Echo® Wireless Vibration System
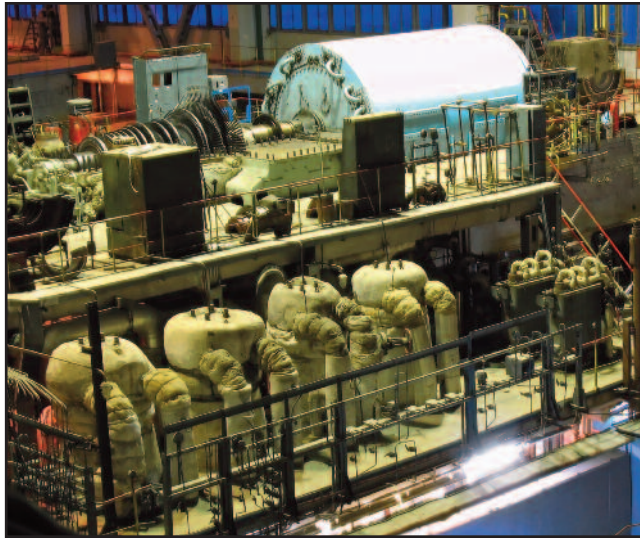
A simple, affordable, effective wireless vibration system

Why use valuable manpower to collect vibration data on healthy machines? Why settle for measurements once a month when you can have them multiple times daily? Why have people venture into unsafe areas to collect routine measurements? Echo® Wireless Vibration Sensors can safely "look" at the machine's health several times per day and provide immediate notification when warning or critical levels are reached. This frees up technical experts, like certified vibration analysts, for higher value tasks such as fault analysis.

- Transmits very long distances
- Batteries last up to 10 years
- Eliminates expensive cable runs
- Requires no repeaters, networks, or mesh
- Run stand alone or with junction box
- Stores data in ODBC format
- Easily installed

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Echo® Wireless Vibration System

Introduction

The Echo® Wireless Vibration System has been tested, and found to perform very well, in a number of different types of plants including: power, steel, food processing, paper, chemical, and automotive. The system has performed reliably and provided accurate and useful data regarding machinery health.

The Echo® Wireless Vibration Sensor and the EchoPlus® Wireless Junction Box make the set of overall vibration measurements, listed below, that are sure to provide early warning of most common machine faults. In addition to these measurements, Echo® provides accurate battery status. Using a user programmable vibration threshold, Echo® can detect if the machine is not running, and if not, skip a measurement to conserve battery power. It also has an optional Raw Vibration Output (requires optional Model 070A86 cable) for use with a portable data collector.

- RMS Velocity - for "balance-of-plant" faults such as unbalance, misalignment, and flow problems
- RMS Acceleration - for higher frequency faults and high frequency energy (HFE) such as high speed gear mesh, broken rotor bars, and loss of bearing lubrication
- True Peak Acceleration - for bearing, gear, and impulsive faults, including looseness
- Crest Factor – for fault severity indication

