamic Range: 100 dB
- Output Impedance: 50 Ω
- Maximum Output Current: 250 mA (HW 7.4 and earlier: 25mA)
- Amplitude Accuracy (1 kHz, 1Vrms) : ±0.2%
- Anti-Imaging Filtering: 160 dB/oct digital plus analog filters
- Source Waveforms: sine, triangle, square, white noise, DC, chirp, swept sine, arbitrary waveform
- Arbitrary Waveform Size Limit: 16,000 points typical. Special configuration allows up to 128,000 points.
- Output Range: ± 10 Volts

Isolated Digital Input and Output
- Connector: 25-pin female D-SUB
- External Circuit Power Supply: 3.3 – 12 VDC (±10%)
- Internal Power: 12 VDC 400 mA
- Maximum Allowable Distance of Signal Extension: 50 meters

Inputs
- Input Format: opto-isolated input (compatible with current-sink output)
- Number of Channels: 4
- Input Resistance: 6.1 kΩ
- Input On Current: 2.0 mA or more
- Input Off Current: 0.16 mA or less
- Interrupt: 8 input signals are arranged into a single interrupt output signal. An interrupt is generated either at the rising edge (HIGH-to-LOW transition) or falling edge (LOW-to-HIGH transition).

Outputs
- Output Format: opto-isolated input (current sink output)
- Number of Channels: 4
- Output Rating: output voltage 12 VDC max, output current 100 mA per channel max
- Residual Voltage with Output On: 1.0 V or less (Output current < 100 mA)
- Pulse Width: 47 ms
- Rise Time: 250 µs
- Fall Time: 50 µs

High Speed Data Port interfacing to Spider-NAS
- Connector Type: 5-pin LEMO
- Maximum Distance of Cable: 2 meters
- Typical Aggregate Data Transfer Speed: Higher than 819.2 K Sample/second

System Specifications
- Total Memory: 4 GB flash memory used for system and data storage
- Total RAM: 32 MB
- Ethernet: 100Base-T, RJ45 female connector
- Serial Port: RS-485

LED Indicators
- RUN/STOP Status Indicator: run light green, stop lightless
- Flash Capacity Status Indicator: less than 60% green, between 60% and 90% yellow, between 90% and 100%, red.
- Power Indicator: power on/off
- LAN Indicator: communication active/inactive

Software Options
- The Spider-80X is compatible with all VCS or DSA software options from Crystal Instruments.

Network Protocols and IEEE 1588 Time Synchronization
Multiple Spider front-ends are synchronized through the IEEE 1588v2 protocol. The synchronization accuracy is better than ±100 ns when a specified network switch is used. The data acquired by all the measurement channels will be on the same time base. Phase match between channels across different Spider front-ends is within 1.0 degree at 20 kHz.

- IPv4 Protocol Stack: ICMP, IP, UDP, TCP, IGMP
- IPv4 Based Applications: DHCP Client
- IEEE 1588v2 Protocol: PTP ordinary clock, both E2E and P2P synchronization supported, hardware level timestamp for PTP event messages
- Time Synchronization Accuracy Between Front-Ends: ±100 ns or better (multiple Spider-80X front-ends connected by the Spider-HUB network switch)

Power Specifications (S80X-A11)
- Power Supply: 100 – 240 VAC (50/60 Hz), 12-22 V_{DC}
- Power Consumption: less than 12 Watts
- S80X-A11NA: power supply with LEMO adapter (North America)
- S80X-A11EU: power supply with LEMO adapter (Europe)
- S80X-A11UK: power supply with LEMO adapter (UK)

Environmental and General Specifications
- Enclosure: rugged sealed metal box, electrical safety compliant, and internal EMI shielding
- Dimensions: 240 x 35 x 310 mm (w x h x l)
- Weight: 2 kg
- Safety Standard: electromagnetic compatibility and sensitivity: EN 61326:1997+A1:1998+A2:2001, EN61000-3-2: 2000, EN61000-3-3: 1995+A1:2001
- Operational Temperature: -10 °C to +55 °C
- Storage Temperature: -20 °C to +70 °C
- Shock: 50 g's, 315 in/sec, tested at 6 sides, non-operational test
- Vibration: 5 – 500 Hz, 0.3 grms, tested at 3 sides, operational test
- Vibration: 5 – 500 Hz, 2.42 grms, tested at 3 sides, non-operational test

5 Slot and 8 Slot Enclosures (S80X-A35)
Description
Enclosure supports 5 or 8 Spider-80X front-ends (40 to 64 channels) and includes AC power supply, Ethernet switch, and cooling fans. The Spider-HUB network switch is included and is installed at the factory. Spider-NAS may be included when the proper option is purchased.

