Keysight Models 6811C, 6812C, and 6813C AC Power Solutions

KEYSIGHT
TECHNOLOGIES

User's and
Service Guide

Notices

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Safety Information

CAUTION
A CAUTION notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in damage to the product or loss of important data. Do not proceed beyond a CAUTION notice until the indicated conditions are fully understood and met.

La mention ATTENTION signale un danger. Si la manoeuvre ou la procédure correspondante n'est pas exécutée correctement, il peut y avoir un risque d'endommagement de l'appareil ou de perte de données importantes. En présence de la mention ATTENTION, il convient de ne pas poursuivre tant que les conditions indiquées n'ont pas été parfaitement comprises et remplies.

WARNING
A WARNING notice denotes a hazard. It calls attention to an operating procedure, practice, or the like that, if not correctly performed or adhered to, could result in personal injury or death. Do not proceed beyond a WARNING notice until the indicated conditions are fully understood and met.

La mention AVERTISSEMENT signale un danger pour la sécurité de l'opérateur. Si la manoeuvre ou la procédure correspondante n'est pas exécutée correctement, il peut y avoir un risque grave, voire mortel pour les personnes. En présence d'une mention AVERTISSEMENT, il convient de s'interrompre tant que les conditions indiquées n'ont pas été parfaitement comprises et satisfaites.

Safety Symbols

The following symbols on the instrument and in the documentation indicate precautions which must be taken to maintain safe operation of the instrument.

$\sim$	Alternating current (AC)	▮	On (mains supply)
⚡	Caution, risk of electric shock	⚠	Caution, risk of danger (refer to this manual for specific Warning or Caution information)
⏚	Protective earth (ground) terminal	⏛	Frame or chassis (ground) terminal
L	Terminal for Line conductor on permanently installed equipment	N	Terminal for Neutral conductor on permanently installed equipment
⏻	Standby (supply). Units with this symbol are not completely disconnected from ac mains when this switch is off. To completely disconnect the unit from ac mains, either disconnect the power cord or have a qualified electrician install an external switch.		

Safety Considerations

Read the information below before using this instrument.

This product is a Safety Class 1 instrument, which means it has a protective earth terminal. That terminal must be connected to earth ground through a power source equipped with a ground receptacle. Before installation or operation, check the ac source and review this guide for safety warnings and instructions. Safety warnings for specific procedures are located at appropriate places in the guide.

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 with specific warnings elsewhere in this manual violates safety standards for design, manufacture, and intended use of the instrument. Keysight Technologies assumes no liability for the customer's failure to comply with these requirements.

GENERAL

This product is a Safety Class 1 instrument (provided with a protective earth terminal). The protective features of this product may be impaired if it is used in a manner not specified in the operation instructions.

Any LEDs used in this product are Class 1 LEDs as per IEC 60825-1.

This ISM device complies with Canadian ICES/NMB-001. Cet appareil ISM est conforme à la norme NMB-001 du Canada.

LIMITATION OF WARRANTY

The foregoing warranty shall not apply to defects resulting from improper or inadequate maintenance by the Customer, Customer-supplied software or interfacing, unauthorized modification or misuse, operation outside of the environmental specifications for the product, or improper site preparation and maintenance. NO OTHER WARRANTY IS EXPRESSED OR IMPLIED. KEYSIGHT TECHNOLOGIES SPECIFICALLY DISCLAIMS THE IMPLIED WARRANTIES OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE.

WARNING **BEFORE APPLYING POWER**

Verify that the product is set to match the available line voltage, the correct fuse is installed, and all safety precautions are taken. Note the instrument's external markings described under "Safety Symbols" on page 4.

AVANT LA MISE SOUS TENSION

Vérifiez que le produit est réglé pour correspondre à la tension secteur disponible, que le fusible adéquat est installé et que toutes les précautions de sécurité sont respectées. Consultez les marquages externes de l'instrument décrits sous "Safety Symbols" à la page 4.

WARNING **GROUND THE INSTRUMENT**

To minimize shock hazard, the instrument chassis and cover must be connected to an electrical ground. The instrument must be connected to the ac power mains through a grounded power cable, with the ground wire firmly connected to an electrical ground (safety ground) at the power outlet. Any interruption of the protective (grounding) conductor or disconnection of the protective earth terminal will cause a potential shock hazard that could result in personal injury.

MISE À LA TERRE DE L'INSTRUMENT

Pour réduire le risque de choc électrique au minimum, le châssis et le couvercle de l'instrument doivent être connectés à la terre. L'instrument doit être connecté au réseau électrique alternatif par le biais d'un câble d'alimentation relié à la terre, le fil de terre fermement connecté dans une terre électrique (masse de sécurité) au niveau de la prise de courant. Toute interruption du conducteur protecteur (de mise à la terre) ou déconnexion de la borne de terre de protection entraînera un risque de choc électrique pouvant entraîner des blessures corporelles.

Un circuit de terre continu est essentiel en vue du fonctionnement sécuritaire de l'appareil. Ne jamais mettre l'appareil en marche lorsque le conducteur de mise ... la terre est débranché,.

WARNING

DO NOT OPERATE IN AN EXPLOSIVE ATMOSPHERE

Do not operate the instrument in the presence of flammable gases or fumes.

NE PAS FAIRE FONCTIONNER DANS UNE ATMOSPHÈRE EXPLOSIVE

Ne faites pas fonctionner l'instrument en présence de fumées ou de gaz inflammables.

WARNING

DO NOT REMOVE THE INSTRUMENT COVER

Operating personnel must not remove instrument covers. Component replacement and internal adjustments must be made only by qualified service personnel.

NE PAS RETIRER LE COUVERCLE DE L'INSTRUMENT

Le personnel d'exploitation ne doit pas retirer les couvercles de l'instrument. Le remplacement des composants et les réglages internes doivent être uniquement effectués par du personnel de service qualifié.

WARNING

IN CASE OF DAMAGE

Instruments that appear damaged or defective should be made inoperative and secured against unintended operation until they can be repaired by qualified service personnel.

EN CAS DE DOMMAGES

Les instruments endommagés ou défectueux doivent être désactivés et protégés contre toute utilisation involontaire jusqu'à ce qu'ils aient été réparés par une personne qualifiée.

WARNING

LETHAL VOLTAGES

AC Sources can supply 425 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. Hazardous voltages can remain active inside the unit even after it has been turned off. If the internal LED's are on, hazardous voltages are present.

TENSIONS MORTELLES

Source AC peuvent fournir 425 V maximum à leur sortie. Tout contact peut entraîner la MORT si les circuits ou bornes de sorties connectés à la sortie sont touchés lorsqu'ils sont sous tension. Des tensions dangereuses peuvent rester actives à l'intérieur de l'unité, même après l'avoir mise hors tension. Si les DEL internes sont allumées, des tensions dangereuses sont présentes.

CAUTION

ENVIRONMENTAL CONDITIONS

This instrument is intended for indoor use in an installation category II, pollution degree 2 environment. It is designed to operate at a maximum relative humidity of 85% and at altitudes of up to 2000 meters. Refer to the specifications tables for the ac mains voltage requirements and ambient operating temperature range.

CONDITIONS ENVIRONNEMENTALES

Cet instrument est destiné à une utilisation en intérieur dans un environnement d'installation de catégorie II, degré de pollution 2. Il est conçu pour fonctionner dans une humidité relative maximale de 85 % et à jusqu'à 2000 mètres d'altitude. Consultez les tableaux de spécifications pour connaître les exigences en matière de tension secteur alternative et de plage de température de fonctionnement ambiante.

CAUTION **FUSES**

Only fuses with the required rated current, voltage, and specified type (normal blow, time delay, etc.) should be used. Do not use repaired fuses or short-circuited fuseholders. To do so could cause a shock or fire hazard.

FUSIBLES

Seuls des fusibles délivrant la tension nominale et le courant nominal requis et ayant le type spécifié (à action normale, à action retardée et autres) doivent être utilisés. N'utilisez pas de fusibles réparés ou de porte-fusibles court-circuités. Vous pourriez provoquer un choc ou un risque d'incendie.

Environmental Conditions

CAUTION   The Models 6811C, 6812C, and 6813C is designed for indoor use and in an area with low condensation. The table below shows the general environmental requirements for this instrument.

Environmental condition	Requirement
Temperature	Operating condition – 0 °C to 40 °C Storage condition – 40 °C to 70 °C
Humidity	Operating condition – Up to 85% RH at 40°C (non-condensing) Storage condition – Up to 95% RH at 40°C (non-condensing)
Altitude	Up to 2000 m
Pollution degree	2

Ce Modèles 6811C, 6812C et 6813C est conçu pour être utilisé dans des locaux fermés où la condensation est faible. Le tableau ci-dessous indique les conditions d'environnement générales requises pour cet instrument.

Condition d'environnement	Exigences
Température	Conditions de fonctionnement – Entre 0°C et 40 °C Conditions de stockage – 40 °C à 70 °C
Humidité	Conditions de fonctionnement – Jusqu'à 85% d'humidité relative à 40 °C (sans condensation) Conditions de stockage – Jusqu'à 95% d'humidité relative à 40 °C (sans condensation)
Altitude	Jusqu'à 2 000 m
Degré de pollution	2

Regulatory Information

CAUTION   The Models 6811C, 6812C, and 6813C AC Power Solutions complies with the following safety and Electromagnetic Compatibility (EMC) compliances:

Safety compliance

– IEC 61010-1:2010/ EN 61010-1:2010
– Canada: CAN/CSA-C22.2 No. 61010-1-12
– USA: UL 61010 Issue:2012/05/11 Ed:3

EMC compliance

– IEC 61326-1:2012 / EN 61326-1:2013
– Canada: ICES/NMB-001
– Australia/New Zealand: AS/NZS CISPR 11:2011
– South Korea RRA Notice 2016-24

Le Models 6811C, 6812C, and 6813C AC Power Solutions est conforme aux normes de sécurité et aux normes EMC suivantes :

Conformité de sécurité

– CEI 61010-1:2010/ EN 61010-1:2010
– Canada : CAN/CSA-C22.2 No. 61010-1-12
– Etats-Unis : UL 61010 Publication :2012/05/11 Ed :3

Conformité CEM

– CEI 61326-1:2012/ EN 61326-1:2013
– Canada : ICES/NMB-001
– Australie/Nouvelle Zélande : AS/NZS CISPR11:2011
– Corée du Sud RRA Notification 2016-24

Regulatory Markings

CE ICES/NMB-001 ISM GRP 1-A	The CE mark is a registered trademark of the European Community. This CE mark shows that the product complies with all the relevant European Legal Directives. ICES/NMB-001 indicates that this ISM device complies with the Canadian ICES-001. Cet appareil ISM est conforme a la norme NMB-001 du Canada. ISM GRP.1 Class A indicates that this is an Industrial Scientific and Medical Group 1 Class A product.	CSA® C US	The CSA mark is a registered trademark of the Canadian Standards Association.
KC	This symbol is a South Korean Class A EMC Declaration. This is a Class A instrument suitable for professional use and in electromagnetic environment outside of the home.	RCM	The RCM mark is a registered trademark of the Australian Communications and Media Authority.
40	This symbol indicates the time period during which no hazardous or toxic substance elements are expected to leak or deteriorate during normal use. Forty years is the expected useful life of the product.		This instrument complies with the WEEE Directive (2002/96/EC) marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.

South Korean Class A EMC declaration:

Information to the user
This equipment has been conformity assessed for use in business environments. In a residential environment this equipment may cause radio interference.

– This EMC statement applies to the equipment only for use in business environment.

사 용 자 안 내 문
이 기기는 업무용 환경에서 사용할 목적으로 적합성평가를 받은 기기로서 가 정용 환경에서 사용하는 경우 전파간섭의 우려가 있습니다 .

– 사용자 안내문은 " 업무용 방송통신기자재 " 에만 적용한다 .

Waste Electrical and Electronic Equipment (WEEE) Directive

This instrument complies with the WEEE Directive marking requirement. This affixed product label indicates that you must not discard this electrical or electronic product in domestic household waste.

Product category:

With reference to the equipment types in the WEEE directive Annex 1, this instrument is classified as a "Monitoring and Control Instrument" product.

The affixed product label is as shown below.

Do not dispose in domestic household waste.

To return this unwanted instrument, contact your nearest Keysight Service Center, or visit http://about.keysight.com/en/companyinfo/environment/takeback.shtml for more information.

Sales and Technical Support

To contact Keysight for sales and technical support, refer to the support links on the following Keysight websites:

– www.keysight.com/find/6800
(product-specific information and support, software and documentation updates)

– www.keysight.com/find/assist
(worldwide contact information for repair and service)

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1   General Information

KEYSIGHT
TECHNOLOGIES

Document Orientation

This manual describes the operation of the Keysight Models 6811C, 6812C, and 6813C AC Power Solutions. These units will be referred to as "ac sources" throughout this manual.

Options and parts

Table 1-1   Options

Option	Model	Description
1CM[a]	All	Rack mount kit (Keysight p/n 5063-1564)
1CP[a]	All	Rack mount kit with handles (Keysight p/n 5063-1575)
100	Keysight 6811C/6812C	100 Vac (±10%), 50/60 Hz (Japan only)
120	Keysight 6811C/6812C	120 Vac (±10%), 50/60 Hz[b]
200	Keysight 6813C	200 Vac (±10%), 50/60 Hz (Japan only)
230	Keysight 6811C/6812C	230 Vac (±10%), 50/60 Hz
831	Keysight 6812C/6813C	12 AWG, 200 to 240 Vac, unterminated
832	Keysight 6813C	4-mm^2 wire size, unterminated
833	Keysight 6812C	1.5-mm^2 wire size, 200 to 240 Vac, unterminated
834	Keysight 6812C	10 AWG, 100 to 120 Vac, unterminated
841	Keysight 6812C/6813C	Line cord with NEMA 6-20P; 20A, 250 V plug
842	Keysight 6813C	Line cord with IEC 309; 32A, 220 V plug
844	Keysight 6813C	Line cord with NEMA 6-30P; 30A, 250 V locking plug
845	Keysight 6812C	Line cord with IEC 309; 16 A, 220 V plug
846	Keysight 6812C	Line cord with NEMA L5-30P; 30 A, 120 V plug
847	Keysight 6812C	Line cord with CEE 7/7; 16 A, 220 V plug
848	Keysight 6812C	Line cord with BS 546; 15 A, 240 V plug
900	Keysight 6811C	Line cord with BS 1363/A (90 deg); 10 A, 240 V plug

Table 1-1   Options (continued)

Option	Model	Description
901	Keysight 6811C	Line cord with AS 3112 (straight); 10 A, 240 V plug
902	Keysight 6811C	Line cord with CEE 7/7 (straight); 10 A, 230 V plug
903	Keysight 6811C	Line cord with NEMA 5-15P (straight); 13 A, 120 V plug
904	Keysight 6811C	Line cord with NEMA 6-15P (straight); 10 A, 230 V plug
906	Keysight 6811C	Line cord with SEV Type 12; 10 A, 220/230 V plug
912	Keysight 6811C	Line cord with SR107-2-D (straight); 10 A, 220/230 V plug
917	Keysight 6811C	Line cord with SABS 164-1 (90 deg); 10 A, 220-250 V plug
918	Keysight 6811C	Line cord with JIS 8303 (straight); 12 A, 100/110 V plug
919	Keysight 6811C	Line cord with SI 32 (90 deg); 10 A, 220 V plug
920	Keysight 6811C	Line cord with IRAM 2073 (90 deg); 10 A, 220 V plug
921	Keysight 6811C	Line cord with CEI 23-16; 10 A, 220 V plug
922	Keysight 6811C	Line cord with GB 1002 (straight); 10 A, 220 V plug
927	Keysight 6811C	Line cord with NEMA 5-15P; 10 A, 220 V plug

[a]   Support rails (Keysight p/n 1494-0059) are required when rack mounting units with options 1CM and 1CP.

[b]   Default factory settings.

Table 1-2   Operator replaceable parts

Item	Keysight part number
Power cord assembly	see "Options" on page 26
Rack mount kit	see "Options" on page 26
4-terminal digital connector plug	1252-1488
AC input safety cover (with strain relief and bushing)	5040-1751
Screw (3), ac input barrier block (6-32 × 5/16 in)	N/A
AC output safety cover	0360-2191
Screw (2), ac output safety cover (m4 × 0.7 in)	0515-0053
Screw (5), ac output barrier block (6-32 × 5/16 in)	N/A
User's Guide (this manual)	06811-90002
Programming Guide	06811-90005
Quick Start Guide	06811-90004
Finding Product Manuals - Quick Guide	9320-6794

Description

The ac source combines three instruments in one unit as shown in the following figure. The waveform generator produces waveforms with programmable amplitude, frequency, and shape. The bipolar amplifier amplifies the waveform generator signal to produce the ac power for your application. The measurement functions range from a simple readback of rms voltage and current, to sophisticated capabilities such as waveform analysis.
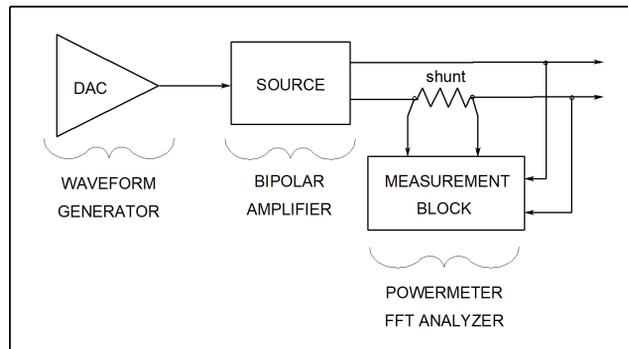
Figure 1-1   AC source functional elements

The following are the ac sources described in this *User's Guide*:

Model	Description
Keysight 6811C	0–300 V_{rms}; 375 VA (425 V_{peak}; 40 A_{peak})
Keysight 6812C	0–300 V_{rms}; 750 VA (425 V_{peak}; 40 A_{peak})
Keysight 6813C	0–300 V_{rms}; 1750 VA (425 V_{peak}; 80 A_{peak})

Features of the ac source

– Programmable AC voltage, DC voltage, frequency, phase, and current limit.

– Sine, square, clipped sine, and user-definable waveforms.

– Programmable output impedance.

– Voltage and frequency slew control.

– Synthesized waveform generation for high resolution and accuracy in frequency, low waveform distortion, and glitch-free phase transitions.

– Step and pulse output transients for generating surge, sag, dropout, and other line disturbance simulations.

– Nonvolatile list programming for generating complex output transients or test sequences.

– Nonvolatile state and waveform storage and recall.

– Extensive measurement capability:

  – AC rms, DC, AC+DC voltage and current and peak current.

  – Real, reactive, and apparent power.

  – Harmonic analysis of voltage and current waveforms gives amplitude, phase, and total harmonic distortion results up to the 50th harmonic.

  – Triggered acquisition of digitized voltage and current with extensive post-acquisition calculations.

  – 16-bit resolution measurements.

– Trigger in and trigger out for synchronizing transient events or measurements with external signals.

– Front panel control with 14-character vacuum fluorescent display, keypad, and rotary pulse generators for voltage and frequency settings.

– Built-in GPIB, RS-232, LAN, and USB interface programming with SCPI command language.

– Overvoltage, overpower, overcurrent, overtemperature, and RI/DFI protection features.

– Built-in output and sense disconnect relays.

– Output terminals floating with respect to chassis ground.

– Extensive self-test, status reporting, and software calibration.

Front Panel with Remote Operation

The front panel has both rotary (RPG) and keypad controls for setting the output voltage and frequency. The panel display provides digital readouts of a number of output measurements. Annunciators display the operating status of the ac source. System keys let you perform system functions such as setting the GPIB address and recalling operating states. Front panel Function keys access the ac source function menus. Front panel Entry keys let you select and enter parameter values. Refer to Chapter 4, " Front Panel Operation" for a complete description of the front panel controls.

Remotely programming   is accomplished from either the GPIB bus, RS-232 serial port, LAN port, or USB. These interfaces use Standard Commands for Programmable Instruments (SCPI) commands that make the ac source programs compatible with those of other instruments. AC source status registers permit remote monitoring of a wide variety of ac source operating conditions.

NOTE	Refer to the *Keysight Models 6811C, 6812C, and 6813C AC Power Solutions Programming Guide* for further information about remotely programming the ac source.

Steady-state Output Characteristic

The ac source's steady-state output characteristic is shown in the following figure. Steady-state characteristics are output ratings that will be maintained by the ac source for an indefinite time. The "Peak Current or Dynamic Power Capability" on page 33 describes the dynamic output capability of the unit. The following figure shows both the AC and the DC characteristics. With programmable output coupling, the ac source can supply both DC and AC output voltages.

AC source operation is specified from 45 to 1000 Hz (refer to Appendix A, "Specifications"). However, you can operate the unit at frequencies less that 45 Hz. The operating characteristics of the ac source at output frequencies below 45 Hz are documented in Table A-3 of Appendix A.
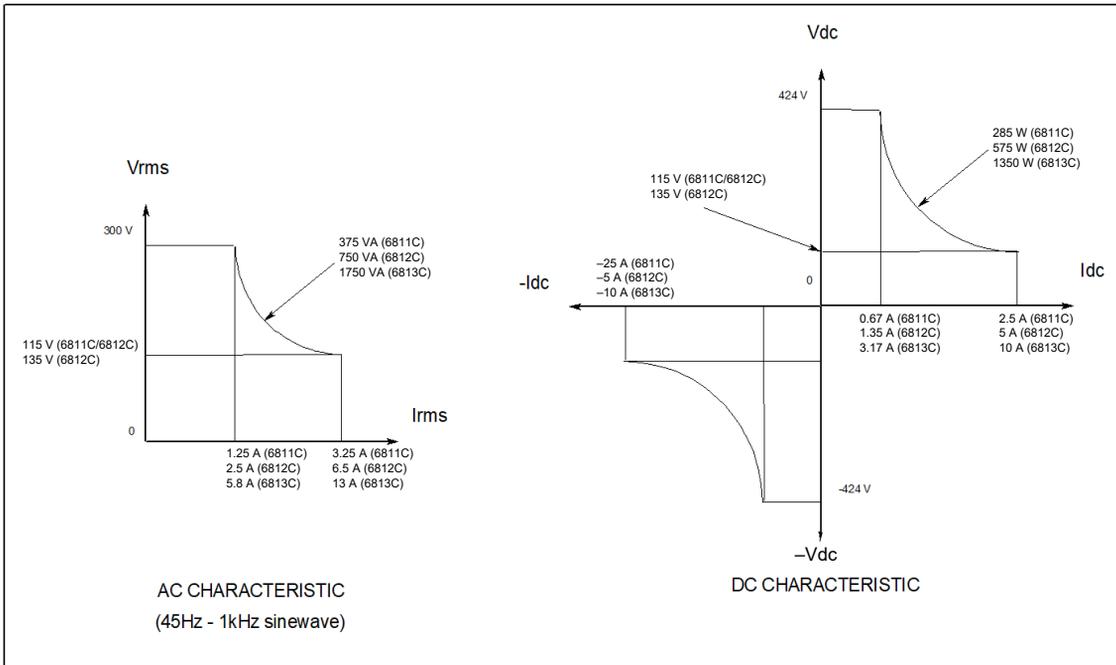
Figure 1-2   Steady-state output characteristic (in real-time mode)

Peak Current or Dynamic Power Capability

The ac source can generate peak currents that exceed the rms current capability of the unit. This not only applies when operating in AC mode, but also when programming output pulses in DC mode. Although the unit will generate peak output currents up to 40 A (Keysight 6811C/6812C) or 80 A (Keysight 6813C), the unit can only maintain this output for a limited time. If the output of the unit exceeds the limit of the safe operating area (SOA), the unit will activate its internal protection mode and turn its output off. This SOA limit is based on output voltage, output current, output duration, and heatsink temperature.

| NOTE | Refer to "Clearing protection conditions" on page 107 on how to clear the unit when the internal protection mode has been activated. |

Peak current limit

By programming the peak current limit, you can prevent the unit from exceeding the SOA, activating its internal protection mode, and turning the output off. The peak current limit circuit limits the instantaneous output current. It functions by reducing the instantaneous output voltage to keep the output peak current within the programmed limit. Because the circuit acts instantly, the effect is that it will clip the peaks of the output voltage waveform. Additionally, with fast and/or large voltage transitions, the unit may momentarily go into CC operating mode due to current in the output capacitor. This serves to limit the rate of change of output voltage.

The following table gives approximate indications of how long the unit will tolerate peak output currents before the SOA limits are exceeded. Because these values are voltage dependent, the table includes various equivalent DC voltages along with the peak current values. The voltages shown in the table are NOT the programmed voltages, but the average voltage values that will appear at the output when the indicated high current condition exists. The SOA circuit becomes active at higher voltage and current values as well as at longer duration times.

Table 1-3   Typical peak current output capacities

Keysight 6813C	Keysight 6811C Keysight 6812C	Equivalent dc voltage when current is flowing[a]					
		25	75	125	190	250	360
20 A	10 A	>100 ms	>100 ms	>100 ms	>100 ms	>100 ms	>100 ms
30 A	15 A	>100 ms	100 ms	30 ms	24 ms	19 ms	15 ms
40 A	20 A	12 ms	9.2 ms	8.4 ms	7.6 ms	6.8 ms	5.9 ms
50 A	25 A	5.6 ms	5.1 ms	4.7 ms	4.4 ms	4 ms	3.5 ms
60 A	30 A	3.7 ms	3.4 ms	3.1 ms	2.9 ms	2.6 ms	2.3 ms
70 A	35 A	2.6 ms	2.4 ms	2.2 ms	2.1 ms	1.9 ms	1.7 ms
80 A	40 A	2 ms	1.8 ms	1.7 ms	1.6 ms	1.4 ms	1.3 ms

[a]   Based on 25 °C ambient temperature, with heatsink temperature less than 50 °C.

Peak inrush example

The following table gives the recommended initial I_{peak} settings when the ac source output is a 127 VAC or 254 VAC 60 Hz sine wave, as a function of load capacitance. The load on the output is a full-wave bridge along with the indicated capacitor. The load resistance across the capacitor is infinite. The recommended I_{peak} will change as a function of changes in input as follows:

– as voltage increases, the I_{peak} setting needs to be decreased.

– as frequency increases, the I_{peak} setting can be increased.

– as load resistance decreases, the I_{peak} setting needs to be decreased.

Note that the purpose of programming the I_{peak} current is to prevent the unit from activating its internal protection mode as a result of exceeding the SOA limits, and turning the output off. These initial settings may have to be reduced if the SOA circuit trips when the output is turned on. Sometimes trial and error must be used to arrive at the proper values of I_{peak}.

