Chroma

Programmable
AC Power Source
64180/64270/65180/65270
User's Manual

Edition
August 2003

1. General Information

1.1 Introduction

Chroma AC source model 64180/64270/65180/65270 are designed to get larger 3-phase AC power. They are assembled by 3 units of nowaday model 6460/6490/6560/6590. Each unit is used as one phase output. This manual only describes the installation, operation and theory specially for 64180/64270/65180/65270 programmable AC source. The detail specification and operation, please refer to the user's manual of 6460/6490 or 6560/6590.

1.2 Description

For model 64180/64270/65180/65270 AC sources, although the model name and appearance are looked almost the same with 6460/6490/6560/6590, the inner F/W and connected cables are different. There is one Master and two Slaves in the three units of 64180/64270/65180/65270. It is impossible to use individual unit as totally the same as 6460/6490/6560/6590. The Master unit can be used individually, but the slaves only can used with the Master together.

In order to help users to operate 64180/64270/65180/65270 AC sources as conveniently as possible, Chroma offers a softpanel. It is a easy-use remote control interface. Users can operate on the computer with GPIB interface.

1.3 Key Features

- Local operation from the front panel keypad
- Remote operation via GPIB interface
- Easy-use softpanel software

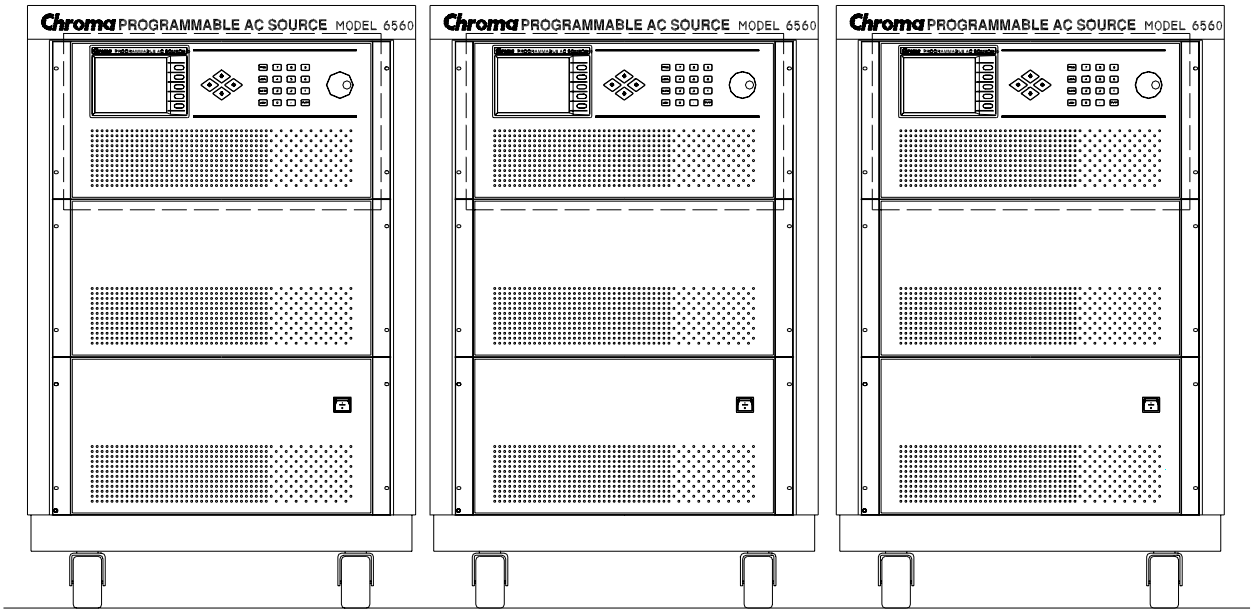
1.4 Specifications

Model 64180/64270/65180/65270 are assembled by 3 units of nowaday model 6460/6490/6560/6590. The detail specification and operation, please refer to the user's manual of 6460/6490 or 6560/6590.

1.5 Names of Parts

1.5.1 The Front Panel

64180/65180



64270/65270

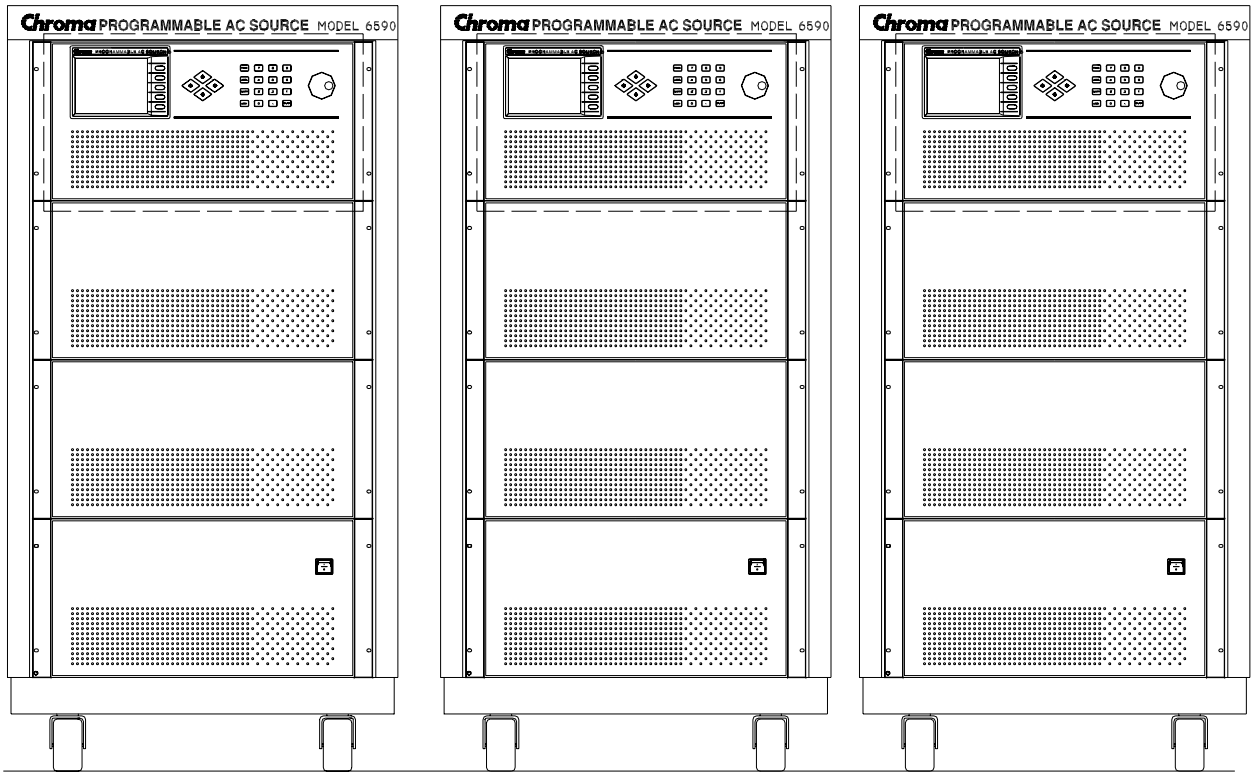
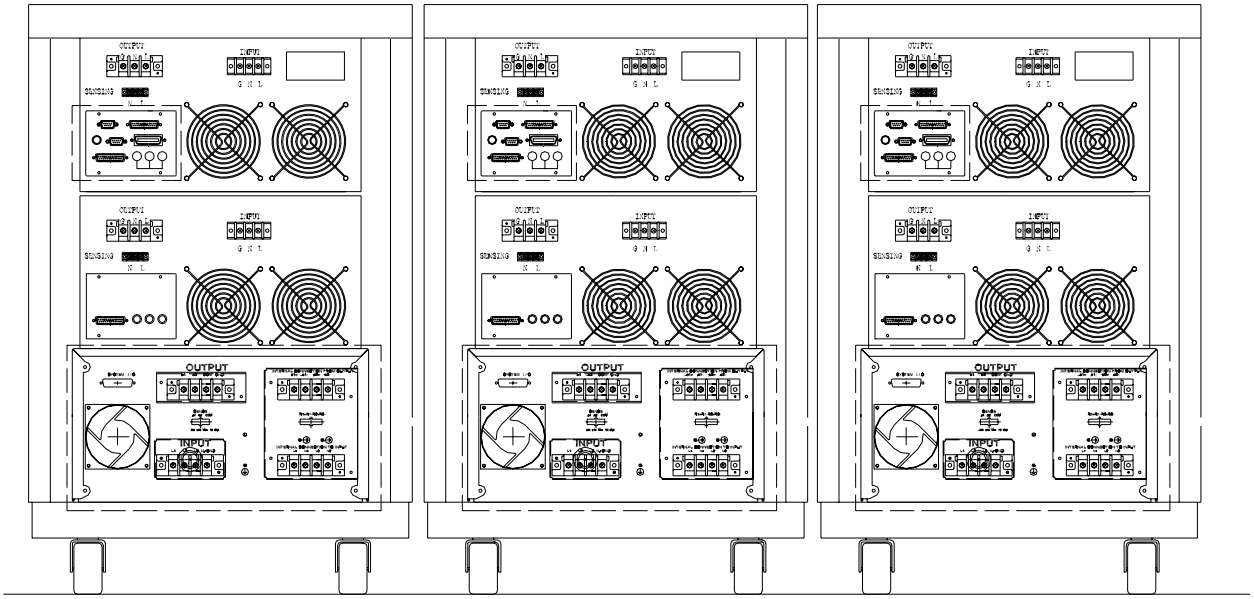


