Model 1133A
Power Sentinel™

with

EnergyDSA™

Digital Signal Analysis

- **Synchronized via GPS**
- **Revenue Accuracy: 0.025%**
- **Power Quality: Harmonics, Flicker, Interruptions**
- **Phasor Measurements for Stability & Flow Analysis**
- **System Time & Frequency Deviation**
- **Internal Data/Event Logging**
- **Two Year Warranty**

Specifications subject to change without notice.

Take a bite out of power problems and lost revenue with the Arbiter Systems®, Inc. Model 1133A Power Sentinel™ multifunction measurement unit. Combining six functions into one compact, 44 mm (1.75 in.) tall unit, the Model 1133A offers unprecedented accuracy, flexibility, and features.

Revenue Metering

With utility deregulation, accurate energy measurement is increasingly important. For the first time, Arbiter Systems®, Inc. combines state-of-the-art measurement techniques, proprietary EnergyDSA™ technology, and the accurate, cost-effective time synchronization of our precision GPS clock products in the Model 1133A Power Sentinel™ multifunction measurement unit. The Model 1133A brings laboratory performance to the substation, delivering unprecedented revenue accuracy of 0.025% under most conditions. Compare this to traditional watt-hour meters which are limited to an accuracy of no better than 0.1% in the lab, with increasing errors as conditions depart from the ideal (see figures next page).

The Model 1133A measures revenue more accurately than any meter ever before. The difference between 0.025% and 0.1% is surprising. With many transmission lines wheeling thousands of megawatts of power, the difference in accuracy of 0.075% translates to hundreds of thousands of dollars over a year's time. Even at lower power levels, improved accuracy yields significant revenue enhancement.

Power Quality Monitoring

The Model 1133A's features only begin with its outstanding accuracy in energy measurement. Our proprietary EnergyDSA™ digital signal analysis algorithms provide you with more information than ever before. You can measure harmonics and K-factor, flicker, interruptions, and log data by time interval, or record out-of-limit events with time of occurrence. You can set limits on any quantity. Also, an alarm contact may be activated, or a dial-up modem call initiated.

System Control and Monitoring

The Model 1133A measures system (absolute) phase angle, system frequency deviation, and system time deviation. See the white paper "Absolute Phase". Phasor measurement data in accordance with IEEE Standard 1344, at a rate of 20 per second, is standard. This data allows for sophisticated, real-time monitoring and control of stability and power flow. These measurements are made possible with the Model 1133A's internal GPS synchronization.

Synchronization

A built-in Global Positioning System (GPS) satellite receiver synchronizes your Model 1133A within 1 µs of Coordinated Universal Time (UTC), which may also be converted to your local time. With synchronization, revenue data can be accumulated in intervals as short as one minute. Other substation equipment, such as digital fault recorders, solid-state relays, remote terminal units, and programmable logic controllers, may be synchronized with the standard IRIG-B unmodulated time code output. This output has sufficient power to drive numerous loads, for example, 40 Schweitzer™ SEL-321 relays.