Table 1-4   Recommended I_{peak} settings as a function of loop capacitance

Capacitance in μF		I_{peak} setting
127 V	**254 V**	
≤1100	500	80 A
1200	-	60 A
1700	700	50 A
5000	1000	45 A
>5000	>1000	<45 A

The following waveform illustrates the inrush current capability of the ac source. The peak current is limited during inrush in accord with Table 1-3 to keep the ac source from turning its output off. Note that the output current waveform returns to its normal shape when the current drops below the peak current limit setting.
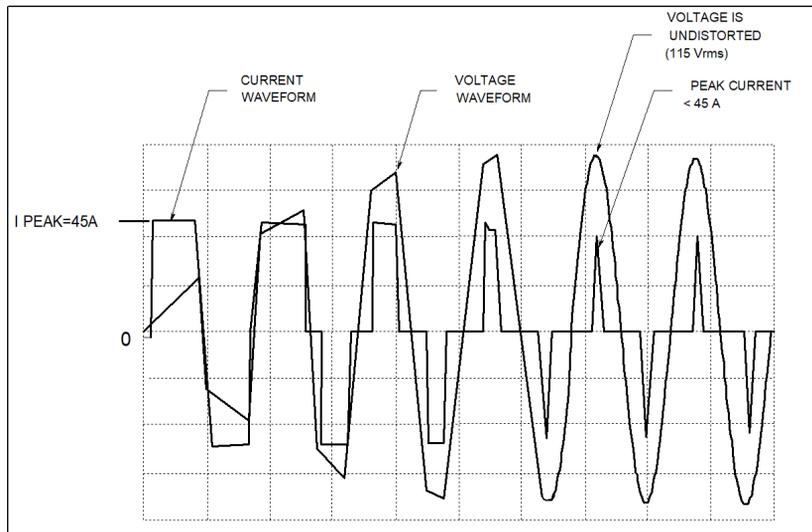
Figure 1-3   Peak inrush current example

RMS Current Limit Circuit

The output rms current limit is adjustable to any value within the range of the unit. If the load attempts to draw more current than the programmed limit, the output voltage is reduced to keep the rms current within the limit. When the output voltage is reduced, the waveform shape is preserved. In other words, all parts of the voltage cycle are reduced and not just the peaks.

NOTE The speed at which the rms current circuit operates depends on the output voltage setting and the load impedance. The circuit responds more slowly at low output voltages and at high output impedances. With constant power or negative resistance loads, the rms current limit circuit causes the output voltage to go to zero.

Voltage Regulation

Real time regulation

The default method of output regulation used by the ac source is real-time voltage regulation. Real-time voltage regulation tries to provide the actual programmed waveform at the output of the ac source. It offers the best overall programming response and fastest settling times. It does not have any limitations for waveforms and transients with frequency content below 45 Hz.

RMS regulation

RMS voltage regulation assists real-time regulation to level out or stabilize the rms value of the ac component of the output voltage. Use rms voltage regulation in the following situations:

– If you experience load regulation effects with heavy loads.

– If you experience frequency regulation problems with heavy loads and you require flatter programming accuracy at higher frequencies.

– In conjunction with programmable output impedance, if you wish to maintain the rms level of output voltage as the source impedance is increases. (Refer to "Output Impedance" on page 38 for more information.)

The command to specify voltage regulation is VOLT:ALC:DET RTIM | RMS.

NOTE   Do not use rms voltage regulation when operating at frequencies less than 45 Hz.

Output Impedance

You can program the real and/or reactive (resistive and/or inductive) part of the output impedance of the ac source. Inductive output impedances can be programmed in the range of 20 to 1000 microhenries. Resistive load impedances can be programmed in the range of 0 to 1 ohms.

When programming output impedances, the lower your load impedance, the LESS programmed impedance you can use and still maintain output voltage stability. This applies particularly for load impedances less than 1 ohm.

NOTE	Programming the ac source output impedance into a load with a low impedance can cause output voltage instability, which may damage the ac source. Stability MUST be maintained when operating the ac source with programmable resistance or inductance.

To check for stability, monitor the output voltage with an oscilloscope. Instability exists if a 5 kHz to 20 kHz oscillation, which is dependent upon the ac source's programmed inductance and the capacitance of the load, is present at any time during the following procedure.

1 When programming inductance, it is recommended that you first add a series resistance either by programming the output resistance to 1 ohm or by adding an equivalent external resistor.

2 Slowly program the inductance to the desired level while monitoring the output for any voltage instability. Do not proceed any further if the output shows any signs of instability.

3 If less output resistance is required, slowly start lowering the resistance while monitoring the output for any voltage instability. Do not proceed any further if the output shows any signs of instability.

4 If you cannot achieve satisfactory results with this procedure, disable the output impedance control and use an external impedance network.

RMS voltage regulation can be used in conjunction with programmable output impedance to regulate the rms value of the ac component of the output voltage when programmed impedances cause distortion with nonlinear loads or reduced output voltage due to regulation effects.

Note that real-time voltage regulation will permit the load current to cause output voltage degradation based on the programmed impedance and current drawn from the source, whereas rms regulation will reestablish the rms value at the programmed level.

Output Coupling

AC output coupling mode   mimics a transformer-coupled output, working to maintain a zero average output voltage. This means that the output tries to remove any DC content on the output, whether the DC content is generated from a programmed offset or results from transients with DC content. The AC output coupling has a corner frequency of about 2 Hz, which will not prevent transient waveforms that may have short-term DC content, but will regulate the waveform back to an average value of zero volts in the steady state.

DC output coupling mode   is used to generate DC offset voltages or output transients that have net DC components. In either mode of operation, the maximum voltage that the ac source can output is limited to 425 V_{peak}.

The AC capability of the output is limited by VA (volt-amperes) rather than power (watts). The amount of VA available to a load can be determined by examining Figure 1-2. Full output VA is available with no limitations except for the boundaries imposed by the maximum rms voltage of 300V, and the maximum rms current, which is model-dependent. Note that large peak power transients can be delivered by the ac source as earlier described under "Peak Current or Dynamic Power Capability" on page 33 (Appendix A documents the ac source's specifications and supplemental characteristics.)

2   Installation

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Inspection

Ensure that your ac source is not damaged and the items supplied is complete.

Damage

When you receive your ac source, inspect it for any obvious damage that may have occurred during shipment. If there is damage, notify the shipping carrier and the nearest Keysight Sales and Support Office immediately. Warranty information is printed in the front of this guide.

Packaging material

Until you have checked out the ac source, save the shipping carton and packing materials in case the unit has to be returned. If you return the ac source for service, attach a tag identifying the model number and the owner. Also include a brief description of the problem.

Items supplied

Check that the following items are included with your ac source. Some items are installed in the unit.

Power cord	A power cord appropriate for your location. The cord may or may not be terminated in a power plug (see "Options and parts" on page 26 in Chapter 2). If the cord is not included, contact your nearest Keysight Sales and Support Office (refer to the "Sales and Technical Support" on page 14).
Digital connector	4-terminal digital plug that connects to the back of the unit.
Safety covers	AC input cover with strain relief AC output cover
Information sheet	*Obtaining Documentation for Keysight 6800C Series AC Power Source/Analyzers*

Cleaning

Use a dry cloth or one slightly dampened with water to clean the external case parts. Do not attempt to clean internally.

WARNING	To prevent electric shock, unplug the unit before cleaning.
	Pour éviter tout choc électrique, débranchez l'unité avant de la nettoyer.

Location

Refer to the Safety Considerations at the beginning of this manual for safety-related information about environmental conditions.

| **CAUTION** | Keysight 6811C/6812C units weigh 29.1 kg (64.2 lbs). |

Keysight 6811C/6812C units weigh 29.1 kg (64.2 lbs).

Keysight 6813C units weigh 30.1 kg (66.4 lbs).

Obtain adequate help when moving or mounting the unit in the rack.

Les unités Keysight 6811C/6812C pèsent 29,1 kg (64,2 lbs).

Les unités Keysight 6813C pèsent 30,1 kg (66,4 lbs).

Faites-vous aider de manière adaptée lors du montage ou du déplacement de l'unité dans l'armoire.

Bench operation

The outline diagram in Figure 2-1 gives the dimensions of your ac source. The feet may be removed for rack mounting. Your ac source must be installed in a location that allows sufficient space at the sides and back of the unit for adequate air circulation. Minimum clearances are 1 inch (25 mm) along the sides. **Do not block the fan exhaust at the rear of the unit**.

Rack mounting

The ac source can be mounted in a standard 19-inch rack panel or cabinet. Rack mounting kits are available as Option 1CM or 1CP. Installation instructions are included with each rack mounting kit. **Keysight ac sources also require instrument support rails** in addition to the rack mount kit. Support rails are normally ordered with the cabinet and are not included with the rack mounting kits.
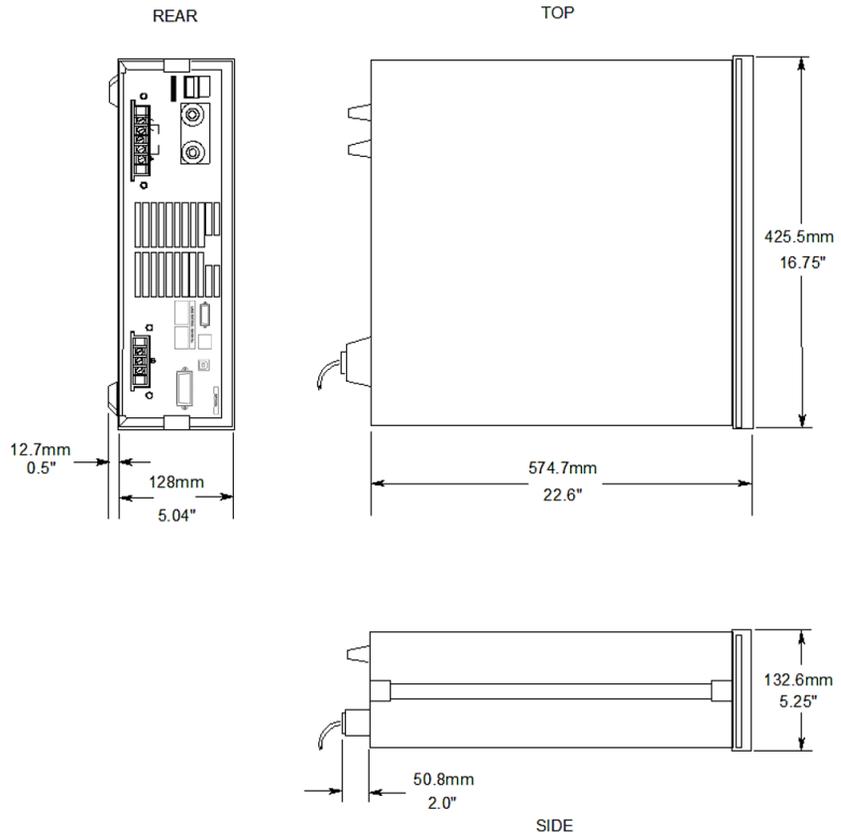
Figure 2-1   Outline diagram

Input Connections

Input source and line fuse

You can operate your ac source from a single-phase ac power source as indicated on the rear panel Line Rating label. Refer to AC input voltage range (V_{ac}) in Table A-2 of Appendix A, "Specifications" for details.

WARNING   **SHOCK HAZARD.** The power cord provides a chassis ground through a third conductor. Be certain that your power outlet is of the three-conductor type with the correct pin connected to earth ground.

RISQUE D'ELECTROCUTION. Le cordon d'alimentation assure la mise à la terre du châssis par l'intermédiaire d'un troisième conducteur. Vérifiez que votre prise de courant comporte trois conducteurs, la broche appropriée étant reliée à la terre.

CAUTION   The ac source must be on a dedicated line with no other devices consuming current from it.

La ac source doit se situer sur une ligne dédiée sans autre dispositif tirant du courant de celle-ci.

The line fuse is located inside the ac source. Refer to "In Case of Trouble" on page 69 of Chapter 3, "Turn-On Checkout" for instructions on fuse replacement.

Installing the power cord

The power cord supplied with the ac source may or may not include a power plug at one end of the cord. Refer to Table 1-1 for detailed information.

For Model 6811C, refer to Figure 2-2 and connect the power cord to the IEC 320 connector on the rear of the unit. If your unit does not have this connector, refer to the procedure for models 6812C and 6813C.
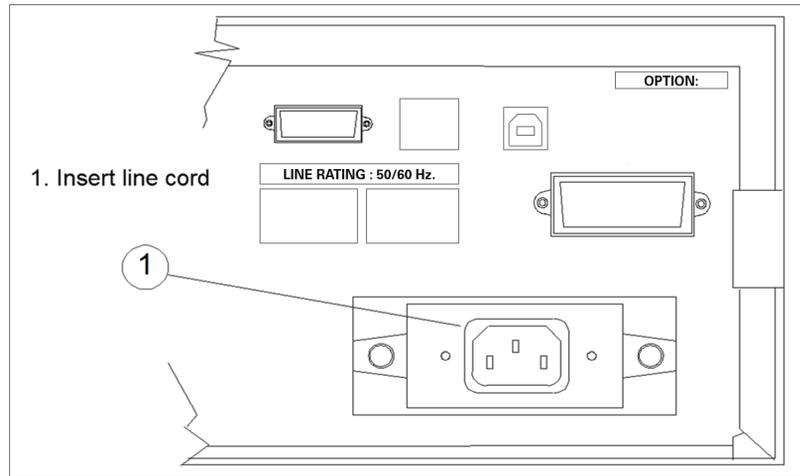
Figure 2-2   Connecting the power cord (6811C)

For Models 6812C and 6813C, refer to Figure 2-3 while performing the following procedure.

WARNING   Installation of the power cord must be done by a qualified and licensed electrician and must be in accordance with local electrical codes.

L'installation du cordon d'alimentation doit être effectuée par un électricien qualifié et agréé et doit respecter les codes électriques locaux.

1 If they are not already in place, position the strain relief connector (8), power safety cover (7), rubber boot (6) and connector nut (5) on the power cord (4).

2 Secure the ground wire (1) to the chassis earth ground stud.

3 Connect the neutral wire (3) to the N power input terminal.

4 Connect the line (2) to the L1 power input terminal.

5 Position the safety cover over the power input terminals, tighten the cover and strain relief screws.
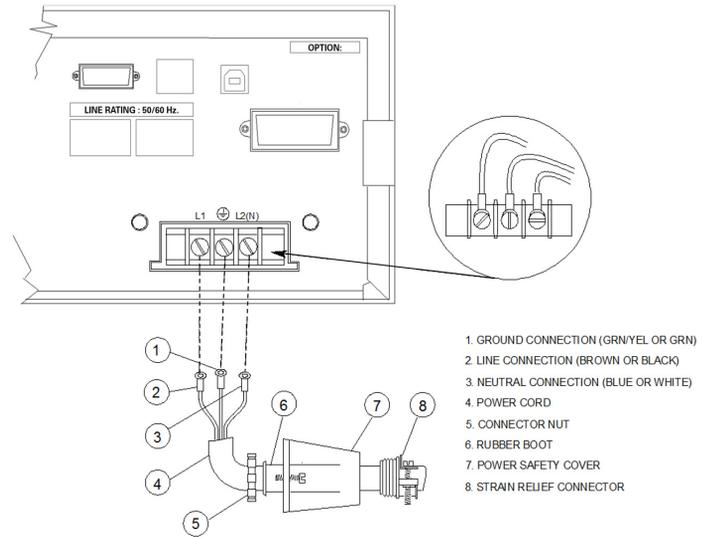
Figure 2-3   Connecting the power cord (6812C and 6813C)

Output Connections

The power output terminal block has a floating output terminal connection and a floating neutral line for the return connection. A separate earth ground terminal is located on the extreme right of the terminal block.
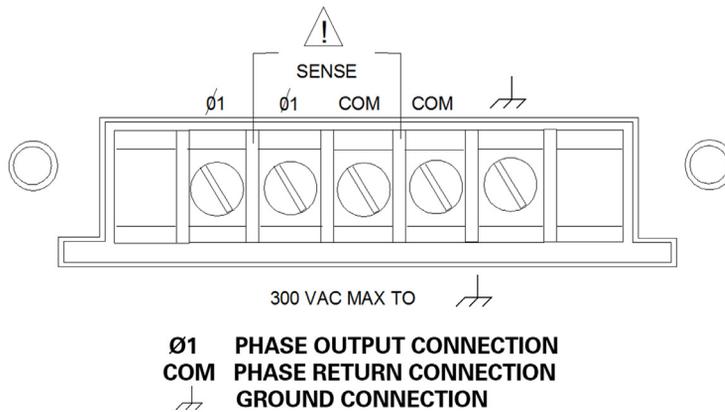
Figure 2-4   Output connections
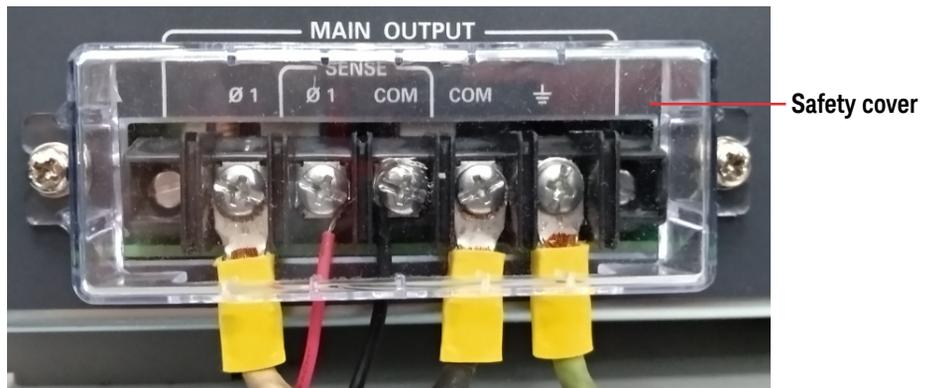
Figure 2-5   Output connections safety cover

> **WARNING** SAFETY HAZARD. You must secure the safety cover (see Figure 2-5) that was removed after completing all connections. This is because the screw terminals will be at line potential during operation.
>
> RISQUE DE SÉCURITÉ. Vous devez fixer fermement le couvercle de sécurité (voir Figure 2-5) qui a été retiré après avoir mis en place toutes les connexions. Les bornes à vis se trouveront en effet au potentiel de ligne pendant le fonctionnement.

Wire considerations

> **NOTE** To minimize the possibility of instability on the output, keep load leads as short as possible bundle or twist the leads tightly together to minimize inductance

Current ratings

> **WARNING** **FIRE HAZARD.** To satisfy safety requirements, load wires must be large enough not to overheat when carrying the maximum short-circuit current of the ac source. If there is more than one load, then any pair of load wires must be capable of safely carrying the full-rated current of the ac source.
>
> **RISQUE D'INCENDIE.** Pour répondre aux exigences en matière de sécurité, les fils de charge doivent être assez gros pour ne pas surchauffer lorsqu'ils transportent le courant de court-circuit maximal de la ac source. S'il existe plus d'une charge, alors toutes les paires de fils de charge doivent pouvoir transporter en toute sécurité le courant nominal total de la ac source.

Table 2-1 lists the characteristics of AWG (American Wire Gauge) copper wire.

Table 2-1   Ampacity and resistance of stranded copper conductors

AWG No.	Ampacity[a]	Resistance[b] (Ω/m)	AWG No.	Ampacity[a]	Resistance[b] (Ω/m)
14	25	0.0103	6	80	0.0016
12	30	0.0065	4	105	0.0010
10	40	0.0041	2	140	0.00064
8	60	0.0025	1/0	195	0.00040

[a]   Ampacity is based on 30 °C ambient temperature with conductor rated at 60 °C. For ambient temperature other than 30 °C, multiply the above ampacities by the following constants:

Temperature (°C)	Constant	Temperature (°C)	Constant
21-25	1.08	41-45	0.71
26-30	1.00	46-50	0.58
31-35	0.91	51-55	0.41
36-40	0.82		

[b]   Resistance is nominal at 75 °C wire temperature.

Voltage drops

The load wires must also be large enough to avoid excessive voltage drops due to the impedance of the wires. In general, if the wires are heavy enough to carry the maximum short circuit current without overheating, excessive voltage drops will not be a problem. Refer to Table 2-1 to calculate the voltage drop for some commonly used AWG copper wire. If load regulation becomes a problem refer to the section "Remote Sense Connections" on page 52.

Remote Sense Connections

Under normal operation, the ac source senses the output voltage at the output terminals on the back of the unit. External sense terminals are available on the **back** of the unit that allow the output voltages to be sensed at the load, compensating for impedance losses in the load wiring as shown in Figure 2-6:

– Connect the phase 1 (1) sense terminals to the side of the load that connects to the corresponding output terminal.
– Connect the Neutral (COM) sense terminal connector to the neutral side of the load.
– Twist and shield all signal wires to and from the sense connectors.

The sense leads are part of the ac source's feedback path and must be kept at a low resistance in order to maintain optimal performance. Connect the sense leads carefully so that they do not become open-circuited.

CAUTION	If the sense leads are left unconnected or become open during operation, the ac source will regulate at the output terminals, but with a 40% increase in output voltage over the programmed limit. The meter circuit cannot read back this increase in output voltage when the sense lead is disconnected.

Si les conducteurs de détection sont laissés dans l'état non connecté ou s'ils s'ouvrent pendant le fonctionnement, la ac source effectuera une régulation au niveau des bornes de sortie, mais avec une augmentation de 40 % de la tension de sortie par rapport à la limite programmée. Le circuit du compteur ne peut pas lire cette augmentation de la tension de sortie lorsque le conducteur de détection est déconnecté.

Set the ALC command to EXT (external) to enable remote sensing. The ALC command is located under the **Voltage** key as explained in Chapter 4, " Front Panel Operation". Set the ALC command to INT (internal) to disable remote sensing.

NOTE	If you are using external relays to connect and disconnect the load and sense connections, do NOT permit the sense connections to open when remote sensing is enabled. First disable remote sensing, then open the sense and load connections.
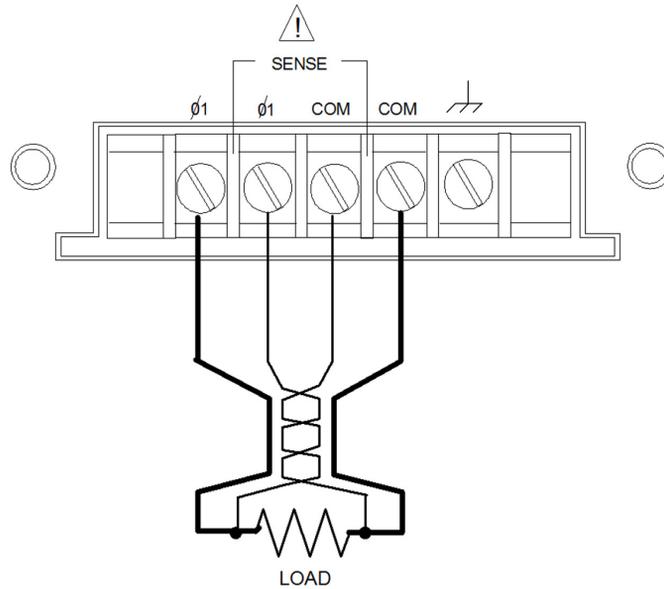
Figure 2-6   Remote sense connections

Remote sensing and overvoltage protection (OVP) considerations

In remote sensing applications, the voltage drop in the load leads subtracts from the available load voltage whereby up to 1 V_{rms} can be dropped across each load lead. As the ac source increases its output to overcome this voltage drop, the sum of the programmed voltage and the load-lead drop may exceed the ac source's maximum voltage rating. This may trip the OVP circuit, which senses the voltage at the output terminals, not at the load. When using remote sensing, you must program the OVP trip voltage high enough to compensate for the voltage drop between the output terminals and the load.

NOTE	If the load causes the peak current limit circuit to become active, voltage transitions on the output may cause unnecessary tripping of the OVP circuit.

Trigger Connections

The BNC trigger connectors on the rear panel let you apply trigger signals to the ac source as well as generate trigger signals from the ac source. The electrical characteristics of the trigger connectors are described in Appendix A, "Specifications". More information on programming external triggers is found in "Chapter 4" of the *Keysight Models 6811C, 6812C, and 6813C AC Power Solutions Programming Guide.*

Trigger IN	Allows negative-going external trigger signals to trigger the ac source.
Trigger OUT	Generates a negative-going pulse when the selected transient output has occurred.

Digital Connections

This connector, which is on the rear panel, is for connecting the fault and the inhibit signals. The fault (FLT) signal is also referred to as the DFI signal in the front panel and SCPI commands. The inhibit (INH) signal is also referred to as the RI signal in the front panel and SCPI commands.

The connector accepts wires sizes from AWG 22 to AWG 12. Disconnect the mating plug to make your wire connections. The electrical characteristics of the digital connectors are described in Appendix A, "Specifications". More information on programming the digital connectors is found in "Chapter 4" of the *Keysight Models 6811C, 6812C, and 6813C AC Power Solutions Programming Guide*.

NOTE	It is good engineering practice to twist and shield all signal wires to and from the digital connectors

The following examples (shown in Figure 2-7) show how you can connect the FLT/INH circuits of the ac source.

– In example A, the INH input connects to a switch that shorts pin + to pin ⊥, whenever it is necessary to disable output of the unit. This activates the remote inhibit (RI) circuit, which turns off the ac output. The front panel **Prot** annunciator comes on and the RI bit is set in the Questionable Status Event register. To re-enable the unit, first open the connection between pins + and ⊥, then clear the protection circuit. This can be done either from the front panel or over the GPIB, RS-232, LAN, or USB.

– In example B, the FLT output of one unit is connected to the INH input of another unit. A fault condition in one of the units will disable all of them without intervention either by the controller or external circuitry. The controller can be made aware of the fault via a service request (SRQ) generated by the Questionable Status summary bit.
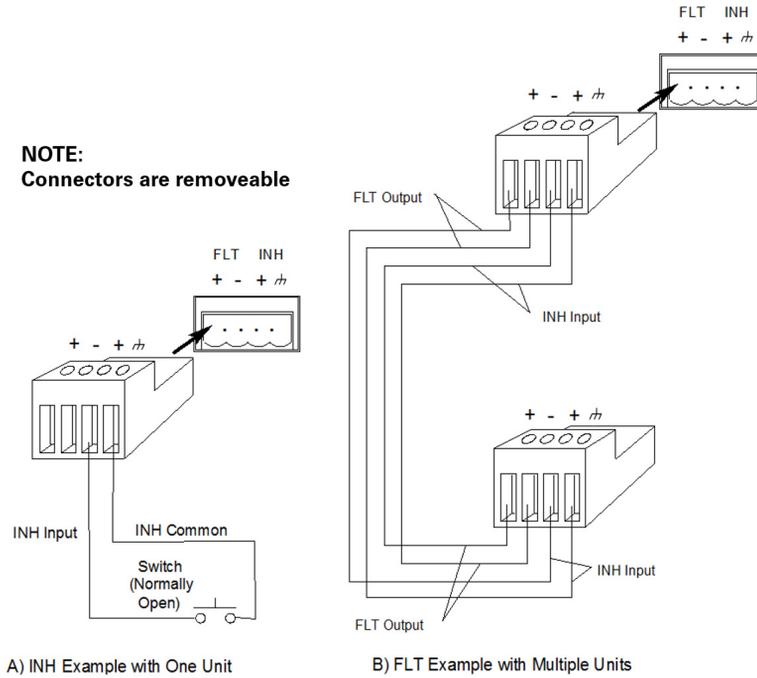
Figure 2-7   FLT/INH examples

Controller Connections

The ac source connects to a controller either through a GPIB, RS-232 connector, LAN, or USB.