Model 670A01
Wireless Vibration Sensor

The Echo® Wireless Vibration Sensor is a stand alone, battery powered, industrial vibration sensor. At the default setting of three measurements per day (user programmable) battery life approaches 10 years. A Raw Vibration (RV) output version includes an integral connector that can be used with an optional cable and a standard vibration data collector for fault analysis. The sensor can be programmed via RS-232 (requires optional Model 070A87 cable) to set the transmission (collection) interval and a Residual Vibration Level (RVL) if desired. Echo® has an LED that provides visual feedback on the status of the sensor, including: on, off, measuring, transmitting, or changing states. The sensor has an embedded magnetic switch and can be activated or deactivated by holding a strong magnet next to the sensor. Upon activation, the sensor makes and transmits a set of measurements.
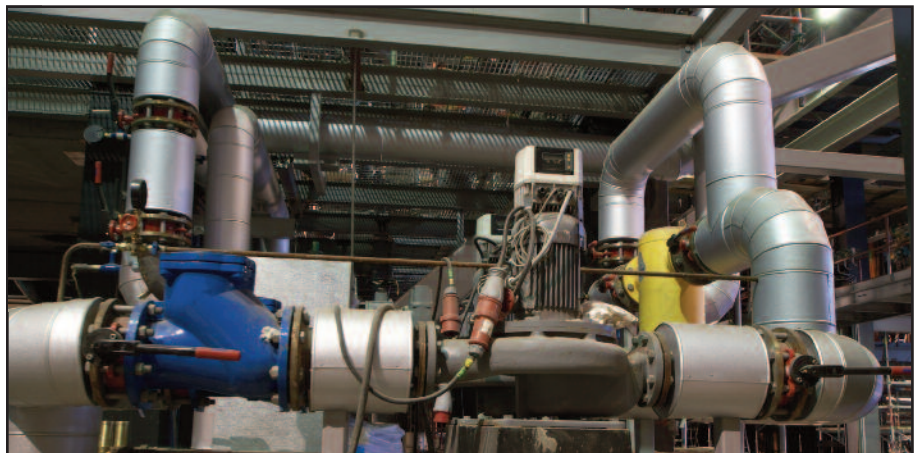
Model 672A01
Wireless Junction Box

The EchoPlus® Wireless Junction Box is an 8-channel junction box that instantly converts installed industrial sensors to wireless operation. This incredibly economical device periodically powers each sensor, makes the same set of overall measurements as Echo®, and transmits them wirelessly. The default transmission interval is 8-hours but is user programmable. Additionally, it operates as a standard junction box allowing full data collection with a portable data collector at the box. It can be powered using either standard 24 VDC or any battery between 6 and 14 VDC. The unit can be used by itself or in conjunction with an existing junction box by simply jumping wires between them.
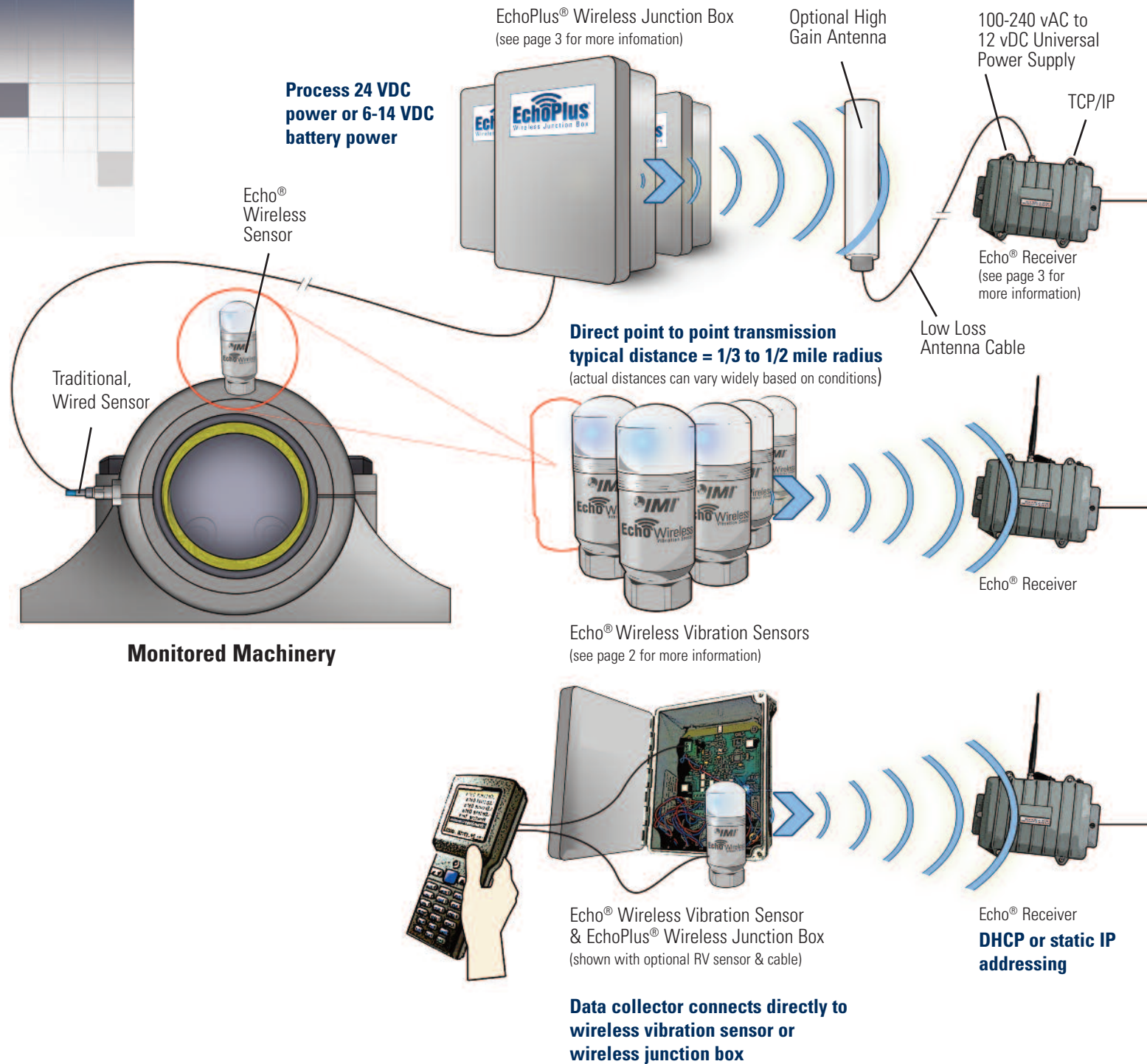
Model 673A01
Receiver

