UPC-3 / UPC-1

PROGRAMMABLE CONTROLLERS

FIRMWARE V5.10 AND LATER

OPERATION
MANUAL

PACIFIC®
POWER SOURCE

UPC-3
UPC-1

OPERATION MANUAL

PPS PART NO. 141020

THIS MANUAL ASSIGNED TO:

CONTROLLER, MODEL: _____ S/N: _____.

POWER SOURCE, MODEL: _____ S/N: _____.

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FOURTH EDITION

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SECTION 1

GENERAL

1 GENERAL

This Operation Manual provides the information required to use a Pacific Power Source Universal Programmable Controller (UPC). Installation, operation, programmable command syntax, and calibration are covered by this manual.

UPC controllers are typically contained within a Power Source chassis. For those UPC installations which are external to the Power Source, a System Control Unit (SCU) chassis is available to house the UPC controller. This SCU chassis is also described in this manual.

This manual is to be used with the programmable controller, models: UPC-3 or UPC-1; or the manual operation controller, models: UPC-3M or UPC-1M.

1.1 USING THIS MANUAL

It is very important to read (4.0) (Front Panel Operation) prior to using this equipment. A thorough understanding of that information is required to properly operate this equipment. If the UPC will be used under REMOTE CONTROL via serial port or GPIB, then also read (5.0), REMOTE OPERATION, which describes the communication protocol and commands. If the serial interface is to be used, (10.0), SERIAL Interface, describes the serial specifications and setup.

The "**HOW TO**" pages immediately following the Table of Contents are a helpful reference for the first time user as well as the experienced user. Also very helpful is the "**OVERVIEW**" (4.1.1) and "**BASIC OPERATION**" (4.1.2). Remote-interface users will find the **"REMOTE INTERFACE FUNCTION REFERENCE"** to be helpful.

1.2 SAFETY NOTICES

The UPC-Series of equipment controls the Pacific Power Source AMX, ASX, MS, and G Series of power sources which are capable of transferring very large amounts of electrical energy very quickly. This basic quality is fundamental to any high-performance power source. The warnings and cautions listed below should be observed at all times.

WARNINGS indicate potentially hazardous situations which, if not avoided, could cause serious injury or death. All warnings throughout this manual will be formatted as shown on the following page. A condition which is hazardous to both personnel and equipment will be issued as a warning.

CAUTION statements indicate a potentially hazardous situation which, if not avoided, may cause minor or moderate injury or damage to the equipment. Cautions will assume the format shown. All cautions should be rigorously observed.

1.2 SAFETY NOTICES (continued)

WARNING

THIS EQUIPMENT CONTAINS HIGH ENERGY, LOW IMPEDANCE CIRCUITS!! LETHAL POTENTIALS ARE CONTAINED WITHIN THE CABINET.

CARE MUST BE EXERCISED WHEN SERVICING THIS EQUIPMENT IN ORDER TO PREVENT SERIOUS OPERATOR INJURY OR EQUIPMENT DAMAGE.

VOLTAGE AT THE TERMINALS RESPONDS INSTANTLY WHEN THE OUTPUT IS ACTIVATED.

OBSERVE THE FOLLOWING WHEN SERVICE, MAINTENANCE, OR CALIBRATION ARE REQUIRED:

1) **REMOVE ALL JEWELRY FROM HANDS, ARMS AND NECK WHEN SERVICING THIS EQUIPMENT. THIS PREVENTS THE POSSIBILITY OF SHORTING THROUGH THE JEWELRY AND CAUSING BURNS OR ELECTROCUTION OF THE OPERATOR.**

2) **WEAR SAFETY GLASSES WHEN SERVICING THIS EQUIPMENT TO PREVENT EYE INJURY DUE TO FLYING PARTICLES CAUSED BY ACCIDENTAL SHORT CIRCUIT CONDITIONS.**

3) **DO NOT REMOVE ANY PANEL OR COVER WITHOUT FIRST REMOVING THE INPUT SERVICE BY OPENING ALL CIRCUIT BREAKERS.**

SERVICE OTHER THAN EXTERNAL CLEANING SHOULD BE REFERRED TO PERSONNEL AUTHORIZED BY THE FACTORY TO SERVICE THIS EQUIPMENT.

WARNING

IF THIS EQUIPMENT IS NOT USED IN A MANNER SPECIFIED BY THE MANUFACTURER, THE PROTECTION PROVIDED BY THE EQUIPMENT MAY BE IMPAIRED

1.2 SAFETY NOTICES (continued)

To protect equipment from damage, a Caution will be used as follows:

CAUTION

USING IMPROPER GAUGE OF INPUT CABLE MAY OVERHEAT AND DAMAGE THE EQUIPMENT.

SEE SECTION 2.0, SPECIFICATIONS, FOR THE PROPER SIZING OF INPUT CABLE.

ALWAYS MAKE SURE THAT THE OUTPUT ON/OFF SWITCH IS IN THE OFF POSITION BEFORE CHANGING THE OUTPUT COUPLING MODE.

LOADS MAY BE DAMAGED DUE TO EXCESSIVE OUTPUT VOLTAGE

CAUTION

Read Section 3, INSTALLATION
Section 4, OPERATION
Section 7, SERVICE
of this manual before installing or operating this equipment.

1.3 GENERAL PRODUCT DESCRIPTION

1.3.1 UPC DESCRIPTION

The UPC controller is a highly versatile one, two, or three phase signal generator. It is designed to be installed into Pacific Power Source's ASX Series Power Sources or into a System Control Unit for use with other power sources. The UPC is designed for use with any of Pacific Power Source, Inc.'s AC Power Sources and is interchangeable with other UPC/UMC Series controllers.

The user may store up to 99 "Programs" in battery backed-up RAM. Each program contains steady-state parameters and may include transient values as well. There are also pre-stored programs that simplify generation of MIL-STD 704D transients.

Auxiliary and Amplitude Modulation inputs are provided to allow control of the power source output from a variety of external control sources. The AUX inputs will accept signals from a waveform generator. The AM inputs allow control of the output amplitude by varying a control voltage.

The signal generator section produces one (UPC-1) or three (UPC-3) signals representing the output waveforms of the power source. The UPC controllers produce steady-state signals - a base set of volts, frequency, waveform and phase angle - and dynamic signals which change with time. The signal generator can produce dynamic transient events lasting from microseconds to hours.

- Each signal can be any of the 22 waveforms stored in memory.
- Waveform 1 is a sine wave and cannot be altered; the other 21 waveforms can be altered by the user to produce any arbitrary wave function.
- The phase angle relation between the three output vectors may be varied.
- The voltage amplitude of each vector may be varied together or independently.
- The frequency of all output vectors is the same and is controllable from 15 to 1200 Hz.

The Display of the UPC utilizes a 160 character Backlit LCD, which selectively displays operating parameters or displays menus which interactively prompt the operator and assist in loading programs or editing. On completion of any programming or editing function, the display automatically reverts to the metering display.

Complete parameter metering is provided by the UPC. Output volts (line-to-line and line-to-neutral), current (true RMS, peak, and crest factor), KVA, KW, and Power Factor can all be displayed. Frequency is indicated based on the set value. Internal or External voltage metering sense points can be selected. Internal metering displays the output voltage as metered at a point prior to the Output Relays. This allows the output voltage to be checked prior to applying power to a load. External metering allows the output voltage to be monitored at a remote point outside of the power source. With CSC enabled (see below), external sense can be used to maintain an accurate voltage at any remote point, compensating for line voltage drops.

The CSC (Continuous Self Calibration) feature provides automatic compensation for real losses due to output transformers and distribution lines by maintaining an accurate COMMAND (program) voltage at the metered sense point. CSC may be enabled or disabled at the user's discretion.

Externally referenced Output Gain and Metering calibration is simplified by internal software that allows external measurements to be entered directly into the front panel or Remote Interface. Correction values (kFactors) are then calculated and stored in the UPC's memory.

An output transformer ratio may be programmed into the UPC for controlling and metering voltages outside of the power source direct coupled range.

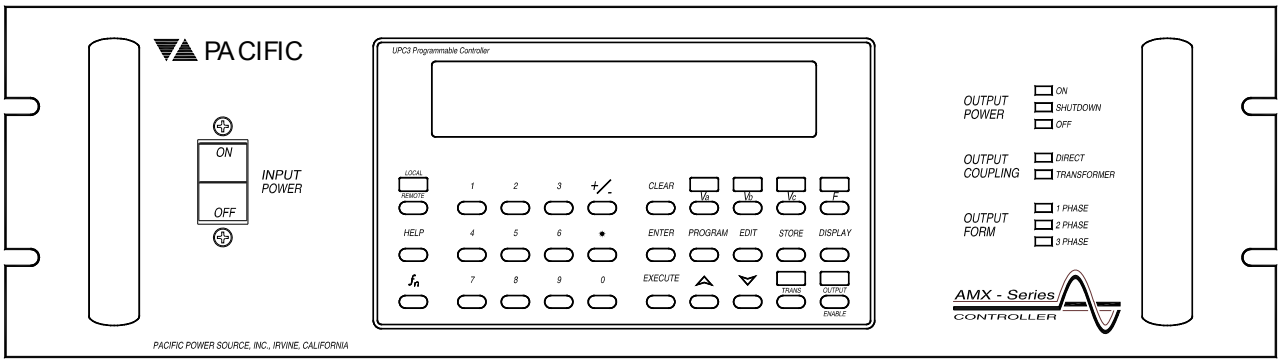


Figure 1.3a SCU/UPC-3

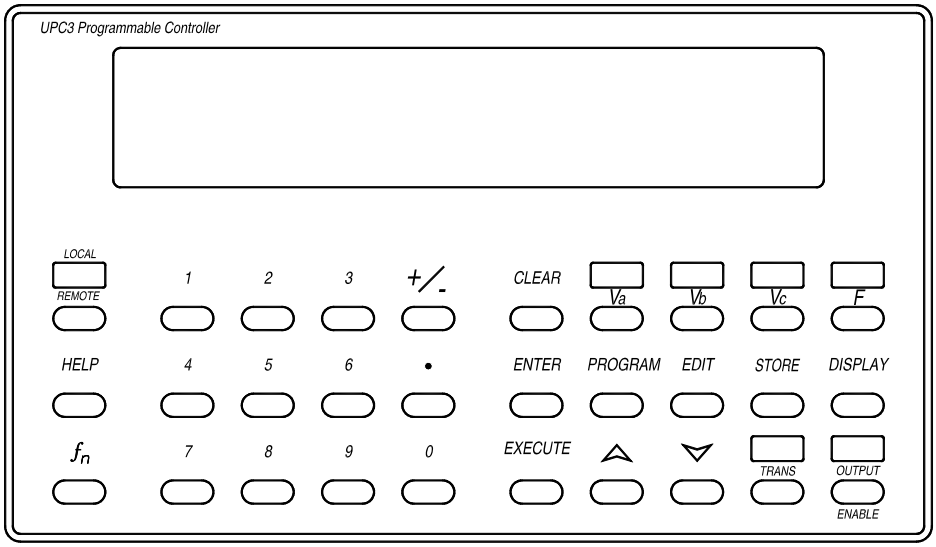


Figure 1.3b UPC-3

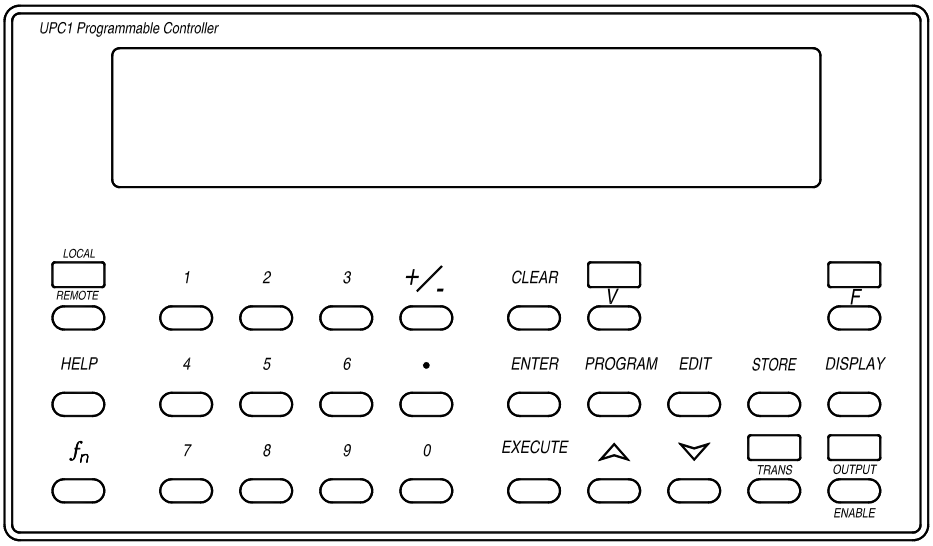


Figure 1.3c UPC-1

1.3.1 UPC DESCRIPTION (continued)

A Programmable Current limit value can be set.

A unique feature available within the UPC is TRANSITION TIME. If Transition time is set to a non-zero value, and a new program is executed, or changes are made in MANUAL MODE (or by REMOTE CONTROL), the UPC will take the specified time to transition from the active voltage and frequency to the new voltages and frequency. This feature may be used when it is undesirable to cause abrupt changes to the output power signal. This feature does not affect transient operation. Transition time may be set from 0 to 300 seconds in increments as small as 200 uSec.

Waveform analysis functions can be optionally provided to report both magnitude and phase angle of each harmonic for metered voltage and current waveforms. THD, ODD and EVEN harmonic distortion measurement data is also reported.

The Programmable Output Impedance option (ProgZo), also known as Current Compensation, provides the ability to compensate for dynamic losses in the output circuit by controlling the output impedance of the power source and responding in real time to changes in the output current.

The UPC may be used in Local (front panel) or Remote (SERIAL or optional GPIB) control. Serial port interface is the standard interface configuration and is IEEE-488.2 and SCPI command format compatible. The optional GPIB interface is fully IEEE-488.1, IEEE-488.2 and SCPI compatible.

Metered voltage and current digitized waveform data can be retrieved via the REMOTE interface.

1.3.2 CONTROLLER MODELS

The term 'UPC' is derived from Universal Programmable Controller.

The UPC-32 is a 3Φ signal generator designed to operate any PACIFIC brand power source which is 1Φ / 2Φ / 3Φ capable.

The UPC-1 is identical in characteristics to the UPC-3, except that it produces only one output signal. It is designed to plug in to any single or split-phase PACIFIC brand power source.

The UPC-3M and UPC-1M are manually operated controllers with no programming capability.

1.3.3 SCU DESCRIPTION

The System Control Unit is a 19” W x 5.25”H x 7” D (48.26cm x 13.33cm x 17.78cm) rack-mount style chassis with a power supply and connector interfaces, to support a UPC. This allows the UPC to operate independently from the power source.

The SCU provides a suitable housing for the controller for applications requiring a controller remotely located from the power source. The complete designation for a "stand-alone" controller housing a UPC-3 is SCU/UPC-3. Such a unit can drive some of the larger PACIFIC power sources through their remote interface. A typical usage might be: to locate the power source at the base of an instrument rack, with the controller installed in an upper slot at a more convenient eye level or even in a completely different location.

SECTION 2

SPECIFICATIONS

2 SPECIFICATIONS

This section states the specifications of both Output Control and Metering capabilities of the UPC.

The UPC-3 is assembly number: 141302
The UPC-1 is assembly number: 141102

The UPC-3M is assembly number 141303
The UPC-1M is assembly number 141103

Environmental Ambient operating conditions are:

Temperature	0-50ºC.
Humidity	0-95% R.H Non-Condensing.

2.1 CONTROL SPECIFICATIONS

2.1.1 FREQUENCY CONTROL SPECIFICATIONS

The UPC output frequency is variable from 15 to 1200 Hz. Internally, there are 4 FREQUENCY SPAN ranges, each with a different resolution as determined by the number of digitized steps in the output waveform and in the metering data. To change FREQUENCY SPAN (4.6.3.2).

FREQUENCY SPAN	WAVEFORM STEPS	METERING SAMPLES
15.00 – 150 Hz.	1024	512
15.00 – 300 Hz.	512	256
15.00 – 600 Hz.	256	128
15.00 – 1200 Hz.	128	64

Accuracy is ± 0.01% of full scale over the full range of ambient conditions.

A unique feature available within the UPC is TRANSITION TIME. If Transition time is set to a non-zero value, and a new program is executed, or changes are made in MANUAL MODE (or by REMOTE CONTROL), the UPC will take the specified time to transition from the active voltage and frequency to the new voltages and frequency. This feature may be used when it is undesirable to cause abrupt changes to the output power signal. This feature does not affect transient operation. Transition time may be set from 0 to 300 seconds in increments as small as 200 uSec.

2.1.2 VOLTAGE CONTROL SPECIFICATIONS

The voltage amplitude of each vector can be varied independently.

There are two output coupling modes selectable in the stored programs of the UPC.

1) DIRECT COUPLED MODE:
   - Range: 0 to 150 VAC rms
   - Resolution: 0.1 volts
   - Output Ratio: 1.0 (This mode is internally fixed)

2) TRANSFORMER COUPLED MODE:
   - Range: 0 to (150 x XFMR RATIO) VAC rms (maximum of 600 volts)
   - Resolution: dependant upon the TRANSFORMER RATIO as described below. This allows for a possible output voltage of up to 375 VAC rms line-neutral, using an output TRANSFORMER RATIO of 2.5.

The voltage range available at any given time is automatically calculated by the UPC and accounts for the Transformer Ratio setting. The power source will be driven with the correct amplitude signal and does NOT require the user to perform any calculations to determine output voltage dependant upon the transformer ratio.

The UPC allows the Power Source to use any output TRANSFORMER RATIO from 0.05 to 5.00. Voltage resolution for TRANSFORMER COUPLED MODE is as follows:

XFMR RATIO	Vresolution
.05 - 1.00	0.1 VAC rms
1.01 - 5.00	0.5 VAC rms

The TRANSFORMER RATIO value may be changed by entering a new value in the UPC STATUS screen and in the program to be executed. The power source must have an output transformer configured with the same ratio as presently set for this feature to work properly.

TRANSFORMER RATIOs greater than 1.0 are step-up types.
TRANSFORMER RATIOs less than 1.0 are step-down types.

Accuracy is ± 0.5% of full scale over the range of ambient conditions with CSC disabled.
Accuracy is ± 0.05% of the voltage referenced to the internal voltmeter with CSC enabled.

NOTE: TRANSFORMER RATIOs are implied as a ratio to one, e.g.; a ratio of 2.5 is implied as a ratio of 2.5:1.

NOTE: The above voltages are power source output voltages. The UPC actually produces an RMS voltage equal to (Power source output Vrms / 25 / TRANSFORMER RATIO). The SCU provides this type of low voltage output at the rear panel connector, to be fed into a power source.

A unique feature available within the UPC is TRANSITION TIME. If Transition time is set to a non-zero value, and a new program is executed, or changes are made in MANUAL MODE (or by REMOTE CONTROL), the UPC will take the specified time to transition from the active voltage and frequency to the new voltages and frequency. This feature may be used when it is undesirable to cause abrupt changes to the output power signal. This feature does not affect transient operation. Transition time may be set from 0 to 300 seconds in increments as small as 200 uSec.

2.1.2.1 CSC (CONTINUOUS SELF CALIBRATION) SPECIFICATIONS

CSC capability is not available in the Manual versions of the controller (UPC-3M and UPC-1M)

The UPC includes a user selectable “Continuous Self Calibration” function. When active, this function maintains a constant output voltage amplitude at the metering sense point, comparing the metered voltage at that point to the set value and correcting for any difference. Accurate calibration of the voltage metering function is essential for CSC to operate accurately.

When INT SENSE is chosen, CSC attempts to precisely maintain accurate COMMAND (program) voltage at the input side of the Output Relay of the power source.

To compensate for load voltage drops due to distribution losses, CSC can be effectively used to maintain COMMAND (program) voltage very precisely at the load by selecting EXT sense with sense leads connected at the load and having CSC enabled.

Basic properties of the CSC function are:

1. Voltage level held to ± 0.05% of the program voltage referenced to the internal voltmeter with CSC enabled.

2. Response time varies from 100 mSec. to 300 mSec. and only responds while the UPC is metering, not while in Program Edit or Setup mode.

3. CSC operates independently of selected waveform, does not increase distortion and is stable into any PF load.

4. Automatically switches between internal and remote voltage sensing as the metering function is switched between INT and EXT.

5. CSC does NOT function during Transients or Transition Time functions.

6. CSC will only correct the Output Voltage by ± 10%. If the sense voltage is not within ± 10% of the COMMAND voltage, CSC will become disabled until the Output Voltage is within ± 10% of the COMMAND voltage. Each phase operates independently.

2.1.3 CURRENT LIMIT CONTROL SPECIFICATIONS

Programmable Current Limit is not available in the Manual versions of the controller (UPC-3M and UPC-1M)

Current limit is provided for all phases through a single RMS current value. The range of this value is equal to the ammeter range, as set by the AMPS TO VOLTS RATIO (2.2.2). This function is an average responding, RMS programmed function, with a response time of approx. 50 mSec.

Range:	Amps to Volts ratio x 10 (divide by 3 for 3Φ power form) (divide by 1.5 for single phase power sources containing 2 power amps).
Resolution:	Range/2000 (.05%)
Accuracy:	±3% of full scale over the full range of ambient conditions

2.1.4 WAVEFORM CONTROL SPECIFICATIONS

A sine wave is the only waveform available in the Manual versions of the controller (UPC-3M and UPC-1M).

Each output phase is generated by one of 22 waveforms stored in RAM and may be independently generated using separate waveforms by creating a Stored program and specifying a different waveform number for each phase within that program.

Waveform 1 is always a Sine wave and cannot be changed. Waveforms 2-22 may be individually edited, or copied. This gives the user the ability to create almost any waveform with the UPC, such as sub-cycle transients. See (4.5.2.2) for an example of creating a cycle-based transient that performs waveform substitution for 1 cycle.

If the ERASE ALL RAM AND RESET CPU function is selected, all waveforms are erased and reset as:

EDITABLE WAVEFORM #	DESCRIPTION
1	SINE WAVE
2	TRIANGLE - 12.7% THD
3	SQUARE - 38.6% THD
4	PULSE (30º WIDTH) - 153% Avg. THD
5-22	SINE WAVE

NOTE: THD is measured as RMS THD with a Distortion Analyzer unless noted above.

To create other waveforms, Waveform Edit (4.6.2.1) allows modification of existing waveforms and the Waveform Synthesis (Harmonic Analysis and Synthesis option, (4.6.2.3)) allows generation of waveforms by defining harmonic content.

2.1.5 OUTPUT POWER FORM CONTROL SPECIFICATIONS

The UPC-3 can create single (one), split (two), or three phase waveforms with ΦB and ΦC at any phase angle referenced to phase A.

The UPC-1 generates only one output vector. When used in an AMX or ASX Power Source, it may generate single (one) and split (two) phase output.

When two phase output form is selected, the hardware in the Power Source causes the ΦB signal to be 180º out of phase with the ΦA signal. The user may program 240 VAC with a result of 120 VAC from ΦA to neutral and 120 VAC from ΦB to neutral and 240 VAC from ΦA to ΦB.

2.1.6 PHASE ANGLE CONTROL SPECIFICATIONS

The phase angle displacement of the UPC 3 and UPC-3M oscillator output may be independently programmed for ΦB and ΦC. The phase relation between the three output vectors can be controlled from 0 to 359 deg. in 1 deg. increments. Phase A is always defined as the 0º reference.

Range: 0 - 359 º
Resolution: ± 1º
Accuracy: ± 0.5º to 3º

FREQUENCY SPAN	ACCURACY
15.00 – 150 Hz.	± 0.5º
15.00 – 300 Hz.	± 1º
15.00 – 600 Hz.	± 2º
15.00 – 1200 Hz.	± 3º

2.1.7 WAVEFORM SYNTHESIS SPECIFICATIONS (Option: Harmonic Analysis and Synthesis [HAS])

HARMONIC RANGE: 2 through 51.

MAGNITUDE: Percentage, referenced to the fundamental (always defined as 100%).
Range: 0% to 999%
Resolution: 0.1%
Accuracy: ± 1% referenced to the fundamental

PHASE ANGLE: Based on a Sine series.
Range: 0º to 359.9º
Resolution: 0.1º
Accuracy: ± 2% F.S.

CALCULATION TIME to create the waveform is approx. 3 seconds + 1 second for each non-zero magnitude.

NOTE: The waveform is synthesized using a sine series with coefficients expressed in polar format (magnitude and phase angle).

2.1.7 WAVEFORM SYNTHESIS SPECIFICATIONS (continued)
(Option: Harmonic Analysis and Synthesis [HAS])

The harmonic synthesis feature uses the formula to calculate the finished waveform values:

$$\text{WAVEFORM} = \Sigma\ \alpha_n\ \sin(nw\tau + \delta)$$

Where: n = harmonic number
α_n = harmonic amplitude (% of fundamental)
δ = harmonic phase angle

For example, the above formula may use values from the following tables:

WAVEFORM #1 SINE WAVE

n	αn %	δ	
1	100	0	THD=0%

IEC 77A CLASS 1 WAVEFORM

n	α_n %	δ	
1	100	0	
3	8	0	
5	9	0	
7	5	0	
11	2	0	
13	2	0	THD = 12.6%

IEC 77A CLASS 2 WAVEFORM

n	α_n %	δ	
1	100	0	
3	6	0	
5	8	0	
7	7	0	
11	7	0	
13	6	0	THD = 14.4%

2.2 METERING SPECIFICATIONS

2.2.1 VOLTMETER SPECIFICATIONS

Three voltmeter inputs are provided, one per phase. Both Voltage Line-to-Neutral (VLN) and Voltage Line-to-Line (VLL) are metered.

Vrms Meter Range:	354 VLN, 708 VLL A.C.
Display Resolution:	0.1 VAC rms. The Remote interface may provide up to 3 digits of precision (digits to the right of the decimal point).
Accuracy:	± 0.2% of Full Scale, ± calibration reference @ 25ºC.

NOTE: Some load voltage may be displayed with NO LOAD attached due to the sensitivity of the metering circuits.

NOTE: Power source voltmeter scaling is internally fixed at 50:1
e.g. 50 VAC at load = 1 VAC input to UPC = 50 VAC displayed.

2.2.2 AMMETER SPECIFICATIONS

Three ammeter inputs are provided, one per phase. Both Peak and RMS values are displayed. Current crest factor is displayed as the ratio: Ipk/Irms

Amp Meter range:	Amps-to-Volts-Ratio x 10 (divided by 3 if 3 Φ form is used)
DISPLAY Range:	00.01 – 99.99 Amps rms or Peak
DISPLAY Resolution:	0.01 Amps rms or Peak. The Remote interface may provide 3 digits of precision (number of digits to the right of the decimal point).
Accuracy:	± 0.2% of Full Scale, ± calibration reference, @ 25ºC.

NOTE: The AMPS TO VOLTS RATIO is set and displayed with the UPC STATUS display (***fn***,3,3).

NOTE: Some load current may be displayed with NO LOAD attached due to the sensitivity of the metering circuits.

2.2.3 kVA METER SPECIFICATIONS

kVA metering is provided by multiplying the metered volts times the metered amps values. Display range and resolution is XXX.XXX kVA. The Remote interface may provide 3 digits of precision (digits to the right of the decimal point).

Accuracy is ± 1% of full scale over the full range of ambient conditions.

2.2.4 KILOWATT METER SPECIFICATIONS

True kilowatt power metering is provided using the voltmeter and ammeter data. Display range and resolution is XXX.XXX kW. The Remote interface may provide 3 digits of precision (digits to the right of the decimal point).

Accuracy is ± 1% of full scale over the full range of ambient conditions.

2.2.5 POWER FACTOR METER SPECIFICATIONS

Power factor is displayed as the ratio: kW / kVA. Display range and resolution is X.XXX. The Remote interface may provide 3 digits of precision (digits to the right of the decimal point).

Accuracy is ± 1% of full scale over the full range of ambient conditions.

2.2.6 FREQUENCY DISPLAY SPECIFICATIONS

The frequency in the metering display is calculated from program data. Internally, there are 3 Frequency Spans, each with a different resolution (2.1.1). The UPC typically performs auto-ranging based on the selected frequency but the Frequency Span can be specified (2.1.1, 2.1.6, and 4.6.3.2).

Range:		15.00 – 1200 Hz..
	10.00 to 99.99 Hz.	0.01 Hz.
Resolution	100.0 to 999.9 Hz.	0.1 Hz.
	1000 to 1200 Hz.	1 Hz.
Accuracy	(over the full range of ambient conditions)	± 0.01% of full scale

2.2.7 WAVEFORM ANALYSIS (Option: Harmonic Analysis and Synthesis [HAS])

WAVEFORM ANALYSIS is an optional feature which derives harmonic content values from any output voltage or current waveform. Harmonics may be displayed on the front panel LCD or may be queried via the Remote Interface. Total Harmonics (THD, RMS) and Even and Odd harmonic sums (EHD & OHD) are also displayed. Harmonic analysis reports both magnitude and phase angle (relative to 0º of voltage) of each harmonic for metered voltage and current waveforms.