GPIB connector

Each ac source has its own GPIB bus address. AC sources may be connected to the bus in series configuration, star configuration, or a combination of the two. You may connect from 1 to 15 ac sources to a controller GPIB interface.

NOTE	The ac source is shipped from the factory with its GPIB address set to 5. This address can be changed as described in "Setting the GPIB address and RS-232 parameters" on page 125 of this guide.

RS-232 interface

The ac source provides an RS-232 programming interface, which is activated by commands located under the front panel **Address** key.

RS-232 data format

- constant 11-bit data format
- one start bit
- seven data bits plus a parity bit (even or odd parity), or eight data bits without parity (parity bit is "0")
- two stop bits

You can specify one of the following baud rates: 1200, 2400, 4800, or 9600

NOTE	The ac source always uses one start bit and two stop bits regardless of the baud rate. The number of start and stop bits is not programmable.

RS-232 connector

The RS-232 connector is a DB-9, male connector. You can connect the ac source to any computer or terminal with a properly configured DB-25 connector. You can use a standard Keysight 24542G or 24542H interface cable.

Table 2-2   RS-232 connector

Pin	Input/Output	Description
1	Output	Reserved for service use
2	Input	Receive Data (RxD)
3	Output	Transmit Data (TxD)
4	Output	Data Terminal Ready (DTR)
5	Common	Signal ground
6	Input	Data Set Ready (DSR)
7	-	No connection
8	-	No connection
9	Output	Reserved for service use
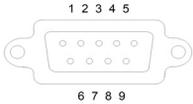
Hardware handshake

The RS-232 interface uses the data terminal ready (DTR) line as a holdoff signal to the bus controller. When DTR is true, the bus controller may send data to the ac source. When DTR goes false, the bus controller must stop sending data within 10 characters, and must not send any more data until DTR goes true again. The ac source sets DTR false under two conditions.

– When the input buffer is full (approximately 100 characters have been received), it will set DTR false. When enough characters have been removed to make space in the input buffer, DTR will be set to true, unless condition 2 (see the following) prevents this.

– When the ac source wants to "talk", which means that it has processed a query, and has seen a <newline> message terminator, it will set DTR false. This implies that once a query has been sent to the power source, the bus controller should read the response before attempting to send more data. It also means that a <newline> must terminate the command string. After the response has been output, the ac source will set DTR true again, unless condition 1 prevents this.

The ac source monitors the data set ready (DSR) line to determine when the bus controller is ready to accept data. It checks this line before each character is sent, and the output is suspended if DSR is false. When DSR goes true, transmission will resume. The ac source will leave DTR false while output is suspended. A form of deadlock exists until the bus controller asserts DSR true to allow the ac source to complete the transmission.

Control-C is the equivalent to the GPIB device clear command. It clears the operation in progress and discards any pending output. For the control-C character to be recognized by the power source while it holds DTR false, the bus controller must first set DSR false.

Null modem RS-232 interface cables swap the DTR and DSR lines as shown in the Figure 2-8. For other bus controllers or languages, you must determine what form of hardware handshake is used. You may have to build a customized cable to connect the holdoff lines as necessary. If your bus controller does not use hardware handshaking, tie the DSR input to the ac source to a signal that is always true. This implies that your bus controller must always be ready to accept data. You may want to set the baud rate to either 2400 or 4800 baud to ensure that this is true.

```
bus controller                                          ac source

      TxD (3) ────────────────╲  ╱──────────────── TxD (3)
      RxD (2) ──────────────────╳──────────────── RxD (2)

     *DTR (4) ───────────────╲  ╱──────────────── DTR (4)
     *DSR (6) ─────────────────╳──────────────── DSR (6)

   Ground (5) ──────────────────────────────── Ground (5)
```
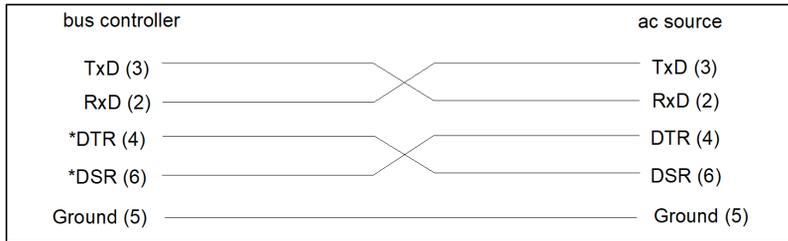
Figure 2-8   Null modem interface lines

Response data terminator

All RS-232 response data sent by the ac source is terminated by the single character <newline> which is identical to the GPIB response data as well.

3 Turn-On Checkout

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Introduction

Successful tests in this chapter provide a high degree of confidence that the ac source is operating properly. For verification tests, see Appendix B, "Verification and Calibration".

NOTE	This chapter provides a preliminary introduction to the ac source front panel. See Chapter 4, " Front Panel Operation" for more details.

Preliminary Checkout

WARNING	**LETHAL VOLTAGES.** AC sources can supply 425 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.

TENSIONS MORTELLES. Les AC source peuvent fournir 425 $V_{maximum}$ au niveau de leur sortie. Tout contact peut entraîner la MORT si les circuits ou bornes de sorties connectés à la sortie sont touchés lorsqu'ils sont sous tension.

1 If you have not already done so, connect the power cord to the ac source and plug it in.

2 Turn the front panel power switch to ON (1).

3 The ac source undergoes a self-test when you turn it on. The following items appear on the display:

   a A brief pattern that lights all display segments, followed by the model number and the software revision number.

   b The display then goes into the meter mode with the **Dis** annunciator on, and all others off. "Meter mode" means that the VOLTS digits indicate the output voltage and the FREQ digits indicate the output frequency. The voltage will be at or near zero and the frequency will be at 60 Hertz.

NOTE	If the ac source detects an error during self-test, the **Err** annunciator on the display will be lit. Pressing the [Shift] and [Error] keys will show the error number. Refer to "In Case of Trouble" on page 69 at the end of this chapter.

4 Check that the ac source fan is on. You should be able to hear the fan and feel the air coming from the unit.

5 Press **[Output On/Off]** once. The **Dis** annunciator will go off and the **CV** annunciator will go on.

6 Turn the unit off.

Using the Keypad

Some of the front panel keys perform two functions, one labeled in white and the other in blue. You access the blue function by first pressing the blue **[Shift]** key. Release the key after you press it. The **Shift** annunciator will be on, indicating that you have access to any key's shifted function.

These function keys let you scroll up and down through the choices in the presently selected function menu. All menu lists are circular; you can return to the starting position by continuously pressing either key.

These entry keys let you select the previous or the next parameter for a specific command. If the command has a numeric range, these keys increment or decrement the existing value.

The backspace key is an erase key. If you make a mistake entering a digit and have not yet pressed **[Enter]**, you can delete the digit by pressing this key. Delete more digits by repeatedly pressing this key.

Executes the entered value or parameter of the presently accessed command. Until you press this key, the parameters you enter with the other keys are displayed but not entered into the ac source. After pressing **[Enter]**, the ac source returns to Meter mode in most cases. In Harmonic or List mode, the ac source displays the next point in the list.

Checkout Procedure

<table>
<tr><td>

WARNING

</td><td>

LETHAL VOLTAGES. AC sources can supply 425 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.

The output test requires that you connect light bulbs to the output of the unit and apply a potentially hazardous voltage of 120 VAC. Properly shield all connections and wires.

TENSIONS MORTELLES. Les AC source peuvent fournir 425 $V_{maximum}$ au niveau de leur sortie. Tout contact peut entraîner la MORT si les circuits ou bornes de sorties connectés à la sortie sont touchés lorsqu'ils sont sous tension.

Le test de sortie nécessite de connecter des ampoules à la sortie de l'unité et d'appliquer une tension potentiellement dangereuse de 120 VAC. Protégez correctement toutes les connexions et tous les fils.

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</table>

The test in this section checks for output voltage and current on the ac source by having you connect light bulbs to the output of the unit. The following equipment is recommended for performing this output checkout procedure:

– One (1) 100 W light bulb
– One (1) light bulb socket
– Wires for connecting socket to the unit

<table>
<tr><td>

NOTE

</td><td>

When the ac source is turned on as shipped from the factory, it asserts the *RST state. You can subsequently program the unit to turn on according to the state stored in *RCL location 0, as explained in "System Keys" on page 78 of Chapter 4, " Front Panel Operation". The following procedures assume that the unit turns on in the *RST state.

</td></tr>
</table>

Make sure that the unit is turned off, and make the following connections to the output.
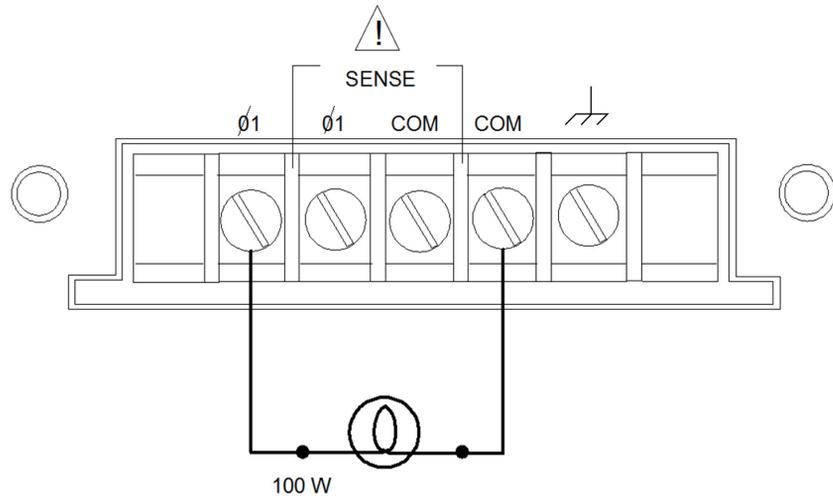
Figure 3-1   Verification connections

	Procedure	Display	Explanation
1	Turn the unit on.	Meter mode	Meter mode is active and the **Dis** annunciator should be on.
2	Press the **Voltage** key.	VOLT 0.00	Display indicates the default settings.
3	Press **[1]**, **[2]**, **[0]**, **[Enter]**.	VOLT 120	Programs the output voltage to 120 V_{rms}. After the value is entered, the display returns to Meter mode, which indicates that no voltage is applied to the output.
4	Press **[Output On/Off]**.	120 V 60 Hz	Turns the output on and applies 120 volts to the light bulb. The **Dis** annunciator should be off and **CV** should be on.

	Procedure	Display	Explanation
5	Press **[Protect]**. Scroll to VOLT:PROT ON/OFF by pressing ▲ or ▼ of the **Function** key group. Select ON by pressing ▲ or ▼ of the **Entry** key group. Press **[Enter]**.	VOLT:PROT ON	You have enabled the overvoltage protection circuit.
6	Press **[Protect]**. Scroll to VOLT:PROT by pressing ▲ or ▼ of the **Function** key group.	VOLT:PROT 500	Display shows the overvoltage protection trip voltage for your unit. The overvoltage protection voltage is programmed in *peak*, not rms volts.
7	Press **[1]**, **[6]**, **[0]**, **[Enter]**.	VOLT:PROT 160	Programs the OVP to 160 Vpeak, the rms value of which is less than the previously set rms voltage.
		0 V 60 Hz	Because the peak OVP voltage entered was less than the rms output voltage, the OVP circuit tripped. The output dropped to zero, **CV** turned off, and **Prot** turned on.
8	Press **[Protect]**. Scroll to VOLT:PROT by pressing ▲ or ▼ of the Function key group. Press **[3]**, **[2]**, **[0]**, **[Enter]**.	VOLT:PROT 320	Programs the OVP to a peak value that is greater than the rms output voltage value. **Note:** You cannot clear an OVP trip until you have first removed the cause of the condition.
9	Press **[Protect]** and **[Enter]**.	120 V 60 Hz	Executes the PROT:CLEAR command, restoring the output. **Prot** turns off and **CV** turns on.
10	Press **[Shift]** and **[Current]**.	CURR:LEV 5	Indicates the default output current limit setting.
11	Press **[.]**, **[5]**, **[Enter]**.	CURR:LEV .5	Sets the current limit to 0.5 amperes. The **CC** annunciator is on, indicating that the unit is in current limit mode and the light bulbs are dimmer because the output voltage has dropped in its attempt to limit output current.
12	Press **[Protect]**. Scroll to CURR:PROT ON/OFF by pressing ▲ or ▼ of the **Function** key group. Select ON by pressing ▲ or ▼ of the **Entry** key group. Press **[Enter]**.	CURR:PROT ON	You have enabled the overcurrent protection circuit. The circuit then tripped because of the output short. The **CC** annunciator turns off and the **OCP** and **Prot** annunciators come on. The output current is near zero.

	Procedure	Display	Explanation
13	Press **[Output On/Off]**.	0.5 V 60 Hz	The output is off and the **Dis** annunciator turns on.
14	Press **[Protect]**. Scroll to CURR:PROT ON/OFF by pressing ▲ or ▼ of the **Function** key group. Select OFF by pressing ▲ or ▼ of the **Entry** key group. Press **[Enter]**.	CURR:PROT OFF	You have disabled the overcurrent protection circuit. The **Prot** annunciator turns off.
15	Turn the unit off.		The next time the unit turns on it will be restored to the *RST or factory default state

In Case of Trouble

Error messages

AC source failure may occur during power-on start-up, self-test, or during operation. In either case, the display may show an error message that indicates the reason for the failure.

Start-up errors

If start-up error messages appear on the front panel display when you turn on the ac source, the ac source requires service.

Table 3-1   Power-on start-up errors

Error no.	Error message on the front panel display	Description
Err 60	ERR FPGA ID	FPGA JTAG error
Err 61	ERR FPGA IMAGE	FPGA image invalid
Err 62	ERR FPGA VER.	Model detection FPGA version invalid
Err 63	ERR VOLT RAIL	Analogue voltage rail failed
Err 64	ERR MODEL BIT	Model detection FPGA model bit invalid
Err 65	ERR CHECKSUM	Model detection EEPROM model checksum failed
Err 66	ERR MISMATCH	Model detection between FPGA and EEPROM incompatible
Err 67	ERR EEPROM VER.	EEPROM version is higher than expected

Self-test errors

Pressing the [Shift] and **[Error]** keys will show the error number. Self-test error messages appear as:

ERROR <n>, where "n" is a number listed in the following table. If this occurs, turn the power off and then back on to see if the error persists. If the error message persists, the ac source requires service.

Table 3-2   Power-on self-test errors

Error no.	Failed test
Err 0	No error
Err 1	Non-volatile RAM RDO section checksum failed
Err 2	Non-volatile RAM CONFIG section checksum failed
Err 3	Non-volatile RAM CAL section checksum failed
Err 4	Non-volatile RAM WAVEFORM section checksum failed
Err 5	Non-volatile RAM STATE section checksum failed
Err 6	Non-volatile RAM LIST section checksum failed
Err 10	RAM self-test
Err 11 to Err 31	DAC self-test 1 to 21
Err 90	Non-volatile RAM IO DATA section checksum failed
Err 91	Non-volatile RAM ROM VERS checksum failed
Err 92	Non-volatile RAM SERIAL section checksum failed
Err 93	Non-volatile RAM MAC ADDR section checksum failed
Err 94	Non-volatile RAM LAN section checksum failed
Err 95	Non-volatile RAM HTTP section checksum failed
Err 96	Non-volatile RAM PERSONA section checksum failed
Err 97	Non-volatile RAM CAL INFO section checksum failed

Runtime error messages

Under unusual operating conditions, the front panel display may show **OVLD**. This indicates that the output voltage or current is beyond the range of the meter readback circuit. If the front panel display indicates **-- -- -- -- -- --**, a GPIB measurement is in progress. Appendix C, "Error Messages" lists other error messages that may appear at runtime.

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4 Front Panel Operation

KEYSIGHT
TECHNOLOGIES

Introduction

This chapter lists the following:

– A complete description of the front panel controls.

– Front panel programming examples that describes how to perform the following:

  – Access ac source information.

  – Program the output voltage and frequency.

  – Measure the output.

  – Program the output pulses and lists.

  – Trigger output changes.

  – Configure LAN connection.

Front Panel Description
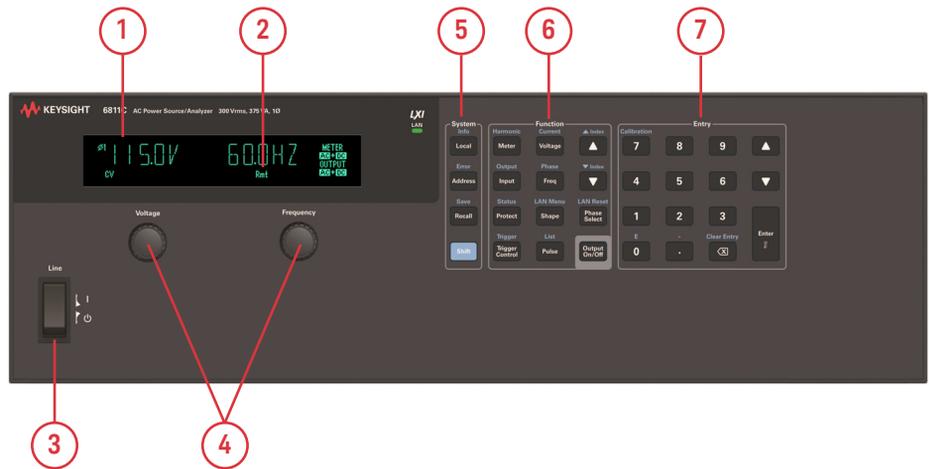
Figure 4-1   Front panel - overall view

| **1** | **Display** | 14-character vacuum fluorescent display for showing programmed commands and measured values. |
| **2** | **Annunciators** | Annunciators light to indicate the following operating modes and status conditions: |

	$\phi1$	Phase 1 is being controlled or metered.
	CV	The ac source output is in constant-voltage mode.
	CC	The ac source output is in constant-current mode.
	Unr	The ac source output is in an unregulated state.
	Dis	The ac source output is disabled (off).
	Tran	The ac source output is initialized to output a transient.
	OCP	The overcurrent protection state is enabled.
	Prot	One of the ac source's output protection features is activated.
	Cal	The ac source is in calibration mode.
	Shift	The Shift key is pressed to access an alternate key function.
	Rmt	The selected interface (GPIB or RS-232) is in a remote state.
	Addr	The interface is addressed to talk or to listen.
	Err	There is a message in the SCPI error queue.
	SRQ	The interface is requesting service from the controller.
	Meter AC+DC	Front panel measurement functions are: AC only, DC only, or AC+DC.
	Output AC+DC	The ac source output coupling is: AC only, or AC+DC

| **3** | **Line** | This turns the ac source on or off. |
| **4** | **Voltage/ Frequency** | The rotary pulse generators let you set the output voltage and frequency when the ac source is in local mode. Their response is rate sensitive. |

– Turning a control rapidly provides coarse control of the value.

– Turning a control slowly provides fine control of the value.

5 **System keys**   The system keys let you:

– Display ac source information

– Return to Local mode (front panel control)

– Set the ac source GPIB address

– Set the RS-232 interface communication baud rate and parity bit

– Display SCPI error codes and clear the error queue

– Save and recall up to 16 instrument operating configurations

6 **Function keys**   Function access command menus that let you:

– Program output voltage, current limit, frequency, and output waveforms

– Turn the output on and off

– Select metering functions

– Send immediate triggers from the front panel

– Program transient output functions

– Set and clear protection functions

– Select output phases

– Select the coupling for output and meter functions

– Monitor instrument status

– Configure LAN connection

– Perform LAN reset

7 **Entry keys**   Entry keys let you:

– Enter programming values

– Increment or decrement programming values

– Calibrate the ac source

System Keys

Refer to the examples later in this chapter for more details on the use of these keys.
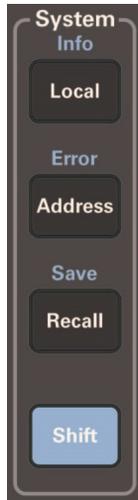
Figure 4-2   System keys

Shift	Press this key to access the alternate or shifted function of a key as indicated in the blue text (such as ERROR). Release the key after you press it. The **Shift** annunciator is lit, indicating that the shifted keys are active.
Local	Press to change the ac source's selected interface from remote operation to local (front panel) operation. Pressing the key will have no effect if the interface state is already Local, Local-with-Lockout, or Remote-with-Lockout.

Press to access the system address menu. This menu lets you configure the ac source's interface. Address Menu entries are stored in non-volatile memory.

Display	Command function
ADDRESS ‹value›	Sets the GPIB Address
BAUDRATE ‹value›	Selects baud rate (1200, 2400, 4800, 9600)
PARITY ‹char›	Message parity (NONE, EVEN, ODD, MARK, SPACE)

‹value› = a numeric value

‹char› = a character string parameter

Press ▲ and ▼ of the **Function** key group to scroll through the command list.

Press ▲ and ▼ of the **Entry** key group to scroll through the parameter list.

Press to place the ac source into a previously stored state. You can recall up to 16 (0 through 15) previously stored states.

Press to display the ac source's instrument information.

Display	Information
MODEL: ‹char›	Instrument model name
OPTION: ‹char›	Instrument option
SERIAL NO.: ‹enter›‹char›	Instrument serial number
FW REV: ‹enter›‹char›	Instrument firmware revision
MAC: ‹enter›‹char›	Instrument MAC address
USB VID: ‹char›	Instrument USB vendor ID
USB PID: ‹char›	Instrument USB product ID

‹enter› = press the [Enter] key to display information.

Shift	Error / **Address**	Press to display the system error codes stored in the SCPI error queue. This action also clears the queue. If there is no error in the queue, 0 is displayed.
Shift	Save / **Recall**	Press to store an existing ac source state in non-volatile memory. The parameters saved are listed under *SAV in the *Keysight Models 6811C, 6812C, and 6813C AC Power Solutions Programming Guide*. You can save up to 16 states (0 through 15).

Function Keys

Refer to the examples later in this chapter for more details on the use of these keys.

Figure 4-3   Function keys

Immediate action keys

Immediate action keys immediately execute their corresponding function when pressed. Other function keys have commands underneath them that are accessed when the key is pressed.

This key toggles the output of the ac source between the on and off states. It immediately executes its function as soon as you press it. When off, the ac source output is disabled and the **Dis** annunciator is on.

This key only applies to three-phase ac sources.

Sends an immediate trigger to the ac source.

Scrolling keys

Scrolling keys let you move through the commands in the presently selected function menu.

(**Function** keys)   These **Function** keys let you move through the choices in a command list. Press ▲ to bring up the next command in the list. Press ▼ to go back to the previous command in the list. Function menus are circular; you can return to the starting position by continuously pressing either key.

(**Function** keys)   These shifted **Function** keys apply only to the Harmonic and List functions. Press these keys to step through integers 0 through 50 when specifying the   desired harmonic number, or 0 through 99 when specifying the desired list point. Hold down these keys to rapidly access any harmonic or list point.

(**Entry** keys)   These **Entry** keys let you scroll through choices in a **parameter** list that apply to a specific command. Parameter lists are circular; you can return to the starting position by continuously pressing either key. If the command has a numeric range, these keys increment or decrement the existing value.

LAN control keys

LAN control keys control the LAN functions of the ac source.

| NOTE | If ✳ is displayed, press **[Enter]** to display the information for the command or save the command settings. |

If △ and ▽ are displayed use ▲ or ▼ of the **Function** keys or **Entry** keys to scroll up or down to display the information.

Function key press	Function command on the front panel display	Entry key press	Description
Shift / **Shape** (LAN Menu) Use ▲ or ▼ to navigate between the **LAN Menu** function commands.	LAN STATUS: ‹✳›‹info›	Press **[Enter]** to display the information for command with ‹✳› symbol.	Display LAN connectivity status.
	DHCP: ON | OFF	Use ▲ or ▼ to navigate between ON | OFF. Press **[Enter]** to save.	Set DHCP for LAN.
	AUTO DNS: ON | OFF	Use ▲ or ▼ to navigate between ON | OFF. Press **[Enter]** to save.	Set auto DNS for LAN.
	MDNS: ON | OFF	Use ▲ or ▼ to navigate between ON | OFF. Press **[Enter]** to save.	Set MDNS for LAN.
	IP: ‹✳›‹info›	Press **[Enter]** to display the information for command with ‹✳› symbol.	Display IP address.
	SUBNET: ‹✳›‹info›	Press **[Enter]** to display the information for command with ‹✳› symbol.	Display subnet address.
	GATEWAY: ‹✳›‹info›	Press **[Enter]** to display the information for command with ‹✳› symbol.	Display gateway address.

Function key press	Function command on the front panel display	Entry key press	Description
Shift / Shape (LAN Menu) Use ▲ or ▼ to navigate between the **LAN Menu** function commands.	DNS 1: ‹✳›‹info›	Press **[Enter]** to display the information for command with ‹✳› symbol.	Display DNS1 address.
	DNS 2: ‹✳›‹info›	Press **[Enter]** to display the information for command with ‹✳› symbol.	Display DNS2 address.
	HOSTNAME: ‹✳›‹info›	Press **[Enter]** to display the information for command with ‹✳› symbol.	Display ac source hostname.
	DOMAIN NAME: ‹✳›‹info›	Press **[Enter]** to display the information for command with ‹✳› symbol.	Display ac source domain name.
	IP CONF: ‹✳›‹value›	Press **[Enter]** then use keypad to key in an exact value.	Configure IP address only when DHCP is OFF.
	SUBNET CONF: ‹✳›‹value›	Press **[Enter]** then use keypad to key in an exact value.	Configure Subnet address only when DHCP is OFF.
	GATEWAY CONF: ‹✳›‹value›	Press **[Enter]** then use keypad to key in an exact value.	Configure Subnet address only when DHCP is OFF.
	DNS 1 CONF: ‹✳›‹value›	Press **[Enter]** then use keypad to key in an exact value.	Configure DNS 1 address only when AUTO DNS is OFF.
	DNS 2 CONF: ‹✳›‹value›	Press **[Enter]** then use keypad to key in an exact value.	Configure DNS 2 address only when AUTO DNS is OFF.
	UPDATE? YES | NO	Use ▲ or ▼ to navigate between YES | NO. Press **[Enter]** to execute.	Update the configuration.
Shift / Phase Select (LAN Reset)	CONFIRM? YES | NO	Use ▲ or ▼ to navigate between YES | NO. Press **[Enter]** to execute.	Reset the LAN configuration to factory default conditions.

Meter display keys

Metering keys control the metering functions of the ac source.

<table>
<tr>
<td>NOTE</td>
<td>If ☀ is displayed, press [Enter] to display the information for the command or save the command settings.

