

CoCo-90 Specifications (v2.51)

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Hardware Specifications

The CoCo-90 is derived from the CoCo-80 platform. It is a powerful and simple to use handheld data recorder and dynamic signal analyzer that is ideal for a wide range of industries including automotive, aviation, aerospace, electronics and military that demand easy, quick and accurate data recording and real-time processing in the field. CoCo-90 is a low cost, light weight, battery powered handheld system with unparalleled performance and accuracy. The user interface of CoCo-90 is specifically designed for easy and simple operation while it maintains the capability of providing a wide variety of analysis functions.

The CoCo-90 hardware platform supports two different software working modes: Dynamic Signal Analyzer (DSA) and Vibration Data Collector (VDC). Each working mode has its own user interface and operation navigation structure. DSA working mode is designed for mechanical structure analysis, testing and optimization or for electrical, geophysics and a wide range of applications. VDC is dedicated to route-based machine vibration data collection and trending. The user will select one of the working modes to execute.

CoCo-90 is equipped with 16 input channels and can accurately measure and record both dynamic and static signals. The mass flash memory can record 16 channels of streaming signals simultaneously up to 51.2 kHz while simultaneously computing real-time time and frequency based functions. An embedded signal source channel provides various signal output waveforms that are synchronized with the input sampling rate.

The handheld system is equipped with two USB ports, 100BaseT Ethernet, SD card interface, audio input/output, 5.7 inch color LCD display and a keypad. The user can connect the CoCo-90 to a PC, download files and upgrade the software through several means of network connections.

In VDC mode, the CoCo-90 utilizes modern database management technology to synchronize the parameter set, route map and measured data to PC. Data can be downloaded to a PC and managed, trended, analyzed and exported to other applications using the EDM software from Crystal Instruments.

The CoCo-90 utilizes a new signal processing method, Configurable Signal Analysis (CSA). This method provides unique flexibility for real-time analysis including filtering and spectral analysis. Data can be downloaded to a PC and managed, analyzed and exported to other applications using the EDM software from Crystal Instruments.

Hardware Architecture

CoCo-90 hardware uses dual CPU architecture. An XScale CPU handles the user interface, project configuration, power management, network communication as well as all the peripherals. A high-speed floating point DSP manages the data input/output and real-time processing. CoCo-90 is also configured with large RAM and NAND flash memory for mass data storage. Special thermo and low power design eliminates the need for a cooling fan and increases the battery operating time. Proprietary hardware technology delivers more than 100 dB dynamic range. The extremely high dynamic range eliminates the need for multiple front end gain settings.

Input Channel Specifications

Input Channels: 16 input channels

Connector Type: SMB

Coupling: AC, DC, or IEPE (ICP[®])

Input Type: single-ended

Input Range: $\pm 10 V_{pk}$, $\pm 1 V_{pk}$, $\pm 0.1 V_{pk}$

Input Impedance: 1 Mohm

Input Protection Voltage: 40 V_{pk}

AC Coupling: analog high-pass filter at 0.3 Hz @ (-3dB) and 0.7 Hz @ (-0.1dB)

A/D Resolutions: 24 bits

Anti-Aliasing Filter: analog anti-aliasing filters

Digital Filter: digital high-pass and low-pass filters

Dynamic Range: 105 dB in one range. 150 dB overall.
Sampling Rate: 0.48 Hz to 102.4 kHz, with 54 stages
Maximum Useful Bandwidth: 0.46 · (sampling rate)
Total THD + Noise: -100 dBfs (DC to 1 kHz)
Amplitude Channel Match: 0.3 dB
Phase Channel Match: better than 0.3 degrees up to 20 kHz
Crosstalk: less than -100 dB
Frequency Accuracy: better than 1/100,000
Common Mode Range: $\pm 10 V_{pk}$
Common Mode Rejection: better than 90 dB
Amplitude Accuracy: 0.5%

Output Channel Specifications

Output Channels: 1
Connector Type: SMB
D/A Resolution: 24 bits
Sampling Rate: up to 102.4 kHz per channel, synchronized with A/D input channels
Dynamic Range: 90 dB
Output Impedance: 50 ohm
Maximum Output Current: 25 mA
Sine Amplitude Accuracy: at 1 kHz $\pm 1\%$ (0.34 dB) for 0.1 V – 5 V_{pk}
Anti-Imaging Filtering: 160 dB/oct digital plus analog filters
Digital Filter: high-pass and low-pass digital filters
Source Waveforms: sine, triangle, square, white noise (band-limited signal generated by special filter), DC, chirp, sweep sine, arbitrary signal (edited and downloaded from PC), pink noise
Output Range: programmable 0 to ± 10 Volts

Tachometer Input Specification

The first analog input channel can be configured for tachometer measurements. Threshold, ± 10 V, is user selectable. This tacho channel accepts either the tacho sensor with regular voltage output or a tacho sensor with IEPE/ICP interface. Typical tachometer measurement specification using a Monarch Instruments PLT200 tachometer (Part Number CI-S40) is:

RPM Range: 5 – 200,000 RPM
Accuracy: $\pm 0.01\%$ of reading
Resolution: 0.001 to 10 RPM
Operating Range: 2 inches to 25 feet

Please select CI-S40 option for PLT200 tachometer from Monarch Instrument.

