

Model 931A Power System Analyzer

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OPERATIONAL OVERVIEW

The Model 931A Power System Analyzer combines unparalleled accuracy, flexibility and versatility in one lightweight, portable instrument. The Model 931A has four voltage inputs (Va, Vb, Vc, Vn), three current inputs (Ia, Ib, Ic), two transducer inputs (V, I) and two timer inputs with a basic accuracy of 0.05% for voltage and current, 0.05 degrees for phase, 0.005% for frequency, 0.01% THD + 5% of reading for harmonics, 0.11% of VA for power and energy quantities, 0.05% + 0.01% range for transducer and 0.005% + 1 digit for the timer.

The Model 931A Power System Analyzer has two input channels that can be configured to measure any of the voltage or current inputs in single-phase mode or automatically switches through the appropriate inputs in the three-phase mode. In addition to the input selections, the unit has three measurement modes, narrow band (measures only the fundamental, rejecting harmonics and noise), wide band (includes all harmonics and noise) and fast mode (does not make harmonics measurements). The measurements are made using PowerDSA Digital Signal Analysis, measurements are not real time even though the sampling rate is 63 kHz, and can be displayed in a variety of formats such as text, waveform, and vector diagram on the graphic LCD display. The transducer and timer functions use their own separate circuitry to make measurements and have a selection of displays to choose from. Data can be stored internally or exported to a printer or computer over the high speed serial port. Some other useful features of the Model 931A are the built-in help messages and the ability to enter individual scale factors.

NEW FEATURES

The Model 931A Power System Analyzer has had a few features, options and accessories added this year and are as follows (may apply to the Models 930A and 929A):

- ! FAST MODE - allows for quicker sampling by not processing harmonics information. Press the SHIFT key twice to enter or exit this mode.
- ! The single-phase measurement display now includes a vector diagram to graphically show the phase relationship between the inputs. See page 8.
- ! A transducer pulse mode operation has been modified to calibrate whr meters using the timer frequency mode. See page 22. (Model 931A only)
- ! FLASHVIEWER software. Discussed in detail in the software session of the Spring 1999 Seminar. (Models 931A and 930A only)

INSTRUMENT SETUP

To configure the Model 931A Power System Analyzer press the MENU key.

```
INSTRUMENT SETUP FUNCTIONS
→RS-232 Port Setup
Set Real-Time Clock
Backlight & Auto-Shutdown
Phase Preference
Print Selections
Print Broadcast Mode
```

If the Extended-Memory Module is installed the display will appear as below, see the extended-memory option on page 31 for configuration information.

```
INSTRUMENT SETUP FUNCTIONS
→RS-232 Port Setup
Set Real-Time Clock
Backlight & Auto-Shutdown
Phase Preference
Print Selections
Print Broadcast Mode
Auto-Log Setup
```

The arrow indicator will appear on the RS-232 Port Setup selection. Press ENTER to configure the RS-232 port. Use the up and down arrow keys on the top key row of the instrument to move the arrow indicator to the next selection.

```
RS232 CONFIGURATION
Baud Rate: →1200      2400      4800
           9600      19200     38400 * 115200
Data Bits:      7      * 8
Stop Bits:      * 1      2
Parity:          * none  even   odd
Flow Control:  * Xon/Xoff  Data Ready
Active Selection = *
```

Set the parameters of the instrument to match those of the computer. The current configuration is indicated by the *. The common communication parameters can be set: baud rate, data bits, stop bits, parity, and flow control. To change a selection, move the arrow indicator to the desired selection and press ENTER, when the port is configured to your liking press the ESCAPE key to return to the Setup Menu. The arrow indicator will automatically advance to the next menu selection “Set-Real Time Clock”, press ENTER.

When entering the Clock Setup display, a blinking cursor will be active under the “seconds” digit, to edit the time and date use the LEFT and RIGHT arrow keys to move the cursor to the desired field and use the UP and DOWN arrow keys to increment or decrement the value by one each time the key is pushed. After entering the desired date and time press ENTER to save the value or ESCAPE to return to the old value, both the ENTER and ESCAPE keys will exit the edit mode and blank the Date-Time field. The arrow indicator will appear next to the daylight saving field use the LEFT and RIGHT arrow keys to select the desired value and press ENTER to save or ESCAPE to leave the same and return to the main setup menu.

```
CLOCK SETUP (Standard Time)
Date-Time      1999 May12 08:28:16
Daylight Saving * Off      On      Auto

Active Selection = *
```

The arrow indicator will automatically advance to the next menu selection “Back light & Auto-Shutdown”, press ENTER.

```
BACKLIGHT & AUTO-SHUTDOWN SELECTIONS
Backlight:    *Off      On      Auto
Auto-Shutdown: * Off      On

Active Selection = *
```

Move the cursor to select the desired Back light and Auto-Shutdown modes. Backlight Auto automatically shuts off the Backlight, 30 seconds after the last key is touched and activates the Backlight on the first keystroke. Auto-Shutdown acts in a similar manner, the unit will Shutdown (turn off) if no input signals or keystrokes are sensed for approximately ten minutes. After making your selections, press ESCAPE. The arrow indicator will automatically advance to the next menu selection “Phase Preference”, press ENTER.

```
PHASE PREFERENCE SELECTIONS
Polarity (Ch2 Lagsing Ch1): *+(-)  (+)
Range:      * +-180    0-360 Dea
Lead/Lag Display: * Enable  Disable

Active Selection = *
```

Select the appropriate phase preferences by pressing the UP, DOWN, LEFT, RIGHT and ENTER keys. The Polarity and Range Selections are for the phase-angle display only and the Lead/Lag selection determines if the word Lead or Lag will appear on the Power Factor display. After making your selections, press ESCAPE. The arrow indicator will automatically advance to the next menu selection “Print Selections”, press ENTER.

An arrow will designate the active selection in the Print Selections display. This menu sets the format of the data to be printed or exported when the print key is pressed. To change the selection, move the arrow indicator and press ENTER or press ESCAPE to keep the previous selection. Both the ENTER and ESCAPE keys will return you to the main setup menu and automatically advance to the next menu selection "Printer Broadcast Mode".

```
PRINT SELECTIONS
Print Screen: →Ascii Format
               Graphics (FX-80)
               Bitmap (Xmodem Transfer)
Spreadsheet:  Send Spreadsheet
               (Comma Delineated)
```

Upon entering the Broadcast Selections display, the active selection will have an arrow next to it. This selection allows the automatic output of the selected print option at various intervals. To change the selection, move the arrow indicator and press ENTER or to keep the previous selection press ESCAPE, both the ENTER and ESCAPE keys will return you to the main setup menu.

```
BROADCAST SELECTIONS
→Broadcast Off
 1 per ten seconds
 1 per minute
 1 per ten minutes
 1 per hour
 1 per day
```

SINGLE-PHASE MEASUREMENTS

SETUP

To make single-phase measurements, inputs must be selected for channel 1 and channel 2. Connect the lowest distortion input signal to channel 1, as it is the internal reference. When measuring only one signal it must be connected to channel 1 or, when measuring power, the voltage input must be connected to channel 1 and the current input to channel 2. To select the input for channel 1 press the CHANNEL 1 SELECT, the available inputs are displayed, along with the current setting (denoted by $\rightarrow \leftarrow$). Move the display pointer by using the UP, DOWN, LEFT, and RIGHT arrow keys to the desired selection and then press ENTER. Press the CHANNEL 2 SELECT key and repeat the above steps to select the input for channel 2. Press ESCAPE to cancel.

```
CHANNEL 1 AC SELECTIONS
Uab   Uac   +Uan+  Uas   Ia
Ubc   Ucb   Ubn    Ubs   Ib
Uca   Uba   Ucn    Ucs   Ic
CHANNEL 1 DC SELECTIONS
Uab   Uac   Uan    Uas
Ubc   Ucb   Ubn    Ubs
Uca   Uba   Ucn    Ucs
```

The range for each channel can be set to a fixed range or to auto-range. To set the range for channel 1 press the SHIFT key and then the CH1 RANGE key. Use the arrow keys to move the indicator and press ENTER when the desired fixed range or the auto-range is selected. Press ESCAPE to exit the menu without changing the range. To change the range for channel 2, press the CH2 RANGE key and repeat the same steps for setting channel 1.

```
SET CHANNEL 2 AC CURRENT RANGE
+Auto Range      0.64 - 1.49
* 0.00 - 0.09    1.28 - 2.98
  0.08 - 0.18    2.56 - 5.97
  0.16 - 0.37    5.12 - 11.9
  0.32 - 0.75    10.24 - 20
Active Range = *
```

Each input can be conveniently scaled by pressing the SHIFT key and then the SCALE key. This will activate a scale menu (image on next page) for the ac voltage and current inputs. Amplitude and phase scale factors can be entered or edited. The amplitude scale factor is multiplied by the signal magnitude and the phase scale factor is added to the input signal.