If ⬜ and ⬜ are displayed use ▲ or ▼ of the Function keys or Entry keys to scroll up or down to display the information.</td>
</tr>
</table>

Function key press	Function command on the front panel display	Entry key press	Description
Harmonic **Meter** Use ▲ or ▼ to navigate between the **Meter** function commands.	\<reading\> V \<reading\> Hz	-	Display rms voltage and frequency.
	\<reading\> V \<reading\> A	-	Display rms voltage and rms current.
	\<reading\> A \<reading\> Hz	-	Display rms current and frequency.
	\<reading\> V \<reading\> W	-	Display rms voltage and power.
	\<reading\> CREST F	-	Display current crest factor.
	\<reading\> A PK REP	-	Display peak current, repetitive.
	\<reading\> A PK NR	-	Display peak current, non-repetitive.
	\<reading\> VA	-	Display apparent power.
	\<reading\> VAR	-	Display reactive power.
	\<reading\> PFACTOR	-	Display power factor.
Output **Input** Use ▲ or ▼ to navigate between the **Input** function commands.	INP:COUP AC | DC | ACDC	Use ▲ or ▼ to navigate between AC | DC | ACDC. Press **[Enter]** to save.	Select meter coupling.
	CURR:RANGE HIGH | LOW	Use ▲ or ▼ to navigate between HIGH | LOW. Press **[Enter]** to save.	Select current measurement range.
	WINDOW KBESSEL | RECT	Use ▲ or ▼ to navigate between KBESSEL | RECT. Press **[Enter]** to save.	Select harmonic measurement window meter.

Function key press	Function command on the front panel display	Entry key press	Description
[Shift] [Meter] (Harmonic) Use ▲ or ▼ to navigate between the **Harmonic** function commands. Press **[Shift]** then ▲ or ▼ to increment or decrement the index of the **Harmonic** function commands.	\<reading\> A　I:MAG: \<index\>	-	Display current harmonic magnitude.
	\<reading\>°　I:PHASE: \<index\>	-	Display current harmonic phase.
	\<reading\> V　V:MAG: \<index\>	-	Display voltage harmonic magnitude.
	\<reading\>°　V:PHASE: \<index\>	-	Display voltage harmonic phase.
	\<reading\> CURR:THD	-	Display current total % harmonic distortion.
	\<reading\> VOLT:THD	-	Display voltage total % harmonic distortion.

Output control keys

Output control keys control the output functions of the ac source.

| NOTE | If ☀ is displayed, press **[Enter]** to display the information for the command or save the command settings. |

If △ and ▽ are displayed use ▲ or ▼ of the **Function** keys or **Entry** keys to scroll up or down to display the information.

Function key press	Function command on the front panel display	Entry key press	Description
Current **Voltage** Use ▲ or ▼ to navigate between the **Voltage** function commands.	VOLT <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set immediate AC output voltage.
	VOLT:T <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set triggered output voltage.
	VOLT:M FIXED | LIST | PULSE | STEP	Use ▲ or ▼ to navigate between FIXED | LIST | PULSE | STEP. Press **[Enter]** to save.	Select the voltage mode.
	OFFSET <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set immediate DC offset voltage.

Function key press	Function command on the front panel display	Entry key press	Description
Current **Voltage** Use ▲ or ▼ to navigate between the **Voltage** function commands.	OFFSET:T <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set triggered DC offset voltage.
	OFFSET:M FIXED | LIST | PULSE | STEP	Use ▲ or ▼ to navigate between FIXED | LIST | PULSE | STEP. Press **[Enter]** to save.	Select the DC offset voltage mode.
	SLEW <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set voltage slew in V/sec.
	SLEW:T <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set triggered voltage slew in V/sec.
	SLEW:M FIXED | LIST | PULSE | STEP	Use ▲ or ▼ to navigate between FIXED | LIST | PULSE | STEP. Press **[Enter]** to save.	Select the voltage slew mode
	OFF:SLW <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set DC offset slew in V/sec.
	OFF:SLW:T <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set triggered DC offset slew in V/sec.
	OFF:SLW:M FIXED | LIST | PULSE | STEP	Use ▲ or ▼ to navigate between FIXED | LIST | PULSE | STEP. Press **[Enter]** to save.	Select the voltage slew mode.

Function key press	Function command on the front panel display	Entry key press	Description
Current / **Voltage** Use ▲ or ▼ to navigate between the **Voltage** function commands.	ALC INT | EXT	Use ▲ or ▼ to navigate between INT | EXT. Press **[Enter]** to save.	Select the voltage sense source.
	ALC:DET RTIME | RMS	Use ▲ or ▼ to navigate between RTIME | RMS. Press **[Enter]** to save.	Select the voltage sense detector.
Shift **Current** / **Voltage** Use ▲ or ▼ to navigate between the **Current** function commands.	CURR:LEV ‹value›	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set immediate rms current limit.
	CURR:PEAK ‹value›	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set immediate peak current limit.
	CURR:PEAK:T ‹value›	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set triggered peak current limit.
	CURR:PEAK:M FIXED | LIST | PULSE | STEP	Use ▲ or ▼ to navigate between FIXED | LIST | PULSE | STEP. Press **[Enter]** to save.	Select the peak current limit mode.

Function key press	Function command on the front panel display	Entry key press	Description
Phase **Freq** Use ▲ or ▼ to navigate between the **Freq** function commands.	FREQ <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set immediate output frequency.
	FREQ:T <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set triggered output frequency.
	FREQ:M FIXED | LIST | PULSE | STEP	Use ▲ or ▼ to navigate between FIXED | LIST | PULSE | STEP. Press **[Enter]** to save.	Select the frequency mode.
	SLEW <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set frequency slew in Hz/sec.
	SLEW:T <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set triggered frequency slew Hz/sec.
	SLEW:M FIXED | LIST | PULSE | STEP	Use ▲ or ▼ to navigate between FIXED | LIST | PULSE | STEP. Press **[Enter]** to save.	Select the frequency slew mode.

Function key press	Function command on the front panel display	Entry key press	Description
Shift **Phase** **Freq** Use ▲ or ▼ to navigate between the **Phase** function commands.	PHASE <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set immediate output phase.
	PHASE:T <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set triggered output phase.
	PHASE:M FIXED | LIST | PULSE | STEP	Use ▲ or ▼ to navigate between FIXED | LIST | PULSE | STEP. Press **[Enter]** to save.	Select the phase mode.
LAN Menu **Shape** Use ▲ or ▼ to navigate between the **Shape** function commands.	SHAPE SINE | SQUARE | CSIN | <user>	Use ▲ or ▼ to navigate between SINE | SQUARE | CSIN | <user>. Press **[Enter]** to save.	Set immediate waveform shape.
	SHAPE:T SINE | SQUARE | CSIN | <user>	Use ▲ or ▼ to navigate between SINE | SQUARE | CSIN | <user>. Press **[Enter]** to save.	Set triggered waveform shape.
	SHAPE:M FIXED | LIST | PULSE | STEP	Use ▲ or ▼ to navigate between FIXED | LIST | PULSE | STEP. Press **[Enter]** to save.	Set waveform shape mode.
	CLIP <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set clipping level.

Function key press	Function command on the front panel display	Entry key press	Description
List **Pulse** Use ▲ or ▼ to navigate between the **Pulse** function commands.	WIDTH <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set the pulse width.
	COUNT <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set the number of output pulses.
	DCYCLE <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set the pulse duty cycle.
	PER <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set the pulse period count.
	HOLD WIDTH	DCYCLE	Use ▲ or ▼ to navigate between WIDTH	DCYCLE. Press **[Enter]** to save.	Set parameter that is held constant.
Shift **Output** **Input** Use ▲ or ▼ to navigate between the **Output** function commands.	OUTP:COUP AC	DC	Use ▲ or ▼ to navigate between AC	DC. Press **[Enter]** to save.	Select output coupling.
	☀ RST	Press **[Enter]** to execute.	Execute the *RST command.
	TTLT:SOUR BOT	EOT	LIST	Use ▲ or ▼ to navigate between BOT	EOT	LIST. Press **[Enter]** to save.	Select trigger out source coupling.
	TTLT:STATE ON	OFF	Use ▲ or ▼ to navigate between ON	OFF. Press **[Enter]** to save.	Set trigger out state.

Function key press	Function command on the front panel display	Entry key press	Description
Use ▲ or ▼ to navigate between the **Output** function commands.	IMP:STATE ON | OFF	Use ▲ or ▼ to navigate between ON | OFF. Press **[Enter]** to save.	Set output impedance programming.
	IMP:REAL ‹value›	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set real part of output impedance.
	IMP:REAC ‹value›	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set reactive part of output impedance.
	PON:STATE RST | RCL0	Use ▲ or ▼ to navigate between RST | RCL0. Press **[Enter]** to save.	Select power-on state command.
	RI LATCHING | OFF | LIVE	Use ▲ or ▼ to navigate between LATCHING | OFF | LIVE. Press **[Enter]** to save.	Set remote inhibit mode.
	DFI ON | OFF	Use ▲ or ▼ to navigate between ON | OFF. Press **[Enter]** to save.	Set discrete fault indicator state.
	DFI:SOUR QUES | OPER | ESB | RQS | OFF	Use ▲ or ▼ to navigate between QUES | OPER | ESB | RQS | OFF. Press **[Enter]** to save.	Select the DFI source.

Protection and status control keys

The Protect and Status keys control the protection functions and status registers of the ac source. Refer to "Chapter 4" of the *Keysight Models 6811C, 6812C, and 6813CAC Power Solutions Programming Guide* for more information on the status registers.

NOTE	If ☀ is displayed, press **[Enter]** to display the information for the command or save the command settings.

If △ and ▽ are displayed use ▲ or ▼ of the **Function** keys or **Entry** keys to scroll up or down to display the information.

Function key press	Function command on the front panel display	Entry key press	Description
Status **Protect** Use ▲ or ▼ to navigate between the **Protect** function commands.	PROT:CLEAR	Press **[Enter]** to execute.	Clear latched protection signal.
	CURR:PROT ON | OFF	Use ▲ or ▼ to navigate between ON | OFF. Press **[Enter]** to save.	Set overcurrent protection function.
	VOLT:PROT ON | OFF	Use ▲ or ▼ to navigate between ON | OFF. Press **[Enter]** to save.	Set overvoltage protection function.
	VOLT:PROT <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set overvoltage protection level.
	DELAY <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set a time delay for activating a protection fault.

Function key press	Function command on the front panel display	Entry key press	Description
Shift / **Status Protect** Use ▲ or ▼ to navigate between the **Status** function commands.	✳ CLS	Press **[Enter]** to execute.	Execute the *CLS command.
	STATUS:PRESET	Press **[Enter]** to execute.	Execute STATus:PRESet command.
	✳ ESR? <value>	Press **[Enter]** to display the information for the command.	Return event status register value.
	✳ STB <value>	-	Return status byte register value.
	OPER:EVEN? <value>	Press **[Enter]** to display the information for the command.	Return STAT:OPER:EVENT? value.
	OPER:COND <value>	-	Return STAT:OPER:COND? value.
	QUES:EVEN? <value>	Press **[Enter]** to display the information for the command.	Return STAT:QUES:EVENT? value.
	QUES:COND <value>	-	Return STAT:QUES:COND? value.

Trigger and list control keys

The Trigger Control key controls output transient triggers. The List key controls the generation of output lists. A list can contain up to 100 points, each of which can specify an output change (or transient). Refer to "Chapter 4" of the *Keysight Models 6811C, 6812C, and 6813CAC Power Solutions Programming Guide* for more information about programming triggers and lists.

NOTE	If ✳ is displayed, press **[Enter]** to display the information for the command or save the command settings.

If △ and ▽ are displayed use ▲ or ▼ of the **Function** keys or **Entry** keys to scroll up or down to display the information.

Function key press	Function command on the front panel display	Entry key press	Description
Trigger Trigger Control Use ▲ or ▼ to navigate between the **Trigger Control** function commands.	INIT:IMMED	Press **[Enter]** to execute.	Initiate trigger immediately.
	INIT:CONT ON | OFF	Use ▲ or ▼ to navigate between ON | OFF. Press **[Enter]** to save.	Initiate trigger continuously.
	TRIG:SOUR BUS | IMM | TTLT | EXT	Use ▲ or ▼ to navigate between BUS | IMM | TTLT | EXT . Press **[Enter]** to save.	Select transient trigger source.
	DELAY <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set trigger delay in seconds.
	ABORT	Press **[Enter]** to execute.	Abort all trigger sequences.
	SYNC:SOUR PHASE | IMM	Use ▲ or ▼ to navigate between PHASE | IMM. Press **[Enter]** to save.	Select synchronous trigger source.
	SYNC:PHASE <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set synchronous phase reference.

Function key press	Function command on the front panel display	Entry key press	Description
Shift **List** **Pulse** Use ▲ or ▼ to navigate between the **List** function commands. Press **[Shift]** then ▲ or ▼ to increment or decrement the index of the **List** function commands.	COUNT <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set the number of times a list repeats.
	DWEL: <index> <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set the list of output dwell times.
	FREQ: <index> <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set the list of output frequencies.
	FSLW: <index> <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set the list of output frequency slew rates.
	IPK: <index> <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set the list of output peak current limits.
	OFFS: <index> <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set the list of DC output voltages.

Function key press	Function command on the front panel display	Entry key press	Description
Shift **List** **Pulse** Use ▲ or ▼ to navigate between the **List** function commands. Press **[Shift]** then ▲ or ▼ to increment or decrement the index of the **List** function commands.	OSLW: <index> <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set the list of DC offset voltage slew rate.
	PHASE: <index> <value>	Use the keypad to key in an exact value, alternatively use ▲ to increment or ▼ to decrement. Press **[Enter]** to save.	Set the list of output voltage phase angles.

Entry Keys

Refer to the examples later in this chapter for more details on the use of these keys.

Figure 4-4   Entry Keys

These **Entry** keys let you scroll through choices in a **parameter** list that apply to a specific command. Parameter lists are circular; you can return to the starting position by continuously pressing either key. If the command has a numeric range, these keys increment or decrement the existing value.
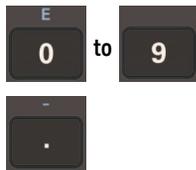
[0] through **[9]** are used for entering numeric values.

[.] is the decimal point.

For example, to enter 33.6, press: **[3] [3] [.] [6] [Enter]**.

The backspace key deletes the last digit entered from the keypad. This key lets you correct one or more wrong digits before they are entered.

This key executes the entered value or parameter of the presently accessed command.

Until you press this key, the parameters you enter with the other **Entry** keys are displayed but not entered into the ac source.

- Before pressing **[Enter]** you can change or abort anything previously entered into the display.

- After **[Enter]** is pressed, the ac source returns to Meter mode in most cases. In Harmonic or List mode, the ac source displays the next point in the list.

This key specifies an exponential power of 10. For example, the value for 100 µs can be entered as either **[.] [0] [0] [0] [1]**, or as **[1] [E] [–] [4]**.

This key, **[–]**, is the minus sign.

This key aborts a keypad entry by clearing the value. This key is convenient for correcting a wrong value or aborting a value entry. The display then returns to the previously set function. When editing a list, pressing **[Clear Entry]** truncates or clears the list at the presently displayed list point.

This key accesses the calibration menu (Refer to Appendix B, "Verification and Calibration" to calibrate your ac source).

Examples of Front Panel Programming

You will find these examples on the following pages:

The examples in the *Keysight Models 6811C, 6812C, and 6813C AC Power Solutions Programming Guide* are similar to the ones in this section, except that they use SCPI commands.

1 Setting the output voltage amplitude

<table>
<tr><td>NOTE</td><td>The maximum voltage that the ac source can output is limited by the peak value of the waveform, which is 425 V_{peak}. Since the output is programmed in units of rms volts, the maximum value that can be programmed is dependent on the peak-to-rms ratio of the selected waveform. For a sinewave, the maximum ac voltage that can be programmed is 300 V_{rms}. For other waveforms the maximum may be different.</td></tr>
</table>

When you turn on the ac source, the default output shape is a 60 Hz sinewave at 0 V_{rms}. There is no output from the ac source because the default output state is OFF, as indicated by the **Dis** annunciator. **Set the output to 120 V_{rms} as follows**:

Action		Display	
You can set the voltage in any of three ways:			
1	On the **Function** keypad, press **[Voltage]**. On the **Entry** keypad, press **[1] [2] [0] [Enter]**. This is the easiest way to enter an accurate value.	VOLT	120
2	On the **Function** keypad, press **[Voltage]**. On the **Entry** keypad, press ▲ or ▼ to increment or decrement the existing value. This technique is useful when you are making minor changes to an existing value.	VOLT	127
3	Rotate the front panel knob to obtain 120 V. This method is best when you want to enter a value without using the voltage menu.	120 V	60 Hz
	Note: You will not see the new voltage on the front panel meter unless the output is enabled.		
To enable the output:			
4	On the **Function** keypad, press **[Output On/Off]**. The **Dis** annunciator will go off, indicating that the voltage is now applied to the output terminals.	120 V	60 Hz

2 Setting the output frequency

When you turn on the ac source, the default output frequency is a 60 Hz. Assuming the voltage output from Example 1 is in effect (120 V$_{rms}$ sinewave), **change the frequency to 50 Hz as follows**:

Action	Display	
You can set the frequency in the same way that you set the voltage:		
1 On the **Function** keypad, press **[Freq]**. On the **Entry** keypad, press **[5] [0] [Enter]**.	FREQ	50
2 On the **Function** keypad, press **[Freq]**. On the **Entry** keypad, press ▲ or ▼ to increment or decrement the existing value.	FREQ	50
3 Rotate the front panel knob to obtain 50 Hz.	FREQ	50
To verify the output, use the meter menu:		
4 The Meter menu is presently displaying the measured voltage and frequency of the selected output phase. On the **Function** keypad, press ▲ or ▼ to scroll through all of the measurement functions in the Meter Menu.	120 V	50 Hz

3 Setting the DC offset

<table>
<tr><td>NOTE</td><td>Because the maximum voltage that the ac source can output is limited to 425 V_{peak}, you cannot program a dc offset that will cause a previously programmed ac voltage to exceed the 425 V_{peak} limit (ac_{peak} + offset   425 V).</td></tr>
</table>

The dc output capability of the ac source lets you independently control the dc and ac components of the output voltage. **Program a dc offset of 100 V as follows**:

Action	Display	
1 On the **Function** keypad, press **[Voltage]** and then press ▼ until you access the OFFSET command.	OFFSET	0
2 On the **Entry** keypad, press **[1] [0] [0] [Enter]**.	OFFSET	100
3 On the **Function** keypad, press **[Shift] [Output]** to access the output coupling command. **Note:** When the output coupling is set to ac, the ac source regulates the dc output voltage to 0, regardless of any programmed voltage offset.	OUTP:COUP	AC
4 On the **Entry** keypad, press ▼ and **[Enter]** to change the output coupling to DC.	OUTP:COUP	DC
5 The ac source output now combines the previously programmed ac rms voltage and the dc offset voltage. This is indicated by the **OUTPUT AC+DC** annunciator. The front panel meter is measuring a 120 V_{rms} sinewave offset by 100 V_{dc}. This is indicated by the **METER AC+DC** annunciator.	156 V	50 Hz

Action	Display	
To measure just the ac or just the dc portion of the output:		
6 On the **Function** keypad, press **[Input]** to access the metering functions.	INP:COUP	ACDC
7 On the **Entry** keypad, press ▼ until you access the DC parameter and press **[Enter]**. This changes the metering function to dc, which measures just the dc portion of the output in volts.	INP:COUP 100 V	DC 50 Hz
The meter annunciator indicates **METER DC**.		
8 On the Function keypad, press **[Input]** again. On the **Entry** keypad, press ▼ until you access AC and press **[Enter]**. This changes the metering function to ac, which measures just the ac portion of the output in rms volts.	INP:COUP 120 V	AC 50 Hz
The meter annunciator indicates **METER AC**.		

4 Setting a protection feature

You can set the ac source to disable its output if it detects an overvoltage or overcurrent fault condition. Other automatic fault conditions (such as overtemperature) also will disable the output. **Set the overcurrent protection feature as follows**:

Action	Display	
1 On the **Function** keypad, press **[Protect]**.	PROT:CLEAR	
2 On the **Function** keypad, press ▼ to obtain the overcurrent command.	CURR:PROT	OFF
3 On the **Entry** keypad, press ▼ once to scroll to the ON parameter and press **[Enter]**. The **OCP** annunciator will light, indicating that the overcurrent protection circuit is on.	CURR:PROT	ON
If you wish to set a time delay between the detection of the fault and the disabling of the output, scroll to the delay command on the protection menu. The default delay is 100 milliseconds.	DELAY	.1
Enter the delay from the Entry keypad, such as **[.] [2] [5] [0] [Enter]**.	DELAY	.250
4 When you want to restore normal operation **after the cause of the overcurrent condition has been removed**, scroll to the protection clear command and press **[Enter]**. The **OCP** annunciator then will go off.	PROT:CLEAR	

5 Clearing protection conditions

When the output **Prot** annunciator is on, the output of the ac source has turned off due to one or more of the following conditions:

Table 4-1   Protection condition description, bit number, and weight

Annunciator	Description	Bit number	Bit weight
OV	Overvoltage protection has tripped	0	1
OCP	RMS overcurrent protection has tripped	1	2
SOA	Safe operating area has tripped	2	4
OT	Overtemperature protection has tripped	4	16
RI	An external remote inhibit signal has occurred	9	512
Rail	Rail protection has tripped	11	2048

Action	Display
1 You must first identify the cause of the protection shutdown, and then eliminate its cause before you can continue operating the unit.	
2 To identify the problem, press [Shift] [Status].	*CLS
3 On the **Function** keypad, press ▼ to obtain the Questionable Event command.	QUES:EVEN?

Action	Display
4 Press **[Enter]** to find out which bits have been set in the Event Register.	QUES:EVEN 20
Note: The value returned is the sum of all of the binary weights of the bits that have been set. For example, a value of 20 indicates that bit 2 (bit weight=4) and bit 4 (bit weight=16) have been set. Refer to Table 4-1 for the bits and bit weights that are assigned to the protection conditions. Refer to Table 4-2 for information on eliminating the cause of the protection condition. Refer to "Chapter 4" in the *Keysight Models 6811C, 6812C, and 6813C AC Power Solutions Programming Guide* for a complete discussion of the status system.	

Table 4-2   Protection condition causes

Condition	Action
OV condition	Usually overvoltage conditions are caused by an external source forcing voltage into the output of the ac source. Remove this external source to eliminate the overvoltage. You can also program the overvoltage level to a higher value, or turn the overvoltage protection off.
	In other cases the output voltage may have exceeded the user-programmed overvoltage level. In this case the unit may have inadvertently been programmed to a voltage that exceeded the programmed overvoltage level. The VOLTage:PROTection command sets the overvoltage protection level.
	Note: The overvoltage protection level is programmed in peak, not rms volts.
OCP condition	If the CURRent:PROTection:STATe command has been programmed to disable the output when rms current limit is activated, the unit will shut down. The rms current limit threshold is set by the CURRent command. In this case you must check to see why the load is drawing more current than the limit that has been programmed by the CURRent command.

Table 4-2   Protection condition causes (continued)

Condition	Action
SOA condition	Protection circuits in the ac source let the load draw peak currents for short periods of time that exceed the continuous capability of the unit. This allows loads that require large inrush currents to turn on. The ac source will shut down if a combination of peak current duration and internal component temperature exceeds a predetermined limit. When this occurs, it means that the load has been drawing peak output currents that are beyond the capability of the ac source to supply for extended periods. Slower output slew rates and reduced peak current limit settings can be used to control the conditions that cause SOA shutdowns.
OT condition	When the internal operating temperatures of the ac source exceed predetermined thresholds, the output turns off. If this happens, you must let the unit cool down before continuing operation.
RI condition	If the Remote Inhibit input has been programmed to disable the output when it receives an external signal, the unit will shut down. The Remote Inhibit input is set by the OUTPut:RI:MODE command. In this case you must check to what external event produced a signal on the RI input.
Rail condition	The internal high voltage rail that provides power for the ac source's output is continuously monitored for proper voltage level. If this voltage is not maintained within predetermined levels, the output will shut down. This can happen if an extenal source forces too much power into the ac source or if too much power is drawn from the ac source. Remove the external source to eliminate the rail condition. Slower output slew rates and reduced peak current limit settings can also be used to control the conditions that cause rail shutdowns.

6   Generating step, pulse, and list transients

The ac source voltage can be programmed in the following transient operating modes:

Transient operating modes	Result
STEP	The output permanently change to its triggered value.
PULSE	The output to change to its triggered value for a specific time, as determined by the Pulse menu parameters.
LIST	The output sequence through a number of values, as determined by points entered in the List menu.
FIXED	Disables transient operation for the selected function.

Step transient

The Voltage Menu lets you specify an alternate or triggered voltage level that the ac source will apply to the output when it receives a trigger. Because the default transient voltage level is zero volts, you must first enter a triggered voltage before you can trigger the ac source to change the output amplitude. Refer to "Chapter 4" of the *Keysight Models 6811C, 6812C, and 6813C AC Power Solutions Programming Guide* for more information about programming triggers.

In the following example, **the voltage output is set to 120 V$_{rms}$ and then stepped down to 102 V$_{rms}$**.

Action		Display	
1	On the **Function** keypad, press **[Output On/Off]** to enable the output. The **Dis** annunciator will go off.	0 V	60 Hz
2	Press **[Voltage]** to access the Voltage Menu. On the **Entry** keypad, press **[1] [2] [0] [Enter]**.	VOLT	120
3	Access the Voltage Menu again and on the **Function** keypad, press ▼ to access the triggered voltage command.	VOLT:T	0

Action	Display	
4 On the **Entry** keypad, press **[1] [0] [2] [Enter]**.	VOLT:T	102
5 Access the Voltage Menu again and on the **Function** keypad, press ▼ to access the voltage mode command. It should be in the default FIXED mode. An ac source function in the FIXED mode does not respond to triggers. On the **Entry** keypad, press ▼ to scroll through the mode parameters. When you have STEP, press **[Enter]**.	VOLT:M	STEP
6 Press **[Trigger Control]** and **[Enter]**. This initiates (or enables) one immediate trigger action.	INIT:IMMED	
7 Press **[Shift] [Trigger]**. This sends the ac source an immediate trigger signal to change the output voltage. The triggered voltage value now becomes the VOLT value.	102 V	60 Hz

Pulse transient

In the following example, the output is four 83.3-millisecond, 120 V$_{rms}$ pulses at 60 Hz. The figure shows the trigger, pulse count, pulse period, and duty cycle.

| NOTE	From the Output Menu, execute the *RST command to reset the ac source. This is necessary because any previously programmed functions remain in effect until cleared.
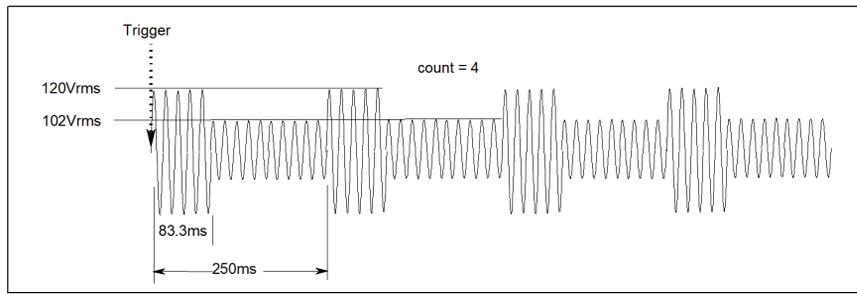
Figure 4-5   Pulse transients

Action	Display	
1 Press **[Voltage]** to access the Voltage Menu. On the **Entry** keypad, press **[1] [0] [2] [Enter]**.	VOLT	102
2 On the **Function** keypad, press ▼ to access the triggered voltage command. On the **Entry** keypad, press **[1] [2] [0] [Enter]**.	VOLT:T	120
3 Access the Voltage Menu again and on the **Function** keypad, press ▼ to access the voltage mode command. On the **Entry** keypad, press ▼to scroll through the mode parameters to obtain PULSE and press **[Enter]**.	VOLT:M	PULSE
4 Press **[Pulse]** to access the Pulse Menu. From the **Entry** keypad, press **[.] [0] [8] [3] [3] [Enter]** to enter a pulse width of 83.3 milliseconds.	WIDTH	.0833

Action	Display	
5 Access the Pulse Menu and on the **Function** keypad, press ▼ to access the duty cycle command. From the **Entry** keypad, press **[3] [3] [Enter]** to change the duty cycle to 33%.	DCYCLE	33
6 Access the Pulse Menu and on the **Function** keypad, press ▼ to access the pulse count. On the **Entry** keypad, press **[4]** and **[Enter]**.	COUNT	4
7 Press **[Trigger Control]** and **[Enter]** to initiate the transient trigger sequence.	INIT:IMMED	
8 Press **[Shift] [Trigger]**. This sends the ac source an immediate trigger signal to generate the four output pulses. **Note:** The ac source output returns to 102 V at the completion of the output pulses.	102 V	60 HZ

List transient

Lists are the most flexible means of generating multiple or synchronized transient outputs. The following figure shows a voltage output generated from a list. The output shown represents three different ac voltage pulses (160 volts for 33 milliseconds, 120 volts for 83 milliseconds, and 80 volts for 150 milliseconds) separated by 67-millisecond, 0-volt intervals.