System Specifications

System CPU: XScale™ PXA270 520 MHz Processor
Operating System on XScale: Microsoft® Windows CE 5.0
Total Storage: RAM 128 MB, flash memory used for system and data storage 4 GB+
LCD: 5.7" brilliant color TFT VGA display with 320 x 240 resolution, 3 backlight stages (normal, dark, darker), typical signal display can reach 20 – 30 updates per second.
Power Management: Two settings: Maximum Active Mode – system keeps all system components running at normal power consumption to ensure the best measurement performance (ideal when powered from AC adaptor) and Automatic Mode – system monitors LCD and peripheral activities and manages the power consumption at optimum state by temporarily powering down unused components (best when powered from battery to maximize battery life).

System Power LED: indicates system is powered on when lit

AC Line Power LED: not lit – no external power, red – external power is on and is charging the main battery, green – external power is on, charge completed, battery capacity indicator on LCD display screen

Audio: 3.5 mm earphone connector and built-in speaker provide audio feedback for user interface, built-in microphone for voice annotations.

Ethernet: 100BaseT, RJ45 female connector supports connection to PC

USB Client: 1.1 (mini connector) supports connection to PC

USB Host: 1.1 (type A connector) supports USB peripherals including USB mouse

Keypad: backlit with power button, SHIFT button that changes the function of navigation buttons. 6 Navigation Buttons: Up, Down, Left, Right, Enter, ESC. 12 Function Buttons: Analysis, Display, Setup, File, Rec/Stop, Save, Next Trace, View Mode, Recall, Trigger On/OFF, Sensors, (User). 6 Soft Buttons with software enabled functions. (User) button leads to one user-designated testing project.

Internal Clock: maintains date and time

SD Card: (MMC/SD/SDIO) supports memory storage for data file transfer. The SD memory card is SD, SDHC or MMC.

System Disaster Recovery: In case of system failure, press Power Button for more than 4 seconds or use dedicated Reset pin.

Environmental and General Specifications

Enclosure: handheld, rugged plastic design, shock proof with integrated protective holster and internal EMI shielding.

Size: 231 x 170 x 69 mm

Weight: less than 1.71 kg including battery

Power Supply: AC adaptor accepts 100 to 240 V_{AC} (47 – 440 Hz), 15 V_{DC} ($\pm 10\%$), DC-DC voltage isolated adapter (automobile cigarette lighter) capable.

Power Consumption: total system power consumption is less than 11 watts in Maximum Active mode. When LCD is turned OFF, power consumption is less than 7.5 watts.

Main Battery: operating time at least 8 hours in Measurement mode, charging time 4 hours, two power management configuration settings for normal and low power consumption, rechargeable Li-ion battery, 6600 mAh.

Safety Standard: electromagnetic compatibility and sensitivity: EN 61326:1997+A1:1998+A2:2001, EN61000-3-2: 2000, EN61000-3-3: 1995+A1:2001

Temperature: operating temperature -5 °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 g_{rms}, tested at 3 sides, operational test.

Vibration: 5 – 500 Hz, 2.42 g_{rms}, tested at 3 sides, non-operational test.

Dynamic Signal Analysis Software Specifications

User can operate CoCo-90 in either Dynamic Signal Analysis (DSA) or Vibration Data Collector (VDC) mode. This section specifies the basic software functions of DSA mode. The functions stated in this section are included in the delivery of CoCo-P03.

Data Acquisition and Real-Time Processing Performance

Real-Time Frequency Response: 1 excitation plus 15 response inputs with sampling rate up to 102.4 kHz (frequency range up to 45 kHz)

Maximum Data Recording Rate: 16 channel simultaneously streaming recording at maximum sampling rate of 51.2 kHz

Recording and Saving Data

Dedicated Rec/Stop Button: controls the recording of continuous time stream data to flash memory. All time streams in the data conditioning stage can be recorded continuously.

Dedicated Save Button: controls the storage of signal snapshots such as spectra or transient time capture. All long time captures or spectra in the signal analysis stage can be saved.

Voice Annotation: voice annotation can be added before data is saved or recorded. Voice annotation is attached to the data files and can be played on the host PC after the files are downloaded. Voice annotation duration: 5 or 10 seconds.

Typical Continuous Recording Time for 4GB storage: 21 minutes for 16 ch sampled at 51.2 kHz; 1.2 hours for 8 ch sampled at 32 kHz; 2.4 hours for 4 ch sampled at 32 kHz.

Input Acquisition Settings

Sensitivity: user defined with engineering unit and input sensitivity setting.

Labels: user defined channel labels.

Input Types: AC/DC/IEPE coupling with single-ended input type

Built-in Integration and Double Integration: When acceleration is selected as measurement physical quantity, digital integration or double integration can be applied to obtain velocity or displacement quantity. When velocity is selected as measurement quantity, digital integration can be applied to obtain displacement. The engineering units after integration or double integration can be set for each channel.

Transducer Calibration

Transducer Calibration tool can be used to calculate the sensitivity of the sensors when the measurements of such sensors are compared against reference sine wave input signals. User enters the following information: Calibration signal nominal frequency, select either RMS reading or dB RMS reading, reference dB value.

CoCo automatically calculates its RMS and updates the sensitivity table. User can accept or reject the calibration results and view the report.

Sampling Rate Settings

User defined sampling rate directly from display screen.

Select one of 54 sampling rate stages without stopping the acquisition.

Signal Source (Output) Settings

Typical Waveforms: sine, triangle, square, white noise, pink noise, DC, chirp, swept sine

Arbitrary Waveform: import any arbitrary waveform with block size 16,384 to CoCo-90 using host PC software. System outputs arbitrary waveform with user-defined active and quiet zones.