Figure 1-1 The Front Panel

1.5.2 The Rear Panel

64180/65180



64270/65270

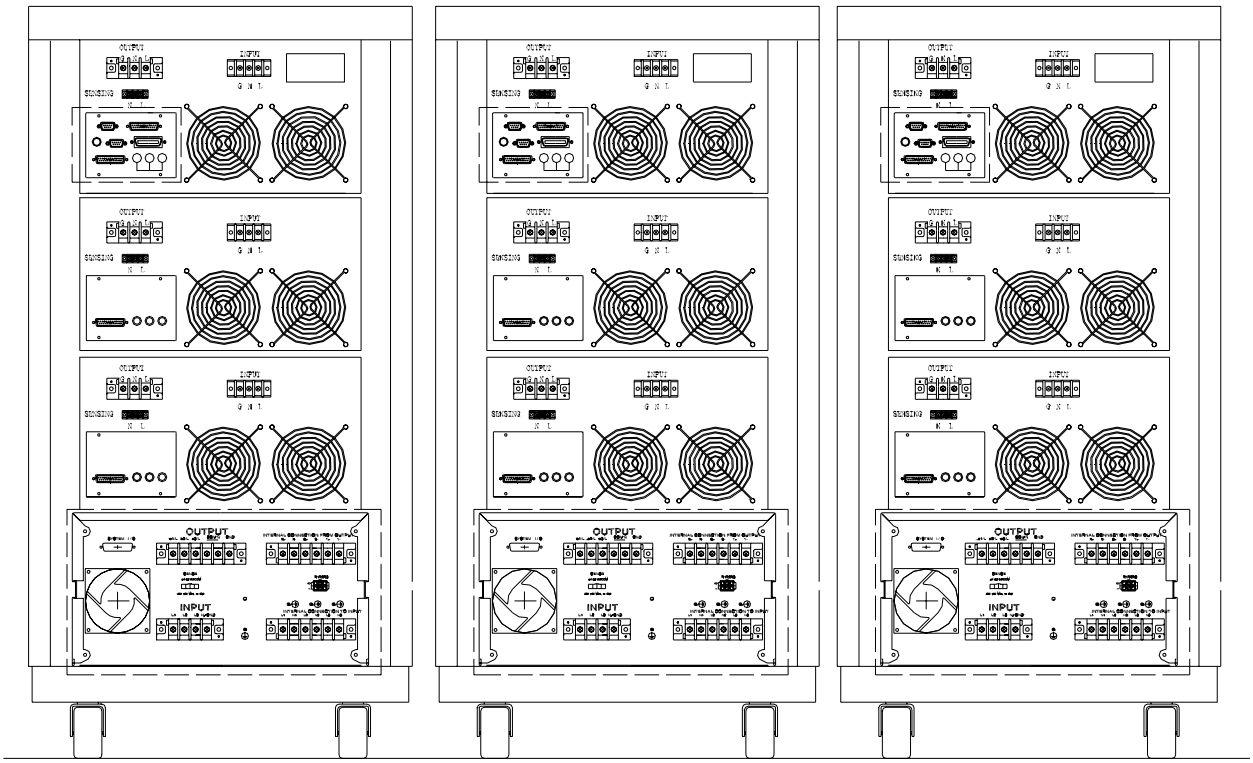


Figure 1-2 The Rear Panel

2. Installation

2.1 Preparation for the Use

Although Chroma AC source model 64180/64270/65180/65270 are assembled by 3 units of nowaday model 6460/6490/6560/6590, the F/W and connecting cables are different. Chroma has install the 64180/64270/65180/65270 F/W before shipping by your order. And the accessories includes connecting cables and input breaker.

Before begins the instrument must be connected with an appropriate AC line input. As the instrument is cooled by fans intelligently, it must be installed in an area with sufficient space for air circulation. It should be used in an area where the environment temperature does not exceed 40°C.

2.2 Requirements of Input Power

2.2.1 Ratings

Input Voltage Range:	190-250 V_{LL}, 3 phases 4 wires Δ, or
	329-433 V_{LL}, 3 phases 5 wires Y
Input Frequency:	47-63 Hz
Max. Current/Phase:	64180/65180 : 50 A
	64270/65279 : 70A

Caution

The AC source can be damaged if it is operated at an input voltage that is beyond its configured input range.

2.2.2 Input Connection

The input terminal block is located on the instrument rear panel. The power cord must be 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.

↗ CAUTION

There are two input voltage rating models, one is 380 V_{LL}3 phases 5 wires (Y), and the other is 220 V_{LL} 3 phases 4 wires (Δ). Be careful to verify the model you have, and make sure that the main voltage is suitable for the model.

See Figure 2-1 and do the following steps one by one:

1. Remove the safety cover from the back of AC source.
2. Open the line clamp on the safety cover, and screw on 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 Figure 2-2 shows.
5. If you need to connect the load to 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 two screws.

+ WARNING

To protect operators the wire connected to the GND terminal must be connected to the 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 in accordance with local electrical codes.

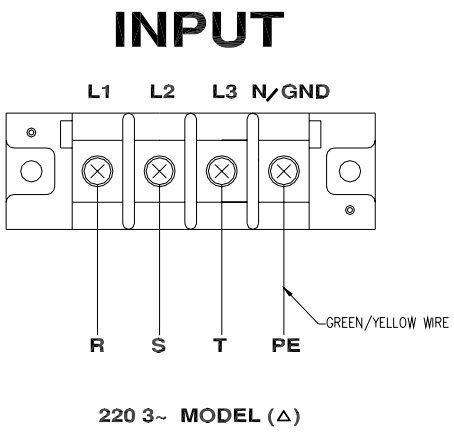


Figure 2-1 6460/6490/6560/6590 220 3~Δ Input Connection

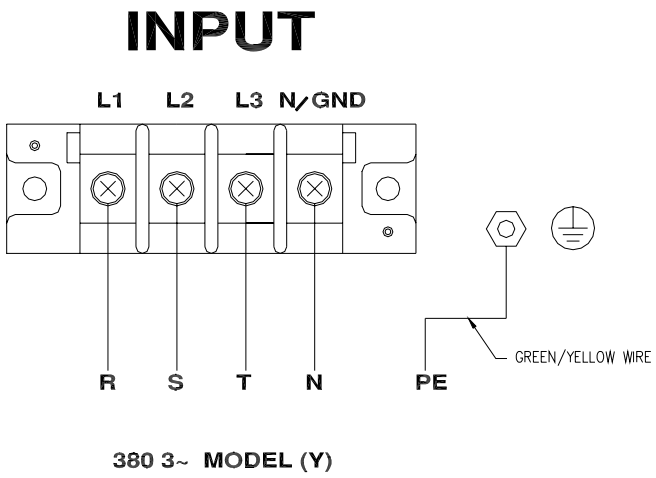


Figure 2-2 6460/6490/6560/6590 380 3~Y Input Connection

For Model 64180/65180, because 6460/6560 only use two of the three phases for its input power, for the phase current balance concern, we strongly suggest the user to connect the three phase equally to the three units input as following :

For 3-phase main power, the three phase marked : R, S, T, N and Ground

R --> Connect to Master L1, Slave 1 L2, and Slave 2 L3.
S --> Connect to Master L2, Slave 1 L3, and Slave 2 L1.