Follow these steps to enter a scale factor:

1. Use the arrow keys to select the desired scale factor and press ENTER, this enables the entry/edit of the scale factor and is indicated by a blinking underline.
2. Use the arrow keys to move the blinking underline under the digit to be edited.
3. Use the UP or DOWN key to increment/decrement the value.
4. Press ENTER when the desired value is set or press ESCAPE to exit without making any changes. After completing the entry process press ESCAPE to exit the Scale menu.


```

SCALE FACTOR GAIN & PHASE SELECTIONS
Uab 1.0000 +0.00° Ia 1.0000 +0.00°
Ubc 1.0000 +0.00° Ib 1.0000 +0.00°
Uca 1.0000 +0.00° Ic 1.0000 +0.00°
Uan 1.0000 +0.00° PT 1.0000 +0.00°
Ubn 1.0000 +0.00° CT 1.0000 +0.00°
Ucn 1.0000 +0.00° PT/CT ON * OFF
Scale Factor Enable * Disable

```

DISPLAY

To view the measured results press the appropriate top-row key to get the desired display:

VOLTS/AMPS: Displays the magnitude and phase (in upper right hand corner) of the input signals connected to channels 1 & 2.

```

CH1 Rms 120.02 -29.91°
          Volts
CH2 Rms 2.9981 Amps
CH1=Van Wide-Band 24 Sep 1996
CH2=Ia Hold Mode Tue 18:42:48

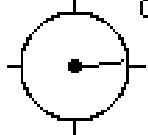
```

Pressing the VOLTS/AMPS key again, toggles to the tabular display shown below. The tabular display contains all information present in the standard display plus power data and a phase indicating graphic. Single-phase energy readings are displayed in place of the power data if the unit is in the energy-measurement mode. Pressing VOLTS/AMPS key multiple times will toggle between the standard and tabular displays.

```

CH1 & CH2 Results CH1= 121.49 V
12 May 1999 CH2= 0.1647 A
13:27:16 + 8.82 Deg
          13.304 W
          -14.951 VAR
          - 20.013 VA
          0.6648 Lead
Wide-Band 59.9852 Hz

```



PHASE/FREQUENCY: Displays the frequency of the input to channel 1 and the phase between the inputs to channels 1 & 2, with the input to channel 1 being the reference signal.

```

PHASE -60.20 DEG.
FREQUENCY 60.001 HZ
CH1=Van WIDE-BAND 8 Oct 1994
CH2=Ia Sat 10:22:44

```

POWER/VARS: Displays the active and reactive power when voltage and current inputs are connected to channel 1 and channel 2.

```
ACTIVE POWER      192.87      KWATTS
REACTIVE POWER    134.58      KVARs
CH1=Van WIDE-BAND      3 Oct 1994
CH2=Ia               Mon 14:05:57
```

Pressing the POWER/VARS key again, toggles to the display shown below. The display consists of active and reactive energy (Watt hrs and VAR hrs) when voltage and current inputs are connected to channel 1 and channel 2. Pressing POWER/VARS multiple times will toggle between the energy and power displays.

```
ACTIVE POWER      539.17      WattHr
REACTIVE POWER    310.01      VarHr
CH1=Van Wide-Band    24 Sep 1996
CH2=Ia               Tue 18:40:04
```

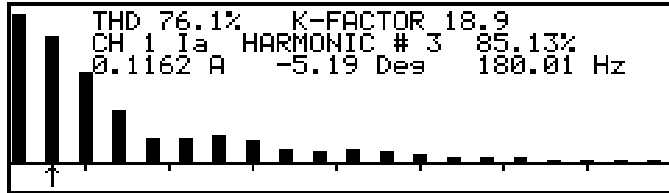
VA/PF: Displays the apparent power (volt-amps) and power factor when voltage and current inputs are connected to channel 1 and channel 2.

```
APPARENT POWER    589.28      VA
POWER FACTOR      0.5011      LAG
CH1=Van WIDE-BAND      3 Oct 1994
CH2=Ia               Mon 14:07:12
```

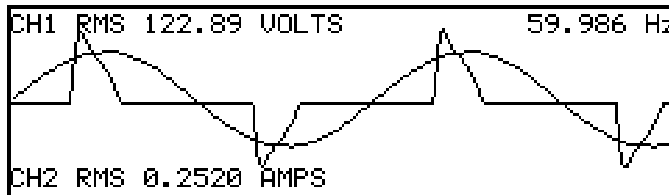
Pressing the VA/PF key again, toggles the to display shown below. The display consists of the energy quantity VA hrs and power factor when voltage and current inputs are connected to channel 1 and channel 2. Pressing VA/PF multiple times will toggle between the energy and power displays.

```
APPARENT POWER    625.49      VAHr
POWER FACTOR      0.8663      Lag
CH1=Van Wide-Band    24 Sep 1996
CH2=Ia               Tue 18:40:39
```

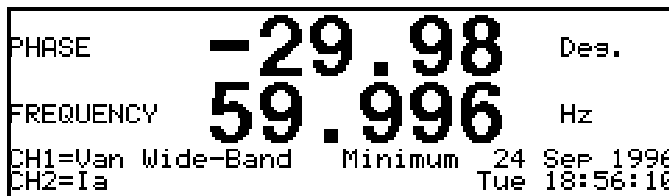
HARMONICS: Presents a graphic display of the magnitude of individual harmonics, K-factor and Total Harmonic Distortion for the signals routed to channel 1 or 2. The display also contains the relative amplitude and phase angle of the selected harmonic. An arrow designates the selected harmonic. Use the LEFT and RIGHT arrow keys to select a different harmonic. K-factor is an estimate of the heating effect of harmonic energy in magnetic materials.



WAVEFORM: Presents a graphic display of the waveforms for the signals routed to channels 1 and 2. The waveform display is normalized relative to the positive-going zero crossing of the fundamental of the signal present at channel 1. Pressing the CHANNEL 1 SELECT or the CHANNEL 2 SELECT key will display only the individual channel selected.



MIN/MAX: Toggles between the minimum, average, maximum and current values of the active display. Min/Max recording is performed continuously after initial power-on, except for 3-phase which only occurs while the 3-phase display is active. Minimum, average and maximum values can be reset by pressing the SHIFT key and then the RESTART key.



MEASURE HOLD: Stops the measurement process and holds the instantaneous values of each measured parameter until the MEASURE HOLD key is pressed again. With the exception of harmonics, waveform and 3-phase data, any display function may be selected during the time that the measurement hold mode is active. Harmonics, waveform and 3-phase data will only be displayed if the instrument was in that respective mode when the MEASURE HOLD key was pressed. The MEASURE HOLD key is also used to leave the REVIEW MODE.

CH1 Rms	120.02	-29.91°
		Volts
CH2 Rms	2.9981	Amper
CH1=Van Wide-Band		24 Sep 1996
CH2=Ia Hold Mode		Tue 18:42:48

CH1/CH2: Displays the measured results as the magnitude and phase angle of the ratio of the signal at channel 1 divided by the signal at channel 2. Units will be in ohms, mhos, or P/U.

CH1/CH2	199.73	P/U
PHASE	-0.65	DEG
CH1=Ia WIDE-BAND		8 Oct 1994
CH2=Ib		Sat 10:32:50

THREE-PHASE MEASUREMENTS

The Model 931A Power System Analyzer uses PowerDSA analysis to measure two signals at a time and combine the results into accurate three-phase measurements. Using this method, the 931A can update complete three-phase data in one second. To start a three-phase measurement press the SHIFT key and then the MEAS 3 PHASE key. This will bring up the 3 PHASE MEASUREMENT SELECTION menu. The active selection is indicated by the arrow.

```
3 PHASE MEASUREMENT SELECTION
→1Ph 3W 2E: (Split; VanIa, VcnIc)
3Ph 3W 2E: (VabIa, VcbIc, 'Vac,Ib')
3Ph 3W 3E: (VasIa, VbsIb, VcsIc)
3Ph 4W 3E: (VanIa, VbnIb, VcnIc)
3Ph 4W 2.5E: (VanIa, 'Vb'Ib, VcnIc)
               (connect Vb to Vn)
```

In 1-phase 3-wire 2-element mode, the instrument alternates between measurements of 'Van, Ia' and 'Vcn, Ic'. This is useful for making measurements on split-phase systems.

In 3-phase 3-wire 2-element mode, the instrument alternates between measurements of 'Vab,Ia', 'Vcb,Ic', 'VabIb', and 'VcbVab'. 'Vac' is computed and included in the 3-phase average voltage. Ib is measured but not included in the 3-phase results. This yields accurate results for active power, but to estimate apparent power, a correction of 0.866 must be arbitrarily applied; accuracy depends on symmetry of the phase voltages. 'VcbVab' phase is measured to determine phase rotation.