Fundamental Frequency Range (Fout):		15-1200 Hz.
Harmonic Range:		2nd - 51st Harmonic.
Data Samples:	Based on FSPAN See (2.1.1 & 4.6.3.2)	64-512
Harmonic Content (Magnitude):		
Accuracy: (see NOTE 1)		± 1% of Fundamental
Resolution:		0.1 %
Harmonic Phase Angle (see NOTE 2):		
Accuracy:	Fout < 100 Hz.	2nd-20th: ± 1º 21st-51st: ± 2º
	100 <=Fout<1000	± 6º
	Fout >1000 Hz.	± 8º
Resolution:(0º - 359º)		1º

2.2.7 WAVEFORM ANALYSIS (continued)

The harmonic data is reported using a sine series with coefficients expressed in polar format (magnitude and phase angle).

Each magnitude can be represented as an absolute value or as a percentage referenced to the fundamental which is always defined as having a magnitude of 100% (4.3.1.1).

*** NOTE:** 1. When analyzing load current or voltage, use as much of the meter range as possible. The specifications given apply to measured waveforms in which the peak values are at least 20% of the meter range. Valid results can be obtained from lower magnitudes, but accuracy of the higher order harmonics will deteriorate.

2. Phase angle accuracy is a guideline value only. It cannot be precisely stated because it varies greatly with waveform type and magnitude. In general, it is most accurate with quasi-sinusoidal waveforms - and poorest with pulse type waveforms and those containing many discontinuities, when resolving high order harmonics.

2.3 ELECTRICAL INTERFACE

2.3.1 ISOLATION

The UPC contains one isolated power supply for all circuits. The REMOTE interface is **NOT** isolated from the CPU or oscillator sections. The UPC's circuits may float with respect to Earth-GND but this is not recommended. In the Power Source, provision is made at one location to tie power supply common to Earth-GND (unit chassis). The user may establish their own local ground by removing the link between power supply common and GND.

2.3.2 INPUT POWER

If the UPC is installed in a Power Source chassis, see the Power Source manual for power requirements.

The System Control Unit (SCU) with a UPC installed will operate from 115 or 230 VAC, 47 to 440 Hz. Input voltage selection is made by a recessed switch on the back of the SCU. Input protection is provided by a front panel circuit breaker.

The UPC controller requires + 10 VDC and ±20 VDC on J6. This is typically supplied by the SCU or Power Source into which the UPC is installed.

2.3.3 ANALOG OUTPUTS

The oscillator waveform (ΦA, ΦB, ΦC) differential outputs are available on J3. They are capable of driving full output of ± 10 V_{peak} into a 600 ohm load.

2.3.4 OUTPUT CONTROL

J3 digital outputs are ± 15 VDC, positive logic.

The UPC sends the following control signals to the power source on J3:

NAME	FUNCTION
3Φ - CMD	3Φ output form command
1Φ - CMD	1Φ output form command
	NOTE: If both 3Φ and 1Φ are false, the form is 2Φ
CONNECTOR - CMD	Verify UPC is connected to power source. Also drives audible beeper in power source installations
EXT SENSE - CMD	External metering command
XFMR CPLD - CMD	Transformer coupled output command
OUTPUT ON -CMD	Close output relay command
PSM1 & 3 – CMD	Power Supply Management commands

2.3.5 OUTPUT CONFIRMATIONS

J3 digital inputs are ± 15 VDC, positive logic.

The power source sends the following control signals to the UPC on J3:

NAME	FUNCTION
CONNECTOR - CONF	Verify UPC is connected to power source (loops back the CONNECTOR – CMD signal)
SHUTDOWN - CONF	Power source shutdown confirmation
3Φ ON - CONF	3Φ output relay is closed
1Φ ON - CONF	1Φ output relay is closed
XFMR CPLD - CONF	Transformer coupled output confirmation

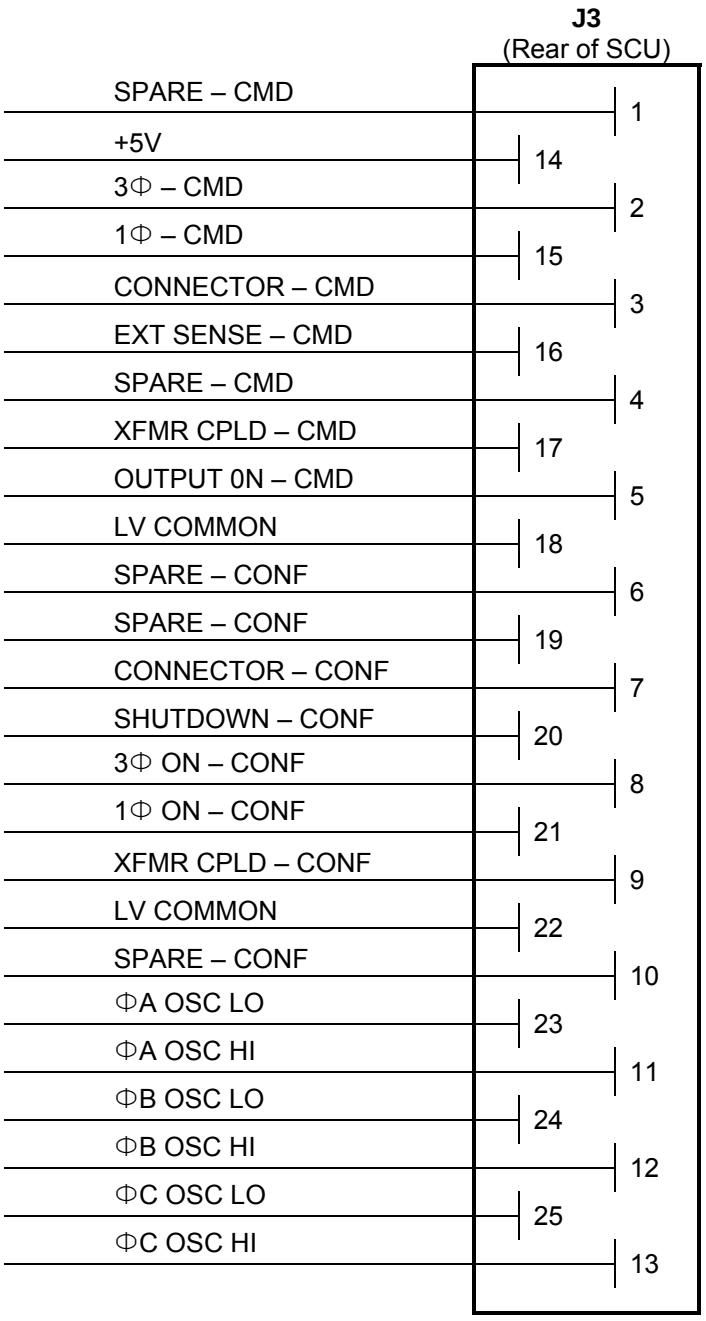


Figure 2.3.3 J3 CONTROL AND OSCILLATOR

2.3.6 ANALOG INPUTS

Three Auxiliary Inputs are provided on J5, one per phase. The Auxiliary Inputs are AC coupled and algebraically summed to the Oscillator signals produced by the UPC. Note that the Auxiliary Inputs can be used as external oscillator inputs simply by programming the UPC for 0 VAC output.

Auxiliary Input voltage range (Vaux):	± 10Vpk (20Vpk-pk)
Input impedance:	600 ohms
Small Signal Gain Bandwidth:	> 100 kHz. (auxiliary inputs to UPC output)

Form 1 and 3:

Power source OUTPUT VOLTAGE = Vprogram + (Vaux x 25 x XFMRratio).

Form 2:

Power source OUTPUT VOLTAGE = Vprogram + (Vaux x 50 x XFMRratio).

Three AM Inputs are provided on J5, one per phase. Varying DC voltage may be used to Amplitude Modulate the output.

AM Input voltage range (Vam):	± 10Vdc (20Vpk-pk)
Input impedance:	600 ohms

Power source OUTPUT VOLTAGE = Vprogram + (Vam/10 x (204.5 x XFMRratio))

(The maximum voltage is limited by the output voltage range of the power source. **NOTE:** Attempting to drive the OUTPUT VOLTAGE beyond the voltage range of the power source will result in a clipped (distorted) output waveform)

2.3.7 DIGITAL OUTPUTS

J5 digital outputs are 0 to 5 VDC, positive logic.

Logic outputs are:

Transient Pedestal:	true when a transient is in progress
DRM:	frequency generating clock, depending on FSPAN (2.1.1, 4.6.3.2)
SYNC OUT:	Positive Zero Crossing (0º) of Phase A analog output

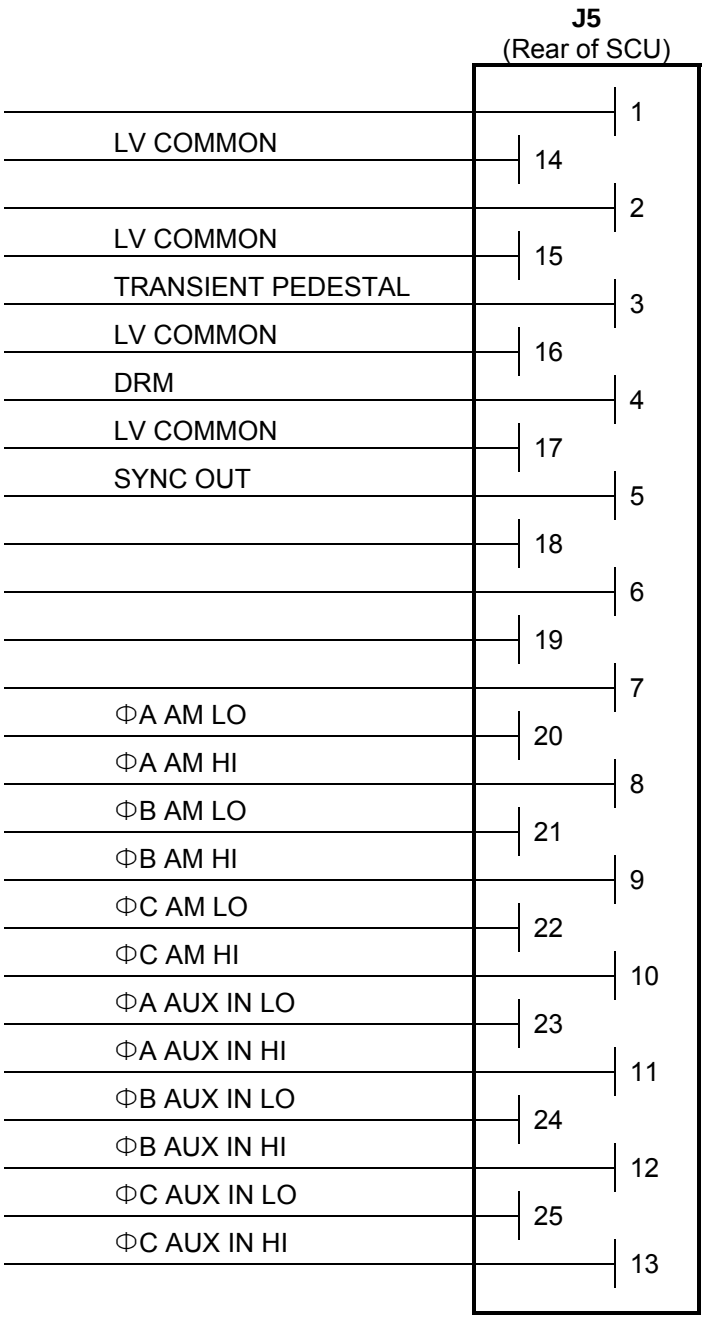


Figure 2.3.6 J5 AUXILIARY INPUTS AND OUTPUTS

2.3.8 METERING INPUTS

Metering inputs are on J2. Common mode must be within ± 10 V_{peak} with respect to power supply common.

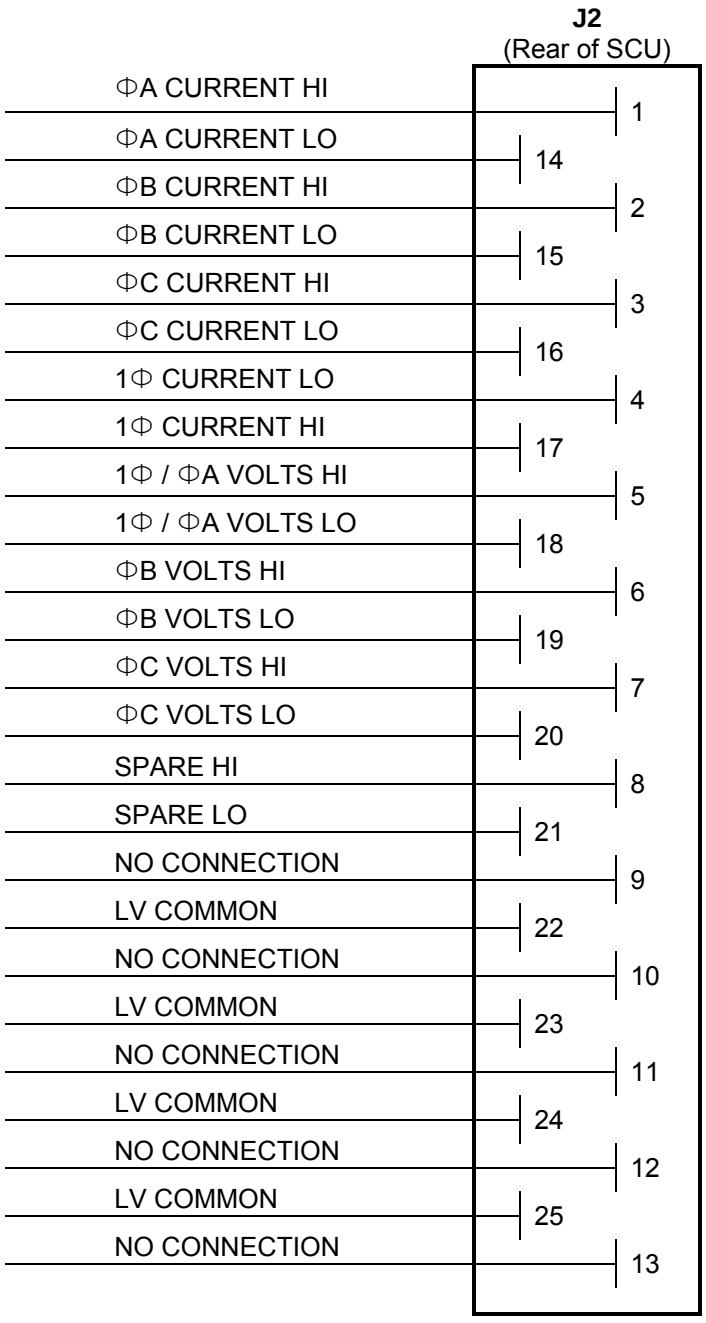


Figure 2.3.8 J2 METERING INPUTS

2.4 GPIB REMOTE INTERFACE (option)

The GPIB Remote Interface is provided on J4. It has listener and talker capabilities.

The GPIB device address is set via the UPC STATUS display screen. Default address is 1. See (4.6.3.3) for configuration and (5.0) for programming information.

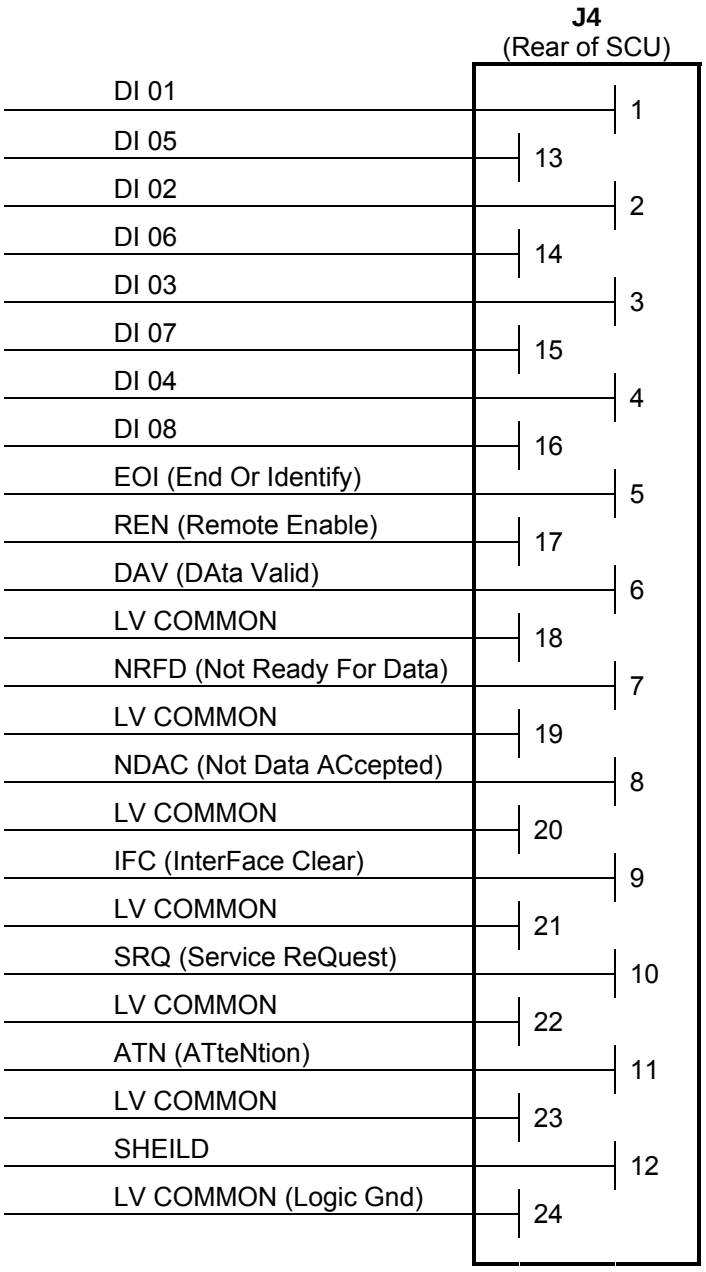


Figure 2.4 J4 GPIB REMOTE INTERFACE

SECTION 3

INSTALLATION

3 INSTALLATION

This section describes installation of an UPC into a SCU.

NOTE: It is recommended that the user return the product to the factory should a controller or power source upgrade is desired, however, the following information is provided for reference system. Should a question arise, call Pacific Power Source, toll free, at 1-800-854-2433.

Installation of an UPC into a SCU consists of the following steps:

STEP	DESCRIPTION	REFERENCE
1	Open all Circuit Breakers and remove Input Service	(3.1)
2	Remove cover and cabling	(3.2)
3	Remove existing controller	(3.3)
4	Install UPC	(3.4)
5	Install cabling and cover	(3.5)
6	Connect Input Service and power on	(3.6)
7	Configure UPC	(3.7)

3.1 REMOVE INPUT SERVICE

Turn the Input Power Circuit Breaker on the front panel OFF. Then disconnect the Input Line Cord from the rear of the SCU chassis (Figure 3.5).

3.2 REMOVE COVER AND CABLING

- Remove six screws from the top cover then remove the top cover.
- Remove J2A from P2A.
- Remove J3A of the existing controller from P3A of the LED PCB.
- Disconnect J4 from the rear panel of the SCU. Reattach mounting hardware to J4.
- Disconnect J5 from the rear panel of the SCU. Reattach mounting hardware to J5.
- Remove J6A of the SCU from P6A of the UPC PCB.
- Remove J3B of the SCU from P3B of the LED PCB.

3.3 REMOVE EXISTING CONTROLLER

Remove the LED PCB by removing the 4 nuts holding the LED PCB to the SCU front panel.

Remove the existing controller by removing the 2 nuts holding the UPC front panel to the SCU front panel.

3.4 INSTALL UPC

NOTE: Most users will not need to concern themselves with the following installation issue if the UPC is packaged with a power source.

Install the UPC with 2 nuts attaching the UPC front panel to the SCU front panel (Figure 3.5).

Install LED PCB with 4 nuts, attaching the LED PCB to the SCU front panel.

3.5 INSTALL CABLING AND COVER

NOTE: Most users will not need to concern themselves with the following installation issue if the UPC is packaged with a power source.

- Connect J2A of the UPC to P2A of the SCU.
- Connect J3A of the UPC to P3A the LED PCB.
- Connect J3B of the SCU to P3B of the LED PCB.
- Attach J4 from the UPC to the rear panel of the SCU.
- Attach J5 from the UPC to the rear panel of the SCU.
- Connect J6A of the SCU to P6A of the UPC PCB.
- Place the top cover on top and install six screws.

3.6 CONNECT INPUT SERVICE

Verify the Input Power Circuit Breaker on the front panel is off. Connect the Input Line Cord to the back of the SCU chassis. Verify the 115/230 volt switch on the rear panel is set to the correct position. Input frequency may be 50 - 400 Hz.

Turn the Input Circuit Breaker ON. Refer to section 4.0 to verify proper operation.

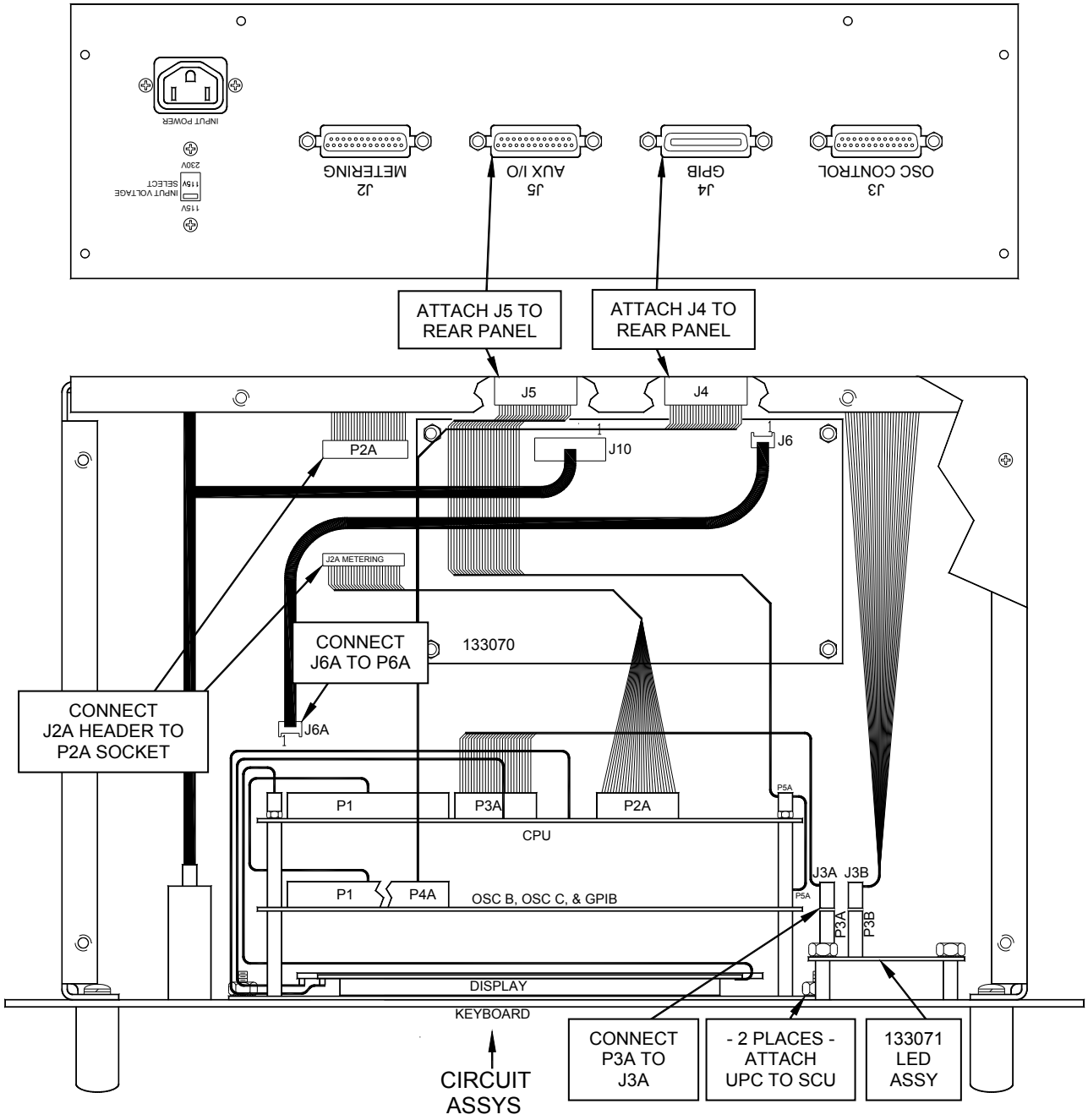


FIGURE 3.5 INSTALLATION

3.7 CONFIGURE UPC

The UPC TRANSFORMER RATIO and AMPS TO VOLTS RATIO must be configured to operate with the Power Source. Setting the GPIB device address or SERIAL Interface parameters is optional depending on whether the user intends to use the REMOTE interface.

3.7.1 CONFIGURE TRANSFORMER RATIO

NOTE: Most users will not need to concern themselves with the unit configuration as it is set at the factory if the UPC is packaged with a power source.

Set the TRANSFORMER RATIO of the UPC to be the same as the turns ratio of the Output XFMR in the Power Source. Refer to the Power Source Manual to determine the TRANSFORMER RATIO of the Power Source. The TRANSFORMER RATIO value is set in the UPC STATUS display.

Press key sequence: **fn, 3, 3, EDIT, ENTER, EDIT**, type the correct ratio, then press **STORE** (4.6.3.3).

NOTE: TRANSFORMER RATIOs are implied as a ratio to one, e.g., a setting of 2.5 is implied as a ratio of 2.5:1.

NOTE: A TRANSFORMER RATIO value of 0 indicates that no transformer is installed

3.7.2 CONFIGURE AMPS TO VOLTS RATIO

NOTE: Most users will not need to concern themselves with the following configuration issue as it is set at the factory if the UPC is packaged with a power source.

The ammeter scale is selected by the AMPS TO VOLTS RATIO value, multiplied by a factor of 10. The AMPS TO VOLTS RATIO scales the voltage fed into the ammeter circuit input to represent a given amount of current. For example, if 5 is selected then the amps to volts ratio is:

5 A (load current) = 1 V (input to ammeter circuit) = 5 A displayed.

In this case, the ammeter range is 50 A (5 x 10).

Set the AMPS TO VOLTS RATIO of the UPC to match the Power Source. Refer to the Power Source Manual to determine the AMPS TO VOLTS RATIO of the Power Source model. The ratio is set by the AMPS TO VOLTS RATIO value set in the UPC STATUS display.

Press key sequence: **fn, 3, 3, EDIT, ENTER, EDIT**, press ENTER to move the cursor to the AMPS TO VOLTS RATIO data position, type the correct ratio, then press **STORE** (4.6.3.3).

3.7.3 CONFIGURE PRI/SEC CURRENT SENSE LOCATION

NOTE: Most users will not need to concern themselves with the following configuration issue as it is set at the factory if the UPC is packaged with a power source.

If the power source does not have output transformers installed, this should be set as PRI. If the power source has output transformers, then the curent transformers that meter output current mmay be installed on the PRImary or SECondary of the output transformers. Select the appropriate location so the UPC can determine whether to display the metered current directly (SEC) or apply the transformer ratio to the current term (PRI).

3.7.4 CONFIGURE SERIAL PORT SETTINGS

After installing the UPC (or after erasing all program memory or after system RESET), the serial communication parameters must be set (BAUD RATE, PARITY and EOS Terminator) as follows:

1. Press the ***fn*** key, select **GENERAL SETUP** then **UPC STATUS**.
2. Press the **EDIT** key and enter the desired **BAUD RATE** numerically, selected from the list above. Then press **ENTER**.
3. Select the **PARITY** by pressing the **+/-** key until the desired selection (NONE, ODD or EVEN) is shown. Then press **ENTER**.
4. Select **EOS** (End Of String) Terminator by pressing the **+/-** key until the desired selection (CR/LF, LF or CR) is shown. Then press **ENTER**.
5. Press **STORE**.

NOTE: Incorrect communication parameters may result in the UPC displaying a:
PARITY ERROR,
FRAMING ERROR, and/or
OVERRUN ERROR.

Sending a BREAK signal will result in a BREAK RCVD message and will terminate data transmission in progress from the UPC.

See (10.0) for more detail.

3.7.5 CONFIGURE GPIB DEVICE ADDRESS (option)

Set the GPIB DEVICE ADDRESS as desired. The GPIB device address is set via the UPC STATUS display screen. Default address is 1. See (4.6.3.3) for configuration.

Press key sequence: **fn, 3, 3, EDIT,** press ENTER to move the cursor to the GPIB ADDRESS data position, type the correct value, then press **STORE** (4.6.3.3).

NOTE: IEEE-488 type cables with 90º "cable to connector" bends may interfere with other interface connectors on the SCU and some power source model's rear panels. It is recommended that a straight "cable to connector" IEEE-488 cable be used (e.g. NATIONAL INSTRUMENTS type X5) or a 90º adapter be used to provide needed clearance.

SECTION 4

FRONT PANEL OPERATION

4 FRONT PANEL OPERATION

This section describes the front panel operation of an UPC Controller installed a power source. The UPC controllers are used with Pacific Power Source, Inc's AMX, ASX, G, and MS series equipment.