T --> Connect to Master L3, Slave 1 L1, and Slave 2 L2.
N --> Connect to Master, Slave 1 and Slave 2 N/GND.
G --> Connect to Master, Slave 1 and Slave 2 Safety GND terminal.

+ **NOTICE**

Because the three 64180/64270/65180/65270 can power on normally only when these three AC sources be turned on almost at the same time. We strongly suggest the user to use an external three phase breaker to switch on/off the main power in stead of their own power switch.

2.3 Output Connection

The output terminal block is located in the rear side of AC source. Load connection to the AC source is done at the output terminals. To meet the safety requirements the wires to the load must use gauges large enough to prevent from overheating while carrying the output current.

It can only output one phase when 6490/6590's F/W is installed for 64270/65270. So, there is only one-phase connecting in this case.

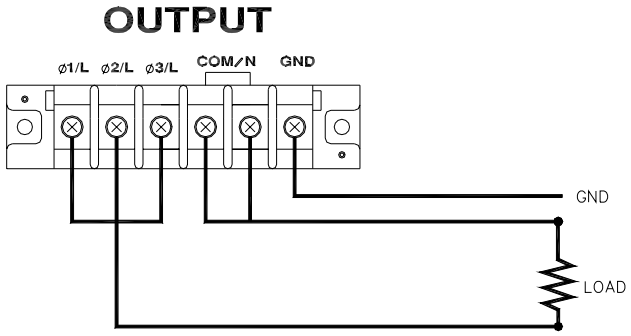


Figure 2-4 6590 One-Phase Output Connection

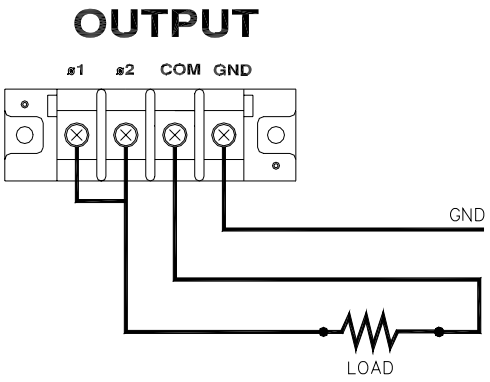
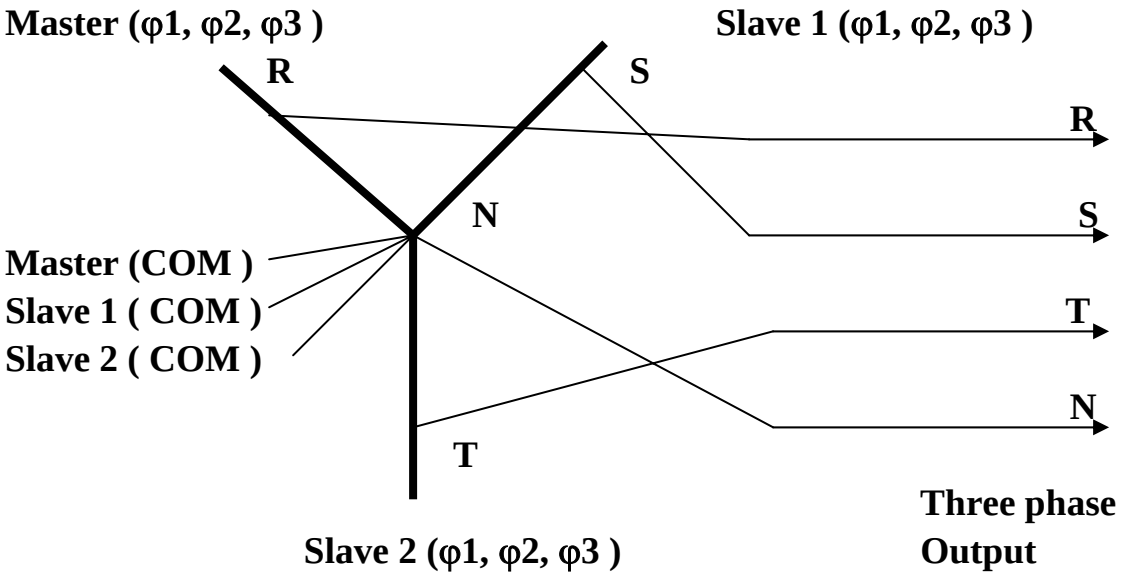


Figure 2-5 6560 One-Phase Output Connection

Model 64180/64270/65180/65270's output configuration is Y type three-phase structure.

The Master output port (φ1, φ2, φ3) makes " R " of the three phase.
The Slave 1 output port (φ1, φ2, φ3) makes " S " of the three phase.
The Slave 2 output port (φ1, φ2, φ3) makes " T " of the three phase.
The Master, Slave 1, Slave 2 output port (COM) makes " N " .



+ NOTICE

What you program at each unit's display is the " Phase voltage ". You have to multiply it by 1.732 to get the Line – Line voltage.

When the user want get phase voltage larger than 300V, he may use SERIES mode of 6460/6560. Be very careful that the SERIES and PARALLEL mode output connection are totally different.

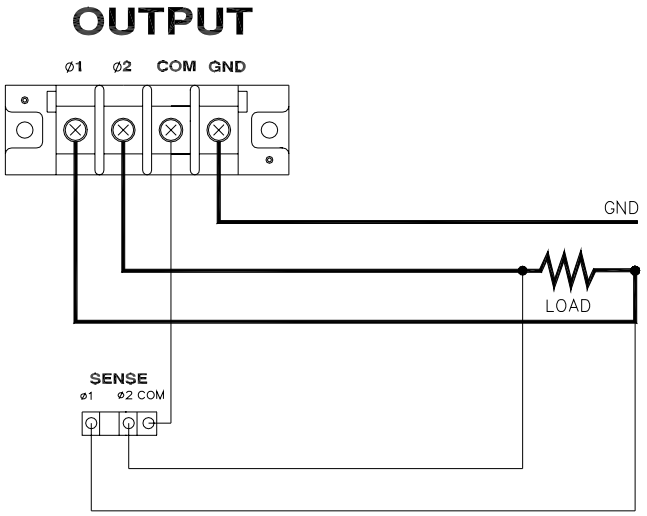


Figure 2-6 6560 Series Output Connection (Note: $V_{LOAD}=2\times V_{set}$)

Output voltage is (φ1, φ2) to (COM) for each 6560 cause φ1 and φ2 are short inside in PARALLEL mode. But output voltage is from (φ1) to (φ2) when in SERIES mode. And the output voltage is Double the programmed voltage on the display. So for SERIES mode :

The Master output port (φ1) makes " R " of the three phase.
The Slave 1 output port (φ1) makes " S " of the three phase.
The Slave 2 output port (φ1) makes " T " of the three phase.
The Master, Slave 1, Slave 2 output port (φ2) makes " N " .

For VLL 380 V at series mode, you have to program 380/2/1.732 = 109.7 at the master display.

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

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

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

2.4 Signal Cable Connection

Please refer to 64180/64270/65180/65270 Install Manual.

2.5 The Procedures of Power-on and Power-off

+ WARNING

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

Because the three 64180/64270/65180/65270 can power on normally only when these three AC sources be turned on almost at the same time. We strongly suggest the user to use an external three phase breaker to switch on/off the main power in stead of their own power switch. So, turn on the power switches on the front panel of every unit before turn on the input breaker. The AC source will do a series of self-tests every time it is turned on.

If any failure is detected on a certain item, an “NG” will be shown at the right side of that item and beep. It takes about eight seconds to complete the routines of self-test.

