Model 933A
Portable Power Sentinel™

with

EnergyDSA™

Digital Signal Analysis

Built by Power Professionals, For Power Professionals

The Arbiter Systems®, Inc. Model 933A Portable Power Sentinel™ is the most accurate and most affordable portable power quality meter in the industry. The proprietary EnergyDSA™ Digital Signal Analysis algorithms allow the user to measure or record harmonics, flicker (per IEC 61000-4-15, P_{ST} and Instantaneous), K-factor, and interruptions. The data logging capabilities allow the user to specify which data to log as well as when to log the data, continuously or when user specified thresholds are exceeded. The high accuracy, portability and data logging capabilities make the Portable Power Sentinel™ the perfect field analyzer for the power quality engineer.

Portability

Thanks to the high level of integration made possible with EnergyDSA™, the Model 933A Portable Power Sentinel™ combines multiple capabilities into one compact, light weight instrument. Weighing less than 5.8 kg (12.8 lbs), the Portable Power Sentinel™ is a power quality monitor, a data and event logger, a system monitor, and a revenue meter designed to accompany you wherever you go and operate continuously for a full eight-hour shift.

Capabilities

Primarily designed for the power engineer, the Portable Power Sentinel™ measures and records harmonics, flicker, K-factor, and interruptions. In addition to these measurements, the Portable Power Sentinel™ has the ability to measure system time, phase, frequency, and phasors. When synchronized using the IRIG-B IEEE-1344 unmodulated input or the GPS input, the Model 933A is capable of accurate revenue metering and synchrophasor analysis per the IEEE-1344. Pre-fault data is buffered for a half second allowing for accurate fault recording and event driven data analysis. The host processor and the DSP each have 128 MB of memory which provides ample space for data storage.

Features

The Model 933A Portable Power Sentinel™ includes a 320 x 240 graphic LCD display with a CCFL backlight, a 30-key multifunction keypad, adjustable tilt-handle/bail assembly, RS-232 cable, safety ground cable, and power cord.

Communications are made via an RS-232 or USB 1.1 port that supports proprietary protocols.

Both the host and DSP processors have 128 MB of flash memory. The host processor memory stores all data types available including fault data (1/sec and 20/sec) and register data. The DSP memory is primarily for waveform storage with data for all channels continuously stored at approximately 170 samples per cycle, a fixed pre-fault window of 0.5 seconds, and a maximum of about 1000 seconds (17 minutes) of data storage.

The 933A is powered by either NiMH batteries (8 hours typical run time) or an external power supply (85 to 264 Vac or 110 to 370 Vdc).

Options and Accessories

Available options include remote GPS receiver synchronization for 1 µs timing accuracy allowing for increased revenue accuracy, optically isolated event inputs, flexible CT inputs, direct current inputs, and programmable KYZ output contacts. Available accessories include a USB cable and a wide selection of test leads.

Model 933A Specifications

Input

Configuration

3Ø	3-element, 2½-element, 2-element, selectable
1Ø	2-element, 1½-element, and 1-element, selectable

Voltage

Range (3Ø/1Ø)	1 Vrms to 650 Vrms, selectable (phase-to-phase for 2 element and 2½ element; phase-to-neutral for 1 element and 3 element)
Overrange	1200 V peak, nominal

Current

Model 933A-01 20 Amp direct input module

Range (3Ø/1Ø)	0.05 Arms to 20 Arms, selectable, per element
Low range	1 mA to 1 A
Overrange	40 A peak, nominal (maximum continuous input current: 20 Arms per element)

VA, W, VAR

Range	Any voltage, current and number of elements within the specified limits

Compensation

CT and PT	Both magnitude and phase compensation, CT with 12 point nonlinear interpolation
Transformer	Both iron and copper loss

Frequency

Range	45 Hz to 65 Hz, for specified accuracy
Harmonics	to 3 kHz

Inputs

Voltage	Safety banana plugs
Current	5-way binding posts (Model 933A-01)
Insulation	400 volts, nominal, to neutral/chassis, surge voltage class III 600 volts, nominal, to neutral/chassis, surge voltage class II

