Chroma

AC Power Source
6530/6520/6512
User's Manual

Legal Notices

The information in this document is subject to change without notice.

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CHROMA ATE INC.
No. 66 Hwa-Ya 1st Rd., Hwa-Ya Technical Park, Kuei-Shan Hsiang, Taoyuan Hsien, Taiwan

Warranty

All Chroma instruments are warranted against defects in material and workmanship for a period of one year after date of shipment.   Chroma agrees to repair or replace any assembly or component found to be defective, under normal use during this period.   Chroma's obligation under this warranty is limited solely to repairing any such instrument, which in Chroma's sole opinion proves to be defective within the scope of the warranty when returned to the factory or to an authorized service center.   Transportation to the factory or service center is to be prepaid by purchaser. Shipment should not be made without prior authorization by Chroma.

This warranty does not apply to any products repaired or altered by persons not authorized by Chroma, or not in accordance with instructions furnished by Chroma.   If the instrument is defective as a result of misuse, improper repair, or abnormal conditions or operations, repairs will be billed at cost.

Chroma assumes no responsibility for its product being used in a hazardous or dangerous manner either alone or in conjunction with other equipment.   High voltage used in some instruments may be dangerous if misused.   Special disclaimers apply to these instruments. Chroma assumes no liability for secondary charges or consequential damages and in any event, Chroma's liability for breach of warranty under any contract or otherwise, shall not exceed the purchase price of the specific instrument shipped and against which a claim is made.

Any recommendations made by Chroma for use of its products are based upon tests believed to be reliable, but Chroma makes no warranty of the results to be obtained.   This warranty is in lieu of all other warranties, expressed or implied, and no representative or person is authorized to represent or assume for Chroma any liability in connection with the sale of our products other than set forth herein.

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Material Contents Declaration

A regulatory requirement of The People's Republic of China defined by specification SJ/T 11364-2006 mandates that manufacturers provide material contents declaration of electronic products, and for Chroma products are as below:

Part Name	Hazardous Substances					
	Lead	Mercury	Cadmium	Hexavalent Chromium	Polybrominated Biphenyls	Polybromodiphenyl Ethers
	Pb	Hg	Cd	Cr^{6+}	PBB	PBDE
PCBA	×	O	O	O	O	O
CHASSIS	×	O	O	O	O	O
ACCESSORY	×	O	O	O	O	O
PACKAGE	O	O	O	O	O	O

"O" indicates that the level of the specified chemical substance is less than the threshold level specified in the standards of SJ/T-11363-2006 and EU 2005/618/EC.

"×" indicates that the level of the specified chemical substance exceeds the threshold level specified in the standards of SJ/T-11363-2006 and EU 2005/618/EC.

1. Chroma is not fully transitioned to lead-free solder assembly at this moment; however, most of the components used are RoHS compliant.
2. The environment-friendly usage period of the product is assumed under the operating environment specified in each product's specification.

Disposal
Do not dispose of electrical appliances as unsorted municipal waste, use separate collection facilities. Contact your local government for information regarding the collection systems available. If electrical appliances are disposed of in landfills or dumps, hazardous substances can leak into the groundwater and get into the food chain, damaging your health and well-being. When replacing old appliances with new one, the retailer is legally obligated to take back your old appliances for disposal at least for free of charge.

CE-Conformity Declaration

For the following equipment:
Product Name: Programmable AC Source
Model Name: 6530/6520/6512
Manufacturer's Name: Chroma ATE Inc.
Manufacturer's Address: 66 Hwa-Ya 1st Rd., Hwa-Ya Technical Park,
Kuei-Shan Hsiang, Taoyuan Hsien, Taiwan

is herewith confirmed to comply with the requirements set out in the Council
Directive on the Approximation of the Laws of the Member States Relating to
Electromagnetic Compatibility(89/336/EEC) and electrical equipment designed
for use within certain voltage limits(73/23/EEC;93/68/EEC)

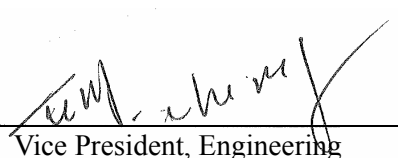For electromagnetic compatibility, the following standards were applied:

EMC: EN55011:1991(Group I Class A)

EN60555-2:1987

EN60555-3:1987

EN50082-1:1992 IEC 801-2: 1991- 8KV AD,4KV CD

IEC 801-3:1984 – 3 V/m

IEC 801-4:1988 – 0.5 kV Signal Lines

1 kV Power Lines

For safety requirement, the following standard was applied:

Safety: EN61010-1(1993)+A2(1995)

Taiwan	May, 2005	Vice President, Engineering
Place	Date	

Warning :
This is a class A product.   In a domestic environment this product may cause radio interference in which case the user may be required to take adequate measures.

Safety Summary

The following general safety precautions must be observed during all phases of operation, service, and repair of this instrument. Failure to comply with these precautions or specific WARNINGS given elsewhere in this manual will violate safety standards of design, manufacture , and intended use of the instrument.

Chroma assumes no liability for the customer's failure to comply with these requirements.

BEFORE APPLYING POWER
Verify that the product is set to match with the line voltage.

PROTECTIVE GROUNDING
Make sure to connect the protective grounding to prevent an electric shock before turning on the power.

NECESSITY OF PROTECTIVE GROUNDING
Never cut off the internal or external protective grounding wire, or disconnect the wiring of protective grounding terminal.   Doing so will cause a potential shock hazard that may bring injury to a person.

FUSES
Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) can be used.   Do not use different fuses or short-circuited fuse holders.   To do so might cause a shock or fire hazard.

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE
Do not operate the instrument in the presence of flammable gases or fumes.

DO NOT REMOVE THE COVER OF THE INSTRUMENT
Operating personnel must not remove the cover of the instrument.   Component replacement and internal adjustment can be done only by qualified service personnel.

WARNING	*LETHAL VOLTAGES.* **Ac sources can supply 426 V peak at their output. DEATH on contact may result if the output terminals or circuits connected to the output are touched when power is applied.**

Safety Symbols

⚡	**DANGER** - High voltage.
⚠	**Explanation:** To avoid injury, death of personnel, or damage to the instrument, the operator must refer to an explanation in the instruction manual.
⏚	**Protective grounding terminal:** To protect against electrical shock in case of a fault. This symbol indicates that the terminal must be connected to ground before operation of equipment.
WARNING	A **WARNING** sign denotes a hazard. It calls attention to a procedure, practice, condition or the like which may result in injury or death of personnel if it is not rightly observed.

ACOUSTIC NOISE INFORMATION
This product has a sound pressure emission (at the operator's side)< 65dB(A).

Revision History

The following lists the additions, deletions and modifications in this manual at each revision.

Date	Version	Revised Sections
Nov. 2002	1.0	Complete this manual.
May 2005	1.1	Change the address and phone number of Chroma.
Aug. 2005	1.2	Add a new function "LCD Sleep Time" in the section of "The Setting of Setup" Add PHASe[:IMMediate]:REVerse command in the following sections: – "Instrument Command Dictionary" – "Command Summary"
Nov. 2007	1.3	Add the following – *"Material Contents Declaration"*. – the description of "NOTICE" in the section of *"The Setting of Output Relay"*. – the section of *"Angle Reverse"*. – the step 3 & 4 in the section of *"The Methods of Measurement"*. Modify the following – Accuracy, Voltage range and Current in the section of *"Specifications"*. – Input Voltage Range and Max. Current in the section of *"Ratings"*. – the table 2-1 in the section of "Output Connection". – the description in the section of *"Internal Waveform Generator"*. – LCD screen in the section of *"The Setting of Setup"*. – the display of the first item in the section of *"The Output Range"*.
Mar. 2008	1.4	Modify the description of "NOTICE" in the section of *"The Output Range"*.

Table of Contents

1. General Information

1.1 Introduction

This manual describes five major things of the Chroma 6530/6520/6512 programmable ac source.   They are specifications, installation, instructions on operation, theory of operation, and instructions on calibration.   In the manual the term, AC source, is applied to the Chroma 6530/6520/6512 programmable ac source.

1.2 Description

The series of AC source is a high efficiency programmable ac power source, which is capable of simulating a wide variety of AC line conditions, harmonic waveforms, and accurate measurement of power.   The microprocessor-controlled waveform oscillator generates accurate, stable output voltage and frequency.   The PWM design of power stage allows for full volt-ampere into loads.   The front panel has both RPG (rotary pulse generator) and keypad controls for setting the output voltage and frequency.   The LCD provides a complete operating state of the unit to the user.   Remote programming is accomplished either through the GPIB bus or the RS-232C serial port.

1.3 Key Features

A. Configuration
■ Local operation from the keypad on the front panel
■ Remote operation via GPIB or RS-232C interface
■ Protection against Over-power, Over-load, Over-temperature, and Fan-fail
■ Temperature-controlled fan speed
■ Built-in output isolation relays

B. Input/Output
■ Selective output voltage with full scale of 150V/300V/Auto
■ Remote control by the use of analog voltage reference
■ Full-page display of setup and measurement results
■ Measurement of V, I, F, P, CF, and PF
■ Remotely inhibited control
■ AC ON/OFF output signal
■ Output transient state acknowledgement

1.4 Specifications

The operation specifications of the model 6530/6520/6512 are listed below (on the next page). All specifications have been tested according to the standard Chroma test procedures. All specifications are based on a remote sense connection, 25 ± 1°C, and resistor load unless specified otherwise.

Model	6530	6520	6512
OUTPUT RATINGS			
Max. power	3 KVA	2 KVA	1.2 KVA
Voltage			
Range	150V/300V/Auto	150V/300V/Auto	150V/300V/Auto
Accuracy	0.2% reading + 0.2% of F.S	0.2% reading + 0.2% of F.S	0.2% reading + 0.2% of F.S
Resolution	0.1V	0.1V	0.1V
Distortion*[1]	1% (15-45 Hz) 0.5% (>45-500 Hz) 1% (>500-1K Hz) 2% (>1K-2K Hz)	1% (15-45 Hz) 0.5% (>45-500 Hz) 1% (>500-1K Hz) 2% (>1K-2K Hz)	1% (15-45 Hz) 0.5% (>45-500 Hz) 1% (>500-1K Hz) 2% (>1K-2K Hz)
Line regulation	0.1%	0.1%	0.1%
Load regulation*[2]	0.1%	0.1%	0.1%
Temp. coefficient	0.02% per degree C	0.02% per degree C	0.02% per degree C
Maximum Current			
rms	30A/15A	20A/10A	12A/6A
peak	90A/45A (15-100 Hz) 75A/38A (>100-1K Hz) 60A/30A (>1K-2K Hz)	60A/30A 50A/25A 40A/20A	36A/18A 30A/15A 24A/12A
Frequency			
Range	15-2K Hz	15-2K Hz	15-2K Hz
Accuracy	0.15%	0.15%	0.15%
Resolution	0.01Hz (15-99.99 Hz) 0.1Hz (100-999.9 Hz) 0.2 Hz (1K-2K Hz)	0.01Hz (15-99.99 Hz) 0.1Hz (100-999.9 Hz) 0.2 Hz (1K-2K Hz)	0.01Hz (15-99.99 Hz) 0.1Hz (100-999.9 Hz) 0.2 Hz (1K-2K Hz)
INPUT RATINGS			
Voltage range	190-250V	190-250V	190-250V
Frequency range	47-63 Hz	47-63 Hz	47-63 Hz
Current	23A Max.	15A Max.	10A Max.
Power factor	0.98 Min. under full load	0.97 Min. under full load	0.95 Min. under full load

MEASUREMENT			
Voltage			
Range	0-150V/0-300V	0-150V/0-300V	0-150V/0-300V
Accuracy (rms)	0.1% F.S. + 0.25%	0.1% F.S. + 0.25%	0.1% F.S. + 0.25%
Resolution	0.1V	0.1V	0.1V
Current			
Range (peak)	0-140A	0-100A	0-60A
Accuracy (rms)	0.1% F.S. + 0.4%	0.15% F.S. + 0.4%	0.25% F.S. + 0.4%
Accuracy (peak)	0.2% F.S. + 0.4%	0.3% F.S. + 0.4%	0.5% F.S. + 0.4%
Resolution	0.01A	0.01A	0.01A

Power			
Accuracy	1% F.S. (CF < 6)	1% F.S. (CF < 6)	1% F.S. (CF < 6)
Resolution	0.01 Watt	0.01 Watt	0.01 Watt
Frequency			
Range	15-2K Hz	15-2K Hz	15-2K Hz
Accuracy	0.01% + 2 count	0.01% + 2 count	0.01% + 2 count
Resolution	0.01 Hz	0.01 Hz	0.01 Hz
OTHERS			
Efficiency	80% typ.	80% typ.	80% typ.
Protection	OPP, OCP, OTP, Fan Fail		
Size	425/222/620 mm	425/222/620 mm	425/222/620 mm
Weight	27 Kg	27 Kg	27 Kg
Temperature range			
Operation	0-40°C	0-40°C	0-40°C
Storage	−40- +85°C	−40- +85°C	−40- +85°C
Safety & EMC	CE (LVD and EMC)	CE (LVD and EMC)	CE (LVD and EMC)

Remarks

*1: Maximum distortion for voltage varies from half to full range with linear load.

*2: Test with sine wave and remote sense.

1.5 Names of Parts

1.5.1 The Front Panel
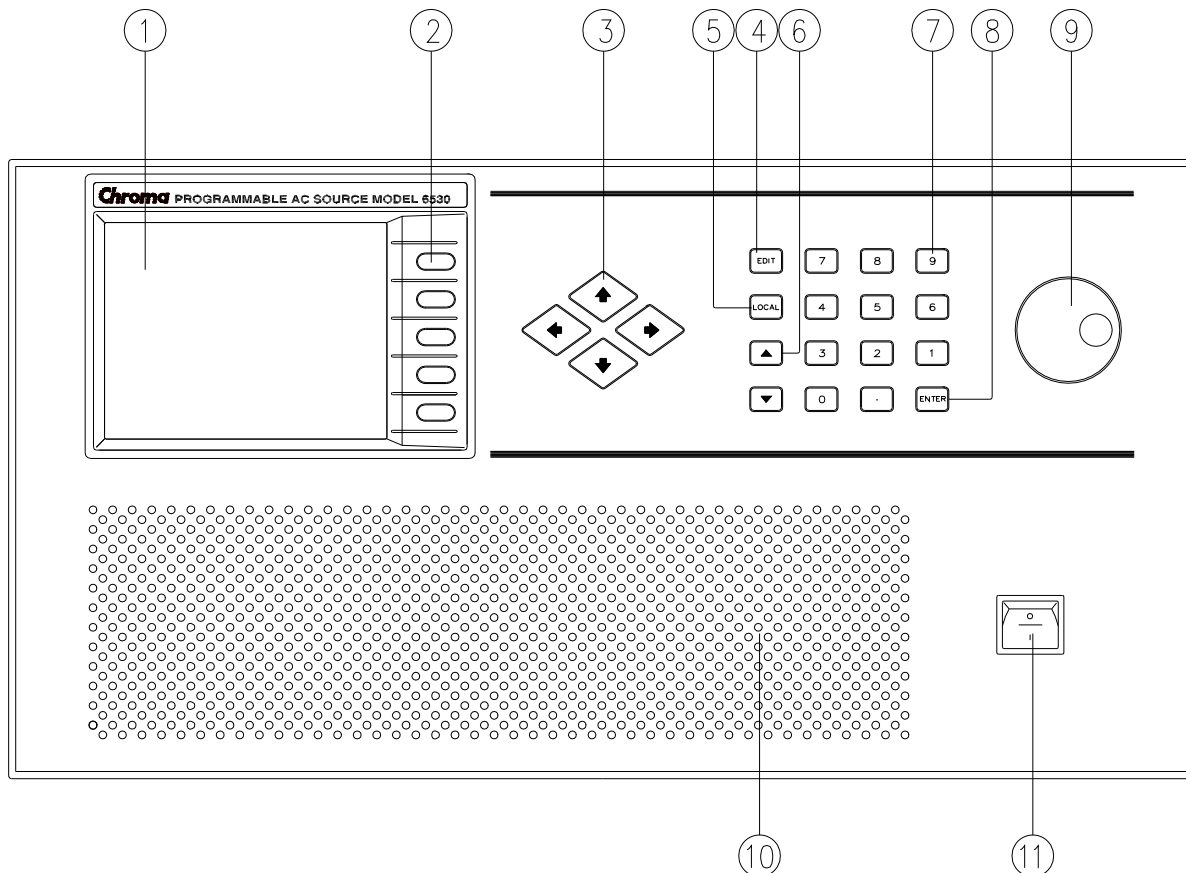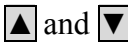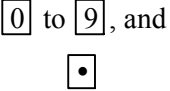
Figure 1-1 The Front Panel

Table 1-1 The Description of the Front Panel

Item	Symbol	Description
1		***Display*:** The LCD is to display configuration, output setup, and measurement results.
2	⬭	***Soft keys*:** Five soft keys are located at the right side of the LCD. Each of them gives a command as indicated on the corresponding command block on the LCD next to the soft keys to guide the user unless that block is blank. Each valid soft key denotes the command string lying within the symbol of a soft key; for example, CONFIG represents that the soft key next to command block "CONFIG" is for entering configuration menu.
3	⬆ ⬅ ➡ ⬇	***Cursor moving keys*:** These four keys are to move the cursor to different directions respectively. In normal mode (non-editing mode), pressing any of these four keys will change the place of the cursor. In editing mode, pressing ⬅ or ➡ will move the cursor from digit to digit for the programming of a parameter.
4	Edit	Edit ***command key*:** Pressing this key will make the user enter

		into or quit from editing mode while he is programming V or F.
5	Local	Local *command key*: Pressing this key will switch the control of the AC source from remote operation to operation through the keypad on the front panel.
6	▲ and ▼	*Up and down keys*: Press ▲ to search upward for the desired programming parameter.　Press ▼ to search downward.
7	0 to 9, and •	*Numeric and decimal keys*: The user can program numeric data by pressing the digital keys and the decimal key.
8	ENTER	ENTER *key*: It is to confirm the setting of parameters.
9	(○)	*RPG*: The user can input programming data or options by turning the RPG to the desired ones.
10		*Airflow inlets*: Cool airflow enters the AC source through these holes.
11		*Main power switch*: It is to power on or off.

1.5.2 The Rear Panel
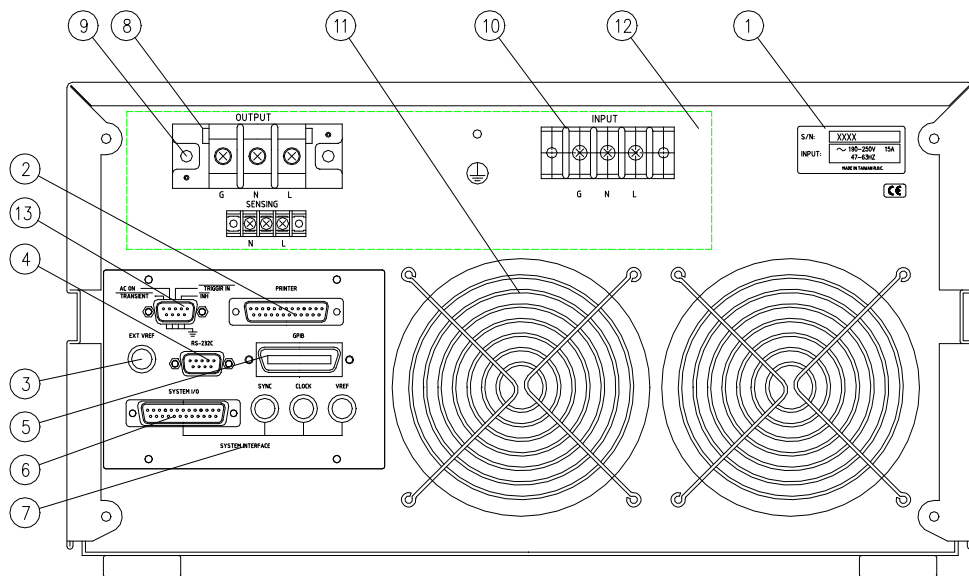
Table 1-2 The Description of the Rear Panel

Item	Name	Description
1	Label	The label includes model number, series number of the AC source and input ratings.
2	Printer Port	The 25-pin, D-type female connector is for transferring measurement data to a parallel printer.
3	Ext. Ref.	The BNC connector inputs control waveform amplitude from external devices.
4	RS-232C	The 9-pin, D-type female connector transfers control commands to and from the remote PC for remote operation.
5	GPIB Connector	A remote controller using GPIB bus is connected to the AC source through this connector for remote operation.
6	System Interface: System I/O	The 25-pin, D-type male connector is for the parallel, three phase Data communication.
7	System Interface	These three BNC signals: SYNC, CLOCK, VREF are for the parallel, three phase synchronization.
8	Output Connector	This connector outputs power to the loading device.
9	Remote Sense Connector	It senses directly at the terminals of the load to eliminate any voltage drop on the connecting cable. Make sure of connecting the terminal "L" of the remote sense connector to the terminal "L" of the load, and the "N" to the "N" of the load. Reverse polarity is not allowed.
10	Power Line in Connector	Power line input is connected to the AC source through this connector.
11	Cooling Fan	Its speed automatically increases or decreases as temperature rises or falls.
12	Safety Cover	It is to protect the user from being shocked.
13	TTL I/O	The 9-pin, D-type male connector transfers control signals (trigger in, remote inhibit, transient and AC ON),

2. Installation

2.1 Inspection

After unpacking the instrument, please inspect any damage that may have occurred during the shipment. Save all packing materials in case the instrument has to be returned one day.

If any damage is found, please file a claim with the carrier immediately. Do not return the instrument to the factory without obtaining the prior RMA acceptance from Chroma.

2.2 Preparation for the Use

In the beginning, the instrument must be connected with an appropriate AC line input. Then, since it is intelligently cooled by fans, it must be installed in sufficient space for circulation of air. It should be used in an area where the ambient temperature does not exceed 40°C.

Before connecting input/output cable, the user must remove the safety cover mounted on the rear panel first. Then, he has to refer to sections 2.3.2, 2.4, and 2.5 for corresponding cable connection. After completion of the connection, he should mount the safety cover on the rear panel again.

2.3 Requirements of Input Power

2.3.1 Ratings

- **Input Voltage Range** : 190-250 Vac, single phase
- **Input Frequency** : 47-63 Hz
- **Max. Current** : 6530 : 23 A
  6520 : 15 A
  6512 : 10 A

Caution: The AC source will be damaged if it is operated at an input voltage that is outside its configured input range.

2.3.2 Input Connection

The input terminal block is located on the rear panel of the instrument.   The power cord must be a three-conductor cord rated at least for 85°C.   The power line input must have a current rating which is greater than or equal to the maximum current rating of the AC source.   Do not use three separate wires to connect power to the AC source input.

See Figure 2-1 (on the next page) and do the following things one by one:

1. Remove the safety cover from the back of the AC source.
2. Open the line clamp on the safety cover, and screw the power cord to the instrument through the cable gland.
3. Position the power cord, and tighten the cable gland to secure the clamp.
4. Connect the ac lines to the terminal blocks of the AC source as follows:
    Green or green/yellow wire to the terminal labeled "G".
    White or blue wire to the terminal labeled "N".
    Black or brown wire to the terminal labeled "L".
5. If you need to connect the load to the AC source, please refer to section 2.4 for output connection.
6. Slip the safety cover over the ac input terminal strip, and secure the cover with four screws.

*** **WARNING** ***

To protect the operators, the wire connected to the GND terminal must be connected to the earth ground.   Under no circumstances shall this AC source be operated without an adequate ground connection.

Installation of the power cord must be done by a professional and in accordance with local electrical codes.
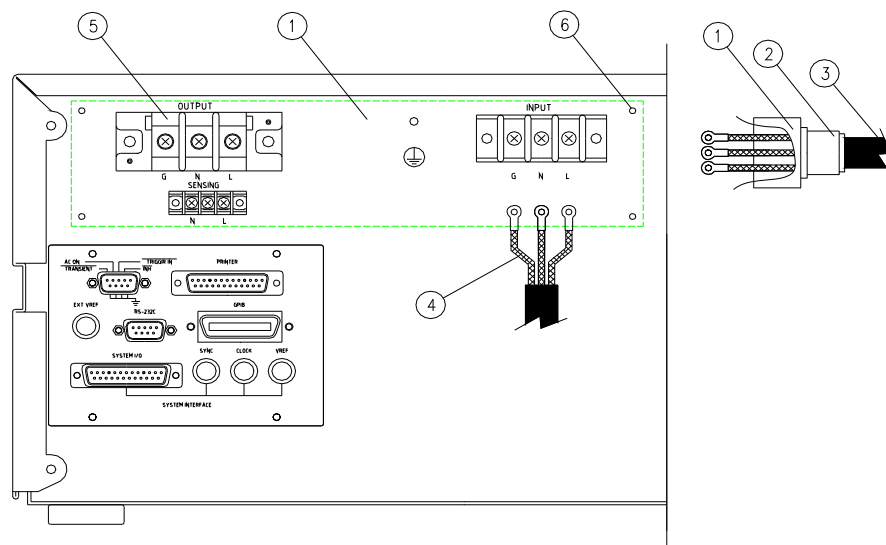
Figure 2-1 Input Connection

2.4 Output Connection

The output terminal block is located in the rear of the AC source.   Please refer to section 2.3 for removing the safety cover for output connection.   Load connection to the AC source is done at the output terminals.   To meet the safety requirements the wires to the load must be sufficiently large gauges, so they will not overheat while carrying the output current.   See Figure 2-2 on the next page.
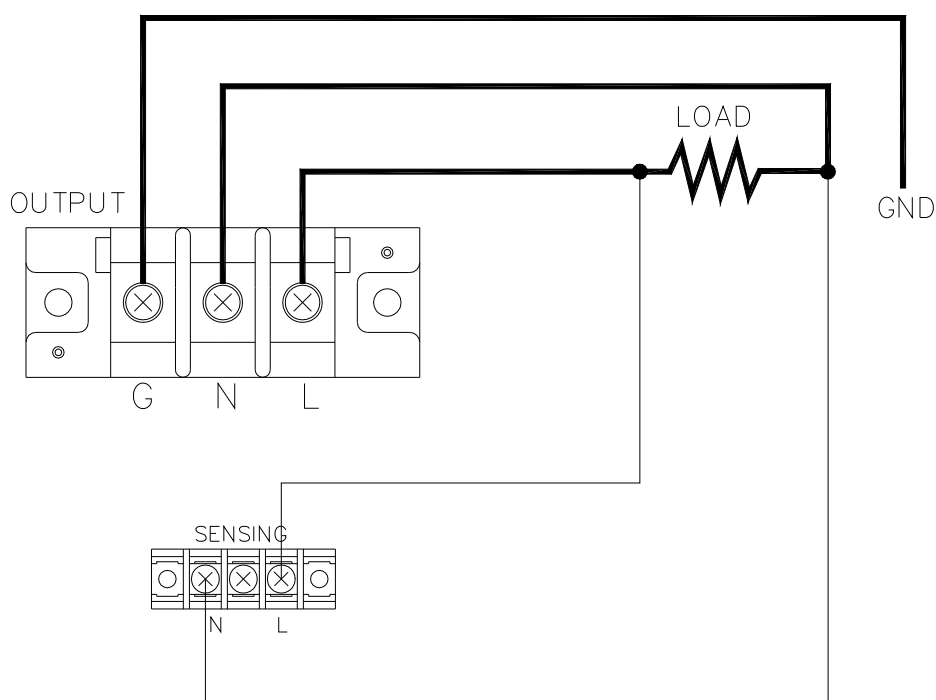
Figure 2-2 Output & Remote Sense Connection

Table 2-1 The Characteristics of AWG (American Wire Gauge) Copper Wire

AWG No.	Current [1]	AWG No.	Current [1]
14	25 A	8	60 A
12	30 A	6	80 A
10	40 A	4	105 A

1: Capacity is based on the ambient temperature of 30°C with the conductor rates at 60°C.