Measurement Instrument Calibration

Calibration software is included with the basic software configuration (CoCo-P03) and can be operated by either the user or a calibration specialist. Calibration software is operated following the step by step online wizard. A final calibration report can be viewed on either CoCo-90 or from the host PC. The system is calibrated at factory before shipping and should be recalibrated annually by a factory authorized calibration service.

Calibration Software Functions: calibrate the signal source and adjust the DC and AC gain and offset calibrate the input channels at different coupling types and adjust the DC and AC error; type in the model number and text for calibration meter; type in the calibration operator name; view the calibration report.

Signal Display

Signal display page consists of a window viewed on the LCD panel. A window consists of one or two traces. Each trace is a graphic area for displaying one or multiple signals with the same type. The user can select any signal display window using a pull down menu. The user can create, edit or remove traces or assign signals to the trace. The user can set the view mode to the active trace from the menu.

Window Type

Four different window types are available: a window with one trace, a window with two traces, a window with 3D waterfall trace, and a window with color spectrogram.

Window Operation

Add window, delete window, clear signals, select signals, select all signals, set View mode

Display-Trace Selection

Trace Format: multiple traces can be created. Traces can be edited, added or deleted

Signal Format: user assigns one or multiple signals or time streams with the same types (time or frequency) to any trace

Trace Display in Plot or Text: each trace can display the signals either in its plot drawing or text signatures, such as Max, Min, RMS values.

Time Domain Display

Auto-Scroll: automatically scrolls when total duration is greater than 0.5 seconds. Horizontal time range is not limited by time capture size.

Block: display signals frame by frame without scrolling.

Horizontal Axis of Spectra

Scaling: linear, log (set in the Display Preferences)

Plot View Mode:

dB, Mag, LogMag, phase, real part, imaginary part, Polar, Orbit and Bode plot.

Cursors

Vertical Cursor: one or two vertical cursors controlled with the arrow buttons

Cursor Numeric Display: signal values displayed on screen at the cursor location for all signals in a trace. Cursor value display area can be moved.

Peak Reading and Damping Calculation

The system finds the peak location between two cursors or calculates damping factor for FRF. Damping calculation uses curve fit to interpolate the FRF peak value.

RMS Calculation

Overall RMS is always calculated. The system can calculate the RMS value for any time or auto power signals between two cursors.

Digit Notation Format

Formats: floating point, scientific notation, and engineering notation.

Signal Trace Scaling

Auto Scaling: software automatically detects the signal magnitude and sets the best window scaling area for each frame of data.

Fixed Scaling (ZOOM in and out): 8 settings controlled by the four arrow buttons and SHIFT buttons: move up, down, left, right, vertical expand, vertical reduce, horizontal expand, horizontal reduce

Time Display Range: user can change the time domain display period from milliseconds to minutes regardless of the sampling rate.

Status Bar

Status Display: a horizontal bar displays the critical status of the running system, including: time, time stream recording status, AC Power and battery status, network connection status, CSA name, input overload status and sampling rate value.

3D Waterfall Display

Time capture or frequency signals can be displayed and stored in the 3D waterfall format. The z-axis is time.

3D Waterfall Signals: transient capture time blocks, auto power spectrum, FRF, coherence, cross power spectrum, and fractional octave spectrum.

Color Theme

Two color themes available: black with dark background and light foreground and white with light background and dark foreground.

Dimensions and Units

Engineering Units

Acceleration: m/s², cm/s², mm/s², g, μ g, ft/s², in/s², mil/s²

Velocity: m/s, cm/s, mm/s, ft/s, in/s, mil/s

Displacement: m, cm, mm, micron, ft, in, mil

Force: Newton, Dyne, Kgf, KIPF, LBF, OZF

Pressure: Pa, μ Pa, Bar, PSI, KSI

Voltage: Volts, mV

Time: Seconds, mS

Frequency: mHz, Hz, kHz, MHz

Angular velocity: Rad/s, Degree/s, RPM

Current: Amp, mA

SPL: dB in reference to 20 μ Pa

Mass: kg, g, LBS, Ounce

Input Units

User selects the preferred physical quantity at system level. User selects corresponding Engineering Units (EU) for each input channel.

Data Scaling

Transducer sensitivity (mV/EU) is assigned to each input channel.

Internal Representation

Units internally are strictly controlled by the ASAM-ODS standard.

Unit Display

Both quantity and unit are displayed on traces.

Measurement Data Storage

Mass Data File Transfer to Host PC

Mass data files can be transferred to host PC through USB, Ethernet, or SD memory card. When SD memory card is used, host PC must have appropriate SD card reader installed.

Mass Data Storage Format

Data Format: compliant with ASAM-ODS hierarchy and structure

Data Precision: mass data saved in 32 bit single precision floating point (4 bytes per word)

Data Structure: all signals are combined and saved in one file for each measurement

Storage of Time Streams and Snapshots

Time Stream Data: storage is controlled by the Rec/Stop button, dedicated Rec/Stop button permits saving a specified list of time streams within the current CSA.

Snapshot Data: spectra or transient capture storage is controlled by the Save button, dedicated Save button permits saving a specified list of signals within the current CSA.

Data Points: single values of time of frequency signals can be saved by a user defined schedule.

Conditional Capture: time streams and signals can be stored by other conditions, such as a timer.

Export Data File Formats

Data is exported using EDM on a host computer

ASAM-ODS XML: the ASAM Open Data Source binary format (default, recommended).

UFF ASCII: the ASCII format of UFF files.

UFF Binary: the binary format of UFF files.