In 3-phase 3-wire 3-element mode, the instrument sequences between measurements of 'Vas,Ia'; 'Vbs,Ib'; and 'Vcs,Ic' ('s' denotes synthesized neutral, which is the average of the signals present at voltage inputs 'a', 'b' and 'c'). Results are accurate for active power, but to estimate apparent power a synthesized neutral is used, and accuracy depends on symmetry of the phase voltages. Reactive power, power factor, and phase angle also are estimated. 'VabVac' phase is measured to determine phase rotation.

In 3-phase 4-wire, 3-element the instrument sequences between measurements of 'Van, Ia'; 'Vbn,Ib'; and 'Vcn, Ic'. All results are accurate. This is the preferred mode for 3-phase measurements when neutral is available. 'VabVac' phase is measured to determine phase rotation.

In 3-phase 4-wire 2.5 element mode, the instrument sequences between measurements of 'Van, Ia'; 'Vb,Ib'; 'Vcn, Ic', and 'VcnVan'. The 'B' voltage input must be externally connected to the 'N' voltage input. 'Vb' is internally generated using the synthesized neutral circuit. The accuracy of all results depends on the symmetry of the phase voltages.

In the three-phase modes, the Model 931A measures and displays the phase sequence, 'ABC' or 'CBA'. A phase measurement of 'Vab to Vac' is made at the end of each sequence. If the 'Vab to Vac' phase measurement is negative, the sequence is 'ABC' otherwise it is 'CBA'.

To select a 3-phase mode, move the cursor to the desired configuration and press ENTER. The next display is 3 PHASE DISPLAY SELECTION, this determines the way the three-phase data is displayed. Move the cursor and press ENTER to select a display mode.

```

3 PHASE DISPLAY SELECTION
→TABULAR DISPLAY (with power)
TABULAR DISPLAY (with energy)
VECTOR DIAGRAM
VOLTAGE & CURRENT SEQUENCE
VOLTAGE SEQUENCE
CURRENT SEQUENCE
  
```

The Tabular Display (with power) shows amplitude power and phase quantities for the individual phases along with the totals for the system. The last column of numbers are identified as totals by a 'T' and as averages by a '*'.
 50.00Hz Wide-Band ABC 3P 4W 3E LOG 1

```

A:122.70 B:121.95 C:121.90 * 122.18 U
10.753 10.112 8.6162 * 9.8275 A
-26.96 -38.96 -27.64 * -31.05 Deg
1.1752 0.9629 0.9287 T 3.0669 KW
0.6001 0.7704 0.4906 T 1.8612 KUAR
1.3195 1.2332 1.0504 T 3.6031 KVA
0.6906 0.7808 0.8842 * 0.8519 Lag
50.00Hz Wide-Band ABC 3P 4W 3E LOG 1
  
```

The Tabular Display (with energy) shows amplitude power and phase quantities for the individual phases along with the accumulated energy readings. The energy readings are set to zero by pressing the SHIFT key and then the RESTART key.

```

A:248.60 B:248.62 C:248.65 * 248.64 U
3.9968 3.9964 3.9963 * 3.9965 A
-29.88 -29.86 -29.85 * -29.86 Deg
0.8615 0.8618 0.8618 H 1.7500 KW
0.4951 0.4949 0.4947 H 1.0062 KUAR
0.9936 0.9938 0.9937 H 2.0187 KVA
0.8670 0.8672 0.8673 * 0.8672 Lag
59.99Hz Wide-Band ABC 3P 4W 3E Ubrlb
  
```

The Vector Diagram display shows a table of the measured voltages, currents and phase angles along with their vector representation. The 'A' phase voltage vector is fixed in the horizontal direction. All other vectors rotate according to their phase angle with respect to the 'A' phase voltage. The length of the vectors shows the relative amplitude of each phase. A vector with a length of less than one pixel is not displayed. All voltage and current measurements are made with respect to the 'A' phase voltage, therefore the 'A' phase voltage must be present for a proper Vector Diagram display.

```

A: 123 U REF0
10.4 A -28
B: 122 U -120
10.0 A -162
C: 122 U 120
8.05 A 88
LOG 2
3P 4W 3E
  
```

The Voltage and Current Sequence displays show the measured voltages, currents and phase angles along with the positive (V1, I1), negative (V2, I2) and zero (V0, I0) sequence values. The 931A defines the positive sequence as the values in the 'ABC' direction and negative sequence as values in the 'CBA' direction. Also included, is a computed value for the neutral current amplitude and phase angle. All voltage and current phases are made with respect to the 'A' phase voltage therefore the 'A' phase voltage must be present for a proper Voltage and Current Sequence displays.

A:122.57	B:121.67	C:121.71	N: LOG	U
REF	-119.71	120.93	3	Deg
10.700	10.010	8.5273	0.1331	A
-26.81	-158.04	92.62	22.30	Deg
U1: 121.98	U2: 0.8144	U0: 0.4328		U
REF	-32.40	-103.15		Deg
I1: 9.7055	I2: 1.2664	I0: 0.0444		A
-30.82	7.40	-157.70		Deg

Positive-Sequence Current (I1) and Voltage (V1) are the normal components represented in balanced three-phase (3-wire and 4-wire) systems. They are present in operating motor and generator windings.

Negative-Sequence Current (I2) and Voltage (V2) are the components in 3-phase systems that result from unbalanced phase-to-phase currents and voltages. They cause undesired heating in motor and generator windings. Reversed phase sequence -- ACB vs ABC -- can be viewed as an extreme negative-sequence case.

Zero-Sequence Current (I0) and Voltage (V0) are characteristic of unbalanced 3-phase 4-wire systems, and correlate to 'neutral shift', where there is a current and potential difference in motor or generator windings with respect to system ground. Zero-Sequence conditions result from unequal phase-to-neutral parameters.

DATA LOGGING/EXPORTING

Logging and Reviewing Data

The Model 931A can record measurement results in internal memory, using the LOG DATA function. The data may then be exported using the PRINT function. There are four data types which can be recorded. The first data type is Standard, which includes all of the Narrow-Band and Wide-Band parameters for channels 1 and 2 along with Timer and Transducer data. The second data type is Harmonic, which is the standard data plus harmonic information. The third data type is Waveform, which stores waveform data plus the data included in the Standard and Harmonic data types. Finally, the fourth data type is Three-Phase, which stores all the three-phase information present on the display. To record data, press the LOG DATA key, a momentary message will appear in the lower right-hand corner of the display, showing that the data was saved under an assigned record number. Stored data records may be reviewed by pressing the SHIFT key and then the REVIEW key to bring up a list of the logged data records.

```
LOG SPACE 86%  AUX MEM 98%  FILES 4
→0 Clear All  (*Key Clears A File)
 1 11May99 16:27:13      1 Standard
 2 11May99 16:27:29      1 3 Ph Tab
 3 11May99 16:27:40      1 Waveform
 4 11May99 16:27:45      1 Harmonic
```

Then, use the 'DOWN' arrow key to select the desired record and press ENTER. This will put the unit into measure hold mode and restore the recorded values. Press the corresponding function key to display the data; harmonics, waveform, or three-phase data will only be available if the data was logged in a compatible mode. To restore the instrument to normal mode press the MEASURE/HOLD key.

The extended-memory option allows for more flexibility in the data types stored. This option is discussed in detail, starting on page 31.

Printing/Exporting Data

The Model 931A is capable of printing or exporting data over the RS-232 port to a computer or printer by simply pressing the PRINT key. When the PRINT key is pressed, the displayed data will be outputted in the format selected in the Print Selections menu. The RS-232 port must be configured properly.