2.5 Remote Sense Connection

The remote sense function of the AC source monitors the voltage at the load instead at the output terminal of the AC source.   It ensures the delivery of accurate voltage as programmed at the load by automatically compensating the output voltage drop over the connecting cable. The user has to set Remote Sense ON so as to enable this function.

Connect the sensing leads from the "N" and "L" terminals on the remote sense to the load as shown in Figure 2-2 (on the previous page).   Because the sensing leads carry only a few mill amperes, the wires for sensing are much lighter than the load leads.   The sensing leads are part of the feedback path of the AC source, so they must be kept at a low resistance in order to maintain the best performance.   Connect the sensing leads carefully so that they will not be open-circuited.   If the sensing leads are left unconnected or become open-circuited during operation, the AC source will disable the output, and display "OPEN INT".   The sensing leads must be a twisted pair to minimize the pickup of external noise.   The sensing leads need to be connected to the load as close as possible.   The user must press $\boxed{\text{ENTER}}$ over two seconds to reset the AC source.

2.6 The Procedures of Power-on

> ***** WARNING *****
>
> Before turning on the instrument, all protective earth terminals, extension cords, and devices connected to the instrument must be connected to a protective earth ground. Any interruption in the protective earth grounding will cause a potential shock hazard that might injure a person.

Apply the line power, and turn on the power switch on the front panel.   No load shall be connected to the output terminal block.   The AC source will do a series of self-tests every time the power switch is turned on.   The LCD on the front panel will light up and display as follows (see the figure on the next page):
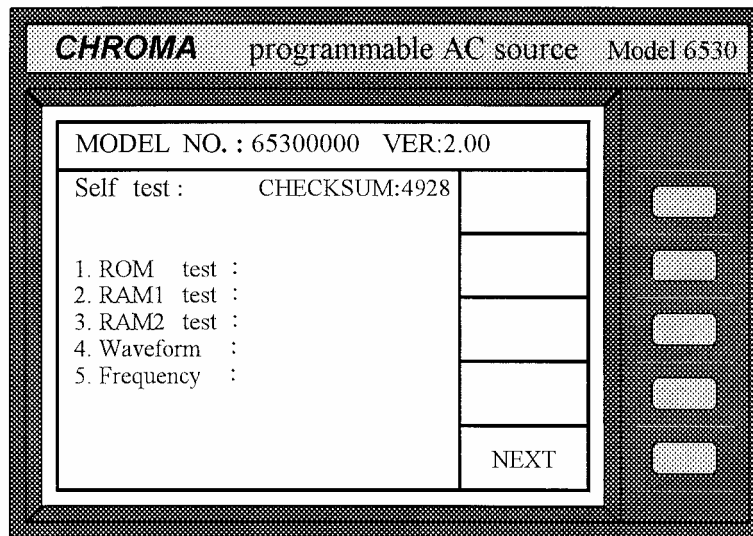
After the routines of the self-test are done, the display will show an "OK" at the right side of each test item indicating that the item is no problem as follows:
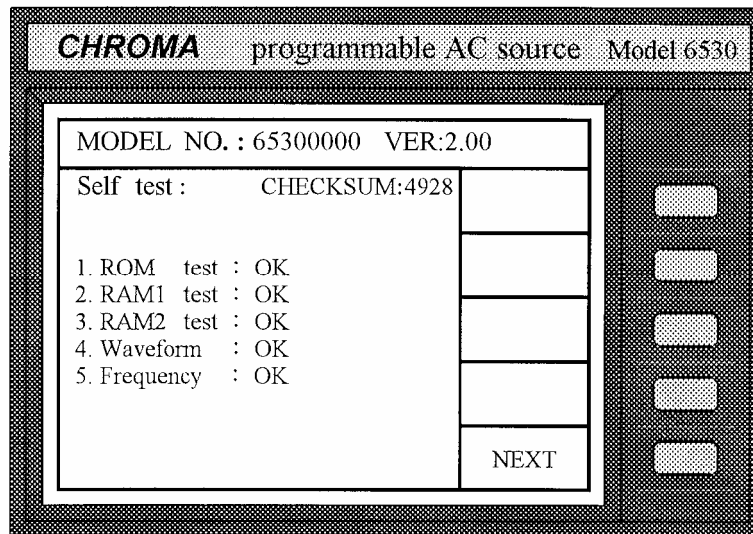
If any failure is detected on a certain item, an "NG" will be shown at the right side of that item, and the sound of "beep" will be heard. It takes about eight seconds to complete the routines of the self-test. If no error is found, the LCD will display as follows:
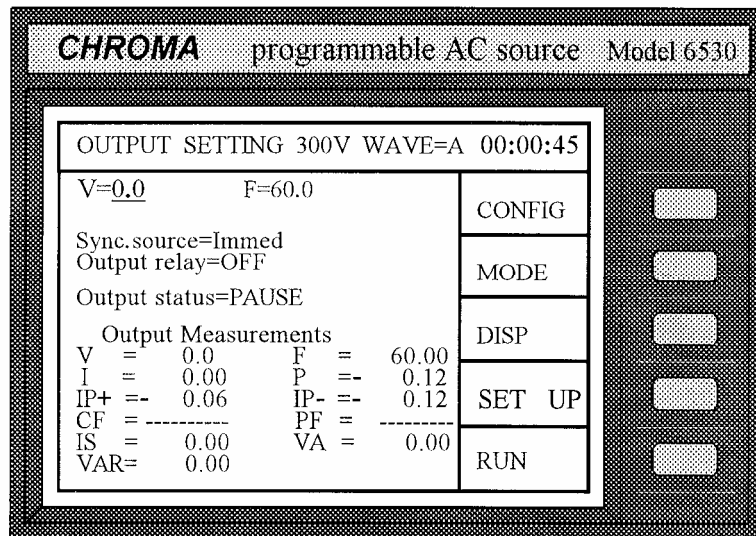
The following table shows all the error messages and recommended actions:

Item	Error Message	Description	Action
1	Rom test NG	System memory test fails.	Consult your dealer for assistance.
2	Waveform test NG	Waveform circuit test fails.	Consult your dealer for assistance.
3	Frequency test NG	Frequency test fails.	Consult your dealer for assistance.
4	RAM1/RAM2 test NG	Battery back-up memory test fails, or memory is bad.	Press $\boxed{0}$, $\boxed{8}$ simultaneously to initialize memory.

*** **NOTICE** ***

If you initialize memory, all of the saved data may be initialized, therefore you must check the saved data before doing so.

3. Local Operation

3.1 Introduction

The AC source can be configured to operate in local or remote mode.   The operation in remote mode through a remote GPIB controller or RS-232C will be described in Section Six. In this section the operation in local mode through the keypad on the front panel for data entry and test is going to be described.   The AC source is configured for local operation when it is turned on.

3.2 Operation through Keypad

3.2.1 Introduction

The AC source provides the user-friendly programming interface using the keypad on the front panel to the user.   Each display of the LCD on the AC source, which represents an operational menu, is divided into three zones.

(1) Headline: It displays characters in reverse video on the first row of the LCD. This line provides information including current operation function, output parameters, and the total operation time after power-on.

(2) Command zone: The farthest right column of the LCD is divided into five blocks. Each block represents a soft key for a minor function, which can be executed by pressing the key next to it.   Hence, all the command sets are structured as a command tree.   Each node of the command tree presents an operational menu.   Also, on each node the LCD always provides the user with five choices to let him enter into other nodes, or quit from the current node.

Sample nodes (operational menu) and the command tree are shown below:
The command tree:

```
Output setting menu ──────────── CONFIG ──────────── SAVE
                                                  ──── RECALL
                                                  ──── S-TEST
                                                  ──── QUIT

                          ──── MODE ──────────── INIT/TRIG
                                              ──── SAVE
                                              ──── RECALL
                                              ──── QUIT

                          ──── DISP ──────────── WAVE ──────── V
                                                          ──── I
                                                          ──── V+I

                                              ──── VIEW
                                              ──── PRINT
                                              ──── TRIG
                                              ──── QUIT

                          ──── SET UP ──────────── SAVE
                                                ──── RECALL
                                                ──── QUIT

                          ──── RUN/PAUSE
```
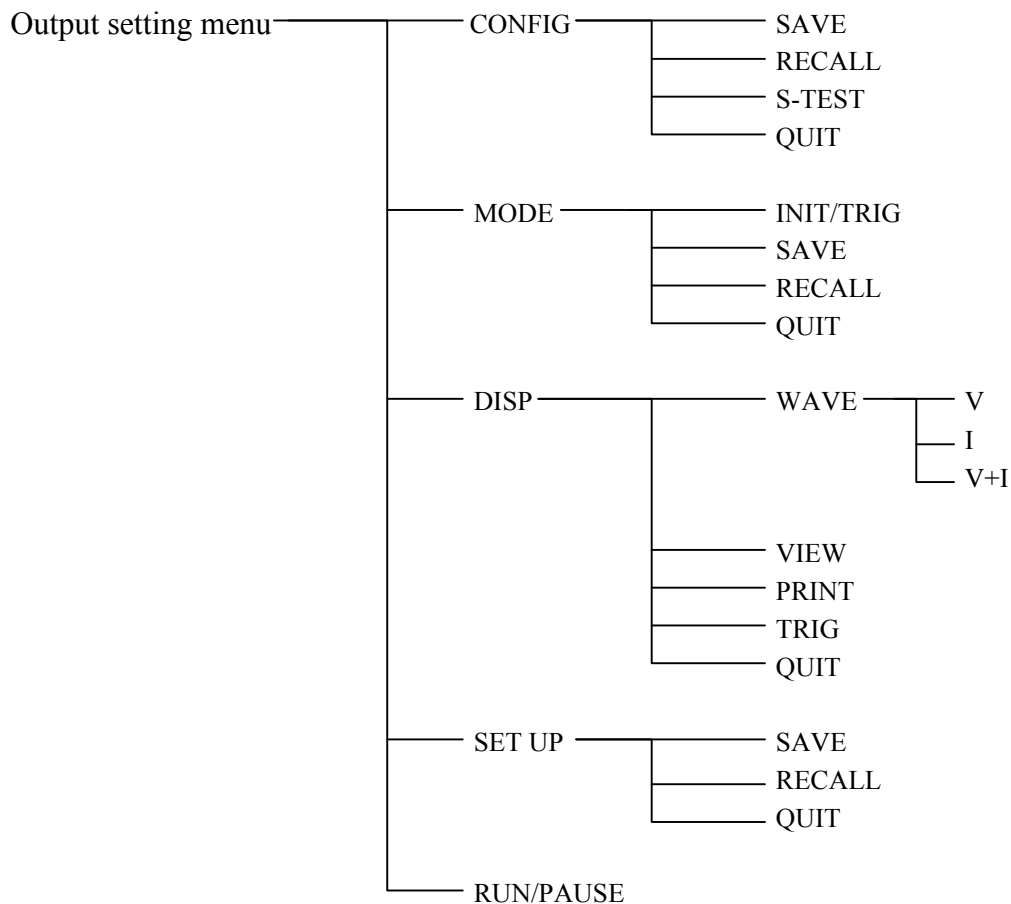
(3) Parameters zone: The remaining area offers information which guides the user to program the AC source, to view the current status, to collect measurement results, etc.

3.2.2 Data Entry

Before describing each menu, the operations common in the parameters zone will be explained below:

Movement of Cursor

Use any of the cursor moving keys: ↑, ↓, ←, →to move the cursor to the desired parameter for programming.
There are two ways for the user to set the parameters.   One is in normal mode, and another in editing mode.   The following example is how to set output voltage.

Normal Mode
(1) Press the desired numeric keys of ⬚1⬚, ⬚3⬚ , ⬚5⬚ , ⬚.⬚ , ⬚2⬚, ⬚ENTER⬚ to set
    V=135.2V.

(2) Press ▲ or ▼ key repeatedly, or keep pressing any of them until the desired value, V = 135.2V, is shown on the LCD.   Then, press │ENTER│ to confirm.

Increase or decrease value is done through the use of the farthest right digit.   Some parameters are specific strings like Sync. source= Immed / phase, Trigger = AUTO/MANUAL, Output relay=ON/OFF, etc. selected by ▲ / ▼ or RPG to be programmed.

*** **NOTICE** ***

If a parameter is modified, the user has to press ENTER to update the current data and save them into memory, otherwise the old data will remain when he exits from the machine.

Editing Mode   Display of Cursor

In editing mode the user can set parameters immediately without pressing │ENTER│ to confirm.   The mode only allows the user to set V or F parameter.   When the user moves the cursor to V parameter, and presses │Edit│ to enter into the editing mode, the cursor will show as right:

V=135.2   F=   60.0

Set the output voltage as 132.2V as follows:

Press │Edit│ to enter into editing mode.   Move the cursor to the position of digit 5 using │◄─│, and press │2│ to set V=132.2. Editing mode is useful when you want to change V or F parameter only one digit, or to set output V or F in step change.   In this mode the user can increase or decrease the value of current position by pressing ▲, ▼ or PRG too.   Press │Edit│ again to quit from editing mode.

3.2.3 Output Setting

The Output Setting on the screen is the main operation menu in the AC source, which accepts AC output parameters, including V, F Sync. source, etc.   In this menu the user can activate the AC source by pressing the soft key of │RUN│, and obtain the measured results at the terminals of the devices under test.

3.2.3.1 Setting Output Voltage and Frequency

*** NOTICE ***

The maximum output voltage of the AC source is limited by the peak value of the waveform, which is about 425 Vpeak.   The output is programmed in units of RMS volts.   For a sine wave, the maximum AC voltage that can be programmed is 300V. For other waveforms, the maximum voltage may be different.   Appendix E is the maximum programmed voltage of non-sine wave.

When you turn on the AC source, the state of default output is set in the Configure menu of Power on output status.   Set the output as V=135.2 Vrms, F=50.0 Hz as follows:

1. After you have powered on the AC source, and accomplished the self-test (or exited from any other menu by pressing QUIT), the LCD will display a main operational picture on the screen as follows (on the next page):

```
CHROMA    programmable AC source   Model 6530

  OUTPUT  SETTING  300V  WAVE=A   00:00:45

  V=0.0            F=60.0
                                        CONFIG
  Sync.source=Immed
  Output relay=OFF                      MODE
  Output status=PAUSE
     Output Measurements                DISP
  V   =      0.0        F   =    60.00
  I   =      0.00       P   =-    0.12
  IP+ =-     0.06       IP- =-    0.12   SET   UP
  CF  = ----------      PF  = ---------
  IS  =      0.00       VA  =     0.00
  VAR=       0.00                        RUN
```
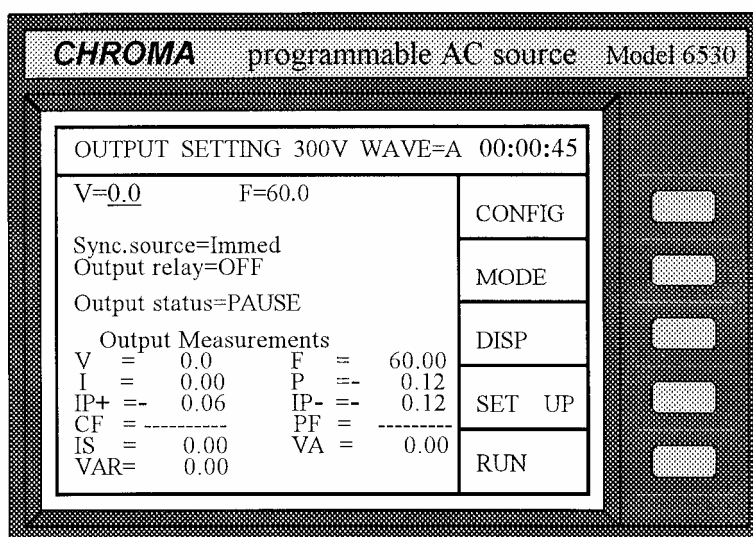
Display of Cursor

The line where the cursor stays indicates that the AC source is waiting for the input of the voltage value.

V= _ 0.0
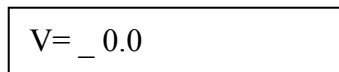
2. Input the value of V as 135.2 by pressing 1 , 3 , 5 ,

. , 2 , ENTER to set voltage of 135.2 Vrms , or using data entry in section 3.2.2.

V=135.2   F= _ 60.00
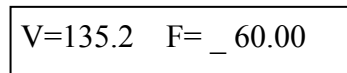
3. Move the cursor to set frequency by inputting the value
of F as 50 Hz, and pressing 5 , 0, ENTER .

V= 135.2   F= 50.00

*** **NOTICE** ***

Voltage ranges from 0 to 300 V in step of 0.1 V.   Frequency ranges from 15 to 2000 Hz in step of 0.01/0.1/0.2 Hz.

3.2.3.2   The Setting of the Output Transition Phase

The AC source can control the transition angle of the output waveform.   It offers Sync. source of "Immed" and "phase".   Immed means that the AC source outputs transition immediately when the user changes output V or F.   Sync. source=phase means that the output transition synchronizes with a reference phase angle.

Set the output "phase" of the AC source, and the phase angle as 90 degrees as follows:

1. Move the cursor to the command of Sync. source.

Sync. source=   Immed

2. Press ▼ to change the parameter from "Immed"
to "phase", and press ENTER .

Sync. source=phase   phase= _0.0

3. Press 9 , 0, ENTER to set the transient phase
angle as 90 degrees.

Sync. source=phase   phase= 90.0

Set the output "Immed" of the AC source as follows:

1. Move the cursor to the command of Sync. source.

Sync. source=phase   phase= 90.0

2. Press ▲ or ▼ to set Immed, and then press
ENTER to confirm.

Sync. source=Immed

*** **NOTICE** ***

The AC source allows the user to program the difference of phase from 0 to 359.9 in step of 0.1 degree.

3.2.3.3 The Setting of Output Relay

There is a relay on the output of the AC source for the connection with a load.   When output relay is "ON", it means that the output relay is closed in spite that the output status of the AC source is in QUIT mode.   When output relay is "OFF", it means that the output relay is closed only as the output status is in RUN mode.   If the output status is in QUIT mode, the output relay will be open.

To set the output relay as ON as follows:

1. Move the cursor to the command of output relay.

2. Press ▲, ENTER to set output relay ON.   A click sound will be produced from the AC source when output relay is activated.

Output relay=OFF

Output relay=ON

ⓘ **NOTICE**
Before powering off, please confirm if the AC SOURCE is outputting voltage.   For ensure the life of the AC SOURCE, it powered off under outputting status is prohibited strongly.

3.2.3.4 The Output Status

There are two status of output.   One is PAUSE, and another is RUN.
PAUSE: It means the output of the AC source is inactive.
RUN   : It means the output of the AC source is active according to the user's set
                parameters.

3.2.4 The Setting of Configuration

The AC source provides the user with a lot of useful features such as Remote sensing, External reference, Transient acknowledgement, Waveform selection, etc.   To use these powerful features the user must program relevant parameters according to the needs of application using the configuration setup.

Press the soft key, CONF, the LCD displays the following picture:
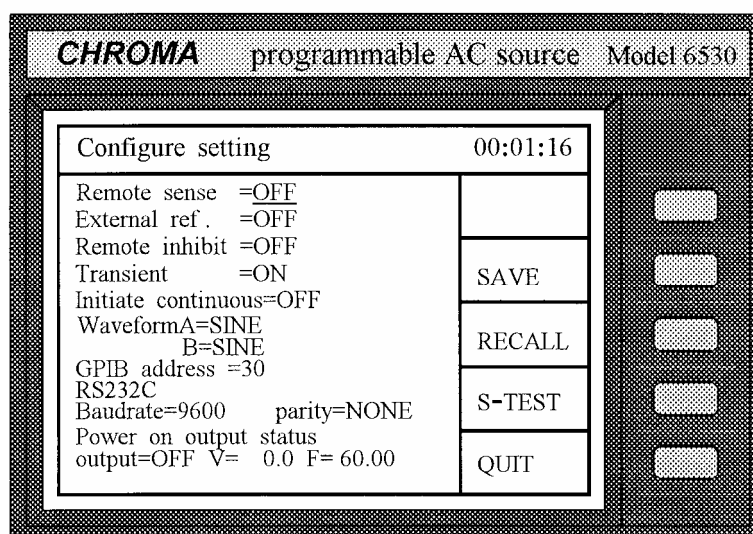
3.2.4.1 Remote Sense

Remote sensing is to eliminate voltage drop on the connection cables from the output terminal of the AC source to that of the load. For the details of wire connection please refer to section 2.5. The procedures of setup are shown below:

1. Move the cursor to the command of Remote Sense.

2. Press ▲, ENTER to change the option from OFF to ON.

Remote Sense =OFF

Remote Sense =ON

*** NOTICE ***

Before choosing "ON" for enabling the function of remote sense, the remote sensing leads must be connected to the load (see 2.5), otherwise the AC source will detect the error and stop output.

3.2.4.2 External Reference

The AC source allows the user to make use of the controlled signal from external devices for the setting of its output. The BNC connector of the external reference on the rear panel lets the user apply DC signal to the AC source for the setting of output voltage. The output voltage (Vout) responses linearly proportional to the controlled DC level with voltage ranging from 0 to 10 V. Vout can be calculated using the following formula:

$Vout = Vcontrol / 10\ V \times V\ range.$

Remark: The formula mentioned above is applicable when the output waveform is sinusoidal. But if the waveform is not sinusoidal, the user may refer to Appendix E for output voltage RMS scaling.

To set Vout to 60Vrms:
1. Select range = 300V in setup menu, apply external DC = 2V, and Vout = 60Vrms.

2. Select range = 150V in setup menu, apply external DC = 4V, and Vout =60Vrms.

The procedures of setup are shown below:

1. Move the cursor to the command of External ref.

External ref. =<u>OFF</u>

2. Press ▲, ENTER to change the option from OFF to ON.

External ref. =ON

```
*** NOTICE ***

When external ref. is set as ON, the output voltage (Vout) will respond to the external
control DC voltage level.   The user cannot control Vout amplitude through the keypad
on the front panel until external ref. is set as OFF again.   However, he can still program
and output other parameters.
```

3.2.4.3   Remote Inhibit

The output of the AC source can be inhibited by the external control or by manual trigger. There are three states for the feature of remote inhibit: OFF, Live, and Trigger.

OFF   : It is to disable the feature of remote inhibit.
Live   : The output of the AC source will be disabled if TTL signal is active, but will be automatically recovered if TTL signal is removed or inactive.
Trigger : The output of the AC source will be disabled if TTL signal is active, and will remain so even TTL signal becomes inactive.   The user has to press ENTER for over two seconds to reset the AC source.

The procedures of setup are shown below:

1. Move the cursor to the command of Remote inhibit to set inhibition by the TTL signal from the external control.

Remote inhibit =<u>OFF</u>

2. Press ▼ to change the option from OFF to LIVE, then press ENTER.

Remote inhibit =LIVE

*** **NOTICE** ***

The remote inhibit is a TTL "active LOW" signal transferred via the TTL I/O connector. For details please refer to pin assignment in Appendix E.

3.2.4.4 Transient State Acknowledgement

The AC source can be sent as a TTL signal to synchronize with the external devices when the state of output changes.

The procedures of setup are shown below:

1. Move the cursor to the command of Transient to enable the acknowledgement of transient state.

Transient =OFF

2. Press ▼, ENTER to change the option from OFF to ON.

Transient =ON

*** **NOTICE** ***

The transient acknowledgement sends a TTL active LOW pulse (10 μS) via the TTL I/O connector. For details please refer to pin assignment in Appendix E.

3.2.4.5 Auto Initialization by Trigger

When the user operates in "MODE", he may take advantage of any of the following modes: STEP, PULSE, and LIST. After having finished the setting of output, he can enable the output by either of the two ways:

A. Press INIT to initialize the process, and follow TRIG to trigger output.
B. Press a single trigger key to use auto initialization.

The procedures of setup are shown below:

1. Move the cursor to the command of Initiate continuous.

Initiate continuous=OFF

2. Press ▲, ENTER to change the option from OFF to ON.

Initiate continuous=ON

3.2.4.6   Internal Waveform Generator

The AC source provides the user with two independent sets of waveforms, A and B.   Both of the waveforms include sinusoidal, square, clipped sinusoidal, 30 sets of built-in waveforms, and 5 sets of user-defined waveforms.

To set waveform A as square wave:

1. Move the cursor to the command of Waveform A.

   Waveform A=SINE

2. Press ▲ or ▼ to change the option to "SQUA", then press ENTER .

   Waveform A=SQUA

To set waveform B as clipped Sin wave, THD:10%

1. Move the cursor to command of Waveform B.

   Waveform B=SINE

2. Press ▲ or ▼ to change the option to "CSIN", then press ENTER , and LCD prompts clipped by AMP or THD.

   Waveform B=CSIN   mode=AMP   % = 0.0

When the user selects "CSIN", the clipped sinusoidal wave, he is requested to program the clipped percentage as follows:

3. Press ▲ , ENTER to change the option from AMP to THD.

   Waveform B=CSIN   mode=THD   % = 0.0

4. Press 1 , 0 , ENTER to set distortion to 10%.

   Waveform B=CSIN   mode=THD   % = 10.0

*** NOTICE ***

1. The clipped sine is programmed by "AMPlitude" or "Total Harmonic Distortion". Programming ranges from 0 to 100% for amplitude (100%: no clipped sine), and from 0 to 43% for THD (0%: no distortion).
2. User-defined waveform is defined on a remote PC and downloaded from it.
3. For details of factory DST waveform refer to Appendix A.
4. When you select non-sinusoidal waveform, the range of output voltage may change to correct rms output voltage when it is in Auto range.

3.2.4.7 GPIB Address

The AC source offers the mode of remote operation too. For details please refer to Chapter Six. Prior to remote operation the user has to set the GPIB address 10 as follows:

1. Move the cursor to the command line of GPIB address.

2. Press $\boxed{1}$, $\boxed{0}$, $\boxed{\text{ENTER}}$ to set address 10.

> GPIB address =30

> GPIB address =10

> *** **NOTICE** ***
>
> Addressing space ranges from o to 30.

3.2.4.8 The Setup of RS-232C

The AC source offers another remote operation through the RS-232C bus. Communication protocol is set as follows:

To set baud rate=19200, parity=ODD.

1. Move the cursor to the command line of Baudrate.

2. Press $\boxed{\blacktriangle}$ or $\boxed{\blacktriangledown}$ or turn RPG to select 19200, then press $\boxed{\text{ENTER}}$.

3. The cursor moves automatically to the setting position of "parity". Press $\boxed{\blacktriangle}$ or $\boxed{\blacktriangledown}$ or turn RPG to select "ODD", then press $\boxed{\text{ENTER}}$.

> Baudrate=4800   Parity=EVEN

> Baudrate=19200   Parity=EVEN

> Baudrate=19200   Parity=ODD

> *** **NOTICE** ***
>
> The options of baud rate are 2400/4800/9600/19200. The options of parity are EVEN/ODD/NONE.

3.2.4.9 The Default of Power-On

The AC source allows the user to store the output voltage and frequency as default before powering off.

To set power-on as V=120 V, F=50 Hz.

1. Move the cursor to the line of "output=" under the "Power on output status".

output=<u>OFF</u>   V=   0.0   F=   60.0

2. Press ▲, ENTER to set output ON.

output=ON   V= _ 0.0   F=   60.0

3. Press 1, 2, 0, ENTER to set V=120.

output=ON   V=120.0   F= _60.0

4. Press 5, 0, ENTER to set F=50.

output=ON   V=120.0   F= 50.0

3.2.4.10 The S-Test

This function is reserved for maintenance and factory testing only.   Please refer to the service manual of the AC source for explanation.