ASCII: end user defined format and selected attributes. User enables the signal attributes and the format of ASCII data and set as template for future use.

Excel CSV: ASCII file can be opened directly in Microsoft Excel.

MATLAB: *.mat binary format that can be opened and analyzed using MATLAB

NI- TDM: National Instruments structured storage format.

.WAV: sound wave files can be played by a media player. Exported wave files do not contain file header information. Only time signals can be exported.

Measurement Data File Review

Storage Capacity Display: lists available capacity of flash memory.

Record Files View: shows measured data file names in tablet format, displays the create time, file size, test note or owner information.

Review: shows file attributes and either text mode or plot in preview mode.

Delete: one or all files can be deleted from flash memory.

Copy To: one or all files can be copied to SD memory card.

System Software Functions

About Information

Version: about box displays version information of hardware platform, firmware and application software.

Subscription: information is displayed to show the valid time period of software subscription.

Calibration: previous calibration date is displayed.

User Information

User Data: user name, address, and email are file attributes available for file management.

Welcome Page

A welcome screen shows the most frequently used shortcut icons and recently used CSA files.

Online Update

The CoCo-90 can use any Internet connection to connect to Crystal Instruments server. The server will determine if any updates are available and list them on the CoCo with update instructions. The latest software is available for download while software subscription is current.

Network Connections

Three tabs to display the connection status of Ethernet or USB Connection status includes hardware physical connection, EDM software detection, Internet connection and CI server connection.

Test Note

Add a text comment for any measurement. Comment will be attached to the measured data as a file attribute.

User can search through the data using Test Note on the PC to manage data.

Power

Display the detail battery power and charging status. Set the power mode: Automatic, fixed period for turning on and off LCD

Memory and CPU Resource

Display the memory and CPU resource usage.

Mouse Support

Mouse is supported with the following operations: F1 – F6 function buttons, two virtual keypads, scrolling and make selections in any combo box, ZOOM-in scaling, ZOOM-out scaling the graph.

Arbitrary Waveform Signal Source

User edits the signal shape with a table and graphic editor on the Host PC and uploads the arbitrary waveform to CoCo-90. User sets the output amplitude in volts and the quiet zone in seconds. The signal source channel outputs arbitrary waveform periodically with a quiet zone in between. Multiple arbitrary waveform files can be loaded onto device.

Arbitrary Waveform Size Limit: 16,000 points typical. Special configuration allows up to 128,000 points.

Data Processing Specifications

CoCo-90 combines two instruments, a data recorder, and a signal analyzer into one system. Data recording function including processing the data from native acquisition channels and data conditioning. All the signals in the data recording stage are continuous time streams. They can be displayed or recorded. Data conditioning include algebraic function (addition,

subtraction, multiplication and division), digital filtering, integration, differentiation, calibration and other math operations that are applied to continuous time streams.

Acquisition Mode controls how the data is acquired block-by-block and feed them into the signal analyzer functions. These time blocks can be either gap free, overlapped, or with gaps, depending on the acquisition mode selection.

Data processing is realized by using the Configurable Signal Analysis technique. The CSA script consists of one or multiple CSA Modules written in XML. A CSA script can be downloaded from the host PC or CI server through the Internet. The CoCo-90 runs CSA scripts to realize various analysis functions.

Data Conditioning Functions

Math Functions: abs, +, -, *, /, square, square root, log, integration with low-pass, integration with high-pass, double integration with low-pass, double integration with high-pass, differentiation, double differentiation.

RMS: apply RMS estimation to an input data stream and generate the output stream continuously.

Peak: extract the peak or peak-peak value over a period of time and generate the time stream.

Offset Scale: apply a multiplier gain and offset to any input data stream and generate the output stream continuously.

Acquisition Mode

Mode Selection: Free Run, Continuous after Trigger, Single Shot with Trigger, Single Shot without Trigger, Auto-Arm Trigger, and Manual-Arm Trigger.

Trigger source: Trigger source is designated by the user when the CSA is edited on the host PC. Any time stream can be used as a trigger source. Multiple time streams can be defined as trigger source candidates but only one can be selected at one time.

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: $\pm 100\%$ of Block Size

Trigger Setup Display: a special display view is created for trigger setup. The user selects acquisition mode, trigger source, trigger condition, overlap ratio. The arrow buttons serve one of three functions: window scaling, window moving, and trigger threshold position change. Trigger delay is operated by the left-right buttons.

Trigger Runtime Display: in manual arm mode, a small window will pop up for the user to accept or reject the transient captured signals. Accepted signals will be averaged into the spectra.

Signal Analyzer Functions

Transient Time Block Size: up to 128k points for 1 channel, up to 8 k points for 16 channels. (Note: Transient Time Capture stores the data in the local memory. The continuous recording stores the data into flash memory and has "unlimited size").

FFT Block Sizes: 256 – 8,192 for 16 channels, 256 – 65,536 for 1 channel

Data Window Functions: Uniform, Hann, Hamming, Flat-top, Kaiser-Bessel, Blackman

Averaging: exponential, linear, peak hold, peak hold for specified number of averages

Time Synchronous Averaging: exponential, linear

Spectrum Types: linear spectrum, auto spectrum, frequency response function, coherence, cross power spectrum, phase spectrum

Auto 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 , $EU^2 \cdot s/Hz$)

Overlapping ratio for Spectral Analysis: automatic, 25%, 50% or 75%

Correlation Functions: auto and cross correlation functions.

Automated Test Control

The Automated Test Control is particularly useful for automated limiting test. The following functions are enabled with or without limiting test option installed. They can be enabled for all CSA projects.