The Echo® Receiver is a stand alone unit that communicates point-to-point with Echo® Wireless Vibration Sensors and EchoPlus® Wireless Junction Boxes. Operating in the 916 MHz range, using an ultra-narrow bandwidth filter with Extended Range RF (ERRF) technology, it has unprecedented -145 dBm sensitivity and can detect and decode RF signals as low as about a millionth of a billionth of a milliwatt. This results in very long distance point-to-point communications in plants, eliminating the need for repeaters or complicated mesh networks. Actual tests in a typical power plant achieved successful signal transmission distances of over 1/3 mile and even through buildings. Outdoor tests have achieved transmission distances measured in miles, and transmissions are at only 0.75 mW ERP using very little battery power.

The antenna and receiver can be centrally located for optimum RF coverage in plants and the receiver conveniently outputs data to the nearest Ethernet port. The IP address of the receiver can either be acquired or permanently assigned as required. In the case where there are too many measurement channels or longer than possible distances for a single receiver, the system is capable of running multiple receivers on different frequency bands. The sensors and junction boxes can be tuned to operate at any of the 12 bands available.

Echo® System Diagram

EchoPlus® Wireless Junction Box
(see page 3 for more infomation)

Optional High Gain Antenna

100-240 vAC to 12 vDC Universal Power Supply

TCP/IP

Process 24 VDC power or 6-14 VDC battery power

Echo® Wireless Sensor

Echo® Receiver
(see page 3 for more information)

Direct point to point transmission typical distance = 1/3 to 1/2 mile radius
(actual distances can vary widely based on conditions)

Low Loss Antenna Cable

Traditional, Wired Sensor

Monitored Machinery

Echo® Wireless Vibration Sensors
(see page 2 for more information)

Echo® Receiver

Echo® Wireless Vibration Sensor & EchoPlus® Wireless Junction Box
(shown with optional RV sensor & cable)

Echo® Receiver
DHCP or static IP addressing

Data collector connects directly to wireless vibration sensor or wireless junction box

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PCB Echo® Software (see page 6 for more information)

Echo® Receiver Data Client

- Collects Transmissions
- Formats Data
- Stores in Database
- Generates Alarm Email

Echo® Data Presentation SW

- Trend Plots
- Status
- Alarms
- Reports
- Echo® sensor configuration utilities

Server instance is fully functional SW that also stores sensor transmissions in database