When the user want turn off the AC source, do not turn off the power switches on the front panel of every unit. Please turn off the external three phase breaker to switch off the main power.

3. Local Operation

The AC source 64180/64270/65180/65270 can be configured to operate in local or remote mode. The operation in remote mode through a remote GPIB interface will be described in Chapter 6 *Remote Operation*. This chapter describes the operation in local mode through the keypad on the front panel for data entry and test. The AC source is configured for local operation when turned on.

3.1 Introduction

The AC source provides a user-friendly programming interface to use the keypad on the front panel. 64180/64270/65180/65270 are assembled from 3 units of 6460/6490/6560/6590. Because the connecting don't include data transfer, some parameters setting need to operate on every unit. The LCD display of each unit is a little different because we define one of them as Master, and the others are Slave. The Master will send some signals to Slaves for proper control. In order to get correct operating, the user must follow a certain setting procedure.

3.2 Output Setting

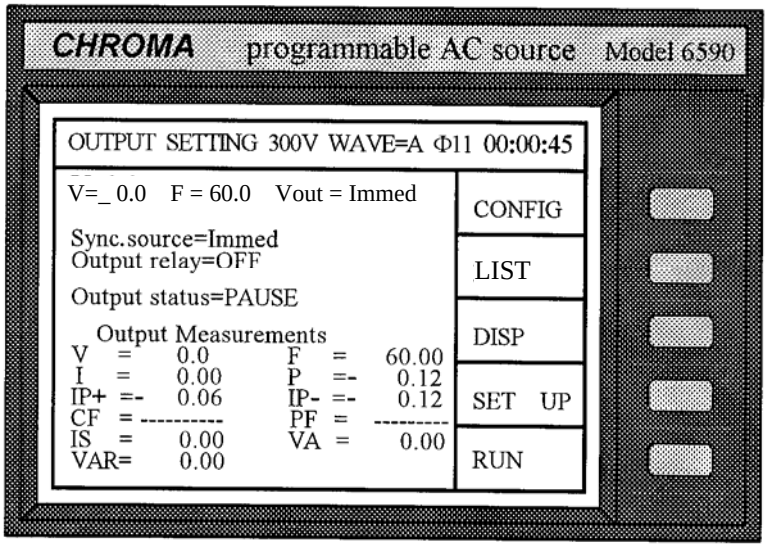
There are many output setting parameters in order to get right output voltage. It includes voltage, frequency…etc. They are on main operation menu or CONF or SETUP page. Please refer the following to set the right value.

ⓘ NOTICE
In order to properly control the 3 units of AC souce, they have been set and fixed which is Master or Slave unit before shipping. Users can press SETUP softkey on main manu page, then press SYSset to see the Machine Set.

ⓘ WARNING
The Machine Set for to be Mater or Slave have been fixed. Please not change it.

3.2.1 Setting Output Voltage, Frequency

After you have powered on the AC source, and accomplished the self-test (or exited from any other menu by pressing **QUIT**), the LCD of Master unit will display a main operational menu on the screen as below:



The line where the cursor stays indicates the AC source is waiting for the voltage value input. Users can easily set voltage for every phase in individual LCD display. There is no frequency setting in the main operational menu of Slaves. Users only need key-in Frequency setting in the Master. The Slaves will follow the frequency setting of Master.

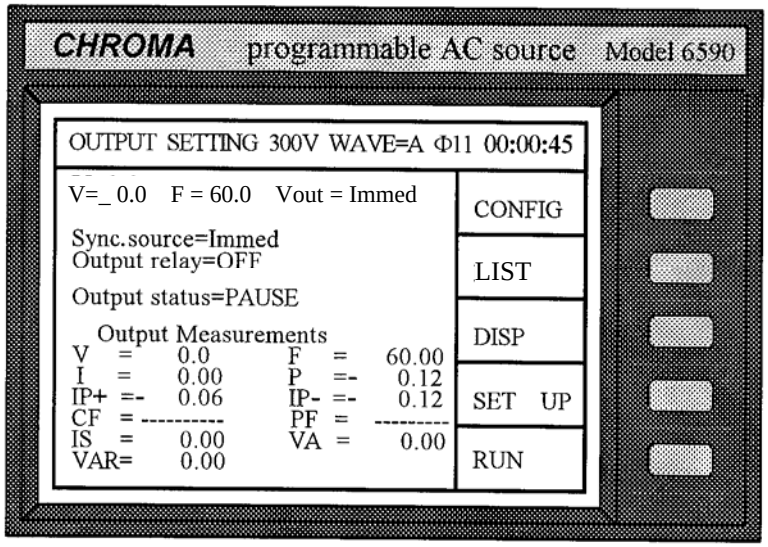
There are two range of voltage output 150V and 300V for each phase. Users can change the range in SET UP to fit their application condition. But to set the same range for every phase is recommended. Please refer to 6460/6490 or 6560/6590 user's manual for more detail.

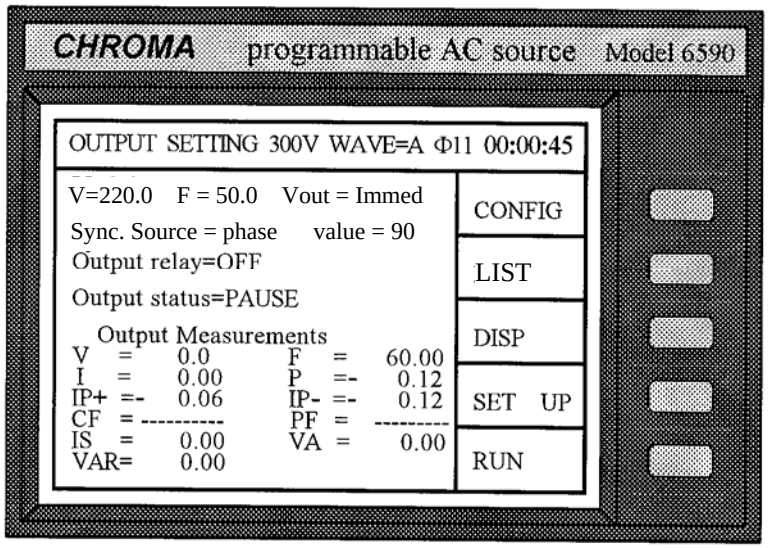
3.2.2 Setting the Output Transition Phase

The AC source can control the transition angle of the output waveform on the setting of Sync. source=phase. Users can easily set the angle by moving cursor to the setting position. When Sync. Source = Immed means the transition angle is not defined, the value depends on the time point the commend executes immediately. But to set a proper phase is recommended.

ⓘ NOTICE

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





In order to get a right transition angle when output voltage for 3 phase, users should set right phase value that is relative to phase angle between Master and Slaves. Please refer the following example : Set the transition output "phase" of Master (**φ1**) to 90 degrees, when the Slaves **φ2, φ3** phase angle to Master are 120 and 240 degree.