Testing Schedule: Testing schedule automatically controls the test duration and automates the operation. Multiple testing schedules can be developed. Only one can be executed at a time. Testing schedule event entry: 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.

Testing Log and Summary Report: log file is automatically created for each run of the schedule and records up to 1024 major events. A summary report is provided for the limiting check status for the last schedule run.

Schedule Activation Control: when the CoCo display window is shown the quick access button is allowed to enable or disable the automated testing schedule. When testing schedule is activated the UI buttons are deactivated.

Optional Dynamic Signal Analysis Functions

User can run the CoCo-90 in either Dynamic Signal Analysis or Vibration Data Collector mode. This section specifies the optional software functions of DSA mode. The functions stated in this section are NOT included in the delivery of CoCo-P03.

Acoustics Data Acquisition (Part Number: CoCo-P11)

Important Notice: No more than 8 channels can be used to run this option.

Fractional Octave Analysis

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 54 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

Midband Frequencies: base 10 complies with ANSI std. S1.11:2004 Annex A.

Average Type: linear, exponential and peak hold.

Time Weighting: fast, slow, impulse and user-defined.

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:-24 – 111dB (1/3 Octave, 2 second stable average) per ANSI S1.11:2004.

Octave Spectrum Display: solid bar, outline bar

RMS Trace Display: RMS trace can be measured against either time or RPM. RMS trace for any octave filter band or overall level, controlled by menu command. Always available for recording. User selects either Time Trace mode or RPM trace mode in CSA Editor.

Waterfall Display: octave spectrum

Time Interval between Spectra: time update rate for RMS traces, 5 ms and multiples of 5 ms. Minimum value varies with channel number and octave resolution.

Acquisition Mode: free run, continue after trigger

Acquisition Source Type: input time signal, RMS level, time delay

Raw Time Streams: always available for display and recording.

Sound Level Meter

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 comply with IEC 61672-2002, or user-defined.

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_{eqmax}), 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}	

Acquisition Mode: free run, continue after trigger

Acquisition Source Type: input time signal, RMS level, time delay

Measure Time Control: free run, user-defined measure time

Decay Time Constant for F and S time-weighted Sound Levels: 34 dB/s (by standard, >25 dB/s) and 4.34 dB/s (by standard, between 3.4 – 5.3 dB/s)

Reference SPL: 94 dB @ 1 kHz

Time Trace: time trace is a scrolling buffer allocated for each channel to record the time streams of one time-weighted, time-averaged or sound exposure measures. User assigns the type of measures. Time trace can be updated much faster than Time Average Interval. User selects either Time Trace mode or RPM Trace mode in the CSA Editor.

Time Trace Update Rate: 5 ms to 60 seconds

RPM Trace: buffer allocated for each channel to display one time-weighted, time-averaged or sound exposure measures against RPM. User selects either Time Trace mode or RPM Trace mode in CSA Editor.

dB Histogram: is a histogram signal per channel that measures the statistical distribution in dB over time.

Raw Time Streams: always available for display and recording.

Order Tracking (Part Number: CoCo-P12)

Important Notice: No more than 8 channels can be used to run this option.

Order tracking option is developed and based on a precise tachometer measurement of rotating speed and fast digital resampling at the rotating speed and a proprietary DFT method to get any required fractional orders of interest at fast slew rate. The following measurements can be made in the Order Tracking option: raw time streams, real-time order tracks and order spectra, narrowband RPM spectra and fixed band RPM spectra, overall RPM spectrum, and order tracks with phase relative to tachometer signals.

Real-Time Order Tracks and Order Spectra

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

Max Order Tracks: up to 28 tracks for 1 channel, up to 8 tracks for 4 channels, up to 4 tracks for 8 channels

Max Order of Interest: 200

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: 3 – 300,000 RPM (0.05 Hz – 5 kHz)

RPM Resolution: 10 – 10,000 RPM

Delta order of Order Spectrum: 0.025 to 1

Acquisition Mode: Free Run, Run Up, Run Down, Run Up and Down, Run Down and Up

Order Spectrum View Mode: 2 dimensional, waterfall or spectrogram (with RPM as z-axis)

Narrowband RPM Spectra

Narrowband RPM spectra are 3D signals that display the auto power spectra changing with RPM. Fixed Band RPM spectra are RMS measurements extracted from the 3D RPM spectrum within fixed frequency bands.

FFT Block Sizes: 256 to 4,096 for 8 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: 3 – 300,000 RPM (0.05 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 .

Order Tracks with Phase

Order Tracks with phase are order spectra with the phase measurement that are relative to the tachometer signals as reference. All the specs are the same as real order tracks except that order tracks with phase can also be displayed as Bode or polar plots. With this option the orbit display can be enabled for any two data channels.

Raw Time Streams

Time streams of all channels and overall RPM spectra are always available for display and recording.

Overall Level Measurement

In all measurements the overall level measurement is available.

Tachometer Processing

User can view either the original tachometer input waveform or translated RPM signal. User sets RPM trigger threshold, rising or falling edge detection, and pulse per revolution. Tachometer signal processing automatically removes unwanted noise and glitches.

Swept Sine Analysis (Part Number: CoCo-P13)

Important Notice: No more than 8 channels can be used to run this option.

Measurement Quantity: time stream of each channel (raw data), amplitude spectrum of each channel, frequency response (transmissibility signals) between any channel to channel 1 as reference channel.