3.2.4.11 The Saving

To save all of the system data except those in the modes of STEP, PULSE and LIST as follows:

1. Press SAVE, and the LCD displays as right.

Save to group   <u>0</u>

2. Press the numbers from 0 to 2 on the numeric keypad to select a desired memory group.

3. Press ENTER to confirm it.

*** NOTICE ***

1. Selection of memory group is programmable by pressing the numeric keypad only
   Other methods, including the turning of rotary knob and the pressing of ▲ or ▼, are
   invalid when the user tries to program a memory group to be "Saved" or
   "Recalled".
2. The AC source provides three memory groups: 0, 1, and 2.   The memory group 0
   keeps power-on defaults.   The setups saved into the memory group 0 will be recalled
   automatically when the AC source is powered on again while those saved into other
   memory groups must be recalled manually.   See 3.2.4.12.

3.2.4.12 The Recalling

To recall the system data as follows:

1. Press RECALL, and the LCD displays
   as right.

Recall from group   0

2. Press the numeric keypad to select a desired
   memory group.

3. Press ENTER to confirm it.

3.2.5 The Setting of Setup

The operational menu of "SET UP" manages the setups for V full range, waveform, data lock,
protections, etc.   Press SET UP to enter into the menu of "SET UP", and the LCD will
display as follows:

```
CHROMA    programmable AC source   Model 6530

SETUP PARAMETERS                    00:02:24

Range= 300V    waveform= A
Data lock = OFF    Buzzer = ON

PROTECTION
   Current  limit= 15.00              SAVE
        delay  time=   0.0 sec
   Voltage  limit=300.0               RECALL
        Phase Reverse=OFF
Measurement method
     Is  meas. time  = 0.01 sec
     Is Delay        = OFF
     LCD sleeo time = 4               QUIT
     average  time  = NONE
```
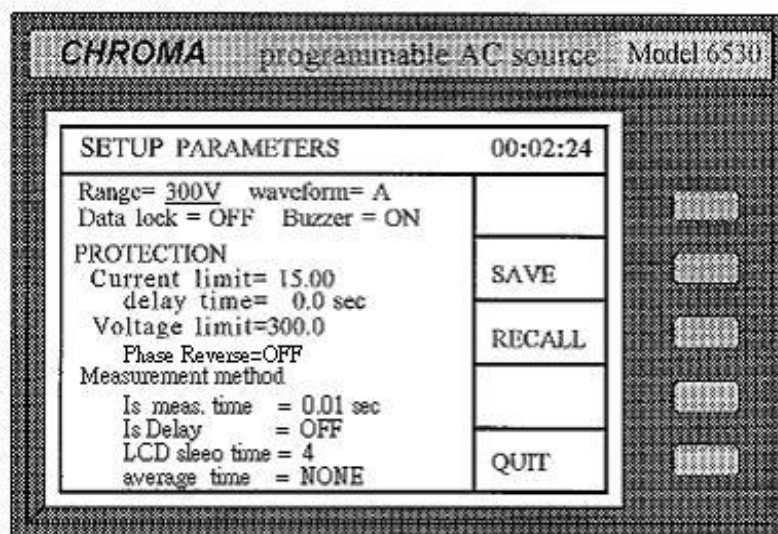
3.2.5.1   The Output Range

The AC source supplies full range of output voltage with three options of 150 V, 300 V, or AUTO.   The AUTO range means that the output range switches automatically between 150 V and 300 V as required.

To set the range of output voltage as AUTO as follows:

1. Move the cursor to the command line of Range.

```
Range=   300V   waveform=   A
```

2. Press ▲ or ▼ to change the option from "300" to "AUTO", then press ENTER .

```
Range= AUTO   waveform=   A
```

*** **NOTICE** ***

The AC source will set output voltage as 0 V first in order to eliminate voltage spike when range changes.   Then, it will set output voltage as set value.   It may cause UUT to shut down or get bad if the output is active, and range changes.   The instrument has AUTO RANGE function under FIX. MODE.   Other modes are without AUTO RANGE function.

3.2.5.2   The Selection of Waveform

The AC source offers two internal waveform generators: A and B.   For details in programming Waveform please refer to 3.2.4.6.   The user is allowed to select one of them as output waveform.

To select waveform B as active buffer as follows:

1. Move the cursor to the command line of "Waveform=".

```
Range= AUTO   waveform =   A
```

2. Press ▲, ENTER to change the option from A to B.

```
Range=   AUTO   waveform =   B
```

*** **NOTICE** ***

The AC source will display the selected waveform on the headline of the output main menu.

3.2.5.3 The Data Lock

The AC source allows the user to lock data entries, so the pre-defined parameters can be protected from being modified by an unauthorized person.

The procedures for the setting of data lock are shown below:

1. Move the cursor to the command line of "Data lock".

2. Press ▲, ENTER to change the option from OFF to ON.

```
Data lock  =  OFF    Buzzer  =  ON
```

```
Data lock  =  ON  Buzzer  =  ON
```

*** **NOTICE** ***

The user must select OFF to unlock.

3.2.5.4 The Setup of Buzzer

The buzzer of the AC source beeps when the user presses the keypad on the front panel, or turns the PRG knob.   If the user does not need it, he can turn if off.

To turn off the buzzer as follows:
1. Move the cursor to the command line of "Buzzer=".

2. Press ▲, ENTER to change the option from ON to OFF.

```
Data lock  =  OFF    Buzzer  =  ON
```

```
Data lock  =  OFF    Buzzer  =  OFF
```

3.2.5.5 Protection

Limitation of output RMS current, output voltage, and delay time are the parameters for triggering overload protection.   The discussion of protection/limitation in this subsection is about user-programmable protection, not hardware protection.

The procedures for setting Current limit = 20A, Delay time = 1 sec., and Voltage limit = 250V are described below:
1. Move the cursor to the command line of "Current limit=".

2. Press 2, 0, ENTER to change the value to "20.00".

```
Current limit= _15.00
```

```
Current limit=  20.00
```

3. The cursor moves to the command line
   of "delay time=" automatically.

| delay time=   _0.0 sec |

4. Press $\boxed{1}$, $\boxed{\text{ENTER}}$ to change the
   value to "1.0".

| delay time=   1.0 sec |

5. The cursor moves to the command line
   of "Voltage limit=" automatically.

| Voltage limit=150.0 |

6. Press $\boxed{2}$, $\boxed{5}$, $\boxed{0}$, $\boxed{\text{ENTER}}$ to
   change the value to "250.0".

| Voltage limit=250.0 |

*** NOTICE ***

1. Delay time is valid for eliminating transient current spike, which is useless in
   voltage protection.

2. Current limit ranges from 0 to 100 in step of 0.01 A.
   Delay time ranges from 0 to 100 in step of 0.1 sec.
   Voltage limit ranges from 0 to 300 in step of 0.1 V.

3. The output of the AC source will be disabled when protection is active, and will
   remain so even the condition is released.   The user has to press ENTER for over
   two seconds to reset the AC source

3.2.5.6   Phase Reverse

The AC Source allows the user to shift the output voltage 180°.

For example, the procedures of setup output voltage phase reverse are shown below:

1. Move the cursor to the "Phase Reverse=" command line.

| Phase Reverse   = OFF |

2. Press $\boxed{\blacktriangle}$ and **ENTER** to change the option from OFF to ON.

```
  Phase Reverse   = ON
```

3.2.5.7   The Methods of Measurement

The AC source measures the performance of a dynamic loading in a short period of time. The indicators of performance, including Vrms, Irms, Ip+, Ip–, Ptrue and F, are measured every 200 mS.   Then, the AC source takes as many successive readings as possible at the user's request, and calculates the average for presentation.   Besides, I surge is measured from the beginning of the transition of output to the end of the measurement time of Is.

For example, set the measurement of I surge for 0.5 sec. and average eight times.   The procedures of setup are shown below:

1. Move the cursor to the command line of "Is meas. time=".

```
  Is meas. time   = _ 0.01
```

2. Press 0 , . , 5 , ENTER to change the value to 0.5 sec.

```
  Is meas. time   =   0.50
```

3. Move the cursor to the command line of "Is Delay   =".

```
       Is Delay        = OFF
```

4. Press ▲ , ENTER to change the option to ON.

```
       Is Delay        = ON
```

5. The cursor moves to the command line of "average times=" automatically.

```
   average times   = _ 4
```

6. Press 8 , ENTER to set average times as 8.

```
   average times   =   8
```

```
                    *** NOTICE ***

1. The measurement time of I surge ranges from 0 to 30 in step of 0.01 sec.   Average
   times range from 1 to 20.


2. If the displayed value is too changeable to be read, the user can select a higher value of
   average times; for example, larger than 8 to stabilize it.
```

3.2.5.8   The Setup of LCD Sleep Time

The AC source allows the user to set LCD sleep time. There are four choices for LCD sleep time: NONE, 5 min, 20 min and 60 min. The LCD backlight will be turned off when the AC source reaches time limit of LCD sleep time without any operation in local mode. The LCD backlight will be turned on once again when the user operates in local mode.

The procedures for setting LCD sleep time: 5 min, are described as below:

1. Move the cursor to the command line
   of "LCD sleep time= NONE"

   ```
   LCD sleep time= NONE
   ```

2. Press ▲ to change the option from
   NONE to 5 min, then press ENTER .

   ```
   LCD sleep time= 5 min
   ```

3.2.5.9   The Saving/Recalling

Please refer to 3.2.4.11 and 3.2.4.12 for related information.

3.3 Applications

3.3.1 The Execution of Output

In the main operational menu of output, the user can press the soft key RUN to enable the execution of output.   When the user presses RUN, the LCD will change from "Output status=PAUSE" to "Output status=RUN", and the command string of the original "RUN" will change to "PAUSE" (Push the soft key PAUSE to disable output when output is in "RUN"). The following example of LCD indicates the states when the user toggles the output between "RUN" and "PAUSE" by the soft key.   If the output is inactive, the LCD will show as follows:
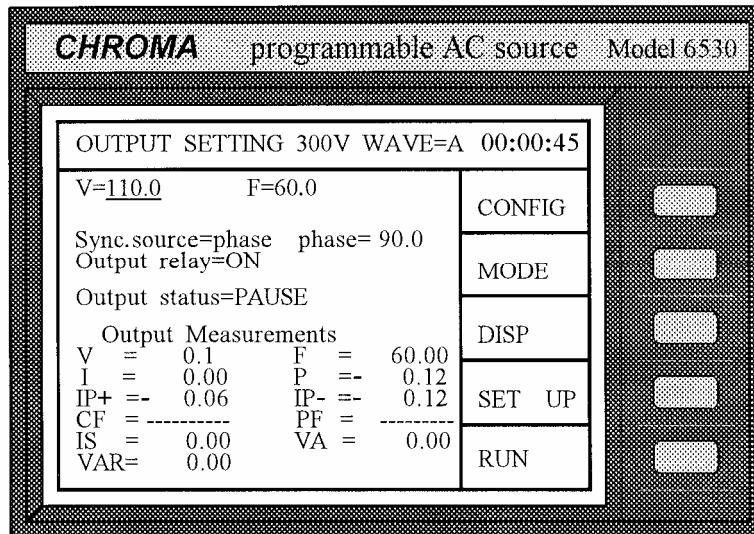
Press RUN to enable the active output, and the LCD will show as follows:
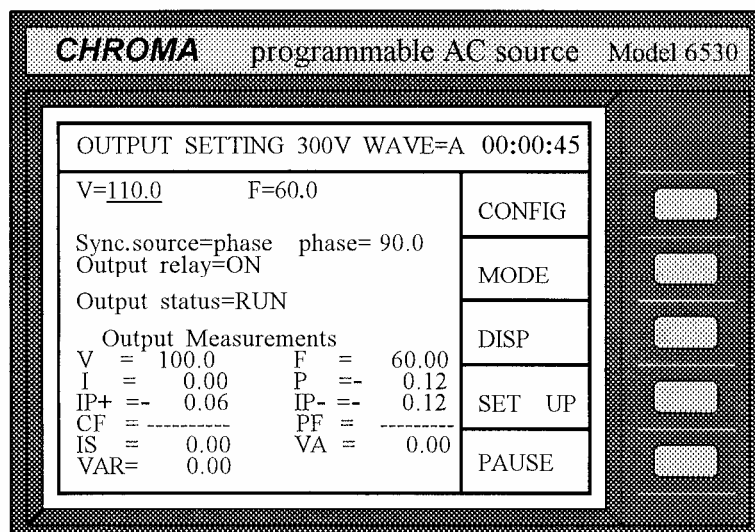
*** **NOTICE** ***

The user may observe the measured values of the measurable items under Output Measurements on the lower part of the LCD.   For detailed description of the measurement please refer to subsection 3.4.

3.3.2 The Modes

The AC source provides three powerful modes: STEP, PULSE, LIST for the user to program the output transient states and fulfill various needs in application.

STEP   It makes the output change to its set values step by step.

LIST   It makes the output change through a number of values as determined by parameters in the LIST menu.

PULSE   It makes the output change to its set value for a specific period of time as determined by parameters in the PULSE menu.

In the main operation menu, the user can make the AC source enter into the screen for the programming of application modes by pressing the soft key MODE, and the LCD will display as follows:

```
CHROMA    programmable AC source   Model 6530

  OUTPUT  SETTING  300V  WAVE=A  00:07:23

  Mode = STEP
                                        INIT
  V=   0.0   F= 60.00  Waveform=A
  Sync.source=Immed

  dV=- 1.0   dF=+ 20.00
  dTrigger=AUTO                         SAVE
  Dwell time=   1.000  sec
  Count=   10
                                        RECALL

  V=        7.08     F=        60.00
  P=-       0.12     I=         0.00    QUIT
```
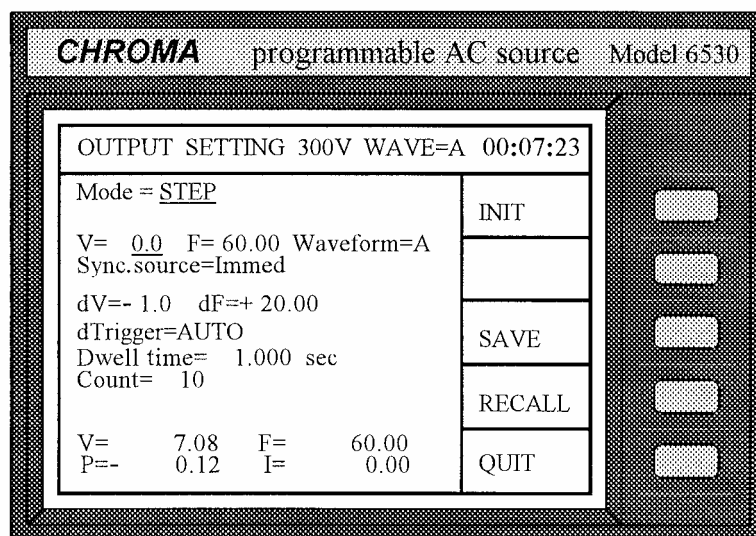
The user may select modes among STEP, PULSE, and LIST for specific applications by the use of ▲ or ▼.   The respective modes and application examples will be described in the following subsections.

3.3.2.1 Mode = STEP
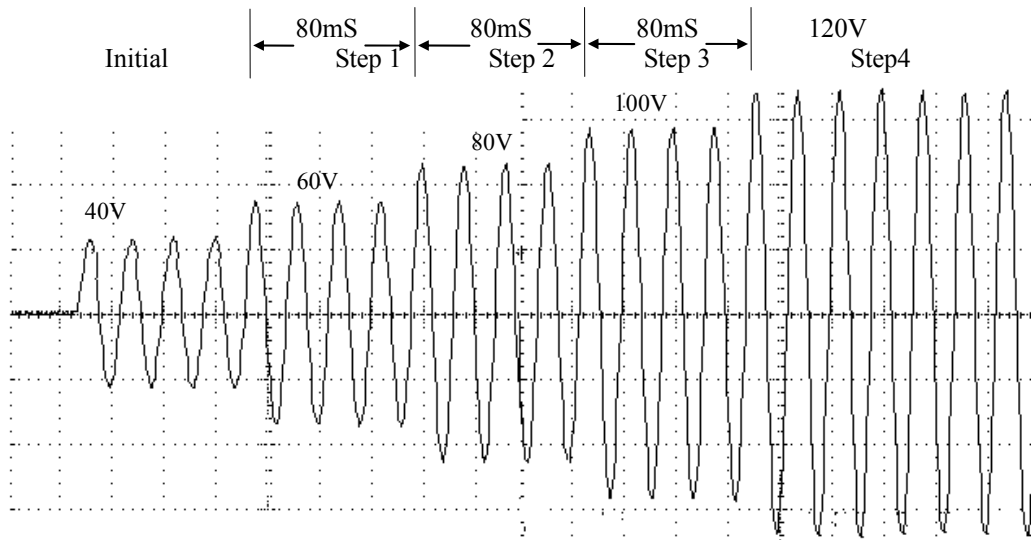
Figure 3-1 STEP Transients

In the STEP mode, the AC source offers Voltage and Frequency for being stepped up or down after programmable preset time (Dwell time).   It also offers selectable waveforms with which the programmable output transient phase is to synchronize.   Moreover, it provides cycle time for the user to repeat execution.

Example: The following example indicates a voltage output generated from the STEP mode.

The initial state is V=40 V, F=50 Hz, V stepping up with increment dv=20 V, F keeping constantly, dF=+0.00, Waveform=A (as sine), Sync. Source=phase, phase=0, Trigger=Auto, Dwell time=40 mS, and count=4 times (see Figure 3-1).

1. Select the STEP mode by following the procedure described in 3.3.2, or press MODE to enter into the setting of transient state, and press ▲ or ▼ to select the STEP mode.   Then, press ENTER .

```
       MODE   =   STEP
```

2. The cursor moves down to the line of Waveform=A
   "V=   0.0".

```
      V= _ 0.0   F=   60.00
```

3. Press 4 , 0 , ENTER for V, and the cursor moves to F=   _60.00.

```
V=   40.0   F= _60.00   Waveform=A
```

4. Press $\boxed{5}$, $\boxed{0}$, $\boxed{\text{ENTER}}$ for F (Skip
   the programming for Waveform and
   eave it unchanged by pressing
   $\boxed{\text{ENTER}}$).

```
┌─────────────────────────────────────┐
│  V=   40.0   F=   50.00   Waveform=A │
│                                      │
└─────────────────────────────────────┘
```

5. The cursor moves to the line of
   Sync. source.   Select phase by
   pressing $\boxed{\blacktriangledown}$, $\boxed{\text{ENTER}}$.   Make
   phase=0.0 by pressing $\boxed{\Downarrow}$
   or $\boxed{\text{ENTER}}$.

```
┌─────────────────────────────────────┐
│       Sync. source=Immed            │
│                                      │
└─────────────────────────────────────┘
```

```
┌─────────────────────────────────────┐
│    Sync. source=phase    phase=0.0  │
│                                      │
└─────────────────────────────────────┘
```

6. Move the cursor to "dV="
   using $\boxed{\blacktriangle}$ to change "–" to
   "+", then press $\boxed{\text{ENTER}}$.
   The cursor moves to "0.0".
   Press $\boxed{2}$, $\boxed{0}$, $\boxed{\text{ENTER}}$ for
   dV.

```
┌─────────────────────────────────────┐
│    dV=   –   0.0      dF= +   20.00  │
│                                      │
└─────────────────────────────────────┘
```

```
┌─────────────────────────────────────┐
│    dV=   +   20.0    dF= +_ 20.00    │
│                                      │
└─────────────────────────────────────┘
```

("+" means increment output voltage while "–" decrement output voltage.)

7. The cursor moves to
   "dF= +   20.00".
   Keep increment of F
   "+" by pressing
   $\boxed{\text{ENTER}}$ or $\boxed{\rightarrow}$.
   Press $\boxed{0}$, $\boxed{\text{ENTER}}$ to
   set frequency unchanged.

```
┌─────────────────────────────────────┐
│    dV= +   10.0     dF= +   0.00     │
│                                      │
└─────────────────────────────────────┘
```

8. The cursor moves to
   "dTrigger=AUTO".
   Skip the setting for
   dTriggering by pressing
   $\boxed{\text{ENTER}}$ or, $\boxed{\Downarrow}$ and
   move the cursor to the
   line of Dwell time.

```
┌─────────────────────────────────────┐
│     Dwell time=   _1.000 sec        │
│                                      │
└─────────────────────────────────────┘
```

9. Press $\boxed{0}$, $\boxed{.}$, $\boxed{0}$, $\boxed{8}$,
   $\boxed{\text{ENTER}}$ for Dwell time.

```
┌─────────────────────────────────────┐
│     Dwell time=   0.080 sec         │
│                                      │
└─────────────────────────────────────┘
```

10. The cursor moves to the line of
    "Count=".

```
┌─────────────────────────────────────┐
│      Count=   10                    │
│                                      │
└─────────────────────────────────────┘
```

Press ☐4☐, ☐ENTER☐ for count.
Count=0 is not allowed.

```
┌─────────────────────────────────┐
│                                 │
│            Count=   4           │
│                                 │
│                                 │
└─────────────────────────────────┘
```

11. Upon completion, press ☐INIT☐
    and ☐TRIG☐ to start the output
    power of the programmed
    parameters.

12. Press ☐QUIT☐ to exit from the
    operation in the STEP mode.

Note 1 : The AC source always measures the V, F, P, and I when dwell time is longer than
         two seconds. The readings of measurement are displayed on the lower part of the
         LCD   which indicates the performance of the load.

Note 2 : The two operation modes, AUTO and MANUAL, are given. AUTO means that the
         V/F will be automatically run step by step when the last step of Dwell time is
         finished, or the soft key ☐PAUSE☐ is pressed (see Note 3). MANUAL means
         that each step of V/F will be run whenever the soft key ☐UP☐ or ☐DOWN☐ is
         pressed. Each time output changes only one step.

```
┌──────────────────────────────────────────────────────┐
│  CHROMA   programmable AC source   Model 6530          │
│  ┌────────────────────────────────────────┐           │
│  │ OUTPUT SETTING 300V WAVE=A  00:07:23   │           │
│  ├──────────────────────────────┬─────────┤  ┌─────┐  │
│  │ Mode = STEP                  │  UP     │  │     │  │
│  │                              │         │  └─────┘  │
│  │ V=100.0  F=50.00  Waveform=A ├─────────┤  ┌─────┐  │
│  │ Sync.source=Immed            │  DOWN   │  │     │  │
│  │ dV=+ 20.0  dF=+ 0.00         │         │  └─────┘  │
│  │ dTrigger=MANUAL              ├─────────┤  ┌─────┐  │
│  │ Dwell time=  0.080 sec       │         │  │     │  │
│  │ Count=   4                   │         │  └─────┘  │
│  │                              ├─────────┤  ┌─────┐  │
│  │ V=    100.00   F=    50.00   │         │  │     │  │
│  │ P=-     0.12   I=     0.00   │ PAUSE   │  └─────┘  │
│  └──────────────────────────────┴─────────┘           │
└──────────────────────────────────────────────────────┘
```
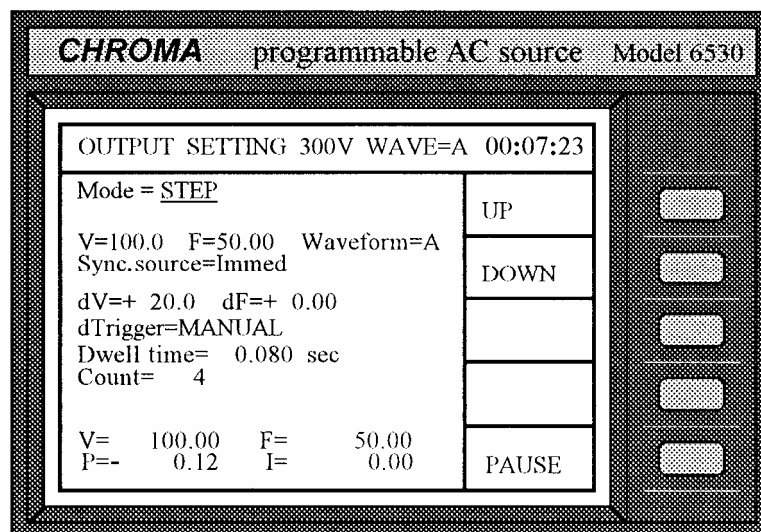
Note 3 : During the execution of the operation mode of dTrigger=AUTO, the user may
         press the soft key ☐PAUSE☐ to stop output. If the user needs to hold output
         temporarily, he can press the soft key ☐HOLD☐. When he wants to resume the
         output, he can press ☐CONT☐.

Note 4 : The pre-programmed output can be saved and recalled using the soft keys ☐SAVE☐
         and ☐RECALL☐. For details please refer to the example of operation in 3.2.2.11
         and 3.2.2.12.

Note 5 : When continuous=ON is initiated in Configure setting, the soft key ☐INIT☐ will be

displayed for the first time. Press INIT , and it will change to TRIG . Press TRIG to start the output power of the programmed specifications in STEP mode.

Note 6 : Upon the completion of the output in STEP mode, the last step will be displayed and menu updated. The AC source will continue to output till the user presses PAUSE in a fixed mode. The same condition is applied to the output status too.

3.3.2.2   Mode = LIST
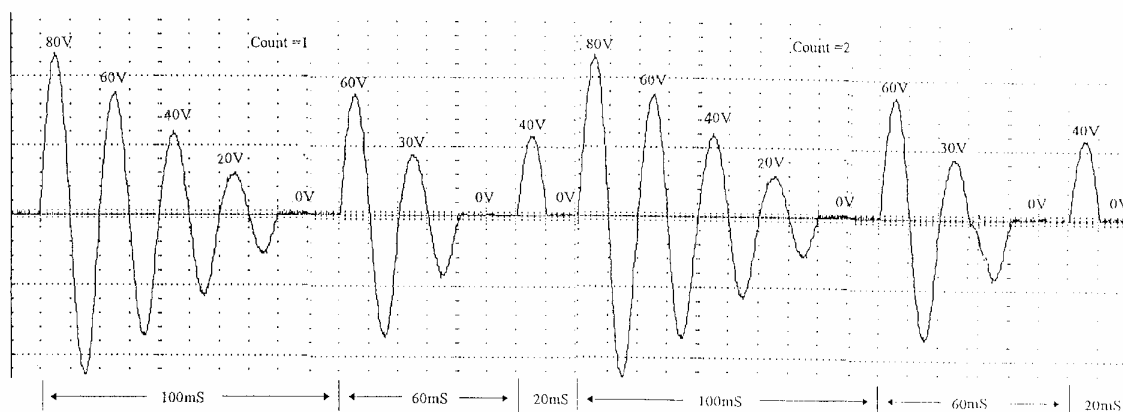
Figure 3-2 LIST Transients

In the LIST mode, the user can specify the output transient state using the parameters of V, F and Time step by step.

Example:

Initial V = 0.0 in normal mode
waveform=A, Trigger=Auto, Sync. source=phase, phase=0 degree

Vs0= 80V, Ve0= 0V, F0= 50Hz, Time0= 100mS Waveform0= A', StepNo0= 5
Vs1= 60V, Ve1= 0V, F1= 50Hz, Time1= 60mS Waveform1= A', StepNo1= 3
Vs2= 40V, Ve2= 0V, F2= 50Hz, Time2= 20mS Waveform2= A', StepNo2= 2
Stop the sequence by Time3=0mS, and repeat the entire cycle for two times (See Figure 3-2).