Ethernet   TCP/IP

Echo® Sensor Data

MS SQL Server 2005

Echo® Data Presentation SW

Access to SQL Database through LAN

- Trend Plots
- Status
- Alarms
- Reports
- Sensor Configuration

All monitor stations, either through LAN or remote access, have all the same functionality as server system, but do not store data

Echo® Data Presentation SW

Access to SQL Database through internet with VPN

- Trend Plots
- Status
- Alarms
- Reports
- Sensor Configuration

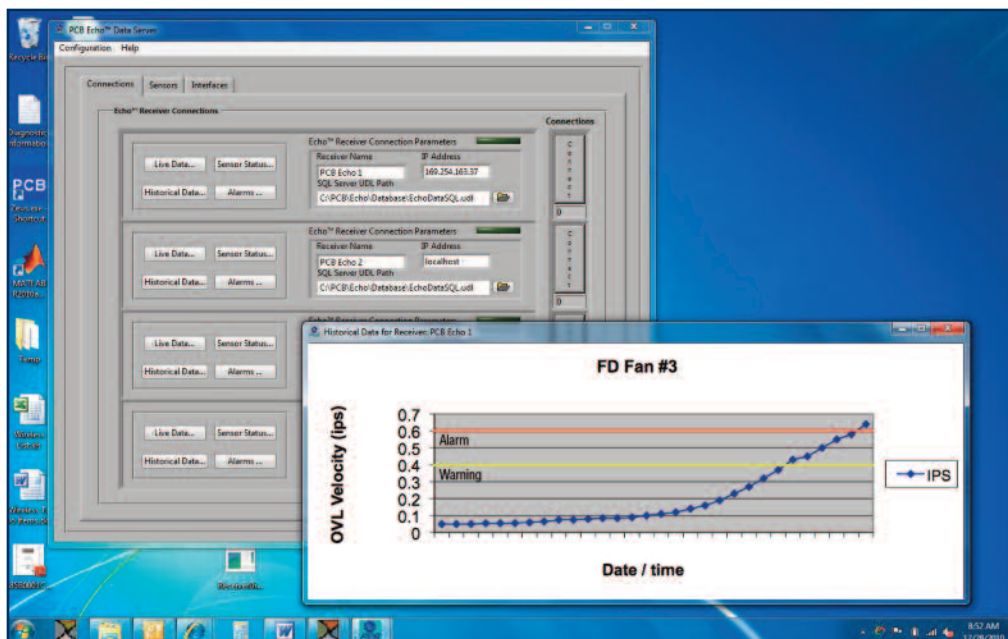# Echo® Data Server and Database

Echo® sensor data is stored in a Microsoft SQL Server 2005 database. The format is published in the User's Manual so it can be accessed by users directly using any ODBC compliant application. The data can also be exported to a tab delimited spreadsheet file that is suitable for use with Excel or other data viewing applications for post processing. Additionally, IMI is working on interfaces to legacy condition monitoring programs and plant monitoring systems. Contact IMI for details.

The Echo® Data Server Software provides two major functions

- Collect transmission data reported by the receiver and stores it in the SQL database
- Present Echo® sensor data to the user through an intuitive and concise interface the includes:

    - Configuration utilities to setup a machinery database and set alarms levels
    - Tabular displays to view live and historical data.
    - System level sensor status display to warn of low batteries, low RF signal, or missed measurements
    - Alarm reporting - graphically via system status screens and electronically via email
    - Single and multi-sensor plot displays with alarm levels to show trends
    - Hardcopy report generation for last transmission and alarm events
    - Additional utilities to query and program Echo® Sensors, EchoPlus® Junction Boxes, and Echo® Receivers.