Sweeping Frequency Range: 0.1 Hz – 20 kHz, up to 8 input channels. 0.1 Hz – 48 kHz, 2 input channels or less.

Display Spectrum Resolution: 200, 256, 400, 512, 800, 1024, 1600, or 2048 (Note: the actual sweeping sine frequency is continuous and not depending on the display spectrum resolution).

Horizontal Scale and Sweep Mode: log or linear

Tracking Filter: on or off, 7 – 100% of sweeping frequency

Sweep Rate: defined by total duration per sweep, or linear rate from 0.01 to 600 Hz/min, or logarithmic rate from 0.01 to 100 octaves per minute.

Averaging: linear or exponential

Initial Sweep Direction: up or down

Initial Voltage: 0.001 to 1 V

Sweep Loops: any integer or fractional number

Sweep Operation Control: Start, Stop, Pause, Jump to (Frequency), Hold (Frequency), and Reverse Sweep.

Output Control in one of three modes: Constant output level; output profile, auto-gain following one of the input profiles. In constant output level the output voltage is fixed. In output profile mode the output follows a

predefined spectral shape. In auto-gain mode the output level is automatically adjust based on the feedback of one of the measurement channels.

Automated Test and Limiting Check (Part Number: CoCo-P15)

Automated limit test function allows the CoCo to conduct automated limit checking for time or frequency signals, or any block signals available to the CoCo during runtime. Limiting signals are designed in CSA Editor on host PC. There are four elements in a limiting test: signals being tested, upper or lower limits applied, testing schedule and a testing log.

Test Signals: time block signals, auto spectrum in various spectrum units, frequency response function, octave spectrum. Signals are assigned in the CSA Editor.

Limit signals: user using mouse and table designs the 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.

Testing schedule: Testing schedule automatically controls 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/lend-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.

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 schedule run.

Schedule Activation Control: when the CoCo display window is shown, the quick access button is allowed to enable or disable the automated testing schedule. When testing schedule is on the UI buttons are deactivated.

Limit Check Alarm Events: beep, screen flashing, event log into testing log, send message to host PC, save signals.

Real-Time Digital Filters (Part Number: CoCo-P16)

Real-Time digital filters are CSA modules that are applied in the data conditioning phase. The user can cascade real-time filter or other data conditioning modules to construct powerful real-time analysis functions. There are mainly three models of real-time digital filters: Decimation filter, FIR filter and IIR filter. According to the criteria, the user designs the filter model with a graphic design tool provided in the CSA Editor and uploads the filter design parameters to the CoCo-90 for execution. The graphic design tool draws the filter performance in vertical axis with dB unit and horizontal axis in relative frequency.

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.

Decimation Filter: 2:1 decimation with built-in anti-aliasing filter. Anti-aliasing attenuation is more than -80 dB which provides sufficient removal for high frequency noise. User sets decimation stages. Each stage decimates data to half.

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 cut-off frequencies either relative to sampling rate or in fixed value; and sets the filter length between 11 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 11 and 127 (number of FIR taps).

IIR Filters (3 types): Butterworth, Chebyshev I, and Elliptic. 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 order between 1 to 20.

Histogram and Statistics (Part Number: CoCo-P17)

Histogram and Statistics function is a single CSA module that can be applied to any time stream. The output of the Histogram and Statistics module is a histogram signal and associated statistics results. The user changes the display format on CoCo-90.

Histogram Parameters: bin number for the bar chart, amplitude ranges

Histogram Display View Mode: linear-normalized, linear-un-normalized, log-normalized, log-un-normalized, and cumulative

Statistics Results: mean, max, min, variance, skewness, crest factor, kurtosis

Continuous Recording to SD Card Memory (Part Number: CoCo-P19)

32 GB SD external memory card included. This option allows data to be directly throughput to the SD memory card. The bandwidth is lower than the throughput to onboard flash memory but the total storage is much larger. Live signal display may be disabled during such recording due to limited bandwidth. This function requires firmware version 1.1.0 or newer.

Maximum simultaneous recording speed: 2-channel at 102.4 kHz; 4-channel at 51.2 kHz; or 8-channel at 25.6 kHz, or 16-channel at 12.8 kHz.

Typical total recording duration: 12 hours for 4ch sampled at 32 kHz; 31 hours for 4ch sampled at 12.8 kHz;

Shock Response Spectrum Analysis (Part Number: CoCo-P21)

Compute SRS for all channels up to 12 octave ranges using maxi-max, maximum negative, and maximum positive analysis techniques.

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 – 100%

Filter Center Frequencies: controlled by low frequency, high frequency and reference frequency

Average Type: linear or exponential

Acquisition and Trigger Mode: same as those available in basic FFT spectral analysis

SRS Spectrum Type: maximum positive, maximum negative, maxi-max.

Raw Time Streams: always available for display and recording.

Advanced Audio Functions (Part Number: CoCo-P24)

This is the audio functions for both “listening” and “speaking”. Listening allows the user to hear, via earphones, any of the input channels without interrupting the measurement or real-time analysis. “Speaking” lets the user record voice annotations which can be attached to a saved signal or recorded data. Accessory **CoCo-A12**, external microphone for controlling the voice recording, is included.

Headphone listening and voice annotation functions can be enabled or disabled in the Audio setup window. When the headphone listening function is enabled, the user selects one of the active input channels. The signal will be normalized to an audible range and played into the headphones.

When the voice annotation function is enabled, the user can record a voice message when the microphone button is pressed down. A voice volume indicator is shown on the screen. The voice annotation is then associated with the saved signals and can be played back on the PC with the EDM software.