Data and Event Logging

Thirty-two megabytes of flash memory are standard. This nonvolatile memory can record revenue data, power quality, internally detected faults, alarms, events, and external events. Four optically-isolated event inputs may be used to monitor external events.
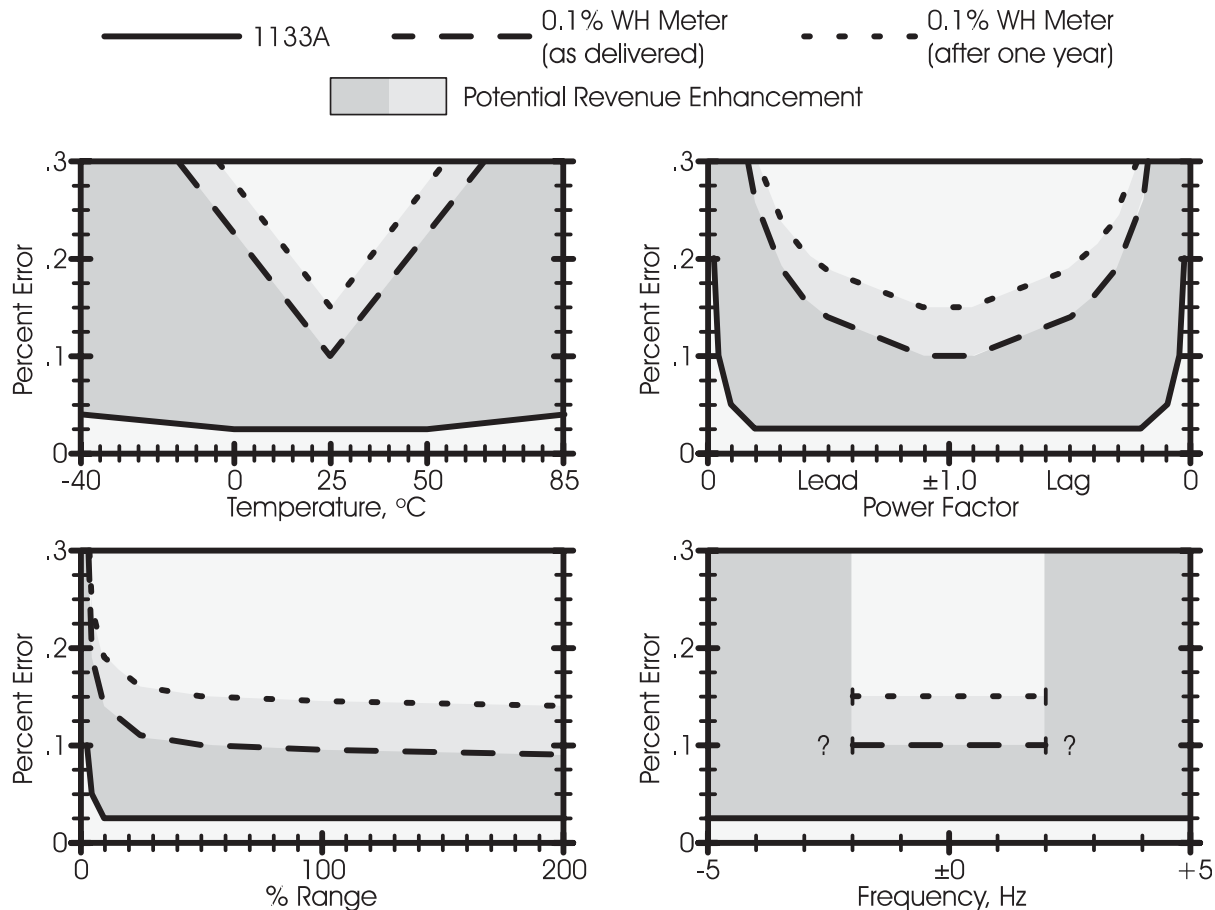
Model 1133A

Technology

Many years of experience making accurate ac signal measurements and providing state-of-the-art timing equipment is the heart of the revolutionary performance provided by the Model 1133A Power Sentinel™. For example, built-in, real-time autocalibration eliminates many sources of error that would otherwise degrade accuracy. This process measures the output of an internal calibration source, time-multiplexed along with the input signals. A complete set of calibration measurements is executed once each second. By passing the calibration signal through the same measurement circuits as the input signals, drift in component values, temperature sensitivities, and many other errors are completely removed.

This design approach minimizes the number of components that can affect accuracy. Therefore, we can afford to use the best available components in those critical applications. Accuracy is (in a simplified fashion) the sum of the imperfections of all of the components that can degrade performance; therefore, by using a small number of highly accurate parts, accuracy is maximized. This is a simple idea, but implementing it properly requires years of experience. See the white paper "What is Accuracy?".

Of course, all of the accuracy in the world means nothing if the resulting signal cannot be processed with equal or better performance. Our proprietary EnergyDSA™ Digital Signal Analysis, an optimized version of the PowerDSA™ analysis developed over the last decade and in use in our Model 931A Power System Analyzer for several years, delivers this performance. We have optimized EnergyDSA™ analysis for the specific requirements of revenue metering and on-line power analysis: speed, accuracy and low cost. Our EnergyDSA™ algorithms measure signals with accuracies characterized not in percent, but in parts per million.

1133A vs. Typical 0.1% Watthour Meter

Model 1133A Specifications

Input

Configuration

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

Voltage

Range (3ø/1ø)	0 to 69, 120, 240, or 480 Vrms, selectable (phase-to-phase for 2 element; phase-to-neutral for 2½ and 3 element)
Overrange	88, 175, 350 or 700 Vrms, nominal

Current

Range (3ø/1ø)	2.5, 5, 10, or 20 Arms, selectable, per element
Overrange	2.9, 5.9, 11.7, or 23.5 Arms, nominal (maximum continuous input current: 20 Arms per element, all ranges)

VA, W, VAR

Range	Product of rated voltage and current ranges and number of elements (2½ (3ø) and 1½ (1ø) element, use 3 and 1, respectively)

Compensation

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

Frequency

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

Input (Continued)

Inputs

Connections	Removable screw-clamp terminal block, accepting 0.2 to 4 mm^2 (AWG 24 to AWG 10) solid or stranded conductors
Insulation	400 volts, nominal, to neutral/chassis, surge voltage class III
	600 volts, nominal, to neutral/chassis, surge voltage class II
	Contact factory for more detailed information