The UPC Controller allows the user to control all output parameters of the power source via the front panel keyboard as well as through the REMOTE interface (see (5.0) for REMOTE operation).

4.1 GUIDE TO OPERATION

These instructions will:

1. present an **OVERVIEW** of UPC operation (4.1.1),
2. help in basic operation, without having to master all of its complexities (4.1.2).

4.1.1 OVERVIEW

The information contained in this section is necessary for use of the UPC controller. In addition to quick usage, this section describes basic operational characteristics that are essential when studying UPC operation in depth.

The UPC is operable either from its front panel keyboard (LOCAL CONTROL operation) or by its Data Bus (REMOTE CONTROL operation, Serial or IEEE-488/GPIB). A host computer can force REMOTE CONTROL when the UPC is displaying a Metering display. LOCAL CONTROL can be resumed either by a bus command (GoTo Local) or by manually pressing the **LOCAL** key. The host computer can force retention of REMOTE CONTROL by issuing a lockout command (Local LockOut (LLO), (5.6.1)), thereby preventing manual override.

When using the UPC controller, it is useful to think of it as being in one of 4 operating "modes" when in LOCAL CONTROL.

1. MANUAL OPERATE
2. PROGRAM OPERATE
3. PROGRAM EDIT
4. SETUP

MANUAL MODE is control of the operating characteristics via the front panel keyboard. Voltage and Frequency parameters are manually set from the front panel. Volts and Frequency may be directly entered through the numeric keyboard or they may be smoothly varied by use of the "slew" controls (up and down arrows). The V/I METER display (default display) shows both command values and metered values. Stored transients may not be executed in the MANUAL MODE.

The UPC-3M and UPC-1M manual version controllers operate ONLY in the MANUAL MODE.

4.1.1 OVERVIEW (continued)

The PROGRAM OPERATE mode attempts to simplify certain test operations by allowing the operator to execute pre-stored programs (combinations of Volts, Frequency, Output Coupling, Transformer tap selection if any, Phase angle, Waveform, and Current limit. A stored program can be executed simply by pressing **PROGRAM**, entering a program number, then **EXECUTE**. Up to 99 programs can be stored - with or without associated transients, as desired. After a program is called up by number, **EXECUTE** causes the base - or static - portion of the program to be executed. These base parameters are commonly referred to as "Steady-state" parameters. Execution of the transient portion of the stored program is separately controlled by the **TRANS** key.

The PROGRAM EDIT mode allows the operator to create new programs, or change existing programs. It is noteworthy that programs other than any program actively executing, can be edited without disrupting power source output. For example, if program 15 is executing, program 23 can be edited without interrupting execution of program 15.

The SETUP MODE is used to make changes in system configuration. Examples are:

- Copy and Delete Programs
- Copy, Edit, and Create Waveforms
- Set Min. and Max. Voltage Limits
- Set Min. and Max. Frequency Limits
- Engage and Disengage CSC (Continuous Self Calibration)
- Set the Metering Sense Point – Internal or External
- Set Slew rates
- Set Transition Time
- Set Transformer Ratio
- Change Frequency Span
- Enable keyboard lockout
- Set initial power on output voltage
- Monitor UPC and Power Source status
- View Firmware Version
- Enable Calibration Mode for Output and Metering
- Set Serial Interface Parameters or GPIB Device Address
- Erase Memory
- Set Amps-to-Volts Current Metering Ratio
- Define Current Transformer Location
- Set Output Range - for power sources that support it
- Define the Number of Power Source Amplifiers
- Synthesize Waveforms from Harmonic values (Option)
- Enable and calibrate Programmable Output Impedance (Option)
- Set Programmable Output Impedance value (Option)

4.1.1 OVERVIEW (continued)

SELECTING OPERATING MODES

On first turn-on the system will operate using a set of default parameters stored in memory. The display will be the V/I METER display. This is the default - and most frequently used - display. It shows all basic operating parameters, and in the lower left portion shows the operating mode. All operating modes can be accessed from the V/I METER display. If the V/I METER display is not active, pressing **CLEAR** a few times will always return to the V/I METER display.

MANUAL OPERATION (4.3) - is available by pressing **Va, Vb, Vc** or **F** for voltage or frequency adjustments. An LED will light above a pressed key to indicate an active selection. The selected parameter can then be changed by typing a new value and pressing **EXECUTE** or holding one of the SLEW keys (⌃ or ⌄).

PROGRAM OPERATION (4.4) -requires pressing **PROGRAM,** select a program number (1-99) and press **ENTER** to display the values stored in that program. Pressing **EXECUTE** will then cause the UPC to use those values. If a transient as been stored in the active program, pressing **TRANS** will activate the transient.

PROGRAM EDIT (4.5) – is accessed by pressing **PROGRAM,** select a program number (1-99) and press **ENTER** to display the values stored in that program. Press **EDIT** to allow changes to the values stored in that program, **ENTER** to move the cursor through the screen, and **STORE** to save the values.

SETUP MODE (4.6) Pressing the ***fn*** key presents the menu list of SETUP features. It is used to copy and delete programs, erase memory, copy and edit waveforms, set meter sense points, toggle CSC on or off, set Programmable Output Impedance (option), set Output range (for power sources that support it), transition time, min and max frequency, min and max voltage. Calibration for metering may also be performed. Status is given for system information such as firmware version, GPIB device address or Serial Interface parameters, transformer ratio, amps to volts ratio, number of Power Source amplifiers and current transformer location

NOTE: The five keys in the lower right portion of the keyboard (highlighted with a different color) are executive keys. Every attempt has been made to ensure that:

- In order to change power applied to the load one of these keys must be pressed.
- Whenever one of these keys is pressed, power to the load may be changed.

This operational feature has been designed to help keep the user from accidentally pressing the wrong key and unintentionally changing power to the load.

Remember! When you press a BLACK key something will probably happen to change output power.

4.1.2 BASIC OPERATION

The following steps provide a quick method (using MANUAL MODE) for setting Voltage and Frequency and applying power to a load. To set other parameters, such as phase angle, waveform, current limit, power form and output coupling mode (transformer or direct), use the PROGRAM EDIT MODE. It also allows you to setup transient events. Programming and executing a stored program is described in (4.5) and (4.4) respectively. For a list of individual functions, see the **HOW TO** reference in the beginning of this manual.

QUICK MANUAL MODE OPERATION

NOTE: OBSERVE ALL SAFETY WARNINGS AND CAUTIONS LISTED AT THE START OF THIS MANUAL !!!

1. **DO NOT CONNECT A LOAD** to the power source until you are satisfied that the power source output is appropriate for the load.

2. Be certain that the **OUTPUT POWER SWITCH** is **OFF**. Then apply input power to the UPC or power source using its INPUT POWER SWITCH. Allow a few seconds for the UPC to initialize. It will beep twice when it is ready.

3. The V/I METER will appear. This is the default display. It shows metered Volts and Amps (AC RMS). It also shows the Voltage and Frequency entries in the upper right corner of the display as the user is entering or changing them.

4. TO CHANGE VOLTAGE - Light the **Va**, **Vb** and/or **Vc** LEDs by pressing the keys below them. Now perform one of the following steps:
   A. Enter a numeric value on the keypad and press **EXECUTE**. - or -
   B. Press the UP or DOWN arrows (⌃ or ⌄) to 'slew' the voltage.
   The phases that are indicated by the V LEDs will be changed to the voltage selected.

5. TO CHANGE FREQUENCY - Light the **F** LED by pressing the F key. Now perform one of the following steps:
   A. Enter a numeric value on the keypad and press **EXECUTE** - or-
   B. Press the UP or DOWN arrows to 'slew' the frequency.

NOTE: You cannot change Voltage and Frequency simultaneously using MANUAL MODE.

6. TO CLOSE THE OUTPUT RELAY - First switch the **OUTPUT POWER SWITCH** on the power source front panel to ON/AUTO. Then press the **OUTPUT ENABLE** key on the UPC keyboard. Verify the power source output (rear panel output terminals) is generating the desired voltage, frequency and phase angle using an oscilloscope and/or meters.

7. TO APPLY POWER TO THE LOAD, first **TURN OFF the INPUT POWER** switch, **TURN OFF the OUTPUT POWER** switch. Connect the load to the rear panel output terminals. Switch ON the INPUT POWER switch, switch ON the OUTPUT POWER switch. Then press the **OUTPUT ENABLE** key on the UPC controller. Power is now being applied to the load.

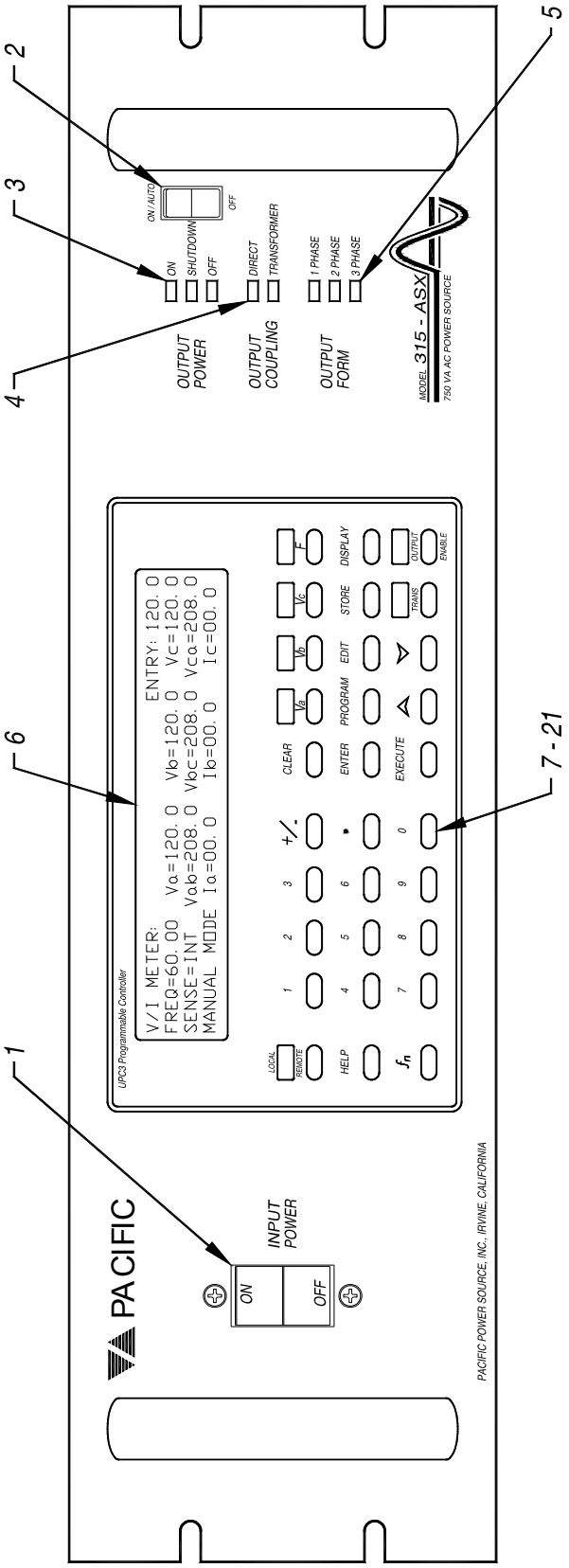


FIGURE 4.1 POWER SOURCE FRONT PANEL

4.2 FRONT PANEL CONTROLS AND INDICATORS

This section shows the locations and defines the functions of the front panel controls and indicators of the UPC as installed in an AMX/ASX Series power source. Operation of an UPC installed in an SCU is identical except the SCU has no Output Power Switch (Figure 4.1).

4.2.1 POWER SOURCE FRONT PANEL

1)	**INPUT POWER** (Circuit Breaker)	Used as the main input power ON/OFF control and protects the power source from drawing excessive input current from the input A.C. line.
2)	**OUTPUT POWER** (Rocker Switch) (ASX and AMX series only)	Controls the Output Relay between the power source and the load and provides a means of manually disconnecting output power. This switch must be in ON/AUTO to allow the UPC to control the Output Relay. In the OFF position the UPC cannot close the Output Relay.
3)	**OUTPUT POWER** (LEDs)	ON is illuminated when the Output Relay is closed. OFF when the Output Relay is open. SHUTDOWN indicates the Power Source is in an error condition.
4)	**OUTPUT COUPLING** (LEDs)	DIRECT is illuminated when the Power Amplifier is directly connected to the Output Relay. TRANSFORMER is illuminated when the Power Amplifier is connected to Transformers and the Transformers are connected to the Output Relay.
5)	**OUTPUT FORM** (LEDs)	1 PHASE (1Φ) is illuminated when the Power Source is connected to the 1Φ Output Relay. Only the 1Φ Output Terminal will become active. 2 PHASE (2Φ) is illuminated when the Power Source is connected to the 3Φ Output Relay. Only ΦA and ΦB Output Terminals will become active. 3 PHASE (3Φ) is illuminated when the Power Source is connected to the 3Φ Output Relay. ΦA, ΦB and ΦC Output Terminals will become active.

4.2.2 UPC FRONT PANEL

6)	**LIQUID CRYSTAL DISPLAY** (LCD)	Gives pertinent information to the user relating to front panel operation.
7)	**LOCAL / REMOTE** (KEY and LED)	When the REMOTE INTERFACE is in control of the UPC and has not issued a local lockout command, this key will return control to the keyboard. The LOCAL LED is lit when in LOCAL CONTROL. The REMOTE LED is lit when in REMOTE CONTROL.
8)	**HELP** (KEY)	From any METER display, this key provides help on how to operate the UPC.
9)	**fn** (KEY)	Function Key - When pressed from any meter display causes the UPC to enter SETUP MODE.
10)	**NUMERIC KEYPAD**	Is used to enter numeric values. The +/- key toggles the sign of a numeric entry or toggles other two state parameters.
11)	**CLEAR** (KEY)	The first key press shall clear an entry and allow new values to be entered. The second key press shall backup the cursor one field. If several key presses backup to the first field in a display, the next key press shall abort edit functions and return to the V/I METER display.
12)	**Va, Vb, Vc and F** (KEYs and LEDs)	From the V/I METER display, pressing any of these keys causes MANUAL MODE to be active. When an LED is lit, this parameter is selected. From the V/I METER display, if the Va, Vb or Vc key is pressed that LED toggles on or off and forces the F LED off. From the V/I METER display, if the F key is pressed that LED toggles on or off and forces Va, Vb and Vc LEDS off. When in the V/I METER display and any of the Va, Vb, Vc or F LED(s) are lit, pressing an ARROW key (⌃ or ⌄) causes selected parameters to slew. When in the V/I METER display and any of the Va, Vb, Vc or F LED(s) are lit; entering a number then pressing EXECUTE causes selected parameters to change to new values.

4.2.2 UPC FRONT PANEL (continued)

13)	**ENTER** (KEY)	Is used to enter numeric values then move the cursor to the next data field.
14)	**PROGRAM** (KEY)	When pressed from any meter display causes PROGRAM OPERATE MODE to be active.
15)	**EDIT** (KEY)	When pressed from the PROGRAM display causes PROGRAM EDIT MODE to be active. Pressing the **EDIT** key again causes the TRANSIENT display to be active.
16)	**STORE** (KEY)	After editing, the **STORE** key is used to save new values.
17)	**DISPLAY** (KEY)	Is used to cycle through the meter displays. If a display other than a meter display is active it will abort edit functions and return to the V/I METER display.
18)	**EXECUTE** (KEY)	In MANUAL MODE, causes the output to change to new values. In PROGRAM OPERATE MODE, causes a new program to be executed. In PROGRAM EDIT MODE and in the PROGRAM display, causes the program to be saved and executed. In SETUP MODE is used to change the setup of the UPC.
19)	**ARROW** (^ or v) KEYS	When in MANUAL MODE, pressing an ARROW key causes the selected parameters to slew up or down.
20)	**TRANS** (KEY)	When in PROGRAM OPERATE MODE and a transient is stored, pressing this key causes the transient to start or stop. When the LED is lit this indicates a transient is in progress.
21)	**OUTPUT ENABLE** (KEY)	Causes the output relay ENABLE to toggle on and off. When the LED is lit this indicates output enable is active. Activating output power of an AMX or ASX power source also requires that the Output Power switch on the front panel be in the ON/AUTO position.

4.3 MANUAL MODE

This section describes operation in Manual Mode. In this mode you may slew or directly enter voltage or frequency values. Parameters other than volts and frequency can only be changed by editing and executing a steady-state Program.

The V/I METER display will indicate MANUAL MODE in the lower left corner of the display.

4.3.1 METERING DISPLAYS

There are three primary metering displays plus a set of optional Harmonic Analysis displays. Pressing the DISPLAY key will cycle through the metering displays. If a display other than a metering display is active, pressing the DISPLAY key will abort common edit functions and return to a metering display.

The V/I METER display indicates FREQuency, metering SENSE point (INTernal or EXTernal) and MANUAL MODE or PROGRAM # executing. This display meters true RMS Voltage (line to neutral and line to line) and true RMS current.

```
V/I METER:                    ENTRY: 120.0
FREQ=60.00  Va=120.0  Vb=120.0  Vc=120.0
SENSE=INT   Vab=208.0 Vbc=208.0 Vca=208.0
MANUAL MODE Ia=00.00  Ib=00.00  Ic=00.00
```

The POWER METER display meters kVA, true kW and PF.

```
POWER METER: PHASE A   PHASE B   PHASE C
KVA            0.000     0.000     0.000
KW             0.000     0.000     0.000
PF             1.000     1.000     1.000
```

The AMPS METER display meters RMS amps, PEAK amps and CREST FACTOR.

```
AMPS METER: PHASE A   PHASE B   PHASE C
RMS            0.00      0.00      0.00
PEAK           0.00      0.00      0.00
CREST FACTOR   1.00      1.00      1.00
```

4.3.1 METERING DISPLAYS (continued)

4.3.1.1 WAVEFORM ANALYSIS (OPTION- Harmonic Analysis and Synthesis)

Waveform analysis functions are optionally available to report both magnitude and phase angle (relative to 0º of the fundamental voltage waveform) of each harmonic for metered voltage and current waveforms. THD, ODD and EVEN harmonic distortion measurement data can also be displayed

The harmonic content is displayed from the 2nd up to the 51st harmonic, depending on the number of samples analyzed. Content can be displayed as percent or absolute, see the **EDIT** key function described below.

Pressing the **DISPLAY** key repeatedly will display the following screen.

```
HARMONIC ANALYSIS:
"ENTER" UPDATE & DISPLAY HARMONIC DATA
"EDIT" HARMONIC ANALYSIS SETUP SCREEN
"HELP" HARMONIC ANALYSIS HOTKEY LIST
```

Pressing the **DISPLAY** key repeatedly at this point will display the HARMONIC DATA in memory with screens similar to the following.

```
ΦA VOLTAGE  THD=0.1 % OHD=0% EHD=0.1%
HARMONIC: FUND   2nd    3rd     4th
CONTENT:  100%   0.17   0.09    0.03
ΦANGLE:    0º     49º    14º     315º
```

THD is TOTAL HARMONIC DISTORTION for all harmonics of the selected parameter and phase.
OHD is ODD HARMONIC DISTORTION for all harmonics of the selected parameter and phase.
EHD is EVEN HARMONIC DISTORTION for all harmonics of the selected parameter and phase.
CONTENT is displayed as a percent of the amplitude of the fundamental or as absolute magnitude
Φ**ANGLE** is displayed in the range of 0º to 359º.

The **Va**, **Vb** and **Vc** keys will light the Phase LED to select which phase is to be updated or displayed. Only one phase can be analyzed at a time. Pressing the **+/-** key will toggle between current and voltage parameters. Pressing the HELP key displays the hotkey list.

The **CLEAR** key will return the display back to the V/I meter.

The **ENTER** key begins the analysis function. The UPC will measure the selected signal, and calculate and update the harmonic data in memory. This may take some time, depending on the number of samples analyzed (see the **EDIT** key function below). A beep is heard when the update is complete. Only the parameter and phase selected as above is updated. Other parameters are retained. All parameters are then retained until power-off or the memory is cleared.

4.3.1.1 WAVEFORM ANALYSIS (continued)
(OPTION- Harmonic Analysis and Synthesis)

The default harmonic content is displayed based upon the percentage of the fundamental. The **EDIT** key displays a setup screen that allows selection of the harmonic content display as absolute value, rather than percentage as shown below:

```
        HARMONIC ANALYSIS SETUP
CHANNEL: CURRENT (USE +/- TO TOGGLE)
CONTENT DISPLAYED AS: ABSOLUTE VALUE
SAMPLES TO ANALYZE: 512  (SEE Fn 3,2)
```

Use the +/- key to select the setup preferences.

The Number of Samples Analyzed is the same as the Metering Samples Per Cycle and can be changed in the Frequency Span setup screen (2.1.1, 4.6.3.2, and 5.4.1). The value of Number of Samples to Analyze will be as listed below. The accuracy of the harmonic calculations improves as the Number of Samples increases. There is a small increase in the calculation time.

Frequency Span (Hz.)	Number of Samples	number of harmonics displayed	Time of calculation (approx.)
15 – 150	512	51	3 sec.
15 – 300	256	51	2 sec.
15 – 600	128	51	1 sec.
15 – 1200	64	32	0.7 sec.

Press **DISPLAY** to return to the harmonic data screen.

Press **EXECUTE** to process new harmonic analysis data

The LCD will always display 51 harmonic positions. The full harmonic data set is also available through the communication port. See (5.5.2), Metered Data Queries, :MEASure:SPECTrum:VOLT1[:MAGnitude] and :MEASure:SPECTrum:PHASe.

4.3.2 VOLTAGE ENTRY

In MANUAL MODE, to change voltage from any meter display, light the Va, Vb, Vc LEDs by pressing those keys. Any single key, or combination of keys may be activated.

Pressing an ARROW key (⌃ or ⌄) causes selected voltages to slew up or down. Entering a number then pressing **EXECUTE** causes selected voltages to change to the new value. The upper right corner of the display shows the most recently entered voltage.

For example: To change to 125 volts, light Va, Vb and Vc LEDs as desired by pressing the keys. Type **125** and press **EXECUTE**. The Power Source should now be generating 125 volts.

```
V/I METER:                  ENTRY: 125.0
FREQ=60.00  Va=125.0  Vb=125.0  Vc=125.0
SENSE=INT   Vab=216.5 Vbc=216.5 Vca=216.5
MANUAL MODE Ia=00.0   Ib=00.0   Ic=00.0
```

4.3.3 FREQUENCY CONTROL

In MANUAL MODE, to change frequency from any meter display, light the F LED by pressing that key.

Pressing an ARROW key (⌃ or ⌄) causes the frequency to slew up or down. Entering a number then pressing **EXECUTE** causes the frequency to change to the new value. The upper right corner of the display shows the most recently entered frequency.

For example to change to 60.50 Hz. light the F LED: enter **60.50** and press **EXECUTE**. The Power Source should now be generating 60.50 Hz.

```
V/I METER:                  ENTRY: 60.50
FREQ=60.50  Va=120.0  Vb=120.0  Vc=120.0
SENSE=INT   Vab=208.0 Vbc=208.0 Vca=208.0
MANUAL MODE Ia=00.0   Ib=00.0   Ic=00.0
```

4.4 PROGRAM OPERATE MODE

Program Operate Mode allows pre-stored program execution including transients.

Not all of the Program Operate features are available with the UPC-3M and UPC-1M manual versions of the controller. Manual controllers allow editing of VOLTAGE, FREQUENCY, FORM and COUPLING only.

When the V/I METER display is active the lower left corner will indicate the number of the PROGRAM currently being executed.

4.4.1 PROGRAM EXECUTION

To achieve Program Operate Mode, from any meter display press the **PROGRAM** key. This will cause the PROGRAM display to become active. The last or currently executing program will be displayed. You may enter a new program number then press **ENTER** to view it.

```
PROGRAM: #1  FORM=3 COUPLING=DIRECT
FREQ=60     Va=120     Vb=120     Vc=120
            WFa=1      WFb=1      WFc=1
#SEGS=0     Ilim=50    PHb=120º   PHc=240º
```

Pressing **EXECUTE** now will cause that program to be executed and the V/I METER display to be active.

```
V/I METER:
FREQ=60.00  Va=120.0  Vb=120.0  Vc=120.0
SENSE=INT   Vab=208.0 Vbc=208.0 Vca=208.0
PROGRAM #1  Ia=00.0   Ib=00.0   Ic=00.0
```

4.4.2 TRANSIENT EXECUTION

The UPC must be in Program Operate Mode to execute a transient and the executing program must have a transient stored, this is indicated by #SEGS=1 (or more), in the lower left hand corner of PROGRAM display. From any metering display, pressing the **TRANS** key will start a transient at positive zero crossing of phase A. Pressing the **TRANS** key again will initiate a new transient instance, or stop the transient if still active.

General steps to create a new transient program are as follows.

1. **Create or edit a program** using the method described in (4.5.1). Executing the program at this point is optional.

2. **Create or edit the transient** portion of the program using the method described in (4.5.2).

3. **Execute the program** as described in (4.4.1).

4. **Execute the transient** by pressing the TRANS key. Pressing the **TRANS** key again will stop the transient if still active.

4.4.2 TRANSIENT EXECUTION (continued)

The basic process of creating a transient program is as follows.

1. From the V/I meter, press **PROGRAM**, enter the program number, press **ENTER**.
2. Press **EDIT**. Change steady-state values if desired, pressing **ENTER** after each entry.
3. Press **EDIT** again. Change transient segment values if desired, pressing **ENTER** after each entry. Setting T to 0 in the first segment makes the transient a cycle based transient. Continue pressing **ENTER** to create new segments.
4. Press **STORE**. Enter the number of desired events then **STORE** again.
5. Execute the program's steady-state values by pressing **PROGRAM, EXECUTE**.
6. Execute the program's transient values by pressing **TRANS**. Pressing the **TRANS** key again will stop the transient if still active.

4.4.2.1 MIL-STD-704D TRANSIENT PROGRAMS

The UPC is capable of producing the Voltage and Frequency excursions required by MIL-STD-704D.

Programs 100-103 are permanent, pre-stored, non-executable transient programs. These permanent programs may be copied to any of programs 1 - 99 for execution. To copy programs see (4.6.1.1).

Program 100 is a MIL-STD-704D over voltage transient.

Program 101 is a MIL-STD-704D under voltage transient.

Program 102 is a MIL-STD-704D over-frequency transient.

Program 103 is a MIL-STD-704D under-frequency transient.

The four voltage and frequency programs are for equipment which is nominally powered by 115/200 volts and a nominal Frequency of 400 Hz. Transient program data is stated for over/under voltage and over/ under frequency tests as specified by paragraph 5.2.3 of MIL-STD-704D is provided in the following paragraphs.

The data presented in this section is based on MIL-STD-704D dated 30 SEP 1980.

NOTE: All four transients described are single event, 3 phase transients.

4.4.2.1 MIL-STD-704D TRANSIENT PROGRAMS (continued)

OVER-VOLTAGE TRANSIENT (Program #100)

The power source will produce the over-voltage transient excursion as defined by MIL-STD-704D (Paragraph 5.2.3.2.1). The power source **must** be configured for a voltage range of at least 180Vrms to perform this test.

INITIAL CONDITIONS:

f_o = 400 Hz. (Nominal Steady-State Value)
V_a, V_b, V_c = 124 VAC (High-Line Steady-State Limit)
WFa=1, WFb=1, WFc=1
XFMR COUPLED, XFMR RATIO=1.5 (or higher)

TRANSIENT COMMAND SEQUENCE:

Segment 1:
F=400 Hz. Va=180, Vb=180, Vc=180, T=0.0002
Segment 2:
F=400, Va=180, Vb=180, Vc=180, T=0.01
Segment 3:
F=400, Va=124, Vb=124, Vc=124, T=0.07

UNDER-VOLTAGE TRANSIENT (Program #101)

The power source will produce the under-voltage transient excursion as defined by MIL-STD-704D (Paragraph 5.2.3.2.1). The power source **must** be configured for a voltage range of at least 108Vrms to perform this test.

INITIAL CONDITIONS:

f_o = 400 Hz. (Nominal Steady-State Value)
V_a, V_b, V_c = 108 VAC (Low-Line Steady-State Limit)
WFa=1, WFb=1, WFc=1
DIRECT COUPLED

TRANSIENT COMMAND SEQUENCE:

Segment 1:
F=400 Hz. Va=80, Vb=80, Vc=80, T=0.0002
Segment 2:
F=400, Va=80, Vb=80, Vc=80, T=0.01
Segment 3:
F=400, Va=108, Vb=108, Vc=108, T=0.07

NOTE: The above transient commands are stated for the transient voltage excursion to occur on all phases, simultaneously. MIL-STD-704D allows for the transient to occur on a single phase or on any combination of phases. To exclude a phase from the transient excursion, simply change the appropriate Va, Vb or Vc field in Segment 1 and 2 to remain the same as the steady-state value.

4.4.2.1 MIL-STD-704D TRANSIENT PROGRAMS (continued)

OVER-FREQUENCY TRANSIENT (Program #102)

The power source will produce the over-frequency transient excursion as defined by MIL-STD-704D (Paragraph 5.2.3.2.1). The power source **must** be configured for a voltage range of at least 115Vrms to perform this test.