The operational procedures are described below:

1. Use the procedures described in 3.3.2 to select the LIST mode, and the LCD will display as follows:

```
┌─────────────────────────────────────────────────────────┐
│  CHROMA    programmable AC source   Model 6530           │
├──────────────────────────────────────────────┬──────────┤
│                                                │          │
│  OUTPUT  SETTING  300V  WAVE=A  00:07:23       │          │
│ ┌──────────────────────────────────┬─────────┐│  ┌────┐  │
│ │ Mode = LIST    Base =Cyc    Page  0│ INIT    ││  └────┘  │
│ │ Count=     6    Trigger= AUTO      │         ││          │
│ │ Sync.source=Immed                  │ SAVE    ││  ┌────┐  │
│ │ Loop setup:                        │         ││  └────┘  │
│ │ Dwell point:                       │         ││          │
│ │ 0.Start= 0      End= 1    Loop= 1  │ RECALL  ││  ┌────┐  │
│ │ 1.Start= 2      End= 3    Loop= 1  │         ││  └────┘  │
│ │ 2.Start= 4      End= 5    Loop= 1  │         ││          │
│ │ 3.Start= 6      End= 7    Loop= 1  │ NEXT    ││  ┌────┐  │
│ │ 4.Start= 8      End= 9    Loop= 1  │         ││  └────┘  │
│ │ 5.Start= 10     End= 11   Loop= 1  │         ││          │
│ │ 6.Start= 12     End= 13   Loop= 1  │ QUIT    ││  ┌────┐  │
│ │ 7.Start= 14     End= 15   Loop= 1  │         ││  └────┘  │
│ │ 8.Start= 16     End= 17   Loop= 1  │         ││          │
│ └──────────────────────────────────┴─────────┘│          │
└──────────────────────────────────────────────┴──────────┘
```
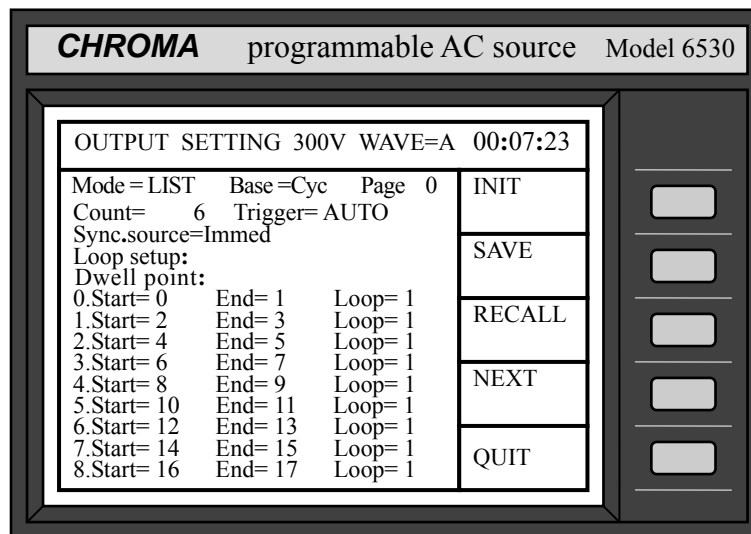
2. Move the cursor to the line of "Base =".   Press ▲ or ▼ to select "Base = Tim", then press ENTER .   There are two base parameters: Cycle, Time.

> Base = Cyc

> Base = Tim

3. Press 2 , ENTER to repeat counts. Count=0 means infinity (Skip Trigger="AUTO", and leave it unchanged by pressing ENTER).

> Count=   2

4. Move the cursor to the line of "Sync. source=". Select Sync. source to be phase by pressing ▲ till "phase" is displayed, then press ENTER .

> Sync. source=Immed

> Sync. source=phase   phase= _ 0.0

5. The cursor moves to "phase" automatically.   Press 0 , ENTER to set phase angle.

> Sync. source=phase   phase=   00.0

6. The cursor moves to the first line of loop setup.

> 0.Start= _ 0   End=   0   Loop=   1

Two rules must be followed in loop setup:
a. The sequence of End must be greater than or equal to that of Start in each line.
b. The sequence of End must be less than that of Start in the next line.

7. Press $\boxed{0}$, $\boxed{ENTER}$ to set Start
   sequence, $\boxed{1}$, $\boxed{ENTER}$ to set
   End sequence, and $\boxed{1}$, $\boxed{ENTER}$
   to set Loop number.

```
0.Start=  0   End=  1   Loop= 1
```

8. Repeat step 7 till Loop setup is finished
   as follows:

```
CHROMA    programmable AC source    Model 6530

OUTPUT  SETTING 300V  WAVE=A  00:07:23

Mode = LIST     Base =Tim     Page  0      INIT
Count=     2    Trigger= AUTO
Sync.source=phase        phase=   0.00
Loop setup:                                SAVE
Dwell point:
0.Start= 0      End= 1      Loop= 1
1.Start= 2      End= 3      Loop= 1         RECALL
2.Start= 4      End= 5      Loop= 1
3.Start= 6      End= 7      Loop= 1
4.Start= 8      End= 9      Loop= 1         NEXT
5.Start= 10     End= 11     Loop= 1
6.Start= 12     End= 13     Loop= 1
7.Start= 14     End= 15     Loop= 1         QUIT
8.Start= 16     End= 17     Loop= 1
```

9. Press the soft key $\boxed{NEXT}$ to go to Page 1.
   The cursor moves to the first line,
   "0.Vstart=0   Vend=0".

10. Press $\boxed{8}$, $\boxed{0}$, $\boxed{ENTER}$ to set sequence 0
    start voltage=   80V.   The cursor moves
    to "Vend=   0.0".   Leave it unchanged
    by pressing $\boxed{ENTER}$.

```
0. Vstart= _80.0        Vend= _ 0.0
```

11. The cursor moves to sequence 0
    "F=   60.00".
    Press $\boxed{5}$, $\boxed{0}$, $\boxed{ENTER}$ to set
    frequency=50 Hz.   The cursor
    moves to "Time =   0 ms".
    Press $\boxed{1}$, $\boxed{0}$, $\boxed{0}$, $\boxed{ENTER}$ to
    set sequence 0 time=   100 mS.

```
F= _ 60.00   Time  =      0 ms
```

```
F =   50.00   Time  =     100 ms
```

12. The cursor moves to
    "Step NO=   1".
    Press $\boxed{5}$, $\boxed{ENTER}$ to

set Step=5.   The cursor moves to "Waveform=A". Leave it unchanged by pressing ENTER .

```
Step NO=   5      Waveform=A
```

*** NOTICE ***

1. The Step NO cannot be 0.   When Step NO=1, only Vstart will be run.   When Step NO=2, only Vstart and Vend will be run.

2. The time resolution of the AC source for LIST mode is 1 mS.   When Time divided by Step NO is less than 1 mS, the AC source will change Step NO to set output, which changes in every 1 mS.

---

13. Repeat step 10 and 12 to set sequence 1, 2 until sequence setup is finished as follows: (For any sequence to which time specified as 0, the corresponding sequence will not be run.)

```
CHROMA   programmable AC source   Model 6530

OUTPUT SETTING 300V WAVE=A 00:07:23

                              Page  1
0.Vstart= 80.0    Vend=   0.0          PAGE0
  F=  50.00       Time =   100 ms
  Step NO=   5    Waveform=A
1.Vstart= 60.0    Vend=   0.0          SAVE
  F= 50.00        Time =    60 ms
  Step No=   3    Waveform=A
2. Vstart= 40.0   Vend=   0.0          RECALL
 . F=  50.00      Time =    20 ms
  Step No=   2    Waveform=A
3. Vstart=  0.0   Vend=   0.0          NEXT
  F=  60.00       Time =     0 ms
  Step No=   1    Waveform=A           PREV
```
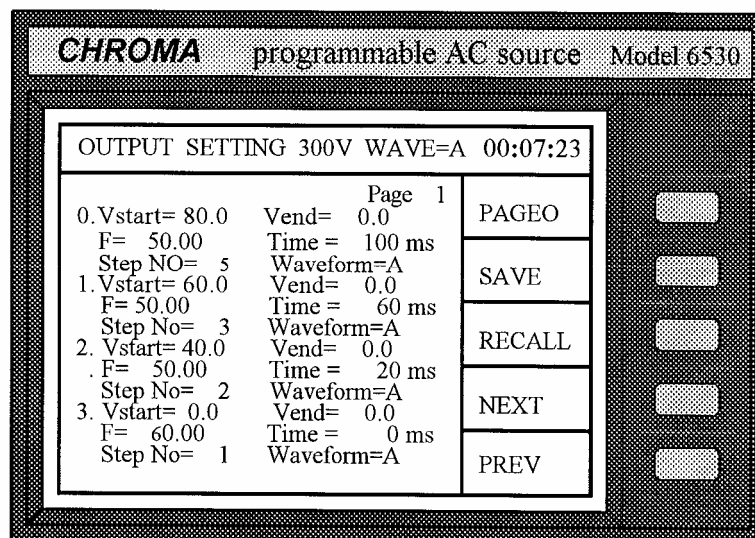
14. If you want to change the base of timing to cycle, please go to Page0, and move the cursor to "Base=Tim".   Press ▲ or ▼ to select "Base=Cyc", then press ENTER . (There is no relationship between Time and Cycle.)

15. Press NEXT to go to Page1.   Time in each sequence is substituted by Cycle.

16. Edit cycle of sequence 0, 1, 2 and update Page1 as follows:
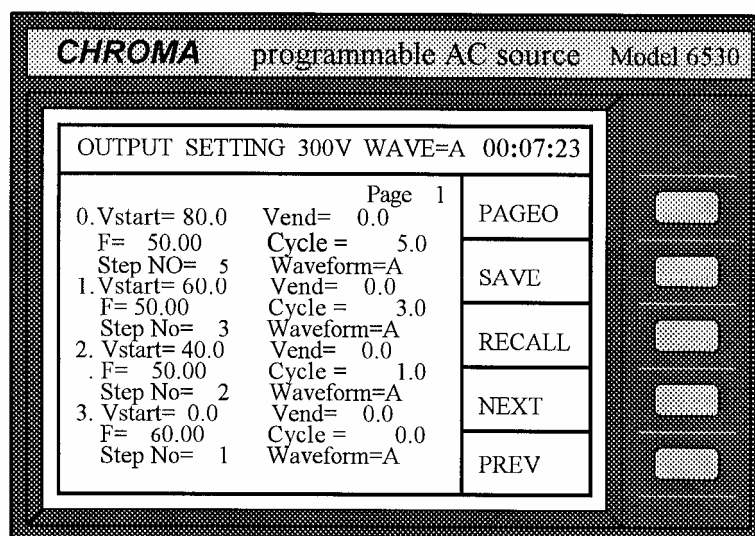
17. Upon completion, press PAGE0 to go to Page0, INIT to initiate LIST mode, and TRIG to start the output power of the programmed specifications in LIST mode.
18. Press QUIT to exit from the operation in LIST mode, and the LCD will return to the main operational menu.

Note 1 : Programmable parameters are listed as Table B-2 in Appendix B.

Note 2 : When the user programs steps of V/F exceeding page 0, he has to press NEXT to make the LCD display extend to other pages, and PREV to go back to the previous page.   Besides, pressing of PAGE0 will let the user return directly to page zero.   The number of total sequences is 40, from sequence 0 to sequence 39.

Note 3 : The pre-programmed output can be saved and recalled by the use of the soft keys SAVE and RECALL.   For details please refer to the example of operation in 3.2.2.11 and 3.2.2.12.

Note 4 : If the "initiate continuous=" is set as ON, INIT will not display after the first round of output.   The user may press TRIG again when he desires the output in the same LIST mode for more times.   If the "initiate continuous=" is set as OFF, the user has to press INIT to initiate it.

Note 5 : If Trigger=MANUAL, press TRIG so that the AC source will run the programmed parameters for only once.   It has the same result in Count=1.

Note 6 : Upon the completion of the output in LIST mode, the last sequence status will not be kept in the output.   The AC source will output the values of V, F in a fixed mode if "Output Status = RUN".   Output will be disabled when "Output Status = PAUSE".

3.3.2.3 Mode = PULSE
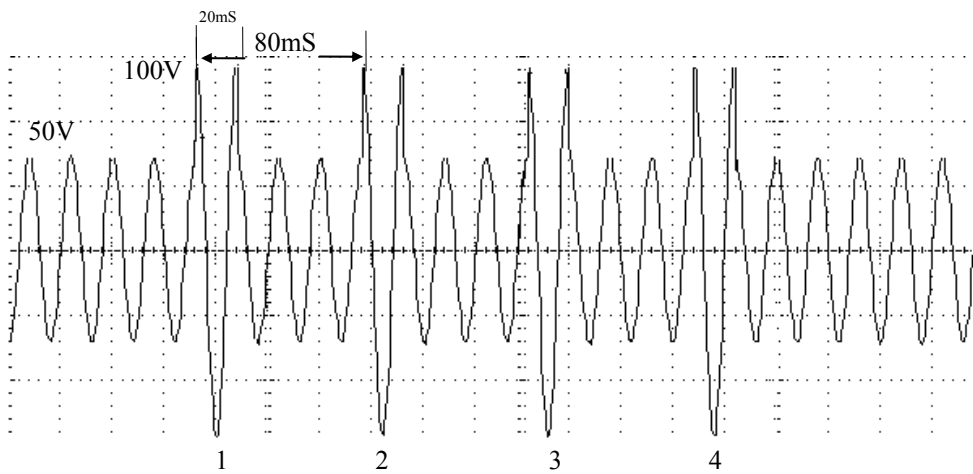
Figure 3-3 PULSE Transients

In the PULSE mode, the user is allowed to specify duty percent on top of the programmed output transient state.   An example indicating how to program the output with specifications is given below:

Output follows the internal waveform generator A under V=50V, F=50Hz, and output=RUN; the pulse criterion is V=100V, F=50Hz, waveform=A, Trigger=Auto, Sync. source=phase, phase=90.00 degrees, Duty =25%, and output duration=80mS, and repeat for count=4 times (see Figure 3-3).

Operating procedures are listed below:

1. Refer to 3.2.3, set the output V and F as V=50V, F=50Hz respectively, and press RUN to activate the outputs.   Then, press MODE and select the PULSE mode.   The LCD displays as follows:
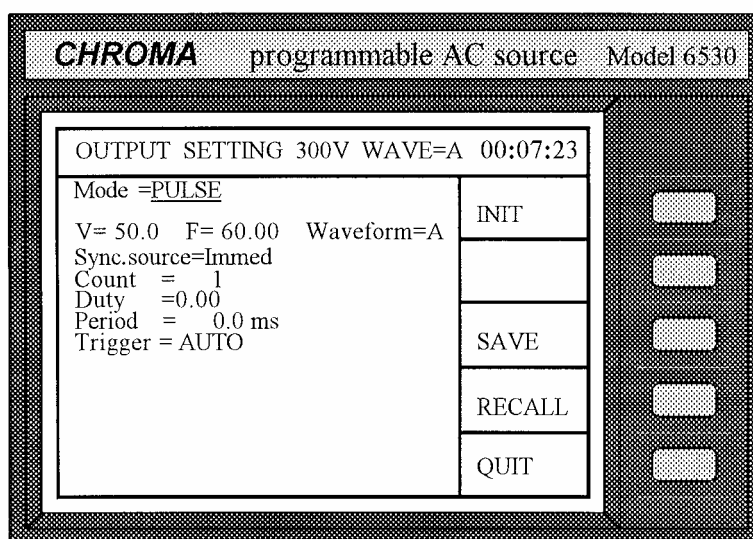
2. Move the cursor down to the line of "V=50.0".

```
V= _ 50.0     F=  60.00    Waveform=A
```

3. Press ⑴, ⓪, ⓪, |ENTER| for V.

   The cursor moves to the line of "F=   60.00".

```
V=100.0      F= _ 60.00   Waveform=A
```

4. Press ⑸ , ⓪, |ENTER| for F.

   The cursor moves to the line of "Waveform=A".

```
V=100.0      F= 50.00     Waveform=A
```

5. Select "Waveform=" as A using ▲ or ▼ key or rotary knob (Leave it unchanged).   Then, move the cursor to the next line by pressing |ENTER| or ⬇ .

```
Sync. source=Immed
```

6. Set Sync. source as phase by pressing ▲ or ▼ key, or turning rotary knob, then press |ENTER|.

```
Sync. source=phase     phase= _0.00
```

7. Press ⑼ , ⓪, |ENTER| for phase angle.

```
Sync. source=phase     phase=90.00
```

8. The cursor moves to "Count=1". Press ⑷, |ENTER| for repeated count number.   Count=0 means infinity.

```
Count    =    4
```

9. The cursor moves to the line of "Duty".
   Press $\boxed{2}$, $\boxed{5}$, $\boxed{\text{ENTER}}$ for duty cycle.

```
Duty    = _ 0.00
```

```
 Duty    =   25.00
```

10. The cursor moves to the line of "Period".
    Press $\boxed{8}$, $\boxed{0}$, $\boxed{\text{ENTER}}$ for period.

```
Period   = _ 0.0
```

```
 Period   =   80.0
```

11. Leave Trigger=AUTO alone.

12. Upon completion, press $\boxed{\text{INIT}}$ and $\boxed{\text{TRIG}}$ to start the output power of the programmed pulse.

13. Press $\boxed{\text{QUIT}}$ to exit from the PULSE mode and return to the main operational menu.

Note 1 : If Trigger=MANUAL, press $\boxed{\text{TRIG}}$ to run programmed parameters only once. It has the same result as count=1.

Note 2 : Upon completion of PULSE output, the last sequence status will not be kept on the output.   The AC source will output the values of V, F in a fixed mode if "Output Status = RUN".   Output is disabled when "Output Status = PAUSE".

Note 3 : The condition of pre-programmed output can be saved or recalled using $\boxed{\text{SAVE}}$ or $\boxed{\text{RECALL}}$.   For details please refer to the operational example in 3.2.2.11 and 3.2.2.12.

3.4 Measurement

The AC source can measure the actual performance of a load connected to it without using an extra measuring instrument.   When the AC source is active, it measures the V, I, F, P, etc. of a load.   The user can select the measurement point at the connector of a load (remote sense= ON), or at the output connector of the AC source itself.

3.4.1 The Selection of Measurement Items

The AC source can display concurrently up to 11 measurable readings, including V, F, I, P, Ip+, Ip–, CF, PF, Is, VA, and Var.   The user can select different measurement functions to display the measured readings.   If the user selects less than three measurement functions, the LCD will display the measurement in enlarged characters as follows (The lower half of the main

operational menu is the display area of measurement):

```
CHROMA    programmable AC source   Model 6530

 OUTPUT  SETTING  300V  WAVE=A  00:00:45
 V=    0.0          F= 60.0
                                          CONFIG
 Sync.source=Immed
 Output relay=OFF
                                          MODE
 Output status=PAUSE
         Output Measurements
 V   =          0.0                       DISP

 F   =        60.00                       SET   UP

 P   =         0.00                       RUN
```
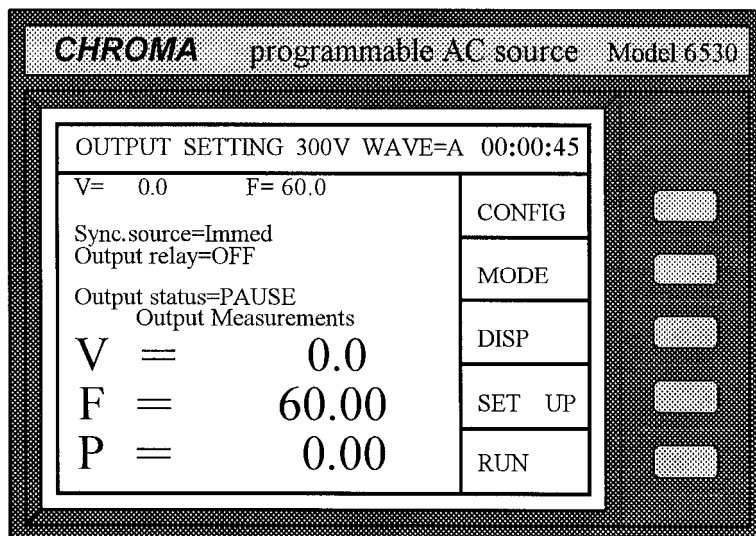
When the output parameters for measurement are more than three, the LCD will display in normal characters.

The procedures for selecting the measurement functions are described below:

1. Enter into the measurement display menu by pressing the soft key DISP in the main operation menu.   The LCD displays as follows:

```
CHROMA    programmable AC source   Model 6530

 MEASUREMENT   DISPLAY      00:03:30
 Mode=continuous
 1. V    =       0.00                     WAVE
 2. F    =      60.00
 3. I    =       0.00
 4. P    =       0.00                     VIEW
 5. IP+  =-      0.06
 6. IP-  =-      0.12
 7. CF   =--------------                  PRINT
 8. PF   =--------------
 9. IS   =       0.00
10. VA   =       0.00                     TRIG
11. VAR  =       0.00
12. empty
                                          QUIT
```
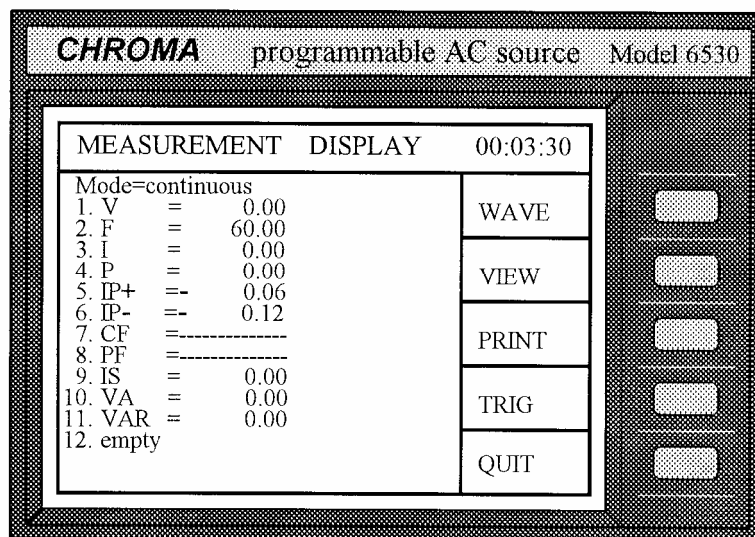
(It is the default setting from the factory for all the measurement items.)

2. Display the readings in a continuous way, or display a single measurement per trigger by turning rotary knob, or pressing ▲ or ▼ key (Leave "continuous" unchanged).

Note : If the user selects "single", he may use TRIG for measurement by manual trigger.

3. Move the cursor to the first display item.
   Number : 1 in front of V means the display
   position of measurement function.

   ```
   1.V  =      0.02
   ```

4. Turn the rotary knob clockwise, or press ▲, and the measurement functions will
   change one by one in the following order:

   V => F => I => P => IP+ => IP– => CF => PF => IS => VA =>
   VAR => empty => (return to V)

Note 1: Turn the rotary knob counterclockwise, or press ▼, the item will appear in
          reverse order.

Note 2: The option "empty" means that nothing is displayed for a corresponding item.

5. Select a desired measurement function, and press ENTER to confirm.   The cursor
   moves to the next item automatically.
   When you return to the main menu, these measurement items will be displayed on the
   lower half of the screen as shown by the above sample.

   Note : If the user selects more than three items, the odd items will be displayed on the
           left column, and the even items on the right one.   If the selected items are less
           than or equal to three, they will be listed with only one column in enlarged
           characters.

6. Repeat step 4 and 5 for the remaining items.

3.4.2 Measurement Functions

The AC source offers 11 measurement functions to the user.   All the functions can be
specified to display in the main operational menu as stated in the previous subsection.   The
definitions of the functions are listed in the following table:

Table 3-1   Available Measurement Functions

Function	Definition
V	It is the measurement readings of Voltage in Volts. (True RMS measurement)
F	It is the measurement readings of Frequency in Hertz.
I	It is the measurement readings of Current in Amperes. (True RMS measurement)
P	It is the true Power measurement in Watts.
Ip+	It is the positive I peak measurement in Amperes, and the peak value measured in every 200 mS. For details please refer to 3.2.5.6.
Ip–	It is the negative I peak measurement in Amperes, and measured similarly as Ip+.
CF	It is the Crest Factor, and its calculation formula = Ipeak/Irms.
PF	It is the Power Factor, and its calculation formula = true power/ (Vrms × Irms)

Is	It is I surge, and only measured from the occurrence of output transition till the end of "Is meas. time" as defined in 3.2.5.6.
VA	It is Apparent Power in Watts, and its calculation formula = Vrms × Irms
VAR	Its calculation formula $= \sqrt{VA^2 - P^2}$

3.4.3 The Display of the Output Waveforms of V & I

If the user wants to view the measured waveform of V or I, he can press $\boxed{\text{DISP}}$ in the main operational menu, then $\boxed{\text{WAVE}}$, and the LCD will show as follows:
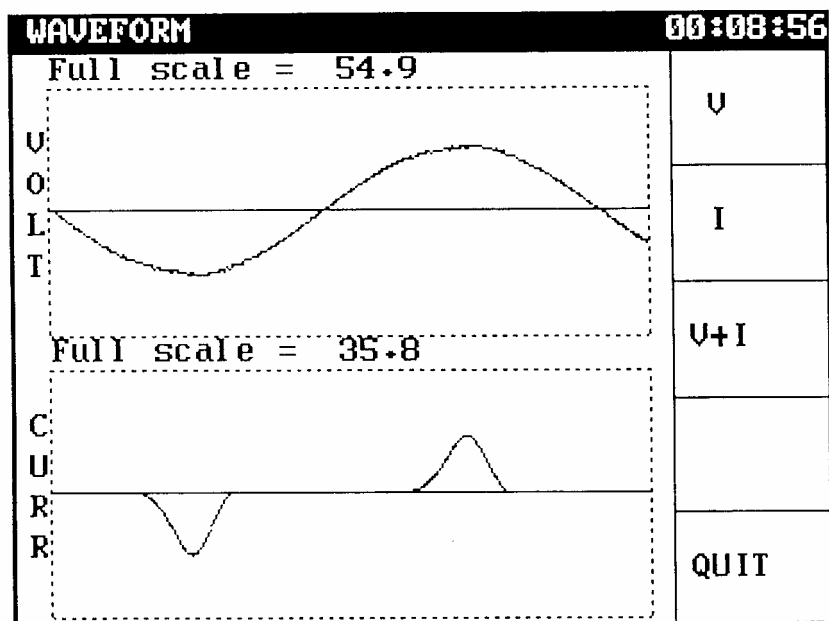
Full scale is automatically changed and displays on the heading of each waveform.

The user can press $\boxed{\text{V}}$ or $\boxed{\text{I}}$ to view V or I, or $\boxed{\text{V+I}}$ to view V and I at the same time.   When everything is ready, press $\boxed{\text{QUIT}}$ in the measurement display menu.