The Master's setting (**φ1**) : Sync. Source = phase phase = 90.0

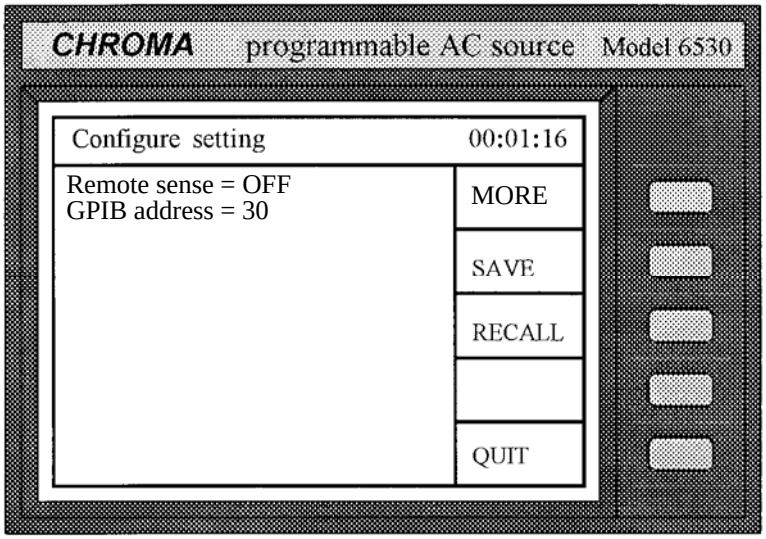
The Slave's setting (**φ2**) : Sync. Source = phase phase = 210.0 (90 + 120 = 210)

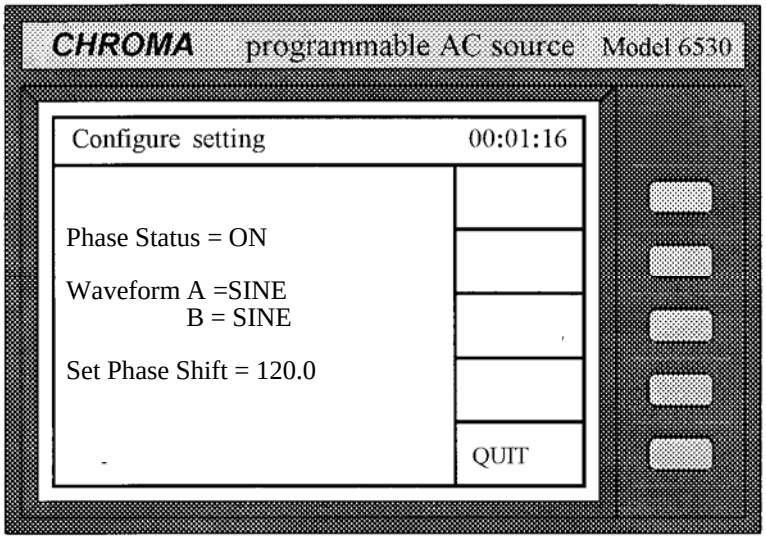
The Slave's setting (**φ3**) : Sync. Source = phase phase = 330.0 (90 + 240 = 330)

3.2.3 The Phase Angle of Phases

Normally, the phase angle between each phase is 120 degree for 3-phase AC power. In order to simulate 3-phase unbalance, users can change phase angles easily on 64180/64270/65180/65270.

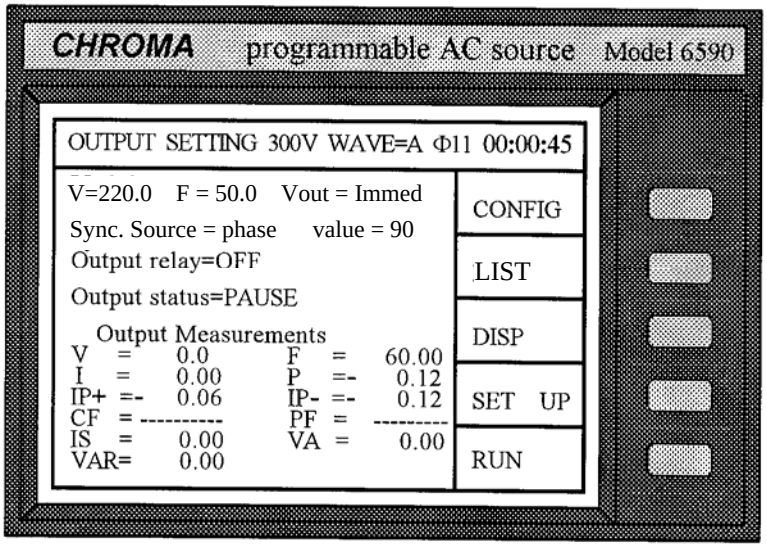
Uses can change phase angle on Slave units by pressing CONFIG softkey for setting. Then press MORE softkey to go to next page. Move cursor to **Set Phase Shift**, then, users can change the phase angle between Master and Slave.

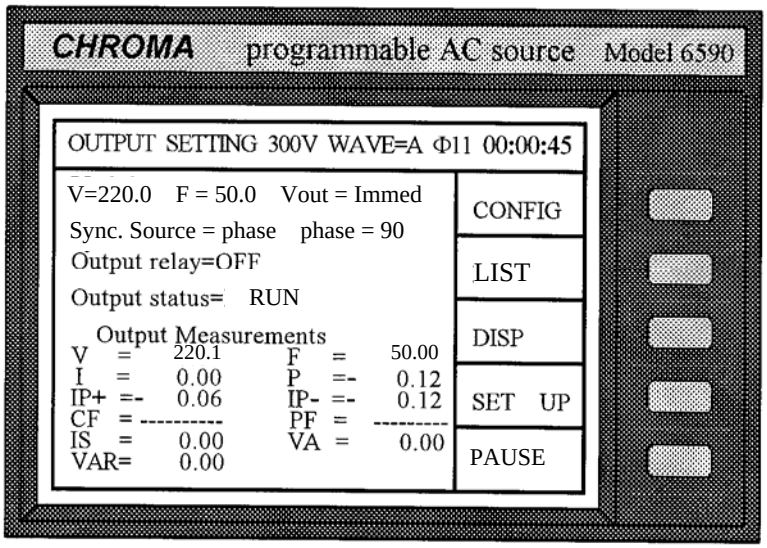




3.2.4 The Execution of Output

You can press the soft key **RUN** in the main menu of Master, to enable the execution of output of 3 phases. When you press **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" (Press the soft key **PAUSE** to disable output when output is in "RUN").

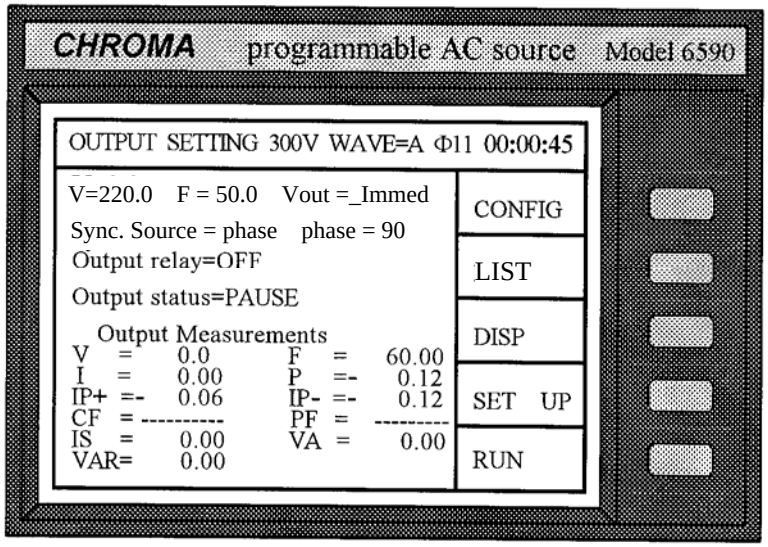




3.2.5 Asynchronizing and Synchronizing Operation

Because 64180/64270/65180/65270 is assembled by 3 units of 6460/6490/6560/6590, users need to program output voltage on each units. For example, if the output status is run, and users want to change output voltage form 220V to 230V, they may key-in 230 on each unit. There should be time delay for key-in action. Normally, the 3 phases of output voltage will not change from 220V to 230V synchronously. For some applications, it is not allowed to change voltage asynchronously.

In order to achieve changing output in asynchronous or synchronous way, users can move cursor to Vout, choose Immed for asynchronizing operation, or choose Buffer for synchronizing operation.

