

ALLEGATO 2 - Schede tecniche dei principali componenti della strumentazione di monitoraggio

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AC-73 / AC-72 / AC-71 Force Balance Accelerometer

Features

- ☐ True Electro-mechanical Force Balance Accelerometer
- ☐ Digital AC-73D version available
- ☐ Dynamic Range 165 dB
- ☐ User selectable Full Scale range $\pm 0.5, 1, 2, 3$ or 4 g
- ☐ Bandwidth from DC to 200 Hz
- ☐ Exemplary Offset stability
- ☐ Temperature and drift compensation
- ☐ Robust suspension system
- ☐ Single Bolt Mounted Enclosure with up to $\pm 10^\circ$ of Leveling Adjustment
- ☐ Integrated Bubble Level

Applications

- ☐ Broadband Seismic, Earthquake and Structural measuring and monitoring



Outline

The AC-73 sensor package is a true electro-mechanical triaxial downhole accelerometer designed for broadband earthquake monitoring and applications requiring highly sensitive and rugged sensors with minimum maintenance and a simple method for periodic testing.

The rugged mass suspension moving coil system improves the signal to noise ratio. The magnetic system and capacitive position sensors offer symmetrical controls for the accurate electronic centring of the mass. At rest the accelerometer mechanism is in balance and no electrical output is generated.

In case of a ground motion, AC-73 yields an electrical output proportional to the current used to keep the mass centred. This output signal is precisely calibrated to provide a signal at the utmost accuracy and with a lowest possible noise level. The symmetrical positioning system incorporated with the force balance accelerometer principle, the accelerometer faithfully keeps its scaling and calibration even under extreme conditions.

The DC response allows the sensor to be easily repaired, tilt tested or recalibrated in the field. With the help of the test line the AC-73 accelerometer can be completely tested assuring proper operation and accurate acceleration measurement. This test line is internally connected to the external world only when a given command is sent to the sensor to avoid any noise pick-up through the test input.

The AC-73 is equipped with electronic offset adjustment features that make its installation very user friendly. This powerful feature allows the users to install the AC-73 without mechanical offset adjustment and fine levelling.

The sensor can be powered from 9.5 to 18 VDC source with the advantage that its power input is insulated from the sensor's electronic ground. This avoids ground loops and reduces noise induced through the power supply.

All the best features of the analog AC-73 accelerometers are now offered with the new AC-73D version, having a digital interface that is directly compatible to operate with the GMSplusD series recorders with upto 1000 meter distances using standard Cat5e cables, providing an extremely compact and versatile measuring solution.



AC-73D version
shown with the GMSplusD



Specifications AC-7x

General Characteristics

Versions:

AC-7x: analog
AC-7xD: digital

Configurations***:

AC-73 or AC-73i*:

AC-72-H or AC-72i-H*:

AC-72-HV or AC-72i-HV*:

AC-71-H or AC-71i-H*:

AC-71-V or AC-71i-V*:

	Triaxial	Bi-axial	Uni-axial	Axes	Alignment**
■	■	■	■	X – Y – Z	H – H – V
■	■	■	■	X – Y	H – H
■	■	■	■	X – Z	H – V
■	■	■	■	X	H
■	■	■	■	Z	V

* i: Internal sensor ** H: Horizontal, V: Vertical

***: add "D" after number of channels for digital version

Full Scale Range: ± 2 std., ± 0.5 , 1, 2, 3 or 4 g
user selectable at field

Sensor Element

Type:

True Electro-mechanical
Force Balance Accelerometer

Dynamic Range:

165 dB (per bin rel. full range)
156 dB (per bin rel. full scale rms)
134 dB (0.02 – 50 Hz, integrated PSD)

Nonlinearity:

< 0.1 %

Cross Axis Sensitivity:

< 0.5 %

Bandwidth:

DC to 200 Hz

Damping:

0.7 \pm 0.1 critical

Offset Drift:

0.0005 g / °C

Span Drift:

200 ppm / °C

Full Scale Output^{NAD}:

± 10 V differential (20 Vpp)

Hysteresis:

< 0.001 % of full scale

Sensitivity:

2.5 to 20 V/g

Output impedance:

100 ohms

Power

Supply Voltage:

AC-7x: 9.5 to 18 VDC

AC-7xD: 48 VDC

Consumption:

AC-73: 41mA typical, 260 mA max.
@15 VDC

AC-73D: 200 mA typical

Overvoltage Protection:

All external interfaces are protected

Connector Pin Configuration

AC-73:

Pin 1-2, 3-4, 5-6

Signal output for axis X, Y, Z

Pin 7-8

Test input, Digital 0/12 V / GND

Pin 9-10

12 VDC insulated power supply input

Pin 11-12

Reserved

Case

Shield connection

AC-73D:

see user manual

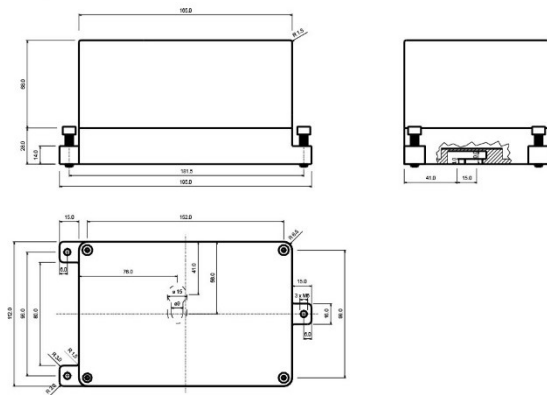
Environment/Housing

Housing Type:

Cast aluminium
Sealed access cover

Housing Size:

195 x 112 x 96 mm



Weight:

3.0 kg

Index of Protection:

IP 65
optional IP 68^{NAD}

Temperature Range:

-20 to 70 °C (operating)
-40 to 75 °C (non-operating)

Humidity:

0 to 100 % (non-condensing)

Orientation:

Can be configured for mounting in any position (please specify at order).

Mounting:

Single bolt, surface mount, adjustable within $\pm 10^\circ$

Standard sensor

Floor mounted, Full scale ± 2 g,
for external sensors: concrete anchor,
GeoSIG recorder mating connector and
AC-7x: 2 m cable with cable inlet
AC-7xD: cable inlet

Options

Full Scale Output^{NAD}:
Cable & connector^{NAD}:

- 4 to 20 mA current loop
- Frame connector (no cable inlet)
- Mating connector (for frame connector)
- Cable with shielded twisted pairs for any length with open end
- Connector on user specification mounted at cable end
- See separate cable & connector options sheet
- Watertight IP68 housing^{NAD}
- Stainless steel protective housing
- See separate sensor orientation options sheet

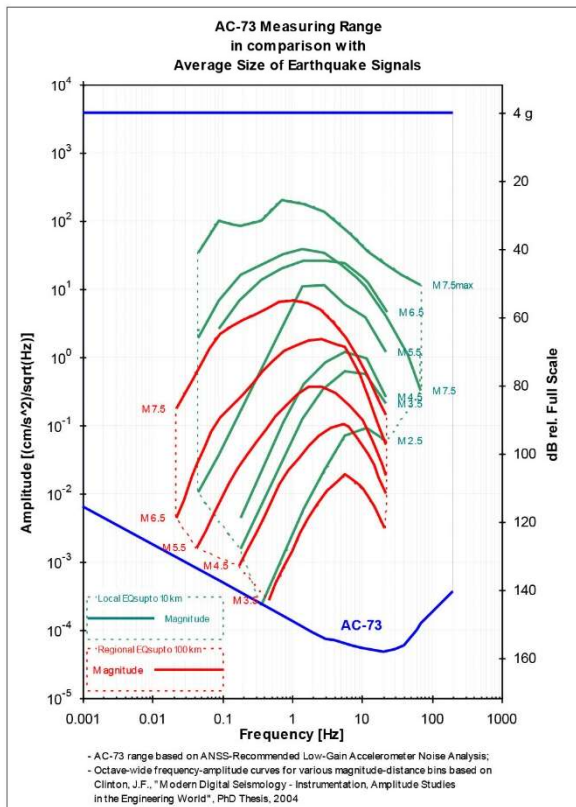
Housing:

Mounting:

Ordering Information

Specify:

Version and configuration of AC-7x, full scale range, and other applicable options



NAD: Not applicable for AC-7xD digital version.