Specification
- Enclosure: metal box
- Available Slots: 5 or 8, depending on selection
- Power Supply: AC adaptor accepts 100 to 240 VAC (50/60 Hz)
- Fan Operation: turns on or off by a switch
- Dimension: 5-slot: 343 x 310 x 407 mm (w x h x l) (measured off the silver front cover, which is wider than the body)
- Dimension: 8-slot: 470 x 310 x 407 mm (w x h x l) (measured off the silver front cover, which is wider than the body)
- Weight : 8-slot with all front-ends installed : 80lb
  5-slot with all front-ends installed : 55lb
- Power consumption:
  8-slot with all front-ends installed: 100W
  5-slot with all front-ends installed: 70W

Configurations
- S80X-A35-5: 5-slot enclosure including power supply for up to 5 Spider-80X front-ends and a built-in Spider-HUB network switch. Shipping case is included.
- S80X-A35-5N: 5-slot enclosure including power supply for up to 5 Spider-80X front-ends and a built-in Spider-HUB network switch. Includes a built-in Spider-NAS storage device. Shipping case is included.
- S80X-A35-8: 8-slot enclosure including power supply for up to 5 Spider-80X front-ends and a built-in Spider-HUB network switch. Shipping case is included.
- S80X-A35-8N: 5-slot enclosure including power supply for up to 5 Spider-80X front-ends and a built-in Spider-HUB network switch. Includes a built-in Spider-NAS storage device. Shipping case is included.

Spider-80X Battery (Spider-BATTERY)

Specifications
- Enclosure: rugged sealed metal box, electrical safety compliant, and internal EMI shielding
- Size: 240 x 35 x 310 mm (w x h x l)
- Weight: 2.72 kg
- Battery: 194Wh (13.5Ah/14.4V)

(continued on next page)

Spider-80X Accessories

Travel Cases

- S80X-A45: ruggedized travel case (single system)
- S80X-A45-5: ruggedized travel case (5-slot system)
- S80X-A45-8: ruggedized travel case (8-slot system)

SPIDER-80Xi
HARDWARE SPECIFICATIONS (v1.1)

INTRODUCTION

The Spider-80Xi is a compact version of Spider-80X. The mechanical design of Spider-80Xi eliminated the enclosure of each modular card inside of chassis. Light weighted, it is ideal for the applications that the portability and size are critical to the usage while exchangeability of cards are not required.

Spider-80Xi system comes with two different chassis, one that can host up to 64 input channels, one up to 32 input channels. Multiple chassis can be chained up to hundreds of channels, all sampled simultaneously. Multiple Spider-80Xi front-ends are accurately synchronized through the IEEE 1588v2 protocol, making sure all measurement channels are on the same time base. Accurate time synchronization results in excellent phase match in the frequency domain between all channels, either on the same Spider front-end or across different front-ends. Channel phase match, even between separate Spider front-ends, is within 1.0 degree at 20 kHz which is suitable for high quality structural and acoustics applications requiring cross channel measurement.

The Spider-80Xi system with the 64 channel chassis is power by AC power, 100 to 240 VAC . The Spider-80Xi system with the 32 channel chassis is power by the DC power, 10V to 22V. The latter can be easily used together with an external battery pack. With Spider-Battery, a special model of battery CI developed, the 32 channel Spider-80Xi can run up to 4 hours without interruption.

Spider-80Xi front-ends have voltage, IEPE, which are ideal for shock, vibration, acoustic, or general purpose voltage measurements. The Spider product line performance is the best in class with the highest dynamic range of any similar product. With patented technology, each measurement channel can detect signals as small as 6 µV and as large as ±20 V. Proprietary hardware technology delivers more than 150 dBFS dynamic range. The extremely high dynamic range eliminates the need for multiple front-end gain settings.

Spider-80Xi can operate in Black Box mode which allows it to acquire data without a PC. In this mode, a PC is used only to configure the system before the test and then to download the data after the test is complete. During the test, the front-end can be operated according to a preset schedule or from a variety of external devices, such a Wi-Fi enabled PDA or iPad.

Spider-80Xi is equipped with powerful and flexible data acquisition functions. Continuous time data recording and spectral analysis can be initiated by many events including user operation, pre-set run schedule, alarm limit trigger, input trigger or digital input trigger. A high-performance removable 2.5-inch hard disk is used as a storage media inside Spider-80Xi. The default capacity of hard disk is 250GB. When recorded, data will be written in the NTFS file format. Data is extracted from

the hard disk using Crystal Instruments PC software to transfer data to the PC, or the hard disk can be physically removed and connected to another PC.