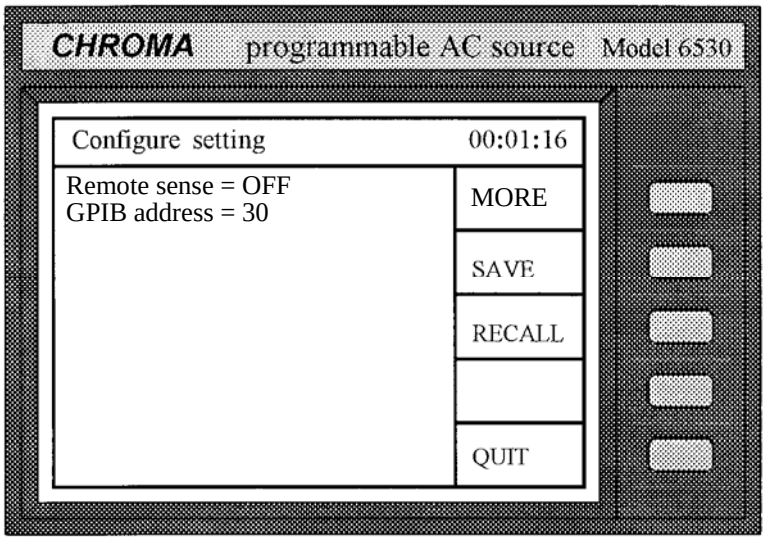


If Vout = Immed, it means the output voltage will change immediately when users program a new voltage setting. It is the asynchronizing operation. It Vout = Buffer, it means users want to do synchronizing operation. In this condition, users need to set Vout = Buffer on every unit. Then, set the new voltage on Slaves first, the output voltage will not change at this moment. The voltage of 3 phases will change synchronously when users set the voltage on the Master unit.

3.2.6 GPIB Address Setting for Remote Control

Because 64180/64270/65180/65270 is assembled by 3 units of 6460/6490/6560/6590, users need to seriesly connect GPIB cable for every unit. Users need to set different and proper GPIB address. Especially when using Softpanel, please notice the GPIB address setting must be the same with setting on Softpanel. For example, if the Softpanel's setting are Master(**φ1)** GPIB Address 30, Slave1(**φ2)** is 29, Slave2(**φ3)** is 28, then users need to set the reletive machines as the same GPIB address.

Users can press CONFIG softkey to enter setting page as following. Then move cursor to GPIB addres to set a proper number.



3.3 Application

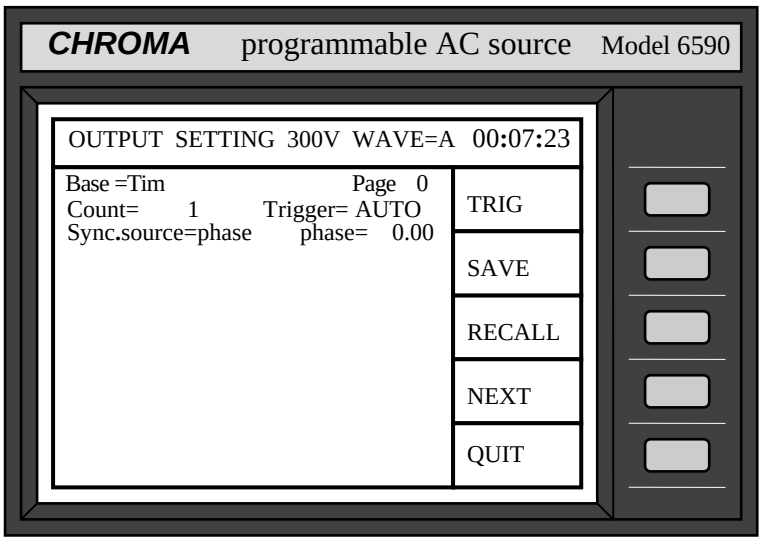
3.3.1 Output Transient Voltage (Only for Model 65180/65270)

Besides pure and stable sine waveform, some kinds of tests need voltage change in a short time. Users need to simulate abnormal conditions to their products. The AC source 6560/6590 provide three powerful modes: STEP, PULSE, LIST for users to program the output transient states and fulfill various needs in application. For some concern, 65180/65270 only offer LIST mode function. Although 65180/65270 don't offer STEP and PULSE modes, the output changes still can be programmed easily by LIST mode.

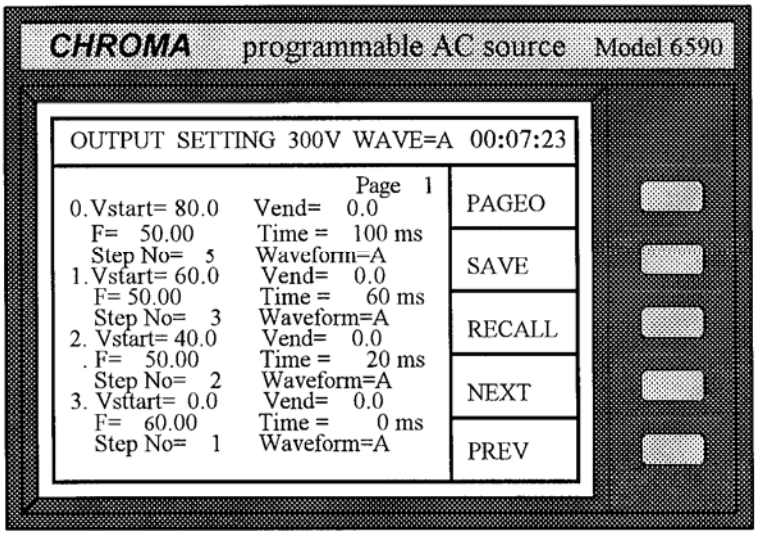
Because it's more complicated to program transient voltage by LIST mode for three phase. Users can use softpanel to help getting the wave they want. Softpanel can show the simulated wave that users program before running output.

3.3.2 LIST Mode Operation (Only for Model 65180/65270)

Users can press softkey LIST to enter LIST mode setting page 0. To set LIST mode is needed not only for the Master unit but also the Slaves. And in page 0, it is necessary to set parameters all the same except Phase setting for 3 phases . The parameter of phase is the angle point that normal voltage connects to LIST mode voltage. In order to let voltage level of 3 phases connect correctly and smoothly, the phase settings must be relative to phase angle. For example, if Master's phase = 0.0, then the Slaves should be set phase = 120.0 or 240.0 if their phase angle = 120.0 or 240.0. (120 = 0 +120, 240 = 0 + 240).



In the page 1, users can start to program the transient voltage on each unit. The LIST mode will always be executed from Sequence 0, and end at the sequence which Time or Cycle = 0. It's necessary to finish setting the parameters of all 3 phases, then turn back to Page 0. Users can press RUN softkey to output normal voltage set on main page, then insert the transient voltage by pressing TRIG softkey on the Master unit. Or users can press TRIG softkey directly to execute the transient voltage programmed on LIST mode.



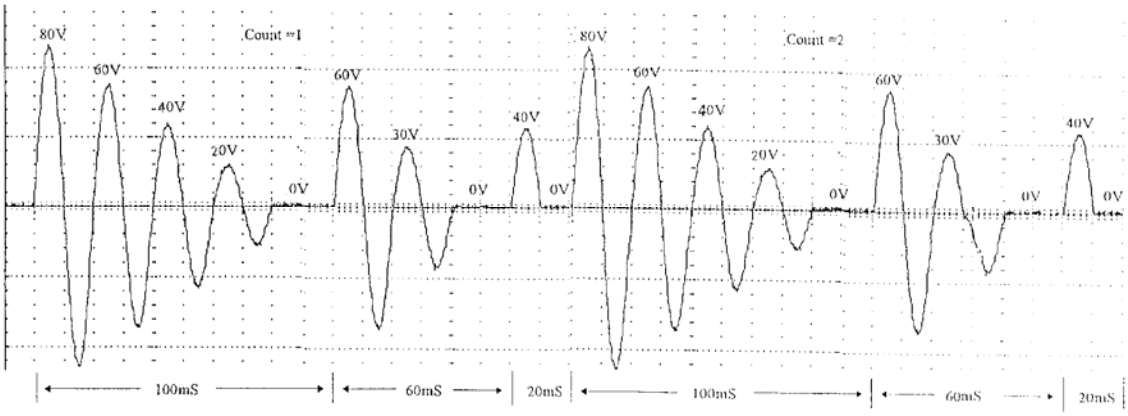
In LIST mode, you can specify the output transient state using the parameters of V, F and Time step by step.

Example:

Initial V and F : V = 40V, F = 50Hz, and
Trigger=Auto, Sync. source=phase, phase=90 degrees

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 .