**fora**

Central Data Acquisition System

CR series

Features

- ☐ Unlimited number of channels by combining 36 channel modules
- ☐ Dynamic range 137 dB, 150 dB*
- ☐ Individual $\Delta-\Sigma$ ADC per channel 24-bit, 32-bit*
- ☐ Adjustable sampling rates up to 2000 sps, 5000 sps*
- ☐ True simultaneous sampling with shared clock for up to 36 channels
- ☐ Internal Fast SSD hard drive up to 1TB with SATA interface and high storage capacity. Mirroring function on SD card* or USB drive*
- ☐ Built-in display for easy inspection of status and parameters
- ☐ Support for interconnection of multiple devices
- ☐ Support for DVI output for direct graphical visualization of data and configuration*
- ☐ USB interface for external, removable storage media and communication devices
- ☐ Continuous and trigger-based recording
- ☐ Simultaneous data streaming to several clients
- ☐ Wired Ethernet; enhanced connectivity via external landline modems*, 3G cellular devices*, satellite links* and serial links*
- ☐ TCXO time base with GNSS (GPS, GLONASS, BEIDOU) or NTP synchronisation
- ☐ Configuration and status monitoring via Web Interface compatible with Smartphones/Tablets
- ☐ Simple and secure communication over internet or intranet with full remote management
- ☐ 3 option slots for adding peripherals
- ☐ Alarm output* with up to 8 independent relays flexibly configurable for different types of events (through 2x4 alarm option boards)
- ☐ Power redundancy through dedicated battery input (internal battery charger included)
- ☐ Extremely compact and modular with higher channel density than ever



Applications

- ☐ Structural Health and Response Monitoring
- ☐ Earthquake and Seismic Monitoring
- ☐ Ambient Vibration Testing
- ☐ Induced Vibration Monitoring and Notification
- ☐ Building Code-Compliant Instrumentation
- ☐ Seismic Alarm and Safe Shutdown

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GeoSIG
swiss made to measure

Overview

fora is a 19" rack module consisting of Slot-in Modules (SiMs) inserted into vertical slots.

Each fora rack is expandable up to 36 channels and by combining several fora systems, hundreds of channels can be monitored.

System parameters of the fora are stored in the non-volatile system memory to allow automatic recovery.

Sensors

The fora offers the most flexible sensor connectivity options to cater for the needs of any measuring requirement. Any type of sensor complying with the fora signal input specifications can be connected on the conveniently available screw terminals.

fora rack

Configuration: Base SiM modules:
 - fora-SBC data handling SiM
 - fora-OVP over voltage protection SiM
 - fora-POWER system power mgmt SiM
 Channel SiM modules:
 - fora-DSP Digital signal processing SiM
 - fora-ADC analog-to-digital SiM
 - fora-OVPS sensor interface SiM
 up to 36 channels

Channels:

Digitiser SiM

Configuration: fora-DSP + fora-ADC
 Mounted at the front of the fora rack
 up to 12 SiMs per one rack
 3 channels per SiM

Channels: 3 channels per SiM

A/D Converter: 24 Bit (or 32 bit) $\Delta\Sigma$ per channel
 with analog and digital FIR anti-aliasing filters

Dynamic range: 146 dB (per bin @ 1 Hz rel. full scale rms)
 137 dB @ 50 sps
 156 dB (per bin @ 1 Hz rel. full scale rms)*
 150 dB @ 40 sps*

Sampling Rate: Up to 2000 (or 5000) sps
Bandwidth: DC to 1000 Hz standard / Others*.

Sensor Interface SiM

Configuration: fora-OVPS
 Mounted at the back of the fora rack
 up to 12 SiMs per one rack

Channels: 3 channels per SiM

Input Signal: 20 VDC or 10 VDC differential
 2.5 VDC \pm 2.5 VDC single ended
 0 - 20 mA current loop

Sensor Power: same as DC Power
 15 or 24* VDC (specify at order)

Data Recording

Type: Continuous and/or event based

Triggering

Type: Level or STA/LTA trigger

Pre-event-Time: 1 to 720 seconds, typical

Post-event-Time: 1 to 7200 seconds, typical

Trigger filtering: User configurable lowpass, highpass or bandpass

Data Stream

Protocol: GSBUS, SeedLink
 (Earthworm compatible)

Storage Memory

Size and Type: Internal 64 GB built in SSD hard drive
 Higher capacity available on request
 Removable SD card or USB storage on request
 FAT32 or EXT4 formatted.

Management: Intelligent management of memory card capacity using policies as per file type and ring buffer capacity specification.

Recording format: miniSEED, or with extended information encapsulated into blockette 2000*.

Power

DC Power: 9 - 36 VDC

AC Power: Available on request, AC/DC adaptor with 230 VAC / 50 Hz or 115 VAC / 60 Hz.

Consumption: typically 15 W with 36 channels excluding the consumption of the connected sensors

Solar Panels: Available on request.

External battery: Available on request, 24 to 100 Ah with battery protection in case of low battery condition with automatic restart after power is restored.

Self-Test

User-configurable periodical sensor test and periodical state of health (SOH) report based on comprehensive test of instrument, which can be requested at any time. Sinewave, triangular wave or square wave calibration signal are supported.