3.4.4 The View of the Stored Waveform

If the user wants to view the stored waveform of the AC source, he can press VIEW in the
measurement display menu, and the LCD will show as follows:

```
Waveform Display                    00:03:17
Waveform=DST01
                                        ┌──────────┐
                                        │  Redraw  │
                                        ├──────────┤
                                        │          │
                                        ├──────────┤
                                        │          │
                                        ├──────────┤
                                        │          │
                                        ├──────────┤
                                        │   QUIT   │
                                        └──────────┘
```
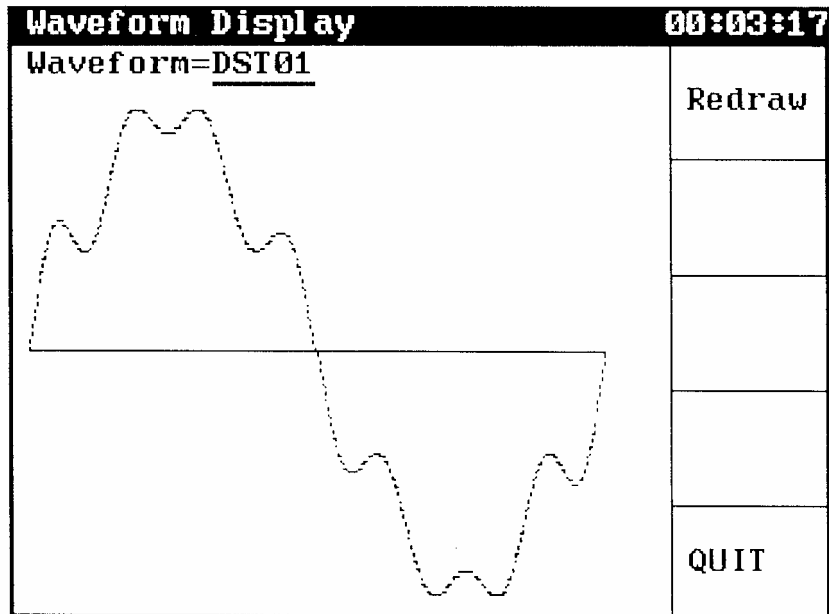
Press ▲ or ▼ key to select the display waveform, and press Redraw to update it.
Press the soft key QUIT to return to the measurement display menu.

3.4.5 The Printout

When the user needs the results of measurement, he can press PRINT in the measurement
display menu, and select what he wants, then press ENTER to start printing.   "FF ON"
means form feed command which will be followed when data printing finishes.   Connect the
printer to printer port on the rear panel.   Press QUIT to return to the measurement display
menu.
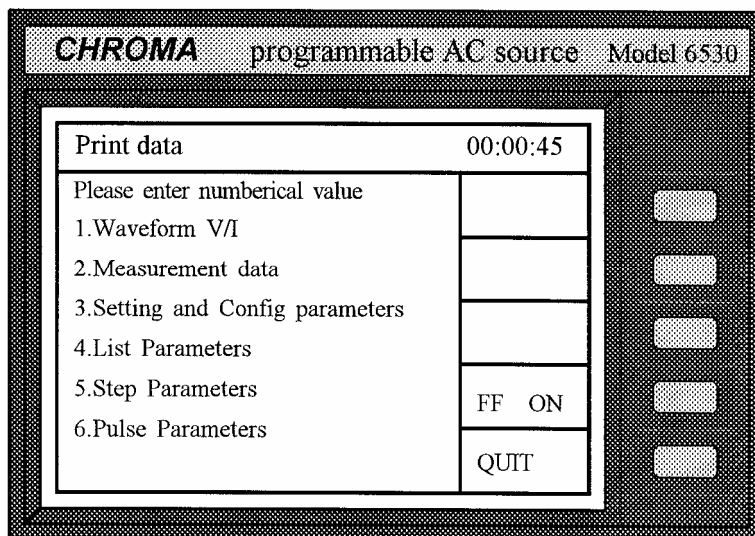
Note: The AC source supports HP LaserJet only.

3.5 Protection

The AC source provides protection for software and hardware.   Protection for software is listed below:

Protection	Description
Current	When current is over the limit, protection is given.
Power	When power is over the limit, protection is given.
Voltage Limit	When the user operates in the mode of STEP, PULSE or LIST, the voltage limit error occurs. If voltage is over voltage limit in normal mode, set voltage cannot exceed the voltage limit.

Protection for hardware is listed below too:

Protection	Description
PFO INT	It is power failure protection, and means that the voltage of the power supply is lower than specification.
FAN INT	It is fan failure protection, and means that the cooling fan malfunctions.
OPP INT	It is over power protection, and means that the output stage is over the power specification.
OCP INT	It is over current protection, and means that the output stage is over the current specification.
SHT INT	It is short protection, and means that the output terminals are shorted.
INP INT	It is power failure protection, and means that the line input voltage is lower than specification.
OTP INT	It is over temperature protection, and will be enabled when the internal temperature of the AC source is too high.
OPEN INT	It is feedback open protection, and means that the feedback loop is broken or the output voltage goes wrong.

If any output protection mentioned above is triggered to hold normal output, please remove the errors, then, press $\boxed{\text{ENTER}}$, and hold the key for two seconds to unlock the output protection so as to resume the normal operation.

4. Theory of Operation

4.1 General Information

The AC source consists of 13 print circuit boards and other components.   Each of the PCBs has its specific function that will be described in the following subsection.

4.2 Description of Overall System

Figure 4-1 (on page 4-3) shows the overall system.   Main power flows through the A/D, D/D, D/A power stage converter.   The A/D power stage is designated as I board, and generates DC voltage from the line input.   The DC voltage of A/D output is applied to the input of D/D power stage.   The G board of D/D stage takes power from the A/D output.   It generates two isolated DC outputs for D/A power stage.   The H board of D/A inverter generates AC output through full bridge controlled by C board to O board.   The D/A power stage is through O board relays in parallel or series control to obtain more current and higher voltage.

A board is identified as CPU.   The CPU of the AC source is used to perform remote control through GPIB, RS-232C or EXT VREF interface on Optional board, to control output frequency and voltage through BS and C boards, to measure voltage, current and power through BM board, to display message, to scan front panel key through LCD module and K board, and to monitor all interrupts.

BM board is identified as measurement unit.   All measurement functions are done here.

BS board is identified as waveform generator.   It generates output waveforms which act as the reference input of C board.

C board is identified as controller of DC to AC (H board).   It controls DC to AC power stage in order to get low distorted waveform output.

K board is identified as keyboard which includes RPG (Rotary Pulse Generator).   It is an interface between the user and the instrument when the latter is used in local operation. Extended and Optional boards are identified as input/output signals which include GPIB, RS-232C, EXT VERF, printer and other I/O control signals.   Optional board is on Extended board.

M1 board is identified as mother board which includes system power supply, fan control circuit, and interconnection of A, BM, BS, C boards.

M2 board is simply an interconnection of M1, Extended, and O boards.
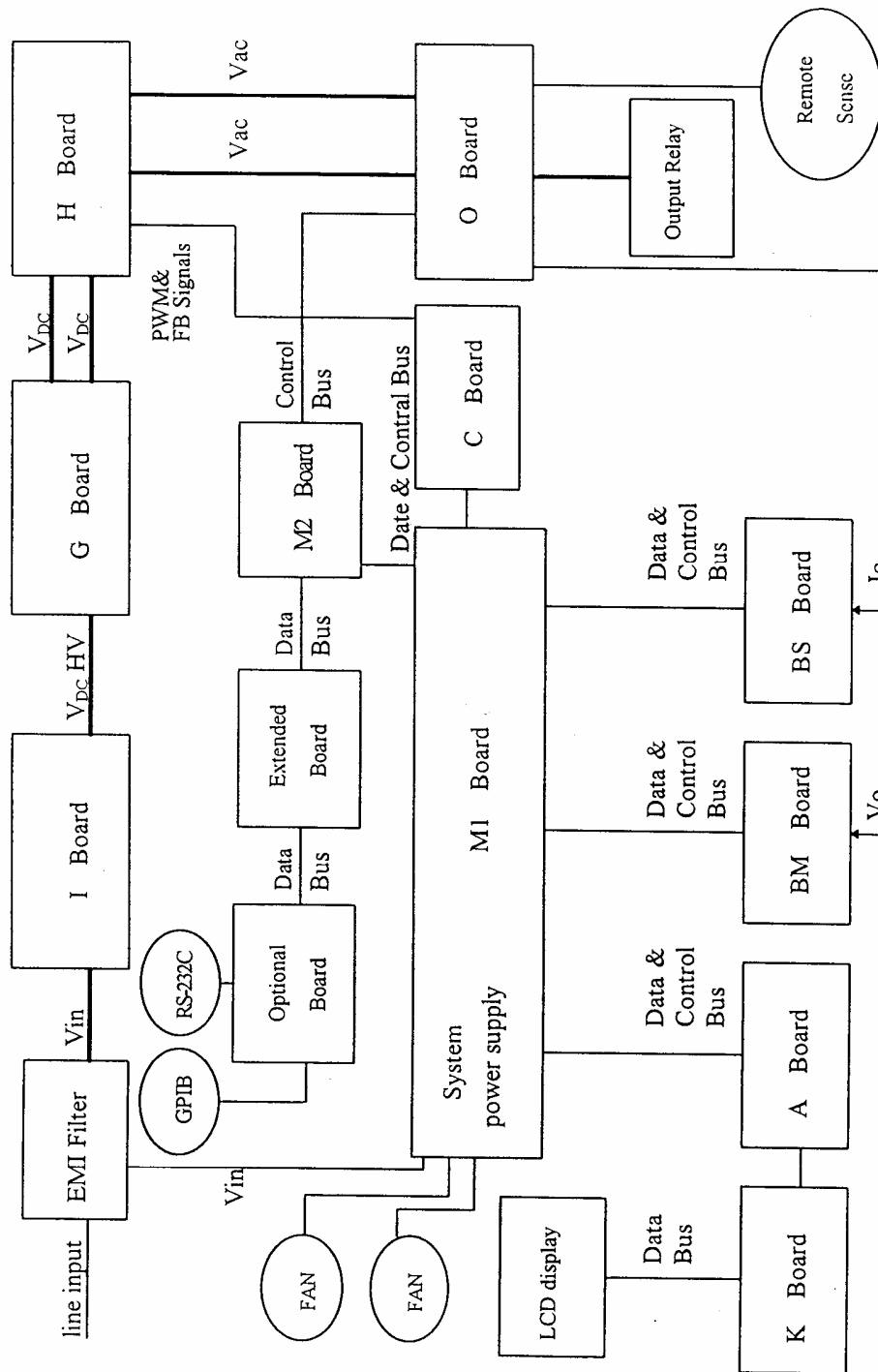
Figure 4-1 System Block Diagram

5. Verification

5.1 General Information

This section is going to talk about the procedures of verification and calibration of the AC source.   The procedures of verification are not to check all operating parameters, but to make certain that the AC source is performing properly.   As for the calibration of the AC source, it must be done at the front panel.

5.2 Required Equipment

The equipment listed in the following table is required for verification and calibration.

Name	Recommended Model or Capacity
Voltmeter	HP 34401A Hewlett Packard
Current Shunt	2575A Valhalla Scientific
Load	5 ohm to 30 ohm

The specified load resistor's value and power depend on the AC source models.   Please refer to the current specifications of the AC source for the needed resistor.

5.3 Verification Test

> *** **WARNING** ***
>
> The AC source can supply 425 V peak or so at output.   Death may be caused if the output terminals connected to the load are touched while power is applied.

This test is to verify the voltage programming, the accuracy in the measurement function of voltage and current.   Be sure to use wire of sufficient size to carry the maximum rated current of the supply when verification of current is under way.
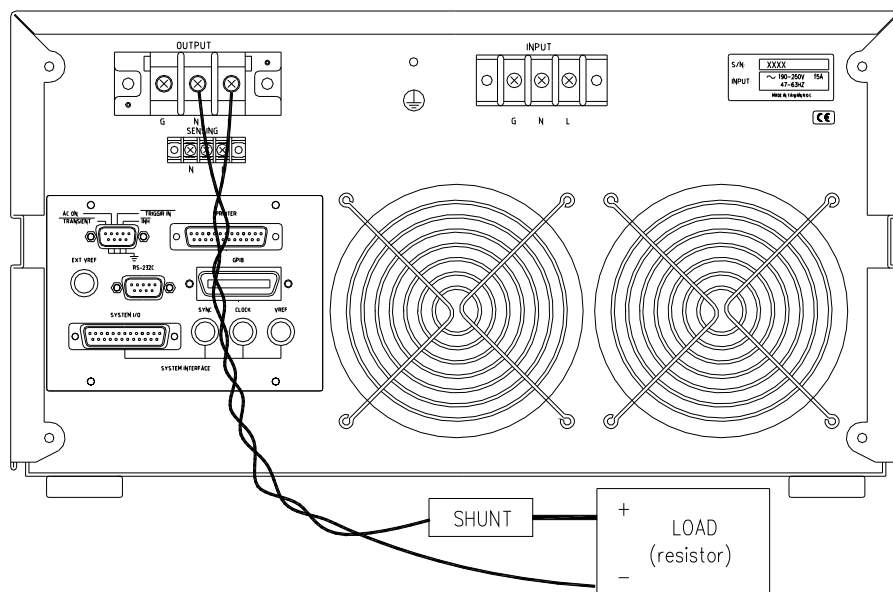
Figure 5-1 The Setup of Verification Test

5.3.1 Voltage Programming & Measurement Accuracy

Procedures:
1. Turn off the AC source, and connect the DVM across the output terminals.
2. Turn on the AC source with no load and voltage range = AUTO on the output.
   Set the current limit to its maximum value.   Program the output as a sinewave of
   150V, 60Hz.
3. Record the voltage reading at DVM and the display on the front panel.
4. Program the output to 300V.
5. Record the voltage reading at DVM and the display on the front panel.

5.3.2 Measurement Accuracy of Current

Procedures:
1. Turn off the AC source, and connect the current shunt between the output terminals
   and the load.
2. Turn on the AC source, set voltage range to 300V, and program the output voltage=10V.
   Set the current limit to its maximum value.
3. Record the current reading at shunt and the display on the front panel.
4. Change the voltage range from 300V to 150V.
5. Record the voltage reading at DVM and the display on the front panel.

Parameters for Verification Test

Test Description	Minimum Spec.	Result	Maximum Spec.
Voltage Programming and Measurement			
Low Voltage (150V)	149.7		150.3
Display of AC source	Vout-500mV		Vout+500mV
High Voltage (300V)	299.4		300.6
Display of AC source	Vout-900mV		Vout+900mV
Current Measurement in Model 6512			
Low Current (6A)	5.9		6.1
Display of AC source	Iout-160mA		Iout+160mA
High Current (12A)	11.9		12.1
Display of AC source	Iout-100mA		Iout+180mA
Current Measurement in Model 6520			
Low Current (10A)	9.9		10.1
Display of AC source	Iout-100mA		Iout+180mA
High Current (20A)	19.9		20.1
Display of AC source	Iout-200mA		Iout+100mA
Current Measurement in Model 6530			
Low Current (15A)	14.9		15.1
Display of AC source	Iout-100mA		Iout+200mA
High Current (30A)	29.9		30.1
Display of AC source	Iout-100mA		Iout+200mA

If the results of verification are not within the specifications, please refer to service manual of the AC source for adjustment.

6. Remote Operation

6.1 General Information

The AC source can be controlled remotely through the GPIB or the RS-232C port. The GPIB port is mostly used, but the RS-232C port is helpful too.

Technically speaking, the GPIB interface is quite different from the RS-232C interface. The GPIB interface is an 8-bit parallel data bus owning a host of bus commands for synchronization, and up to one Megabyte transfer rate. The RS-232C interface, a series bus with a few handshake lines for synchronization, is less capable, so its requirement is not so much, and the user can write a simple program to do basic remote control easily.

6.1.1 Setting the GPIB Address and RS-232C Parameters

The AC source is shipped with the GPIB address which is set at 30. The address can be only changed from the front panel by pressing the soft key CONFIG in the "Configure setting" menu. This menu is also used to select the RS-232C interface, and specify the parameters of RS-232C such as baud rate and parity.

Set the GPIB address as follows:

1. Press CONFIG to enter into the "Configure setting" menu.

2. Move the cursor to the line of GPIB address.

3. Enter the new address from the numeric keys such as 5 , ENTER , and the GPIB address will change to 5.

Set the RS-232C interface as follows:

1. Press CONFIG to enter into the "Configure setting" menu.

2. Move the cursor to RS-232C parameters of baud rate.

3. Select baud rate by pressing ▲ or ▼ key, then press ENTER .

4. Move the cursor to the line of parity, and select parity as you select baud rate.

Display of Cursor

GPIB address =30

GPIB address =5

Baudrate=4800   Parity=EVEN

6.1.2 Wire Connection of RS-232C

The AC source is shipped with the baud rate which is set at 9600, and with parity which is set as None.   For RS-232C interface, only the signals of TxD, RxD, are used for its transfer of data.   The RS-232C connector is a 9-pin D subminiature female connector.   The following table describes the pins and signals of RS-232C connector.

Pin No.	Input/Output	Description
1	---	No connection
2	OUTPUT	TxD
3	INPUT	RxD
4	---	DSR
5	---	GND
6	---	DTR
7	---	CTS
8	---	RTS
9	---	No connection

Interconnection between the computer (compatible with IBM PC) and the AC source is illustrated below:

```
PIN        IBM PC          AC source
 1         DCD         X
 2         RX      ←   TX
 3         TX      →   RX
 4         DTR         X
 5         GND     —   GND
 6         DSR         X
 7         RTS         X
 8         CTS         X
 9         RI          X
```

6.2 The GPIB Capability of the AC Source

GPIB Capability	Description	Interface Functions
Talker/Listener	Commands and response messages can be sent and received over the GPIB bus. Status information can be read using a series poll.	AH1, SH1, T6, L4
Service Request	The AC source sets the SRQ line true if there is an enabled service request condition.	SR1
Remote/Local	The AC source powers up in local state. In local state, the front panel is operative, and the AC source responds to the commands from GPIB. In remote state, all front panel keys except the local key are disabled. Press local key to return the AC source to local state. Local key can be disabled using local lockout so that only the controller or the power switch can return the AC source to local mode.	RL1

6.3 Introduction to Programming

All commands and response messages are transferred in form of ASCII codes.   The response messages must be read completely before a new command is sent, otherwise the remaining response messages will be lost, and a query interrupt error will occur.

6.3.1 Conventions

Angle brackets   <   >   Items in angle brackets are parameter abbreviations.
Vertical bar | Vertical bar separates alternative parameters.
Square brackets   [   ]   Items in square brackets are optional.   For example,
                                  OUTP [: STATe] means that : STATe may be omitted.
Braces   {   }   Braces indicate the parameters that may be repeated.
                                  The notation <A> {<, B>} means that parameter "A" must
                                  be entered while parameter "B" may be omitted or entered
                                  once or more times.

6.3.2 Numerical Data Formats

All data programmed to or returned from the AC source are ASCII.   The data can be numerical or character string.

Numerical Data Formats

Symbol	Description	Example
NR1	It is a digit with no decimal point. The decimal is assumed to be at the right of the least significant digit.	123, 0123
NR2	It is a digit with a decimal point.	12.3, .123
NR3	It is a digit with a decimal point and an exponent.	1.23E+2

6.3.3 Boolean Data Format

The Boolean parameter <Boolean> takes only the form ON|OFF.

6.3.4 Character Data Format

The character strings returned by query command may take either of the following forms:

<CRD>   Character Response Data: character string with maximum length of 12.
<SRD>   String Response Data: character string.

6.3.5 Basic Definition

Command Tree Table:

The commands of the AC source are based on a hierarchical structure, also known as a tree system.   In order to obtain a particular command, the full path to that command must be specified.   This path is represented in the table by placing the highest node in the farthest left position of the hierarchy.   Lower nodes in the hierarchy are indented in the position to the right, below the parent node.

Program Headers:

Program headers are key words that identify the command.   They follow the syntax described in subsection 7.6 of IEEE 488.2.   The AC source accepts characters in both upper and lower case without distinguishing the difference.   Program headers consist of two distinctive types, common command headers and instrument-controlled headers.

Common Command and Query Headers:
The syntax of common command and query headers is described in IEEE 488.2.   It is used together with the IEEE 488.2-defined common commands and queries.   The commands with a leading " * " are common commands.

Instrument-Controlled Headers:

Instrument-controlled headers are used for all other instrument commands.   Each of them has a long form and a short form.   The AC source only accepts the exact short and long forms.   A special notation will be taken to differentiate the short form header from the long one of the same header in this subsection.   The short forms of the header are shown in characters of upper case, whereas the rest of the headers are shown in those of lower case.

Program Header Separator (:):

If a command has more than one header, the user must separate them with a colon (FETC:CURR   FUNC:SHAP).   Data must be separated from program header by one space at least.

Program Message:

Program message consists of a sequence of zero or more elements of program message unit that is separated by separator elements of program message unit.

Program Message Unit:

Program message unit represents a single command, programming data, or query.

Example : VOLT?,　OUTPut　ON.

Program Message Unit Separator (;):

The separator (semicolon ;) separates the program message unit elements from one another in a program message.

Example : VOLT　110 ; FREQ　120<PMT>

Program Message Terminator (<PMT>):

A program message terminator represents the end of a program message.　Three permitted terminators are:

(1) <END> : end or identify (EOI)
(2) <NL> : new line which is a single ASCII-encoded byte 0A (10 decimals).
(3) <NL> <END> : new line with EOI.

Note: The response message is terminated by <NL> <END> for GPIB, and <NL> for RS-232C.
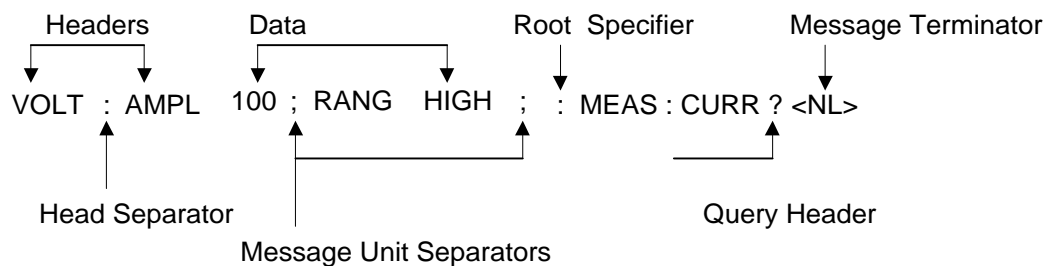
Figure 6-1 The Structure of Command Message

6.4 Traversal of the Command Tree

Multiple program message unit elements can be sent in a program message.　The first command is always referred to the root node.　Subsequent commands are referred to the same tree level as the previous command in a program message.　A colon preceding a program message unit changes the header path to the root level.

Example:

OUTPut : PROTection : DELAY 1　　　　　　　　All colons are header separators.

OUTPut : PROTection : DELAY 1   Only the first colon is a specific root.
OUTPut : PROTection : DELAY 1; : VOLT 100 Only the third colon is a specific root.

6.5 Execution Order

The AC source executes program messages by the order received.   Program message units except coupled commands are executed in order of reception.   The execution of coupled commands is deferred until program message terminator is received.   A coupled command sets parameters which are affected by the setting of other commands.   Problems may arise, because the prior state of the AC source will affect the response of a coupled parameter to its programming.

For example, assume that the current output voltage range is LOW, a new state is desired with output voltage range HIGH, and amplify 220 Volt.   If the commands

> VOLTage   220<PMT>
> RANGe   HIGH<PMT>

are sent, data out of range error will be produced.   Such kind of error can be avoided by reversing the order, or sending the commands in one program message.   For the above example, the program message

> VOLTage   220 ; RANGe   HIGH<PMT>

can be sent without error.
The following commands are coupled : VOLTage,   : RANGe.

6.6 The Commands of the AC Source

This subsection is going to talk about the syntax and parameters for all commands of the AC source.   The examples given for each command are generic.

Syntax Forms   Definitions of syntax are in long form headers, whereas only short form headers appear in examples.

Parameters   Most commands require a parameter, and all queries return a parameter.

Models   If a command is merely applied to specific models, these models will be listed in the Model only entry.   If there is no Model only entry, the command will be applied to all models.

6.6.1 Common Command Dictionary

Common commands begin with a " * " , and consist of three letters and/or one " ? " (query). Common commands and queries are listed alphabetically.

*CLS   Clear status

          This command clears the following registers
          (1) Questionable Status Event
          (2) Status Byte
          (3) Error Queue

*ESE<n>   Standard event status enabled

          This command programs the Standard Event register bits.   If one or more
          of the enabled events of the Standard Event register is set, the ESB of Status
          Byte Register is set too.

          Bit Configuration of Standard Event Status Enabled Register

Bit Position	7	6	5	4	3	2	1	0
Bit Name	PON	- - -	CME	EXE	DDE	QYE	- - -	OPC
CME = Command error				DDE = Device-dependent error				
EXE = Execution error				OPC = Operation complete				
PON = Power-on				QYE = Query error				

*ESE?   Return standard event status enabled

          The query reads the Standard Event Status Event register.   Reading of the
          register clears it.   The bits of configuration is the same as Standard Event
          Status Enabled Register.

*IDN?   Return the AC source identification

          Return Parameter Chroma ATE 6530, 1234, 2.01
          Chroma ATE : Company name
          6530   : Model name
          1234   : Serial number
          2.01   : Firmware version number

*RCL<n>   Restore the values of the specific group which is previously stored in memory.

          Parameter   0 - 2

*SAV<n>   Save the values into the specific group in memory.

          Parameter   0 - 2

*SRE   This command sets conditions of the Service Request Enabled register.   If
          one or more of the enabled events of the Status Byte Register is set, the MSS
          and RQS of Status Byte Register are set too.

*STB?   This query returns the Status Byte Register.

Bit configuration of Status Byte Register

Bit Position	7	6	5	4	3	2	1	0
Condition	- -	MSS RQS	ESB	MAV	QUES	- -	- -	- -

ESB = event status byte summary
QES = questionable status summary
RQS = request for service
MSS = master status summary
MAV = message available

6.6.2 Instrument Command Dictionary

The commands are listed in alphabetical order.   Commands followed by question marks (?) take only the query forms.   When commands take both the command and query forms, they are noted in the syntax descriptions.

FETCh | MEASure
    [: SCALar]
        : CURRent
            : AC?   Query AC rms current
            : AMPLitude : MAXimum?   Query peak current
            : CREStfactor?   Query current crest factor

This command lets the user get measurement data from the AC source.   Two measurement commands are available: MEASure and FETCh.   MEASure triggers the acquisition of new data before returning data.   FETCh returns the previously acquired data from measurement buffer.   Individual outputs of a multi-phase source are specified by the setting of INSTrument : NSELect command.

FETCh [: SCALar] : CURRent : AC?
MEASure [: SCALar] : CURRent : AC?

Return parameters   <NR2>

These queries return the rms current which is being output at the output terminal.

FETCh [: SCALar] : CURRent : AMPLitude : MAXimum?
MEASure [: SCALar] : CURRent : AMPLitude : MAXimum?

Return parameters   <NR2>

These queries return the absolute value of peak current.

FETCh [: SCALar] : CURRent : CREStfactor?
MEASure [: SCALar] : CURRent : CREStfactor?

Return parameters   <NR2>

These queries return the output current crest factor.   It is the ratio of peak output current to rms output current.

FETCh [: SCALar] : CURRent : INRush?
MEASure [: SCALar] : CURRent : INRush?

Return parameters   <NR2>

These queries return the value of inrush current.

FETCh | MEASure
     [: SCALar]
           : FREQuency?   Query the output frequency

FETCh [: SCALar] : FREQuency?
MEASure [: SCALar] : FREQuency?

Return parameters   <NR2>

These queries return the output frequency in Hertz.

FETCh | MEASure
     [: SCALar]
           : POWer
                : AC
                     [: REAL] ?   Query real power
                     : APParent?   Query apparent power
                     : REACtive?   Query reactive power
                     : PFACtor?   Query power factor
                     : TOTal?   Query total power

FETCh [: SCALar] : POWer : AC [: REAL] ?
MEASure [: SCALar] : POWer : AC [: REAL] ?

Return parameters   <NR2>

These queries return the true power which is being output at output terminals in watts.

FETCh [: SCALar] : POWer : AC : APParent?
MEASure [: SCALar] : POWer : AC : APParent?

Return parameters   <NR2>

These queries return the apparent power which is being output at output terminals in volt-amperes.