Interface

Operator

Status LEDs	Operate (green)
	Time Set (green)
	Alarm (red)
	Fault (red)
Display	2 x 20 character LCD display
Keyboard	8 key for status

Communications

Serial

Port 1	RS-232 (1133opt10)
	RS-422/485 half-duplex (1133opt11)
	Modem (V.34bis, 33.6k) (1133opt12)
Port 2	RS-232 (1133opt20)
	RS-422/485 half-duplex (1133opt21)
	Modem (V.34bis, 33.6k) (1133opt22)
Connectors	RJ-11 modular; two
Ethernet	One, 10Base-T per IEEE 802.3i
Connector	RJ-45 modular

Protocols

Proprietary	PowerSentinelCSV (PSCSV)
Standard	DNP 3.0, MODBUS, PQ-DIF, IEEE C37.118

Model 1133A Specifications

Interface (Continued)

Programmable Contact Outputs

Type and Number	Form C (SPDT), four (4) sets
Connections	Pluggable 12-pole, 5 mm terminal strip, with four, 3-pole mating connectors included
Rating	250 Vac/125 Vdc, 8 A maximum, 2000 VA/150 W maximum Optional KYZ (solid state) contact rating: 240 Vac, 120 mA, 800 mW max.
Isolation	4000 Vrms for 1 minute to chassis Optional KYZ (solid state) contact isolation: 3750 Vrms Input/Ouput
Functions, Selectable	Programmable Load Control, with preset times or via system interface
	Fault *Fail-safe (faulted with power off)*
	Alarm *Fail-safe*
	Out-of-Lock *Fail-safe*
	One Pulse per Hour; contacts closed for one minute at top of hour
	Optional KYZ contacts
	Other Functions, as required

Event Inputs

Type and Number	Four, optically-isolated 24 to 240 Vdc (may be configured for 5 V logic level)
Connections	Pluggable 8-pole 5 mm terminal strip, with 4, 2-pole mating connectors
Isolation	4000 Vrms for 1 minute to chassis
Resolution	1 μs

Flash Memory Data Storage

Capacity	32 MB standard; number of records stored depends on data items selected. See Operation Manual for record length and capacity calculations
Data	Selectable from all functions measured and totalized by the Model 1133A; each record is stored with a time tag
Data Retention	Indefinite; no power or battery is required to retain data

Flash Memory Data Storage (Continued)

Storage Rate	Selectable; default is 15 minutes. Other intervals as short as one minute may be selected. Event data stored upon occurrence
Lifetime	100,000 storage cycles minimum

Specifications

Note: Accuracy specifications include all sources of uncertainty. Except as noted, specifications apply for the full operating range, including temperature (-10° 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.

Accuracy

Watts, Wh	0.025% of reading, 10% of range or greater and PF > 0.2 0.005% of VA for PF < 0.2
Underrange	0.0025% of range, below 10% of range
VA, VAh	Same as W, Wh except no PF effect
VAR, VARh	Same as W, Wh except replace PF with $(1 - PF^2)^{0.5}$
Vrms	0.02% of reading or 0.002% range, whichever is greater
Arms	0.03% of reading or 0.003% range, whichever is greater
V^2h	0.04% of reading or 0.004% range, whichever is greater
A^2h	0.06% of reading or 0.006% range, whichever is greater
Phase Angle, ø	0.01°, phase-to-phase or voltage-to-current, 10% of range minimum
Power Factor	$0.0002 \cdot \sin(ø)$, 10% of range min.
Harmonics	0.05% THD or 5% of reading, whichever is greater
Frequency	< 1 ppm (0.0001%) of reading, 50 or 60 Hz nominal, plus timebase error
System Phase	0.03° plus [timebase error • 360° • frequency]
System Time	1 μs plus timebase error
Event Inputs	±10 μs (typical)

Model 1133A Specifications

Power Quality

Harmonics Measurement

Standard	Per IEC 61000-4-7, 100 ms overlapping data window
Measurements	THD, K-factor, 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; or event-logged when user-specified limits are exceeded

Interruptions

Logged Data	Selectable, may be regularly logged or registered; or event-logged 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; or event-logged 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 or contact closure

System Control and Monitoring

System Time, Phase and Frequency

System Time	Unlimited accumulation with ±1 μs resolution
Frequency	7 digits, xx.xxxxx Hz
System Phase	0 to 360° with 0.01° resolution
Effect of DC & Harmonics	None; Rejected by narrow-band digital filtering

System Control and Monitoring (Continued)

Phasors

Standard	Per IEEE 1344, IEEE C37.118, or PSCSV
Rate	Selectable: 1,2,3,4,5,6,10,12,15,20,30,60/sec for 60 Hz or 1,2,5,10,25,50/sec for 50 Hz. Including frequency and df/dt.