Time Base

Internal: Intelligent Adaptive Real Time Clock (IARTC)

External: NTP or GNSS

Std. TCXO accuracy: ± 0.5 ppm (15 s/year) @ +25 °C
 ± 2.5 ppm (75 s/year) @ -10 to +50 °C

Higher accuracy available on request

Accuracy after learn: $< \pm 0.5$ ppm (15 s/year or 2 ms/h)

Accuracy with NTP: $< \pm 4$ ms typical, assuming reasonable access to NTP servers

Communication Channel

Ethernet TCP/IP
 Internal landline modem*
 External GSM modem*
 External Satellite modem*
 External GPRS modem*
 External UMTS/3G modem*

User Interface

An intuitive web interface is available for easy configuration with any web browser. Alternatively the configuration file in XML format can be edited on site through the instrument console, exchanged by replacing the memory card, remotely from a server or through SSH. Although the configuration file can be manually edited at any time, a tool is provided to edit it securely.

Network based link allows the user optionally to interact with the unit over the Internet, from anywhere around the world.

Alarm (SiM*)

Alarms: 4 or 8 independent relay contacts for trigger alarm and/or error (NO and NC contacts available)

Relay Hold-On: 1 to 60 seconds (User programmable)

Contacts: Suitable for a low voltage control. In case large loads must be switched, then external relays should be implemented.

Max voltage: 125 V / 250 mA

Environment / Housing

Operational temperature: -20 °C to +70 °C

Storage temperature: -40 °C to +85 °C

Humidity: 0 % to 100 % (non-condensing)

Rack Dimensions: 19" rack, 3 HU, 350 mm depth

Housing: Various fixed or portable housings available on request

Protection: Housings with variable protection available on request

*: optional

Digital Sensor System

GeoSIG Digital Sensor System has been developed to accommodate the requirements for a cost effective and practical installation in circumstances where several measuring points need to be deployed over long distances.

The system consists of GMSplusD recorder and AC-7xD or AC-4xD digital accelerometers, with the option of adding analogue sensors. Each digital accelerometer transfers its data digitally, accurately and effectively to the GMSplusD through a single cost effective Cat5E cable.

It is possible to connect up to 4 digital accelerometers (AC-7xD / AC-4xD) to a GMSplusD with a total length of 1'000 meters.

Additionally internal or external analogue sensors can be connected to the same GMSplusD to increase the number of monitored channels to 15.



Applications

- **Structural Health Monitoring**
Residential, Commercial, High Rise Buildings
Dams, Bridges, Pipelines, Towers
Damage and Serviceability Assessment
- **Monitoring for chemical, oil & gas industry**
Seismic Alarm and Safe Shutdown
- **Ambient vibration testing & monitoring**
Operational Modal Analysis
Induced Vibration Monitoring and Notification
- **Seismic and Earthquake monitoring**
Earthquake Early Warning and Rapid Response
Earthquake Monitoring Networks
Real-time Seismology
- **Disaster Management**
Shake Mapping & Hazard Mapping

Features

- **High expandability**
Up to 15 channels thru 3 analogue and 12 digital inputs
Easy and low cost installation
- **Real-time data conversion and processing**
Acceleration, velocity and displacement
Low and Highpass filtering, decimation
- **Reliability**
500'000 hours MTBF obtained from real field statistics
- **Reliable Data**
for damage detection, decision making and post event evaluation
Building code compliant (e.g. California, Panama, etc)
- **Self Test**
Permanent self-monitoring without affecting its normal operation
User-configurable periodical state of health (SOH) report

Installation & Configuration

Rugged aluminium housing:
with levelling base plate for fast and easy installation
User-friendly web interface:
easy to reach via web browser, tablets or smartphones
Multiple advanced triggers:
with highly flexible configuration and combinations
Easy configuration of interconnected networks:
with common timing and triggering

Data Acquisition & Analysis

Event based and continuous ringbuffer recording:
with freely adjustable duration and period definitions
Continuous realtime data streams:
in SEEDlink and GSBUS (low latency) formats
Intelligent file management:
with user defined storage, transmission and lifetime allocation
Smart and flexible time source options:
including RTC, NTP, GPS* or interconnected network*

Output & Alarms

Data output in industry compatible format:
miniSEED as well as including enhanced miniSEED format
Data interface/conversion to specialised software:
such as Artemis Extractor, MATLAB, SEISAN etc
Earthquake early warning and rapid response*:
approved by JICA Japan International Cooperation Agency
Alarm functions*:
via SMS, Email, audible or direct interface (relays)

Communication & Remote Management

Simultaneous data streaming to several clients
Full remote management, maintenance and software updates
Simple and secure wireless communication*
Communication via wired Ethernet and serial links.
Enhanced connectivity via cellular or satellite devices*
USB interface for communication devices