INITIAL CONDITIONS:

f_o = 407 Hz. (Maximum Steady-State Limit)
V_a, V_b, V_c = 115 VAC . (Nominal Steady-State Value)
WFa=1, WFb=1, WFc=1
DIRECT COUPLED

TRANSIENT COMMAND SEQUENCE:

Segment 1:
F=425 Hz. Va=115, Vb=115, Vc=115, T=0.0002
Segment 2:
F=425, Va=115, Vb=115, Vc=115, T=1
Segment 3:
F=420, Va=115, Vb=115, Vc=115, T=0.0002
Segment 4:
F=420, Va=115, Vb=115, Vc=115, T=4
Segment 5:
F=410, Va=115, Vb=115, Vc=115, T=0.0002
Segment 6:
F=410, Va=115, Vb=115, Vc=115, T=5

4.4.2.1 MIL-STD-704D TRANSIENT PROGRAMS (continued)

UNDER-FREQUENCY TRANSIENT (Program #103)

The power source will produce the under-frequency transient excursion as defined by MIL-STD-704D (Paragraph 5.2.3.2.1). The power source **must** be configured for a voltage range of at least 115Vrms to perform this test.

INITIAL CONDITIONS:

f_o = 393 Hz. (Minimum Steady-State Limit)
V_a, V_b, V_c = 115 VAC (Nominal Steady-State Value)
WFa=1, WFb=1, WFc=1
DIRECT COUPLED

TRANSIENT COMMAND SEQUENCE:

Segment 1:
F=375 Hz. Va=115, Vb=115, Vc=115, T=0.0002
Segment 2:
F=375, Va=115, Vb=115, Vc=115, T=1
Segment 3:
F=380, Va=115, Vb=115, Vc=115, T=0.0002
Segment 4:
F=380, Va=115, Vb=115, Vc=115, T=4
Segment 5:
F=390, Va=115, Vb=115, Vc=115, T=0.0002
Segment 6:
F=390, Va=115, Vb=115, Vc=115, T=5

4.5 PROGRAM EDIT MODE

The Program Edit Mode allows program and transient definition and editing.

4.5.1 PROGRAM EDITING

To achieve Program Edit Mode, from any meter display press the **PROGRAM** key, program number, **ENTER** key then **EDIT** key. The cursor will move to FORM.

```
PROGRAM: #1  FORM=3 COUPLING=DIRECT
FREQ=60   Va=120    Vb=120     Vc=120
          WFa=1     WFb=1      WFc=1
#SEGS=0   Ilim=50   PHb=120º   PHc=240º
```

The following may be programmed:

FORM: Enter 1, 2, or 3 Phase output FORM.

FORM 1 enables Single phase output and is connected to the 1 Phase Output Relay. Only the 1Φ Output Terminal will become active. 1 Phase loads must be connected between the 1Φ Terminal and the "N" (neutral) Terminal.

FORM 2 enables the high range Split/Single phase output. The Power Source output is connected to the 3 Phase Output Relay. Only ΦA and ΦB Output Terminals will become active and are 180º out of phase. Voltages are programmed phase to phase. This may be called split phase and can be loaded between the ΦA and ΦB Output Terminals or from either phase to "N" (neutral) at half voltage.

FORM 3 enables 3 phase output and the Power Source is connected to the 3 Phase Output Relay. ΦA, ΦB and ΦC Output Terminals will become active. Loads may be connected either line-to-line or line-to-neutral.

COUPLING: Select DIRECT or XFMR (transformer) coupled output by pressing the **+/-** key.

DIRECT connects the Power Amplifier directly to the Output Relay.

XFMR connects the Power Amplifier to the Output Transformers and the Transformers are then connected to the Output Relay.

XFMR(N.NN): When COUPLING=XFMR is selected, you may enter the transformer ratio. The transformer ratio for the system (see UPC STATUS, (4.6.3.3)) must be the same as this value before the program may be executed. Ratios above 1 are step up and ratios below 1 are step down.

4.5.1 PROGRAM EDITING (continued)

FREQ: Any desired output frequency from 15.00 to 1200 Hz. may be entered. The FREQUENCY SPAN must be set for the correct range before the Program can be EXECUTED.

RANGE	RESOLUTION
15.00 - 99.99 Hz.	0.01 Hz.
100.0 - 999.9 Hz.	0.1 Hz.
1000 – 1200 Hz.	1 Hz.

Va, Vb, Vc: Line to neutral voltages are entered for 1Φ and 3Φ Forms. Line to Line voltages are entered for 2Φ operation.

Direct Coupled: 0 to 150 volts rms (Line-Neutral) in steps of 0.1 volts.
Actual maximum output voltage varies, depending on the power source model, load, and input voltage.

Transformer Coupled: 0 to 375 volts rms (TRANSFORMER RATIO= 0.1-2.5)
steps of 0.1 volts for ratios < 1.0
steps of 0.5 volts for ratios > 1.0

WFa, WFb, WFc: Select the desired output waveform. Waveform 1 is always a sine wave and is the only waveform available with the UPC-3M and UPC-1M manual version controllers. Waveforms 2-16 may be copied and/or edited as desired using the SETUP (**fn**) functions.

The UPC will attempt to generate the selected waveform at the rms voltage programmed. Because of the Crest Factor (Vpeak/Vrms) of various waveforms the UPC may not be able to reproduce the waveform at the voltage desired. If the waveform is peak-voltage-limiting, then selecting transformer coupled output with a higher ratio may solve this problem.

#SEGS: Not Editable. Reports Number of Transient Segments defined in this Program (4.5.2).

Ilim: Programmable current limit can be set as desired. The range will change depending upon which Power Source the UPC is controlling. One value is used for all three phases. This function is average responding, RMS programmed. Programmable current limit is not available with the UPC-3M and UPC-1M.

PHb, PHc: Phase angle can be set from 0-359º for Phase B and Phase C, referenced to Phase A. Phase A is always at 0º. The phase angles of the UPC-3M and UPC-1M are fixed at 120ºfor phase B and 240º for phase C.

Pressing **STORE** at any time during editing will cause the program to be stored. The V/I METER display will become active.

Pressing **EXECUTE** at any time during editing will cause the program to be stored and executed. The V/I METER display will become active.

Pressing **EDIT** again while in the Program Edit Mode will allow transients to be created and edited. The TRANSIENT edit display will become active (4.5.2).

4.5.1.1 PROGRAM EXAMPLE

The following is an example of how to create and execute a 3 phase, 108/187 volt, 400 Hz. program. From any metering display press the **PROGRAM** key.

```
PROGRAM: #1  FORM=3 COUPLING=DIRECT
FREQ=60     Va=120     Vb=120     Vc=120
            WFa=1      WFb=1      WFc=1
#SEGS=0     Ilim=50    PHb=120º   PHc=240º
```

Press **4, ENTER, EDIT,** to edit program #4.

```
PROGRAM: #4  FORM=3 COUPLING=DIRECT
FREQ=60     Va=120     Vb=120     Vc=120
            WFa=1      WFb=1      WFc=1
#SEGS=0     Ilim=50    PHb=120º   PHc=240º
```

Press **3, ENTER,** to select 3 phase form.

```
PROGRAM: #4  FORM=3 COUPLING=DIRECT
FREQ=60     Va=120     Vb=120     Vc=120
            WFa=1      WFb=1      WFc=1
#SEGS=0     Ilim=50    PHb=120º   PHc=240º
```

Press **ENTER,** to select DIRECT coupling. If XFMR is shown press **+/-,** then **ENTER**.

```
PROGRAM: #4  FORM=3 COUPLING=DIRECT
FREQ=60     Va=120     Vb=120     Vc=120
            WFa=1      WFb=1      WFc=1
#SEGS=0     Ilim=50    PHb=120º   PHc=240º
```

Press **400, ENTER,** to select 400 Hz.

```
PROGRAM: #4  FORM=3 COUPLING=DIRECT
FREQ=400    Va=120     Vb=120     Vc=120
WFa=1       WFb=1      WFc=1
#SEGS=0     Ilim=50    PHb=120º   PHc=240º
```

4.5.1.1 PROGRAM EXAMPLE (continued)

Press **108, ENTER, 108, ENTER, 108, ENTER,** to select 108 volts line to neutral on all three phases.

```
PROGRAM: #4  FORM=3 COUPLING=DIRECT
FREQ=400   Va=108    Vb=108     Vc=108
           WFa=1     WFb=1      WFc=1
#SEGS=0    Ilim=50   PHb=120º   PHc=240º
```

Press **1, ENTER, 1, ENTER, 1, ENTER,** to select Waveform 1 on all three phases.

```
PROGRAM: #4  FORM=3 COUPLING=DIRECT
FREQ=400   Va=108    Vb=108     Vc=108
           WFa=1     WFb=1      WFc=1
#SEGS=0    Ilim=50   PHb=120º   PHc=240º
```

Press **ENTER** to select default maximum Ilim for this Power Source.

```
PROGRAM: #4  FORM=3 COUPLING=DIRECT
FREQ=400   Va=108    Vb=108     Vc=108
           WFa=1     WFb=1      WFc=1
#SEGS=0    Ilim=50   PHb=120º   PHc=240º
```

Press **120, ENTER, 240, ENTER,** to select 120º phase shift for phase B and 240º phase shift for phase C referenced to phase A.

```
PROGRAM: #4  FORM=3 COUPLING=DIRECT
FREQ=400   Va=108    Vb=108     Vc=108
           WFa=1     WFb=1      WFc=1
#SEGS=0    Ilim=50   PHb=120º   PHc=240
```

Press **EXECUTE** to execute this new program. The V/I METER display will become active.

```
V/I METER:
FREQ=400.0  Va=108.0  Vb=108.0  Vc=108.0
SENSE=INT   Vab=187.1 Vbc=187.1 Vca=187.1
PROGRAM #4  Ia=00.0   Ib=00.0   Ic=00.0
```

4.5.2 TRANSIENT EDITING

Before beginning to create a transient, the sequence of the voltage, frequency, and waveform changes should be fully defined. The UPC allows transient events to be defined in two ways: Time-based transients and Cycle-based transients.

Transient event timing always begins at 0 degrees of ΦA (the rising 0 volt crossing), and will proceed based on defined Segments. Each Segment has 5 editable values:

a) SEGMENT # defines the order of segment execution
b) Time defines the duration of the segment
c) Voltage(s) defines the Voltage at the end of the segment
d) Frequency defines the frequency at the end of the segment
e) Waveform(s) defines the waveform used for the duration of the segment

Time-based transients use absolute time to sequence through the defined segments. Each segment has a duration, defined by **T=** <0.0002 to 300 sec>. Up to 50 segments can be defined in a transient event. The total transient duration will be the sum of the defined segment times.

Cycle-based transient segments substitute a single cycle of a specified waveform. Up to 50 segments can be defined in a transient event. Each segment may use any waveform. The transient duration is counted in number of cycles and is therefore dependent on frequency. Custom waveforms can be created (4.6.2) or the existing waveform table (2.1.4) may be used.

Transient sequences can be repeated, from single events to endless looping terminated by the operator. The UPC can store up to 500 transient segments, total. It is not possible to have 99 Programs with each having a 50 segment transient

Transient voltage amplitudes will be calculated based on the RMS voltage or on the amplitude of the Program that contains the transient. The calculation method is defined by the TRANSIENT WFs setting in the GENERAL SETUP tables (4.6.3.8).

RMS=ENABLED, causes the transient voltages to be calculated as true RMS.
RMS=DISABLED, causes the transient voltage amplitudes to be referenced to the Program voltage and waveform for that phase.

To start the Transient Edit Mode from any meter display, press the **PROGRAM** key, select a program number, press the **ENTER** key then **EDIT** key. The cursor will move to FORM. This example uses the program #4 information as described in the previous example.

```
PROGRAM: #4  FORM=3 COUPLING=DIRECT
FREQ=400    Va=108     Vb=108      Vc=108
            WFa=1      WFb=1       WFc=1
#SEGS=0     Ilim=50    PHb=120º    PHc=240º
```

From the PROGRAM edit display pressing **EDIT** again allows transients to be created and edited. The TRANSIENT edit display will become active.

```
TRANSIENT: PRGM #4   SEGMENT #1   OF 1
T=0.0002   Va=108    Vb=108     Vc=108
F=400      WFa=1     WFb=1      WFc=1
```

4.5.2 TRANSIENT EDITING (continued)

The following may be programmed:

SEGMENT #: Segments define each “event” of a transient. Each segment provides a linear transition in volts and/or frequency in the time indicated. Different waveforms may also be switched in during each segment.

Normally don't enter a number here. It will automatically increment as required. Up to 50 segments may be used to generate a transient. The total number of segments for all programs can not exceed 500. If you want to edit a specific segment you may enter that segment number.

In the upper right hand corner, the total number of segments is displayed. If you wish to reduce the number of segments in the transient you may enter the last segment number there, then you must press **STORE** to save the transient.

T (Segment time): Enter a time from 0.0002 to 300 seconds for a time-base transient.

If cycle-based transients are desired, entering 0 in the first segment will make the transient a cycle-based transient. The display will then show "1 CYCLE". The time for each segment will then be 1 period of the output waveform. This is useful for switching in different waveforms on a cycle by cycle basis for sub-cycle transients.

Va, Vb, Vc: Line to neutral voltages are entered for 1Φ and 3Φ Forms. Line to Line voltages are entered for 2Φ operation.

Direct-Coupled output = 0 to 150 Vrms in steps of 0.1 volts
Transformer-coupled output = 0 to 375 Vrms in steps of 0.5 volts (if XFMR Ratio is 2.5)

FREQ: Any desired output frequency from 15.00 to 1200 Hz. may be entered.

RANGE	RESOLUTION
15.00 - 99.99 Hz.	0.01 Hz.
100.0 - 999.9 Hz.	0.1 Hz.
1000 – 1200 Hz.	1 Hz.

WFa, WFb, WFc: Select the desired output waveform. Waveform 1 is always a sine wave. Waveform 2-22 may be copied and/or edited as desired using the SETUP (**fn**) functions.

Depending on the TRANSIENT WFs setting (4.6.3.9), the UPC may attempt to generate the selected waveform at the rms voltage programmed at the beginning of each segment. Because of the difference in the rms voltage content of various waveforms, the UPC may not be able to reproduce the waveform at the voltage desired. If the waveform is peak-voltage-limiting, then selecting transformer coupled output with a higher ratio may solve this problem.

TRANSIENT EVENTS: Enter the number of times you wish the transient to repeat. 0 causes the transient to repeat continuously, until the **TRANS** key is pressed again.

4.5.2.1 TIME BASED TRANSIENT EXAMPLE

The following is an example of how to create a MIL-STD-704D time based transient. (See (4.4.2) regarding pre-stored transients)

Start with the previous program #4 example as shown in (4.5.1). From any metering display press **PROGRAM, 4, ENTER, EDIT, EDIT,** and you should see the following display:

```
TRANSIENT: PRGM #4   SEGMENT #1   OF 1
T=0.0002   Va=108    Vb=108    Vc=108
F=400      WFa=1     WFb=1     WFc=1
```

Press **1, ENTER, ENTER,** to select segment 1 of 1.

```
TRANSIENT: PRGM #4   SEGMENT #1   OF 1
T=.0002    Va=108    Vb=108    Vc=108
F=400      WFa=1     WFb=1     WFc=1
```

Press **.OOO2, ENTER,** to select a time .0002 seconds. This is the smallest time allowed for a time based transient segment.

```
TRANSIENT: PRGM #4   SEGMENT #1   OF 1
T=0.0002   Va=108    Vb=108    Vc=108
F=400      WFa=1     WFb=1     WFc=1
```

Press **80, ENTER, 80, ENTER, 80, ENTER,** to select 80 volts on all three phases.

```
TRANSIENT: PRGM #4   SEGMENT #1   OF 1
T=0.0002   Va=80     Vb=80     Vc=80
F=400      WFa=1     WFb=1     WFc=1
```

Press **400, ENTER,** to select 400 Hz. output frequency.

```
TRANSIENT: PRGM #4   SEGMENT #1   OF 1
T=0.0002   Va=80     Vb=80     Vc=80
F=400      WFa=1     WFb=1     WFc=1
```

4.5.2.1 TIME BASED TRANSIENT EXAMPLE (continued)

Press **1, ENTER, 1, ENTER, 1,** to select Waveform 1 on all three phases.

```
TRANSIENT: PRGM #4   SEGMENT #1   OF 1
T=0.0002   Va=80     Vb=80     Vc=80
F=400      WFa=1     WFb=1     WFc=1
```

Press **ENTER**, now we are starting segment 2 of 2.

```
TRANSIENT: PRGM #4   SEGMENT #2   OF 2
T=0.0002   Va=108    Vb=108    Vc=108
F=400      WFa=1     WFb=1     WFc=1
```

Press **ENTER, ENTER, .01, ENTER,** to select default segment 2 of 2 and a time 10 milliseconds.

```
TRANSIENT: PRGM #4   SEGMENT #2   OF 2
T=.01      Va=108    Vb=108    Vc=108
F=400      WFa=1     WFb=1     WFc=1
```

Press **80, ENTER, 80, ENTER, 80, ENTER,** to select 80 volts on all three phases.

```
TRANSIENT: PRGM #4   SEGMENT #2   OF 2
T=0.01     Va=80     Vb=80     Vc=80
F=400      WFa=1     WFb=1     WFc=1
```

Press **400, ENTER,** to select 400 Hz.

```
TRANSIENT: PRGM #4   SEGMENT #2   OF 2
T=0.01     Va=80     Vb=80     Vc=80
F=400      WFa=1     WFb=1     WFc=1
```

4.5.2.1 TIME BASED TRANSIENT EXAMPLE (continued)

Press **1, ENTER, 1, ENTER, 1,** to select Waveform 1 on all three phases.

```
TRANSIENT: PRGM #4   SEGMENT #2   OF 2
T=0.01     Va=80     Vb=80     Vc=80
F=400      WFa=1     WFb=1     WFc=1
```

Press **ENTER**, now we are starting segment 3 of 3.

```
TRANSIENT: PRGM #4   SEGMENT #3   OF 3
T=0.01     Va=108    Vb=108    Vc=108
F=400      WFa=1     WFb=1     WFc=1
```

Press **ENTER, ENTER, .07, ENTER,** to select default segment 3 of 3 and a time 70 milliseconds.

```
TRANSIENT: PRGM #4   SEGMENT #3   OF 3
T=.07      Va=108    Vb=108    Vc=108
F=400      WFa=1     WFb=1     WFc=1
```

Press **108, ENTER, 108, ENTER, 108, ENTER,** to select 108 volts on all three phases.

```
TRANSIENT: PRGM #4   SEGMENT #3   OF 3
T=0.07     Va=108    Vb=108    Vc=108
F=400      WFa=1     WFb=1     WFc=1
```

Press **400, ENTER,** to select 400 Hz.

```
TRANSIENT: PRGM #4   SEGMENT #3   OF 3
T=0.07     Va=108    Vb=108    Vc=108
F=400      WFa=1     WFb=1     WFc=1
```

4.5.2.1 TIME BASED TRANSIENT EXAMPLE (continued)

Press **1, ENTER, 1, ENTER, 1,** to select Waveform 1 on all three phases.

```
TRANSIENT: PRGM #4   SEGMENT #3   OF 3
T=0.07     Va=108    Vb=108    Vc=108
F=400      WFa=1     WFb=1     WFc=1
```

Press **STORE,** to save the transient sequence.

```
TRANSIENT EVENTS:
ENTER # OF TRANSIENT EVENTS 1
0 FOR INFINITE OR 1-65535.
```

Press **1, STORE,** to cause only one transient event.

```
V/I METER:
FREQ=400.0  Va=108.0  Vb=108.0  Vc=108.0
SENSE=INT   Vab=187.1 Vbc=187.1 Vca=187.1
MANUAL MODE Ia=00.0   Ib=00.0   Ic=00.0
```

If the UPC was previously executing program #4, it will now be in MANUAL MODE. This is because program #4 has changed. To execute the transient you must first execute program #4. Press **PROGRAM, 4, ENTER, EXECUTE,** to execute the program.

```
V/I METER:
FREQ=400.0  Va=108.0  Vb=108.0  Vc=108.0
SENSE=INT   Vab=187.1 Vbc=187.1 Vca=187.1
PROGRAM #4  Ia=00.0   Ib=00.0   Ic=00.0
```

Press **TRANS** to execute the transient.

This is a MIL-STD-704D under voltage time based transient (Figure 4.5.2.1).

4.5.2.2 CYCLE BASED TRANSIENT EXAMPLE

The following is an example of how to create a cycle based transient. This example presumes the user has loaded the program information as described in the previous examples.

Start with program #4 example as shown in (4.5.1.1). From any metering display press **PROGRAM, 4, ENTER, EDIT, EDIT,** and you should see the following display:

```
TRANSIENT: PRGM #4   SEGMENT #1   OF 1
T=0.0002   Va=108    Vb=108    Vc=108
F=400      WFa=1     WFb=1     WFc=1
```

Press **1, ENTER, ENTER,** to select segment 1 of 1.

```
TRANSIENT: PRGM #4   SEGMENT #1   OF 1
T=.0002    Va=108    Vb=108    Vc=108
F=400      WFa=1     WFb=1     WFc=1
```

Press **0, ENTER,** to select a cycle based transient.

```
TRANSIENT: PRGM #4   SEGMENT #1   OF 1
T=1 CYCLE  Va=108    Vb=108    Vc=108
F=400      WFa=1     WFb=1     WFc=1
```

Press **122, ENTER, 122, ENTER, 122, ENTER,** to enter 122 volts on all three phases. Note 122 volts is higher than the 108 volts of the steady-state program. This will cause the base sine wave to remain at constant amplitude while adding extra voltage for the spikes.

```
TRANSIENT: PRGM #4   SEGMENT #1   OF 1
T=1 CYCLE  Va=122    Vb=122    Vc=122
F=400      WFa=1     WFb=1     WFc=1
```

Press **400, ENTER,** to select 400 Hz.

```
TRANSIENT: PRGM #4   SEGMENT #1   OF 1
T=1 CYCLE  Va=122    Vb=122    Vc=122
F=400      WFa=1     WFb=1     WFc=1
```

4.5.2.2 CYCLE BASED TRANSIENT EXAMPLE (continued)

Press **15, ENTER, 15, ENTER, 15,** to select waveform #15 on all three phases.

```
TRANSIENT: PRGM #4   SEGMENT #1   OF 1
T=1 CYCLE  Va=122    Vb=122    Vc=122
F=400      WFa=15    WFb=15    WFc=15
```

Press **STORE,** to save the transient sequence.

```
TRANSIENT EVENTS:
ENTER # OF TRANSIENT EVENTS 1
0 FOR INFINITE OR 1-65535.
```

Press **1**, **STORE**, to cause only one transient event.

```
V/I METER:
FREQ=400.0  Va=108.0  Vb=108.0  Vc=108.0
SENSE=INT  Vab=187.1 Vbc=187.1 Vca=187.1
MANUAL MODE Ia=00.0   Ib=00.0   Ic=00.0
```

If the UPC was previously executing program #4, it will now be in MANUAL MODE. This is because program #4 has changed. To execute the transient you must first execute program #4. Press **PROGRAM, 4, ENTER, EXECUTE,** to execute the program.

```
V/I METER:
FREQ=400.0  Va=108.0  Vb=108.0  Vc=108.0
SENSE=INT  Vab=187.1 Vbc=187.1 Vca=187.1
PROGRAM #4  Ia=00.0   Ib=00.0   Ic=00.0
```

Press **TRANS** to execute the transient.

This cycle based transient will switch waveform #15 in for one cycle. This will cause a spike on the positive and negative half of the sine wave for one cycle (Figure 4.5.2.2).

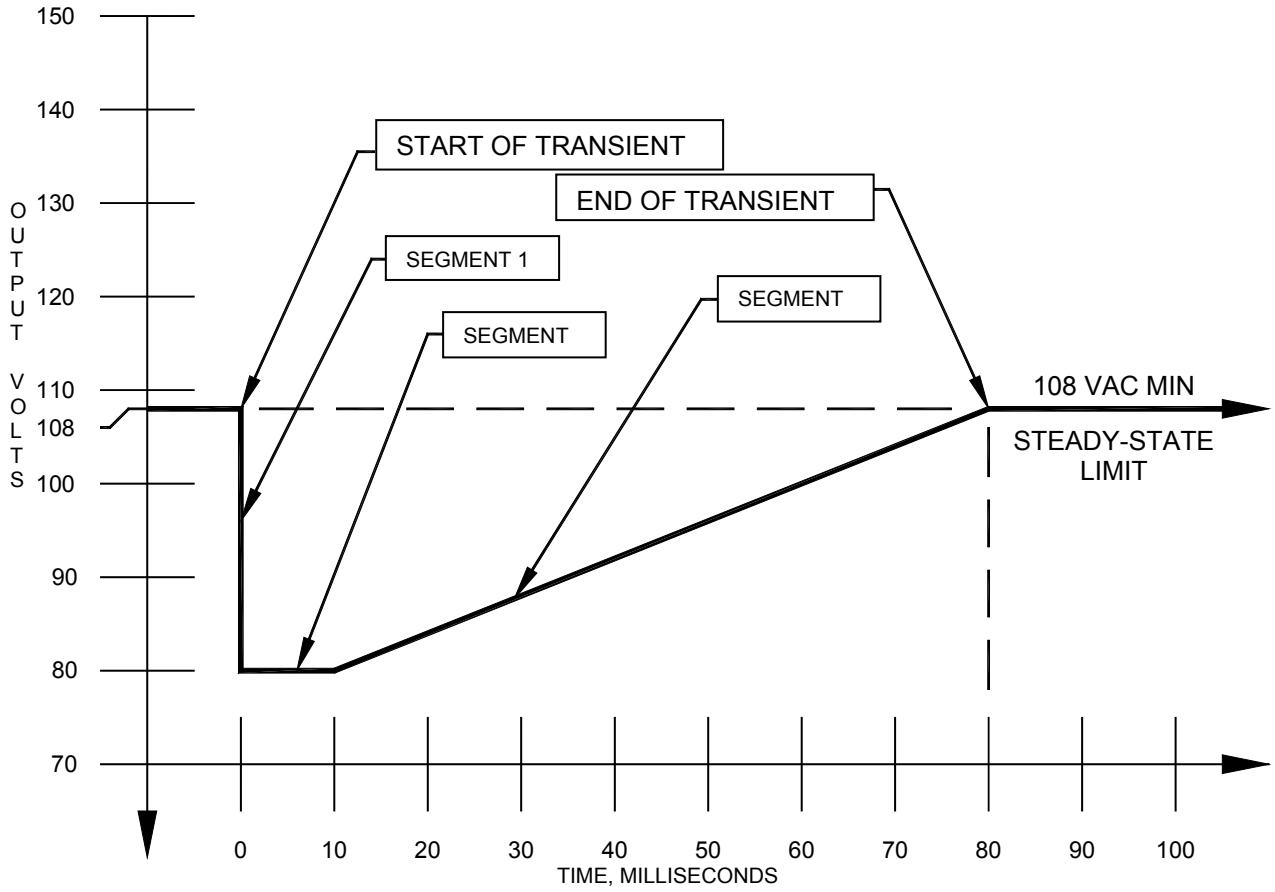
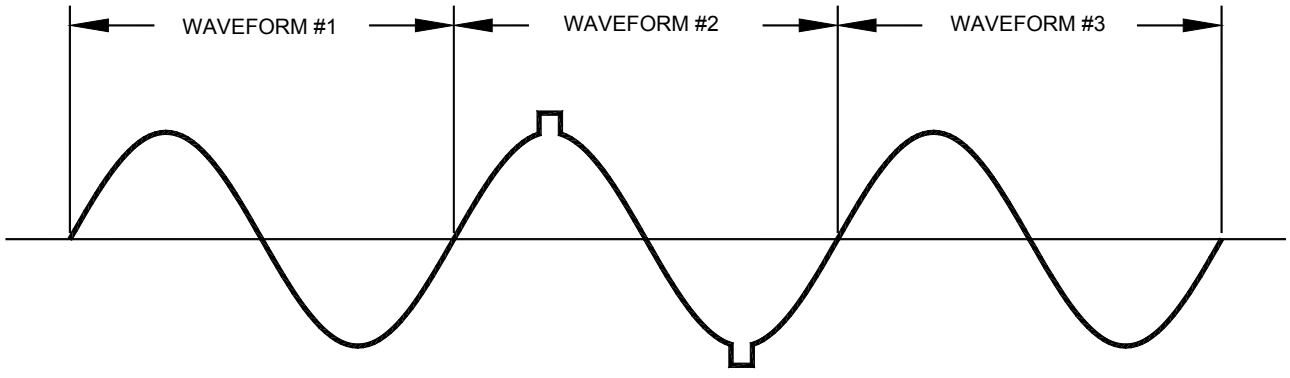


FIGURE 4.5.2.1 TIME BASED TRANSIENT - MIL-STD-704D UNDERVOLTAGE TRANSIENT



CYCLE BASED TRANSIENT
FIGURE 4.5.2.2 SPIKE TRANSIENT

4.6 SETUP MODE

SETUP MODE is used to:

- Copy and Delete Programs
- Copy, Edit, and Create Waveforms
- Set Min. and Max. Voltage Limits
- Set Min. and Max. Frequency Limits
- Engage and Disengage CSC (Continuous Self Calibration)
- Set the Metering Sense Point – Internal or External
- Set Slew rates
- Set Transition Time
- Set Transformer Ratio
- Change Frequency Span
- Enable keyboard lockout
- Set initial power on output voltage
- Monitor UPC and Power Source status
- View Firmware Version
- Enable Calibration Mode for Metering
- Set Serial Interface Parameters or GPIB Device Address
- Erase Memory
- Set Amps-to-Volts Current Metering Ratio
- Define Current Transformer Location
- Set Output Range - for power sources that support it
- Display and set the Number of Power Source Amplifiers
- Synthesize Waveforms from Harmonic values (Option)
- Calibrate Programmable output impedance (Option)
- Enable and Set Programmable Output Impedance (Option)

From any meter display, press the ***fn*** key to enter SETUP MODE.

```
SETUP MENU:  1 PROGRAM
             2 WAVEFORM
             3 GENERAL
             4 CALIBRATION
```

NOTE: Holding the ***fn*** key while applying power to the UPC will bring up the SETUP MENU directly, without any Program executing and therefore no output. The SETUP functions can be accessed as described below. If CLEAR is pressed, the UPC will indicate “NO PROGRAM RUNNING”. Select a PROGRAM and EXECUTE to initiate normal operation and display the V/I screen.