Input Channel Specifications

Number of Input Channels per chassis: 16, 24, 32, 48 or 64 when ordered with S80Xi-A35-8N, the 8 slot chassis; 16, 24, 32 when ordered with S80Xi-A35-4N, the 4 slot chassis. This is only factory configurable.

- Connector Type: BNC
- TEDS: IEEE 1451.4 compliant
- Coupling: AC, DC, IEPE (ICP®)
- IEPE DC offset Volt and Current: 4.2 mA at 21 V
- Input Type: Differential or Single-Ended
- Input Range: ±20 Vpk
- Input Impedance: 1 MΩ for differential; 500 kΩ for single-end
- Input Protection Voltage: ±40V
- AC Coupling: analog high-pass filter at 0.3 Hz @ (-3 dB) and 0.7 Hz @ (-0.1 dB)
- A/D Resolutions: 2 x 24-bit (patented dual A/D technology per input channel)
- Anti-Aliasing Filter: analog anti-aliasing filters plus digital decimation technique
- Digital Filter: high-pass filters (user programmable)
- Dynamic Range: 150 dBFS
- Sampling Rate: 0.48 Hz to 102.4 kHz, with 54 stages
- Maximum Bandwidth: 46.08 kHz
- THD: -95 dB (SV sine, DC to 1kHz)
- Amplitude Channel Match (1 kHz, 1V input): 0.02 dB
- Channel Phase Match: < ±1.0 degree up to 20 kHz
- Crosstalk: less than -100 dB
- Frequency Accuracy: 0.00025%
- Common Mode Range: ±20 Vpk
- Common Mode Rejection: better than 70 dB (typical)
- Amplitude Accuracy (kHz, 1V input): ± 0.1%
- LED indicator: displays the status of each channel in red or green

Tachometer Input Specifications

- Number of Tachometers: 2

- Connector type: BNC
- Configuration: Software configures the port as either output or tacho input
- Input Voltage Range of Rotating Pulses: zero to +/-10Vpk
- Maximum RPM: 300,000

Tacho channel 1 can be used for both pulse counting and order tracking measurement. Tacho channel 2 is with 50MHz ultra-high counter resolution, is only used for pulse counting.

Output Channel Specifications
- Channels: 2 channels
- Connector Type: BNC
- D/A Resolution: 24-bits
- Max Output Frequency: 46 kHz
- Dynamic Range: 100 dB
- Output Impedance: 50 Ω
- Maximum Output Current: 250 mA
- Amplitude Accuracy (1 kHz, 1Vrms) : ±0.2%
- Anti-Imaging Filtering: 160 dB/oct digital plus analog filters
- Source Waveforms: sine, triangle, square, white noise, DC, chirp, swept sine, arbitrary waveform
- Arbitrary Waveform Size Limit: 16,000 points typical. Special configuration allows up to 128,000 points.
- Output Range: ± 10 Volts

Isolated Digital Input and Output
Total 4 bits digital channels that can be configurable by the software to either input or output type.

- Connector: 9pin female D-SUB
- External Circuit Power Supply: 12 V_{DC} (±10%)
- Internal Power: 12 V_{DC} 400 mA
- Maximum Allowable Distance of Signal Extension: 50 meters

Digital Inputs
- Input Format: opto-isolated input (compatible with current-sink output)
- Number of Channels: 4 channel maximum
- Input Resistance: 6.1 kΩ
- Input On Current: 2.0 mA or more
- Input Off Current: 0.16 mA or less
- Interrupt: 8 input signals are arranged into a single interrupt output signal. An interrupt is generated either at the rising edge (HIGH-to-LOW transition) or falling edge (LOW-to-HIGH transition).

Digital Outputs
- Output Format: opto-isolated input (current sink output)
- Number of Channels: 4 channel maximum
- Output Rating: output voltage 12 VDC max, output current 100 mA per channel max
- Residual Voltage with Output On: 1.0 V or less (Output current < 100 mA)
- Pulse Width: 47 ms
- Rise Time: 250 µs
- Fall Time: 50 µs

Mass Storage
A high-performance removable Serial ATA (SATA) 2.5-inch hard disk is used as storage media. When recorded, data will be written in NTFS file format. Data is extracted from the Spider-NAS using Crystal Instruments software to transfer data to the PC. Alternatively, the SATA hard disk can be physically removed and connected to extract data to the PC.

When it is shipped, a solid state hard-drive with a capacity of 250GB is installed internally. The solid state drive performs very well in the high shock and vibration environment. A special error-checking algorithm developed by Crystal Instruments detects and avoids any errors that may occur in the data transfer and storage.