The list specifies the pulses as three voltage points (point 0, 2, and 4), each with its corresponding dwell point. The intervals are three zero-voltage points (point 1, 3, and 5) of equal intervals. The count parameter causes the list to execute twice when started by a single trigger.

| NOTE	From the Output Menu, execute the *RST command to reset the ac source. This is necessary because any previously programmed functions remain in effect until cleared.
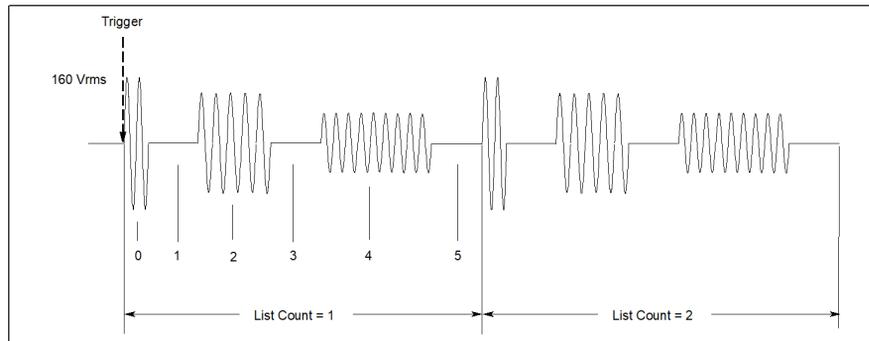
Figure 4-6   List transients

Action	Display	
1 Press **[Voltage]** to access the Voltage Menu. Then on the Entry keypad, press ▼ to access the voltage mode command.	VOLT:M	FIXED
2 On the **Entry** keypad, press ▲ or ▼ to scroll through the mode parameters to obtain LIST and press **[Enter]**.	VOLT:M	LIST
3 Access the List Menu by pressing **[Shift] [List]**. The first menu command is the count. From the **Entry** keypad, change the list count from the default (1) to **[2]**. Press **[Enter]**.	COUNT	2
4 Access the List menu again and on the **Function** keypad, press ▼ until you access the dwell time. This specifies the "on" time for each voltage point, which is effectively the output pulse width. The first dwell point (0) appears in the display. On the **Entry** keypad, press **[.] [0] [3] [3]** and **[Enter]**.	DWEL 0	.033
5 Pressing the **[Enter]** key automatically advances to the step in the list. Enter the following values for dwell list points 1 through 5: .067, .083, .067, .150, .067. Press **[Enter]** to enter each value. When you finish, you will be at point 6, which is the end of the list.	DWEL 1 DWEL 2 DWEL 3 DWEL 4 DWEL 5 DWEL 6	.067 .083 .067 .150 .067 EOL
Note: Press **[Shift] [▲ Index]** or **[Shift] [▼ Index]** to access and edit any list point.		
6 On the **Function** keypad, press ▼ until you access the voltage list. This specifies the amplitude of each output point during its corresponding dwell period. The first voltage list point (0) appears in the display. On the **Entry** keypad, press **[1] [6] [0]** and **[Enter]**.	VOLT 0	160

Action		Display	
7	Pressing the **[Enter]** key automatically advances to the step in the list. Enter the following values for voltage list points 1 through 5: 0, 120, 0, 80, 0. Press **[Enter]** to enter each value. When you finish, you will be at point 6, which is the end of the list.	VOLT 1 VOLT 2 VOLT 3 VOLT 4 VOLT 5 VOLT 6	0 120 0 80 0 EOL
	Note: Press **[Shift] [▲ Index]** or **[Shift] [▼ Index]** to access and edit any list point.		
8	On the **Function** keypad, press ▼ until you access the step command. Check that it is at the default mode (AUTO). This lets a single trigger run your list for the specified count.	STEP	AUTO
9	Press **[Output On/Off]** to enable the output. The **Dis** annunciator will go off.	0 V	60 Hz
10	Press **[Trigger Control]** and **[Enter]** to initiate the transient trigger sequence.	INIT:IMMED	
11	Press **[Shift] [Trigger]**. This sends the ac source an immediate trigger to generate the four output pulses. The output returns to the immediate value at the end of the list.	0 V	60 Hz
	Note: *To clear a list*, press **[Clear Entry]**. This truncates or clears the list at the presently displayed list point. Each list must be accessed and cleared separately.		

7 Programming trigger delays and phase synchronization

The ac source trigger system also lets you program trigger delays as well as synchronize output changes to a specific phase angle of the output waveform.

In Example 1, the output transient is triggered immediately at the receipt of the trigger signal. In Example 2, a delay time of approximately 16.7 milliseconds elapses between the occurrence of the trigger and the start of the output transient. In Example 3, the trigger source is programmed for phase synchronization, which means that the transient occurs at the first occurrence of the specified phase angle after the trigger signal is received.

Note that phase synchronization is referenced to an internal phase signal. The output of the unit is normally offset by 0° with respect to this internal reference. Because synchronized transient events always occur with respect to the internal reference, the output will normally be in phase with the value programmed for phase synchronization. (The Phase command can be used to change the offset of the output with respect to the internal phase reference.)
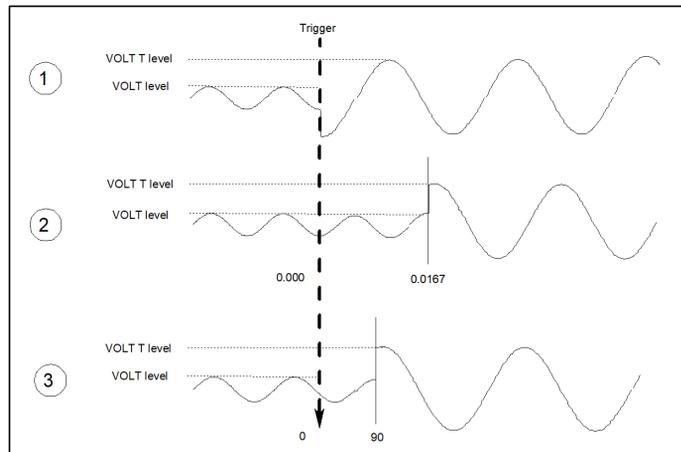

Figure 4-7   Trigger delays and phase synchronization

Action	Display	
1 This example uses the default trigger parameters. First, access the Voltage menu and program the immediate and triggered voltage levels, followed by the voltage transient mode.	VOLT VOLT:T VOLT:M	120 150 STEP
Then press **[Trigger Control]** and **[Enter]**, followed by **[Shift] [Trigger]**.	INIT:IMMED	
2 In this example, you will set a trigger delay. First, access the Voltage menu and program the immediate and triggered voltage levels, followed by the voltage transient mode.	VOLT VOLT:T VOLT:M	120 150 STEP
Press **[Trigger Control]**. Then on the **Function** keypad, press ▼ until you access the delay parameter. On the **Entry** keypad, press **[.] [0] [1] [6] [7] [Enter]**.	DELAY DELAY	0 .0167
Then press **[Trigger Control]** and **[Enter]**, followed by **[Shift] [Trigger]**.	INIT:IMMED	
3 This example uses the phase sync mode with no delay, but synchronized at 90. First, access the Voltage menu and program the immediate and triggered voltage levels, followed by the voltage transient mode.	VOLT VOLT:T VOLT:M	120 150 STEP
Press **[Trigger Control]**. Then on the **Function** keypad, press ▼ until you access the delay parameter. If necessary, set it to 0. On the **Function** keypad, press ▼ until you access the sync source command. On the **Entry** keypad, press ▼ to obtain PHASE. Press **[Enter]**.	DELAY SYNC:SOUR	0 PHASE
Access the Trigger Control menu again and on the **Function** keypad, press ▼ to access the sync phase reference parameter. On the **Entry** keypad, program a 90° phase reference by entering **[9] [0] [Enter]**.	SYNC:PHAS	90
Then press **[Trigger Control]** and **[Enter]**, followed by **[Shift] [Trigger]**.	INIT:IMMED	

8   Using slew rates to generate waveforms

As shown in the previous examples there are a number of ways that you can generate custom waveforms. Programmable slew rates provide additional flexibility when customizing waveforms. The following figure illustrates how programmable slew rates are applied in the transient operating modes.

In Example 1, an immediate slew rate of 50 volts/second is used whenever a new output voltage is programmed. In Example 2, a triggered slew rate of 50 volts/second steps the voltage level to its new value. 50 volts/second becomes the new immediate slew rate in step mode. In Example 3, a triggered slew rate of 50 volts/second is used at the start of the pulse. The immediate slew rate of infinity applies at the trailing edge of the pulse. In Example 4, the slew rates are set by the values in the voltage slew list.
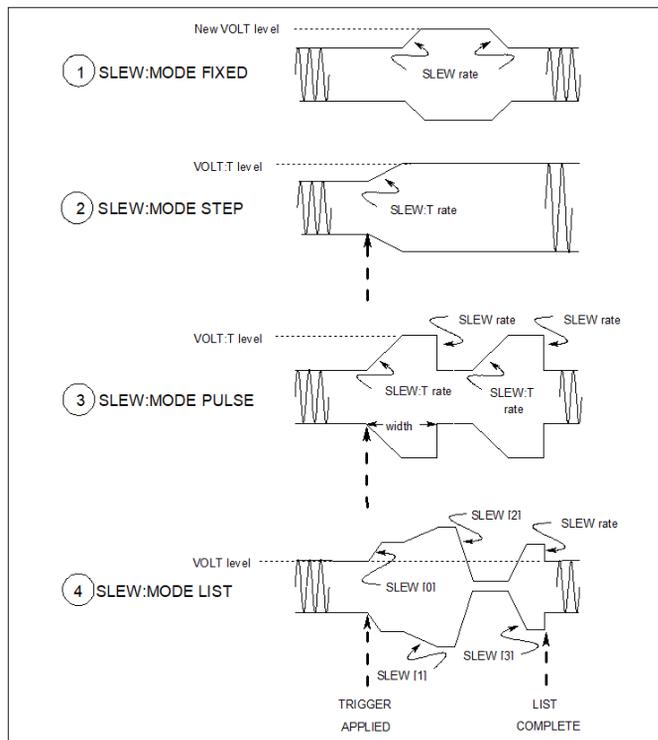

Figure 4-8   Programming slew rates

Action	Display	
1 This example uses the immediate slew rate. First, access the Voltage menu and on the **Function** keypad, press ▼ until you access the mode command. On the **Entry** keypad, press ▼ to obtain FIXED. Press **[Enter]**.	VOLT:M	FIXED
Access the voltage menu and on the **Function** keypad, press ▼ until you access the slew command. On the **Entry** keypad, press **[5] [0] [Enter]** to program a slew rate of 50 volts/ second.	SLEW	50
Whenever a new immediate voltage value is entered, the output will slew to the new level at 50 volts/second.		
2 Step mode uses the triggered slew rate. First, access the Voltage menu, program the immediate and triggered voltage levels, and set the slew mode to STEP.	VOLT VOLT:T SLEW:M	120 150 STEP
Access the Voltage menu and on the **Function** keypad, press ▼ to access the immediate slew command. On the **Entry** keypad, enter a value that equals infinity.	SLEW	9.9+E37
Access the Voltage menu and on the **Function** keypad, press ▼ until you access the triggered slew command. On the **Entry** keypad, enter a value such as **[5] [0] [Enter]**, which sets the triggered slew rate to 50 volts/second.	SLEW:T	50
Then press **[Trigger Control]** and **[Enter]**, followed by **[Shift] [Trigger]**.	INIT:IMMED	
After the trigger has been sent, in step mode, the triggered value becomes the new immediate value.		

Action	Display	
3 Pulse mode uses the triggered slew rate at the leading edge of the pulse, and the immediate slew rate at the trailing edge of the pulse. First, access the Voltage menu, program the immediate and triggered voltage levels, and set the slew mode to PULSE.	VOLT VOLT:T SLEW:M	120 150 PULSE
Access the Pulse menu and program the pulse count, duty cycle, and pulse period.	COUNT DCYCLE PER	2 33 .0166
Access the Voltage menu and on the **Function** keypad, press ▼ to access the immediate slew command. On the **Entry** keypad, enter a value that equals infinity.	SLEW	9.9+E37
Access the Voltage menu and on the Function keypad, press ▼ until you access the triggered slew command. On the **Entry** keypad, enter a value such as **[5] [0] [Enter]**, which sets the triggered slew rate to 50 volts/second.	SLEW:T	50
Then press **[Trigger Control]** and **[Enter]**, followed by **[Shift] [Trigger]**.	INIT:IMMED	
4 When the voltage slew mode is set to LIST, the slew rates are set by the values in the voltage slew list. Refer to the List Transient example for more information on how to program lists. You must program the voltage values and dwell times as explained in that example. You must also program a slew rate for each point in the list (even if it is 9.9+E37).		

NOTE	When specifying a dwell time, you must take the slew time into consideration. If the dwell time at any given list point is less than the slew time at the same point, the voltage will never reach its programmed level before the next list point becomes active.

9 Measuring peak inrush current

Peak inrush current is a non-repetitive measurement whereby the peak inrush current occurs only when the unit under test is first turned on. In order to repeat the measurement, you must turn the unit off and wait for any input filter capacitors to discharge completely.

This example shows how you can measure the peak inrush current using the front panel meter. The voltage is set to 120 V_{rms} and the output is triggered at an output phase of 75°, which optimizes the conditions under which inrush current is applied to the unit under test.

Action		Display	
1	Set the immediate voltage to 0. Press **[Voltage]**, then press **[0]** and **[Enter]**.	VOLT	0
2	Set the triggered voltage to 120 V_{rms}. In the Voltage menu, on the **Function** keypad, press ▼ to access the triggered voltage command. Then press **[1] [2] [0] [Enter]**.	VOLT:T	120
3	Set the voltage mode to step. In the Voltage menu, on the **Function** keypad, press ▼ to access the mode command. On the **Entry** keypad, press ▼ to scroll to STEP and press **[Enter]**.	VOLT:M	STEP
4	Make sure the triggered voltage slew rate is set to the fastest possible speed. In the Voltage menu, access the triggered slew command. If necessary, reset the slew rate to a faster speed.	SLEW:T	9.9000+E37

Action	Display	
5 Make sure the peak current and rms current limits are set to high values. In the Current menu, access the rms current limit and then the peak current limit commands. If necessary, reset the rms current and the peak current limits to higher values. (Keysight 6811C units have an rms current limit of 3.25 A. Keysight 6813C units have an rms current limit of 13 A and a peak current limit of 80 A.)	CURR:LEV CURR:PEAK	6.5 40
6 Synchronize the trigger source with a reference phase angle. In the Trigger Control menu, on the **Function** keypad, press ▼ to access the sync source command. On the **Entry** keypad, press ▼ to obtain PHASE and press **[Enter]**.	SYNC:SOUR	PHASE
7 Set the reference phase angle to 75. In the Trigger Control menu, on the **Function** keypad, press ▼ to access the sync phase command. Then press **[7] [5] [Enter]**.	SYNC:PHAS	75
8 Initiate (or enable) the unit for one immediate trigger from the front panel. Press **[Trigger Control]** and **[Enter]**.	INIT:IMMED	
9 Set the meter function to measure non-repetitive peak inrush current. In the Meter menu, on the **Function** keypad, press ▼ to access the peak inrush current display.	0 A	PK NR
10 Enable the output by pressing **[Output On/Off]**.	0 V	60 HZ
11 Send the trigger to step the output from 0 V to 120 V. Press **[Shift] [Trigger]**. The inrush current is displayed on the Meter.	48 A	PK NR

NOTE	With fast and/or large voltage transitions, the **CC** annunciator may turn on due to current in the output capacitor. This is normal and will limit the rate of change of output voltage. To prevent the CC operating mode from limiting the rate of change of output voltage, program the peak current limit to a higher value.

10 Setting the GPIB address and RS-232 parameters

Your ac source is shipped with the GPIB address set to 5. This address can only be changed from the front panel using the Address menu located under the **[Address]** key. This menu is also used to specify RS-232 parameters such baud rate and parity.

Action	Display	
To set the GPIB address, proceed as follows:		
1 On the System keypad, press **[Address]**.	ADDRESS	5
2 Enter the new address. For example, Press **[7]** **[Enter]**.	ADDRESS	7
To configure the RS-232 interface, proceed as follows:		
1 On the System keypad, press **[Address]**.	ADDRESS	5
2 Scroll through the Address menu by pressing ▼ on the **Function** keypad. The baudrate command selects the baudrate. The parity command selects the parity.	BAUDRATE	1200
	PARITY	EVEN
3 The ▲ and ▼ keys on the **Entry** keypad lets you select the command parameters.		

11 Saving and recalling operating states

You can save up to 16 states (from location 0 to location 15) in non-volatile memory and recall them from the front panel. All programmable settings are saved. List data, however, cannot be saved in state storage. Only **one** list is saved in non-volatile memory.

Action	Display	
To save an operating state in location 1, proceed as follows:		
1 Set the instrument to the operating state that you want to save.		
2 Save this state to location 1. Press **[Shift] [Save] [1] [Enter]**.	*SAV	1
To recall a saved state in location 1, proceed as follows:		
1 Recall the state saved in location 1 by pressing **[Recall] [1] [Enter]**.	*RCL	1
To select the power-on state of the ac source, proceed as follows:		
1 On the **Function** keypad, press **[Shift] [Output]**, and scroll through the Output menu until you get to the PON state command.	PON:STATE	RST
2 Use the ▲ and ▼ keys on the **Entry** keypad to select either RST or RCL0. RST sets the power-on state of the unit as defined by the *RST command. RCL0 sets the power-on state of the unit to the state saved in *RCL location 0.		
To clear the non-volatile memory of the ac source, proceed as follows:		
1 On the **Function** keypad, press **[Shift] [Output]** and scroll to the *RST command. Then press **[Enter]**. This returns the unit to the factory-default settings.	*RST	
2 Save these settings to location 1. Press **[Shift] [Save] [1] [Enter]**.	*SAV 1	

Action	Display
3 Repeat step 2 for memory locations 2 through 15.	*SAV 2
	*SAV 3
	*SAV 4
	.
	.
	*SAV 15

12 Accessing the ac source information

You can display the ac source basic information such as model, option, serial number, firmware revision, media access control (MAC) address, USB vendor identification (VID), and USB product identification (PID).

Action	Display
To display the ac source basic information, proceed as follows:	
1 Press **[Shift] [Info]**.	
2 Use the ▲ and ▼ keys on the **Function** keypad to access the ac source basic information.	MODEL: 6811C

13 Setting the LAN interface and accessing the LAN information

You can set the LAN interface and access the LAN information.

Action	Display
To configure the LAN, proceed as follows:	
1 Press **[Shift] [LAN Menu]**.	LAN STATUS:
2 Use the ▲ and ▼ keys on the **Function** keypad to display DHCP. Use the ▲ and ▼ keys on the **Entry** keypad to turn DHCP:OFF. Then press **[Enter]**.	DHCP: OFF
3 Use the ▲ and ▼ keys on the **Function** keypad to display IP CONF, SUBNET CONF, or GATEWAY CONF. Then press **[Enter]** to configure IP CONF, SUBNET CONF, or GATEWAY CONF. Enter the respective configuration using the keypad of the **Entry** key group.	
4 Use the ▲ and ▼ keys on the **Function** keypad to display the update option.	UPDATE? NO
5 Use the ▲ and ▼ keys on the **Entry** keypad to allow update. Then press **[Enter]**.	UPDATE? YES
To configure DNS 1 and DNS 2 after you turn off auto DNS, proceed as follows:	
1 Press **[Shift] [LAN Menu]**.	LAN STATUS:
2 Use the ▲ and ▼ keys on the **Function** keypad to display AUTO DNS. Use the ▲ and ▼ keys on the **Entry** keypad to turn AUTO DNS: OFF. Then press **[Enter]**.	AUTO DNS: OFF
3 Use the ▲ and ▼ keys on the **Function** keypad to display DNS 1 CONF or DNS 2 CONF. Then press **[Enter]** to configure DNS 1 CONF or DNS 2 CONF. Enter the respective configuration using the keypad of the **Entry** key group.	

Action	Display
4 Use the ▲ and ▼ keys on the **Function** keypad to display the update option.	UPDATE? NO
5 Use the ▲ and ▼ keys on the **Entry** keypad to allow update. Then press **[Enter]**.	UPDATE? YES

To view LAN information, proceed as follows:

1 Press **[Shift] [LAN Menu]**.

2 Use the ▲ and ▼ keys on the **Function** keypad to access the LAN information of the ac source.   LAN STATUS:

14 Performing LAN reset

You can reset the LAN settings.

Action	Display	
To reset the LAN settings, proceed as follows:		
1 Press **[Shift] [LAN Reset]**.	CONFIRM?	NO
2 Use the ▲ and ▼ keys on the **Entry** keypad to confirm the LAN reset. Then press **[Enter]**.	CONFIRM?	YES

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5 Remote Control and Firmware Update

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Remote Control

There are two ways to control the ac source.

- Program the instrument via SCPI, use Keysight IO Libraries.
- Control the instrument via a simulated front panel, use the instrument's Web interface.

Keysight IO Libraries Suite

Keysight IO Libraries Suite is a collection free instrument control software that automatically discovers instruments and allows you to control instruments over the LAN, USB, GPIB, RS-232, and other interfaces. For more information, or to download IO Libraries, go to www.keysight.com/find/iosuite.

6811C/6812C/6813C Web interface

You can monitor control the instrument from a Web browser by using the instrument's Web interface. To connect, simply enter the instrument's IP address or hostname in your browser's address bar and hit **Enter**.

| NOTE | If you see an error indicating 400: Bad Request, this is related to an issue with "cookies" in your Web browser. To avoid this issue, either start the Web interface by using the IP address (not host name) in the address bar, or clear cookies from your browser immediately before starting the Web interface. |

Figure 5-1   Connect ac power source to simulated front panel

Check the checkbox below the picture of the instrument to enable an indicator on the instrument's front panel. This is helpful if you have several 681XC Series instruments and you wish to identify the one to which you are connected.

The Configure LAN tab on the top allows you to change the instrument's LAN parameters; exercise caution when doing so, as you may interrupt your ability to communicate with the instrument.
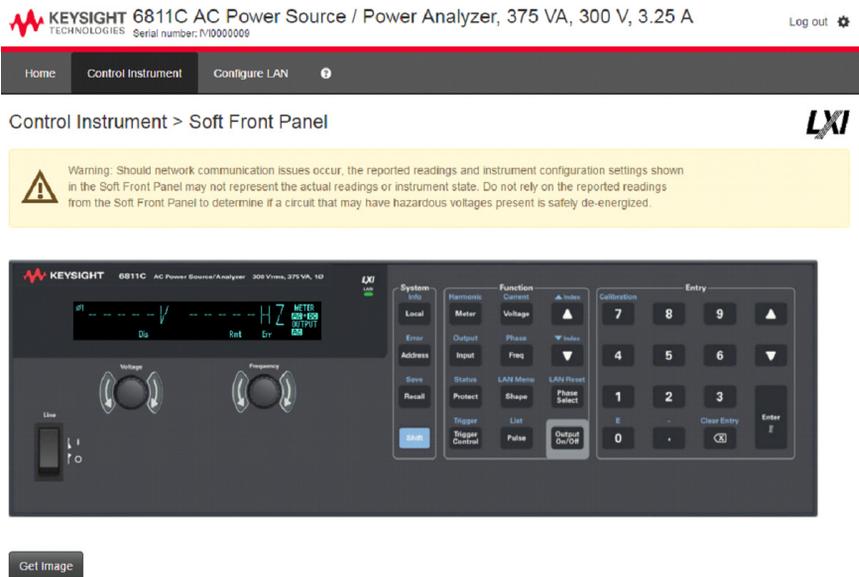
Figure 5-2   Soft front panel

When you click the Control Instrument tab, the instrument will ask you for a password (default is ***keysight*** and not case sensitive), and then it will open a new page.

This interface allows you to use the instrument just as you would from the front panel. Note the curved arrow keys that allow you to "turn" the knob.

NOTE	**Read warning.**
	Be sure to read and understand the warning at the top of the Control Instrument page.

Special Symbols

Press **[Enter]** to display the information for the command.

Press **[Enter]** to save the command settings.

Press the ▲ or ▼ keys of the **Function** or **Entry** keypads to display the information.

Using Telnet

In an MS-DOS Command Prompt box type: *telnet hostname 5024* where *hostname* is the instrument's hostname or IP address, and 5024 is the instrument's telnet port.

You should get a Telnet session box with a title indicating that you are connected to the power system. Type the SCPI commands at the prompt.

Using Sockets

| NOTE | AC sources allow up to **two** simultaneous data socket, **two** control socket, and **two** telnet connections to be made. |

Keysight instruments have standardized on using port 5025 for SCPI socket services. A **data socket** on this port can be used to send and receive ASCII/SCPI commands, queries, and query responses. All commands must be terminated with a newline for the message to be parsed. All query responses will also be terminated with a newline.

The socket programming interface also allows a **control socket** connection. The control socket can be used by a client to send device clear and to receive service requests. Unlike the data socket, which uses a fixed port number, the port number for a control socket varies and must be obtained by sending the following SCPI query to the data socket: SYSTem:COMMunicate:TCPip:CONTrol?

After the port number is obtained, a control socket connection can be opened. As with the data socket, all commands to the control socket must be terminated with a newline, and all query responses returned on the control socket will be terminated with a newline.

To send a device clear, send the string "DCL" to the control socket. When the power system has finished performing the device clear it echoes the string "DCL" back to the control socket.

Service requests are enabled for control sockets using the Service Request Enable register. Once service requests have been enabled, the client program listens on the control connection. When SRQ goes true the instrument will send the string "SRQ +nn" to the client. The "nn" is the status byte value, which the client can use to determine the source of the service request.