FETCh [: SCALar] : POWer : AC : REACtive?
MEASure [: SCALar] : POWer : AC : REACtive?

Return parameters   <NR2>

These queries return the reactive power which is being output at output terminals in volt-amperes.   Reactive power is computed as:

$$VAR = \sqrt{APPARENTPOWER^2 - REALPOWER^2}$$

FETCh [: SCALar] : POWer : AC : PFACtor?
MEASure [: SCALar] : POWer : AC : PFACtor?

Return parameters   <NR2>

These queries return the power factor which is being output at output terminals.   Power factor is computed as:
PF = TRUE POWER / APPARENT POWER

FETCh [: SCALar] : POWer : AC : TOTal?
MEASure [: SCALar] : POWer : AC : TOTal?

Return parameters   <NR2>

Model 6590/6560 only.

These queries return the total true power which is being output at output terminals in watts.

FETCh | MEASure
     [: SCALar]
          : VOLTage
               : AC?   Query the output voltage

Return parameters   <NR2>

FETCh [: SCALar] : VOLTage : AC?
MEASure [: SCALar] : VOLTage : AC?

These queries return the ac rms voltage which is being output at the output terminals.

INITiate
     [: IMMediate]
      : CONTinuous
           : SEQuence1   ON | OFF

INITiate [: IMMediate]

The INITiate commands control the initiation of the transient generator trigger system. Commands make the trigger system change from idle state to waiting-for-trigger state.

INITiate : CONTinuous : SEQuence1   ON | OFF
This command controls the transient generator trigger system.

ON   continuously initiates the transient trigger system.
OFF   turns off triggering continuously.   In this state, the user must initiate each trigger using
     INITiate : SEQuence1.

INSTrument
   : COUPle ALL | NONE   Set coupled phases for programming
   : NSELect   <n>   Select output phase to program
   : SELect   <OUTPut>

Model 6590 only.

INSTrument : COUPle ALL | NONE

Query syntax   INSTrument : COUPle
Return parameters   ALL | NONE

In a multi-phase power source it is convenient to set parameters of all phases simultaneously
with one programmed command.   When INST : COUP ALL command is programmed, a
command will be sent to the AC source, and to all phases in the end.   INST : COUP NONE
command cancels COUP ALL command.

This command has no effect on queries and can set parameters only.

INSTrument : NSELect   1| 2| 3
INSTrument : SELect   OUTPut1| OUTPut2| OUTPut3
Query syntax   INSTrument : NSELect?
Return parameters   1| 2| 3

This command sets individual outputs in a multi-phase model for subsequent commands or
queries.   If INST : COUP NONE is programmed, the phase-selective commands are sent to
the particular output phase set by INSTrument : NSELect command.   If INST : COUP ALL
is programmed, all commands are sent to all output phases.

INST : NSEL selects phase by its number, and INST : SEL refers to it by its name.

ORELay   ON | OFF   Set output relay on (closed) or off (open)

This command sets output relay on/off.

ON   sets the output relay of the AC source on (closed).
OFF   sets the output relay of the AC source off (open).

OUTPut
   [: STATe]   <bool>   Enable/disable the output of the AC source
   : PROTection
       : CLEar   Reset protection status

       : DELay   <n>   Set the delay time of protection

OUTPut [: STATe]   ON | OFF

Query syntax	OUTPut?
Return parameters	ON	OFF

This command enables or disables the output of the AC source.   Disable output is to set an output voltage amplitude at 0 Volt.

OUTPut : PROTection : CLEar

This command clears the latch that disables the output when an over current (OC), overtemperature (OT), overpower (OP) or remote inhibit (RI) is detected.   All conditions which have generated the fault must be removed before the latch is cleared.

OUTPut : PROTection : DELay   <NR2>

Query syntax	OUTPut : PROTection : DELay?
Parameter	0.0 to 100.0
Return parameters	<NR2>

This command sets delay time when software protection occurs.   The time unit is 0.1 second.

RANGe   HIGH | LOW | AUTO   Set output voltage range

This command sets the output voltage range of the AC source.
HIGH   sets the AC source at 300V (high) range.
LOW   sets the AC source at 150V (low) range.
AUTO sets the AC source at Auto range.   It means that if output voltage > 150V, the AC source will be in HIGH range, whereas if output voltage $\leq$ 150V, the AC source will be in LOW range.

[SOURce :]
     CURRent
        [: LEVel]
            [: IMMediate]
                [: AMPLitude]   <n>   Set the rms current limit

[SOURce :] CURRent [: LEVel] [: IMMediate] [: AMPLitude]   <NR2>

Query syntax	CURRent [: LEVel] [: IMMediate] [: AMPLitude] ?
Parameter	0.00 to 100.00
Return parameters	<NR2>

This command sets the rms current limit of the AC source for software protection.   The unit is 0.01 ampere.

[SOURce :]
     FREQuency

[: CW | : IMMediate]   <n>   Set output frequency

[SOURce :] FREQuency [: CW | : IMMediate]   <NR2>

Query syntax   [SOURce :] FREQuency [: CW | : IMMediate] ?
Return parameters   <NR2>

The command sets the frequency of the output waveform of the AC source.

[SOURce :]
    FUNCtion
        : SHAPe
           : A | B   Select active waveform buffer
               [<shape>]   Set waveform buffer shape

[SOURce :] FUNCtion : SHAPe   A | B

Query syntax   [SOURce :] FUNCtion : SHAPe?
Return parameters   A | B
This command sets the active buffer of waveform generator.   There are two waveform buffers.   One is A and another is B.   The user can select active buffer through FUNC : SHAP A | B command.

[SOURce :] FUNCtion : SHAPe : A | B <shape>

Query syntax   [SOURce :] FUNCtion [: SHAPe] [: A | B]?
Return parameters   SIN| SQU| CSIN| DST<1. .30>| US<1. .6>

This command specifies the waveform buffer.   There are two buffers for the output of the AC source, so the user must specify the contents of waveform buffer A or B of the AC source.

<shape>
SINusoid   Sine waveform output
SQUare   Square waveform output
DST <n>   Distorted waveform output 1-30
CSINusoid <n>   Set the % of peak at which the clipped sine (or % THD) is
US <n>   The user-defined waveform output 1-6

The clipping level is expressed as a percentage of the peak amplitude at which clipping occurs. Range is from 0 to 100 percent.   These are the default units when the optional THD suffix is not sent.   If the THD suffix is sent, the range will be from 0 to 43 percent.   The maximum peak voltage that the AC source can output is 425V peak.   Therefore, the maximum rms value that can be programmed depends on the peak to rms ratio of selected waveform.   Refer to Appendix E for non-sine wave maximum programmed voltage.

[SOURce :] FUNCtion : TRANsient ON | OFF

Query syntax   [SOURce :] FUNCtion :TRANsient?
Return parameters   ON/OFF

This command sets transient option.

[SOURce :]
    VOLTage
        [: LEVel]
            [: IMMediate]
                [: AMPLitude]   <n>   Set the rms voltage amplitude

[SOURce :] VOLTage [: LEVel] [: IMMediate] [: AMPLitude] <NR2>

Query syntax   VOLTage [: LEVel] [: IMMediate] [: AMPLitude]?
Return parameters   <NR2>

This command sets the rms output voltage level of the AC source.
This command is programmed to change only the setting value. But it doesn't output until "OUTP ON" is programmed.

V <NR2>
This command makes AC Source output the setting value immediately.

There is No Query command.

SYSTem
    : ERRor?   Query the error string

Response error string :
    No Error   Data Format Error   Data Range Error
    Too Many Errors   Execution Error

TRACe | DATA
    [: DATA] <US1, . . , US6>, <D1, D2. . .> Assign value to a waveform

These commands set the value of user-defined waveform table.   The first parameter is the waveform of No.1 to 6.   Those that follow are 1000 data points.   They define the relative amplitudes of exactly one cycle of the waveform.   The first data point defines the relative amplitude that will be output at 0 degree phase reference.   An error will occur if there are not exactly 1000 data points being sent with the command.

Data points should be in range of 0 to 4095 so as to meet the correct rms value.   The data should meet the following requirements:
1:    $D1+D2+. . . . +D1000 = 1000 \times 2048$
2:    $(D1-2048)^2 + (D2-2048)^2 + ... + (D1000-2048)^2 = 500 \times (2048)^2$

The first requirement is to set the average value at the middle of 0 to 4095.   The second requirement is to get the rms value.

The size of receiver buffer in the AC source is 1000 byte, so when data are downloaded to the AC source, time limit must be long enough for the AC source to process data.   The time limit

should be at least 20 seconds for multi-phase (Model 6590) system.

Waveform data are stored in battery back-up RAM, and retained when input power is removed.

TRIGger
   [: SEQuence1 | : TRANsient]
       [: IMMediate]

This command controls the triggering of the AC source in execution MODE.   When MODE command is executed, INITiate command must be sent to the AC source to initialize the transient trigger system.   TRIGger command follows INIT to trigger the AC source.

TRIGger [: SEQuence1 | : TRANsient] [: IMMediate]

After the trigger status has been initiated, the TRIGger command will generate a trigger signal.

TPHase   <NR2>   Sets transient phase angle

Query syntax   TPHase?
Parameter   0.0 to 359.99
Return parameters   <NR2>

This command sets transient phase of the AC source.

TPHase:SYNC IMM | SYNC
Query syntax   TPHase:SYNC?
Return parameters   IMM | PHAS

"TPH:SYNC IMM" is programmed, the transient phase is random. If "TPH:SYNC PHAS" is programmed, the transient phase is outputted according to the transient phase angle.

PHASe[:IMMediate]:REVerse
Query Syntax   PHASe[:IMMediate]:REVerse?
Parameters   OFF | ON
Return parameters   OFF | ON

This command takes effect on the phase angle of output. If the option is selected as ON, the starting phase angle of output will shift 180°. If the option is selected as OFF, the starting phase angle of output will follow the setting.

Example   PHASe[:IMMediate]:REVerse ON
                                    PHASe[:IMMediate]:SYNC PHAS
                                    PHASe 90.0

If the above commands are programmed sequentially and then output voltage. The starting phase angle of output will be 270°.

[SOURce:]
    LIST
        :COUNt   <n> | INFinity
        : SYNC   IMMediate | PHASe
        : SPHase
        : QUIT
        : BASE   TIME | CYCle
        : DWEL   <n>{, <n>}
                : POINts?
        : FREQuency [: LEVel]   <n>{, <n>}
                        : POINts?
        : VOLTage [: LEVel]
                : STARt   <n>{, <n>}

                        : POINts?
             : END   <n>{, <n>}
                    : POINts?
        : SHAPe   A | B {, A | B}
             POINts?
        : STARt   <n>{, <n>}
        : END   <n>{, <n>}
        : LOOP   <n>{, <n>}
        : STEPno <n>{, <n>}

LIST : COUNt   <NR1> | INFinity

This command sets the number of times for the execution of the LIST.   Use INFinity to execute a LIST indefinitely.

Query Syntax   [SOURce :] : LIST : COUNt?
Parameter   1 to 60000
Return parameters   <NR1> | INFINITY

LIST : SYNC   IMMediate | PHASe
LIST : SYNC   IMM   Let the AC source output transient phase immediately in LIST mode.
LIST : SYNC   PHASe Let the AC source output transient phase synchronously in LIST mode.

Query Syntax   [SOURce:] : LIST : SYNC?
Parameter   IMM | PHAS
Return parameters   IMM | PHAS

LIST : SPHase   <NR2>

This command sets the phase of the output voltage waveform in LIST mode.

Query Syntax   [SOURce :] : LIST : SPHase?
Parameter   0 to 359.99

Return parameters   <NR2>

LIST: QUIT

This command interrupts the runnig LIST.

LIST : BASE TIME | CYCle

This command sets time base in LIST mode.

Query Syntax   [SOURce :] : LIST : BASE?
Parameter   TIME | CYCle
Return   TIME | CYCle

LIST : DWEL   <NR2>{, <NR2>}

This command sets the sequence of LIST dwell time.   Each value represents the time in second.   The output will stay at the LIST sequence before completing it.   Notice that you must select the base of time (LIST: BASE TIME | CYCle) before sending the command.

Query Syntax   [SOURce :] : LIST : DWEL?
Parameter   0 second to 999999 ms   (Time base)
                           0 cycle to 6000.0 cycles   (Cycle base)
Return parameters   <NR2>

LIST : DWEL : POINt?   <NR1>

This query returns the number of points specified in LIST: DWEL.   The return value is the total number of points.

Return parameters   <NR1>

LIST : FREQuency [: LEVel]   <NR2>{, <NR2>}

This command sets the sequence of frequency.   The frequency points are given in the command parameter, which are separated by commas or space.

Query Syntax   [SOURce:] : LIST: FREQuency?
Parameter   15.00 to 2000.00
Return parameters   <NR2>

LIST : FREQuency [: LEVel] : POINt?

This query returns the number of points specified in LIST: FREQ.   The return value is the total number of points.

Return parameters   <NR1>

LIST : VOLTage [: LEVel] : STARt   <NR2>{, <NR2>}

This command sets the sequence of beginning voltage.   The beginning voltage points are given in the command parameters, which are separated by commas or space.

    Query Syntax   [SOURce :] : LIST: VOLTage: STARt?
    Parameter   0.0 to 300.0
    Return parameters   <NR2>{, <NR2>}

LIST : VOLTage [: LEVel] : STARt : POINt?

This query returns the number of points specified in LIST: VOLTage [: LEVel] : STARt. The return value is the total number of points.

    Return parameters   <NR1>

LIST : VOLTage [: LEVel] : END   <NR2>{, <NR2>}

This command sets the sequence of the ending voltage.   The ending voltage points are given in the command parameters, which are separated by commas or space.

    Query Syntax   [SOURce :] : LIST: VOLTage: STARt?
    Parameter   0.0 to 300.0
    Return parameters   <NR2>{, <NR2>}

LIST : VOLTage [: LEVel] : END : POINt?   <NR1>

This query returns the number of points specified in LIST: VOLTage [: LEVel] : END. The return value is the total number of points.

    Return parameters   <NR1>

LIST : SHAPe   A | B{, A | B}

This command sets the sequence of the shape.   The shape points are given in the command parameters, which are separated by commas or space.   There are two waveform buffers. One is A and another is B.   The user can select an active buffer through FUNC: SHAP A | B command.

    Query Syntax   [SOURce :] : LIST : SHAPe?
    Parameter   A | B
    Return parameters   A | B{, A | B}

LIST: SHAPe: POINt?

This query returns the number of points specified in LIST: SHAPe.   The return value is the total number of points.

    Return parameters   <NR1>

LIST : STARt   <NR1>{, <NR1>}

This command sets the sequence of the starting sequence in LOOP SETUP.   These parameters are separated by commas or space.

Query Syntax	[SOURce :] : LIST : STARt?
Parameter	0 to 39
Return parameters	<NR1>{, <NR1>}

LIST : END   <NR1>{, <NR1>}

This command sets the sequence of the ending sequence in LOOP SETUP.
These parameters are separated by commas or space.

Query Syntax	[SOURce :] : LIST : END?
Parameter	0 to 39
Return parameters	<NR1>{, <NR1>}

LIST : LOOP   <NR1>{, <NR1>}

This command sets the sequence of the loop's cycles.   The loop means that the number of   times is executed from the starting sequence to end.

Query Syntax	[SOURce :] : LIST : LOOP?
Parameter	0 to 9999
Return parameters	<NR1>{, <NR1>}

LIST : STEPno   <NR1>

This command sets how many steps are executed in a sequence.

Query Syntax	[SOURce :] : LIST : STEPno?
Parameter	0 to 999
Return parameters	<NR1>{, <NR1>}

[SOURce :]
   : STEP
       : VOLTage   <n>
       : FREQuency <n>
       : SPHase   <n>
       : SHAPe   <n>
       : DVOLtage   <n>
       : DFRequency <n>
       : DWELl   <n>
       : COUNt   <n>

STEP : VOLTage   <NR2>

This command sets the initial voltage.

Query Syntax	[SOURce :] : STEP : VOLTage?
Parameter	0.0 to 300.0
Return parameters	<NR2>

STEP : FREQuency   <NR2>

This command sets the initial frequency.

Query Syntax	[SOURce :] : STEP : FREQuency?
Parameter	15.0 to 2000.0
Return parameters	<NR2>

STEP : SPHase   <NR2>

This command sets the start phase of step mode.

Query Syntax	[SOURce :] : STEP : SPHase?
Parameter	0.00 to 359.99
Return parameters	<NR2>

STEP : SHAPe   A | B

This command sets waveforms.

Query Syntax	[SOURce :] : STEP : SHAPe?
Parameter	A	B
Return parameters	A	B

STEP : DVOLtage   <NR2>

This command sets the delta voltage in each step.

Query Syntax	[SOURce :] : STEP : DVOLtage?
Parameter	−300.0 to +300.0
Return parameters	<NR2>

STEP : DFRequency   <NR2>

This command sets the delta frequency in each step.

Query Syntax	[SOURce :] : STEP : DFRequency?
Parameter	−2000.0 to +2000.0
Return parameters	<NR2>

STEP : DWELl   <NR2>

This command sets the dwell time in each step.

Query Syntax   [SOURce :] : STEP : DWELl?
Parameter   0.000 to 999.999 sec
Return parameters   <NR2>

STEP : COUNt   <NR1>

This command sets the number of times for the execution of the step.
Query Syntax   [SOURce :] : STEP : COUNt?
Parameter   0 to 30000
Return parameters   <NR1>

[SOURce :]
   : PULSe
          : SYNC   IMMediate | PHASe
          : SPHase   <n>
          : VOLTage   <n>
          : FREQuency   <n>
          : SHAPe   <n>
          : COUNt   <n>
          : DCYCle   <n>
          : PERiod   <n>
          : QUIT

PULSe : SYNC   IMMediate | PHASe

If PULSe : SYNC PHASe is programmed, the AC source will synchronize specific phase
angle to output voltage in PULSE mode.   The phase angle will be neglected if PULSe:
SYNC IMM is programmed.

Query Syntax   [SOURce :] : PULSe : SYNC?
Parameter   PHASe | IMMediate
Return parameters   PHAS | IMM

PULSe : SPHase   <NR2>

If PULSe : SPHase 90 is programmed, the AC source will not output the specific voltage
until 90 degrees.   The command is invalid when PULSe: SYNC IMM is programmed.

Query Syntax   [SOURce :] : PULSe : SPHase?
Parameter   0.00 to 359.99
Return parameters   <NR2>

PULSe : VOLTage   <NR2>

This command sets voltage in the duty cycle of PULSE mode.

Query Syntax   [SOURce :] : PULSe : VOLTage?

Parameter   0.0 to 300.0

Return parameters   <NR2>

PULSe : FREQuency <NR2>

This command sets frequency in the duty cycle of PULSE mode.

Query Syntax   [SOURce :] : PULSe : FREQuency?

Parameter   0.00 to 2000.00

Return parameters   <NR2>

PULSe : SHAPe A | B

This command sets waveform A or B in the duty cycle of PULSE mode.

Query Syntax   [SOURce :] : PULSe : SHAPe?

Parameter   A | B

PULSe: COUNt <NR1>

This command sets the number of pulses that are output in PULSE mode.

Query Syntax   [SOURce :] : PULSe : COUNt?

Parameter   1 to 60000 or INFINITY

Return parameters   <NR1>

PULSe : DCYCle <NR2>

This command sets the duty cycle of the triggered output pulse in PULSE mode.

Query Syntax   [SOURce :] : PULSe : DCYCle?

Parameter   0.01% to 100.00%

Return parameters   <NR2>

PULSe : PERiod <NR2>

This command sets the period of a triggered output pulse in PULSE mode.

Query Syntax   [SOURce :] : PULSe : PERiod?

Parameter   0.0 to 999999.0 ms

Return parameters   <NR2>

PULSe : QUIT

This command stops the generation of output pulses.

SYSTem
  : VERSion?
  : LOCal

: REMote
: RWLock

SYSTem : VERSion?

This query requests the AC source to identify itself.

Return parameters   Chroma ATE, 6530, 1234, 2.01

SYSTem : LOCal

This command can only be used under the control of RS-232C.   If SYST : LOC is
programmed, the AC source will be set in the LOCAL state, and the front panel will
work.

SYSTem : REMote

This command can only be used under the control of RS-232C.   If SYST : REM is
programmed, the AC source will be set in the REMOTE state, and the front panel will
be disabled except the Local key.

SYSTem : RWLock

This command can only be used under the control of RS-232C.   If SYST : RWL is
programmed, the AC source will be set in the Remote-Lockout state, and front panel
will be disabled without exception.

STATus

STATus : QUEStionable [: EVENt] ?

This query returns the value of the Questionable Event register.   The Event register
is a read-only register which holds all events that are passed by the Questionable NTR
and/or PTR filter.   If QUES bit of the Service Request Enabled register is set, and the
Questionable Event register > 0, QUES bit of the Status Byte register is set too.

STATus : QUEStionable : CONDition?

This query returns the value of the Questionable Condition register, which is a read-only
register that holds the real-time questionable status of the AC source.

Return parameters   0 to 255

STATus : QUEStionable : ENABle   <NR1>

This command sets or reads the value of the Questionable Enable register.   The
register is a mask which enables specific bits from the Questionable Event register
to set the questionable summary (QUES) bit of the Status Bye register.

Query Syntax STATus : QUEStionable : ENABle?
Parameter 0 to 255
Return parameters <NR1>

STATus : QUEStionable : NTRansition <NR1>

Query Syntax STATus : QUEStionable : NTRansition?
Parameter 0 to 255
Return parameters <NR1>

STATus : QUEStionable : PTRansition <NR1>

Query Syntax STATus : QUEStionable : PTRansition?
Parameter 0 to 255
Return parameters <NR1>

These commands make the values of the Questionable NTR and PTR register set or read. These registers serve as polarity filters between the Questionable Enable and Questionable Event registers, and result in the following actions:

* When a bit of the Questionable NTR register is set at 1, a 1-to-0 transition of the corresponding bit in the Questionable Condition register will cause that bit in the Questionable Event register to be set.

* When a bit of the Questionable PTR register is set at 1, a 0-to-1 transition of the corresponding bit in the Questionable Condition register will cause that bit in the Questionable Event register to be set.

* If the two same bits in both NTR and PTR registers are set at 0, no Transition of that bit in the Questionable Condition register can set the corresponding bit in the Questionable Event register.

Bit Configuration of Questionable Status Register

Bit Position	15-8	7	6	5	4	3	2	1	0
Condition	- -	FAN	OPP	OCP	SHT	OTP	INP	OPEN	PFO

FAN : Fan failure.
OPP : Over power protection.
OCP : Over Current protection.
SHT : Output short protection.
OTP : Over temperature protection.
INP : Line input protection.
OPEN : Remote sense protection.
PFO : Power supply failure.

6.7 Command Summary

Common Commands

* CLS	Clear status
* ESE\<n>	Standard event status enable
* ESE?	Return standard event status enable
* IDN?	Return the AC source identification
* RCL\<n>	Recall the AC source file
* SAV\<n>	Save the AC source status
* SRE	Set request enable register
* STB?	Return status byte

Instrument Commands

FETCh | MEASure
    [: SCALar]
            : CURRent
                    : AC?
                    : AMPLitude : MAXimum?
                    : CREStfactor?
                    : INRush?

FETCh | MEASure
    [: SCALar]
            : FREQuency?

FETCh | MEASure
    [: SCALar]
            : POWer
                    : AC
                            [: REAL] ?
                            : APParent?
                            : REACtive?
                            : PFACtor?
                            : TOTal?

FETCh | MEASure
    [: SCALar]
            : VOLTage
                    : AC?

INITiate
    [: IMMediate]
    : CONTinuous
        : SEQuence1 ON | OFF

INSTrument
    : COUPle ALL | NONE
    : NSElect   \<n>
    : SELect   \<OUTPut>

ORELay   ON | OFF

OUTPut
    [: STATe]   <bool>
    : PROTection
          : CLEar
          : DELay   <n>

RANGe   HIGH | LOW | AUTO

[SOURce :]
    CURRent
        [: LEVel]
                [: IMMediate]
                        [: AMPLitude]   <n>

[SOURce :]
    FREQuency
        [: CW | : IMMediate]   <n>

[SOURce :]
    FUNCtion
        : SHAPe   A/B
            [: A/B] [shape]
        : TRAN   ON/OFF

[SOURce :]
    VOLTage
        [: LEVel]
                [: IMMediate]
                        [: AMPLitude]   <n>

SYSTem
    : ERRor?