Time Synchronization
Through the Ethernet connection, multiple Spider-80Xi front-ends can be synchronized through the IEEE 1588v2 protocol. The synchronization accuracy is better than ±100 ns when a specified network switch is used. The data acquired by all the measurement channels will be on the same time base. Phase match between channels across different Spider front-ends is within 1.0 degree at 20 kHz.

Environmental and General Specifications
- Ethernet: 100Base-T Ethernet. RJ 45 connector
- Hard Buttons: Power, Fan On/Off, Start measurement, Stop measurement
- Cooling Fan: Manually controlled
- Grounding: Connect to common ground of power amplifier to reduce ground-loop interference. Connector Type: 0.166 inch (4.23 mm) jack connector for standard 0.166 inch banana plug
- Safety Standard: electromagnetic compatibility and sensitivity: EN 61326:1997+A1:1998+A2:2001, EN61000-3-2: 2000, EN61000-3-3: 1995+A1:2001
- Operational Temperature: -10 °C to +55 °C
- Storage Temperature: -20 °C to +70 °C
- Shock: 50 g's, 315 in/sec, tested at 6 sides, non-operational test
- Vibration: 5 – 500 Hz, 0.3 grms, tested at 3 sides, operational test
- Vibration: 5 – 500 Hz, 2.42 grms, tested at 3 sides, non-operational test

8 slot chassis (S80Xi-A35-8N)
- Enclosure: rugged sealed metal box, electrical safety compliant, and internal EMI shielding
- Power Supply: 100 – 240 VAC (47 – 440 Hz),
- Power Consumption: less than 90W when 64 channels configured
- Size: 274 X 259 X 298 mm (W x H x L)
- Total Weight: 10.4 kg when 64 channels configured

4 slot chassis (S80Xi-A35-4N)
- Enclosure: rugged sealed metal box, electrical safety compliant, and internal EMI shielding
- Power Supply: DC input, 10 VDC to 18 VDC
- Power Consumption: less than 50W when 32 channels configured
- Size: 194 X 259 X 298 mm (W x H x L)
- Total Weight: 7 kg when 32 channels configured
- Battery hours: 4 hours with Spider-Battery applied

ORDERING INFORMATION

Software Configuration

The Spider-80Xi is fully compatible with all EDM VCS or DSA software options that are developed for Spider-80X.

PC Requirements for EDM Software

- Operating System Support: Windows 7 or higher
- Operating System Type: 32-bit or 64-bit
- Minimum Processor Speed: 1.5GHz Dual-Core x86
- Minimum RAM: 4 GB
- Minimum Free Space: 10 GB

Hardware Part Numbers

Part Number	Short Description
S80Xi-P08	Spider-80Xi Front-end card: Eight Inputs
S80Xi-A35-4N	4-slot chassis with Switch and NAS
S80Xi-A35-8N	8-slot chassis with Switch and NAS

PROJECT PROFILE

Monitoring Network - Provincial Groundwater

KEY ELEMENTS

- **Client**
  MOE
- **Client Contact**
  Jim Cliffard
- **Contract Price**
  $2.5 Million
- **Duration**
  30 Months
- **Project Manager**
  John Gilby

The project involves the development of the Provincial Groundwater Monitoring Network (PGMN) covering 38 Conservation Authorities in Ontario, and includes for the supply and installation of approximately 380 water level monitoring devices in existing wells and the establishment of an automatic monitoring system to allow readings to be collected and downloaded to a Central Data Management System (CDMS) at the MOE offices at Resources Road, Toronto. As part of this work the development of a web based data management system has been completed to collect and hold data for approval by Conservation Authorities prior to data being permanently held within PGMIS.

The monitoring instrument selected for this work is the Solinst Levelogger, and in association with Solinst we have developed a cellular phone telemetry system for automated data collection by the CDMS. In areas of the province where cellular service is not available data is collected from time to time at the wellhead and transmitted to the CDMS for processing.

The Levelogger is a pressure sensor with a 10 year lithium battery and datalogger all contained within a stainless steel housing 22 mm in diameter and 125 mm long. Communication with the Levelogger to program and retrieve data is achieved through an infrared interface that is located at the top of the logger housing in the well. The specific reasons why we selected this instrument for the project were:

- The data taken by the logger is stored within the instrument that is downloadable from the well. This means that even if remote communication is lost at the surface due to, heavy snowfalls, lightning strikes, vandalism, loss of power to the telemetry system, the data is securely held in the logger for future retrieval either manually or when remote reading services are resumed. This feature also greatly reduces the risk of damage to the instrument. The logger has a storage capacity of 24,000 readings. At a reading rate of once per hour this represents 1,000 days of data.

- As there are no physical connections to the inside of the Levelogger, the logger is not affected by stray currents.

The instrument is easy to install and easy to us

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