Power Quality

Harmonics Measurement

Standard	2^{nd} to 50^{th} (50 or 60 Hz) Per IEC 61000-4-7, 100 ms overlapping data window
Measurements	THD, K-factor, sags, swells, interruptions, rms harmonic current and voltage, rms harmonic current and voltage with K-factor compensation (each harmonic magnitude is multiplied by the square of the harmonic number before summing), individual magnitude and phase
Logged Data	Selectable, may be regularly logged or registered. Event-logged also available when user-specified limits are exceeded

Interruptions

Logged Data	Selectable, may be regularly logged or registered. Event-logged also available when user-specified limits are exceeded

Flicker

Standard	Per IEC 61000-4-15, P_{ST} and Instantaneous
Logged data	Selectable, may be regularly logged or registered. Event-logged also available when user-specified limits are exceeded

Limit Alarms

Functions	Upper or lower limits may be set on most measured functions. Limits may also be set on maximum imbalance (ratio of Zero and Negative Sequence Components to Positive Sequence)
Output	Via system interface and display

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Model 933A Specifications

Accuracy

Note: Accuracy specifications include all sources of uncertainty. Except as noted, specifications apply for the full operating range, including temperature (- 10 °C to + 50 °C), line voltage, input range including specified overrange, power factor, input frequency, and drifts over a one-year calibration interval. Specifications assume synchronization to GPS and operation in 3-element mode or in a well-balanced system where imbalance does not degrade accuracy.

Watts, Wh	0.05 % of reading, for voltage 7 Vrms to 650 Vrms and current 10 mA to 20 Arms and PF > 0.2
Vrms	0.05 % of reading[1] or ± 5 mV, whichever is greater
Low range	1 % of reading
Arms	0.05 % of reading[1] or ± 0.1 mA, whichever is greater
Phase Angle, Ø	0.01 °, phase-to-phase or voltage-to-current[1]
Underrange	0.05 ° (current 10 mArms to 50 mArms)
VA, VAh	0.05 % of reading[1] 0.1 % (current 10 mArms to 50 mArms)
VAR, VARh	Same as W, Wh except replace PF with $(1 - PF^2)^{0.5}$
Power Factor	0.0002 • sin (ø)[1] 0.001 • sin (ø) (current 10 mArms to 50 mArms)
Harmonics	0.1% THD or 5% of reading, whichever is greater
Frequency	< 1 ppm (0.0001 %) of reading, 50 Hz or 60 Hz nominal, plus timebase error
System Phase	0.03 ° + [timebase error • 360 ° • frequency] [2]
System Time	1 µs plus timebase error[2]
Event Inputs	± 10 µs (typical)

Flash Memory Data Storage

Host Processor

Capacity	128 MB. See Operation Manual for record length and capacity calculations
Data	All functions measured and totalized by Model 933A; each record is stored with a time tag
Storage Rate	Selectable Event data stored upon occurrence
Lifetime	100,000 storage cycles minimum
Data Retention	Indefinite; no power or battery is required to retain data

DSP Processor

Capacity	128 MB; about 1000 seconds or 17 min.
Data	Primary waveform
Storage Rate	10240 samples per second (approximately 170 samples per cycle) Fixed 0.5 seconds of pre-fault data. Event data stored to Host Processor flash memory upon occurrence. User has same triggers as the Host Processor flash and can select the max fault duration, post fault recording time, and retrigger on/off.
Lifetime	100,000 storage cycles minimum
Data Retention	Indefinite; no power or battery is required to retain data

System Control and Monitoring

System Time, Phase and Frequency

System Time	Unlimited accumulation with ±1 µs resolution
Frequency	6 digits, xx.xxxx Hz
System Phase	0 ° to 360 ° with 0.01 ° resolution

Phasors

Standard	Per IEEE Standard 1344 or PSCSV
Rate	20 Measurements/second

[1] For voltage 50 to 650 Vrms and current 50 mA to 20 Arms

[2] With GPS Option

Interface

Operator

Display	320 x 240 graphic LCD display with CCFL Backlight
Keyboard	30 keys: 5 soft function, 7 dedicated function, 5 cursor control, power on/off and 12 key numeric key pad

Communications

Serial	RS-232, RJ-11 modular connector
USB	Version 1.1, B-Type receptacle

Protocols

Proprietary	PowerSentinel CSV933 (PSCSV933)