4.6.1 PROGRAM SETUP

PROGRAM SETUP is used to copy and delete programs and erase memory.

From any METER display (V/I, AMPS or POWER), press the ***fn*** key to enter SETUP MODE.
From the SETUP display, press **1** to enter PROGRAM SETUP.

```
PROGRAM MENU:
1 COPY PROGRAM
2 DELETE PROGRAM
3 INITIALIZE PROGRAMS, WAVEFORMS, SETUP
```

4.6.1.1 COPY PROGRAM

COPY PROGRAM is used to copy Program data.

From any METER display (V/I, AMPS or POWER), press the ***fn*** key to enter SETUP MODE.
From the SETUP display, press **1** to enter PROGRAM SETUP.
From the PROGRAM SETUP display, press **1** to enter COPY PROGRAM.

```
COPY PROGRAM:                          RANGE
SOURCE PROGRAM NUMBER=1                0-103
DESTINATION PROGRAM NUMBER=2           1-99
PRESS STORE TO COPY.
```

SOURCE PROGRAM NUMBER:

0 will copy the present MANUAL MODE operating parameters.

1-99 are user created programs that may be edited or copied to and from.

Program **100** is a MIL-STD-704D over-voltage transient.
Program **101** is a MIL-STD-704D under-voltage transient.
Program **102** is a MIL-STD-704D over-frequency transient.
Program **103** is a MIL-STD-704D under-frequency transient.

These programs may be copied to any of programs **1 - 99** and executed.

DESTINATION PROGRAM NUMBER:

1-99 are user created programs that may be edited or copied to and from.

NOTE: You cannot copy to a program that is currently executing.

4.6.1.2 DELETE PROGRAM

DELETE PROGRAM is used to delete programs. This is useful to free up memory.

From any METER display (V/I, AMPS or POWER), press the ***fn*** key to enter SETUP MODE.
From the SETUP display, press **1** to enter PROGRAM SETUP.
From the PROGRAM SETUP display, press **2** to enter DELETE PROGRAM.

```
DELETE PROGRAM:                    RANGE
PROGRAM TO DELETE=1                1-99
PRESS STORE TO ERASE.
```

NOTE: You cannot delete a program that is currently executing.

4.6.1.3 INITIALIZE PROGRAMS, WAVEFORMS, SETUP

INITIALIZE PROGRAMS, WAVEFORMS, SETUP will erase all user entered programs and reset Program 1 and and all Waveforms and Setup values to their original factory defaults. This is convenient if you want to reset the UPC to the factory state without affecting the calibration.

From any METER display (V/I, AMPS or POWER), press the ***fn*** key to enter SETUP MODE.
From the SETUP display, press **1** to enter PROGRAM SETUP.
From the PROGRAM SETUP display, press **3**.

```
WARNING: REMOVES ALL USER SETTINGS
PRESS "EXECUTE" TO INITIALIZE PROGRAMS
WAVEFORMS AND SETUP TO FACTORY DEFAULTS
PRESS "CLEAR" TO CANCEL
```

Press **EXECUTE** to initialize all programs, waveforms and setup to factory defaults.
Press **CLEAR** to cancel.

4.6.1.4 ERASE ALL RAM AND RESET CPU

If the programming has been corrupted and the UPC will not start properly, the system can be completely reset by holding down the **CLEAR** key while applying INPUT POWER. This will clear ALL RAM (including calibration data) and RESET the CPU.

NOTE: All Programs, Waveforms, and Calibration data will be erased when RAM is cleared.

4.6.2 WAVEFORM SETUP

WAVEFORM SETUP is used to copy and edit waveforms. The UPC Output ENABLE must be off before you can change a waveform.

From any METER display (V/I, AMPS or POWER), press the ***fn*** key to enter SETUP MODE.
From the SETUP display, press **2** to enter WAVEFORM SETUP.

```
WAVEFORM MENU:
1 EDIT WAVEFORM
2 COPY WAVEFORM
3 WAVEFORM SYNTHESIS
```

4.6.2.1 EDIT WAVEFORM

EDIT WAVEFORM is used to change or modify waveforms.

From any METER display (V/I, AMPS or POWER), press the ***fn*** key to select SETUP MODE.
From the SETUP display, press **2** to enter WAVEFORM SETUP.
From the WAVEFORM SETUP display, press **1** to enter EDIT WAVEFORM.

```
EDIT WAVEFORM: NUMBER=16      RANGE=2-22
STARTING PHASE ANGLE =0       0-359.9º
ENDING PHASE ANGLE   =0       0-359.9º
VOLTAGE IN PERCENT   =-100   (+/-)0-100%
```

Press **EXECUTE** to save a new waveform.
The UPC will stop generating any output while the new waveform is being calculated.

NUMBER: Waveforms number **2-22** may be edited.
(waveform 1 is always a sine wave)

PHASE ANGLE: The STARTING AND ENDING PHASE ANGLE determine what portion of the waveform is being edited.

NOTE: Since the UPC1 and UPC3 creates the waveform with 1024, 512. 256. or 128 time steps, depending on the active Frequency Span (2.1.1), the actual angle increment is 0.352, 0.703, 1.406, or 2.813 degrees (360/ # of Steps). All phase angle entries will be rounded to the closest increment, e.g. 85 degrees is actually shown as 85.078 (Frequency Span 150, 1024 steps). The precision of the displayed number is 3 decimal places to more accurately depict the actual waveform data involved. The example on the next page illustrates this characteristic

4.6.2.1 EDIT WAVEFORM (continued)

VOLTAGE IN PERCENT: All points on the waveform between the starting and ending phase angle defined above will change to this new amplitude. Enter the amplitude as a percent, relative to the peak of the waveform, either positive or negative.

The UPC will attempt to generate the selected waveform at the rms voltage programmed. Because of the difference in the rms voltage content of various waveforms, the UPC may not be able to reproduce the waveform at the voltage desired. If the waveform is peak-voltage-limiting, then selecting transformer coupled output with a higher ratio may solve this problem.

Basic sinusoidal waveforms with large dropouts or spikes will change the rms content of the waveform. Depending on the TRANSIENT WFs setting (4.6.3.9), the UPC may cause the basic sine wave to change in amplitude in order to keep the correct rms voltage. If you wish to keep the basic sine wave at the same amplitude and add a large dropout, you must program a proportionally lower rms voltage or DISABLE the RMS calculation in the TRANSIENT WF display. If you wish to keep the basic sine wave at the same amplitude and add a large spike, you must also allow for the higher peak voltage.

EXAMPLE: To put a 10% spike on top of a sine wave, first copy waveform 1 to waveform 2 at a 90% amplitude scale factor to allow 10% more voltage at the peak of the sine wave to accommodate the spike.. See the example in (4.6.2.2), Copy Waveform.

From the WAVEFORM SETUP display, press **1,** to enter EDIT WAVEFORM.

```
EDIT WAVEFORM: NUMBER =2       RANGE=2-22
STARTING PHASE ANGLE  =0       0-359.9º
ENDING PHASE ANGLE    =0       0-359.9º
VOLTAGE IN PERCENT    =-100  (+/-)0-100%
```

Press **2, ENTER,** to select waveform 2.

```
EDIT WAVEFORM: NUMBER=2        RANGE=2-22
STARTING PHASE ANGLE =0        0-359.9º
ENDING PHASE ANGLE   =0        0-359.9º
VOLTAGE IN PERCENT   =100    (+/-)0-100%
```

Press **85, ENTER,** to select the start angle.

```
EDIT WAVEFORM: NUMBER=2        RANGE=2-22
STARTING PHASE ANGLE =85       0-359.9º
ENDING PHASE ANGLE   =0        0-359.9º
VOLTAGE IN PERCENT   =100    (+/-)0-100%
```

4.6.2.1 EDIT WAVEFORM (continued)

Press **95, ENTER,** to select the end angle.

```
EDIT WAVEFORM: NUMBER=2        RANGE=2-22
STARTING PHASE ANGLE =85.078   0-359.9º
ENDING PHASE ANGLE   =95       0-359.9º
VOLTAGE IN PERCENT   =100     (+/-)0-100%
```

Press **100**, to select the voltage (% of full scale) between the starting and ending phase angles.

```
EDIT WAVEFORM: NUMBER=2        RANGE=2-22
STARTING PHASE ANGLE =85       0-359.9º
ENDING PHASE ANGLE   =94.922   0-359.9º
VOLTAGE IN PERCENT   =100     (+/-)0-100%
```

Press **EXECUTE** to save the new waveform. The UPC will temporarily stop producing any output signal while the new waveform data is being calculated internally in the UPC.

Pressing **EDIT** will step the display to the next available waveform section, beginning with the previous ENDING PHASE ANGLE and the VOLTAGE IN PERCENT of the waveform at that point.

A program using Waveform 2 should appear as:

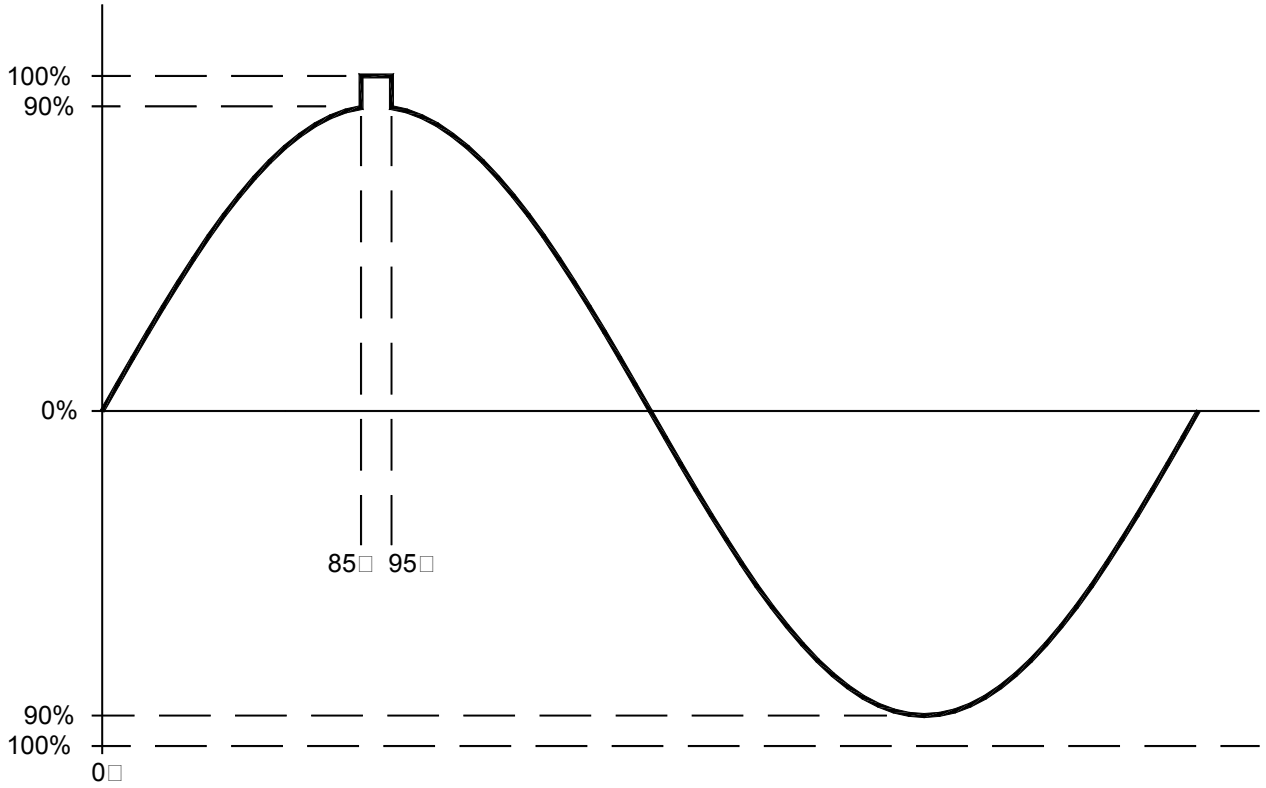


FIGURE 4.6.2.1 EDITED WAVEFORM

4.6.2.2 COPY WAVEFORM

COPY WAVEFORM is used to copy waveforms from one waveform number to another.

From any METER display (V/I, AMPS or POWER), press the ***fn*** key to enter SETUP MODE.
From the SETUP display, press **2** to enter WAVEFORM SETUP.
From the WAVEFORM SETUP display, press **2** to enter COPY WAVEFORM.

```
COPY WAVEFORM:                      RANGE
AMPLITUDE SCALE FACTOR  =100        0-100%
SOURCE WAVEFORM         =1          1-22
DESTINATION WAVEFORM    =2          2-22
```

Press **EXECUTE** to copy a waveform.
This will cause the UPC to stop generating any output while the waveform is being copied.

AMPLITUDE SCALE FACTOR: Sets the amplitude of the destination waveform relative to the source waveform.

SOURCE WAVEFORM: **1-22** may be copied from. **1** is a sine wave. **2-22** may be edited.

DESTINATION WAVEFORM: **2-22** may be copied to and edited.

Example: To put a 10% spike on a sine wave: Copy WF 1 to WF 2 at a 90% scale factor, allowing 10% more voltage to accommodate the spike. Edit WF 2 adding a 10% spike (4.6.2.1).

From the WAVEFORM SETUP display, press **2** to enter COPY WAVEFORM.

```
COPY WAVEFORM:                      RANGE
AMPLITUDE SCALE FACTOR  =100        0-100%
SOURCE WAVEFORM         =1          1-22
DESTINATION WAVEFORM    =2          2-22
```

Press **90, ENTER, 1, ENTER, 2,** to select amplitude scale factor, source and destination waveforms.

```
COPY WAVEFORM:                      RANGE
AMPLITUDE SCALE FACTOR  =90         0-100%
SOURCE WAVEFORM         =1          1-22
DESTINATION WAVEFORM    =2          2-22
```

Press **EXECUTE** to copy the waveform.
The UPC will stop generating any output while the waveform is being calculated and copied. Waveform 2 is now a sine wave but at 90% of the amplitude of waveform 1.

NOTE: When a Program is executed, the UPC will attempt to use the specified waveform at the programmed voltage. E.g. If the programmed voltage is 100 volts, the above 90% sine wave will produce an output of 100 V, NOT 90 V. See (4.6.2.1) for an example of using a 90% waveform.

4.6.2.3 WAVEFORM SYNTHESIS (Option: Harmonic Analysis and Synthesis)

WAVEFORM SYNTHESIS creates waveforms by using a sine wave series defined by Harmonic Magnitude and Phase Angle coefficients expressed in polar format (magnitude and phase angle). Each magnitude percentage is referenced to the fundamental which is always defined as having a magnitude of 100%.

From any METER display (V/I, AMPS or POWER), press the ***fn*** key to enter SETUP MODE.
From the SETUP display, press **2** to enter WAVEFORM SETUP.
From the WAVEFORM SETUP display, press **3** to enter WAVEFORM SYNTHESIS.

If the Harmonic Analysis and Synthesis option is installed, the following is displayed.

```
WAVEFORM SYNTHESIS: WAVEFORM #2
HARMONIC: 2nd   3rd   4th   5th   6th
CONTENT:  0.1%  0.0%  0.0%  0.0%  0.0%
ΦANGLE:   0.0º  0.0º  0.0º  0.0º  0.0º
```

The CONTENT fields hold the Magnitude values.

NOTE: The WAVEFORM SYNTHESIS screen is a workspace only and does not display the content of stored waveforms. The values shown on the screen will be retained from the previous edit.

To create a waveform by Harmonic Synthesis:

a) Specify the Waveform number that will hold the newly created waveform.

b) After entering the Waveform number, ZEROS? will be displayed. Press 0 to zero out any values presently in that waveform or press enter to continue editing the existing values.

c) Press **ENTER** to move the cursor to each Magnitude and Phase Angle position. Type the value for each harmonic. Harmonics up to the 51st may be entered. Press **CLEAR** to back up to the previous position. Pressing **EDIT** will advance the cursor to the next screen set of harmonics.

d) When all desired harmonic data has been entered, either:
   a) press the **EXECUTE** key and any waveform previously stored in the specified Waveform location # will be overwritten. All Programs referring to this waveform # are affected and will immediately use the new waveform.
   b) Press the **STORE** key to save the data entered so far, without calculating and producing the new waveform. The display will return to standard metering. The waveform will continue to use the old content. The new values are saved in the WAVEFORM SYNTHESIS screen and may be further edited or EXECUTED later.

4.6.3 GENERAL SETUP

GENERAL SETUP is used for UPC SETUP, UPC STATUS and POWER SOURCE STATUS.

From any METER display (V/I, AMPS or POWER), press the ***fn*** key to enter SETUP MODE.
From the SETUP display, press **3** to enter GENERAL SETUP 1.

```
GENERAL SETUP 1:    4 POWER SOURCE STATUS
1 UPC SETUP         5 RANGE CONTROL
2 FREQUENCY SPAN    6 SLEW RATE SETUP
3 UPC STATUS        7 More Options...
```

Press **7** to display these additional items:

```
GENERAL SETUP 2:    4
1 INITIAL VOLTAGE   5
2 KEYBOARD LOCK     6
3 TRANSIENT WFs     7
```

The following pages describe each menu item shown above.

4.6.3.1 UPC SETUP

UPC SETUP is used to select meter sense point, enable or disable Continuous Self Calibration (CSC), set the Programmable Output Impedance (Option), set transition time and voltage and frequency limits.

From any METER display (V/I, AMPS or POWER), press the ***fn*** key to enter SETUP MODE.
From the SETUP display, press **3** to enter GENERAL SETUP 1.
From the GENERAL SETUP 1 display, press **1** to enter UPC SETUP.

```
UPC SETUP: SENSE=INT, CSC=OFF
PROG.Zo-Hit EDIT. TRANSITION TIME=0.0000
FREQ.   LIMITS MIN=45.00  MAX=1200
VOLTAGE LIMITS MIN=0.00   MAX=600.0
```

SENSE: **INT**ernal or **EXT**ernal. This is the sense point for metering and CSC. **EXT**ernal uses the remote sense terminals on the rear panel of the Power Source.

CSC: **OFF** or **ON**. Continuous Self Calibration. If EXTernal SENSE is selected, CSC may be used to compensate for output wiring losses and maintain accurate program output voltage at a sense point which may be at the load.

4.6.3.1 UPC SETUP (continued)

PROG.Zo: Programmable Output Impedance (OPTION) - Press **EDIT** to access the PROG.Zo menu (4.6.3.1.1). This option is used to compensate for dynamic loss in the output circuit or to control the output impedance of the power source by responding in real time to changes in the output current.

TRANSITION TIME: **0** to **300** seconds in increments as small as 200 uSec. If set to a non-zero value, and a program is executed, or changes are made in MANUAL MODE or by REMOTE CONTROL, the UPC will take the specified time to transition from the active voltage and frequency to the new voltage and frequency. This feature may be used when it is undesirable to cause abrupt changes to the output power signal. Transition Time does not affect transient operation. Waveform and phase angle changes take effect at the end of the Transition.

FREQ LIMITS: **15.00** to **1200** - Sets the MINimum and MAXimum programmable frequency limits of the UPC. The default MINimum is set to 45 Hz. for safe operation with output transformers. Before attempting to use very low frequencies with any magnetics, be aware of Volt-Second limitations.

VOLTAGE LIMITS: Sets the MINimum and MAXimum allowable voltage range. This is useful for protecting delicate loads. The voltage range is 0-150 Vac when the output is Direct Coupled and 0-(150 x XFMR Ratio) when XFMR Coupled.

4.6.3.1.1 PROGRAMMABLE OUTPUT IMPEDANCE SETUP MENUS (OPTION: Prog-Zo)

The Programmable Output Impedance (Prog.Zo) option is used to compensate for dynamic regulation losses such as line resistance or output transformer impedance, or to control the Output Impedance of the power source. Press **EDIT** while the display cursor is located in the PROG. Zo field in the UPC SETUP menu to access the PROG. Zo menu.

```
PROG. Zo SETUP: PRESS EXECUTE TO SAVE.
PROG. Zo = OFF: PROG. Zo OHMS = 0.000
                MAX=2.516   MIN=-2.484
(PRESS EDIT TO CALIBRATE, THEN EXECUTE)
```

PROG.Zo =: **ON** or **OFF**. Pressing the **+/-** key while the cursor is in this field will enable/disable the Prog.Zo function. When disabled, no output compensation occurs and the inherent output impedance of the power source and wiring will remain uncompensated. When enabled, the UPC will attempt to provide an output impedance at the load equal to the value set in the PROG.Zo OHMS field.

Zo OHMS =: Max and MIN impedance values are shown on the display as this range dynamically changes based upon active operating parameters such as Form, Coupling and XFMR ratio. Enter a value to synthesize a non-zero output impedance.

Press **EXECUTE** to exit the screen.

4.6.3.1.1 PROGRAMMABLE OUTPUT IMPEDANCE SETUP MENUS (continued)

CAUTION

USE THIS FUNCTION WITH CARE

CARELESS OR IMPROPER USE OF THE PROGRAMMABLE OUTPUT IMPEDANCE FUNCTION
MAY RESULT IN OVER-VOLTAGE OR UNDER-VOLTAGE BEING PRESENTED TO THE LOAD,
AND MAY CAUSE DAMAGE TO THE LOAD.

REACTIVE LOADS MAY CAUSE THE OUTPUT POWER TO BECOME UNSTABLE (OSCILLATE)
AND MAY CAUSE DAMAGE TO THE LOAD IF EXCESSIVE NEGATIVE IMPEDANCE IS USED!

4.6.3.1.1.1 PROGRAMMABLE OUTPUT IMPEDANCE CALIBRATION MENU

Press **EDIT** again, while the PROG.Zo menu is displayedto access the Prog.Zo Calibration screens to enter calibration values for the Prog.Zo function.

NOTE: Each power source is pre-calibrated at the factory, but if the system configuration change, re-calibration of this function is desired, or if the RAM (memory) in the UPC has been lost or erased, use this screen to enter new calibration values. The calibration procedure is listed below.

The Z direct and Z xfmr values calibrated at the factory are compensated for the power source impedance at the output terminal of the power source. To compensate for additional wiring, fixtures, magnetics, etc., follow the calibration procedure; include the external devices in the measurements.

Φ	Z direct	XFMR ratio	Z xfmr	
1	0.006	1.50	0.450	
2	0.032	2.00	1.400	
3	0.016	2.50	2.970	RESET

Ø column: indicates the Power Form of operation (1, 2 or 3 phase).

Z direct column: accepts the Direct coupled impedance of the power source (per phase) for each Power Form listed on the far left. During DIRECT coupled operation, the proper Z direct value is used to calibrate the PROG.Zo function based upon the Power Form selected in the Program being executed.

XFMR ratio column: accepts up to 3 separate XFMR ratios. Typically only one will be entered.

Z xfmr column: accepts the impedances of the XFMR listed in the XFMR ratio column. During XFMR coupled operation, the proper Z xfmr value is used to calibrate the PROG.Zo function based upon the XFMR ratio selected in the Program being executed.

RESET: restores system default values to all PROG Zo calibration entries

4.6.3.1.1.1 PROGRAMMABLE OUTPUT IMPEDANCE CALIBRATION MENU (continued)

To reset Prog.Zo calibration values, press **ENTER** to position the cursor over RESET then **EXECUTE**.

```
WARNING: RECALIBRATION REQUIRED
PRESS "EXECUTE" TO RESET PROG Zo CAL
PRESS "CLEAR" TO CANCEL
```

Calibration values for Direct coupled operation may be established via the following procedure.

1. Turn CSC OFF. Disable PROG.Zo. Execute a program in Direct coupled mode.
   A. Establish the difference in output voltage between no-load and full-load voltage.
   B. Divide the Voltage difference by the full-load current. The net result is the inherent direct coupled impedance of the power source.
   C. Use the result to enter in as Z-Direct for the power form used to perform this test.

$$Z = \frac{V\_no\_load - V\_full\_load}{I\_full\_load}$$

2. Calibration values for XFMR coupled operation may be determined in the same manner, except the Z direct value must be subtracted from the Z XFMR calculation prior to entering the Z XFMR value into the UPC.

   A good approximation of transformer impedance can be estimated by measuring the DC resistance of each XFMR secondary tap. That value may be entered for Z XFMR as an alternative to using the above procedure for measuring actual XFMR impedance.

   NOTE: XFMR impedances may vary greatly with temperature.

4.6.3.2 FREQUENCY SPAN

FREQUENCY SPAN sets the available frequency range and resolution of the output waveform and the number of samples per cycle used for metering data and harmonic analysis.

The FREQUENCY SPAN menu is accessed from the General Setup menu (***fn***,**3**,2).

```
FREQUENCY : PRESS       1 FOR 150 Hz
SPAN=600Hz              2 FOR 300 Hz
                        3 FOR 600 Hz
                        4 FOR 1200 Hz
```

PRESS	FREQUENCY SPAN	WAVEFORM STEPS	METERING SAMPLES
1	15.00 – 150 Hz.	1024	512
2	15.00 – 300 Hz.	512	256
3 (default)	15.00 – 600 Hz.	256	128
4	15.00 – 1200 Hz.	128	64

4.6.3.3 UPC STATUS

UPC STATUS indicates firmware part-number and version, SERIAL or GPIB interface status, and other system settings such as GPIB device address. See section (10.0) if the SERIAL REMOTE INTERFACE is installed. The UPC SETUP menu is accessed from the General Setup menu (***fn***,3,1). The firmware part-number will vary depending on the features inplemented (e.g. Prog Zo, HAS, etc.).

The UPC STATUS menu is accessed from the General Setup menu (***fn***,**3**,3).

If your UPC is configured with a serial port interface the UPC STATUS screen is:

```
UPC STATUS: FIRMWARE 141500 v5.00
BAUD:19200  PARITY:NONE    LAST BYTE=00h
TRANSFORMER RATIO 2.00  PAs=3
AMPS:VOLTS RATIO 4.00A=1 V PRI  EOS=CR/LF
```

For systems equipped with a GPIB (IEEE-488) communication port, the display will be:

```
UPC STATUS: FIRMWARE 141501 v5.00
GPIB ADDRESS 1  IFC    LAST DATA BYTE=00h
TRANSFORMER RATIO 2.00 PAs=3
AMPS:VOLTS RATIO 4.00A=1 V PRI
```

For systems equipped with a manual controller (UPC-3M or UPC-1M), the display will be:

```
UPC STATUS: FIRMWARE 141999 v5.00

TRANSFORMER RATIO 2.00 PAs=3
AMPS:VOLTS RATIO 4.00A=1 V PRI
```

To change any of these settings, press **ENTER** to move the cursor to each data field. Press **EDIT** when the cursor is positioned on the value to be changed. Type the new value, then press **ENTER** to continue editing or **STORE** to save and exit.

BAUD: **300, 1200, 2400, 4800, 9600, 19200, 38400**. This is the serial port baud rate. The factory default value is 19200.

PARITY: **NONE, ODD or EVEN**. The default serial port parity value is NONE.

LAST BYTE= This field indicates the last data byte (DAB) received by the remote interface. The byte is shown in hexadecimal format. Hex 0D (Carriage Return) is displayed as Hex 0A (New Line). This is used for troubleshooting the remote interface.

GPIB ADDRESS: **0** to **30**. This is the IEEE-488 device address for the UPC. The factory default address is 1.

4.6.3.3 UPC STATUS (continued)

IFC: "**Interface Clear**". This is displayed only if an IEEE-488 Interface Clear message is received while this status display is shown. This display latches the IFC message. Press **CLEAR** to clear this display and the IFC field. It is used for troubleshooting the GPIB interface.

LAST DATA BYTE= Same as LAST BYTE=, above.

TRANSFORMER RATIO: Output Transformer Ratio: The value MUST match the ratio of the output transformer presently installed (3.7.1).

PAs= **1**, **2**, or **3**. This is the number of power amplifiers in the Power Source.

AMPS:VOLTS RATIO This sets the ratio of current to voltage for the UPC metering signals (3.7.2).