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Echo® & EchoPlus® Measurements	Details
RMS Velocity	3 Hz to 2400 Hz
RMS Acceleration	> 2 kHz (2 kHz HP fliter)
True Peak Acceleration	of 2 kHz HP filtered acceleration
Battery voltage at maximum load	For battery status report

System Information Provided	Details
Date	
Time	
Sensor / Channel ID	Factory set unique ID
RMS Velocity	
Derived Peak Velocity	1.414 x RMS Velocity
RMS Acceleration	High pass filtered for improved HFE detection
Derived Peak Acceleration	1.414 x RMS Acceleration
True Peak Acceleration	3.7 sec time sample @ 61.4 kHz sample rate
Modified Crest Factor	True Peak / RMS Acceleration Maximum Value = 16
Battery Status	4-levels, status based on previous transmission @ max load
RF Status	4 - levels
Noise Power	Background noise level (dBm)
Average Power	Average transmission power (dBm)
Average SNR	Difference between Noise and Average Power (dB)

Radio & Standard	Specification
Radio Standard	Proprietary
Modulation	Narrowband FSK
Transmission Range	250' to >1 mile radius, installation dependent
Transmission Interval	Progrmmable from 12 sec to 24 hours in 4 sec increments (default = 8 hours)
Certifications	FCC, IC
Minimum Noise Floor	-155 dBm
Radio Sensitivity	-145 dBm
Frequency Band	900 MHz ISM Band
Number of RF Bands	12 (User selectable)
Maximum Power (ERP)	0.75 mW
Signal Attenuation	-45 dBm, user selectable for sensors close to receiver
RF Data Rate	20 bps
Programming	RS-232 (Echo® sensor requires optional 070A87 adapter. EchoPlus® uses standard 9-pin serial cable.)
Number of receivers handled by a single computer	No Limit
Sensors per receiver @ 3 meas/day, 1% miss rate, measurement spaced	~400
Sensors per receiver @ 3 meas/day, 5% miss rate, measurements	~2000
Antenna	Integral 1/2" Ceramic

Performance	Specification
RMS Velocity	Analog Integration, FFT Sum
Velocity HP Filter	2 Hz, 1-pole RC
Velocity LP Filter	2400 Hz, 3-pole Chebyshev
Velocity Resolution	0.001 ips
Velocity Range	4.096 ips
Derived peak velocity	1.414 x RMS Velocity
RMS Acclleration (HP filtered)	Time Sample Average @ 61.4 kHz
Acceration HP Filter	2000 Hz, 4-pole Chebyshev
Acceration LP Filter	15k Hz, 3-pole Chebyshev + 1-pole RC
Acceleration Resolution	0.005 g
Acceleration Range	20.48 g
Derived Peak Acceleration	1.414 x RMS Acceleration
Minimum True Peak Acceleration Pulse Width	~50 s
Modified Crest Factor	True Peak / RMS Acceleration, Maximum Value = 16
ADC/dynamic range	16 bit / >90 dB
Echo® Frequency Response (±3 dB)	3 Hz to >15 kHz
Residual Vibration Level (RVL)	
If RVL = 0	Collect on normal transmission period
If RVL > 0	Check at normal transmission period and collect data only if RMS velocity ≥ RVL
Operation Status Indicator	LED
Echo® Sensor Activation/Deactivation	Magnetic Switch (MAVT)

Environmental	Specification
Echo® Mechanical Shock	5000 g through mounting base
Temperature Range (Electronics)	-20° to 70° C (-4 to 158° F)
Temperature Range (Echo® Base)	-54° to 121° C (-65° to 250° F)
Humidity	5% - 95%, non-condensing
Echo® Enclosure Rating	IP 67

Echo® Electrical	Specification
Echo® Power	7.2V Lithium Battery (073A20 battery replacement kit)
Replaceable	Yes
Battery Operating Temperature	-60° to 85° C (-76 to 185° F)
Battery Life	>5 years @ 3-measurements per day, room temperature
Electrical Isolation (Case)	>108 ohm

Echo® Physical	Specification
Dimensions	
Base Assembly	1-3/8" Hex
Housing	1.6" Dia
Height (overall)	4.5"
Weight (including battery pack)	450 g (15.9 Oz)
Mounting Thread	1/4-28 Female
Mounting Torque	2 to 5 ft-lb
Sensing Element	Piezo Ceramic Shear
Material	
Base	304L Stainless Steel
Housing Material	304L Stainless Steel
Housing Cap	Ploycarbonate
Mechanical Isolator	Urethane
Mounting	1/4-28 Stud
Sealing	O-ring