The audio function requires that: CoCo Software version $\geq 1.7.8$; Base Hardware System version $\geq 2.0.9$; Measurement hardware version $\geq 10.1.0$; Firmware version $\geq 1.5.0$.

Mechanical Shock Test (Part Number: CoCo-P26)

Used to verify if a shock pulse generated by shock-testing machine meets a customer defined standard. This option measures the shock pulse after a trigger signal from the input channel and compares the pulse with high limit and low limit that are given in the standard.

Mechanical Shock Test for the CoCo includes the following four distinct testing parts, shock acceleration pulse test, shock velocity pulse test, determination of uniformity of acceleration on the table of a shock-testing machine, and determination of the ratio of horizontal to vertical movement of the table of a shock-testing machine.

Acceleration Pulses Tested: half-sine, terminal-peak saw tooth, and trapezoid.

Zoom Spectrum Analysis (Part Number: CoCo-P28)

Compute FRF, coherence, auto power spectra and phase spectra within user-defined frequency band. With Zoom Spectrum Analysis, user can achieve very high frequency resolution without computing the entire spectrum.

Optional Vibration Data Collector Software

VDC Mode (Part Number: CoCo-P08)

The CoCo-90 runs in either Dynamic Signal Analysis (DSA) or Vibration Data Collector (VDC) mode. This section specifies the optional software functions of VDC mode. In VDC mode only Channels 1 through 4 are active.

CoCo-90 VDC mode has both route based data collection and onsite measurement functions. The route based data collection mode includes: overall readings, time waveform, spectrum and demodulated spectrum. Onsite measurement mode conducts following test in addition to the data collection functions: bump test, coast-down / run-up, and balancing. For balancing purchase Part Number CoCo-P09.

Route Collection Function

Route Tree Structure: database, factory, machine, point, direction and measurement entry. User can quickly navigate to each measurement entry. User may skip or advance the point or measurement entry.

Advance in Measurement Entry: manual or automatic.

Measurement Channels: 1 or 3 channels (tri-axis) with tachometer enabled or disabled

Data Review: previously measured data can be recalled for review in the same format and style when the data is saved. Data acquired in recent 24 hours will be indicated in the tree-view.

Route Collection Control: easy navigation from the UI level to routes. View or hold live signals, review measured record, previous measurement entry, next measurement entry, previous point, next point, point and route management.

Vibration Overall Level Readings

Overall readings are available in both route collection and onsite mode.

Measurement Quantity: acceleration, velocity, displacement, current and tachometer

Overall Level Readings: peak, peak-peak, average, overall RMS, true RMS

AdB, VdB, amps: US and SI options for both AdB and VdB

Magnitude and Cursors: overall RMS value, dual cursors, harmonics, digital readouts on chart

Amplitudes at Orders: display the spectrum amplitude at 1, 2, and 3 rotating orders

RMS Calculation in Band: calculate RMS value for any time or auto power signals between two cursors.

Waveform and Spectrum

Waveform and spectrum are available in both route collection and onsite mode.

Time Waveform Number of Samples: 1024, 2048, 4096, 8192, 16384, 32768

FFT resolution: 400, 800, 1600, 3200, 6400, 14400 (selectable)

Frequency Range: 22 Hz to 46 kHz in 34 selectable stages (and equivalent RPM)

Data Window Functions: Uniform, Hanning

Spectral Averaging: exponential, linear, peak hold for specified number of averages

Overlapping ratio for spectral analysis: automatic, 0%, 25%, 50%, or 75%

Measurement Quantity: acceleration, velocity, displacement, or electrical current

Display Spectrum Type: peak, peak-peak, RMS or dB

Frequency Domain Axis: Hz, RPM, or Order

Unit: English and metric units

RPM detection: user-defined, read from tachometer, or estimated from spectrum.

Demodulated Spectrum

Demodulated Spectrum is available in both route collection and onsite mode.

Demodulation Bandwidth: 24 bandwidth options from 125 Hz to 1.44 kHz up to 32 kHz to 46.08 kHz

Other settings are the same as that of Waveform and Spectrum.

Signal Display

Signal display window consists of one or two traces on the LCD panel. Each trace displays one or more signals, in the format of reading or graphic plot.

Display Traces: readings only, waveform only, spectrum only, readings + readings, readings + waveform, readings + spectrum, waveform + waveform, waveform + spectrum, spectrum + spectrum and demodulation spectrum. User can switch from one trace to another by pressing Next Trace button.

Horizontal Axis of Spectrum Scaling: linear, log (set in the Display Preferences)

Vertical Cursor: one or two vertical cursors controlled with the arrow buttons

Cursor Numeric Display: shows the signal values on screen at the cursor location for all signals in a trace. Cursor value display area can be moved.

Alarms

Alarms Levels: up to 3 alarm levels (warning, alarm, danger), comparison to previous measurement

Reading Alarm: alarms can be applied to overall RMS, peak, peak-peak, average or true RMS for each channel. Alarms can be created using baseline values.

Waveform Alarm: alarms will apply to the time domain

Spectrum Band Alarm: applied to any spectrum and checked against the whole frequency range or a specific band.

ISO Standard Alarm: ISO-10816-2 for land-based steam turbines; ISO 10816-3 for industrial machines; ISO 10816-4L for gas turbines.

Display: instantaneous measurement, measured value, alarm limits, and previous measurement. Bar graph display of measurement and alarm levels.

Input Channel and Sensor Settings

Level Display: bar graph displays the input level. IEPE sensor detection.