Basic Firmware Update Utility Instructions for Keysight 681XC Series

The following lists the prerequisite information, installation procedure, and firmware update error troubleshooting.

The following are the prerequisite information for the basic firmware update utility instructions for Keysight 681XC series.

– Do not update more than one 681X Series unit at a time.

– For Windows XP, the tool requires Service pack 3 onwards.

– Download and install the Keysight Basic Firmware Update Utility Tool.

– Go to C:\Program Files(x86)\Keysight\BasicFirmwareUpdate\Driver and open either one of the following folders:

  – x64 folder (for 64-bit PCs)

  – x86 folder (for 32-bit PCs)

– Run one of the following to install the USB driver:

  – dpinst_amd64.exe (for 64-bit PCs)

  – dpinst_x86.exe (for 32-bit PCs)

– Download the firmware update (*.dfu) file.

NOTE	Be sure to execute the firmware update procedure only under conditions of reliable power and I/O connectivity to the instrument. For example, do not update firmware with an intermittent LAN connection, a loose power cord, or during a thunderstorm that may interrupt power. Loss of power or connectivity may cause the firmware update to fail, possibly leading to instrument inoperability.

NOTE	The example shown is for a 681xC Series Instrument, but these instructions apply to any instrument that uses the Keysight Basic Firmware Update Utility.

Installation procedure

1 Double-click on the **FirmwareUpdate.exe** file to launch the Keysight Basic Firmware Update Utility. Then click **Browse** to find the firmware update file to load onto your instrument.
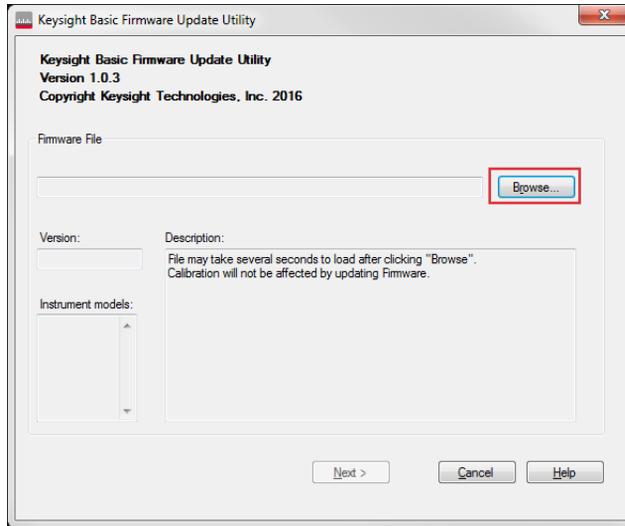
Figure 5-3   Keysight Basic Firmware Update Utility

2 Browse to find the firmware update file (*.dfu). Then click **Open**.
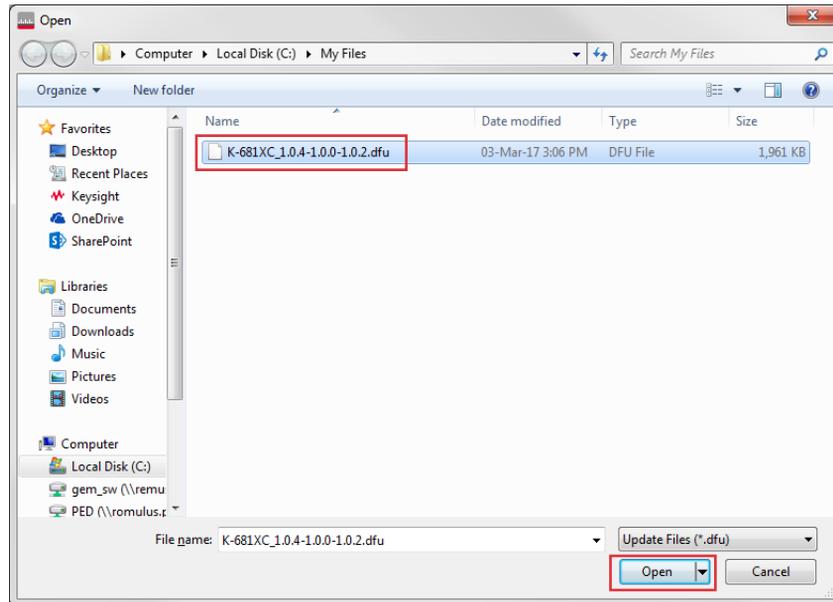
Figure 5-4   Keysight Basic Firmware Update Utility

3 Check the **Description:** on the lower left corner of the window to verify that the
file applies to the proper instrument. Then click **Next**.
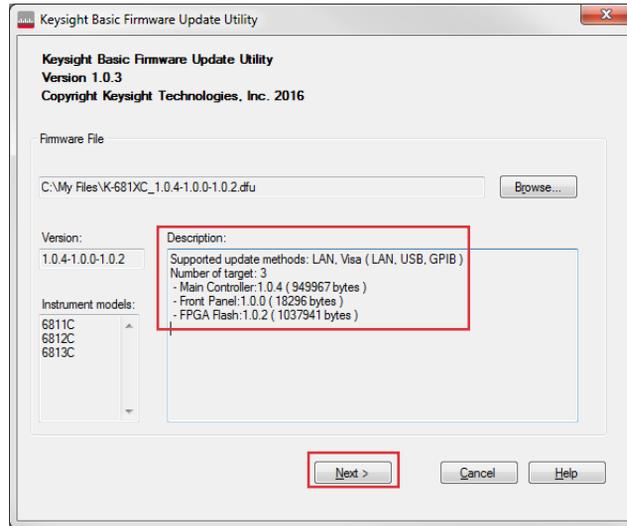
Figure 5-5   Check description

4   Enter the appropriate LAN Sockets, LAN VISA, USB, or GPIB connection information for your instrument. Then click **Update**.

NOTE	– The ac source does not support updating firmware from instrument's front panel.
	– DO NOT use Recovery mode during normal firmware update instruction.
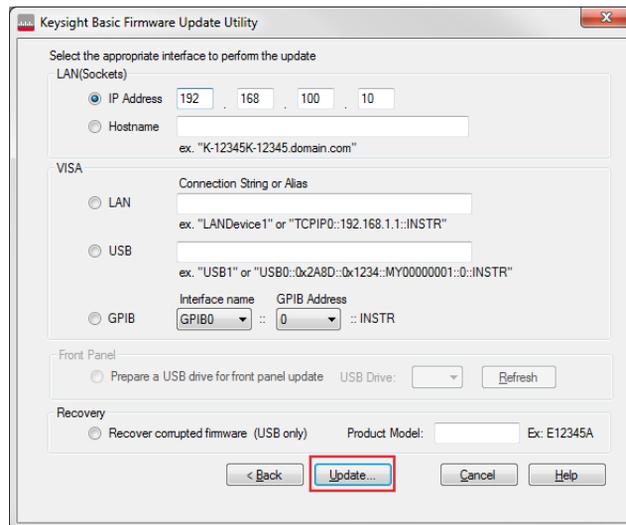
Figure 5-6   Update the interface to perform update

5 Verify the information shown on the screen and click **Begin Update**.
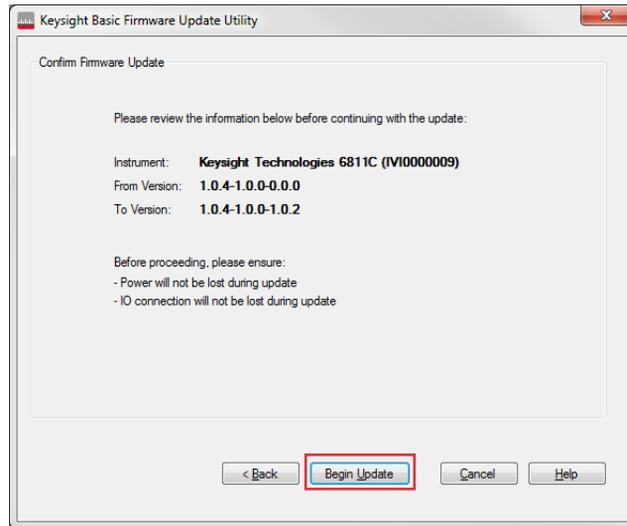
Figure 5-7   Begin update after verifying information

6 The utility tools will copy the firmware update file to the instrument. The utility will then erase the current firmware and write the new firmware into memory.

7 The instrument will automatically restart itself with the new firmware. The utility will verify that the memory has been written correctly.

NOTE	Click **Update another instrument** to update another instrument with same firmware.
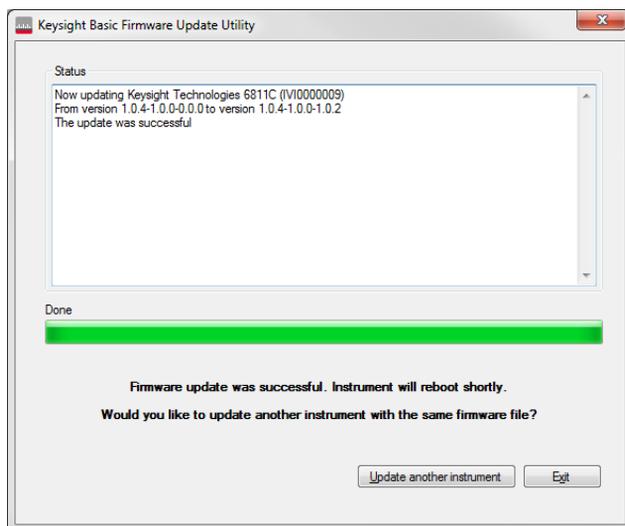
Figure 5-8   Successfully updated firmware

Troubleshooting firmware update error

1 If the firmware update was interrupted or unsuccessful, click **OK** and **Restart Firmware Update** to retry.
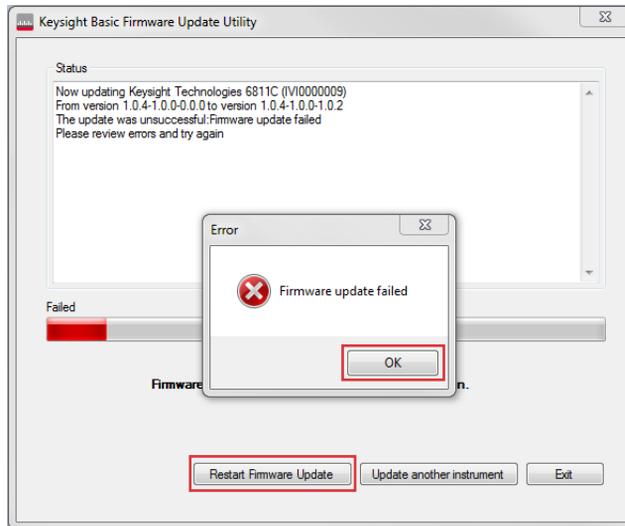
Figure 5-9   Firmware update failed

2   Repeat step 1 to step 3 from Installation procedure. Select **Recover corrupted firmware (USB only)** and provide the model number (6811C, 6812C, or 6813C). Then click **Update**.
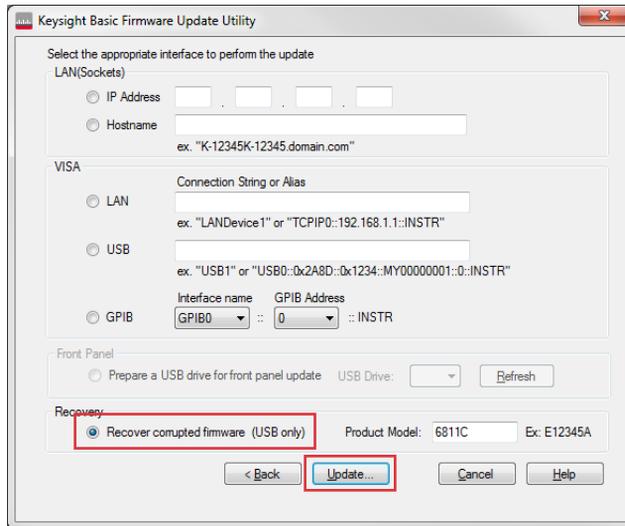
Figure 5-10   Recover corrupted firmware (USB only)

3 Verify the information shown on the screen and click **Begin Update**.
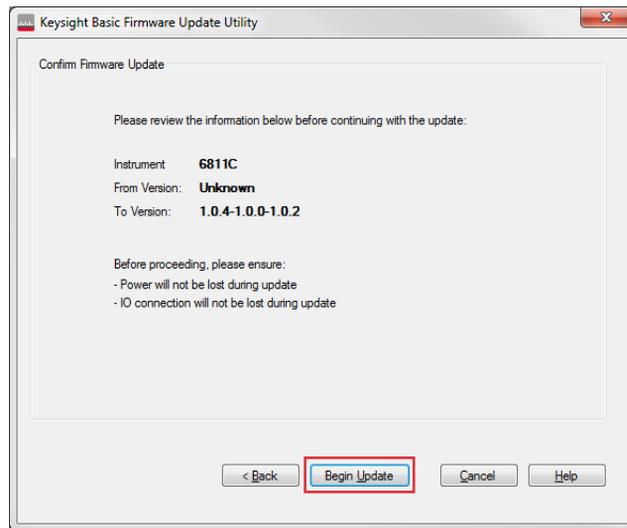
Figure 5-11   Begin update after verifying information from recovery of corrupted firmware

4 If the tools prompt you to enter boot loader, turn the ac source off. Press and hold **[Trigger Control]**, **[Output On/Off]** and **[.]** keys on the front panel while you turn the ac source on.
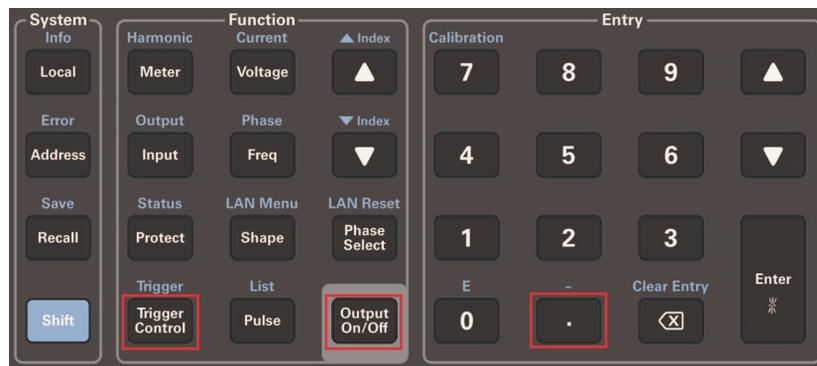
Figure 5-12   Enter boot loader using the ac source

> **NOTE**   Ensure the instrument front panel indicates **BOOTLOADER** before you click OK.
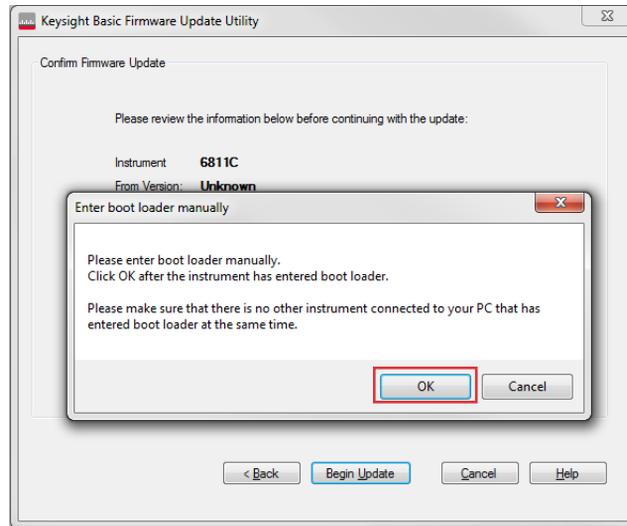
Figure 5-13   After entering boot loader, click OK

5   The utility will copy the firmware update file to the instrument and write the new firmware into memory.

6   The instrument will automatically restart itself with the new firmware. The utility will verify that the memory has been written correctly.
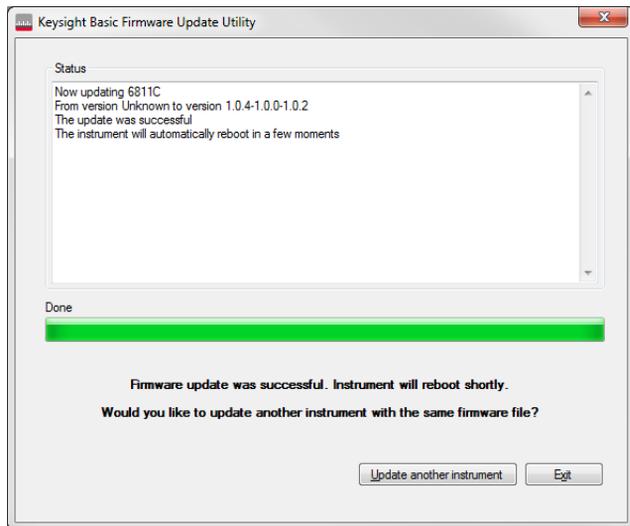
Figure 5-14   Successfully updated firmware from troubleshooting

A   Specifications

For the characteristics and specifications of the Keysight Models 6811C, 6812C, and 6813C AC Power Solutions, refer to the data sheet at http://literature.cdn.keysight.com/litweb/pdf/5992-2370EN.pdf.

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A   Specifications

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B   Verification and Calibration

KEYSIGHT
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Introduction

This appendix includes verification and calibration procedures for the Keysight Models 6811C, 6812C, and 6813C AC Power Solutions. Instructions are given for performing the procedures either from the front panel or from a controller over the GPIB.

The verification procedures do not check all the operating parameters, but verify that the ac source is performing properly.

Because the output of the ac source must be enabled during verification or calibration, proceed with caution, since voltages and currents will be active at the output terminals.

NOTE	Perform the verification procedures before calibrating your ac source. If the ac source passes the verification procedures, the unit is operating within its calibration limits and does not need to be recalibrated.

WARNING	*LETHAL VOLTAGES.* AC sources can supply 424 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. These procedures must be performed by a qualified electronics technician or engineer trained on this equipment.
	TENSIONS MORTELLES. Les AC source peuvent fournir 424 $V_{maximum}$ au niveau de leur sortie. Tout contact peut entraîner la MORT si les circuits ou bornes de sorties connectés à la sortie sont touchés lorsqu'ils sont sous tension. Ces procédures doivent être réalisées par un ingénieur ou technicien en électronique qualifié formé sur l'équipement.

Equipment required

The equipment listed in the following table, or the equivalent to this equipment, is required for verification and calibration.

Table B-1   Equipment required

Equipment	Characteristics	Recommended model
Digital voltmeter	Resolution: 10 nV @ 1 V Readout: 8.5 digits Accuracy: >20 ppm	Keysight 3458A
Current monitor[a]	0.01 Ω, ±200 ppm, 10 Watts	Guildline 7320/0.01
Ratio transformer[b]	30:1 ratio, 50 ppm, 45 Hz to 1 kHz	
Load resistor	10 Ω, 20A, 2000 Watts minimum for Keysight 6811C/6812C/6813C 5 Ω, 20A, 2000 Watts minimum for Keysight 6813C Option 019	
Impedance resistor	1 Ω, 100 Watts minimum	
GPIB controller	Full GPIB capabilities	Keysight 82375B GPIB/USB

[a] The 4- terminal current shunt is used to eliminate output current measurement error caused by voltage drops in the load leads and connections. It has special current-monitoring terminals inside the load connection terminals. Connect the voltmeter directly to these current-monitoring terminals.

[b] A ratio transformer is required only when verifying output voltage readback to MIL-STD-45662A 4:1 test equipment ratio requirements.

Test setup

Figure B-1 shows the setup for the tests. Be certain to use load leads of sufficient wire gauge to carry the full output current (see Chapter 2, "Installation").

R_L = Load resistor for CC test (20 ohms)
Rs = Current Monitor resistor (0.01 ohms)
Rz = Impedance resistor (1 ohm)
S1 = Switch is for convenience (not required).
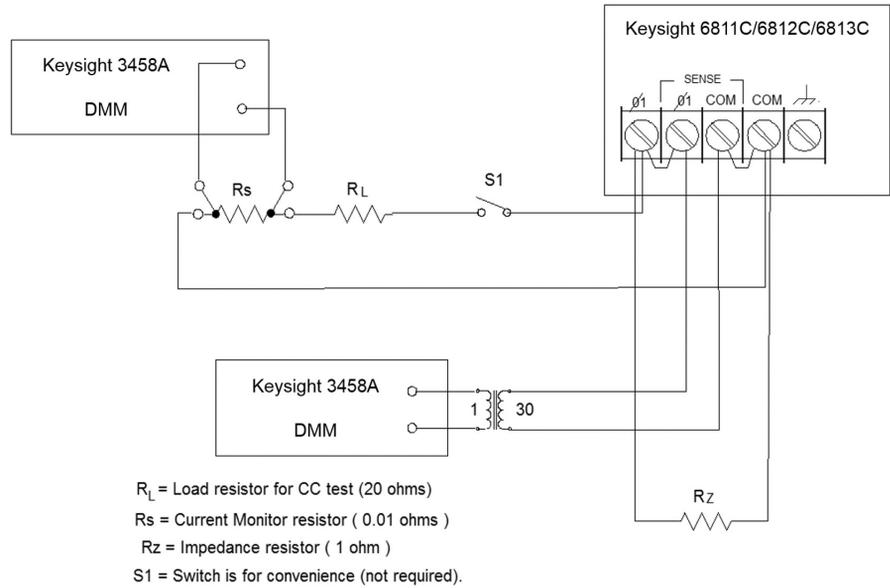
Figure B-1   Verification and calibration test setup

Performing the Verification Tests

The following procedures assume you understand how to operate the ac source from the front panel as explained in Chapter 4, " Front Panel Operation".

When performing the verification tests from a GPIB controller, you may have to consider the relatively slow settling times and slew rates of the ac source as compared to computer and system voltmeters. Suitable WAIT statements can be inserted into the test program to give the ac source time to respond to the test commands.

Perform the following tests for operation verification in the order indicated.

1 Turn-on checkout procedure

2 AC voltage programming and measurement accuracy and DC voltage programming and measurement accuracy

3 RMS current accuracy test

Turn-on checkout procedure

Perform the turn-on checkout as directed in Chapter 3, "Turn-On Checkout".

| NOTE | The ac source must pass turn-on self-test before you can proceed with the verification tests. |

AC voltage programming and measurement accuracy

This test verifies the voltage programming, GPIB measurement, and front panel meter functions. Values read back over the GPIB should be the same as those displayed on the front panel.

If more than one meter or if a meter and an oscilloscope are used, connect each to the sense terminals by separate leads to avoid mutual coupling effects.

Action	Normal result
1 Make sure the ac source is turned off. Connect the DMM and ratio transformer as shown in the test setup in Figure B-1.	
2 Turn on the ac source with no load. In the Output menu, execute the *RST command to reset the unit. Enable the output by pressing **[Output On/Off]**. Program the output voltage as follows: VOLT 300, FREQ 45, SHAPE:SIN, CURR 1	**CV** annunciator on. Output current near 0.
3 Record voltage readings at the DMM[a] and on the front panel display.	Readings within specified high range limits (300 V/45 Hz).
4 Program FREQ 400	
5 Record voltage readings at the DMM1 and on the front panel display.	Readings within specified high range limits (300 V/400 Hz).
6 Program FREQ 1000, CURR:PEAK 40	
7 Record voltage readings at the DMM[a] and on the front panel display.	Readings within specified high range limits (300 V/1 kHz).

[a]   Multiply the DMM reading by the transformer ratio if a ratio transformer is used.

DC voltage programming and measurement accuracy

NOTE   Disconnect the ratio transformer for this test.

This test verifies the DC voltage programming, GPIB readback, and front panel meter functions. Values read back over the GPIB should be the same as those displayed on the front panel. Connect the negative terminal of the DMM to the COM output terminal to determine the DC offset voltages.

Action	Normal result
1 Make sure the ac source is turned off. Connect the DMM directly to the sense terminals.	
2 Turn on the ac source with no load. In the Output menu, execute the *RST command to reset the unit. Enable the output by pressing **[Output On/Off]**. Program the output voltage as follows: VOLT 0, OUTP:COUP DC, OFFSET 425	Output voltage at +425 VDC Output current near 0.
3 Record DC voltage readings at the DMM and on the front panel display.	Readings within specified dc voltage programming and readback limits.
4 Program OFFSET –425	Output voltage at –425 VDC
5 Record DC voltage readings at the DMM and on the front panel display.	Readings within specified dc voltage programming and readback limits.

RMS current accuracy test

This test verifies the accuracy of the current measurement in rms detection mode.

Action	Normal result
1 Turn off the ac source and connect the DMM, the 20 ohm load resistor and current shunt as shown in Figure B-1 with S1 closed. Connect the DMM across the current shunt.	
2 Turn on the ac source. In the Output menu, execute the *RST command to reset the unit. Enable the output by pressing **[Output On/Off]**. Program the output as follows: For Keysight 6811C: VOLT 60, CURR:RANGE LOW, CURR:LEV 2.50 For all other models: VOLT 120, CURR:RANGE LOW, CURR:LEV 5.00	**CC** annunciator on Output current at 2.5 A (Keysight 6811C) or 5.0 A (all other models).
3 Record the DMM voltage reading and calculate the rms current.	Readings within specified limits.
4 Program CURR:RANGE HIGH	**CC** annunciator on Output current at 2.5 A (Keysight 6811C) or 5.0 A (all other models).
5 Record the DMM voltage reading and calculate the rms current.	Readings within specified limits.