ⓘ NOTICE

1. The Step NO cannot be 0. When Step NO=1, only Vstart will run. When Step NO=2, only Vstart and Vend will be run.
2. The time resolution of AC source for LIST mode is 1 mS. When the Time divided by Step NO is less than 1 mS, the AC source will change Step NO every 1 mS for output.
3. The voltage resolution in LIST mode is 1mV. Some unexpected situations would happen when ΔV/Step scale is smaller then 1mV.

Note 1: When you program the steps of V/F exceeding page0, press **NEXT** to let the LCD display extend to other pages, and **PREV** to go back to the previous page. Besides, press **PAGE0** can return to page0 directly. The number of total sequences is 40, from 0 to 39.

Note 2: The pre-programmed output can be saved and recalled by the use of the soft keys **SAVE** and **RECALL**.

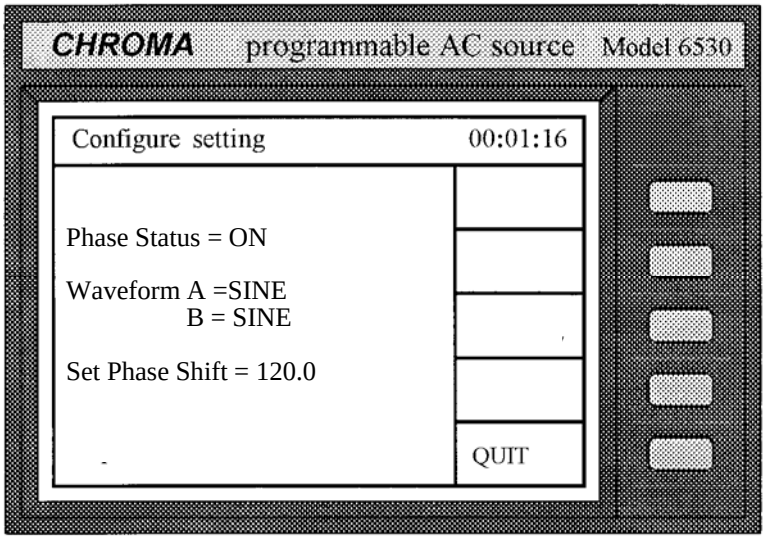
Note 3: If Trigger=MANUAL, press **TRIG** so that the AC source will run the programmed parameters for one time only. It has the same result as Count=1.

Note 4: 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 is disabled when "Output Status = PAUSE".

3.3.3 Distorted Waveform (Only for Model 65180/65270)

Besides pure and stable sine waveform, some kinds of tests need distorted waveform to simulate main power in the real world. The AC source provides two independent sets of waveforms, A and B on each unit. Both of the waveforms contain sinusoidal, square, clipped sinusoidal, 30 sets of built-in waveforms, and 6 sets of user-defined waveforms. Users can easily set the waveform as they like.

Users can press CONFIG softkey, then press MORE softkey to the page as showing. Move cursor to Waveform A or B to change the waveform setting. And choose the Waveform A or B on SETUP page.



ⓘ 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 the manual of 6560/6590.
4. When you select non-sinusoidal waveform, the range of output voltage may change to correct rms output voltage.

Besides the waveform library built-in AC source, users can progrom their own waveform. Users can edit the harmonic components of waveform up to 40 orders on a software, 65180/65270's Softpanel. Then, send the data to user-defined waveform library for any phase. Users can recall the waveform when they need it.

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 for each phase. You can select the measurement point at the load connector (remote sense= ON), or at the AC source output connector.

3.4.1 The Selection of Measurement Items

The AC source can display concurrently up to 12 measurable readings, including V, P, I, Ip+, Ip–, CF, PF, VA, Var, F, P, and Is. You can select different measurement functions to display the measured readings. If you select less than three measurement functions, the LCD will display the measurement in enlarged characters as follows: (The lower half of the main menu is the display area of measurement.)

3.4.2 Measurement Functions

The AC source offers 12 measurement functions. All of the functions can be specified to display in the main menu as stated in the previous section. The definitions of the functions are listed in the following table:

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 *3.1.5.6*.
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 *3.1.5.6*.
VA	It is Apparent Power in Watts, and its calculation formula = Vrms × Irms
VAR	Its calculation formula = $\sqrt{VA^2 - P^2}$
P	It is the sum of the power for the unit

4. Calibration Procedure

Although Chroma AC source model 64180/64270/65180/65270 are assembled by 3 units of 6460/6490/6560/6590, the F/W and inner signals of each unit is different. If calibration is needed, users may need the original F/W of 6460/6490/6560/6590 and inner circuit connecting data. For further help, please refer to the user's manual of 6460/6490/6560/6590, and contact Chroma ATE INC.

5. Remote Operation

5.1 Setting the GPIB Address

The AC source can be controlled remotely through the GPIB. Normally, Chroma AC source is shipped with the GPIB address, which is set to 30. Because 64180/65180/64270/65270 have 3 units of 6460/6560/6490/6590, users need set the different address for every unit. And users need to send commands to each unit in order to control voltage for each phase. The address can only be changed from the front panel by pressing **CONFIG** in the "Configure Setting" menu.

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.

   GPIB address =30

3. Enter the new address number such as **5** and press **ENTER**. The GPIB address changes to 5.

   GPIB address =5

5.2 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,	RL1

	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.	

5.3 Introduction to Programming

All commands and response messages are transferred in the 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.

5.3.1 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] indicates that : STATe may be omitted.
Braces	{	}	Braces indicate the parameters may be repeated. The notation <A> {<, B>} means parameter "A" must be entered while parameter "B" may be omitted or entered once or more times.

5.3.2 Numerical Data Formats

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

Numerical Data Formats

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

5.3.3 Boolean Data Format

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

5.3.4 Character Data Format

The character strings returned by query command may in the following two forms:

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

5.3.5 Basic Definition

Command Tree Table:

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

Program Headers:

Program headers are the key words to identify the command. They follow the syntax described in IEEE 488.2 section 7.6. The AC source accepts characters in both upper and lower case without distinction. 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 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 accepts the exact short and long forms only. A special notation will be taken to differentiate the short form header from the long one of the same header in this section. The short form of the header is shown in upper case characters, whereas the rest of the header are shown in lower case.

Program Header Separator (:):

If a command has more than one header, you 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.

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 indicates 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.

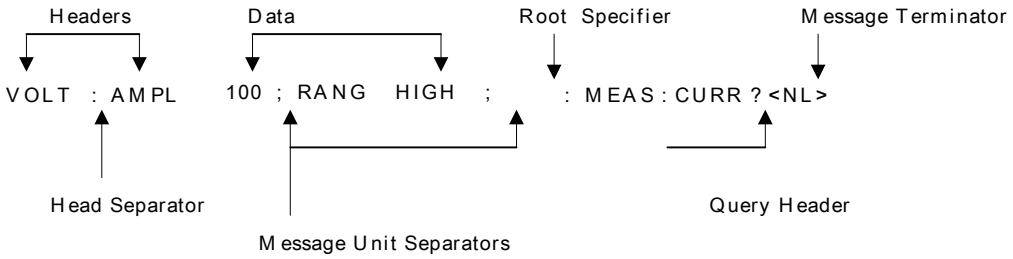


Figure 6-1 The Structure of Command Message

5.4 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.

5.5 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 the program message terminator is received. A coupled command sets the parameters that are affected by the setting of other commands. Problems may arise as the AC source prior state will affect the response of a coupled parameter to its programming.

For example, assuming the current output voltage range is LOW, a new state of output voltage range is HIGH, and amplifies to 220 Volt. If the commands

VOLTage 220<PMT>
RANGe HIGH<PMT>

are sent, the error of data out of range will be generated. Reversing the order, or sending the commands in one program message can avoid such kind of error. For the above example, the program message below

VOLTage 220 ; RANGe HIGH<PMT>

can be sent without error.

The following commands are coupled: VOLTage, : RANGe.

5.6 The Commands of the AC Source

This section covers 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, while only short form headers appear in the 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.

5.6.1 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 enabled events of the Standard Event register is set, the ESB of Status Byte Register is set too.