Synchronization

IRIG-B Unmodulated Input

TTL-Level Shift per IEEE-1344
As output from an Arbiter Systems Model 1084B

Optional Remote GPS

Tracking	GPS–L1 (1575.42 MHz); 12 channel (tracks up to 12 satellites)
Acquisition	2 minutes typical
Accuracy	UTC-USNO ± 1 µs (only need 1 satellite with correct position)
Out-of-Lock Indication	Via system interface and status display; optional, via contact closure

Timebase Error

GPS locked	Less than ±1 µs, when locked to at least one satellite with correct position
Unlocked	10 ppm, typical, after being locked for 10 minutes minimum (< 1 second/day unlocked, typical)
IRIG-B	Less than ± 1 µs + accuracy of IRIG-B source

General

Physical

Size	205 mm x 305 mm x 225 mm (8 in x 12 in x 8.75 in) 483 mm x 483 mm x 305 mm (16 x 16 x 12 in), shipping
Weight	5.8 kg (12.8 lbs), maximum 9.1 kg (20 lbs), shipping

Environment

Temperature	Operating: - 10 °C to + 50 °C Nonoperating: - 40 °C to + 75 °C
Humidity	Noncondensing

Power Requirements

Internal Battery

Type	NiMH
Operation	8 hours typical
Charging	4 hours
Standby Use	5 VA typical

External Power

Range	85 Vac to 264 Vac, 47 to 440 Hz or 110 Vdc to 370 Vdc, 25 VA typ. charging battery, 5 VA typical stand-by use
Input	IEC-320 connector with fuse; surge withstand per ANSI C37-90.1 and IEC 801-4 standard

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Model 933A Specifications

Options

Input Modules (select only one)

Description	Order No.
CT Input Module, 20 Amp Direct with 5-way Binding Posts	933Aopt01
CT Input Module with Banana Connectors. Uses standard shrouded banana jacks	933Aopt02
CT Input Module with Audio Connectors Requires use of CA0027100 or CA0027200, available separately	933Aopt03

Accessories

Included

Description	Order No.
Operation Manual	PD0031100
Power Cord	P01R-P10R
Safety Ground Lead	812HC-8
Modular DB-9 to RJ-11 Adapter, Preconfigured	AP0007700
RJ-11 Cable, Four-Pin Crossed	CA0023600

Available

Description	Order No.
USB Data Cable	CA0026106
CT Input Module with 5-way Binding Post Connectors	AS0097700
CT Input Module with Banana Connectors.	AS0097800
CT Input Module with Audio Connectors Requires use of CA0027100 or CA0027200, available separately	AS0097900
CT Cable, Current Output	CA0027100
CT Cable, Voltage Output	CA0027200
Remote GPS Receiver with Mounting Bracket and 15 m (50 ft) cable	AS0077600
Remote GPS Receiver Extender Cable, 7.6 m (25 ft)	CA0029800
400 Amp 20:1 Precision CT, 0.1% Accuracy	09311A
400 Amp CT Bracket (each)	AS0036000

Accessories (Continued)

1000:1 Clamp-On CT, 1000 A, Current Output	AP0001300
250:5, 500:5, 1000:5 Clamp-On CT, 1000 A, Current Output	AP0012900
100:1 Clamp-On CT, 600 A, Current Output	AP0010300
100:1 Clamp-On CT, 150 A, Voltage Output	AP0012300
1000:1 Clamp-On CT, 200 A, Current Output	AP0012800
Universal Test Plug, Current Shunt, Set of Three	AS0079030
Programmable KYZ Contacts and Event Inputs	AS0077700
3-Phase Safety Voltage Lead Set	813AT
3-Phase Spade-Lug Current Lead Set	816AT
3-Phase Univ. Test Plug Current Lead Set	811AT
1-Phase Clamp-On CT Test Lead	817AA
3-Phase Clamp-On CT Test Lead Set	817AT
3-Phase Safety C-Hook Current Lead Set	818AT

Cordset and Plug Styles

The following are the available IEC-320 mating, right angle cordset plug style and specifications:

No.	Country	Specification	Rating
P01R	Continental Europe	CEE 7/7	220V
P02R	Australia/NZ/PRC	AS 3112-1981	240V
P03R	U.K.	BS 1363	240V
P05R	India	BS 546	220V
P07R	Italy	CEI 23-16/VII 1971	220V
P09R	North America and ROC	NEMA 5-15P CSA C22.2 #42	120V