TRANSDUCER MEASUREMENTS (Model 931A Only)

Configuration

To configure the Model 931A Power System Analyzer for measuring the outputs of transducers, press the SHIFT key and then press the CONFIG key.

```
      TRANSDUCER CONFIGURATION
→Input Mode:      1Ph 2Wire 1E
Input Type:       Volts
Input Range:      0 - 150.0   Urms
Output Range:     0.0 - 100.0 mA dc
Display Input As: Measured Quantity
Display Output As: Percent Error
```

The arrow indicator will appear on the Input Mode selection. To select the input mode, press the UP and DOWN arrow keys on the top key row, then press ENTER to finalize the selection.

```
      TRANSDUCER MODE SELECTION
→1Ph 2W 1E:      (Single Phase)
1Ph 3W 2E:      (Split; VanIa, VcnIc)
3Ph 3W 2E:      (VabIa, VcbIc)
3Ph 4W 3E:      (VanIa, VbnIb, VcnIc)
3Ph 4W 2.5E:    (VanIa, 'Ub'Ib, VcnIc)
                  (connect Ub to Un)
```

The arrow indicator will appear on the 1Ph 2W 1E selection. Use the arrow keys to move the indicator and press ENTER when the desired mode is selected. The arrow indicator will automatically advance to the next menu selection "Input Type". Press ESCAPE to exit the menu without changing the mode.

```
      TRANSDUCER INPUT TYPE
→Volts
Phase
Power
Volt-Amps
Amps
Frequency
Vars
Power Factor
```

The arrow indicator will appear on the Volts selection. Use the arrow keys to move the indicator and press ENTER when the desired type is selected. The arrow indicator will automatically advance to the next menu selection "Input Range". Press ESCAPE to exit the menu without changing the type.

```

TRANSDUCER INPUT VOLTS
→0 - 150          90 - 150
0 - 300          180 - 300
0 - 600          360 - 600
Custom

```

The arrow indicator will appear on the present range setting for the selected input. Use the arrow keys to move the indicator and press ENTER when the desired range is selected. The arrow indicator will automatically advance to the next menu selection “Output Range”. Press ESCAPE to exit the menu without changing the range.

```

TRANSDUCER DC OUTPUT
→0 - 0.5 mA      0 - 50 mV
0 - 1 mA         0 - 1 V
0 - 20 mA        0 - 5 V
4 - 20 mA        0 - 10 V
0 - 50 mA        Custom V
0 - 100 mA       Custom mA
20 - 100 mA

```

The arrow indicator will appear on the present output-range setting. Use the arrow keys to move the indicator and press ENTER when the desired output range is selected. The arrow indicator will automatically advance to the next menu selection “Display Input As:”. Press ESCAPE to exit the menu without changing the range.

```

TRANSDUCER INPUT DISPLAY MODE
→Measured Quantity
Percent Full Scale

```

The arrow indicator will appear on the present input-display mode. Use the arrow keys to move the indicator and press ENTER when the desired input mode is selected. The arrow indicator will automatically advance to the next menu selection “Display Output As:”. Press ESCAPE to exit the menu without changing the input mode.

```

TRANSDUCER OUTPUT DISPLAY MODE
→Measured Quantity
Percent Full Scale
Percent Error

```

The arrow indicator will appear on the present output-display mode. Use the arrow keys to move the indicator and press ENTER when the desired output mode is selected. Press ESCAPE to exit the menu without changing the input mode.

Press ESCAPE after configuration is complete to return to the transducer measurement mode.

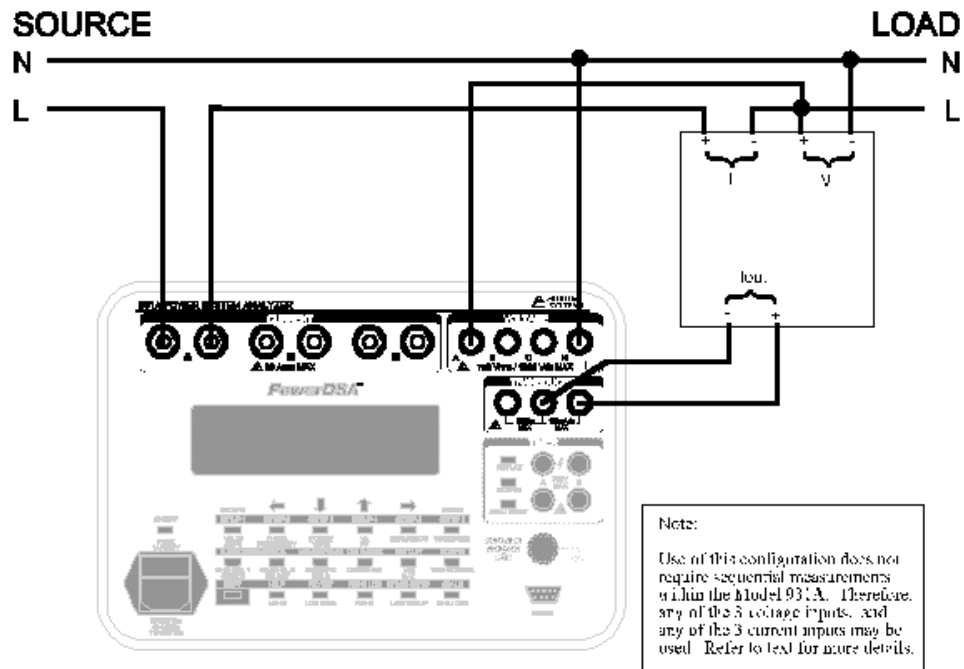
Measurements

To view the measured-transducer results press the TRANSDUCER key.

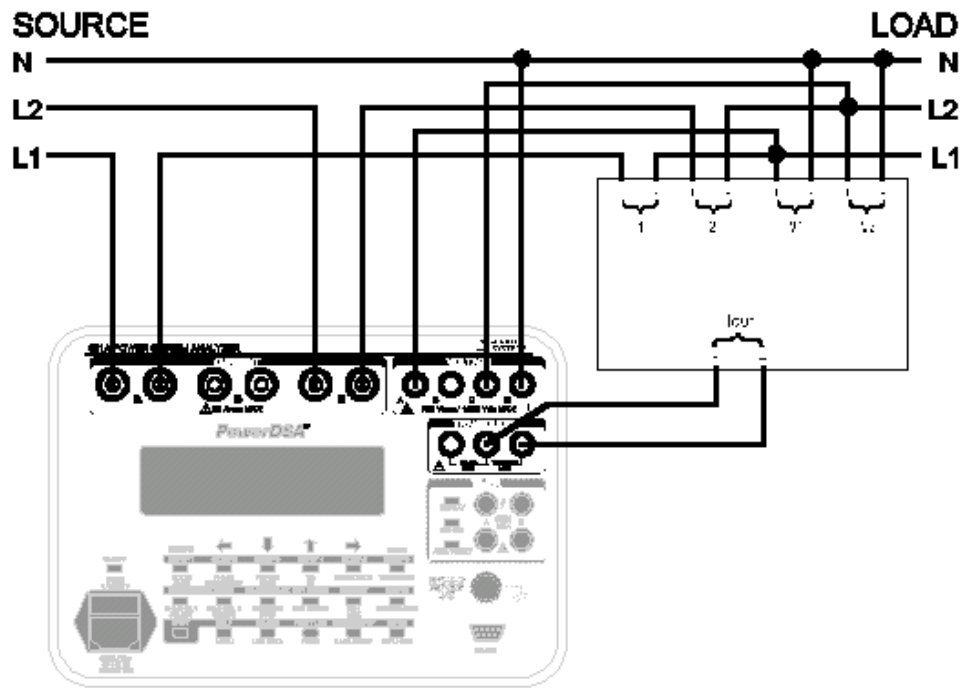


Configuration

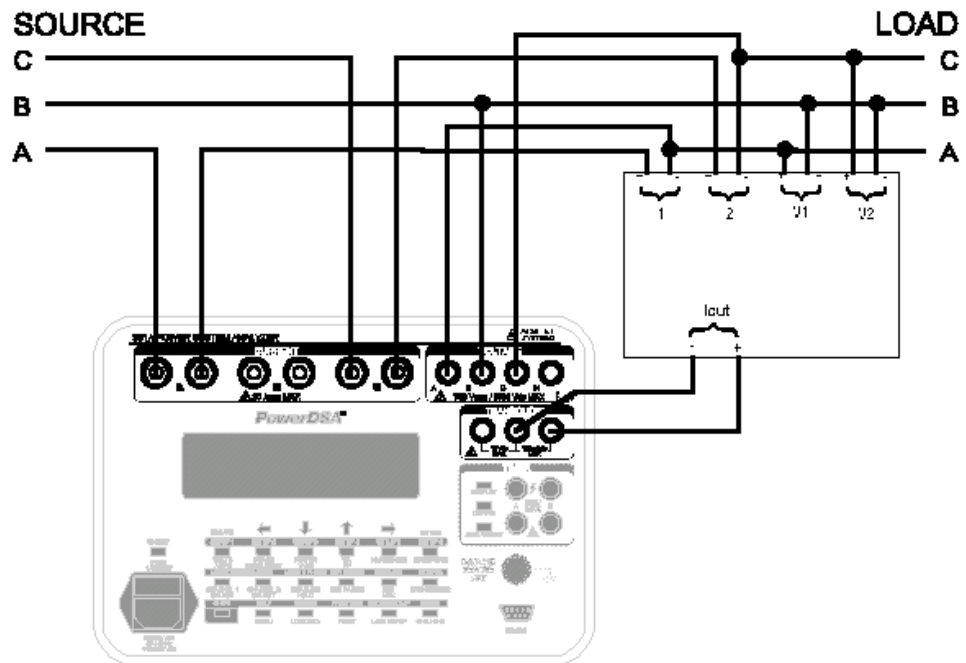
The Model 931A Power System Analyzer must be connected correctly to accurately measure the transducer outputs. The following are the correct configurations for the different modes:



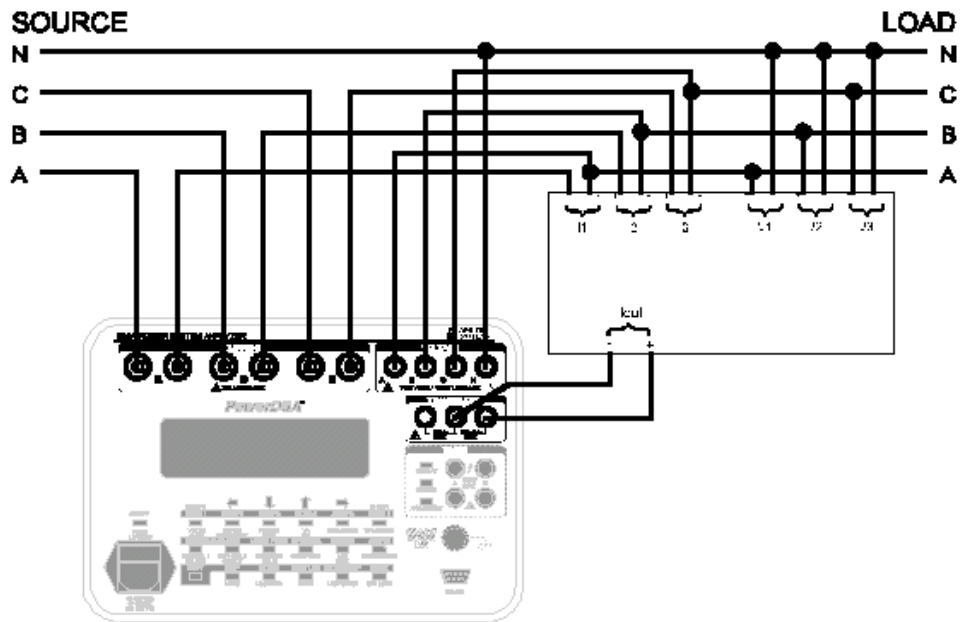
1Ph 2W 1E (Single Phase)



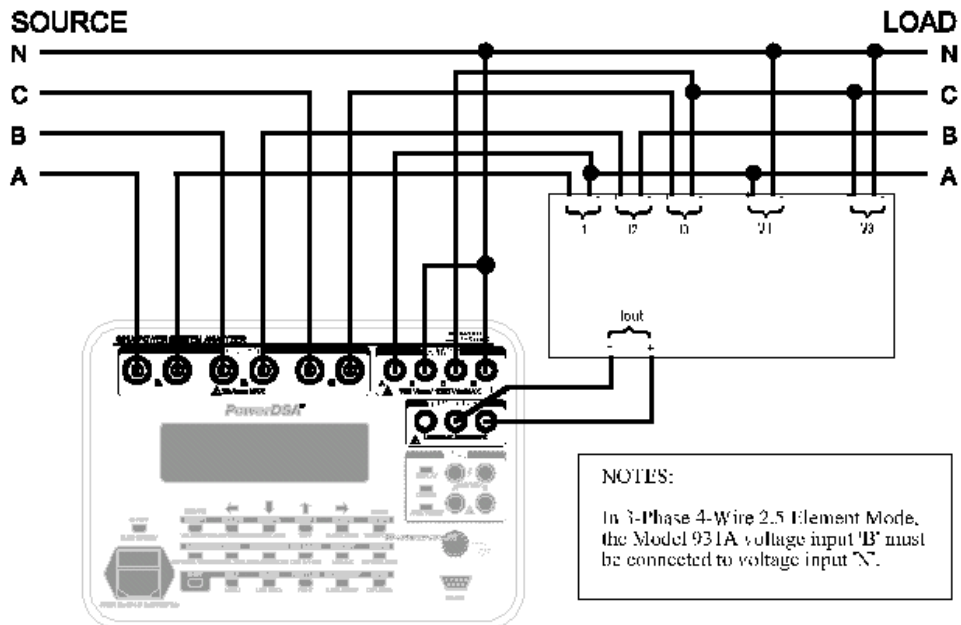
1Ph 3W 2E (Split Phase)



3Ph 3W 2E (VabIa, VcbIc)



3Ph 4W 3E ($V_{an}I_a$, $V_{bn}I_b$, $V_{cn}I_c$)



NOTES:
 In 3-Phase 4-Wire 2.5 Element Mode,
 the Model 931A voltage input 'B' must
 be connected to voltage input 'N'.

3Ph 4W 2.5E ($V_{an}I_a$, $'V_b'I_b$, $V_{cn}I_c - V_b$ connected to V_n)

Custom Pulse, or Contact Output Measurements

Choosing a Testing Method

This section is intended to help in selecting an appropriate method for calibrating transducers that use pulse contact output. Steps for configuring and testing a transducer using its output contacts or pulses:

1. Determine the type of transducer and output rate.
2. Configure the Model 931A Transducer Menu.
3. Configure the Model 931A Timer Menu.
4. Setup the required test equipment and transducer.
5. Test the transducer.

Determine the Transducer Type and Output Rate

Most transducers with a pulse or contact output use either an electromechanical or a solid-state relay. Transducers with electromechanical relays may need to have Debounce set ON in the Timer Menu. Transducers with solid-state relays should have Debounce set to OFF. Consult the transducer manufacturer's data sheet or transducer nameplate if possible.

Determine the transducer pulse output rate, or the contact closure rate. The Model 931A uses only two Timer Functions for this measurement: "Rate of A" or "Time A for X counts".

Use "Rate of A" if the pulse or contact rate is more (usually much more) than once per second (i.e. Rate > 1 Hz).

Use "Time A for X counts" if the pulse or contact rate is less than once per second (i.e. Rate < 1 Hz).

Configuring in the Transducer Menu

Press the SHIFT key then the CONFIG key to access the Transducer Configuration menu. (Refer to page 17, "Configuring the Transducer," if necessary.) Set each of the six categories that best fits the transducer being tested. Use the arrow keys and the ENTER key to make and confirm selections. As each of the six categories is configured, the arrow moves down to the next category.

The sample menu shown below pertains to a 3-phase power transducer illustrated at the top of page 21.

```
TRANSUDUCER CONFIGURATION
→Input Mode:      3Ph 4W 3E:
Input Type:       Power
Input Range:      0.0 - 1500.0 W
Output Range:     1.00000 Whr/Pulse
Display Input As: Measured Quantity
Display Output As: Percent Error
```

Output Range (Transducer Configuration Menu)

Select Output Range and press ENTER to access the Output Range Menu and its selections.

```
TRANSUCER OUTPUT
0 - 0.5 mA      0 - 50 mV
0 - 1 mA       0 - 1 V
0 - 20 mA      0 - 5 V
4 - 20 mA      0 - 10 V
0 - 50 mA      Custom V
0 - 100 mA     Custom mA
20 - 100 mA    →Custom Pulse
```

Select Custom Pulse with the arrow keys and press ENTER. The last line of the Model 931A display will clear and change to read as follows: Watt hours per pulse = 0.00000

The line under the last digit indicates that you can change the digit value. Use the RIGHT and LEFT arrow keys to locate the correct digit you wish to change and the UP or DOWN arrow keys to change the digit value or decimal point. When the custom pulse value is set correctly (per the transducer rating), press ENTER. The display returns to the “Transducer Configuration” menu and shows the installed custom pulse value in Whr/pulse (Watt-hours per pulse). *The largest “Output” value accepted for a Custom Pulse is 100 Watt-hours per pulse.*

In the sample Transducer Configuration menu shown above, a power transducer is connected as shown in the figure on the top of page 21. Notice the setup values for each category, especially the Output Range set to 1.00000 Watt-hours per pulse. This value, as well as the Input Range, is listed on the nameplate of the transducer.

The Output Range, for the power transducer used in this example, was calculated based on the maximum transducer rating (1.5 kiloWatt) and the pulse rate (1500 P/H – pulses per hour).

$$1.5 \text{ kW} \div 1500 \text{ p/h} = 1.00000 \text{ Whr/pulse}$$

Note that the Output Range unit is Whr/Pulse. If testing other Input Types than active power, the unit of Whr/Pulse does not change. In this case, set up all of the Transducer Configuration values correctly, including the “Output Range” and the displayed measurement will be correct.

The sample Transducer Configuration Menu shown below illustrates settings for different transducer using “Rate of A” function instead of “Time A to X Counts.” Notice the large difference in Output Range compared to the “Time A to X Counts” configuration above.

```
TRANSUCER CONFIGURATION
Input Mode:      3Ph 4W 3E:
Input Type:      Power
Input Range:     0.0 - 1000.0 W
→Output Range:  0.00001 Whr/Pulse
Display Input As: Measured Quantity
Display Output As: Percent Error
```

When all categories are configured correctly, press the ESCAPE key to return to the main menu.