EchoPlus® Parameter	Specification
Channels per Box	8
Channels Active	User selectable in any combination
Channel ID	Individual factory set unique ID per channel
Sensors Supported	ICP® (≤2 sec settling time, 10, 50, 100, 500 mV/g)
Sensor Power Supplied	24 VDC @ 2.2 mA constant current
Channel Gain	Set per channel for sensor normalization (Default set for 100 mV/g accelerometer)
Buffered Sensor Analog Output	BNC, push SELECT SENSOR
Sensor Select timeout	15 min of non-use
External DC Power	24 VDC ±1 V
External Battery Power (battery not supplied)	6 to 13 VDC
Over Voltage Protection on Battery Terminals	14 to 30 VDC (Fuse auto resets after voltage removed)
Reverse Polarity Protection	Yes
Transmission Interval	Programmable in 4 sec increments up to 24 hours, default = 8 hours, minimum dependent on the number of active channels
Low Frequency Response	3 Hz, May be limited by sensor FR
High Frequency Response	15 kHz, May be limited by sensor FR

EchoPlus® Physical	
Enclosure Rating	NEMA 4X, IP 66
Input Connector	Terminal strip
Enclosure Material	Fiberglas
Size (Height x Width x Depth)	8 x 6 x 4 in (203 x 152 x 102 mm)
Weight	2.88 lb (1.3 kg)
Cord Grips	10 Individual, PGME07

Echo® Receiver Parameter	Specification
Power/RS232 Connector	TBD
Power	12 DC, 15 W max, Using supplied AC power adapter
RS-232	TBD
Antennal Connector	N-female
Ethernet Connector	RJ-45 Waterproof
LED	Power indicator
Interface	Ethernet TCP/IP packet containing XML text
Antenna supplied	916 MHz, Whip SMA w/N connector adapter
Enclosure Rating	TBD

Echo® Receiver Physical	
Enclosure Material	TBD
Size Overall (Length x Width x Height)	8.4 x 7.2 x 2.1 in (213 x 182 x 53 mm)
Weight (without mounting bracket)	2.84 lb (1.23 kg)
Weight (with mounting bracket)	3.76 lb (1.71 kg)

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Echo® Wireless Accessories

Model 070A86
Echo® RV Output Cable

When used in conjunction with a portable data collector, it converts standard sensor power to the low voltage required by Echo® and allows normal broadband data collection with the RV Echo® Sensor.

Model 070A87
Echo® Programming Cable

This special RS-232 to Micro USB cable allows serial communication with the mating Micro USB connector in the Echo® Sensor.

Model 070A88
Echo® RV Shorting Cap

This is used on the RV670A01 Echo® Sensor for normal wireless use. When removed, the Model 070A86, Echo® RV Output Cable can be used for data collection with a portable data collector.

Model 073A20
Echo® Replacement Battery Kit

The kit includes a battery pack, o-ring, silicon grease, foam compressor, and instructions.

Model 009M201
Echo® Receiver Serial Cable

Special serial cable that mates with the industrial MIL style connector on the Echo® Receiver

Antennas, Low Loss Antenna Cable, and Antenna Accessories are available through many commercial outlets such as L-com (www.L-com.com). IMI Sensors can, however, quote these if desired. Contact IMI for details.

IMI Sensors designs and manufactures a full line of accelerometers, sensors, vibration switches, vibration transmitters, cables and accessories for predictive maintenance, continuous vibration monitoring, and machinery equipment protection. Products include rugged industrial ICP® accelerometers, 4-20 mA industrial vibration sensors and transmitters for 24/7 monitoring, electronic and mechanical vibration switches, the patented Bearing Fault Detector, high temperature accelerometers to +900 °F (+482 °C), 2-wire Smart Vibration Switch, and the patented Reciprocating Machinery Protector. CE approved and intrinsically safe versions are available for most products.

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