Table B-2   Keysight 6811C verification test record

Model Keysight 6811C	Report number_____	Date_____	
Test description	**Minimum specification**	**Recorded results**	**Maximum specification**
Voltage programming and measurement accuracy			
300 V_{rms} accuracy at 45 Hz Front panel measurement	299.250 V V_{rms} −190 m	——————V ————————V	300.750 V V_{rms} +190 mV
300 V_{rms} accuracy at 400 Hz Front panel measurement	298.200 V V_{rms} −400 mV	——————V ————————V	301.800 V V_{rms} +400 mV
300 V_{rms} accuracy at 1 kHz Front panel measurement	296.700 V V_{rms} −700 mV	——————V ————————V	303.300 V V_{rms} +700 mV
DC programming and measurement accuracy			
425 VDC accuracy Front panel measurement	424.075 V VDC −0.363 V	——————V ————————V	425.925 V V_{rms} +0.363 V
−425 VDC accuracy Front panel measurement	−424.075 V VDC −0.363 V	——————V ————————V	−425.925 V V_{rms} +0.363 V
RMS current measurement accuracy			
Low range High range (I_{out} = calculated output current @ 60 Hz)	I_{out} −0.00275 A I_{out} −0.01125 A	—————A —————A	I_{out} +0.00275 A I_{out} +0.01125 A

Table B-3   Keysight 6812C verification test record

Model Keysight 6812C	Report number_____	Date_____	
Test description	Minimum specification	Recorded results	Maximum specification
Voltage programming and measurement accuracy			
300 V_{rms} accuracy at 45 Hz Front panel measurement	299.250 V V_{rms} −190 mV	_____V _____V	300.750 V V_{rms} +190 mV
300 V_{rms} accuracy at 400 Hz Front panel measurement	298.200 V V_{rms} −400 mV	_____V _____V	301.800 V V_{rms} +400 mV
300 V_{rms} accuracy at 1 kHz Front panel measurement	296.700 V V_{rms} −700 mV	_____V _____V	303.300 V V_{rms} +700 mV
DC programming and measurement accuracy			
425 VDC accuracy Front panel measurement	424.075 V VDC −0.363 V	_____V _____V	425.925 V Vrms +0.363 V
−425 VDC accuracy Front panel measurement	−424.075 V VDC −0.363 V	_____V _____V	−425.925 V Vrms +0.363 V
RMS current measurement accuracy			
Low range High range (I_{out} = calculated output current @ 60 Hz)	I_{out} −0.0040 A I_{out} −0.0125 A	_____A _____A	I_{out} +0.0040 A I_{out} +0.0125 A

Table B-4   Keysight 6813C verification test record

Model Keysight 6813C	Report number_____	Date_____	
Test description	**Minimum specification**	**Recorded results**	**Maximum specification**
Voltage programming and measurement accuracy			
300 V_{rms} accuracy at 45 Hz Front panel measurement	299.250 V V_{rms} −190 mV	_____V _____V	300.750 V V_{rms} +190 mV
300 V_{rms} accuracy at 400 Hz Front panel measurement	298.200 V V_{rms} −400 mV	_____V _____V	301.800 V V_{rms} +400 mV
300 V_{rms} accuracy at 1 kHz Front panel measurement	296.700 V V_{rms} −700 mV	_____V _____V	303.300 V V_{rms} +700 mV
DC programming and measurement accuracy			
425 VDC accuracy Front panel measurement	422.575 V VDC −0.363 V	_____V _____V	427.425 V Vrms +0.363 V
−425 VDC accuracy Front panel measurement	−422.575 V VDC −0.363 V	_____V _____V	−427.425 V Vrms +0.363 V
RMS current measurement accuracy			
Low range High range (I_{out} = calculated output current @ 60Hz)	I_{out} −0.0040 A I_{out} −0.0125 A	_____A _____A	I_{out} +0.0040 A I_{out} +0.0125 A

Performing the Calibration Procedure

Table B-1 lists the equipment required for calibration. Figure B-1 shows the test setup.

NOTE	You do not have to do a complete calibration each time. You may calibrate only the voltage or current and proceed to "Saving the calibration constants" on page 173. However, before you calibrate OVP, you must first calibrate the output voltage.

The following parameters may be calibrated:

- AC output voltage
- output voltage measurement
- overvoltage protection (OVP)
- AC output current
- output current measurement
- output impedance

Before calibrating the output impedance, you must first calibrate the output voltage and the output current.

Front panel calibration menu

The **Entry** keypad is used for calibration functions.
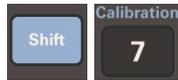
Shift **7** (Calibration)   Press this key to access the calibration menu.

Display	Command function
CAL ON ‹value›	Turns calibration mode on when the correct password value is entered.
CAL OFF	Turns calibration mode off.
CAL:LEV ‹char›	Advance to next step in sequence (P1, P2, P3, or P4).
CAL:DATA ‹value›	Input a calibration measurement.
CAL:VOLT:OFFSET	Begin voltage offset calibration.
CAL:VOLT:DC	Begin dc voltage calibration sequence.
CAL:VOLT:AC	Begin ac voltage calibration sequence.
CAL:VOLT:PROT	Begin voltage protection calibration.
CAL:CURR:AC	Begin ac current calibration sequence.
CAL:CURR:MEAS	Begin current measurement calibration sequence.
CAL:IMP	Begin output impedance calibration sequence.
CAL:SAVE	Saves the calibration constants in non-volatile memory.
CAL:PASS ‹value›	Set new calibration password.

Notes:

– value = a numeric value
– char = a character string parameter
– Press ▲ and ▼ of the **Function** key group to scroll through the command list.
– Press ▲ and ▼ of the **Entry** key group to scroll through the parameter list.

Front Panel Calibration

WARNING *LETHAL VOLTAGES.* AC sources can supply 424 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. These procedures must be performed by a qualified electronics technician or engineer trained on this equipment.

TENSIONS MORTELLES. Les AC source peuvent fournir 424 V$_{maximum}$ au niveau de leur sortie. Tout contact peut entraîner la MORT si les circuits ou bornes de sorties connectés à la sortie sont touchés lorsqu'ils sont sous tension. Ces procédures doivent être réalisées par un ingénieur ou technicien en électronique qualifié formé sur l'équipement.

The following procedures assume you understand how to operate front panel keys (see Chapter 4, " Front Panel Operation").

Enable calibration mode

Action	Display
1 Reset the unit by selecting **[Output]**, scrolling to the *RST command and pressing **[Enter]**.	*RST
2 To begin calibration press **[Shift] [Calibration]**, scroll to CAL ON and press **[Enter]**.	CAL ON 0.0
3 Enter the calibration password from **Entry** keypad and press **[Enter]**. If the password is correct the **Cal** annunciator will come on.	
If CAL DENIED appears, then an internal switch has been set to prevent the calibration from being changed.	CAL DENIED
If the password is incorrect, an error occurs. If the active password is lost, the calibration function can be recovered by setting an internal switch that defeats password protection.	OUT OF RANGE

Calibrating and entering voltage offset values

Connect the negative terminal of the DMM to the COM output terminal. Note that some calibration points are negative; be sure to enter the CAL:DATA as negative values when required.

	Action	Display
1	Connect the DMM (dc volts mode) directly to the ac source. Do not connect the ratio transformer or load resistor shown in Figure B-1.	
2	Press **[Shift] [Calibration]**, scroll to the CAL VOLT OFFSET command, and press **[Enter]**.	CAL:VOLT:OFFSET
3	Press **[Shift] [Calibration]**, scroll to the CAL LEV P1 command, and press **[Enter]** to select the first calibration point.	CAL:LEV P1
4	Press **[Shift] [Calibration]**, scroll to CAL DATA 0.00, and use the **Entry** keypad to enter the DC voltage value displayed on the DMM.	CAL:DATA 0.00
5	Press **[Shift] [Calibration]**, scroll to the CAL LEV P1 command, use ▼ on the **Entry** keypad to scroll to the P2 parameter, and press **[Enter]**. This selects the second calibration point.	CAL:LEV P2
6	Press **[Shift] [Calibration]**, scroll to CAL DATA 0.00, and use the **Entry** keypad to enter the DC voltage value displayed on the DMM.	CAL:DATA 0.00
7	Press **[Shift] [Calibration]**, scroll to the CAL LEV P1 command, use ▼ on the **Entry** keypad to scroll to the P3 parameter, and press **[Enter]**.	CAL:LEV P3
8	Press **[Shift] [Calibration]**, scroll to CAL DATA 0.00, and use the **Entry** keypad to enter the DC voltage value displayed on the DMM.	CAL:DATA 0.00

Action	Display	
9 Press **[Shift] [Calibration]**, scroll to the CAL LEV P1 command, use ▼ on the **Entry** keypad to scroll to the P4 parameter, and press **[Enter]**.	CAL:LEV	P4
10 Press **[Shift] [Calibration]**, scroll to CAL DATA 0.00, and use the **Entry** keypad to enter the DC voltage value displayed on the DMM.	CAL:DATA	0.00

The ac source is now holding the new voltage offset calibration constants in RAM.

Calibrating and entering DC voltage gain values

Connect the negative terminal of the DMM to the COM output terminal. Note that some calibration points are negative; be sure to enter the CAL:DATA as negative values when required.

Action	Display	
1 Connect the DMM (dc volts mode) directly to the ac source. Do not connect the ratio transformer or load resistor shown in Figure B-1.		
2 Press **[Shift] [Calibration]**, scroll to the CAL VOLT DC command, and press **[Enter]**.	CAL:VOLT:DC	
3 Press **[Shift] [Calibration]**, scroll to the CAL LEV P1 command, and press **[Enter]** to select the first calibration point.	CAL:LEV	P1
4 Press **[Shift] [Calibration]**, scroll to CAL DATA 0.00, and use the **Entry** keypad to enter the DC voltage value displayed on the DMM.	CAL:DATA	0.00
5 Press **[Shift] [Calibration]**, scroll to the CAL LEV P1 command, use ▼ on the **Entry** keypad to scroll to the P2 parameter, and press **[Enter]**. This selects the second calibration point.	CAL:LEV	P2

Action	Display	
6 Press **[Shift] [Calibration]**, scroll to CAL DATA 0.00, and use the **Entry** keypad to enter the DC voltage value displayed on the DMM.	CAL:DATA	0.00
7 Press **[Shift] [Calibration]**, scroll to the CAL LEV P1 command, use ▼ on the **Entry** keypad to scroll to the P3 parameter, and press **[Enter]**.	CAL:LEV	P3
8 Press **[Shift] [Calibration]**, scroll to CAL DATA 0.00, and use the **Entry** keypad to enter the DC voltage value displayed on the DMM.	CAL:DATA	0.00

The ac source is now holding the new dc voltage gain calibration constants in RAM.

Calibrating and entering AC rms voltage gain values

Action	Display	
1 Connect the DMM (ac volts mode) directly to the ac source using the ratio transformer shown in Figure B-1.		
2 Press **[Shift] [Calibration]**, scroll to the CAL VOLT AC command, and press **[Enter]**.	CAL:VOLT:AC	
3 Press **[Shift] [Calibration]**, scroll to the CAL LEV P1 command, and press **[Enter]** to select the first calibration point.	CAL:LEV	P1
4 Press **[Shift] [Calibration]**, scroll to CAL DATA 0.00, and use the **Entry** keypad to enter the product of the transformer ratio times the AC voltage value displayed on the DMM.	CAL:DATA	0.00
5 Press **[Shift] [Calibration]**, scroll to the CAL LEV P1 command, use ▼ on the **Entry** keypad to scroll to the P2 parameter, and press **[Enter]**. This selects the second calibration point.	CAL:LEV	P2

Action	Display	
6 Press **[Shift] [Calibration]**, scroll to CAL DATA 0.00, and use the **Entry** keypad to enter the product of the transformer ratio times the AC voltage value displayed on the DMM.	CAL:DATA	0.00
7 Press **[Shift] [Calibration]**, scroll to the CAL LEV P1 command, use ▼ on the **Entry** keypad to scroll to the P3 parameter, and press **[Enter]**.	CAL:LEV	P3
8 Press **[Shift] [Calibration]**, scroll to CAL DATA 0.00, and use the **Entry** keypad to enter the product of the transformer ratio times the AC voltage value displayed on the DMM.	CAL:DATA	0.00
9 Press **[Shift] [Calibration]**, scroll to the CAL LEV P1 command, use ▼ on the **Entry** keypad to scroll to the P4 parameter, and press **[Enter]**.	CAL:LEV	P4
10 Press **[Shift] [Calibration]**, scroll to CAL DATA 0.00, and use the **Entry** keypad to enter the product of the transformer ratio times the AC voltage value displayed on the DMM.	CAL:DATA	0.00

The ac source is now holding the new ac rms voltage calibration constants in RAM.

Calibrating the OVP trip point

Action	Display
1 Press **[Shift] [Calibration]**, scroll to the CAL VOLT PROT command, and press **[Enter]**.	CAL:VOLT:PROT
2 Wait for the ac source to compute the OVP calibration constant. The display returns to Meter mode when the OVP calculation is complete.	

The ac source is now holding the new OVP calibration constants in RAM.

Calibrating and entering rms current values

Action	Display
1 Connect the DMM (ac rms mode), current shunt, and load resistor as shown in Figure B-1 with S1 closed.	
2 Press **[Shift] [Calibration]**, scroll to the CAL CURR AC command, and press **[Enter]**.	CAL:CURR:AC
3 Press **[Shift] [Calibration]**, scroll to the CAL LEV P1 command, and press **[Enter]**.	CAL:LEV P1
4 Press **[Shift] [Calibration]**, scroll to CAL DATA 0.00 command. Calculate the rms current value (DMM ac rms voltage/shunt resistance), and use the **Entry** keypad to enter the rms current.	CAL:DATA 0.00
5 Press **[Shift] [Calibration]**, scroll to the CAL LEV P1 command, use ▼ on the **Entry** keypad to scroll to the P2 parameter, and press **[Enter]**.	CAL:LEV P2

Action	Display
6 Press **[Shift] [Calibration]**, scroll to CAL DATA 0.00 command. Calculate the rms current value (DMM ac rms voltage/shunt resistance), and use the **Entry** keypad to enter the rms current.	CAL:DATA 0.00

The ac source is now holding the new rms current calibration constants in RAM.

Calibrating and entering rms current measurement values

Action	Display
1 Connect the DMM (ac rms mode), current shunt, and load resistor as shown in Figure B-1 with S1 closed.	
2 Press **[Shift] [Calibration]**, scroll to the CAL CURR MEAS command, and press **[Enter]**.	CAL:CURR:MEAS
3 Press **[Shift] [Calibration]**, scroll to the CAL LEV P1 command, and press **[Enter]**.	CAL:LEV P1
4 Press **[Shift] [Calibration]**, scroll to CAL DATA 0.00 command. Calculate the rms current value (DMM ac rms voltage/shunt resistance), and use the **Entry** keypad to enter the rms current.	CAL:DATA 0.00
5 Press **[Shift] [Calibration]**, scroll to the CAL LEV P1 command, use ▼ on the **Entry** keypad to scroll to the P2 parameter, and press **[Enter]**.	CAL:LEV P2
6 Press **[Shift] [Calibration]**, scroll to CAL DATA 0.00 command. Calculate the rms current value (DMM ac rms voltage/shunt resistance), and use the **Entry** keypad to enter the rms current.	CAL:DATA 0.00

The ac source is now holding the new rms current calibration constants in RAM.

Calibrating the output impedance

Action	Display
1 Connect only the output impedance resistor across the output of the ac source. Do not connect any other equipment.	
2 Press **[Shift] [Calibration]**, scroll to the CAL IMP command, and press **[Enter]**.	CAL:IMP
3 Wait for the ac source to compute the output impedance calibration constant. The display returns to Meter mode when the calculation is complete.	

The ac source is now holding the new output impedance calibration constants in RAM.

Saving the calibration constants

NOTE	Storing calibration constants overwrites the existing ones in non-volatile memory. If you are not sure you want to permanently store the new constants, omit this step. The ac source calibration will then remain unchanged.

Action	Display
1 Press **[Shift] [Calibration]**, scroll to the CAL SAVE command, and press **[Enter]**.	CAL:SAVE
2 Press **[Shift] [Calibration]**, select CAL OFF, and press **[Enter]** to exit Calibration mode. *RST and *RCL will also set the calibration state to OFF.	CAL OFF

Changing the Calibration Password

The factory default password is 0. You can change the password when the ac source is in calibration mode (which requires you to enter the existing password). Proceed as follows:

Action	Display	
1 Begin by pressing **[Shift] [Calibration]** and scrolling to the CAL ON command.	CAL ON	0.0
2 Enter the existing password from **Entry** keypad and press **[Enter]**.		
3 Press **[Shift] [Calibration]** and scroll to the CAL PASS command.	CAL:PASS	0
4 Enter the new password from the keypad. You can use any number with up to six digits and an optional decimal point. If you want the calibration function to operate without requiring any password, change the password to 0 (zero).		

NOTE   If you want the calibration function to operate without requiring any password, change the password to 0 (zero).

Calibration Error Messages

Errors that can occur during calibration are shown in the following table.

Table B-5   GPIB calibration error messages

Error	Meaning
401	CAL switch prevents calibration (This is a hardware disable)
402	CAL password is incorrect
403	CAL not enabled
404	Computed readback cal constants are incorrect
405	Computed programming cal constants are incorrect
406	Incorrect sequence of calibration commands

Calibration Over the GPIB

You can calibrate the ac source by using SCPI commands within your controller programming statements. Be sure you are familiar with calibration from the front panel before you calibrate from a controller. Each front panel calibration command has a corresponding SCPI command.

The SCPI calibration commands are explained in "Chapter 3" of the *Keysight Models 6811C, 6812C, and 6813C AC Power Solutions Programming Guide*. Calibration error messages that can occur during GPIB calibration are shown in Table B-5.

C   Error Messages

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Error Number List

This appendix gives the error numbers and descriptions that are returned by the ac source. Error numbers are returned in two ways:

– Error numbers are displayed on the front panel

– Error numbers and messages are read back with the SYSTem:ERRor? query. SYSTem:ERRor? returns the error number into a variable and returns two parameters: an NR1 and a string.

The following table lists the errors that are associated with SCPI syntax errors and interface problems. It also lists the device dependent errors. Information inside the brackets is not part of the standard error message, but is included for clarification. When errors occur, the Standard Event Status register records them in bit 2, 3, 4, or 5:

Table C-1   Error numbers

Error number	Error string [description/explanation/examples]
Command Errors –100 through –199 (sets Standard Event Status register bit #5)	
–100	Command error [generic]
–101	Invalid character
–102	Syntax error [unrecognized command or data type]
–103	Invalid separator
–104	Data type error [e.g., "numeric or string expected, got block data"]
–105	GET not allowed
–108	Parameter not allowed [too many parameters]
–109	Missing parameter [too few parameters]
–112	Program mnemonic too long [maximum 12 characters]
–113	Undefined header [operation not allowed for this device]
–121	Invalid character in number [includes "9" in octal data, etc.]
–123	Numeric overflow [exponent too large; exponent magnitude >32 k]
–124	Too many digits [number too long; more than 255 digits received]

Table C-1   Error numbers (continued)

Error number	Error string [description/explanation/examples]
–128	Numeric data not allowed
–131	Invalid suffix [unrecognized units, or units not appropriate]
–138	Suffix not allowed
–141	Invalid character data [bad character, or unrecognized]
–144	Character data too long
–148	Character data not allowed
–150	String data error
–151	Invalid string data [e.g., END received before close quote]
–158	String data not allowed
–160	Block data error
–161	Invalid block data [e.g., END received before length satisfied]
–168	Block data not allowed
–170	Expression error
–171	Invalid expression
–178	Expression data not allowed
Execution errors –200 through –299 (sets Standard Event Status register bit #4)	
–200	Execution error [generic]
–221	Settings conflict [check current device state]
–222	Data out of range [e.g., too large for this device]
–223	Too much data [out of memory; block, string, or expression too long]
–224	Illegal parameter value [device-specific]
–225	Out of memory
–270	Macro error
–272	Macro execution error
–273	Illegal macro label
–276	Macro recursion error

Table C-1   Error numbers (continued)

Error number	Error string [description/explanation/examples]
–277	Macro redefinition not allowed
System Errors –300 through –399 (sets Standard Event Status register bit #3)	
–310	System error [generic]
–350	Too many errors [errors beyond 9 lost due to queue overflow]
Query Errors –400 through –499 (sets Standard Event Status register bit #2)	
–400	Query error [generic]
–410	Query INTERRUPTED [query followed by DAB or GET before response complete]
–420	Query UNTERMINATED [addressed to talk, incomplete programming message received]
–430	Query DEADLOCKED [too many queries in command string]
–440	Query UNTERMINATED [after indefinite response]
Self-test Errors 0 through 99 (sets Standard Event Status register bit #3)	
0	No error
1	Non-volatile RAM RD0 section checksum failed
2	Non-volatile RAM CONFIG section checksum failed
3	Non-volatile RAM CAL section checksum failed
4	Non-volatile RAM WAVEFORM section checksum failed
5	Non-volatile RAM STATE section checksum failed
6	Non-volatile RAM LIST section checksum failed
7	Non-volatile RAM RST section checksum failed
10	RAM self-test
11 - 31	DAC self-test error, expected ‹n›, read ‹reading›
40	Voltage self-test error, output 1
41	Voltage self-test error, output 2
42	Voltage self-test error, output 3
43	Current self-test error, output 1

Table C-1   Error numbers (continued)

Error number	Error string [description/explanation/examples]
44	Current self-test error, output 2
45	Current self-test error, output 3
60	FPGA JTAG error
61	FPGA image invalid
62	Model Detection FPGA version invalid
63	Analog voltage rail failed
64	Model Detection FPGA model bit invalid
65	Model Detection EEPROM model checksum failed
66	Model Detection between FPGA and EEPROM incompatible
67	EEPROM version is higher than expected
70	Fan voltage failure
71	3.3V voltage failed
72	5V voltage failed
80	Digital I/O self-test error
90	Non-volatile RAM IO DATA section checksum failed
91	Non-volatile RAM ROM VERS section checksum failed
92	Non-volatile RAM SERIAL section checksum failed
93	Non-volatile RAM MAC ADDR section checksum failed
94	Non-volatile RAM LAN section checksum failed
95	Non-volatile RAM HTTP section checksum failed
96	Non-volatile RAM PERSONA section checksum failed
97	Non-volatile RAM CAL INFO section checksum failed
Device-Dependent Errors 100 through 32767 (sets Standard Event Status register bit #3)	
200	Outgrd not responding
201	Front panel not responding
210	Ingrd receiver framing error

Table C-1   Error numbers (continued)

Error number	Error string [description/explanation/examples]
211	Ingrd uart overrun status
212	Ingrd received bad token
213	Ingrd receiver buffer overrun
214	Ingrd input buffer overrun
215	Outgrd output buffer overrun
216	RS-232 receiver framing error
217	RS-232 receiver parity error
218	RS-232 receiver overrun error
219	Ingrd inbuf count sync error
220	Front panel uart overrun
221	Front panel uart framing
222	Front panel uart parity
223	Front panel buffer overrun
224	Front panel timeout
401	CAL switch prevents calibration
402	CAL password is incorrect
403	CAL not enabled
404	Computed readback cal constants are incorrect
405	Computed programming cal constants are incorrect
406	Incorrect sequence of calibration commands
481	Model bit detection failed
501	LAN disconnect
502	LAN invalid IP address
503	LAN duplicate IP address
504	LAN failed to renew DHCP lease
505	LAN failed to configure

Table C-1   Error numbers (continued)

Error number	Error string [description/explanation/examples]
506	LAN failed to initialize
507	LAN VXI-11 fault
600	Systems in mode:list have different list lengths
601	Requested voltage and waveform exceeds peak voltage capability
602	Requested voltage and waveform exceeds transformer volt-second rating
603	Command only applies to RS-232 interface
604	Trigger received before requested number of pre-trigger readings
605	Requested RMS current too high for voltage range
606	Waveform data not defined
607	VOLT, VOLT:SLEW, and FUNC:SHAP modes incompatible
608	Measurement overrange
609	Output buffer overrun
610	Command cannot be given with present SYST:CONF setting
614	Measurement error occurred
900	Firmware update failed

C   Error Messages

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D   Option 019

KEYSIGHT
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2000 VA Output Capability

The 2000 VA Output Capability Option 019 is available on the Keysight 6813C Option 019 AC Power Source (2000VA).

Option 019 increases the output VA capability of the standard Keysight 6813C AC Power Source from 1750 VA to 2000 VA. To achieve the increased output VA capability, the output rms voltage, DC voltage and rms current ratings have increased slightly, to the maximum ratings documented in Table D-1. The primary restriction that this increased output imposes on Option 019 units as compared to standard units, is the reduction in the output frequency range to between 45 and 100 Hz.

Specifications for Option 019

Table D-1 lists the specifications changes for units with Option 019. Performance specifications are warranted over the ambient temperature range of 0 to 40 °C. Unless otherwise noted, specifications are for a sine wave with a resistive load at a frequency range of 45 Hz to 100 Hz, after a 30-minute warm-up.

Table D-1   Performance specifications

Parameter	Keysight 6813C Option 019
Phases	1
Maximum Output Ratings	
Power	2000 VA
DC power	1500 W
RMS voltage	308 V
DC voltage	±436 V
Isolation to ground	308 V_{rms}/436 V_{dc}
RMS current (in real-time mode)	16 A
DC current	10 A
Repetitive peak current	48 A
Non-repetitive peak current (inrush)	48 A
Crest factor (current)	3 at 16 A (crest factor is higher at lower currents)
Output frequency range	DC; 45 Hz to 100 Hz
Programming accuracy (rms detection mode at 25°C ± 5°C), ±(% of output + offset)	
RMS voltage (45 to 100 Hz)	0.15% + 0.3 V
Frequency	0.01% + 10 µHz
DC voltage	0.5% + 0.3 V
Measurement accuracy (at 25 °C ± 5 °C), ±(% of output + offset)	
RMS voltage (45 to 100 Hz)	0.03% + 100 mV

Table D-1   Performance specifications

Parameter	Keysight 6813C Option 019
Frequency	0.01% + 0.01 Hz
DC voltage	0.03% + 150 mV

Table D-2   Supplemental characteristics

Parameter	Keysight 6813C Option 019
AC input voltage range	230 Vac (±10%) (230 Vac nominal)
Net weight	30.1 kg (66.4 lbs)
Shipping weight	34.59 kg (76.26 lbs)

E   Option 020

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Keysight Dual Power Analyzer Description

The Keysight Dual Power Analyzer Option 020 is available on the following ac sources:

– Keysight 6811C AC Power Source (375VA)

– Keysight 6812C AC Power Source (750VA)

– Keysight 6813C AC Power Source (1750VA)

Option 020 consists of an additional Power Analyzer input on the back of the ac source, an external current shunt, and a cable to connect the current shunt to the ac source. Option 020 adds the following capabilities to the above listed ac source models:

– Voltage and current measurement inputs on the rear panel, with capabilities similar to the output voltage and current measurements available in standard Keysight ac sources.

– The ability to use any shunt for the external current measurement, allowing current measurements over a very wide range of magnitudes.

– Precisely synchronized measurements between the rear panel Power Analyzer input and the ac source output. This is possible because the Power Analyzer input has its own dedicated measurement buffer.

– New measurement commands that may be used in evaluating uninterruptible power supplies (for example measuring transfer time, peak voltage, and phase locked loop performance).

– Frequency modulation of the ac source output.

As shown in the following figure, the Keysight Dual Power Analyzer also includes a Keysight supplied current shunt, which must be connected to the output of the equipment under test to make accurate voltage and current measurements. The specifications and supplemental characteristics of the Keysight Dual Power Analyzer are documented toward the end of this document.
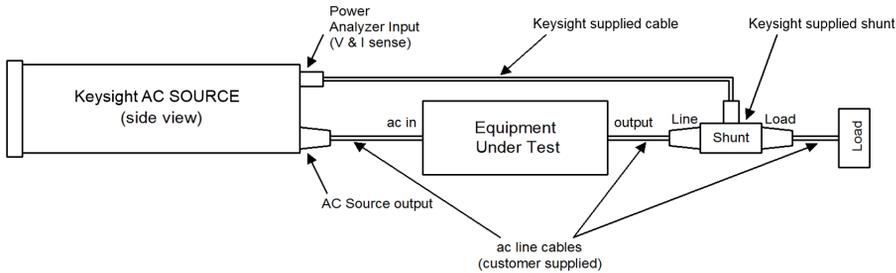
Figure E-1   Option 020 Typical Connections

Front Panel Menus - Additions

The Power Analyzer input uses the same front panel menu commands that are used to measure the Main Output of the ac source. The following menu commands have been added to let you access the Power Analyzer input, control the output frequency modulation, and calibrate the Power Analyzer input. In most cases you will need to press the ▲ or ▼ on the Function key pad to access the menu item. Press ▲ or ▼ on the Entry key to access the parameter.