Configuring in the Timer Menu

Press the Timer CONFIG key to access the Timer Menu. Select “Function” in the Timer Configuration menu with the arrow keys and press ENTER. A sample menu is shown below.

```
TIMER CONFIGURATION MENU
→Function:          Time A For X Counts
Display Choice:     Seconds
Hold Mode On Stop: Disable
Trisser A:          Contact Closed
Trisser B:          DC Applied
* Debounce A 'ON'  Debounce A 'OFF'
Debounce B 'ON'   * Debounce B 'OFF'
```

If the transducer output count rate is less than one contact or pulse per second (Rate < 1 Hz) then use “Time A to X Counts.” If it is more (usually much more) than one pulse or contact per second (Rate > 1 Hz) use “Rate of A.” See below for “Rate of A.”

To make a good Timer Function selection, either check its pulse output rate with an oscilloscope or calculate the output rate. To calculate the pulse rate in seconds, divide the transducer output contact rating (e.g. pulses per hour) by 3600 seconds. For the power transducer in the above example, the computed value in pulses per second is:

$$1500 \text{ pulses per hour} \div 3600 \text{ sec per hour} = 0.42 \text{ pulses per sec}$$

Transducers with solid-state relays normally do not need Debounce set “ON” for Timer Input A. If this is the case select Debounce A ‘OFF’, with the arrow keys, and press ENTER. Transducers with electromechanical relays may need Debounce A set to “ON.” *Trigger B and Debounce B are not used and do not need to be set.*

In the Timer Configuration menu (above), select Function with the arrow keys and press ENTER to access the Timer Function Menu.

Using “Time A to X Counts” Function

Note that the Model 931A uses only the Timer A input for these measurements.

In the Timer Function Menu select “Time A to X counts” and press ENTER. When ENTER is pressed, X changes to an integer value that is modified by pressing the UP and DOWN arrow keys.

```
SELECT TIMER FUNCTION
Time A To B
→Time A For X Counts
Time Width Of A
Rate Of A
Count A Events
Count A Gated By B
```

After selecting the X-counts value with the UP and DOWN arrow keys, press ENTER. The Timer Function menu returns you to the Timer Configuration menu.

Averaging Output Values

To enable this feature, select a value for X greater than one ($X > 1$). If you plan to use more than one count per measurement cycle (for averaging readings), the Model 931A averages the number of transducer pulses and displays the mean measurement value. To average, the Model 931A counts the number pulses, measures the overall time described by X intervals and computes the mean output value.

Electromechanical Relays - Suggestions

For transducers with large mechanical contacts

During testing, if the “Output” measurement appears inflated compared to the “Transducer Input” measurement, it is possible that the Model 931A Debounce function is not adequate. If that is suspected, check the output pulse with an oscilloscope for a secondary pulse generated from bouncing contacts. The secondary pulse will add to the “Output” measurement and create a reading error. If bouncing contacts are present, place an external capacitor across the Timer A input terminals. Base the capacitor value on the pulse width.

Using “Rate of A” Function

“Rate of A” is generally used for transducers with output rates much greater than 1 Hz. For example some transducers have a nameplate rating of 0.00001 Watt-hours per pulse. Under normal tests this would give a pulse or contact rate in the thousands per second. See the sample Transducer Configuration Menu below for details.

Press the Timer CONFIG key to access the Timer Configuration Menu. With the arrow keys, select “Function” and press ENTER to access the Timer Function Menu. In the Timer Function Menu select “Rate of A” and press ENTER. Notice the values listed in the Timer Configuration Menu. *Trigger B and Debounce B are not used in this transducer measurement.*

```
TIMER CONFIGURATION MENU
→Function:          Rate Of A
Display Choice:     Seconds
Hold Mode On Stop: Disable
Trigger A:          Contact Closed
Trigger B:          DC Applied
Debounce A 'ON'    * Debounce A 'OFF'
Debounce B 'ON'    * Debounce B 'OFF'
```

If the transducer output count rate is less than 1 Hz then use “Time A to X Counts.” If it is more than 1 Hz use “Rate of A.” *Note that the Model 931A uses only the Timer A input for these measurements.*

In this example, “Rate of A” was chosen based on the nameplate rating of 0.00001 Whr/pulse. Dividing the number of Transducer Input Watts by 0.00001 Whr/pulse and dividing by 3600 sec/hour gives a pulse rate of approximately 20,000 pulses per second. The calculation is shown below.

$$(718.8 \text{ Watts} \div 0.00001 \text{ Whr/pulse}) \div 3600 \text{ sec/hr} = 19,966 \text{ pulses/sec}$$

The “Rate of A” Function also continuously updates the transducer measurements during a test.

Equipment Setup

Connect the transducer pulse output to the Model 931A *Timer A* input terminals using suitable cables. *The Custom Pulse function works only with Timer Input A.* Connect the transducer and the Model 931A to a calibrated source providing the required output levels for testing the transducer. Refer to illustrations starting on page 19 for sample connection diagrams of power transducers.

Note: Check the Model 931A maximum ratings prior to applying power.
Failure to do so may damage the equipment.

Always consult the manufacturers original documentation for the power source and the transducer for proper test setup.

Performing a Test

Using “Time A for X Counts”

After setting up the test and configuring the Model 931A, apply the input power source to the transducer and Model 931A. Press the TRANSDUCER key to view the standard measurement screen. Press the ARM/RESET key twice to reset and arm the timer function. For $X = 1$, the first pulse starts the timer and the next pulse concludes the timing interval. If using multiple counts per measurement ($X > 1$), the timer will begin counting on the first pulse and stop with the last pulse.

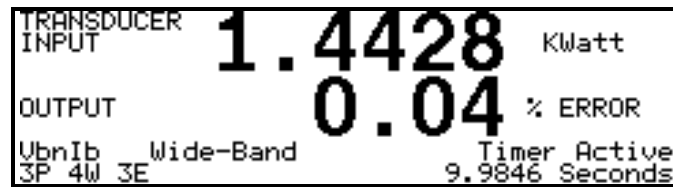
Initially, for the Model 931A display will appear similar to the screen below. Note that the Output measurement is configured to display as percent error (% ERROR).

```
TRANSDUCER  1.4428  KWatt
INPUT
OUTPUT      100.00  % ERROR
UbnIb  Wide-Band      31 Mar 1999
3P 4W 3E              Wed 11:46:29
```

During the custom pulse test, the OUTPUT value will change to dashes, as shown below and the date (in the lower right) will be replaced with a timer value, incrementing in seconds.

```
TRANSDUCER  1.4428  KWatt
INPUT
OUTPUT      - - - - -  % ERROR
UanIa  Wide-Band      Timer Active
3P 4W 3E              6.2220 Seconds
```

When the test is complete the OUTPUT measurement value will replace the dashes, and the timer value will freeze, showing total test time. The measured Output value may be displayed as either % ERROR or as the measurement value (in this case KWatt).

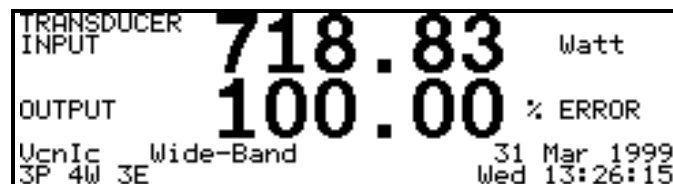


The display will hold the measured value(s) after the test is completed for recording or printing to the serial port. While holding, the Model 931A cycles through the selected phases to show all of the measured values. For example, the resultant display above shows phase VbnIb. To repeat the test, press ARM/RESET twice (once to reset the timer and a second time to arm the timer).

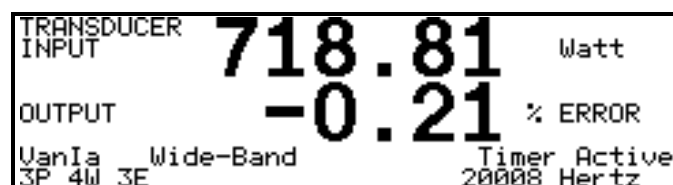
To configure new test parameters, press either SHIFT then CONFIG (transducer) or just CONFIG (timer) to change the measurement settings. After re-configuring the test parameters, press TRANSDUCER and the Model 931A is ready for another test. To start the next test, press the ARM/RESET key twice.

Using “Rate of A”

After setting up the test and configuring the Model 931A, apply the input power source to the transducer and Model 931A. Press the TRANSDUCER key to view the standard measurement screen. Press the ARM/RESET key again if the display is not indicating the desired output value.



If date and time information is showing (found in the lower right corner of the display) press the ARM/RESET key. It should immediately begin measuring the transducer. Also, the Timer information (including the contact or pulse output rate in Hertz) should appear and replace the date and time information. The screen below illustrates the Model 931A measuring a transducer using “Rate of A.”