Bit Configuration for 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 are 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 number
1234 : Serial number
2.01 : Firmware version number

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

Parameter 0 - 2

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

Parameter 0 – 2

5.6.2 Instrument Command Dictionary

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

FETCh | MEASure
[: SCALar]
: CURRent

:AC?	Query the AC rms current
:AC :TOTal?	Query the AC summary rms current
: AMPLitude : MAXimum?	Query the peak current
: AMPLitude : MAXimum:TOTal?	Query the peak current
: CREStfactor?	Query the current crest factor
: CREStfactor:TOTal?	Query the summary current crest factor

This command lets you get the measurement data from 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 the measurement buffer. Individual outputs of a multi-phase source are specified by 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 : AC : TOTal?
MEASure [: SCALar] : CURRent : AC: TOTal?

Return parameters <NR2>

These queries return the summary 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 : AMPLitude : MAXimum : TOTal?
MEASure [: SCALar] : CURRent : AMPLitude : MAXimum : TOTal?

Return parameters <NR2>

These queries return the absolute value of summary 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 : CREStfactor :TOTal?
MEASure [: SCALar] : CURRent : CREStfactor :TOTal?

Return parameters <NR2>

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

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

Return parameters <NR2>

These queries return the value for 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 the real power
: APParent? Query the apparent power
: APParent:TOTal? Query the summary apparent power
: REACtive? Query the reactive power
: REACtive: TOTal? Query the summary reactive power
: PFACtor? Query the power factor
: PFACtor: TOTal? Query the summary power factor
: TOTal? Query the 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 : APParent : TOTal?
MEASure [: SCALar] : POWer : AC : APParent : TOTal?

Return parameters <NR2>

These queries return the summary 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:

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

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

Return parameters <NR2>

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

$$\text{VAR} = \sqrt{TOTAL\_APPARENTPOWER^2 - TOTAL\_REALPOWER^2}$$

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

Return parameters <NR2>

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

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

Return parameters <NR2>

For 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
:TOTal
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.

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

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

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

For 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 for 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 affects the set voltage only.

This command has no effect on queries and is able to 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. If INST : COUP ALL is programmed,

all commands are sent to all output phases. This command affects the set voltage and queries Measurement data. For example, if "INST : COUP ALL ", "INST : NSEL 2" and "Meas : V?" are programmed, the AC source will return ∅2's measured voltage. INST : NSEL selects phase by number, and INST : SEL refers to it by 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 AC source
: PROTection		
: CLEar		Reset protection status
: DELay	<n>	Set the delay time of protection
PROPerty		Set output property

OUTPut [: STATe] ON | OFF

Query syntax OUTPut?
Return parameters ON | OFF

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

There are two ways to program output

1. Synchronization: Programming "OUTP:PROP BUFF" will let 6590s/6560s be a synchronized state. And then, Programming Master by this command to control output ON/OFF.
2. Independence: Programming "OUTP:PROP IMM" will let 6590s/6560s be a independent state. And then, Programming this command controls any 6590/6560 to be ON/OFF.

OUTPut : PROTection : CLEar

This command clears the latch that disables the output when a condition of over current (OC), over temperature (OT), overpower (OP) or remote inhibit (RI) is detected. All conditions that generate 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.

OUTP[UT]:PROP[ERTY]

Query syntax	OUTPut : PROPerty ?
Parameter	BUFF[ER] |IMM[EDIATELY]
Return parameters	BUFF[ER] |IMM[EDIATELY]

Programming "OUTPut : PROPerty BUFF[ER] " will output property to be synchronous.
Programming "OUTPut : PROPerty] IMM[EDIATELY]" will output property to be .independent

RANGe HIGH | LOW Set the output voltage range

Query syntax	RANGe?
Parameter	HIGH | LOW
Return parameters	HIGH | LOW

This command sets the output voltage range of AC source.
HIGH sets the AC source to 300V (high) range.
LOW sets the AC source to 150V (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 AC source for software protection. The unit is 0.01 ampere.

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

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

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

The command sets the frequency of the AC source output waveform. Only Master can be programmed by this command, or the error message “Execution Error” will generates.

[SOURce :]
FUNCtion
: SHAPe
: A | B Select the active waveform buffer
[<shape>] Set the 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. You can select active buffer using 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 AC source output. You need to specify the contents of waveform buffer A or B for AC source.

<shape>

SINusoid	Sine waveform output
SQUare	Square waveform output
DST <n>	Distorted waveform output 1-30
CSINusoid <n>	% of peak where the clipped sine (or % THD) is
US <n>	User-defined waveform output 1-6

The clipping level is expressed as a percentage of the peak amplitude when 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 AC source can output is 425V peak. Therefore, the maximum rms value can be programmed depends on the peak to rms ratio of selected waveform. Refer to *Appendix F* for non-sine wave maximum programmed voltage.

[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 AC source.
This command is programmed to change the setting value only. But it does not output until "OUTP ON" is programmed.

There are two ways to program voltage

1. Synchronization: Programming "OUTP:PROP BUFF" will let 6590s/6560s will let 6590s /6560s be a synchronized state. And then, programming voltages of Slave2, Slave1, and Master *sequentially* .6590s/6560s will output voltage together when the voltage of Master is programmed.
2. Independence: Programming "OUTP:PROP IMM" will let 1 6590s/6560s be a independent state. Every 6590s/6560s can be programmed individually and output immediately.

V <NR2>
This command sets the AC Source output value immediately. The programming ways is the same as **[SOURce :] VOLTage [: LEVel] [: IMMediate] [: AMPLitude]**

There is No Query command.

SYSTem

: ERRor? Query the error string

Response error strings:

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 and follows by 1000 data points. They define the relative amplitudes exactly one cycle of the waveform. The first data point defines the relative amplitude that outputs at 0 degree phase. 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 AC source to process the data. The time limit should be at least 20 seconds for multi-phase (Model 6560/6590) system.

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

TRIGger

[: SEQuence1 | : TRANsient]
[: IMMediate]

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

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

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

DPHase

Query Syntax	DPH[ASE]?
Parameter	0.0 to 359.9
Return parameters	<NR2>

The Difference Phase between Master and Slave can be programmed from 0 .0 to 359.9. Of

course, Master is zero and unchangeable.

TPHase <NR2> Set transient phase angle

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

This command sets the transient phase of AC source.

TPHase:SYNC IMM | SYNC

Query syntax	TPHase:SYNC?
Return parameters	IMM	PHAS

When “TPH:SYNC IMM” is programmed, the transient phase is random. If ”TPH:SYNC PHAS” is programmed, the transient phase is output according to the transient phase angle.

NPHase PARALLEL | SERIES (6560)

This command switches relay PARALLEL | SERIES. Output must be off before programming. This command takes no effect on 6590. If it is programmed, an error message ”Execution Error” generates.

[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 executing 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	Change the AC source output transient phase immediately to LIST mode.
LIST : SYNC PHAse	Change the AC source output transient phase synchronously to 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 running LIST.

LIST : BASE TIME | CYCle

This command sets the 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 completion. 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 returned value is the total number of points.

Return parameters	<NR1>

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

This commands sets the frequency sequence. The frequency points are given in the command parameter, which are separated by comma 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 commands sets the sequence of beginning voltage. The beginning voltage points are given by command parameters that are separated by comma 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

by command parameters that are separated by comma 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 shape. The shape points are given by command parameters that are separated by commas or space. There are two waveform buffers, A and B. You 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 comma 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 loop cycles. The loop means the number of times it 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>}

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 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 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 Remote-Lockout state, and the front panel will be disabled.

5.7 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
* RLC<n>	Recall the AC source file

* SAV<n> Save the AC source status

Instrument Commands:

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

FETCh | MEASure
[: SCALar]
: FREQuency?

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

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

:TOTal

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

ORELay ON | OFF

OUTPut
[: STATe] <bool>
: PROTection
: CLEar
: DELay <n>
PROPerty BUFF[ER] |IMM[EDIATELY]
RANGe HIGH | LOW

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

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

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

[SOURce :]

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

SYSTem
: ERRor?

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

TRIGger
[: SEQuence1 | : TRANsient]
[: IMMediate]
DPHAse <NR2>
TPHAse <NR2>
: SYNC IMMediate | PHASe

[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>}

SYSTem

: VERSion?

: LOCal

: REMote

: RWLock