Synchronization

General

Tracking	GPS–L1, C/A code (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

Antenna Characteristics

Mounting	0.75 in. NPT pipe thread (1 in. - 14 marine type) mount
Dimensions	77.5 diameter x 66.2 mm (3.05 in. x 2.61 in.)
Weight	170 grams (6.0 oz)
Connections	F-type
Cable	15 m (50 ft) included; longer cables optionally available

Synchronization Output

Type	One; IRIG-B000 or IRIG-B003 per C37.118 (unmodulated or level-shift), 200 mA peak; pluggable 5 mm terminal strip with mating connector, two-pole

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)

Certifications and Approvals

Compliance to IEC-687 International Standard for AC Static Watthour Meter for Active Energy

Compliance to IEEE C37.118 Standard for Synchrophasors for Power Systems

Certificate of Conformance to NIST

CE mark/label and certification

ARBITER SYSTEMS

Model 1133A Specifications

Power Requirements

Standard

Voltage	85 to 264 Vac, 47 to 440 Hz or 110 to 275 Vdc, 5 VA typical
Inlet	Terminal strip with fuse; surge withstand per ANSI C37-90.1 and IEC801-4 standard

General

Physical

Size	1 RU (430 mm W x 44 mm H) rack mount or tabletop; 260 mm deep FMS. Rack mounts included 508 x 381 x 203 mm (20 x 15 x 8 in.), shipping
Weight	2 kg (4.5 lbs), net 5.5 kg (12 lbs), shipping

Environment

Temperature	Operating: -10° to +50° C Nonoperating: -40° to +85° C
Humidity	Noncondensing

Options

I/O

Description	Order No.
IRIG-B Input (C37.118 or C37.118.1): Replaces GPS receiver	1133opt07
Port 1:	
RS-232	1133opt10
RS-422/485 half-duplex	1133opt11
Modem (V.34bis, 33.6k)	1133opt12
Port 2:	
RS-232	1133opt20
RS-422/485 half-duplex	1133opt21
Modem (V.34bis, 33.6k)	1133opt22

Power (select only one)

Description	Order No.
Terminal Power Strip, Surge Withstand, 85 to 264 Vac, 110 to 275 Vdc	1133opt03
Terminal Power Strip, Surge Withstand, 10 to 60 Vdc	1133opt04

[1] Used for cable length greater than 75 m (250 ft)

Options (Continued)

General

Description	Order No.
Mechanical output relays	1133opt05
Solid-State output relays (KYZ)	1133opt06

Accessories

Included

Description	Order No.
Operation Manual	AS0058400
GPS Antenna, pipe mountable	AS0087800
15 m (50 ft) RG-6 Antenna Cable	CA0021315
Mating Connectors, 2-pole, 5 mm (5 ea.)	CN0019202
Mating Connectors, 3-pole, 5 mm (4 ea.)	CN0019303
Mating Connector, Current Input	CN0030006
Mating Connector, Voltage Input	CN0030004
19 in. Rack Mount Kit	AS0028200
Modular DB9 to RJ-11 Adapter, preconfig	AP0007700
RJ-11 Cable Four-pin crossed, 7 ft	CA0023600

Available

Description	Order No.
15 m (50 ft) RG-6 Antenna Cable	CA0021315
30 m (100 ft) RG-6 Antenna Cable	CA0021330
45 m (150 ft) RG-6 Antenna Cable	CA0021345
60 m (200 ft) RG-6 Antenna Cable	CA0021360
75 m (250 ft) RG-6 Antenna Cable	CA0021375
GPS Antenna Mounting Kit	AS0044600
21 dB In-Line Preamplifier[1]	AS0044700
Antenna Grounding Block Kit	AS0048900
GPS Surge Protector	AS0094500
GPS Antenna Cable Splitter	AP0013400
300 m (1000 ft) Roll RG-6 Cable	WC0005000
RG-6 Stripping Tool	TF0013200
RG-6 Type F Crimp Tool	TF0006400
RG-6 Type F Male Crimp-on Connector	CN0027700
300 m (1000 ft) Roll RG-11 Cable	WC0004900
RG-11 Stripping Tool	TF0013300
RG-11 Type F Crimp Tool	TF0006000
RG-11 Type F Male Crimp-on Connector	CN0027800
Modular DB9 to RJ-11 Adapter, unconfig	AP0007900
Modular DB25 to RJ-11 Adapter, unconfig	AP0008000
19 in. Rack Slide Kit	AS0033100
24 in. Rack Mount Kit	AS0055600