PRI/SEC: **PRI**mary or **SEC**ondary. This is the current transformer location relative to an output transformer. To change this value, move the cursor to the field and press the +/- key (3.7.3).

EOS: **CR/LF, LF or CR**. The factory default Serial port End-Of-String character(s) value is CR/LF. Use the +/- key to select this value.

4.6.3.4 POWER SOURCE STATUS

POWER SOURCE STATUS indicates the state of internal control signals between the UPC and the Power Source circuits. See (2.3.4) OUTPUT CONTROL and (2.3.5) INPUT CONTROL for a description of these signals. This display is only used for technical diagnostics.

The UPC STATUS menu is accessed from the General Setup menu (***fn***,**3**,3).

```
POWER SOURCE STATUS:
          3PH     1PH    CONNECTOR     XFMR
CMD     FALSE   FALSE      FALSE       FALSE
CONF    FALSE   FALSE      FALSE       FALSE
```

CMD: Are Command signals sent from the UPC to the Power Source.

CONF: Are Confirmation signals sent from the Power Source to the UPC.

Pressing the **+/-** key toggles the Connector CMD signal state.

4.6.3.5 RANGE CONTROL

Some power source models support Range Control to achieve maximum efficiency by matching the internal power supply to the output voltage requirement. The UPC allows selection of Range Control parameters even when it is not supported by the attached power source. In this case the following screens have no effect.

The RANGE CONTROL SETUP menu is accessed from the General Setup menu (***fn***,**3**,**5**).

```
RANGE CONTROL MODE: MANUAL
SELECT OUTPUT RANGE: 1
```

RANGE CONTROL MODE: **AUTO**, **MANUAL**. There are 2 modes of operation for Range Control: AUTO and MANUAL. AUTO is the default mode. Pressing the ***+/-*** key when the cursor is in the MODE field toggles between AUTO and MANUAL MODE. When MANUAL MODE is selected, an OUTPUT RANGE value may be set.

SELECT OUTPUT RANGE: **1**, **2**, **3**, **4**. The following ranges are applicable.

PROGRAMMED OUTPUT AC VOLTS	RANGE #
< 110	1
110 - 120.9	2
121 - 130.9	3
> 131	4

NOTE: The above Output voltages are for Single phase operation. If split (2) phase operation is used, the listed Output voltage ranges are doubled.

Press **EXECUTE** to save the parameter entries.

4.6.3.6 SLEW RATE SETUP

SLEW RATE SETUP allows the arrow key (^ or v) functions to transition at a predetermined rate

The SLEW RATE SETUP menu is accessed from the General Setup menu (***fn***,**3**,**6**).

```
SLEW RATE SETUP:
VOLTS / SEC. = 1
HERTZ / SEC. = 1.00
```

Default values are 1 volt/second and 1.00 Hz./second.

Press EXECUTE to save the parameter entries.

NOTE: Slew rates are approximate.

4.6.3.7 INITIAL VOLTAGE

INITIAL VOLTAGE SETUP allows you to specify the initial power up output voltage amplitude.

The INITIAL VOLTAGE SETUP menu is accessed from the General Setup menu (***fn***,**3**,7,1).

```
INITIAL VOLTAGE SETUP:
VOLTAGE=0
(Press +/- Key to Toggle Selection
(Press ENTER or EXECUTE to Exit
```

VOLTAGE=: **0** or **LAST EXECUTED.** If **0** is chosen, the unit will set the output voltage to 0 regardless of output voltage prior to turning the unit off. Choosing **LAST EXECUTED** means the power source will automatically power on with the output voltage setting that existed prior to turning the unit off. The output relay will always be open at power-up unless an "Auto-Start" option has been installed.

NOTE: The default factory setting for INITIAL VOLTAGE is 0.

4.6.3.8 KEYBOARD LOCK

KEYBOARD LOCK SETUP allows you to control the keyboard lock feature.

The KEYBOARD LOCK SETUP menu is accessed from the General Setup menu (***fn***,**3**,7,2).

```
KEYBOARD LOCK SETUP: LOCK=OFF

(Press +/- Key to Toggle Selection
(Press ENTER or EXECUTE to Exit
```

LOCK=: **OFF** or **ON.** If **OFF** is chosen, the keyboard is always enabled. If ON is chosen, the keyboard is locked and disabled after pressing the **DISPLAY** key. Key presses are ignored when the keyboard is locked. The only exceptions are the **CLEAR** key and **OUTPUT ENABLE** key. To enable the keyboard, press the **fn** and **EDIT** keys at the same time. The keyboard remains enabled until you press the **DISPLAY** key.

NOTE: The default factory setting for KEYBOARD LOCK is off.

4.6.3.9 TRANSIENT WFs

TRANSIENT WAVEFORM CALCULATION SETUP allows you to specify the voltage calculation method used during transients.

The TRANSIENT WAVEFORM CALCULATION SETUP menu is accessed from the General Setup menu (***fn***,**3**,7,3).

```
TRANSIENT WAVEFORM CALCULATION SETUP:
K-FACTOR CALC FOR AUTO RMS=ENABLED
(Press +/- Key to Toggle Selection
(Press ENTER or EXECUTE to Exit
```

RMS= ENABLED or **DISABLED.**

If **ENABLED** is chosen, the amplitude of each transient segment is calculated based on the RMS value of the waveform used in that segment. Time based transients, using the same waveform throughout, could use this setting.

For transients involving waveform substitution, the RMS calculation may cause the peak voltages to vary. For example, a sine wave which has been modified to create a ¼ cycle dropout is substituted for one cycle at 120 Vrms. Since it is missing a portion of the waveform, the RMS calculation will determine that the voltage peaks must be higher than a normal sine wave in order to maintain the specified 120 Vrms.

If **DISABLED**, the RMS calculation of substituted waveforms does not occur. The amplitude of all waveforms used in the transient will then be based on the system gain factor for each phase, as calculated for the Program which contains the transient. This facilitates constant-amplitude transients, such as partial cycle dropouts or sub-cycle spike transients. To have the transient waveforms track the amplitude of the Program steady-state values, the base waveforms used in all segments must be consistent.

EXAMPLE: If a 10% spike transient waveform is desired, the base sine wave was copied at 90% to allow margin for the spike (4.6.2.2). The TRANSIENT WFs setting should be RMS=DISABLED and the Program must use a sine wave copied at 90% but without the spike. The Program will calculate the system gain to create the programmed voltage using the 90% waveform and the transient will then be executed using that gain, thereby maintaining sine wave continuity.

SECTION 5

GPIB and SERIAL REMOTE OPERATION

5 GPIB and SERIAL REMOTE OPERATION

This section describes remote control functions of the UPC for communication over the IEEE-488 BUS or Serial Remote Interface. To select the proper commands for accurate setup and control of the UPC/power-source system, a thorough understanding of the UPC capabilities is needed. It is strongly recommended that the user read (4.0) (Front Panel Operation) to become familiar with the features and capabilities of the UPC.

Most commands listed in this section are also used with both the Serial and optional GPIB Remote Interface. See (10.0) for detailed information on the Serial Remote Interface parameter setup.

5.1 INTRODUCTION

For GPIB communications, REMOTE CONTROL is established when control or programming commands are sent to the UPC by a Bus Controller with REN (remote enable) set true. The REN line on the bus interface must be held TRUE to maintain REMOTE CONTROL. REMOTE CONTROL can only be initiated and maintained while the UPC is displaying a Metering display or while in the UPC STATUS display, but not while manually editing any screen data. All front panel programming and signal controls are disabled while REMOTE CONTROL is active, but metering information is still accessible for viewing at the front panel display.

Status and metered data queries do not place the UPC into REMOTE CONTROL.

The front panel **LOCAL** key allows the user to restore LOCAL CONTROL unless the Bus controller has sent the IEEE-488 - LOCAL LOCKOUT (LLO) message. The Bus Controller may restore LOCAL CONTROL by sending the IEEE-488 - GOTO LOCAL (GTL) message.

Refer to (4.6.3.3) for setting the GPIB device address.

NOTE: Pacific Power Source has Virtual Instrument drivers available for use with **National Instruments LabWindows**, and **LabView** programming environments. These software drivers simplify custom programming and control of the UPC via the REMOTE interface. A sample application, UPC Interactive, written in LabView, including the source code, is provided.

5.2 CONVENTIONS

1. COMMANDS are shown in the left hand column in **BOLD,** beginning with an asterisk (*****) or colon (**:**) text with NO underline.

2. Command DESCRIPTIONS appear in the right hand column.

3. SCPI is "Standard Commands for Programmable Instruments -1992". Refer to the SCPI 1992 standard for more information. The full standard publication is available from:
SCPI Consortium, 8380 Hercules Dr. Suite P3, La Mesa Ca. 91942.
(http://www.scpiconsortium.org)

4. Some SCPI keywords are optional, and are ignored by the device. Optional keywords are enclosed in **[ ]** brackets.

5. Lowercase letters of commands shown are also optional.

6. The SCPI 1992 standard requires uppercase text in all SCPI commands (start with **:**), however, the UPC is not case sensitive and will accept commands sent in lower case. It is recommended that programming formats follow the SCPI standard.

7. All SCPI commands have query command counterparts unless noted. A query command consists of the command immediately appended with a question mark (**?**). Values cannot be sent with a query. IEEE-488.2 commands do not have query counterparts unless explicitly shown with a question mark appended.

8. IEEE-488.2 commands start with an asterisk (*****) and are not case sensitive.

9. All required Functional Elements for devices are implemented. Refer to IEEE-488.2 (4.4.1) for more information.

10. Refer to the ANSI/IEEE-488.1 1987 and ANSI/IEEE-488.2 1987 standards for more information. These standards are available from:
IEEE Standards Board, 445 Hoes Ln. PO Box 1331 Piscataway, NJ 08855-1331.

11. Voltage and Waveform parameter names without a channel number suffix (1,2,3) may be used to set all 3 channels (phases) simultaneously, as an alternative to setting each separately to the same value.

12. All numerical values are ASCII encoded decimal strings consisting of 1 or more ASCII digits. 8 and 16 bit register values are binary weighted values represented by an ASCII string of 1 or more decimal digits. One exception, the Serial Poll byte, is an 8 bit hexadecimal byte.

13. Multiple Commands and Queries may be sent in one Program Message but each must be separated by a semicolon (**;**). The term 'Program Message' refers to 1 or more commands and/or queries sent to the UPC as one continuous string and is not to be confused with Stored Programs (1-99) within the UPC.

5.2 CONVENTIONS (continued)

14. Multiple data parameter names and values must be separated by commas.

15. 'Multiple keyword' messages may be sent without duplicating the first level SCPI keyword (i.e., SOURce).
e.g., **:SOURce:VOLTage1,120; VOLTage2,120; VOLTage3,120**.
A keyword is a single word beginning with a colon (:).

16. Program Messages MUST be terminated with a LINE FEED (0Ahex, 10dec) or END (EOI) signal. This is referred to as an end-of-string <eos>. A Carriage Return character (0Dhex, 13dec) is converted to a LINE FEED by the UPC. Further SCPI commands shall begin with a first level keyword (i.e.,**:SOURce:**).

17. All values shown in angle brackets <> are examples of real values used with commands but labels are sometimes used to indicate a variable which is not known until actual time of use. e.g., <AMPS meter range> might actually be <50>.

    Units such as AAC, Hz. or % shown after the angle bracketed value are not to be included inside the value, but are shown as a reference to the units. The angle brackets are not part of the value.

18. The UPC data input buffer is 8k bytes, as is its data output buffer. No program message may exceed this length.

19. All **:SOURce:** commands also support query. An alternate method of writing or reading the presently active :SOURce:FORM, COUPLing, VOLTage, FREQuency, CURRent:LIMit, PHASe, and WAVEFORM values is to use PROGram 0 (see examples). PROGram 0 contains the MANUAL MODE parameters.

    NOTE: Sending any **:SOURce:** command invokes MANUAL MODE and REMOTE CONTROL.

20. Command strings may contain spaces.

21. The UPC interface accepts IEEE-488.2 NR1, NR2 and NR3 numeric formats. Most query responses are NR1 or NR2 types. i.e., NR1=120, NR2=120.0, NR3=1.2E+02.

22. Follow any command (in the same Program Message) with ***OPC** (5.5.3.1) to detect completion of the command or termination of a Transient event. An SRQ occurs when the command or Transient is complete (if ESB bit is set in SRE and OPC bit is set in ESE). ***OPC?** may be used in the same manner.

5.3 PROGRAM CONTROL

:PROGram:NAME <nn> Command**:** selects program “nn” for executing, deleting or copying.
nn = <0> to <99>
Query: returns the program number last selected.

:PROGram[:SELected]:DEFine <program>
Command: defines the values stored in program “nn”. Both steady-state and transient segment parameter names and values may be sent. Program parameters are defined in the following sections.
NOTE: Only commas may separate the values, NO Carriage Returns or Line Feeds may separate the values within a single Command.

Query: returns steady-state values of selected program and segment values of most recently selected segment or multiple segments if specified by a previous NSEGS parameter. "LAST" is returned with segment data if the segment is the last segment in the program.

STEADY-STATE OUTPUT PARAMETERS

FORM,<n>,
COUPLing,<s>,
XFMRRATIO,<n.nn>,
FREQuency,<n>,
VOLTage,<n>, see Convention #11.
VOLTage1,<n>,
VOLTage2,<n>,
VOLTage3,<n>,
CURRent:LIMit,<n>,
PHASe2,<n>,
PHASe3,<n>,
WAVEFORM,<n>, see Convention #11.
WAVEFORM1,<n>,
WAVEFORM2,<n>,
WAVEFORM3,<n>,
EVENTS,<n>,
NSEGS,<n>

TRANSIENT SEGMENT PARAMETERS (OPTIONAL)

SEGment,<n>, Multiple segments per Program Message may be sent, see Convention 18
FSEG,<n>,
VSEG,<n>, see Convention #11.
VSEG1,<n>,
VSEG2,<n>,
VSEG3,<n>,
WFSEG,<n> see Convention #11.
WFSEG1,<n>,
WFSEG2,<n>,
WFSEG3,<n>,
TSEG,<n>,
LAST Sent only if this is the LAST segment.

5.3.1 STEADY-STATE OUTPUT PARAMETERS

FORM,<n> sets Output Power Form of selected program.
n = <1>Single Φ, <2>Split Φ, or <3>Three Φ

COUPLing,<s> sets Output coupling of selected program.
s = <DIRECT> or <XFMR>

XFMRRATIO,<n.nn> sets Output XFMR ratio (n.nn:1) of selected program.
n.nn = <0.05> to <5.00>

FREQuency,<n> sets Output Frequency of selected program.
n = <:SOUR:FREQ:LIM:MIN> to <:SOUR:FREQ:LIM:MAX> Hz.

VOLTage,<n> sets Output VOLTAGE ΦA, ΦB, ΦC of selected program.
n = <0> to <150, or 150 x XFMRRATIO> Volts

VOLTage1,<n> sets Output VOLTAGE ΦA of selected program.
n = <0> to <150, or 150 x XFMRRATIO> Volts

VOLTage2,<n> sets Output VOLTAGE ΦB of selected program.
n = <0> to <150, or 150 x XFMRRATIO> Volts

VOLTage3,<n> sets Output VOLTAGE ΦC of selected program.
n = <0> to <150, or 150 x XFMRRATIO> Volts

CURRent:LIMit, <n> sets Output Current Limit of selected program.
n = <0> to <AMPS meter range> Amps

PHASe2,<n> sets Output Φ angle B of selected program.
n = <0> to <359> degrees

PHASe3,<n> sets Output Φ angle C of selected program.
n = <0> to <359> degrees

WAVEFORM,<n> sets Output Waveform ΦA, ΦB, ΦC of selected program.
n = <1> to <16>

WAVEFORM1,<n> sets Output Waveform ΦA of selected program.
n = <1> to <16>

WAVEFORM2,<n> sets Output Waveform ΦB of selected program.
n = <1> to <16>

WAVEFORM3,<n> sets Output Waveform ΦC of selected program.
n = <1> to <16>

EVENTS,<n> sets number of times to repeat the transient portion of the selected program when the Transient is executed.
n = 0-65535. A value of 0 specifies continuous repetition.

5.3.1 STEADY-STATE OUTPUT PARAMETERS (continued)

NSEGS,<n>

Command: Specifies the number of Transient segments (all parameters) to return in a subsequent :PROG:DEFine query?. If NSEGS is not specified, 1 segment is returned by :PROG:DEFine?.
EXAMPLE: :PROG:DEF SEG,3,NSEGS,4;PROG:DEF? will return 4 transient segments, starting with Segment 3.
NOTE: The value will revert back to 1 after each query.

Query: The NSEGS parameter of a :PROG:DEF? query returns total number of Transient segments defined in the selected program

5.3.2 TRANSIENT SEGMENT PARAMETERS

SEGment,<n> Transient segment n of the selected program to be edited. Also the starting segment when querying multiple segments (see NSEGS)
n = <1> to <100>

FSEG,<n> sets objective Frequency of selected segment.
n = <:SOUR:FREQ:LIM:MIN> to <:SOUR:FREQ:LIM:MAX> Hz.

VSEG,<n> sets objective voltage ΦA, ΦB, ΦC of selected segment.
n = <0> to <150, or 150 x XFMRRATIO> Volts

VSEG1,<n> sets objective voltage ΦA of selected segment.
n = <0> to <150, or 150 x XFMRRATIO> Volts

VSEG2,<n> sets objective voltage ΦB of selected segment.
n = <0> to <150, or 150 x XFMRRATIO> Volts

VSEG3,<n> sets objective voltage ΦC of selected segment.
n = <0> to <150, or 150 x XFMRRATIO> Volts

WFSEG,<n> sets Waveform ΦA, ΦB, ΦC of selected segment.
n = <1> to <22>

WFSEG1,<n> sets Waveform ΦA of selected segment.
n = <1> to <22>

WFSEG2,<n> sets Waveform ΦB of selected segment.
n = <1> to <22>

WFSEG3,<n> sets Waveform ΦC of selected segment.
n = <1> to <22>

TSEG,<n> sets execution time (to reach objective Voltage and Frequency) of selected segment.
n = <0> or <.0002> to <300> seconds. Setting n to <0> selects cycle-based transient operation, i.e., each segment time is equal to the period of 1 cycle (1/FREQ)

LAST sets selected segment to be the last segment of selected transient.

5.3.3 PROGRAM MEMORY CONTROL

:PROGram:[SELected:]DELete Command: (No query) deletes selected program.
Attempting to DELete an EXECuting Program will report an Error.

:PROGram:DELete:ALL Command: (No query) deletes all programs, waveforms, calibration data and setup values. Performs device RESET, loads Program #1 with *RST default values (5.6.2), executes MANUAL MODE with *RST values. Waveforms (1-16) are re-loaded from ROM.
Attempting to DELete an EXECuting Program will report an Error.
NOTE: Calibration values are deleted.

:PROGram:COPY <dest> Command: (No query) copies the selected program (previously specified by :PROG:NAME <nn>) to <dest>.
<dest> = 1 thru 99
NOTE: that the destination Program cannot be currently EXECuting.

:PROGram:CATalog? <list> Query: returns a comma separated list of NR1 values representing stored programs (e.g. 1,2,7…). If the MANUAL MODE program exists, list includes **0.** If no programs are stored, query returns **-1**.

5.4 SIGNAL CONTROL

5.4.1 OUTPUT PARAMETERS

:PROGram:EXECute Command: executes selected Program steady-state values. Selected program is specified by previous PROGram:NAME <nn> command.
Query: returns the number of the currently executing program. If no program is executing, query returns -1.

:PROGram:EXECute:TRANS Command: (No query) executes pre-processed Transient portion of selected Program. Pre-processing is performed by executing a Program. Transient terminates upon receipt of any data byte (DAB) from the IEEE-488 Bus, Device Clear, or when the LAST segment of the last EVENT is executed. Steady-state values are then restored. Follow this command (in the same Program Message) with ***OPC** (5.5.3.1) to detect termination of the Transient event. An SRQ occurs when the Transient is complete (if ESB bit is set in SRE and OPC bit is set in ESE). ***OPC?** may be used in the same manner.

***TRG** Same as **:PROGram:EXECute:TRANS**

:[SOURce:]VOLTage <n> sets Output VOLTAGE amplitude of all available Phases.
n = <0> to <150, or 150 x XFMRRATIO> Volts

:[SOURce:]VOLTage1 <n> sets Output VOLTAGE ΦA.
n = <0> to <150, or 150 x XFMRRATIO> Volts

:[SOURce:]VOLTage2 <n> sets Output VOLTAGE ΦB.
n = <0> to <150, or 150 x XFMRRATIO> Volts

:[SOURce:]VOLTage3 <n> sets Output VOLTAGE ΦC.
n = <0> to <150, or 150 x XFMRRATIO> Volts

5.4.1 OUTPUT PARAMETERS (continued)

:[SOURce:]FREQuency <n> sets Output Frequency.
n = <:SOUR:FREQ:LIM:MIN> to <:SOUR:FREQ:LIM:MAX> Hz.
Query: Returns the programmed frequency value. For metered frequency, see **:MEASure:FREQuency?** (Page 86).

:[SOURce:]CURRent:LIMit <n> sets Output Current Limit.
n = <0> to <Current meter range> RMS Amps

:[SOURce:]CURRent:LIMit:MAX? <n> query returns the maximum current limit allowed based on the present Form, Coupling and current transformer.

:[SOURce:]PHASe2 <n> sets Output Φ angle B.
n = <0> to <359> degrees

:[SOURce:]PHASe3 <n> sets Output Φ angle C.
n = <0> to <359> degrees

:[SOURce:]WAVEFORM <n> sets Output Waveform, all phases.
n = <1> to <22>

:[SOURce:]WAVEFORM1 <n> sets Output Waveform ΦA.
n = <1> to <22>

:[SOURce:]WAVEFORM2 <n> sets Output Waveform ΦB.
n = <1> to <22>

:[SOURce:]WAVEFORM3 <n> sets Output Waveform ΦC.
n = <1> to <22>

:[SOURce:]RAMP <t> sets Output TRANSITION TIME of voltage and frequency execution.
t = <0> to <300> seconds in increments as small as .0002 Sec

:[SOURce:]FREQuency:SPAN <n> sets Output Frequency Span.
n = <150>, <300>, <600> <1200> Hz.
After sending, allow 8 seconds for UPC restart before sending any additional command or query.

This setting changes the resolution of the output signal, metering and Harmonic Analysis option (2.1.1) and (4.3.1.1).

:[SOURce:]FREQuency:LIMit:MAXimum <n> sets Output Frequency max limit.
n = <15.00> to <1200> Hz., depending on Frequency Span

:[SOURce:]FREQuency:LIMit:MINimum <n> sets Output Frequency min limit.
n = <15.00> to <1200> Hz., depending on Frequency Span

:[SOURce:]FREQuency:LIMit:RANGe? <min,max> Query: Returns the minimum and maximum allowable frequency limits.

:[SOURce:]VOLTage:LIMit:MAXimum <n> sets Output Voltage max limit.
n = <0.00> to <600> VAC RMS, must be greater than MIN

5.4.1 OUTPUT PARAMETERS (continued)

:[SOURce:]VOLTage:LIMit:MINimum <n> sets Output Voltage min limit.
n = <0.00> to <600> VAC RMS, must be less than MAX

:[SOURce:]VOLTage:LIMit:RANGe? <min,max> query only. Returns the minimum and maximum allowable voltage limit.

:[SOURce:]VOLTage:INITial <b> sets initial output voltage at power up.
b = <0> (0 volts) or <1> (last executed)

:[SOURce:]RANGe <n> sets Output Range Control (for power sources with Range Control).
n = <0> to <4>. 0 sets Range Control to AUTO (4.6.3.5).

:[SOURce:]IMPEDance:STATE <b> Enable or disable, Programmable Output Impedance option.
b = <OFF>, <0> or <ON>, <1>

:[SOURce:]IMPEDance <z> sets the value of the Programmable Output Impedance option.
z = varies based on the configuration and operational mode of the power source.
Use :SOUR:IMPED:LIM:MIN? and :SOUR:IMPED:LIM:MAX? to determine the available range.

:[SOURce:]IMPEDance:LIMit:MINimum? <min z>
Query: returns the minimum allowable impedance

:[SOURce:]IMPEDance:LIMit:MAXimum? <max z>
Query: returns the maximum allowable impedance

:[SOURce:]IMPEDance:CAL <z1,z2,z3, x1,z4, x2,z5, x3,z6>
Calibrates the Programmable Output Impedance option. Values are:

Description	x values	z values
Direct Coupled 1Φ		**z1** Ω
Direct Coupled 2Φ		**z2** Ω
Direct Coupled 3Φ		**z3** Ω
XFMR Coupled - Ratio X	**x1**:1	**z4** Ω
XFMR Coupled - Ratio Y	**x2**:1	**z5** Ω
XFMR Coupled - Ratio Z	**x3**:1	**z6** Ω

x values are transformer ratios. Relation to unity (1) is assumed. For a 2.5:1 step-up transformer, the x value is 2.5.
For a 0.1:1 step-down transformer, the x value is .1.

z values are the calibrated impedance value, expressed in ohms.

See (4.6.3.1.1) for details on this function.

:[SOURce:]IMPEDance:RESet Resets Programmable Output Impedance calibration values to the system defaults.

:[SOURce:]TRANSient:AUTO <b> Sets Transient WFs auto RMS mode.
b = <OFF>, <0> or <ON>, <1> (4.6.3.8)

5.4.2 SIGNAL ROUTING

:[SOURce:]FORM <n> Sets Output power form.
n = <1>Single Φ, <2>Split Φ, or <3>Three Φ

:[SOURce:]COUPLing <s> Sets Output coupling.
s = <DIRECT> or <XFMR>

:[SOURce:]VOLTage:ALC[:STATE] <b> The ALC keyword controls CSC enable/disable.
b = <OFF> or <ON> or <0>OFF or<1>ON

:SENSe:PATH <s> Selects source location for metering and CSC.
s = <0>Internal or <1>External

:OUTPut[:STATE] <b> Command: OUTPUT ENABLE. Opens or Closes the power source output relay.
b = <OFF> or <0>, <ON> or <1>.
Query: returns actual state of output relays, <0>OFF or <1>ON, not the OUTPUT ENABLE value

NOTE: Setting the OUTPUT POWER ON-AUTO/OFF switch (front panel of the power source) to OFF, overrides the OUTPUT ENABLE command.

5.4.3 WAVEFORM CONTROL

:PROGRAM:NAME <WFnn> selects waveform "nn" for loading or data query.
nn = 1 - 22 for data query or 2 - 22 for data defining (loading).

:PROGram:[SELected:]DEFine <data>
loads selected waveform (2-22) with data from the IEEE-488 Bus. The number of data elements must be 1024, representing 0-359.7 degrees in 0.3512º steps. Each element is a signed percentage of peak full scale voltage and may have a maximum of 2 decimal digits. Each element must be separated by a comma.
NOTE: Only commas may separate the values, NO Carriage Returns or Line Feeds may separate the values.
e.g., <0,+5.23,+10,-50,+20,+25.7,+30,-43.91,+100>

5.5 QUERY FUNCTIONS

The following are 'query only' functions sent to the UPC through the communication bus.

5.5.1 CONFIGURATION QUERIES

These query parameters cannot be set via the remote communication port. The values of each are specific to the hardware configuration of the individual power source.

:[SOURce]:XFMRRATIO? Query: Output XFMR ratio.
Returns <0.05> to <5.00> (3.7.1) and (4.6.3.3).

:[SOURce]:AVR? Query: Current transformer AMPS:VOLTS ratio.
Returns <1> to <500> (3.7.2) and (4.6.3.3).

:[SOURce]:CTLOC? Query: Current transformer location.
Returns <1> (PRIMARY) or <0> (SECONDARY) (4.6.3.7).

:[SOURce]:AMPLIFIERS? Query: Number of installed power amplifiers in Power Source (4.6.3.3).

:SENSe:CURRent:RANGe? Query: AMPS meter range.
Returns <0> to <AMPS meter range> RMS Amps

5.5.2 METERED DATA QUERIES

Measurement occurs once per :MEASure: command. AC measurements are assumed.

- The SCPI **:AC** keyword following **:MEASure** is optional and is not shown here.
- The "**?**" is optional, **:MEASure:** implies a query. Values following a command are ignored
- 'Multiple keyword' queries may be performed to obtain values of simultaneous measurements. e.g., **:MEASure:VOLTage1;VOLTage2;VOLTage3?**

:MEASure:VOLTage1? Query: metered voltage ΦA.
Returns <0> to <354> VAC RMS

:MEASure:VOLTage2? Query: metered voltage ΦB.
Returns <0> to <354> VAC RMS

:MEASure:VOLTage3? Query: metered voltage ΦC.
Returns <0> to <354> VAC RMS

:MEASure:VLL1? Query: metered Line to Line voltage ΦA - ΦB.
Returns <0> to <354> VAC RMS

:MEASure:VLL2? Query: metered Line to Line voltage ΦB - ΦC.
Returns <0> to <354> VAC RMS

:MEASure:VLL3? Query: metered Line to Line voltage ΦC - ΦA.
Returns <0> to <354> VAC RMS

5.5.2 METERED DATA QUERIES (continued)

:MEASure:FREQuency? Query: Metered frequency value.
Returns <15.00> to <1200> Hz.