Using the “Rate of A” Function, the Model 931A should continually update the measurement values. The Model 931A also cycles between each measured phase indicated in the lower left corner of the display. In the above display the measured phase is VanIa.

TIMER FUNCTIONS (Model 931A Only)

Configuration

To configure the Model 931A Power System Analyzer for timing functions, press the timer CONFIG key located next to the timer inputs.

```
TIMER CONFIGURATION MENU
→Function:      Time A To B
Display Choice: Seconds
Hold Mode On Stop: Disable
Trigger A:      DC Applied
Trigger B:      DC Applied
```

The arrow indicator will appear on the Function selection, use the arrow keys to move the indicator and press ENTER when the desired function is selected.

```
SELECT TIMER FUNCTION
→Time A To B
Time A To Next A
Time Width Of A
Rate Of A
Count A Events
Count A Gated By B
```

The arrow indicator will appear on the previously selected function, use the arrow keys to move the indicator and press ENTER when the desired function is selected. The arrow indicator will automatically advance to the next menu selection, Display Choice. Press ESCAPE to return the display to Volts/Amps and exit the timer function.

```
SELECT DISPLAY CHOICE
→Seconds
Cycles (50 Hz)
Cycles (60 Hz)
Cycles (Ch 1 Hz)
```

The arrow indicator will appear on the previously selected Display Choice, use the arrow keys to move the indicator and press ENTER when the desired display is selected. The arrow indicator will automatically advance to the next menu selection, Hold Mode On Stop. Press ESCAPE to return the display to Volts/Amps and exit the timer function.

```
SELECT HOLD MODE ON STOP
→Disable
Enable
```

The arrow indicator will appear on the previously selected mode, use the arrow keys to move the indicator and press ENTER when the desired mode is selected. The arrow indicator will automatically advance to the next menu selection, Trigger A. Press ESCAPE to return the display to Volts/Amps and exit the timer function.

```

SELECT TIMER TRIGGER A
  →DC Applied
   DC Removed
   AC Applied
   AC Removed
   Contact Open
   Contact Closed
  
```

The arrow indicator will appear on the previously selected Trigger, use the arrow keys to move the indicator and press ENTER when the desired Trigger is selected. The arrow indicator will automatically advance to the next menu selection, Trigger B. Press ESCAPE to return the display to Volts/Amps and exit the timer function.

```

SELECT TIMER TRIGGER B
  →DC Applied
   DC Removed
   AC Applied
   AC Removed
   Contact Open
   Contact Closed
  
```

The arrow indicator will appear on the present input display mode, use the arrow keys to move the indicator and press ENTER when the desired input mode is selected. The arrow indicator will automatically return to the previous menu selection, Trigger A. Press ESCAPE to exit the menu without changing the input mode.

```

TIMER Stopped 0.0167 Seconds
FUNCTION      TRIGGER A      TRIGGER B
Time         DC           DC
A to next A  Applied          Applied
  
```

In the main timer display, FUNCTION shows the parameter that the timer is configured to measure. TRIGGER A and TRIGGER B describe the actions which will constitute valid triggers for the 'A' and 'B' inputs.

Pressing the ARM/RESET button stops and resets the active timer. Once stopped, pressing the ARM/RESET key again will reset the timer. Pressing the ARM/RESET key another time arms the timer for next cycle. The ARM/RESET may also be used to manually stop the timer during a measurement cycle.

HELP MESSAGES

The Model 931A Power System Analyzer has built in help messages. Get complete configuration and operation information. To access help: press SHIFT, HELP, then the key of interest. For a menu of general topics, press SHIFT, HELP, SHIFT, HELP.

```
PHASE FREQ displays the channel 1
frequency and the phase angle of channel
2 relative to channel 1. In data entry
or menu mode, this key moves the cursor
left one selection or digit.
Phase angle may be 0 to 360 or +/-180,
leading or lagging; see MENU, Phase
Preference.
```

The general topics are:

- Help Mode Operation
- RS-232 Pinout
- PT/CT Testing

Extended Memory

The extended-memory option allows the user to store large amounts of data for later recall and analysis. All of the computed data and configuration parameters of the instrument may be saved. This option consists of a 16 mega-byte PCMCIA flash card interfaced to the main microprocessor. The memory card is hard mounted inside the analyzer and not meant to be removed. The data stored in the extended memory is retained regardless of the power on/off state of the analyzer. The data may only be erased by deliberate action of the operator.

Data Organization

The data stored in the extended memory is organized as a set of one or more files. Each file has a header and a set of records. The first time data is logged into a file the header is created. For each subsequent data log a record is stored. The header contains all information necessary to reconfigure the instrument as it was when the file was created and a description of the data contained in the individual records. Each of the records will contain the same set of parameters. There are two types of data records that can be stored in the extended memory, normal and custom.

The analyzer takes different sets of data depending on the selected display. The main four data sets are standard, harmonics, waveform and three-phase. Whenever the display is changed from one of these data sets to another, and data is logged, a new file will be created.

Data Types

They're two types of data that can be stored in the extended memory. These data types are designated as normal and custom. Normal data is stored as in the standard instrument memory. Custom data allows the user to define the data parameters that are stored.

Normal Data

There are four types of normal records. The type of data stored depends on the active instrument display at the time the record was logged. In addition to data, each record contains the configuration data for the moment it was recorded.

Each record within a logged-data file contains the same set of parameters. A new file with its own header and set of records will be created, the next time data is logged, if the display is changed to a different type of normal data or if a new custom data record is defined,.

- Standard data, which includes all of the Narrow-Band and Wide-Band parameters for channels 1 and 2 along with Timer and Transducer results. All logged data is tagged with the time and date. This type of record occupies the least memory space of any of the normal data sets. One record of standard data occupies 153 bytes of memory.
- Harmonics data, which incorporates all of the features of standard data and adds information regarding harmonic content of the signals routed to channels 1 and 2. This type of data is recorded whenever data is logged while harmonics are being displayed. One record of Harmonics data occupies 945 bytes of memory.
- Waveform data, which includes standard data, harmonic data, plus a record of waveforms present on channels 1 and 2. Waveform data is recorded whenever data is logged while displaying waveforms. Waveform data recording uses the most memory of any of the normal data types. One record of Waveform data occupies 1,425 bytes of memory.
- 3-phase data, includes all the data presently on the 3-phase display. One record of 3-phase data occupies approximately 366 bytes of memory.

Custom Data

The user may create a custom-data record. Custom-data records are designed to allow the operator to store only the parameters of interest, therefore, maximizing the number of data records that may be stored in the extended memory. The custom-data record is defined by a 32-bit word. Each bit of the word corresponds to a particular data parameter. When recalling custom-data records, only the parameters that are part of the custom record will be updated. All other parameters will be recalled from the header of the logged file. The custom data record can be programmed from the front panel or RS-232 port as described below.

There is a relation between the active display and the data collected. When harmonics, waveform or three phase data is selected for storage the respective display must also be active.

Custom Data Table

ID Bit#	Decimal Weight	Name	#Bytes
0	1	Time	6
1	2	Frequency	4
2	4	Phase	4
3	8	Power	8
4	16	PF	8
5	32	VA	8
6	64	VAR	8
7	128	Ch1 DC	4
8	256	Ch1 RMS (wide-band)	4
9	512	Ch1 MAG (narrow-band)	4
10	1,024	Ch1 Residual	4
11	2,048	Ch1 Phase reference	4
12	4,096	Ch1 Min	20
13	8,192	Ch1 Max	20
14	16,384	Ch2 DC	4
15	32,768	Ch2 RMS (wide-band)	4
16	65,536	Ch2 MAG (narrow-band)	4
17	131,072	Ch2 Residual	4
18	262,144	Ch2 Phase reference	4
19	524,288	Ch2 Min	20
20	1,048,576	Ch2 Max	20
21	2,097,152	Ch1&2 Min	80
22	4,194,304	Ch1&2 Max	80
23	8,388,608	3Ph Tabular	293
24	16,777,216	1Ph Energy	12
25	33,554,432	3Ph Sequence	48
26	67,108,864	Timer	10
27	134,217,728	Transducer	35
28	268,435,456	Harmonic	784
29	536,870,912	Ch1 Waveform	240
30	1,073,741,824	Ch2 Waveform	240
31	2,147,483,648	Not used	

Computing the Number of Files and Records

There is a limit of 20 files. The number of records allowed for each file is only limited by the amount of memory available.

Each type of record requires a fixed number of bytes of memory. When the extended memory is cleared there are 16,777,216 bytes (16 megabytes) available for data-record storage. Divide 16,777,216 by the number of bytes per record to determine the number of records that may be stored. The size of a particular custom record is determined by adding the number of bytes for each selected parameter.