Sensitivity: user-defined with engineering units and input sensitivity settings

Labels: user-defined channel labels

Input Types: AC/DC/IEPE coupling and differential or single-ended input type

Built-in Integration and Double Integration: when acceleration is selected as the physical measurement quantity, digital integration or double integration can be applied to obtain velocity or displacement quantity. When velocity is selected as measurement quantity, digital integration can be applied to obtain displacement. The engineering units after integration or double integration can be set for each channel.

Digital High-Pass Filter: high-pass filter with user set cutoff frequency for each channel

Rotor Balancing (Part Number: CoCo-P09)

This function allows correcting the unbalance without having to dismantle the machine. It is possible to balance rotors of any size with either 1 or 2 plane balancing. Using multiple channel option, parallel measurements on 2 sensors are possible, resulting in a faster, safer and more accurate procedure. The user interface allows stopping and starting balancing as wanted and to perform again any single operation without running the whole procedure.

Measurement Type: acceleration, velocity, or displacement

Trial Weight Estimate: available for both planes

Trim Balance: multiple iterations available

Average: measurement with programmable averaging to reduce the noise

Display: RPM signal display, balancing graphic polar display and time trace display

Trial Run: trial and compensation weight display in tabular mode or graphic polar mode

Split Weight: integrated function to split weight on two defined angles

Combine Weight: multiple weights can be combined together

Units: English or metric units

RPM Range: 5 to 200,000 RPM

Phase Display: display with 4 digits from 0 to 360° (or any other user-defined unit). Accuracy + 0.5°

Project Management: save, recall, and send to PC

Ordering Information

Warranty and Support

Warranty and support are available for all Crystal Instruments products. Warranty and support options are separated into two types: software subscription renewal and hardware extended warranty.

Software subscription renewal includes periodic updates, bug fixes, and application support by phone or online. All new CSAs can be downloaded without extra charge during the subscription period. Software subscription renewal will not be offered through distributors. The user will purchase it directly from the factory using the online store.

The hardware extended warranty provides repair and calibration at no additional charge. For repair the customer pays the shipping fee when the unit is returned to the factory and CI pays when it is shipped to the user. Hardware warranty only applies to the products that are still under warranty. Hardware warranty will not be offered through distributors. The user will purchase it directly from the CI factory using the online store. Each main product purchase, CoCo-Pxx or Spider-Pxx, comes with 1 year software subscription renewal and 1 year hardware warranty.

Part Number Description

- CoCo-P01 Four channel CoCo-80 system and accessories
- CoCo-P02 Eight channel CoCo-80 system and accessories
- CoCo-P03 Sixteen channel CoCo-90 system and accessories
- CoCo-P04 Two channel CoCo-80 system and accessories
- CoCo-P06 Hardware Option: Extend Input Range from ± 10 V to ± 20 V
- CoCo-P07 Hardware Option: Enable 2 remaining inputs for 2 channel CoCo-80
- CoCo-P08 VDC Software Option: Vibration Data Collector (VDC) Mode
- CoCo-P09 VDC Software Option: Rotor Balancing
- CoCo-P10 VDC Software Option: Remove Dynamic Signal Analyzer (DSA) Mode
- CoCo-P11 DSA Software Option: Octave Analysis and Sound Level Meter
- CoCo-P12 DSA Software Option: Order Tracking
- CoCo-P13 DSA Software Option: Swept Sine Test
- CoCo-P15 DSA Software Option: Automated Limiting Test
- CoCo-P16 DSA Software Option: Real-Time Digital Filters
- CoCo-P17 DSA Software Option: Histogram and Statistics Functions
- CoCo-P18 DSA Software Option: Playback Recorded Signals
- CoCo-P19 DSA Software Option: Continuous Recording to SD Card Memory
- CoCo-P21 DSA Software Option: Shock Response Spectrum Analysis
- CoCo-P22 DSA Software Option: Modal Data Acquisition
- CoCo-P23 DSA Software Option: Remote Noise and Vibration Monitoring
- CoCo-P25 VDC Software Option: Bearing Library (Contact Factory prior to Ordering)
- CoCo-P26 DSA Software Option: Mechanical Shock Test
- CoCo-P28 DSA Software Option: Zoom Spectrum Analysis
- CoCo-P30 DSA Software Option: Order Tracking and Octave Analysis Bundle
- CoCo-P31 VDC Software Option: Vibration Data Collector and Rotor Balancing Bundle

- CoCo-A01 Accessory: Additional Battery (Rechargeable Li-ion, 6600 mAh)
- CoCo-A03 Accessory: DC-DC adapter using automobile cigarette lighter, voltage isolated
- CoCo-A04 Accessory: Calibration Service at Crystal Instruments
- CoCo-A05 Accessory: One year extended software subscription for renew
- CoCo-A06 Accessory: One year extended hardware warranty
- CoCo-A08 Accessory: BNC-BNC cable (6ft)
- CoCo-A09 Accessory: SMB-BNC cable (1 ft)
- CoCo-A10 Accessory: Additional installation CD for EDM software and User's Guides
- CoCo-A11 Accessory: Additional AC-DC adapter for CoCo-80
- CoCo-A12 Accessory: External microphone for voice annotation
- CoCo-A13 Accessory: Optional Soft Handbag
- CoCo-A14 Accessory: AC charger for charging battery without CoCo-80
- CoCo-A15 Accessory: Ruggedized Carrying Case
- CoCo-A17 Accessory: Nylon and Plastic Enclosure, IP65 Rated