:MEASure:CURRent[:RMS]1? Query: metered RMS current ΦA.
Returns <0> to <current meter range> AAC RMS

:MEASure:CURRent[:RMS]2? Query: metered RMS current ΦB.
Returns <0> to <current meter range> AAC RMS

:MEASure:CURRent[:RMS]3? Query: metered RMS current ΦC.
Returns <0> to <current meter range> AAC RMS

:MEASure:CURRent:PEAK1? Query: metered peak current ΦA.
Returns <0> to <current meter range> AAC Peak

:MEASure:CURRent:PEAK2? Query: metered peak current ΦB.
Returns <0> to <current meter range> AAC Peak

:MEASure:CURRent:PEAK3? Query: metered peak current ΦC.
Returns <0> to <current meter range> AAC Peak

:MEASure:CURRent:CREST1? Query: metered current Crest Factor ΦA.
Returns <0> to <1000>

:MEASure:CURRent:CREST2? Query: metered current Crest Factor ΦB.
Returns <0> to <1000>

:MEASure:CURRent:CREST3? Query: metered current Crest Factor ΦC.
Returns <0> to <1000>

:MEASure:POWer1? Query: metered Kilowatts ΦA.
Returns <0> to <1000> KW

:MEASure:POWer2? Query: metered Kilowatts ΦB.
Returns <0> to <1000> KW

:MEASure:POWer3? Query: metered Kilowatts ΦC.
Returns <0> to <1000> KW

:MEASure:KVA1? Query: metered KiloVoltAmps ΦA.
Returns <0> to <1000> KVA

:MEASure:KVA2? Query: metered KiloVoltAmps ΦB.
Returns <0> to <1000> KVA

:MEASure:KVA3? Query: metered KiloVoltAmps ΦC.
Returns <0> to <1000> KVA

5.5.2 METERED DATA QUERIES (continued)

:MEASure:PF1? Query: metered power factor (KW/KVA) ΦA.
Returns <0> to <1.0>

:MEASure:PF2? Query: metered power factor (KW/KVA) ΦB.
Returns <0> to <1.0>

:MEASure:PF3? Query: metered power factor (KW/KVA) ΦC.
Returns <0> to <1.0>

:FETCh[:WAVEform]:VOLT1?
:FETCh[:WAVEform]:CURRent1? Query: metered waveform data (line-to-neutral voltage only).
Use **:VOLT1** for ΦA, **:VOLT2** for ΦB, and **:VOLT3** for ΦC volts
Use **:CURR1** for ΦA, **:CURR2** for ΦB, and **:CURR3** for ΦC current
Returns a string of NR2 type numbers, comma delimited. Only a single waveform may be queried in a command.

:MEASure:SPECTrum:VOLT1[:MAGnitude]? (option: Harmonic Analysis and Synthesis)
[:ABSolute]? (option: Harmonic Analysis and Synthesis)
:MEASure:SPECTrum:CURRent1[:MAGnitude]? (option: Harmonic Analysis and Synthesis)
[ABSolute]? (option: Harmonic Analysis and Synthesis)
Query: waveform harmonic magnitudes
Use **:VOLT1** for ΦA, **:VOLT2** for ΦB, and **:VOLT3** for ΦC volts
Use **:CURR1** for ΦA, **:CURR2** for ΦB, and **:CURR3** for ΦC current
Returns a data set of 51, NR2 type numbers, comma delimited. The 1st element is the magnitude of the fundamental, for reference. The 2nd element is the 2nd harmonic, etc. The accuracy of harmonics may be limited by the FREQUENCY SPAN setting (4.3.1.1) and (5.4.1).
:MAG returns each magnitude as a percent of the fundamental.
:**ABS** returns absolute magnitude

:MEASure:SPECTrum:PHASe? (option: Harmonic Analysis and Synthesis)
Query: phase angles in degrees for the most recent harmonics data
Returns a data set of 51, NR2 type numbers, comma delimited. The 1st element is the angle of the fundamental, for reference. The 2nd element is the angle of the 2nd harmonic, etc. The previous **:MEASure:SPECTrum:** command defines which data are sent. If parameter was VOLT1 then the phase angles will be for VOLT1.

:MEASure:SPECTrum:THD? (option: Harmonic Analysis and Synthesis)
Query: Returns Total Harmonic Distortion of the most recent **:MEASure:SPECTrum:parameter** command, as above.

:MEASure:SPECTrum:OHD? (option: Harmonic Analysis and Synthesis)
Query: Returns Odd Harmonic Distortion of the most recent **:MEASure:SPECTrum:parameter** command, as above.

:MEASure:SPECTrum:EHD? (option: Harmonic Analysis and Synthesis)
Query: Returns Even Harmonic Distortion of the most recent **:MEASure:SPECTrum:parameter** command, as above.

5.5.3 EVENT and STATUS REPORTING

Events and device Status may be queried by the Bus Controller through the following registers and queues. Query commands are explicitly shown in this section for clarity.
NOTE: It is recommended that reading EVENT and STATUS registers and queues occur in the following order. Reading any register or queue is optional. Indents indicate a hierarchy.

1. STB register, read via Serial Poll or ***STB?**.
    2. ESR register, read via ***ESR?**.
        3. **SYSTem:ERRor?** queue.
    4. **STATus:OPERation:EVENt?** register.
    5. **STATus:QUEStionable:EVENt?** register.

NOTE: For most applications, the STB register and SYSTem:ERRor queue will satisfy status and error reporting.

5.5.3.1 IEEE-488.2 STATUS REPORTING

Both IEEE-488 and serial port communications with UPC support the status reporting standards. Query commands are explicitly shown for clarity. Refer to the ANSI/IEEE-488.2 1987 standard for more information.
NOTE: <NRf> indicates Numeric Response format. See (5.2) Conventions regarding <NRf>.

STATUS BYTE REGISTER (STB)
STATUS conditions reported by the STATUS BYTE may be queried via the IEEE-488 Bus Serial Poll function, or read directly using *STB?. The SRQ function will be invoked to signal the Bus controller that service is requested, when an unmasked STATUS BYTE bit goes true. Note that no SRQ is generated while in LOCAL CONTROL. *CLS clears the ESR and the STB (Figure 5.1).

The IEEE-488.2 Common Commands for **Status Reporting** from the UPC are:

BIT	NAME	DEFINITION
7	SOS	:STATus:OPERation register bit summary
6	MSS/RQS	- MASTER SUMMARY summarizes all STATUS BYTE bits (except bit 6) for *STB?, or, - REQUEST SERVICE indicates the device requested service when Serial Poll was performed.
5	ESB	STANDARD EVENT STATUS REGISTER bit summary
4	MAV	MESSAGE AVAILABLE indicates Query response data is available
3	SQS	:STATus:QUEStionable register bit summary
2	EEQ	ERROR/EVENT QUEUE indicates an SCPI Error/Event message is available
1	BUSY	indicates UPC front panel not in V/I mode
0	SHUTDOWN	indicates Power Source SHUTDOWN

Setting a SERVICE REQUEST ENABLE (SRE) bit true unmasks the STATUS bit in the STB. Bit 6 of the SRE is not applicable as the MASTER SUMMARY bit of the STB cannot be masked. The STB, SRE, ESR and ESE registers are 8 bits each.

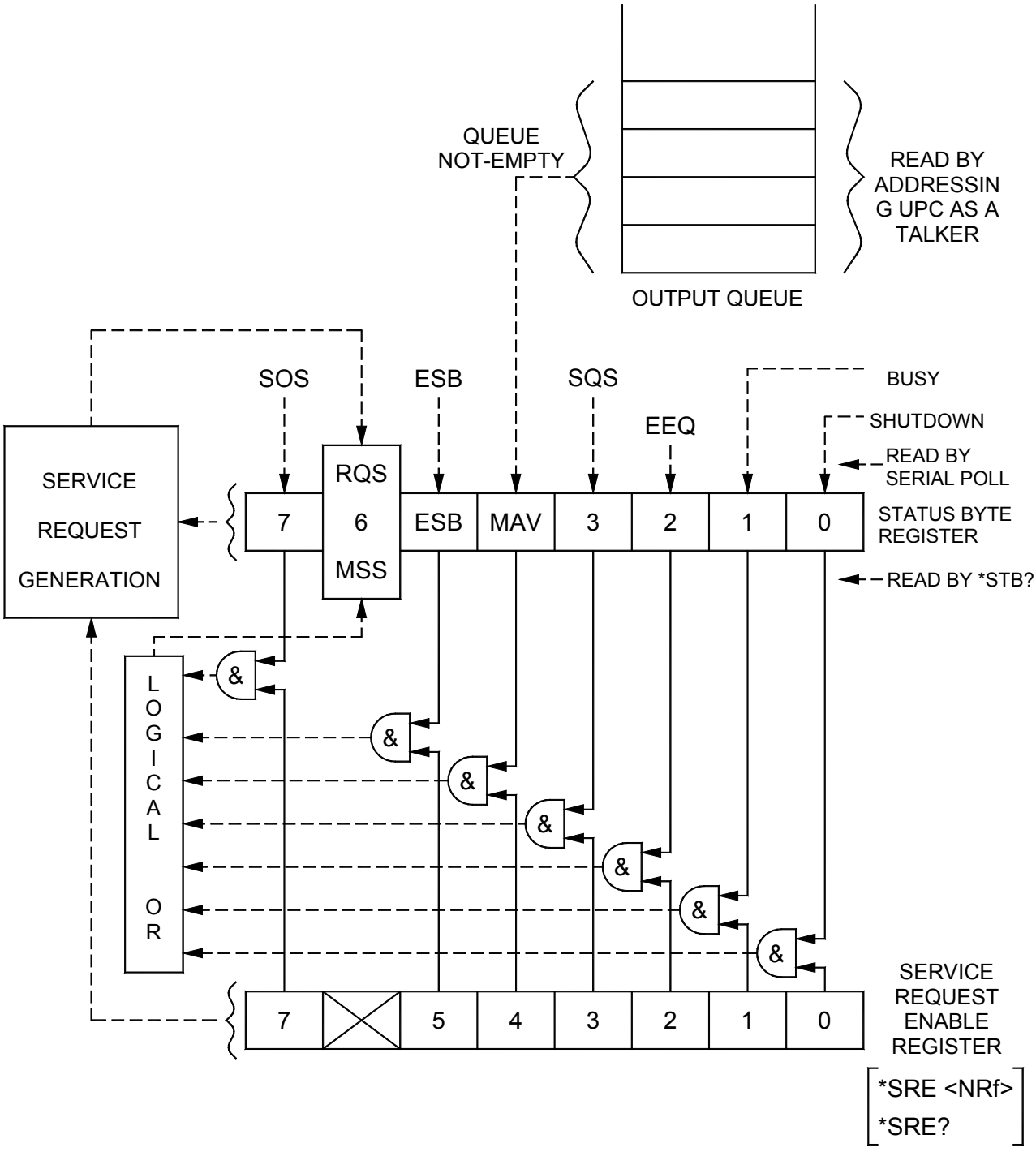


FIGURE 5.1 STATUS BYTE MODEL

5.5.3.1 IEEE-488.2 STATUS REPORTING (continued)

STANDARD EVENT STATUS REGISTER (ESR)

Events reported by the STANDARD EVENT STATUS register may be queried via the ***ESR?** command. Reading the ESR register clears it. The EVENT STATUS summary bit in the STATUS BYTE (STB) will be set when an unmasked EVENT STATUS bit goes true (Figure 5.2).

BIT	NAME	DEFINITION
7	PON	POWER ON indicates Input power was just applied
6	URQ	USER REQUEST indicates "LOCAL" key was just pressed
5	CME	COMMAND ERROR indicates invalid command or query received
4	EXE	EXECUTION ERROR indicates can't execute command with data received
3	DDE	DEVICE DEPENDANT ERROR indicates UPC not properly configured
2	QYE	QUERY ERROR indicates cannot respond with data
1	RQC	REQUEST CONTROL - not used
0	OPC	OPERATION COMPLETE indicates previous operation complete

Setting an EVENT STATUS ENABLE (ESE) bit true unmasks the EVENT bit in the ESR. Also see **:SYSTem:ERRor?** query for corresponding information.

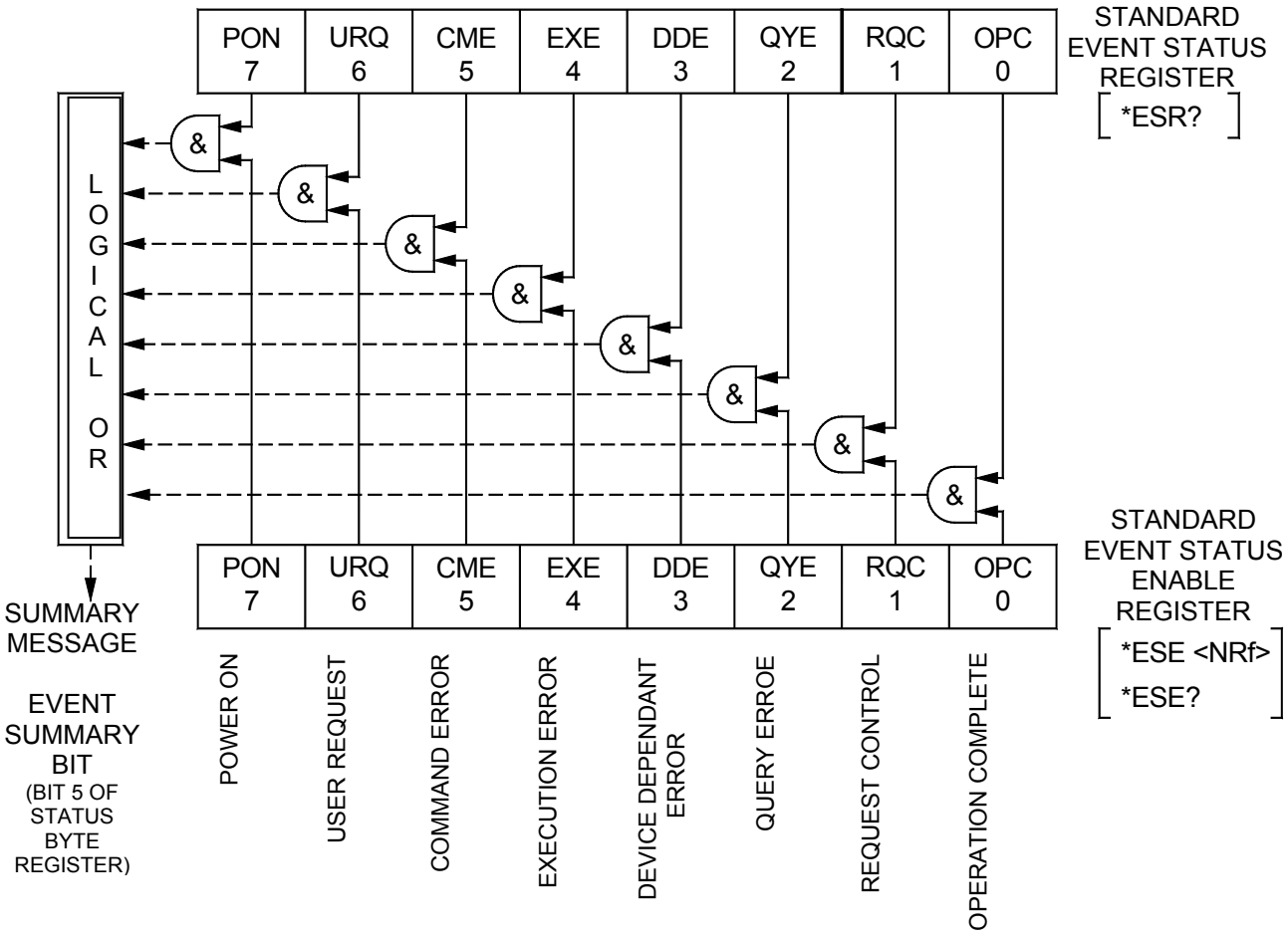


FIGURE 5.2 STANDARD EVENT REGISTER MODEL

5.5.3.1 IEEE-488.2 STATUS REPORTING (continued)

IEEE-488.2 STATUS REPORTING COMMANDS

NAME	DEFINITION
***IDN?**	Device Identification query. Returns <PPSC,UPC-M,vN.NN,1415XX> where M is the model number (1 or 3), N.NN is the firmware version number XX is the firmware assembly indicating installed options
***CLS**	Clears the ESR and the STB registers as well as the SCPI :EVENt registers and ERROR/EVENT queue
***STB?**	Read status byte query. Bit 0 is Power Source SHUTDOWN
***SRE <n>**	Service request enable command
***SRE?**	Service request enable query
***ESE <n>**	Standard event status enable
***ESE?**	Standard event status enable query
***ESR?**	Standard event status register query
***OPC**	Operation complete command
***OPC?**	Operation complete query

5.5.3.2 SCPI STATUS REPORTING

The following lists the SCPI Commands for **Status Reporting** from the UPC. Refer to the SCPI 1992 standard for more information. Query commands are explicitly shown in this section for clarity (Figure 5.3). See (5.2) Conventions regarding SCPI.

:SYSTem:ERRor? Query: system error

Returns one of the following types of messages, with details appended to it if possible. A maximum of 256 characters may be sent as a response to this query.

-0, "No error"	No error detected
-100, "Command error"	indicates invalid command or query received
-200, "Execution error"	indicates can't execute command with parameters received
-300, "Device-specific error"	indicates UPC not properly configured
-400, "Query error"	indicates query aborted

NOTE: The SYSTem:ERRor query clears the corresponding error bit in the ESR.

:SYSTem:VERSion? Query: SCPI version. Returns <1992.0>.

:SYSTem:SERIALNUMber? Query: Returns serial number string (1-15 characters). Note: The serial number is also displayed on the LCD display at power up.

5.5.3.2 SCPI STATUS REPORTING (continued)

The STATus:OPERation and STATus:QUEStionable registers provide information about the present mode of operation (Figure 5.3).

- Transition of a CONDition bit to the true state causes the EVENt bit to be set true.
- Unmasked ENABle bits allow an EVENt bit to be reported in the summary bit for that EVENt register in the STATUS BYTE register.
- Setting an ENABLe bit true unmasks the corresponding EVENt bit.
- Reading an EVENt register clears it.
- All :STATUS registers are 16 bits.

The STATus:OPERation registers provide information about the present mode of operation.

NOTE: Most bits in the following :STATus registers are not applicable to the UPC but are shown for reference and may be used for future product enhancements. The PROGram running bit (14) in the :STATus:OPERation registers indicates a stored program (PROGRAM# 1-99) is running.

:STATus:OPERation:CONDition? present condition query.

:STATus:OPERation:ENABle enables events to be reported in the SOS bit in the STB.

:STATus:OPERation:ENABle? STAT:OPER:ENABLE register query.

:STATus:OPERation:EVENt? latched condition query.

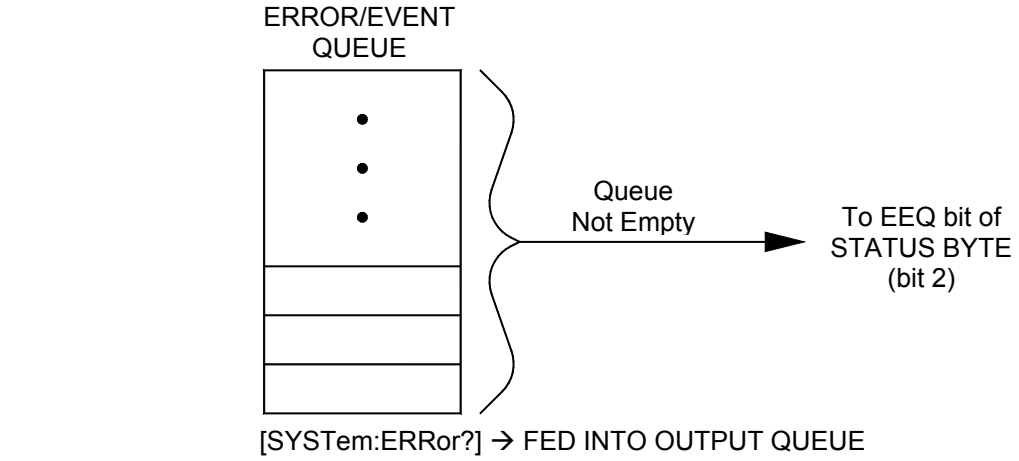
The STATUS:QUESTIONABLE registers provide information about errors and questionable measurements.
NOTE: All bits in the following :STATus registers are not applicable to the UPC but are shown for reference and may be used for future product enhancements.

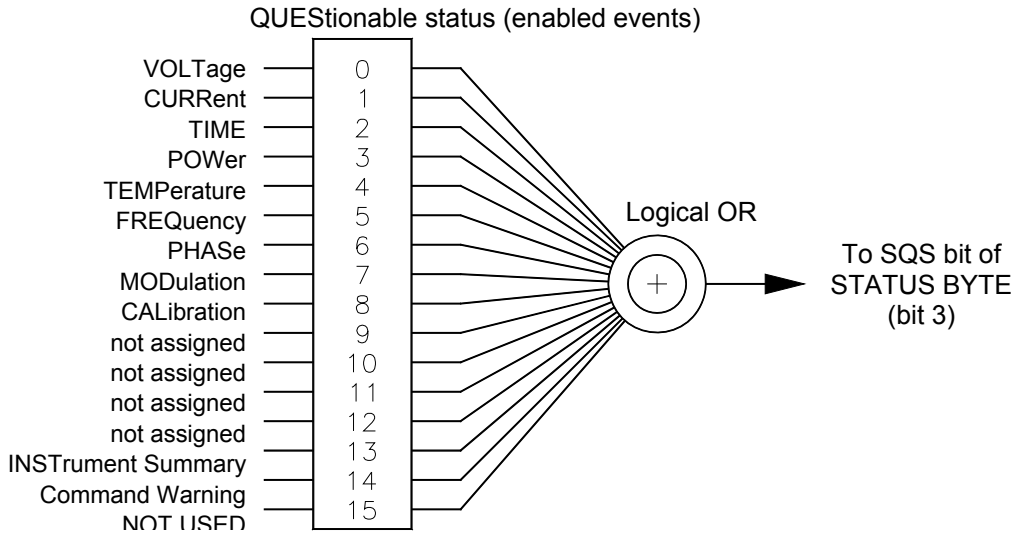
:STATus:QUEStionable:CONDition? present condition query.

:STATus:QUEStionable:ENABle enables events to be reported in the SQS bit in the STB.

:STATus:QUEStionable:ENABle? STAT:OPER:ENABLE register query.

:STATus:QUEStionable:EVENt? latched condition query.





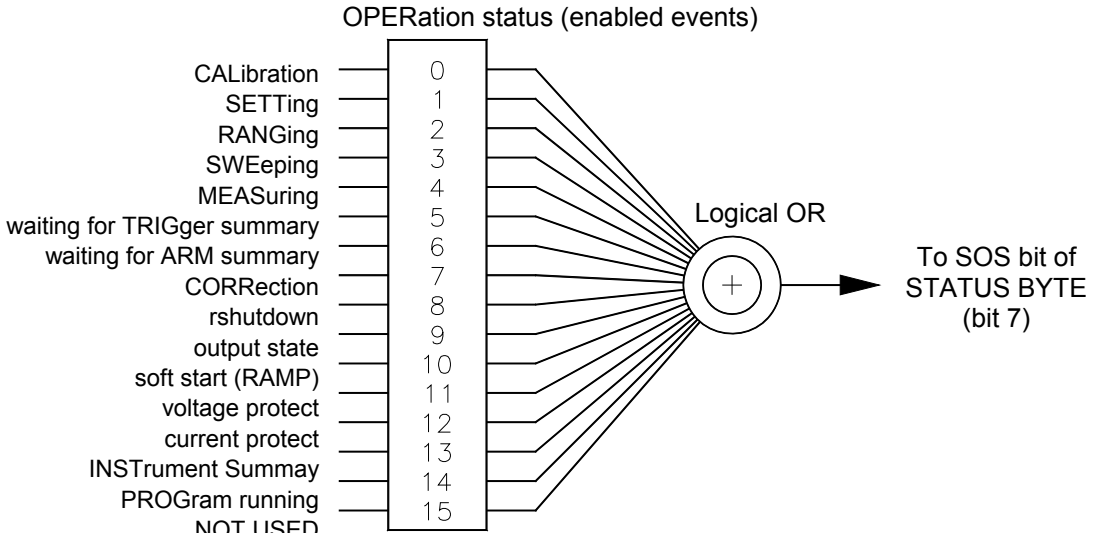


FIGURE 5.3 SCPI STATUS REGISTERS MODEL

5.6 DEVICE CONTROL

:SYSTem:BEEPer Command: sounds the front panel beeper once. No query.

:SYSTem:KLOCK <b> Command: sets the keyboard lock enable state (4.6.3.8).
b = .<1> enables keyboard lock; <0> disables keyboard lock.
Query: returns present lock enable state.

:CALibrate:ZERO Command: resets all Metering correction factors. No query.
UPC meters are then uncalibrated although still functional.
See Externally Referenced Calibration (8.2) for details.

:CALibrate:DATA <meter_int_Va, meter_int_Vb, meter_int_Vc,
meter_ext_Va, meter_ext_Vb, meter_ext_Vc,
meter_Ia, meter_Ib, meter_Ic>
Command: loads values measured with an external DVM and Ammeter for calibration of UPC metering. No query

- The first 3 values are Voltages measured at the output relay of the power source.
- The second set of 3 values are Voltages measured at the EXTernal Sense point (at the load).
- The third set of 3 values are Currents measured to the load.

NOTE: If FORM=1 is currently selected, **meter_Ia** is the Phase 1 current.
Loading a value of 0 will cause that metering parameter to be uncalibrated although it will still be functional. See Externally Referenced CALIBRATION (8.2) for more details.

:CALibrate:KFACTORS <k_int_Va, k_int_Vb, k_int_Vc,
k_ext_Va, k_ext_Vb, k_ext_Vc,
k_Ia, k_Ib, k_Ic
k_oscA, k_oscB, k_oscC >
Command: directly loads calibration factors for UPC metering.

- The first 3 values are Voltage kFactors for the INTernal sense metering of the power source.
- The second set of 3 values are Voltage kFactors for the EXTernal Sense point (at the load).
- The third set of 3 values are current (amperes) kFactors
- The fourth set of 3 values are the oscillator gain kFactors

NOTE: The values apply only to the presently set output FORM. If FORM=1 is currently selected, **k_Ia** is the Phase 1 Current kFactor. Refer to (8.2.1) for more information about kFactors.
Query: Returns the presently stored kFactors.

:CALibrate:KFACTORS:ALL **<k_int_V1, NAN, NAN, k_ext_V1, NAN, NAN, k_I1, NAN, NAN, k_osc1, NAN, NAN,**
k_int_V2, NAN, NAN, k_ext_V2, NAN, NAN, k_I2, NAN, NAN, k_osc2, NAN, NAN,
k_int_Va, k_int_Vb, k_int_Vc, k_ext_Va, k_ext_Vb, k_ext_Vc, k_Ia, k_Ib, k_Ic,k_oscA, k_oscB, k_oscC >

Query: Returns all kFactors without having to specify the Form

5.6.1 IEEE-488.1 INTERFACE FUNCTIONS

The following lists the IEEE-488.1 capabilities of the UPC. Refer to the ANSI/IEEE-488.1 1987 standard for more information.

FUNCTION MNEMONIC	**REMOTE MESSAGE RECEIVED** / Description
SH1	Source handshake functions
AH1	Acceptor handshake functions
T6	**MTAnn** - Talker subset 6. nn is GPIB device address 0-30
L3	**MLAnn** - Listener subset 3. nn is GPIB device address 0-30
SR1	Service request/Serial Poll functions **SPE** - Serial Poll Enable **SPD** - Serial Poll Disable
RL1	Local/Remote functions **GTL** - Go To Local **LLO** - Local Lockout
DC1	Device clear functions **DCL** - causes a hardware RESET of the UPC **SDC** - Same as DCL but device must be addressed
DT1	Device Trigger function **GET** - Group Execute Trigger message executes Transient Events (if any), of currently executed program
PP0	No Parallel Poll functions
C0	No Controller functions
E1	Electrical interface Type 1
IFC	InterFace Clear (**IFC**) sets the UPC IEEE-488 bus interface to an idle state. The data input and data output buffers remain unchanged

5.6.2 IEEE-488.2 DEVICE CONTROL COMMANDS

The following lists the IEEE-488.2 Common Commands for **Device Control** of the UPC. Refer to the ANSI/IEEE-488.2 1987 standard for more information.

***RST** Command: RESET. Initialize the UPC with the following parameters:

CSC	OFF
CURRENT LIMIT	CURRENT METERING RANGE
INITIAL VOLTAGE	0
KEYBOARD LOCK	OFF
MAX FREQUENCY	1200 Hz.
MAX VOLTS	600 V
MIN FREQUENCY	45 Hz.
MIN VOLTS	0 V
MODE	MANUAL
OUTPUT	DISABLED
OUTPUT COUPLING	DIRECT
OUTPUT FORM	1 or 3 (depending on model)
OUTPUT FREQUENCY	60 Hz.
OUTPUT VOLTAGE(S)	0
PHASE ANGLE B	120º
PHASE ANGLE C	240º
PROG.Zo	OFF
RANGE CONTROL	AUTO
SENSE	INTERNAL
TRANSITION TIME	0
WAVEFORM ΦA	1
WAVEFORM ΦB	1
WAVEFORM ΦC	1

NOTE: Stored programs are not erased. FREQUENCY SPAN is not changed.