TRACe | DATA
    [: DATA]   <US1, . . ,US6>, <D1, D2. . . >

TRIGger
    [: SEQuence1 | : TRANsient]
        [: IMMediate]

TPHAse   <NR2>
        : SYNC   IMMediate | PHASe

PHASe[:IMMediate]:REVerse

QUIT | OFF

[SOURce :]
    LIST
        : COUNt   <n> | INFinity
        : SYNC   IMMediate | PHASe
        : SPHase
        : QUIT
        : BASE TIME | CYCle
        : DWEL   <n>{, <n>}
                : POINts?
        : FREQuency [: LEVel]   <n>{, <n>}
                       : POINts?
        : SHAPe   A | B{, A | B}
               POINts?
        : STARt   <n>{, <n>}
        : END   <n>{, <n>}
        : LOOP   <n>{, <n>}
        : STEPno   <n>{, <n>}

[SOURce :]
    : STEP
        : VOLTage   <n>
        : FREQuency   <n>
        : SHAPe   <n>
        : DVOLtage   <n>
        : DFRequency   <n>
        : DWELl   <n>
        : COUNt   <n>

[SOURce :]
    : PULSe
        : SYNC IMMediate | PHASe
        : SPHase   <n>
        : VOLTage   <n>
        : FREQuency <n>
        : SHAPe   <n>
        : COUNt   <n> | INFinity

        : DCYCle   <n>
        : PERiod   <n>
        : QUIT

SYSTem
    : VERSion?
    : LOCal
    : REMote
    : RWLock

STATus
: QUEStionable
[: EVENt]?
: CONDition?
: ENABle   <n>
: NTRansition <n>
: PTRansition <n>

Appendix A   Built -in Waveforms

DST01

Harmonic	%
2	2.07
5	9.8
7	15.8
8	2.16
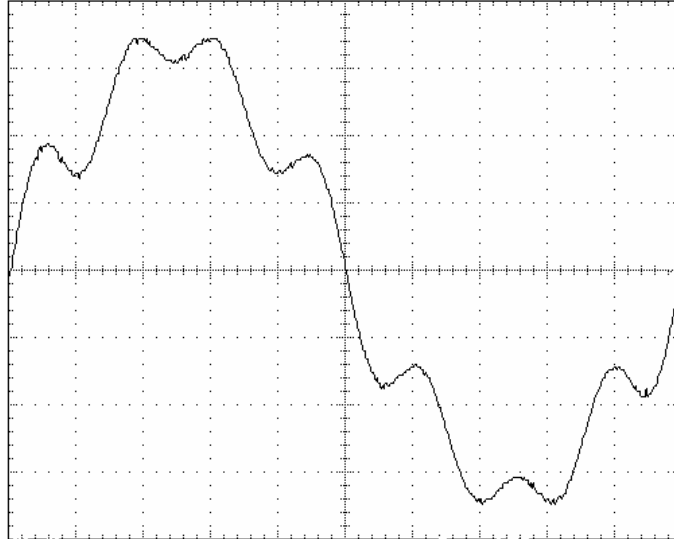
DST02

Harmonic	%
3	1.5
7	1.5
19	2
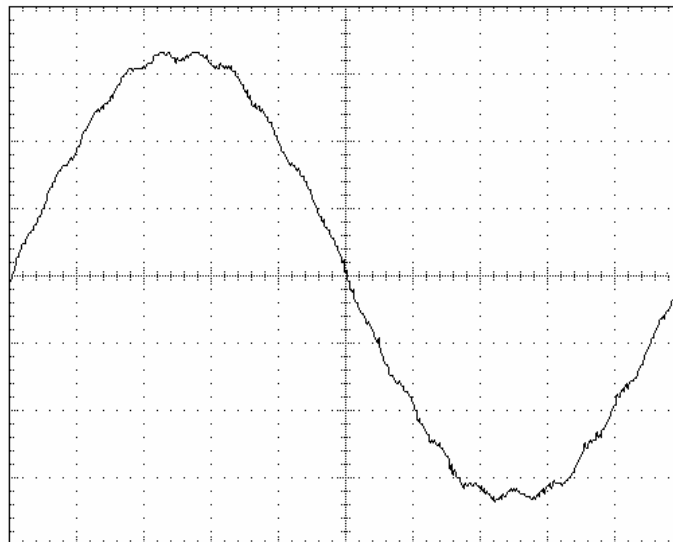
DST03

Harmonic	%
3	2
5	1.4
7	2
23	1.4
31	1
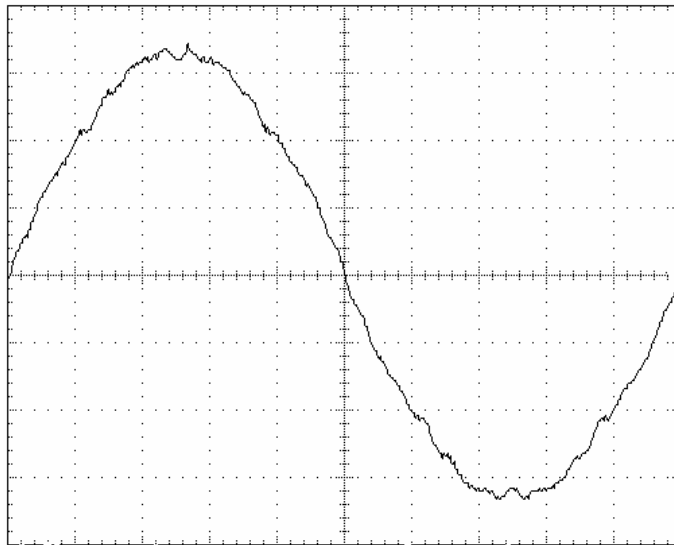
DST04

Harmonic	%
3	2.5
5	1.9
7	2.5
23	1.9
25	1.1
31	1.5
33	1.1
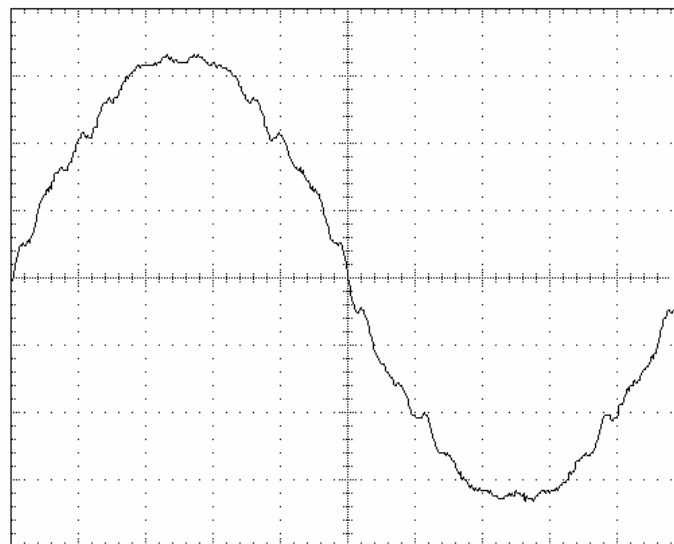
DST05

Harmonic	%
3	1.1
5	2.8
7	1.4
9	2.3
11	1.5
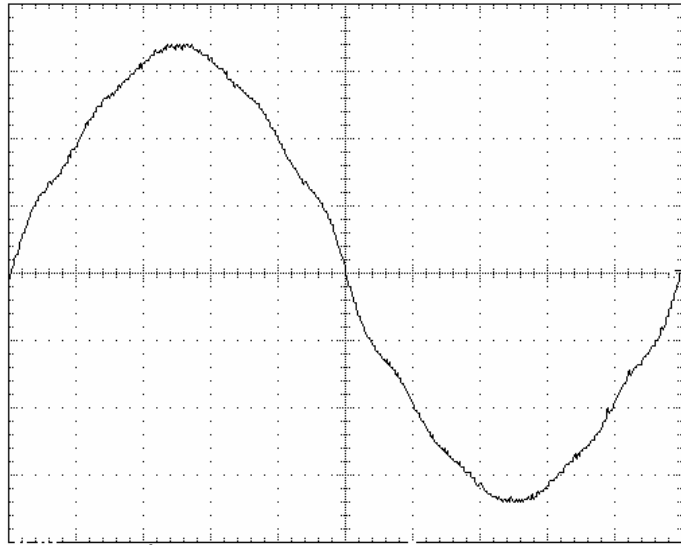
DST06

Harmonic	%
3	1.65
5	4.2
7	3.45
15	1.05
19	3
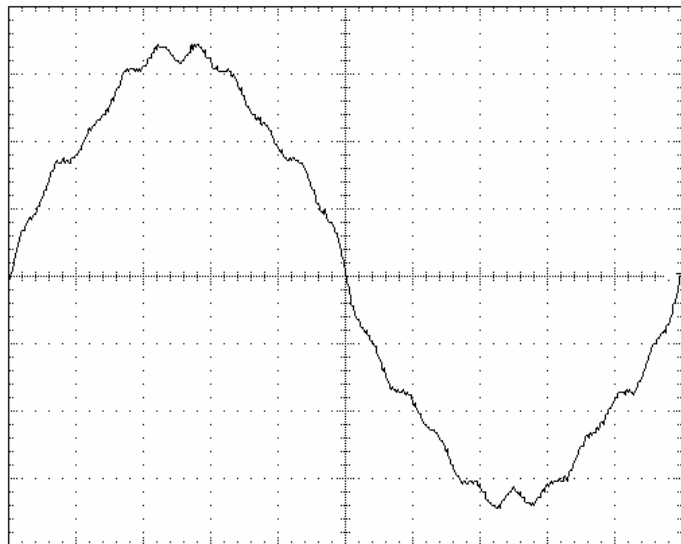
DST07

Harmonic	%
3	2.2
5	5.6
7	2.8
9	4.6
11	3
15	1.4
21	1
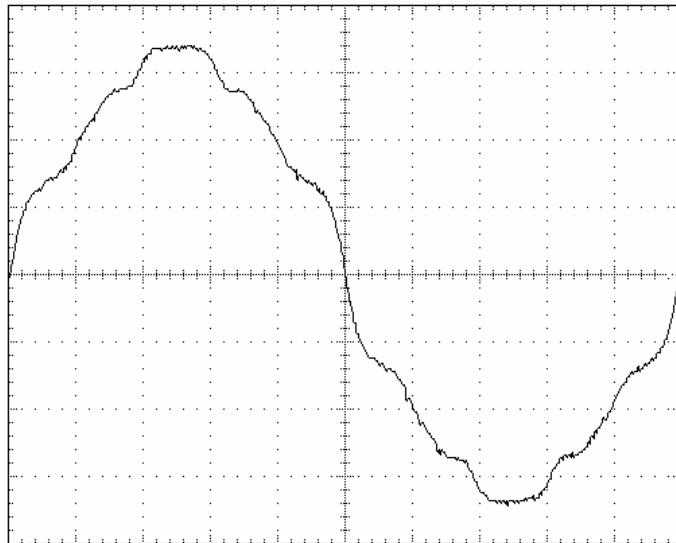
DST08

Harmonic	%
3	4.9
5	1.6
7	2.7
11	1.4
15	2
17	1.1
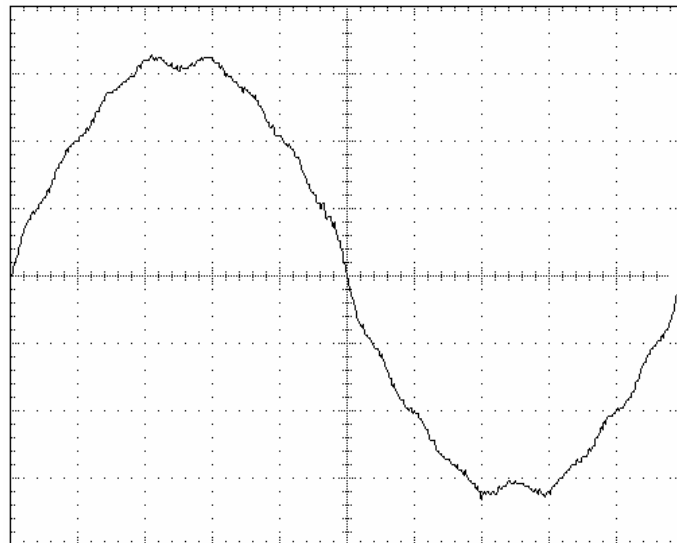
DST09

Harmonic	%
3	7.35
5	2.4
7	4.05
11	2.1
13	1.05
15	3
17	1.65
19	1.05
21	1.05
23	1.2
25	1.05
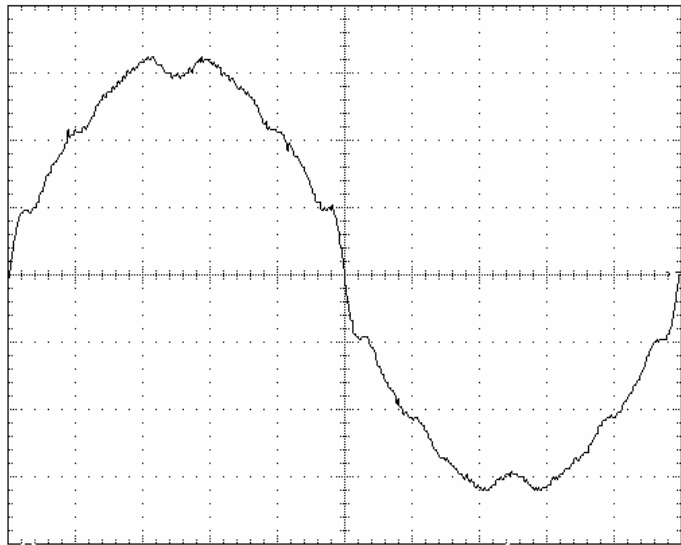
DST010

Harmonic	%
3	9.8
5	3.2
7	5.4
9	1.2
11	2.8
13	1.4
15	4
17	2.2
19	1.4
21	1.4
23	1.6
25	1.4
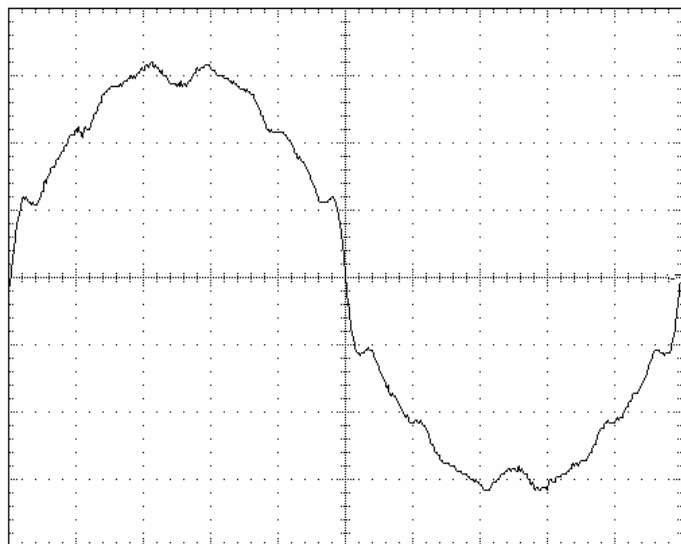
DST011

Harmonic	%
3	17.75
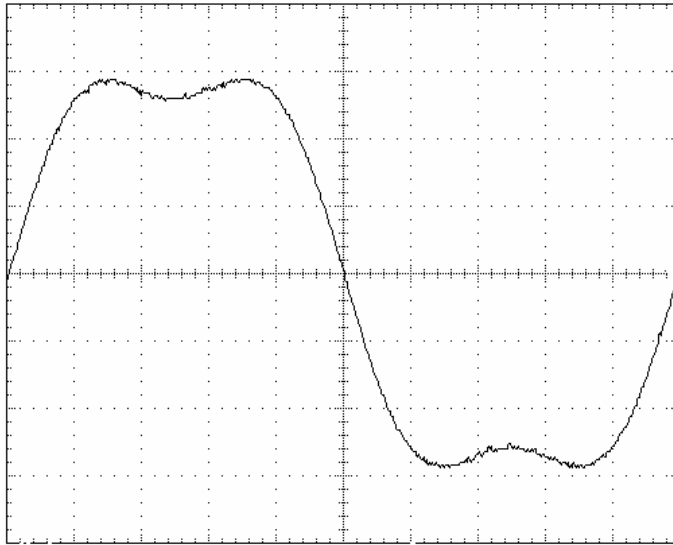
DST012

Harmonic	%
3	21.25
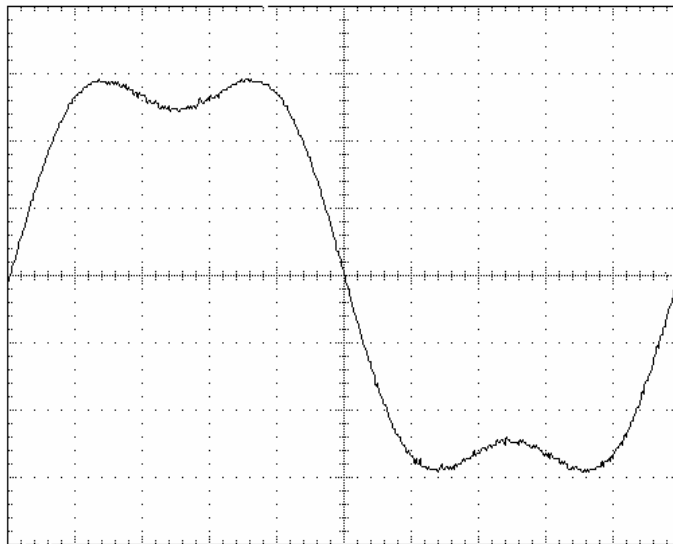
DST013

Harmonic	%
3	24.5
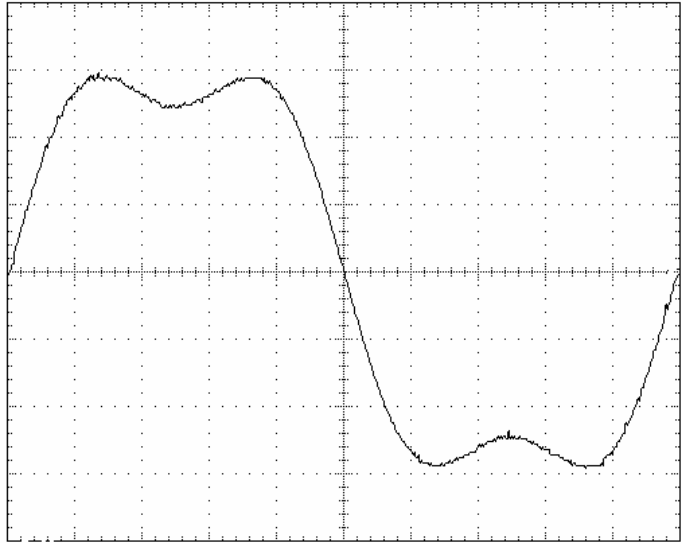
DST014

Harmonic	%
2	2.3
5	9.8
7	15.8
8	2.5
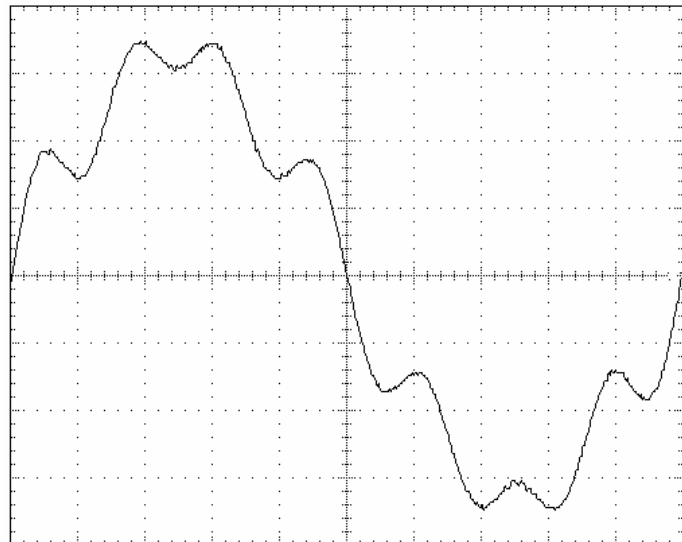
DST015

Harmonic	%
2	1.15
5	4.9
7	7.9
8	1.25
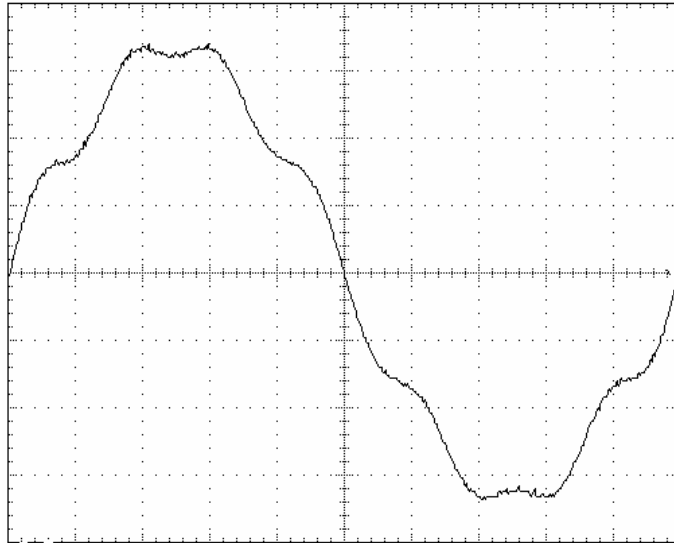
DST016

Harmonic	%
5	2.45
7	3.95
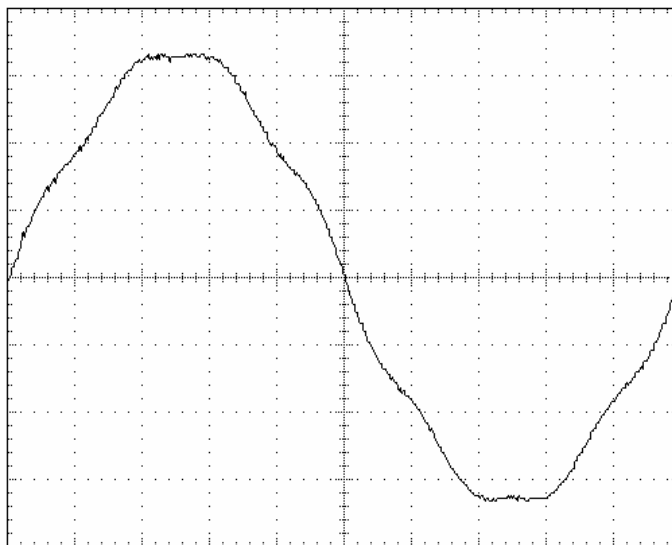
DST017

Harmonic	%
3	11
5	4.05
7	2
9	1.3
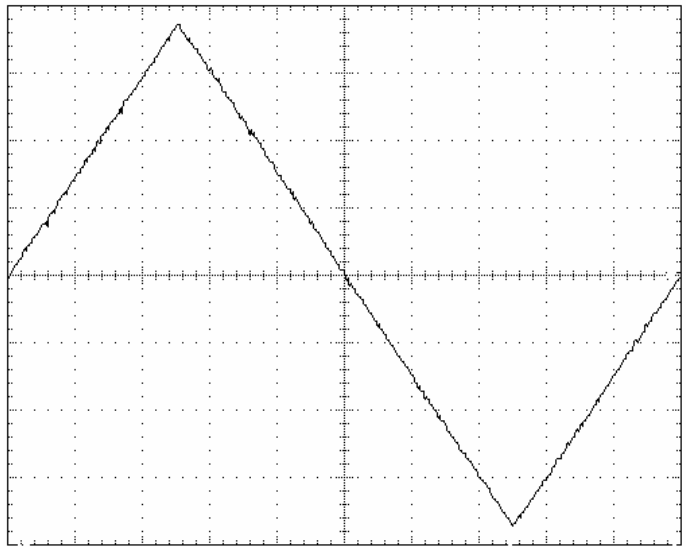
DST018

Harmonic	%
3	7.17
5	3.42
9	0.8
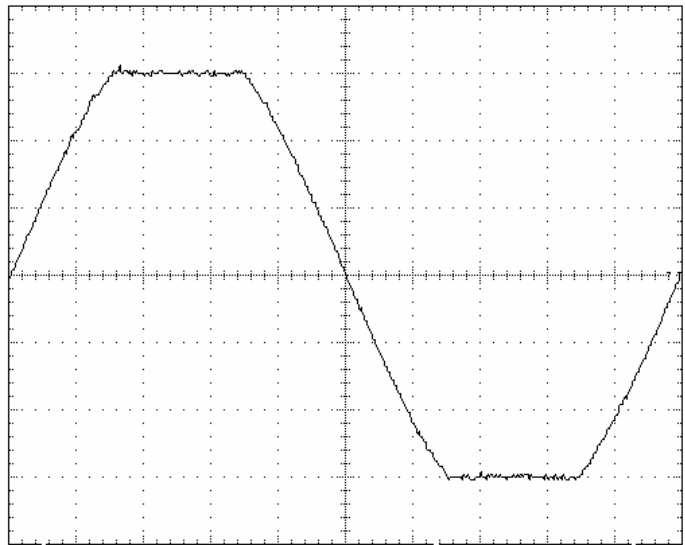
DST019

Harmonic	%
3	8.11
5	3.48
9	1
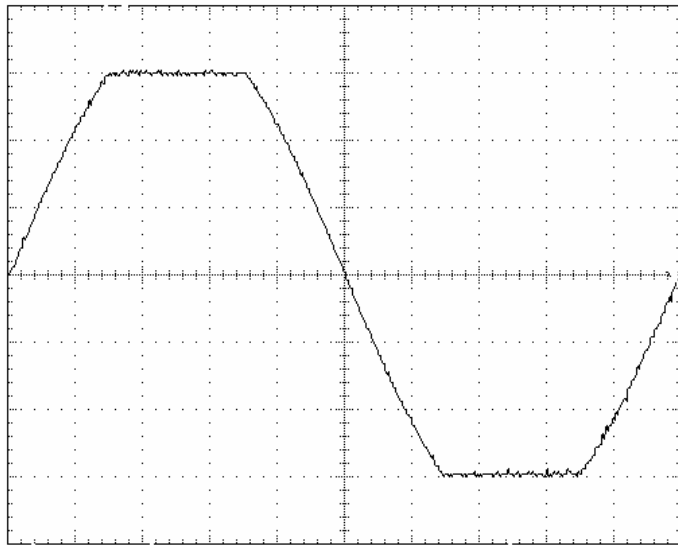
DST020

Harmonic	%
3	9.38
5	3.44
9	1.15
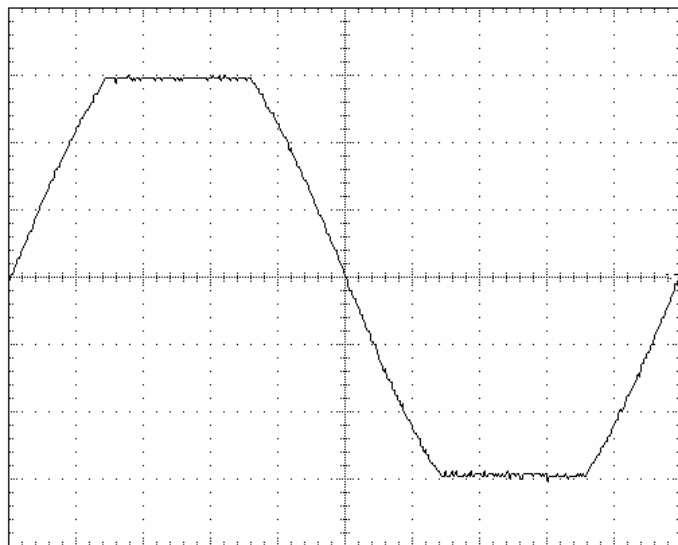
DST021

Harmonic	%
3	2
5	1.8
7	1.6
9	1.23
11	0.9
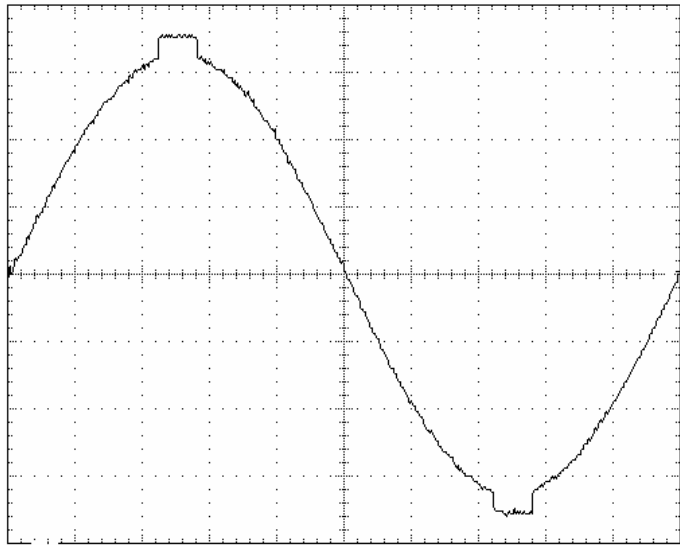
DST022

Harmonic	%
3	3
5	2.75
7	2.4
9	2
11	1.4
13	0.8
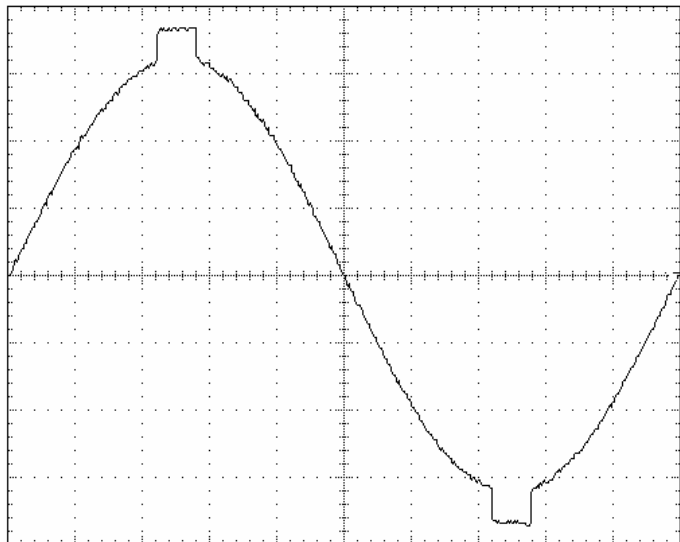
DST023