<u>Type</u>	<u>Calculation</u>	<u>Maximum Records Stored</u>
Standard	1,677,216 / 153	109,655
Harmonic	1,677,216 / 945	17,753
Waveform	1,677,216 / 1425	11,773
3-Phase	1,677,216 / 366	45,839

Log Data Triggering

Data logging may be triggered by the front panel LOG DATA key, the RS-232 LOG command, a valid timer A event, or on a programmed time interval. When Log Data key or RS-232 is selected as the trigger, the requested data will be logged whenever the front panel LOG DATA key is pressed or the RS-232 LOG command is received.

Using the timer for triggering requires a bit more setup. First, select the timer as the trigger using the auto-log setup. Next, use the timer configuration to select the desired timer A trigger condition. If normal data is to be stored, set the display to show one of the normal data screens. When ready to begin data collection, arm the timer by pressing the front panel ARM/RESET key or issue the RS-232 TAM command. Data will be logged each time a valid timer A trigger is received. Data logging will not occur faster than once per second. Triggers received faster than once per second will be ignored. Press the ARM/RESET key or issue the TRS command to suspend data logging.

To trigger data on a programmed time interval, three times must be set: time interval, start time, and stop time. The time interval may be set from one second to 23 hours, 59 minutes and 59 seconds. This is the interval between each data record. Data logging will occur at the set time interval while the present time is between the start and stop time. The stop time must be later than the start time. Data logging will stop when the stop time is reached or when the extended memory is full.

Front Panel Operation

The first sign-on display will show “16 Mbyte Log Memory Card Installed” if the analyzer is equipped with the extended-memory option. “Auto-Log Setup” has been added as a selection item on the main menu. Press the MENU key and use the arrow keys to select “Auto-Log Setup”, press ENTER and the following display will appear.

```
AUTO-LOG SETUP (Active Selection = *)
Trisser:  →Log Data Key or RS232
          Timer
          * Time Interval
Start Log: Date/Time
Stop Log:  Date/Time
Log Data: * Normal      Custom
Auto-Log: Enable * Disable  New Log
```

First, select a trigger condition. If Time Interval is selected, the Start Log and Stop Log time must also be set. Next, choose the Log Data type, either Normal or Custom. The type of normal data recorded will depend on the active display at the time data is logged. Selecting Custom data allows the user to define the parameters to be logged. After selecting Custom the operator is led through a list of 32 data parameters. As each parameter is displayed use the up and down arrow keys to select or deselect the parameter. Use the ENTER key to move to the next parameter and the ESCAPE key to quit the selection process. Along with the name of each data parameter is the number of bytes it requires each time it is logged. A list of the available custom data parameters is on page 33. Time is shown as an optional parameter, however, it is automatically stored with each data record.

Select Enable or New File to begin logging the selected data. Each time New Log is selected a new file will be created for the next set of data records. Select Disable to stop data logging.

A header is created the first time data is stored in a new log data file. An indication will appear on the display (i.e. Saved in1) showing the number of the new file created. As each subsequent record is logged a message will appear showing the file number with the record number in brackets (i.e. Saved in 1[3]).

Press the SHIFT key then the REVIEW key to recall logged data. A display similar to the following one will appear.

```
LOG SPACE 88%  AUX MEM 98%  FILES 5
0 Clear All! (+Key Clears A File)
→1 9Dec96 11:10:03 4 Standard
2 9Dec96 13:28:51 2 Standard
3 9Dec96 13:37:54 9 Waveform
4 9Dec96 13:38:05 4 Harmonic
5 9Dec96 13:38:37 15 Cust:0004211
```

Select 0 to clear all data in the extended memory. The two percentage numbers, in the top row, show the amount of memory available. The LOG SPACE stores the headers for each file. The LOG SPACE will decrease as the quantity of files increases. The AUX MEM stores the individual records. As the number of records increases, the available AUX MEM will decrease.

Use the UP and DOWN arrow keys to select individual logged data files then, press ENTER to recall the selected file. Press the LEFT arrow key to erase one selected file. After selecting and recalling a file the display will include a message indicating the file number (i.e. Hold Log 2). Press the LOG DATA key to proceed through the logged records of the selected file. The record number will be displayed in square brackets. The arrow keys are used to control the record retrieval direction and increment number. Press SHIFT and the appropriate arrow key to:

Up arrow Review records in ascending order.
Down arrow Review records in descending order.
Left arrow Set review increment to 1.
Right arrow Set review increment to 10.

Remote operation

There are three RS-232 commands that provide for remote operation of the extended memory. These commands allow the user to configure, store and recall data in the extended memory.

Setup of Logged data Operation

SLO #1,#2,#3,#4,#5,#6,#7 SLO sets flash log operation

If no numbers present:

starts new file.

If 1 number is present:

0=disable data logging.

1=enable data logging.

If 3 numbers are present:

#1=0 manual trigger from front panel LOG key or RS-232 LOG command.

#1=1 trigger from timer A.

#1=2 auto trigger with interval set by #2.

#2=1 to 86400 auto log store trigger interval in seconds.

#3=32 bit data descriptor entered as decimal number.

If 7 numbers are present:

#1=0 #2...#7 = autolog start time.

#1=1 #2...#7 = autolog stop time

#2=yyyy year.

#3=1 thru 12 month.

#4=1 thru 31 day of month.

#5=0 thru 23 hour of day.

#6=0 thru 59 minute of hour.

#7=0 thru 59 seconds of minute.

Examples:

<u>Command</u>	<u>Action</u>
SLO	A new extended-log file is started. If time-interval data storage is selected, the start time must be later than the present time.
0SLO	Data logging is disabled.
1SLO	Data logging is enabled. A new file will be started. See "SLO" above.
0,0,0SLO	Configures data logging for normal data with the store trigger set for the front panel LOG key or the RS-232 LOG command.
0,0,33281SLO	Configures data logging for custom data with the store trigger set for the front panel LOG key or the RS-232 LOG command. The custom data includes time, channel 1 rms and channel 2 rms.
1,0,0SLO	Configures data logging for normal data with the store trigger set for timer A. Use the timer RS-232 commands (TCF, TAM, TSP, TST) to configure the timer. Each time a valid event occurs on Timer A data will be logged.
0,5,2SLO	Configures data logging for normal data with the store trigger set for automatic with a time interval of 5 seconds. The start time must be set to a time, later than the present time.
0,1996,12,25,12,0,0SLO	Sets the autolog start time to December 25, 1996 at 12:00 noon. The start time must be set to a time, later than the present time.
1,1997,1,1,0,0,0SLO	Sets the autolog stop time to January 1, 1997 at midnight. The stop time must be set to a time, after the start time.

The configuration of custom data is contained in a 32-bit word. Each bit in this word refers to a data parameter. The custom-data table above lists each of the available parameters along with their assigned ID bit and decimal weight. To remotely program the custom word, add the decimal weight of each desired parameter. The following example shows how to compute the custom data word for logging time and channels 1 and 2 magnitude data.

<u>Parameter</u>	<u>Decimal weight</u>
Time	1
Channel 1 rms	512
Channel 2 rms	32768
Custom configuration value	33281

Review of Logged Data

- RLD #1,#2RLD selects a log record for review or removal.
If #1 and #2 are absent:
 A list of stored records is returned.
If only 1 number is present:
 #=0 all records are cleared including flash memory, if present.
 #>0 the specified record data overwrites current instrument data and Measure Hold is enabled to allow data review or return.
If both numbers are present:
 #1=0 clears file selected by #2.
 #1>0 reviews the record indicated by #2 of the file indicated by #1.

Examples:

Command Action

RLD A list of the logged-data files is returned. This is example of the returned message.

```
LOG SPACE 87% AUX MEM 98% FILES 6
1 9 Dec 1996 13:37:54 9 Waveform
2 9 Dec 1996 13:38:05 4 Harmonic
3 9 Dec 1996 13:38:37 15 Custom
4 9 Dec 1996 14:17:25 0 Standard
5 9 Dec 1996 14:17:40 0 Standard
6 9 Dec 1996 14:17:47 1 Custom
```

The message includes the file numbers, the file date, the number of flash records in the file, and the type of data. To get the information on the number of records in each file, Auto-Log must be enabled.

- 0RLD All data records are erased.
- 3RLD Recalls the header data for file number three. The unit will be reconfigured to the state it was in when the file was created. The unit is placed in Measure Hold mode. To return to normal operation issue the "0MHD" command or press the MEASURE HOLD key.
- 0,4RLD Logged-data file number four is erased. All files 5 and greater will have their file number decremented by one.
- 3,12RLD Recalls the data stored in the twelfth record of the third file. If custom data was recorded all the unrecorded parameters will be set to their values in the file header.

Trigger remote data logging

"LOG" is the RS-232 command for remotely logging data. If the log data trigger is set to Log Data Key or RS-232, issuing this command causes one data record to be stored.