***TST?** Query: Self test. Test validity of non-volatile RAM.
Returns 0 if no error.

***WAI** Command: Wait-to-continue. Only useful following the :PROG:EXEC:TRANS or *TRG commands. All other commands are executed sequentially as the Program Message is parsed.

***TRG** Command: IEEE-488.2 Device trigger function. Executes Transient Events (if any), of currently executed program.

***LLO** Command: LOCAL LOCKOUT. Puts the UPC into REMOTE mode and disables local operation of the UPC keyboard.

***GTL** Command: GOTO LOCAL. Enables local operation of the UPC keyboard.

***DCL** Command: DEVICE CLEAR. Performs a hardware RESET of the UPC.

5.7 REMOTE CONTROL EXAMPLES

The REN (remote enable) line on the bus interface must be kept true to maintain REMOTE CONTROL. REMOTE CONTROL can only be initiated while the UPC is displaying a Metering display or while in the UPC STATUS display, not while editing.

See (10.0) for setting up the SERIAL INTERFACE parameters.

If the GPIB option is installed, be sure that the UPC GPIB device address is set to a known unique address within any GPIB system. The factory default device address is 1. See (4.6.3.3) for configuration of the GPIB device address.

Optional keywords have been omitted throughout this section for clarity. The command strings may contain spaces.

NOTE: Un-address means to send the UNTALK and UNLISTEN messages. This is only applicable for the GPIB, NOT the serial option. With many programming languages that support GPIB communications, listener and talker addressing and un-addressing is handled automatically and is transparent to the user. Check your programming language or driver documentation for verification.

NOTE: <eos> should be a LINE FEED (0Ahex, 10dec). See GPIB convention #16 (5.2) for more details.

CAUTION

ALL :SOURce PARAMETERS SHOULD BE SET
PRIOR TO ENABLING THE OUTPUT FOR THE FIRST TIME
AFTER POWER-ON OR AFTER RESETTING THE UNIT.

THE PARAMETERS MAY BE SET INDIVIDUALLY OR
BY USING :DEFine AND :EXECute OF A STORED PROGRAM

SEE PARA. 5.7.1, 5.7.3 AND 5.7.5

5.7.1 EXAMPLE OF STORING A PROGRAM

Step A. Address the UPC as a listener.

:PROGram:NAME 1 <eos> Step B. Select Program 1.
NOTE: <eos> is a LINE FEED (0Ahex, 10dec).

Step C. Define program 1. Program 1 consists of steady-state and optional transient segment parameter names and values. This is one continuous string of commands and parameters.
NOTE: Only commas may separate the values, NO Carriage Returns or Line Feeds may separate the values as transmitted.

:PROGram:DEFine **FORM,3,**
COUPLing,DIRECT,
XFMRRATIO,1.0,
FREQuency,60,
VOLTage1,115,
VOLTage2,115,
VOLTage3,115,
CURRent:LIMit,10
PHASe2,120,
PHASe3,240,
WAVEFORM1,1,
WAVEFORM2,1,
WAVEFORM3,1,
EVENTS,0,

OPTIONAL TRANSIENT PARAMETERS
SEGment,1,
FSEG,60,
VSEG1,120,
VSEG2,120,
VSEG3,120,
WFSEG1,1,
WFSEG2,1,
WFSEG3,1,
TSEG,.01,
LAST<eos>

Step D. Un-address UPC.

5.7.2 EXAMPLE OF PROGRAM QUERY

Step A. Address the UPC as a listener.

:PROGram:NAME 1 <eos>

Step B. Select Program 1.
NOTE: <eos> is a LINE FEED (0Ahex, 10dec).

:PROGram:DEFine? <eos>

Step C. Query Program 1.
Program 1 consists of steady-state and optional transient segment parameter names and values. This Query returns steady-state values of the selected program and segment values of the most recently selected segment (see NOTE 1). "LAST" is returned with segment data if the segment is the last segment in the program.

Step D. Address the UPC as talker, read back the response string.
NOTE: Only commas separate the values, NO Carriage Returns or Line Feeds separate the values as received.

STEADY-STATE OUTPUT PARAMETERS returned

FORM,3,
COUPLing,DIRECT,
XFMRRATIO,1.0,
FREQuency,60,
VOLTage1,115,
VOLTage2,115,
VOLTage3,115,
CURRent:LIMit,10
PHASe2,120,
PHASe3,240,
WAVEFORM1,1,
WAVEFORM2,1,
WAVEFORM3,1,
EVENTS,0,
NSEGS,1,

NOTE: To query transient segment data (5.3.1), NSEGS.

OPTIONAL TRANSIENT PARAMETERS returned

SEGment,1,
FSEG,60,
VSEG1,120,
VSEG2,120,
VSEG3,120,
WFSEG1,1,
WFSEG2,1,
WFSEG3,1,
TSEG,.01,
LAST<eos>

Step E. Un-address UPC.

5.7.3 EXAMPLE OF EXECUTING A STORED PROGRAM

Step A. Address the UPC as a listener.

:PROGram:NAME 1 <eos> Step B. Select Program 1.
NOTE: <eos> is a LINE FEED (0Ahex, 10dec)

:PROGram:EXECute <eos> Step C. Execute Program.

Step D. Un-address UPC.

5.7.4 EXAMPLE OF EXECUTING A STORED PROGRAM TRANSIENT

Step A. Address the UPC as a listener.

:PROGram:NAME 1 <eos> Step B. Select Program 1 for executing.

:PROGram:EXECute <eos> Step C. Execute Program.

:PROGram:EXECute:TRANS <eos> Step D. Execute Transient.

Step E. Un-address UPC.

5.7.5 EXAMPLE OF DIRECTLY CHANGING THE OUTPUT PARAMETERS

Change Frequency and Volts for all phases then ENABLEs the OUTPUT.

Step A. Address the UPC as a listener.

:FREQuency 50 <eos> Step B. Change Frequency to 50 Hz.

:VOLTage 117 <eos> Step C. Change Volts to 117 VAC RMS for all phases.

:OUTPut ON <eos> Step D. ENABLES the OUTPUT.
The OUTPUT POWER switch must be in the ON/AUTO position to allow power to be applied to the load.

Step E. Un-address UPC.

An alternative to steps B, C and D above is:

:FREQ 50; :VOLT 117; :OUT ON<eos> This example uses all shortform keywords in one Program Message. The OUTPUT POWER switch must be in the ON/AUTO position to allow power to be applied to the load.

- or -

:OUTPut OFF <eos> Turns the output OFF.

5.7.6 EXAMPLE OF VOLTAGE and CURRENT MEASUREMENT QUERY

How to query the UPC for three phase RMS volts (Line to Neutral) and RMS current metered values.

LINE to LINE volts, KVA, KW, Power Factor, CURRENT Crest Factor, and Peak Current may also be queried in the same way.

See the **:FETCH** command and example for obtaining metered waveform data.

Step A. Address the UPC as a listener.

Step B. Select Voltages A,B,C and Load Current A,B,C for AC-RMS query by sending the following command.

:MEAS:VOLT1;VOLT2;VOLT3;CURR1;CURR2;CURR3? <eos>

NOTE: <eos> is a LINE FEED (0Ahex, 10dec).

All parameters will be measured simultaneously upon receipt of the :MEAS: command. This may take several hundred milliseconds depending upon Frequency and other factors. The values are not stored in the UPC and another :MEAS: command will re-measure the values, further delaying response.

Step C. Address the UPC as a talker to read back a query response string, similar to the following example, representing the three voltages and currents.

120.2,120.3,121.0,3.2,2.9,3.0<eos>

Step D. Un-address UPC.

5.7.7 EXAMPLES OF VOLTAGE and CURRENT WAVEFORM QUERY

This is an example of how to query the UPC for metered waveform values for phase A voltage and current.

Step A. Address the UPC as a listener.

Step B. Select Voltage A and Load Current A for waveform query by sending the following command.

:FETCh:VOLTage1? <eos>
:FETCH:CURRent1? <eos>

NOTE: <eos> is a LINE FEED (0Ahex, 10dec).

NOTE: To obtain waveform data corresponding with the values retrieved by a :MEASure query, this command should immediately follow the :MEASure query in one Program Message (example shown below).

NOTE: All parameters will be measured simultaneously upon receipt of the :FETCH query. This may take several hundred milliseconds depending upon Frequency and other factors. The values are not stored in the UPC and another :FETCH? command will re-measure the values.

Step C. Address the UPC as a talker.
The UPC returns a string representing the last metered waveform data. Each waveform consists of a string of NR2 type numbers separated by commas. The number of data points returned in each waveform is equal to the number of metering samples, as determined by the FREQUENCY SPAN (2.1.1).

Step D. Un-address UPC.

An example command (substitute for step B above) for obtaining simultaneous RMS voltage and current values and waveforms for PHASE A is as follows.

:MEASure:VOLTage1?;:FETCh:VOLTage1? <eos>
:MEASure;CURRent1?;:FETCH:CURRent1? <eos>

SECTION 6

MAINTENANCE

6 MAINTENANCE

No maintenance is required for the UPC controller.

See the AMX, ASX, G, or MS series power source Operator's Manual for proper maintenance of the power systems.

SECTION 7

SERVICE

7 SERVICE

There are no user serviceable components in the UPC assembly. Pacific Power Source maintains a staff of highly trained technicians which are able to assist with diagnosing abnormal operation of the UPC. If questions arise, please call the factory at 1-800-854-2433 (8am to 5pm PST, California, U.S.A.).

SECTION 8

CALIBRATION

8 CALIBRATION

This section describes calibration of a UPC. To fully calibrate the SYSTEM for output voltage and metering accuracy, it is necessary to perform a complete EXTERNALLY REFERENCED CALIBRATION.

The Exterally Referenced Calibration requires NO manual adjustment or access of internal circuits. Externally Referenced Calibration achieves high calibration accuracy of the oscillator and metering circuits. This procedure must be performed in order for the CSC (Continuous Self Calibration) function to operate accurately as accurate metering assures that the CSC function will be able to track the programmed value.

8.1 CALIBRATION INTERVAL

Accurate control and measurement requires calibration every six months or after any service.

8.1.1 TEST EQUIPMENT REQUIREMENTS

The test equipment listed below is required for calibration of the UPC installed in a Power Source.

1. Digital Voltmeter: 4½ Digit True-RMS responding, 1200 Hz. bandwidth, min.
2. Frequency counter: 5 digit counter, min.
3. Oscilloscope: (Optional)
4. High current load (capable of 60% Peak rated output current of power source)
5. Ammeter probe (Shunt type preferred) or ammeter capable of reading RMS amps.

8.2 EXTERNALLY REFERENCED CALIBRATION

The UPC is designed to be easily calibrated in the field. Calibration may be required in order to ensure that the EXECUTEd voltage produced by the power source is the same as the COMMAND voltage, that the CSC function is able to precisely match the output voltage of the power source to the programmed command voltage, and that the metered values correctly represent the actual output. Potential sources of error which may cause difference between these are:

a) Drift in oscillator signal level.
b) Power Amplifier gain drift.
c) Output transformer turns ratio error. i.e. Actual turns ratio different from encoded turns ratio.
d) Difference between INT SENSE metering circuit and EXT SENSE metering circuit.
e) Internal metering inaccuracy.

8.2 EXTERNALLY REFERENCED CALIBRATION (continued)

Since the UPC display can show both PROGRAM (Command) and METERED voltages, these errors will be apparent - if they occur - as a slight difference between the two voltages. Only basic metering inaccuracy will not reveal itself on the display.

To calibrate the UPC, it will be necessary to:

1. Set up the UPC to generate output voltage and current.

2. Measure the voltages and currents on all phases using an external Voltmeter and Current Meter that have been calibrated to a traceable standard (i.e., NBS, NIST), and are at least 2x as accurate as the UPC metering (see (2.0), SPECIFICATIONS)

3. Enter the measured values into the UPC via the keyboard or Remote Interface.

The UPC then creates the required calibration factors (kFactors,) and stores them in memory. The kFactors can be viewed on the display by pressing ***fn***, **4**, **3,** (8.2.1), or through the control bus (5.6), **:CALibrate:KFACTORS**).

Typically, calibration is performed with output settings of 60 Hz. and 120 volts. Because of the precision and stability of the system, the calibration factors are the same for all other values of volts and frequency. For convenience, or if precision at a particular setting is needed, the system may be calibrated at any frequency, voltage and current desired. Calibration of current metering is based on the Load Current set by the user. Therefore a nominal Load Current should be chosen for this calibration process.

NOTE: Only RMS voltages and currents are corrected.

NOTE: If the Programmable Impedance Option is installed, it must also be calibrated, (4.6.3.1.1) or (5.4.1), :[SOURce]:IMPEDance:CAL.

WARNING

OBSERVE THE FOLLOWING WHEN CALIBRATION IS REQUIRED:

1) REMOVE ALL JEWELRY FROM ARMS AND NECK WHEN CALIBRATING EQUIPMENT. THIS PREVENTS THE POSSIBILITY OF SHORT CIRCUIT THROUGH THE JEWELRY, CAUSING BURNS TO, OR ELECTROCUTION OF, THE OPERATOR.

2) WEAR SAFETY GLASSES TO PREVENT EYE INJURY DUE TO FLYING PARTICLESCAUSED BY ACCIDENTAL SHORT CIRCUIT CONDITIONS.

3) DO NOT REMOVE ANY PANELS OR COVERS WITHOUT FIRST OPENING ALL CIRCUIT BREAKERS AND THEN REMOVING THE INPUT SERVICE.

8.2 EXTERNALLY REFERENCED CALIBRATION (continued)

To calibrate the UPC:

1. Apply power to the power source and UPC.

2. Display the 'CALIBRATION' menu. Press ***fn***, **4**

```
CALIBRATION MENU:
1 RESET ALL KFACTORS
2 EXTERNALLY REFERENCED CALIBRATION
3 KFACTOR DISPLAY
```

3. Press **2** to select EXTERNALLY REFERENCED METER CALIBRATION

```
Φ   INT.V-SENSE   EXT.V-SENSE |   I1 0.00
A    0.000         0.000      |  Ia 0.00
B    0.000         0.000      |  Ib 0.00
C    0.000         0.000      |  Ic 0.00
```

4. Enter the measurements taken with external test equipment (voltmeter, ammeter) for each parameter shown on the UPC display. All measurements taken are to be AC RMS (True RMS metering is absolutely necessary), Line to Neutral only for voltages.

5. Upon completion, press **EXECUTE**.

The UPC has separate current metering circuits for FORM 1 (single phase) and for FORM 2 and FORM 3. In order to fully calibrate all current meters for all power forms, this procedure must be performed twice.

UPC-1
a. Operate the power source in FORM 1 to calibrate `I1` (single phase).
b. Operate the power source in FORM 2 (Vab) to calibrate `Iab` (single/split phase).

UPC-3
a. Operate the power source in FORM 1 to calibrate `I1` (single phase).
b. Operate the power source in FORM 3 to calibrate `Ia, Ib` and `Ic` (three phase).

Only the phases existent need to have values entered. If a phase parameter is not used or is not available as in the case of a 1 or 2 phase power source, the phase C parameters should be set to 0. Entering 0 for a parameter causes the correction factor (kFactor) for that parameter to be set to the default value, 1.0000 .

NOTE: Only the values pertaining to the present output FORM will be displayed.
Voltages are AC RMS, **LINE-NEUTRAL for FORM 1 & 3, LINE-LINE (A-B) FOR FORM 2 voltages**.
Currents are AC RMS.

Each time a non-zero value is entered, the UPC measures the output signal for that parameter and compares it against the entered external meter calibration value. A new calibration factor (kFactor) is then calculated and used to correct the meter display for that value.

If a value for a parameter is not keyed in, the existing calibration factor will not be re-calculated. The correction factors are stored in Battery-backed memory (RAM) until the memory is lost or cleared.

8.2.1 K FACTOR DISPLAY

The correction factors (kFactors) created during EXTERNALLY REFERENCED CALIBRATION may be displayed or modified directly, from the kFactors display screen. Activate the CALIBRATION Menu (***fn,* 4**), press **3** and the kFactor display appears as shown below.
(FORM 3 display shown).

```
Kin A:1.0000 B:1.0000 C:1.0000
Kex A:1.0000 B:1.0000 C:1.0000
Ki  A:1.0000 B:1.0000 C:1.0000
Ko  A:1.0000 B:1.0000 C:1.0000
```

Kin - are the kFactors for internal voltage sensing of phase A, B and C.
Kex - are the kFactors for external voltage sensing of phase A, B and C.
Ki - are the kFactors for current sensing of phase A, B and C.
Ko - are the oscillator gain kFactors.

It is recommended that the kFactors are reset to 1.000 before calibration. The new kFactor is then the ratio of the external metered value to the UPC meter display value. This minimizes error and will provide the best results.

$$\text{new kFactor} = \left(\frac{\text{test equipment value}}{\text{UPC meter display value}} \right)$$

To manually calculate and revise a particular existing kFactor,

1. observe the UPC meter display value
2. use the following equation to calculate the new kFactor:

$$\text{new kFactor} = \text{old kFactor} \times \left(\frac{\text{test equipment value}}{\text{UPC meter display value}} \right)$$

8.2.2 RESET ALL KFACTORS

Resets all kFactors to the factory default (1.000). Activate the CALIBRATION Menu (***fn,* 4**), press **1** and the kFactor reset warning appears as shown below.

```
WARNING: RECALIBRATION REQUIRED
PRESS "EXECUTE" TO CONTINUE
PRESS "CLEAR" TO CANCEL
```

WARNING: You will have to recalibrate your power source.

SECTION 9

USER DIAGNOSTICS

9 USER DIAGNOSTICS

This section is intended to aid the user in solving common problems that may occur while using the UPC.

PROBLEM

Incorrect or illogical operation,
or program values invalid,
or "NO PROGRAM RUNNING",
or "FPERR" is displayed.

PROBABLE CAUSE:
UPC memory has become corrupt.

SUGGESTED CURE:
Clear ALL RAM and RESET CPU.
Refer to (4.6.1.3) to perform this function.

To prevent the UPC from executing program parameters upon power-up, hold the **fn** key down while applying power with the INPUT POWER switch. You may then press **fn** again to enter the SETUP mode.

If after Reset, the unit functions properly but the problem recurs after being powered-down, the battery that maintains the RAM data probably needs to be replaced.

PROBLEM

LCD Display not readable

PROBABLE CAUSE:
UPC memory has become corrupt.

SUGGESTED CURE:
Clear ALL RAM and RESET CPU.

Refer to (4.6.1.3) to perform this function.

9 USER DIAGNOSTICS (continued)

PROBLEM

ERROR Message states

"ERROR - PROGRAMMED OUTPUT VOLTAGE VALUE EXCEEDS OUTPUT VOLTAGE RANGE. CHANGE VOLTAGE, COUPLING or WAVEFORM."

PROBABLE CAUSE:
RMS content of selected Waveform is not great enough to produce programmed voltage, requiring more system gain than is available.

If this type of error occurs when the UPC calculates segment step data for a transient program, the segment just prior to the one indicated as erroneous may contain a voltage which cannot be achieved by the segment indicated (because the active segment may be ramping from a voltage set in the previous segment).

SUGGESTED CURE:
Change programmed Voltage, or change Coupling (to XFMR coupled with a higher voltage range (VR)), or change the selected waveform (either by editing the Waveform or selecting a Waveform with a greater RMS content). See (4.6.2.1) to edit a Waveform.

For this problem with transient segments, you may have to reduce the voltage in the segment prior to the one indicated as having the error as well as the one indicated as having the error.

PROBLEM

KEYS BEEP when pressed
but display does not respond.

PROBABLE CAUSE:
UPC is in REMOTE CONTROL
(check the REMOTE LED on the keyboard)

SUGGESTED CURE:
Change to LOCAL CONTROL by pressing the **LOCAL** key. If the REMOTE LED remains ON then the REMOTE INTERFACE controller has put the UPC into LOCAL LOCKOUT (LLO). Use the REMOTE INTERFACE controller to send the GOTO LOCAL (GTL) message or clear the REN (REMOTE ENABLE) signal from the GPIB controller. Turning the INPUT POWER to OFF will also restore LOCAL CONTROL.

9 USER DIAGNOSTICS (continued)

PROBLEM

KEYS do not respond at all.

PROBABLE CAUSE:
Keyboard is locked

SUGGESTED CURE:
Press **fn** and **EDIT** keys to unlock keyboard (4.6.3.8).

PROBLEM

UPC does not respond to the GPIB

PROBABLE CAUSE #1:
The front panel LCD does not show the V/I meter display.

SUGGESTED CURE #1:
Press the **CLEAR** key to show the V/I meter display.

PROBABLE CAUSE #2:
GPIB device address incorrect or not unique

SUGGESTED CURE #2:
Verify that the device address selected within the GPIB controller software matches the GPIB device address within the UPC. There may only be a single device at each GPIB address. Refer to (4.6.3.3) (UPC STATUS display) to verify or set the GPIB device address within the UPC.

You may also use the UPC STATUS display to verify receipt of an INTERFACE CLEAR (IFC) by the UPC from a GPIB controller. Refer to (4.6.3.3) (UPC STATUS display) for usage of the IFC field.

The "LAST DATA BYTE" field indicates the data byte received by the UPC from the GPIB when the UPC was addressed as a listener. Normally if a properly terminated command string was received by the UPC, the LAST DATA BYTE received should be 0Ah (a Line Feed). The Line Feed character or END signal (EOI) is the proper end of string <eos> terminator. Refer to (4.6.3.3) (UPC STATUS display) for usage of the LAST DATA BYTE field.

Characters sent one at a time to the UPC via the GPIB when the UPC is addressed to “listen” will be displayed in the LAST DATA BYTE field.

9 USER DIAGNOSTICS (continued)

PROBLEM

UPC does not respond to serial port commands
or
responds with a COMMAND ERROR message.

PROBABLE CAUSE #1:
The front panel LCD does not show the V/I meter display.

SUGGESTED CURE #1:
Press the **CLEAR** key to show the V/I meter display.

PROBABLE CAUSE #2:
Incorrect communication parameters, i.e., Serial baud rate, parity or number of data/start/stop bits.

SUGGESTED CURE #2:
Verify parameter settings match that of host computer (10.3), (10.4).

PROBABLE CAUSE #3:
Handshaking signals may not be wired correctly.

SUGGESTED CURE #3:
Verify handshake signals are connected properly. See (10.4.1) for additional help

SECTION 10

SERIAL REMOTE INTERFACE OPTION

10 SERIAL REMOTE INTERFACE OPTION

This section describes using the optional Serial Remote Interface of the UPC. This section is intended to be used in conjunction with (5.0) of this Operation Manual.

10.1 GENERAL

The Serial Remote Interface of the UPC is the standard communication port for the UPC-3 and UPC-1. See (10.3) for setup information. An optional GPIB/IEEE-488 parallel communication port may be installed in place of the serial port. Check the connector label at the rear of the unit to determine which interface is installed.

10.2 SERIAL PORT SPECIFICATIONS

The Serial Remote Interface of the UPC is compatible with the ANSI/IEEE-488.2, SCPI and RS-232C standards. It loosely adheres to the RS-232C standard as some interfacing requirements of that standard are not necessary.

This Remote Interface of the UPC has the following communication characteristics:

1. Selectable **BAUD RATES** of:
   - 38400 BAUD
   - 19200 BAUD (default)
   - 9600 BAUD
   - 4800 BAUD
   - 2400 BAUD
   - 1200 BAUD
   - 300 BAUD

2. Selectable **PARITY** of ODD, EVEN or NONE (default).

3. Selectable **EOS** (End Of String) Terminator CR, LF or CR/LF (default): Sets the EOS sent from the UPC. The UPC accepts any of the above combinations when receiving.

4. 8 Data bits, 1 Start bit, 1 Stop bit.

5. HANDSHAKE: None.
   The Serial Remote interface of the UPC-1 and UPC-3 has no Handshake. This is a simple 2 wire interface.

6. Operation is HALF-DUPLEX (per IEEE-488.2).

   Refer to (10.6) below for Pinouts and Signal names.

10.3 SETUP

After installing the Serial Interface into the UPC - OR - after erasing all program memory – OR - after system RESET, the serial communication parameters must be set (BAUD RATE, PARITY and EOS Terminator) as follows:

1. Press the ***fn*** key, select **GENERAL SETUP** then **UPC STATUS**.

2. Press the **EDIT** key and type the desired **BAUD RATE** numerically, selected from the list above. Then press **ENTER**.

3. Select the **PARITY** by pressing the **+/-** key until the desired selection (NONE, ODD or EVEN) is shown. Then press **ENTER**.

4. Select **EOS** (End Of String) Terminator by pressing the **+/-** key until the desired selection (CR/LF, LF or CR) is shown. Then press **ENTER**.

5. Press **STORE**.

NOTE: Incorrect communication parameters may result in the UPC displaying a:
PARITY ERROR,
FRAMING ERROR, and/or
OVERRUN ERROR.

Sending a BREAK signal will result in a BREAK RCVD message and will terminate data transmission in progress from the UPC.

10.4 OPERATION

Operation of the UPC via Remote Serial Interface consists of utilizing the same commands available for the IEEE-488 interface (5.0) except as noted in (10.4.1), (10.4.2), and (10.4.3).

NOTE: Normally the UPC is in the LISTENER mode. When the UPC is Queried for information, the UPC automatically enters the Talker mode until the response data is sent or another command is sent from the Host.

10.4.1 COMMUNICATION MONITORING AID

The UPC STATUS Display (***fn***,**3**,**3**) displays "LISTENER" while data is being received from the HOST, or "TALKER" if a Query response (Message Available) is available and has not yet been completely sent by the UPC.

The UPC STATUS Display will display the LAST DATA BYTE received from the HOST. Carriage Returns (0Dhex) are displayed as Line Feeds (0Ahex).

This monitoring aid is not updated as fast as serial communications can occur, therefore sudden changes on the Serial Interface may not be seen on the UPC display.

The UPC 1 and UPC 3 controllers do not support RTS/CTS.

10.4.2 FUNCTIONAL EXCEPTIONS

Some functions applicable with the IEEE-488 interface are **NOT** applicable with the Serial Interface. Specifically they are the following:

1. All IEEE-488.1 interface functions (5.6.1).

2. IEEE-488.2 commands: ***SRE** and ***SRE?**, are ignored, as Service Requests and Serial Polls are not applicable (5.5.3.1).
   (Use ***STB?** to obtain the Status Byte.)

10.4.3 FUNCTIONAL ADDITIONS

The following commands have been **added** to replace functions lost due to the removal of the IEEE-488.1 GPIB. These commands are similar to the IEEE-488.2 Common Commands and fall into the category of DEVICE CONTROL COMMANDS (5.6.2).

***DCL** DEVICE CLEAR - Causes a Hardware RESET of the UPC.

***LLO** LOCAL LOCKOUT - Puts the UPC into REMOTE with LOCAL LOCKOUT state.

***GTL** GOTO LOCAL - Restores LOCAL mode.

10.5 PHYSICAL CONNECTIONS

Connection to the UPC Serial Interface is made via a DB-25 connector on the rear panel of the UPC SCU or POWER SOURCE.

UPC Pinouts: (For connection to IBM-PC type DB-25)

PIN 1		CHASSIS GROUND	
PIN 2	TxD	TRANSMIT DATA	(from HOST to UPC)
PIN 3	RxD	RECEIVE DATA	(from UPC to HOST)
PIN 7		SIGNAL GROUND	

Pinouts for IBM-PC DB-9 are listed below for reference.

PIN 2	RxD	RECEIVE DATA	(from UPC to HOST)
PIN 3	TxD	TRANSMIT DATA	(from HOST to UPC)
* PIN 5		SIGNAL GROUND	

All other pins are reserved for future use.

10.6 TESTING THE SERIAL REMOTE INTERFACE

1. Connect the UPC Serial Interface to a DTE serial port of a PC using a DB-25 cable. Most 25 pin connectors on PC's are DTE type. The UPC is a DCE type and must connect to a DTE port. If using a 9 pin connector on the PC, verify the pinouts of the cable match the UPC to the PC correctly.

2. Configure the PC Baud Rate to 19200 or 9600 Baud, No Parity, 8 Data bits, 1 stop, 1 start bit using a terminal emulation program. Ensure the UPC is configured the same (see (10.3) of this manual for setup). Leave the EOS set to CR/LF.

3. Enter the UPC STATUS display of the UPC (**fn,3,3**), do NOT press EDIT this time. See (10.4.1) for info on the **COMMUNICATION MONITORING AID**.

4 Send Executable commands from the PC such as :SYST:BEEP, :VOLTS 100, :FREQ 50, and verify that the UPC responds correctly.

5. Send Query commands from the PC such as *IDN?, FETCH:VOLT1?, and verify that the PC receives correct data from the UPC after each Query command is sent. No other operation is needed to cause the UPC to send the response data.

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NOTES

MODIFICATIONS

MODIFICATIONS

This section is reserved for any modifications that may be made.