Harmonic	%
3	4.15
5	3.8
7	3.24
9	2.6
11	2
13	1.25
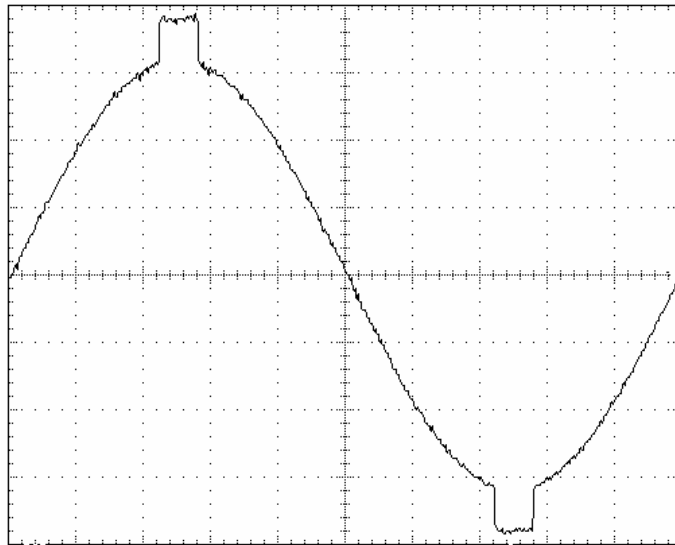
DST024

Harmonic	%
3	5.63
5	5.13
7	4.42
9	3.56
11	2.63
13	1.68
15	0.79
21	1.04
23	1.27
25	1.32
27	1.2
29	0.95
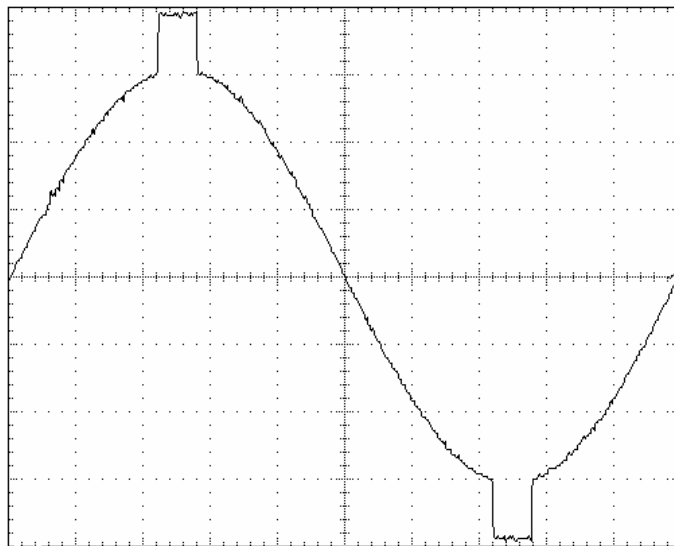
DST025

Harmonic	%
3	7.28
5	6.63
7	5.71
9	4.61
11	3.42
13	2.19
15	1.04
21	1.32
23	1.63
25	1.69
27	1.54
29	1.22
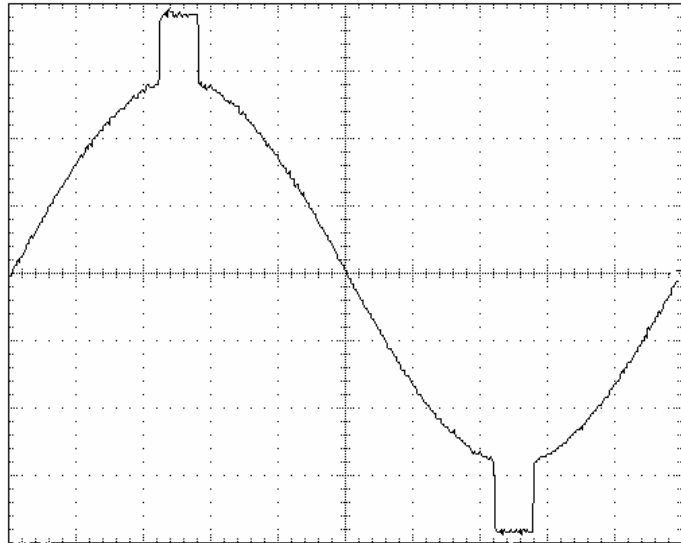
DST026

Harmonic	%
5	3.54
7	2.68
11	8.87
13	7.86
19	1.04
23	4.11
25	4.13
35	2.61
37	2.82
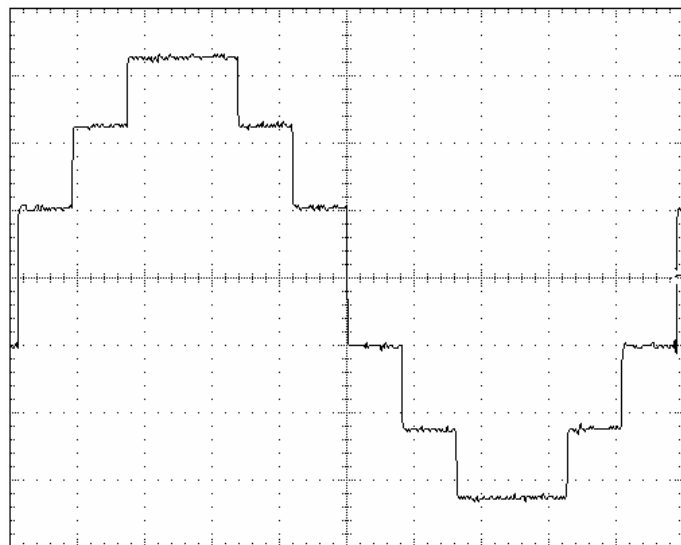
DST027

Harmonic	%
21	1.38
23	5.39
25	2.29
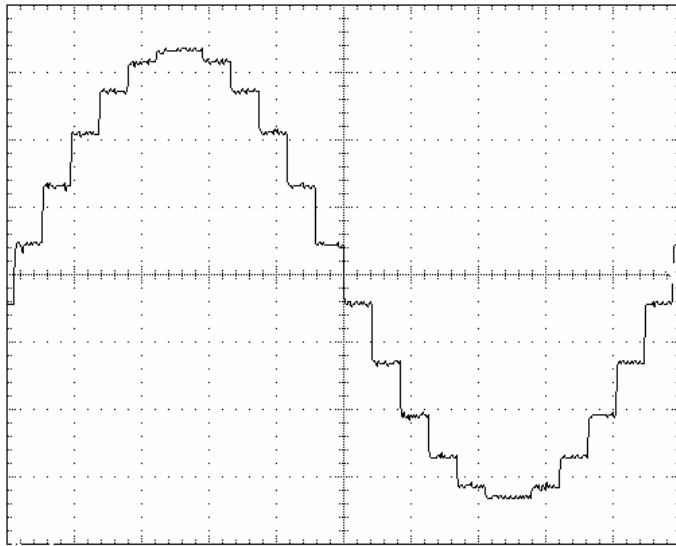
DST028

Harmonic	%
3	33.3333
5	20
7	13.8
9	10.8
11	8.5
13	7.2
15	6
17	5
19	5
21	4.5
23	4
25	3.5
27	2.95
29	2.5
31	2
33	2
35	2
37	2
39	2

A-14
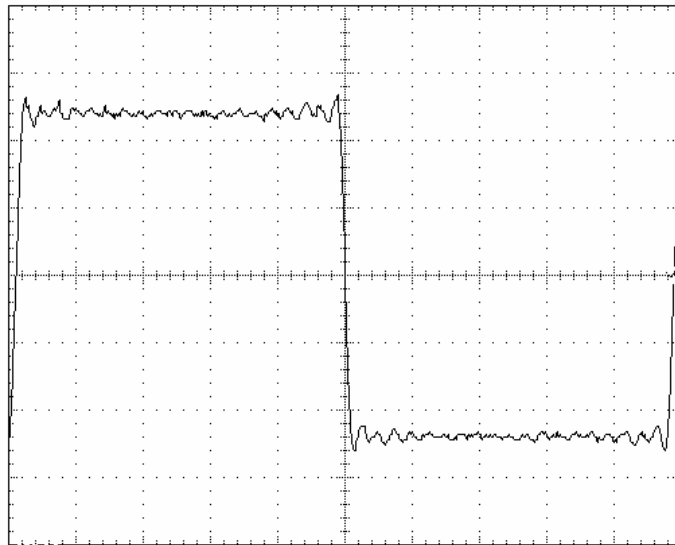
DST029

Harmonic	%
3	33.3333
5	20
7	13.8
9	10.8
11	8.5
13	7.2
15	6
17	5
19	5
21	4.5
23	4
25	1
27	1
29	1
31	1
33	1
35	1
37	1
39	1
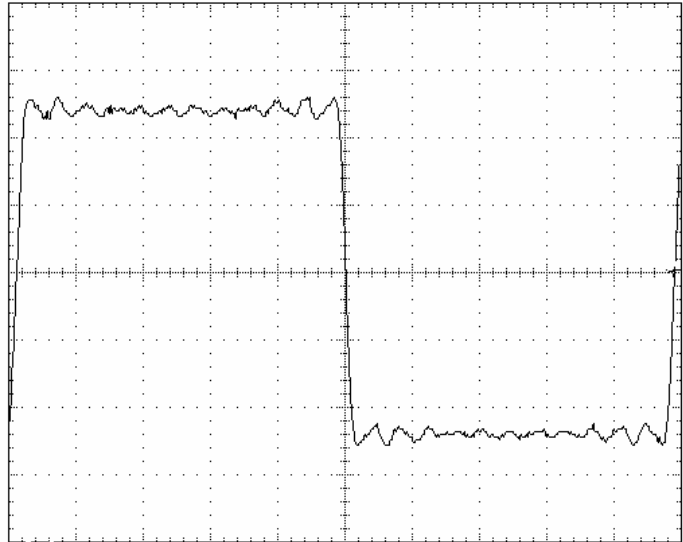
DST030

Harmonic	%
3	33.3333
5	20
7	13.8
9	10.8
11	8.5
13	7.2
15	5.5
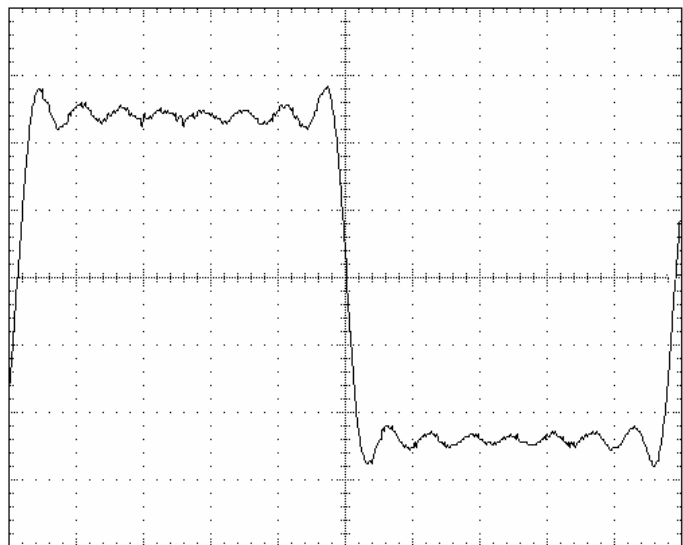
Appendix B   Parameters in Mode Operations

Table B-1 Programmable Parameters for Mode = STEP

Parameters	Options	Description
V	0 – 300 (@ 0.1) V	It is initial Voltage.
F	15 – 2K (@ 0.01) Hz	It is initial Frequency.
Waveform	A/B	The user can choose waveform A or B, which is defined in "CONFIG".
Sync. source Phase	Immed/phase 0 – 359.99 (@ 0.01) Degree	These two parameters are for the user to set output waveform, and make it synchronize with source waveform immediately, or with a phase difference. It is the same as "output setting" described in 3.4.2.
dV	−300 − +300V (@ 0.1 V)	It is constant increment dV to V if dV> 0, or decrement if dV< 0.
dF	−2000 − +2000 Hz (@ 0.1 Hz)	It is similar to dV for programming frequency increment (decrement).
dTrigger	Auto / Manual	Select "Auto", and output V and F will keep changing in every period (=Dwell time) See next parameter.
Dwell time	0 – 999999 (@ 0.1) mSec.	It is duration before each output state changes V or F.
count	1 – 30000	They are total steps for the change of output state. If the user selects 0, the AC source will output according to the initial parameter without executing the "STEP" operation.

Table B-2 Programmable Parameters for Mde = LIST

Parameters	Options	Description
Base	Cyc/Tim	There are two kinds of bases for the setting of LIST mode. One is Cycle and another Time. If the user selects Cycle, it means that the output of LIST mode will use inverse of frequency as base. If the user selects Time, it means the output of LIST mode will use time as base.
count	0 – 65535	They are total loops for the repetition of the entire listed output states. If the user selects 0, the AC source will repeat output infinitely.
Trigger	AUTO/MANUAL	Selection of "AUTO" means automatic change of the value of V or F in every period t (For the setting of t see the description below). Selection of "MANUAL" means manual change triggering with the soft key.
Sync. source Phase	Immed/phase 0 – 359.99	These two parameters are for the user to set output waveform, and make it synchronize with source waveform immediately, or with a phase difference. It is the same as "output setting" described in 3.4.2.
Dwell point		
Start	0 – 39	They are loop start sequence numbers.
End	0 – 39	They are loop end sequence numbers.
Loop	1 – 9999	They are loop count numbers.
Vstart	0 – 300 (@ 0.1) V	The desired output V is defined at each sequence of first step.
Vend	0 – 300 (@ 0.1) V	The desired output V is defined at each sequence of last step.
F	15 – 2K (@ 0.1) Hz	The desired output F is defined at each sequence.
Cycle	0.0 – 60000.0	It is sequence duration. The execution stops when Cycle=0.
Time	0 – 999999 mS (@ 1 mSec)	It is sequence duration. The execution stops when Time=0.
StepNO	1– 999	They are step numbers for all sequences.
Waveform	A/B	The user can choose waveform A or B, which is defined in "CONFIG".

Table B-3 Programmable Parameters for Mode = PULSE

Parameters	Options	Description
V	0 – 300 (@ 0.1) V	It is output Voltage in volt.
F	15 – 2K (@ 0.01) Hz	It is output Frequency in Hertz.
Waveform	A/B	The user can choose waveform A or B, which is defined in "CONFIG".
Sync. source Phase	Immed/phase 0 – 359.99 (@ 0.01) Degree	These two parameters are for the user to set output waveform, and make it synchronize with source waveform immediately, or with a phase difference. It is the same as "output setting" described in 3.4.2.
Duty	0 – 100 (@ 0.01) %	The percentage indicates the time interval for output over a period.
Count	0 – 65535 loops	They are total number of times for the repetition of the entire listed output states. If the user selects 0, the AC source will repeat output infinitely.
Period	0.1 – 999999 (@ 0.1) mS	It is duration before output state changes V or F at each step.
Trigger	AUTO/MANUAL	Selection of "AUTO" makes output V and F keep change stepwise in every period t (see the description below). Selection of "MANUAL" makes output change state, and wait for manual trigger.

Appendix C   Pin Assignment of User Interface

25-Pin D-Type Male Connector:

Pin No.	Signal	Pin No.	Signal	Description
1	GND	14	System Used	
2	GND	15	System Used	
3	GND	16	System Used	
4	GND	17	System Used	
5	GND	18	System Used	
6	GND	19	System Used	
7	GND	20	System Used	
8	GND	21	System Used	
9	GND	22		
10	GND	23		
11	GND	24		
12	System Used	25		
13	System Used			

Appendix D   Pin Assignment of Printer Interface

25-Pin D-Type Female Connector:

Pin No.	Signal	Direction	Pin No.	Signal	Direction
1	$\overline{\text{STROBE}}$	Out	14	$\overline{\text{FF}}$	Out
2	DATA0	Out	15	$\overline{\text{ERROR}}$	In
3	DATA1	Out	16	$\overline{\text{INIT}}$	Out
4	DATA2	Out	17	$\overline{\text{SLCT IN}}$	Out
5	DATA3	Out	18	GND	
6	DATA4	Out	19	GND	
7	DATA5	Out	20	GND	
8	DATA6	Out	21	GND	
9	DATA7	Out	22	GND	
10	$\overline{\text{ACK}}$	In	23	GND	
11	BUSY	In	24	GND	
12	PE	In	25	GND	
13	- - - -				

Appendix E   Pin Assignment of TTL I/O

9-Pin D-Type Female Connector:

Pin No.	Signal	Direction	Pin No.	Signal	Direction
1	$\overline{\text{TRANS}}$	Transient	6	GND	
2	AC ON	Output enable	7	GND	
3	$\overline{\text{TRIG}}$	Trigger	8	GND	
4	$\overline{\text{INH}}$	Remote inhibit	9	GND	
5	-------				

Appendix F   Table of Output Voltage RMS Range of Non-Sinusoidal Waveforms

Waveform	Ratio	V range	V range
SIN	1	(150V)	(300V)
SQR	1	150	300
CSIN	1	150	300
DST01	1.0326	145.3	290.5
DST02	1	150	300
DST03	1	150	300
DST04	1	150	300
DST05	1.0101	148.5	297
DST06	1.0225	146.7	293.4
DST07	1.0141	147.9	295.8
DST08	1	150	300
DST09	1	150	300
DST10	1	150	300
DST11	1	150	300
DST12	1	150	300
DST13	1	150	300
DST14	1.0326	145.3	290.5
DST15	1	150	300
DST16	1.2211	122.8	245.7
DST17	1	150	300
DST18	1	150	300
DST19	1	150	300
DST20	1	150	300
DST21	1.0635	141	282.1
DST22	1.0985	136.5	273.1
DST23	1.1354	132.1	264.2
DST24	1.1844	126.6	253.3
DST25	1.2366	121.3	242.6
DST26	1	150	300
DST27	1	150	300
DST28	1	150	300
DST29	1	150	300
DST30	1	150	300

Appendix G   Parameters in List Mode for Firmware Version under 2.00
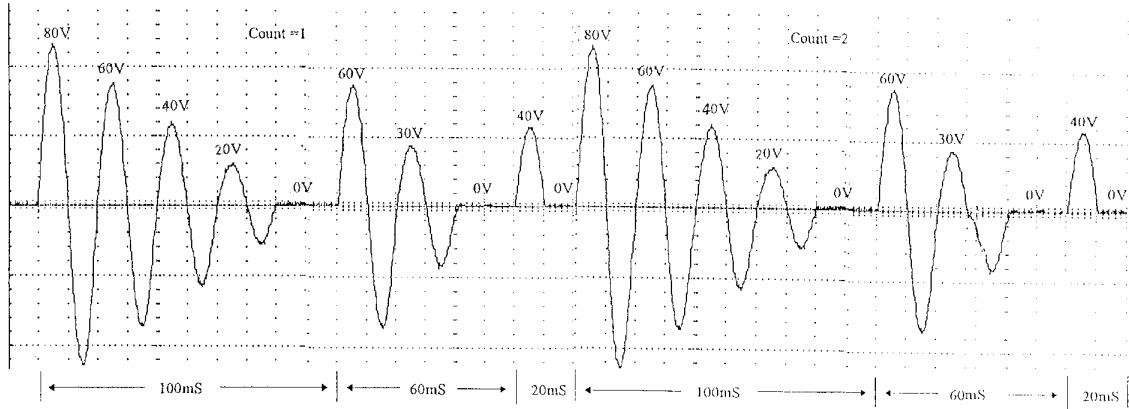
Mode = LIST

Figure G-1 List Transients

In the LIST mode, the user can specify the output transient state using the parameters of V, F, and t step by step.

Example:

Initial V and F: V = 40V, F = 50Hz, waveform = A; Trigger=Auto, Sync. source=phase, phase=0 degree.

V0 = 80V,	F0 = 50Hz,	t0 = 20 mSec,	waveform = A;
V1 = 60V,	F1 = 50Hz,	t1 = 20 mSec,	waveform = A;
V2 = 40V,	F2 = 50Hz,	t2 = 20 mSec,	waveform = A;
V3 = 20V,	F3 = 50Hz,	t3 = 20 mSec	waveform = A;
V4 = 0V,	F4 = 50Hz,	t4 = 20 mSec,	waveform = A;
V5 = 60V	F5 = 50Hz,	t5 = 20 mSec,	waveform = A;
V6 = 30V,	F6 = 50Hz,	t6 = 20 mSec,	waveform = A;
V7 = 0V,	F7 = 50Hz,	t7 = 20 mSec,	waveform = A;
V8 = 40V,	F8 = 50Hz,	t8 = 10 mSec,	waveform = A;
V9 = 0V,	F9 = 50Hz,	t9 = 10 mSec,	waveform = A;

Stop the sequence in t10=0, and repeat the entire cycle twice (see Figure G-1).

The procedures of operation are listed below:

1. Select the LIST mode by the procedure described in 3.3.2.   The LCD displays as follows:
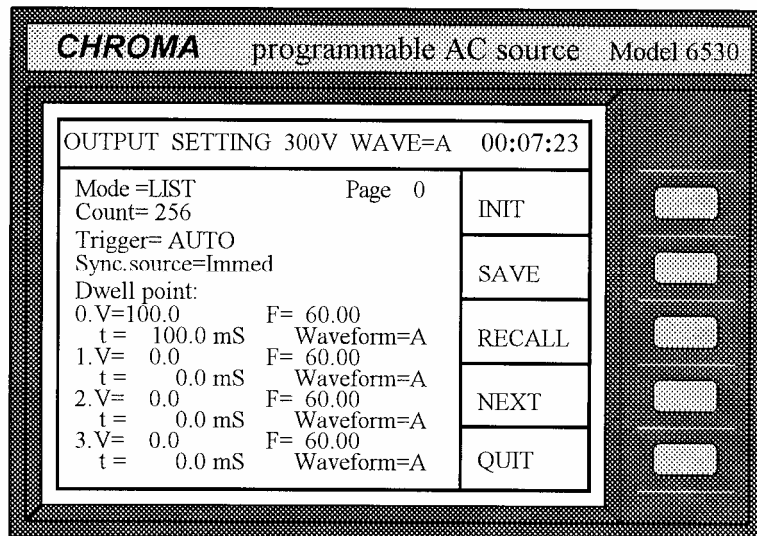
2. Move the cursor to the line of "Count=".

```
Count= _ 256
```

3. Press [2], [ENTER] for repetitive counts
   (Skip Trigger=AUTO, and keep Count=0.
   It means infinity).

```
Count=   2
```

4. Move the cursor to the line of "Sync.
   source =".
   Select Sync. source as phase by
   pressing [▲] until "phase" is displayed,
   then press [ENTER].

```
Sync. source=Immed
```

```
Sync. source=phase   phase=   0.0
```

5. The cursor moves to "phase=".
   Press [0], [ENTER] to set phase
   angle.

```
Sync. source=phase   phase=   00.0
```

6. The cursor moves to the line of
   "0.V=100.0".
   Press [8], [0], [ENTER] to set
   v=80.

```
0.V= _100.0          F=   60.00
```

```
0.V=   80.0          F= _60.00
```

7. The cursor moves right for the
   programming of F.
   Press [5], [0], [ENTER] to set
   F=50.

```
0.V=   80.0          F=   50.00
```

8. Move the cursor to the line of
"t=".

   Press ⎡2⎤ , ⎡0⎤, ⎡ENTER⎤ to set

   t=20 mS.

```
t=   _ 100.0
```

```
t=      20.0
```

9. The cursor moves to the line of
"Waveform=A".   Leave it

   unchanged by pressing ⎡ENTER⎤ .

10. Repeat step 6 to 9, and enter the desired values of V1= 60V, F1=50Hz, t1=20mS;
    V2=40V, F2=50Hz, t2=20mS; V3=20V, F3=50Hz, t3=20mS.

11. Press the soft key ⎡NEXT⎤ to go to the second page, and set sequence 4.   Repeat
    step 6 to 9 to enter the desired values of V4=0V, F4=50Hz, t4=20mS; V5=60V,
    F5=50Hz, t5=20mS; V6=30V, F6=50Hz, t6=20mS; V7=0V, F7=50Hz, t7=20mS;
    V8=40V, F8=50Hz, t8=10mS; V9=0V, F9=50Hz, t9=10mS. (For any sequence, time is
    specified as 0 to end the sequence.   The corresponding sequence will not be executed,
    and LIST mode will stop at this sequence.   Now set t10=0.)
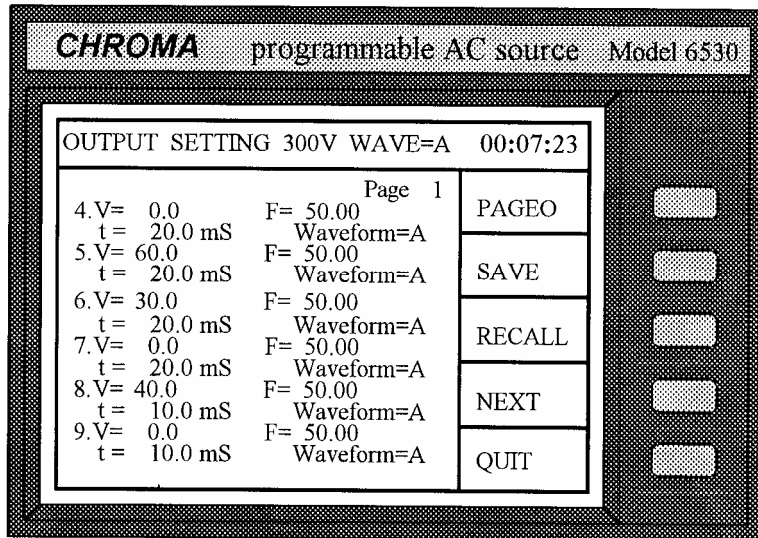
12. Upon completion, press ⎡PAGE0⎤ to go to Page0.   Then, press ⎡INIT⎤ to initiate
    LIST mode, and ⎡TRIG⎤ to start the output power of the programmed spec. in LIST
    mode.

13. Press ⎡QUIT⎤ to exit from the operation in LIST mode, and the LCD will return to the
    main operational menu.

Note 1 :   When the user programs steps of V/F/t exceeding the page0, he has to press
           ⎡NEXT⎤ to extend the display of LCD to other pages, and ⎡PREV⎤ to return to the
           previous page.   Besides, pressing ⎡PAGE0⎤ makes the user return directly to the
           page zero.   The total number of sequence is 100, from sequence 0 to 99.

Note 2 : The pre-programmed output condition can be saved and recalled using the soft
keys SAVE and RECALL.   For details please refer to the operational example in
3.2.2.11 and 3.2.2.12.

Note 3 : If the "initiate continuous=" is set as ON, the INIT will not be displayed after the
first round of output.   The user can press TRIG again when he wants the output
in the same LIST mode more times.   If the "initiate continuous=" is set as OFF,
the user has to press INIT first to initiate it.

Note 4 : If Trigger=MANUAL, press TRIG , and the AC source will execute programmed
parameters only once.   It has the same result as count=1.

Note 5 : Upon completion of the output in LIST mode, the last sequence status will not be
kept in the output.   The AC source outputs the values of V, F in a fixed mode if
"Output Status=RUN".   The output will be disabled if "Output Status=PAUSE".

A table of programmable parameters for Mode=LIST is listed on the next page.

Table G-1 Programmable Parameters for Mode=LIST

Parameters	Options	Description
count	0 – 65535	They are total loops for the repetition of the entire listed output states. If the user selects 0, the AC source will repeat output infinitely.
Trigger	AUTO/MANUAL	Selection of "AUTO" means automatic change of the value of V or F in every period t (For the setting of t see the description below). Selection of "MANUAL" means manual change triggering with the soft key.
Sync. source Phase	Immed/phase 0 – 359.99 (@ 0.01) Degree	These two parameters are for the user to set output waveform, and make it synchronize with source waveform immediately, or with a phase difference. It is the same as "output setting" described in 3.4.2.
Dwell point		
V	0 – 300 (@ 0.1) V	The desired output V is defined at each sequence.
F	15 – 2K (@ 0.1) Hz	The desired output F is defined at each sequence.
Time	0 – 999999 mS (@ 0.1 mSec)	It is sequence duration. The execution stops when Time=0.
Waveform	A/B	The user can choose waveform A or B, which is defined in "CONFIG".