Function key press	Function command on the front panel display	Description
LAN Reset **Phase Select** Press **Phase Select** to toggle between ϕ1 and ϕ2.	ϕ1 115V 60 Hz	Display the Main Output measurement when ϕ1 is selected.
	ϕ2 120V 60 Hz	Display the Power Analyzer measurement when ϕ2 is selected.
Phase **Freq** Use ▲ or ▼ to navigate between the **Freq** function commands.	FM OFF	Enable or disable output frequency modulation (OFF or ON).
	FM:FREQ 50	Specify the modulating frequency of the output.
	FM:DEV 10	Specify the peak deviation of the output frequency modulation.
Output **Input** Use ▲ or ▼ to navigate between the **Input** function commands	FREQ:SRC VOLT	Specify the frequency input source (VOLT or CURR)

Entry key press	Function key press	Entry command	Description
Shift / Calibration 7	Use ▲ or ▼ to navigate between the **Calibration** function commands	CAL:CURR: EXT	Begin external current calibration
		CAL:VOLT: EXT	Begin external voltage calibration
		SHUNT	Enter a value for the external shunt in ohms

NOTE	With no signal connected to the Power Analyzer input, the φ2 front panel display may return a very high frequency value. This is normal, since there is no external frequency for the measurement circuit to detect.

Rear Panel Connections

Power Analyzer input with removable connector plug

**Figure E-2**   Rear panel - overall view

Installation

Turn the unit off before connecting any wires.

The Power Analyzer input to the ac source has both voltage and current sense inputs. Each sense input has a HI and a LO connection. The center pin of the connector is not used. The maximum isolation voltage to ground is 300 Vac ($\pm$ 425 V_{dc}).

Use the 1-meter, Keysight supplied cable and connect the Power Analyzer input to the external shunt. Note that the cable connectors are keyed so that the cable will only fit one way. Disconnect the cable from the unit by pulling it straight back.

| NOTE | You should always connect the V SENSE inputs for the Power Analyzer input to operate properly, even if you are not making voltage measurements. This is because frequency measurements are made by sensing the voltage signal, and many of the power analyzer measurements depend on an accurate frequency measurement. If a voltage signal is not available, use SENSe:FREQuency:SOURce (or its front panel equivalent) to select and measure the frequency from the current signal instead. |

Cable connections are shown in the following figure.
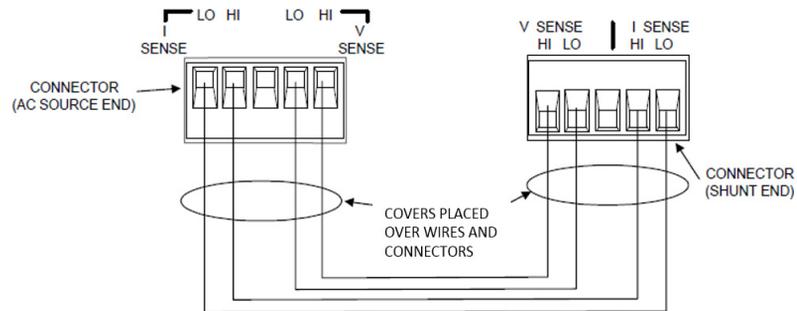
Figure E-3   Measurement cable connections

CAUTION	The insulator on the cover must not be removed because it provides ESD protection to the AC source. Please contact Keysight Technical Support for cable length adjustment.
	L'isolateur sur le couvercle ne doit pas être retiré car il fournit une protection ESD pour la AC source. Veuillez contacter l'assistance technique de Keysight pour le réglage de longueur du câble.

WARNING	SAFETY HAZARD. The connector screw terminals will be at line potential during operation.
	RISQUE DE SÉCURITÉ. Les bornes à vis du connecteur seront au potentiel de ligne pendant le fonctionnement.

External shunt line and load connections

The Keysight supplied current shunt has both input (line) and output (load) connectors. The customer must supply the cables to connect the ac lines to and from the external current shunt. Keysight supplies one hooded cable cover for the input of the ac source and two hooded cable covers for the shunt. All three of these covers are assembled and installed in the same way. It is the customer's responsibility to use these covers when making line cable connections. Note that a different cable cover is provided for the ac output of the ac source.

The following figure shows the Load and Line connectors on the external current shunt. Note the location of the line, neutral and ground connectors and connect your cables accordingly. Note that the connections on the output of the ac source are not in the same order on the barrier block as on the shunt barrier block.

WARNING SAFETY HAZARD. You must secure the power safety cover that was removed after completing all connections. This is because the connector screw terminals will be at line potential during operation.

RISQUE DE SÉCURITÉ. Vous devez fixer fermement le couvercle de sécurité d'alimentation qui a été retiré après avoir réalisé toutes les connexions. Les bornes à vis du connecteur seront en effet au potentiel de ligne pendant le fonctionnement.
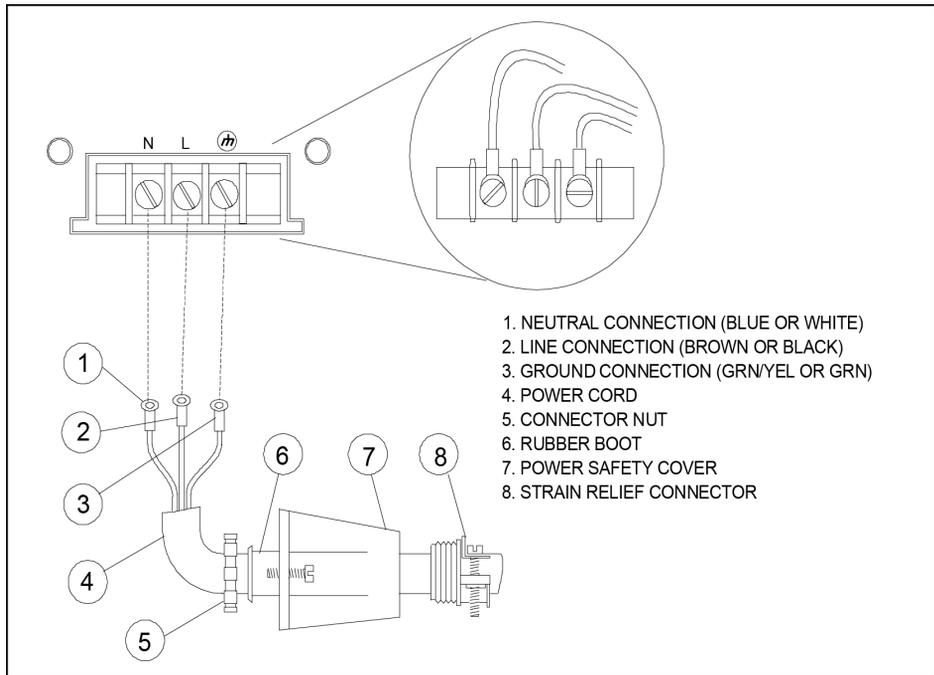
Figure E-4   Line connections
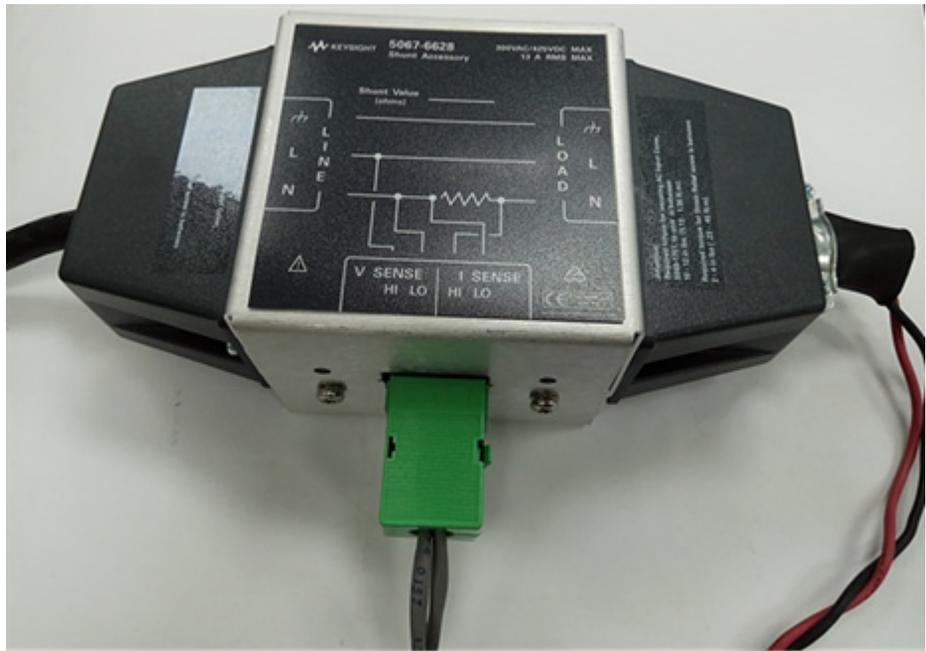
Figure E-5   Shunt box connection orientation

WARNING   For the best safety practice, ensure that the shunt box is placed with its label always facing up. See Figure E-5 for the correct shunt box connection orientation set up.

Pour les meilleures pratiques de sécurité, veillez à ce que la boîte de dérivation soit placée avec son étiquette vers le haut. Consultez la Figure E-5 pour la configuration adéquate de l'orientation de connexion de la boîte de dérivation.

Check the external current shunt setting

After you have completed your cable connections, you can turn on and check out the ac source as described in the Chapter 3, "Turn-On Checkout". One additional step in checking out a unit with Option 020 installed, is to make sure that the correct shunt value has been entered in the unit. To check the shunt value setting, proceed as follows:

Action		Display	
1	Turn on the ac source and wait for the unit to finish its internal self-test.		
2	Press **[Shift] [Calibration]** and scroll to the SHUNT command.	SHUNT	0.01
3	Check to see if the resistance value on the display matches the value written on the outside of the external current shunt.		
	If it matches, press **[Meter]** to return to meter mode. You are done.		
	If it does not match, you must enter the correct value. Proceed as follows:		
4	Press **[Shift] [Calibration]**, scroll to **CAL ON** and press **[Enter]**. If necessary, enter the calibration password from **Entry** keypad and press **[Enter]**. If the password is correct the **Cal** annunciator will come on.	CAL ON	0.0
5	Press **[Shift] [Calibration]**, and scroll to the **SHUNT** command. Enter the shunt value written on the outside of the external current shunt exactly as it is written on the label. Then press **[Enter]**.	SHUNT	0.01
6	Press **[Shift] [Calibration]**, scroll to **CAL SAVE**, and press **[Enter]**.	CAL:SAVE	

Action	Display	
7 Press **[Shift] [Calibration]**, select **CAL OFF**, and press **[Enter]** to exit calibration.	CAL	OFF

NOTE	The shunt value that you enter applies only to the Power Analyzer input and has no effect on ac source output measurements. Therefore, ignore the $\phi 1$ and $\phi 2$ annunciators while entering the shunt value.

Front Panel Programming

Setting the output frequency modulation

The following steps describe how to set the output frequency modulation.

Action	Display	
1 Press **[Freq]** on the **Function** keypad. Then scroll to the **FM:FREQ** command to enter a modulating frequency. Use the numeric keypad to enter a modulating value and press **[Enter]**.	FM:FREQ	1
2 Press **[Freq]** to set the peak frequency deviation of the output frequency modulation. Then scroll to the **FM:DEV** command to enter a frequency deviation. Use the numeric keypad to enter a value and press **[Enter]**. The deviation frequency must be less than the programmed output frequency by at least 0.001 Hz. Otherwise, it will result in Error 613.	FM:DEV	10
3 Enable frequency modulation by pressing **[Freq]**, scroll to **FM OFF**, select the **ON** parameter and press **[Enter]**.	FM ON	

Using the front panel display with the Power Analyzer input

The following describes how to select the measurement source.

Action	Display	
Press **[Meter]** to return the display to **Meter** mode. Press **[Phase Select]** at any time to toggle between the Main Output and the Power Analyzer input. The left-most digit of the front panel display will indicate either ϕ**1** for the Main Output, or ϕ**2** for the Power Analyzer input. If the ϕ**2** front panel display returns a very high frequency value, it usually means that there is no signal connected to the Power Analyzer input.	ϕ2 115V	60 Hz
Note that the **[Phase Select]** key also selects the measurement source to which the current range setting applies. The current range command is located in the input menu.		

Making Power Analyzer input measurements

All measurements are based on acquiring and subsequently processing waveform information. Waveform information is acquired either from the ac source output or from the Power Analyzer input. When the ac source is on, it continually takes measurements and updates the front panel meter from whichever measurement source is active. The **[Meter]** key accesses the measurement functions from the front panel. This menu applies to both the ac source output and the Power Analyzer input.

NOTE   The Shift Harmonic functions also apply to the Power Analyzer input.

If the display indicates OVLD, the measurement capability of the unit has been exceeded.

Use the **Meter** menu for making Power Analyzer input measurements.

Action	Display	
1 Press **[Phase Select]** to toggle to the Power Analyzer input. A φ2 will appear on the display when the Power Analyzer input is selected.	φ2 115V	3.04A
2 Press **[Meter]** and ▼ repeatedly to access the following measurement functions:		
– rms voltage and frequency (the default)	φ2 ‹reading›V	‹reading›Hz
– rms voltage and rms current	φ2 ‹reading›V	‹reading›A
– rms current and frequency (the default)	φ2 ‹reading›A	‹reading›Hz
– rms voltage and power	φ2 ‹reading›V	‹reading›W
– current crest factor	φ2 ‹reading› CREST F	
– peak current, repetitive	φ2 ‹reading›A PK REP	
– peak current, non-repetitive	φ2 ‹reading›A PK NR	
– apparent power	φ2 ‹reading› VA	
– reactive power	φ2 ‹reading› VAR	
– power factor	φ2 ‹reading› PFACTOR	

The ac source uses the output frequency value when calculating many of the output measurements. For ac source output measurements, the ac source uses the programmed output frequency value. For the Power Analyzer input, the ac source uses the frequency measured at the V SENSE input channel. This is the default setting. You can also select the I SENSE input channel as the frequency measurement source.

The following describes how to use the input menu for selecting the frequency source.

Action	Display	
If a voltage signal is not available to measure the output frequency, you must select the current measurement as the frequency source. Press **[Input]**, scroll to **FREQ:SRC VOLT**, select the **CURR** parameter and press **[Enter]**.	φ2 115V	60 Hz

Power Analyzer Input Specifications

Table E-1 lists the specifications of the Keysight Dual Power Analyzer Option 020. Performance specifications are warranted over the ambient temperature range of 0 to 40 °C. Unless otherwise noted, specifications are for a sine wave with a resistive load at a frequency range of 45 Hz to 1 kHz, with the Keysight supplied current shunt, after a 30-minute warm-up.

Table E-1   Performance specifications

Parameter	Keysight 6813C Option 020
Measurement accuracy (at 25 °C ±5 °C), ±(% of output + offset)	
RMS voltage	
(45 to 100 Hz)	0.03% + 100 mV
(>100 to 500 Hz)	0.1% + 100 mV
(>500 Hz to 1 kHz):	0.2% + 100 mV
DC voltage	0.03% + 150 mV
RMS current high range	
(45 to 100 Hz)	0.05% + 10 mA
(>100 to 500 Hz)	0.05% + 15 mA
(>500 Hz to 1 kHz)	0.05% + 30 mA
RMS current low range	
(45 to 100 Hz)	0.05% + 1.5 mA
(>100 to 500 Hz)	0.05% + 8 mA
(>500 Hz to 1 kHz)	0.05% + 25 mA
Repetitive pk current high range (45 Hz 1 kHz)	0.05% + 150 mA
Repetitive pk current low range (45 Hz 1 kHz)	0.03% + 150 mA
Power (VA) low range	
(45 to 100 Hz)	0.1% + 1.5 VA + 1.2 mVA/V
(>100 to 500 Hz)	0.1% + 2 VA + 1.2 mVA/V
(>500 Hz to 1 kHz)	0.1% + 6 VA + 1.2 mVA/V

Table E-1   Performance specifications

Parameter	Keysight 6813C Option 020
Power (VA) high range	
(45 to 100 Hz)	0.1% + 1.5 VA + 12 mVA/V
(>100 to 500 Hz)	0.1% + 2 VA + 12 mVA/V
(>500 Hz to 1 kHz)	0.1% + 6 VA + 12 mVA/V
Power (Watts) low range	
(45 to 100 Hz)	0.1% + 0.3 W + 1.2 mW/V
(>100 to 500 Hz)	0.1% + 1.2 W + 1.2 mW/V
(>500 Hz to 1 kHz)	0.1% + 2.5 W + 1.2 mW/V
Power (Watts) high range	
(45 to 100 Hz)	0.1% + 0.3 W + 12 mW/V
(>100 to 500 Hz)	0.1% + 1.2 W + 12 mW/V
(>500 Hz to 1 kHz)	0.1% + 2.5 W + 12 mW/V
Power Factor	0.01
Harmonic measurement accuracy (50/60 Hz, at 25 °C ±5 °C), (% of output + offset)	
Voltage magnitude	0.03% + 100 mV + 0.2%/kHz
Current magnitude (low range) fundamental	0.03% + 1.5 mA
Harmonics 2 to 49	0.03% + 1 mA + 0.2%/kHz
Current magnitude (high range) fundamental	0.05% + 5 mA
Harmonics 2 to 49	0.05% + 3 mA + 0.2%/kHz
Isolation to ground	300 V_{rms}/425 V_{dc}
Measurement ranges	
AC voltage	0 to 300 Vrms
DC voltage	± 425 V
Current	±80 A peak (high range) ±8 A peak (low range) 13 A_{rms} maximum continuous

Table E-1   Performance specifications

Parameter	Keysight 6813C Option 020
Average measurement resolution	
RMS voltage	10 mV
RMS current	2 mA
THD (for a fundamental amplitude ≥5% of full scale):	5% of reading + 0.1%
Average measurement resolution	
Measurement source synchronization	< 100 ns
Measurement buffer length	4096 points
Measurement/Generation synchronization	≤ 50 µs
Measurement acquisition sampling rate range	25 to 250 µs
Voltage/Current digitization accuracy	12 bits
Voltage/Current digitization resolution	16 bits
Harmonic measurement time (amplitude)	
Meas:Curr:Harm? <n>	400 ms
Meas:Array:Curr:Harm?	10 s

Table E-2   Supplemental characteristics

Parameter	Keysight 6811C Option 020	Keysight 6812C Option 020	Keysight 6813C Option 020
Net weight	30 kg (66.1 lbs)		31 kg (68.3 lbs)
Shipping weight	34.49 kg (76.04 lbs)		35.49 kg (78.24 lbs)

Verification and calibration for Option 020

This section includes verification and calibration procedures for the Keysight Dual Power Analyzer Option 020. Add these procedures to those described in Appendix B.

The verification procedures do not check all the operating parameters, but verify that the ac source is performing properly.

The output of the ac source must be enabled during verification or calibration, as such, proceed with caution since the voltages and currents will be active at the output terminals.

NOTE	Perform the verification procedures before calibrating your ac source. If the ac source passes the verification procedures, the unit is operating within its calibration limits and does not need to be re-calibrated.

WARNING	LETHAL VOLTAGES. AC sources can supply 425 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. These procedures must be performed by a qualified electronics technician or engineer trained on this equipment.
	TENSIONS MORTELLES. AC source peuvent fournir 425 V maximum à leur sortie. Tout contact peut entraîner la MORT si les circuits ou bornes de sorties connectés à la sortie sont touchés lorsqu'ils sont sous tension. Ces procédures doivent être réalisées par un ingénieur ou technicien en électronique qualifié formé sur l'équipement.

Equipment Required

The equipment listed in the following table, or the equivalent to this equipment, is required for verification and calibration.

Table E-3   Equipment required for option 020

Equipment	Characteristics	Recommended Model
5-pin connector plug	This connector is supplied with the ac source when ordered with Option 020.	0360-2681
Digital voltmeter	Resolution: 10 nV at 1 V Readout: 8.5 digits Accuracy: >20 ppm	Keysight 3458A
Current monitor[a]	0.01 Ω, ±200 ppm	Guildline 7320/0.01
Load resistor	30 Ω, 100 W minimum	
Capacitor (calibration only)	1.0 µF, 50 V	0160-3490
Function generator (calibration only)	50 mV, 500 mV, 60 Hz sine wave capability	Keysight 33120A
GPIB controller	Full GPIB capabilities	HP Series 200/300 or equivalent

[a]   The 4-terminal current shunt is used to eliminate output current measurement error caused by voltage drops in the load leads and connections. Connect the voltmeter directly to these current-monitoring terminals.

Verification Procedure

The following verification procedures assume you understand how to operate the ac source from the front panel as explained in Chapter 4, " Front Panel Operation".

Perform the following tests for operation verification in the order indicated.

1 Turn-on checkout.

2 Voltage measurement accuracy.

3 Current measurement accuracy.

| NOTE	The ac source must pass turn-on self-test before you can proceed with the verification.

Test setup
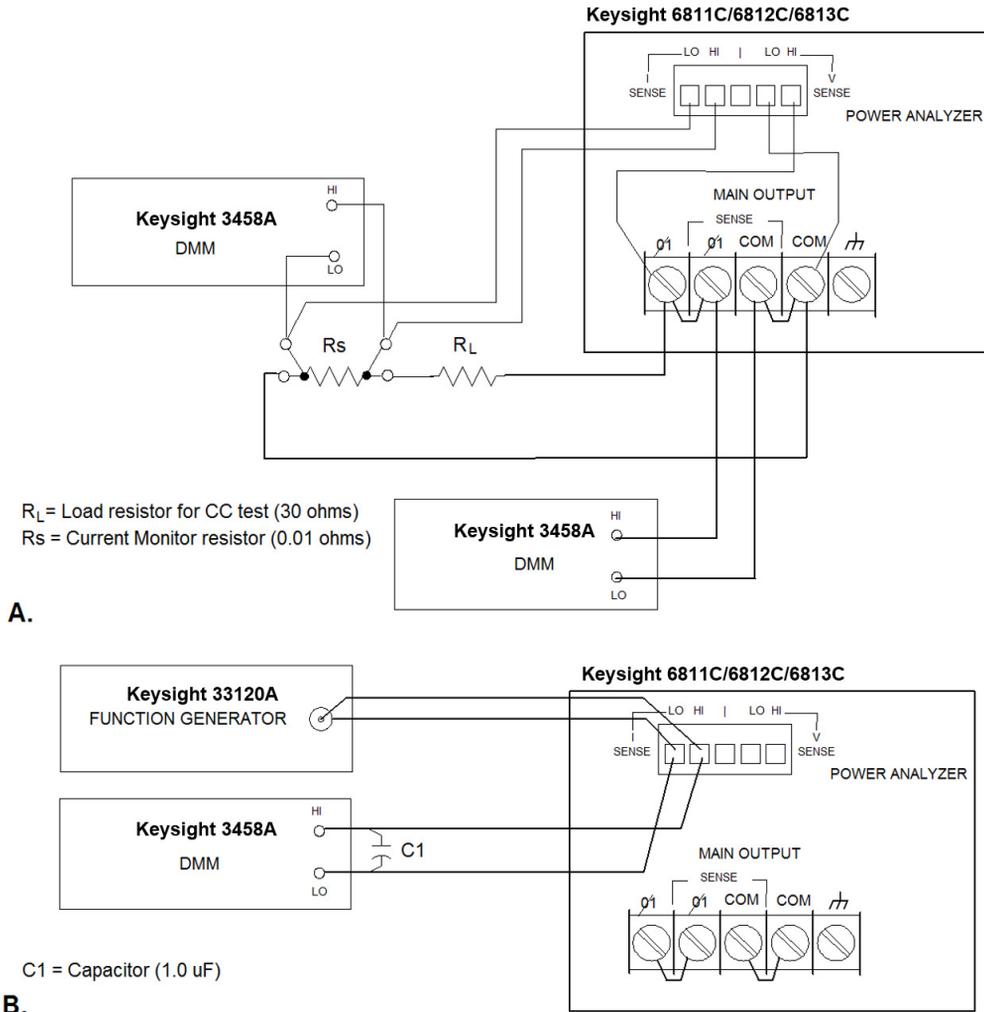
Figure E-6   Verification/Calibration test setup

Power Analyzer voltage measurement accuracy

This test verifies the accuracy of the Power Analyzer voltage measurements. The Phase 2 annunciator on the left side of the display, must be on for the front panel to display Power Analyzer input measurements. Part A in Figure E-6 shows the setup. Measure the ac output voltage directly at the output terminals.

Action	Normal result
1 Make sure the ac source is turned off. Connect the DMM to the output terminals the ac source. Connect the Power Analyzer voltage sense terminals (V SENSE) to the Main Output terminals of the ac source (see Part A in Figure E-6).	
2 Turn on the ac source with no load. In the **Output** menu, execute the *RST command to reset the unit to its factory default state.	*RST
3 If the Phase 2 annunciator does not appear on the right side of the display, press the **[Phase Select]** key.	ϕ^2 0 V 60 Hz
4 Program the output voltage to 150 volts and set the output current limit to its maximum value.	CV annunciator on
5 Enable the output by pressing **[Output On/Off]**.	Output voltage near 150 V
6 Record voltage readings at the DMM and on the front panel display.	$\phi2$ front panel reading within 145 mV of DMM reading
7 Program the output voltage to 300 volts.	Output voltage near 300 V
8 Record voltage readings at the DMM and on the front panel display.	$\phi2$ front panel reading within 190 mV of DMM reading

Power Analyzer current measurement accuracy

This test verifies the accuracy of the Power Analyzer current measurements. The Phase 2 annunciator on the left side of the display, must be on for the front panel to display Power Analyzer input measurements. Part A in Figure E-6 shows the setup. Use the Keysight supplied current shunt. It has the accuracy specified in Table E-3. Use wire of sufficient size to carry the maximum rated current of the ac source.

NOTE	Check to make sure that the internal shunt value in the ac source matches the value written on the external current shunt. Refer to "Check the external current shunt setting" on page 199.

Action	Normal result
1 Turn off the ac source. Connect the 30 Ω load resistor, current shunt, and the DMM across the current shunt. Connect the Power Analyzer current terminals (I SENSE) across the current shunt (see part A in Figure E-6).	
2 Turn on the ac source. In the **Output** menu, execute the ***RST** command to reset the unit to its factory default state.	*RST
3 If the Phase 2 annunciator does not appear on the right side of the display, press the **[Phase Select]** key.	ϕ^2 0 V 60 Hz
4 Program the output voltage to 100 volts and set the current limit to 3 amperes. Enable the output by pressing **[Output On/Off]**.	CC annunciator on, output current near 3 amperes
5 Record the DMM voltage reading and calculate the rms current. Divide the DMM reading by the current monitor resistor value. Record the front panel reading.	ϕ2 front panel reading within 11.5 mA of measured output current

Calibration Procedure

Table E-3 lists the equipment required for calibration. Figure E-6 shows the test setup. The following procedures assume you understand how to operate front panel keys (see Chapter 4, " Front Panel Operation").

WARNING   LETHAL VOLTAGES. AC sources can supply 425 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. These procedures must be performed by a qualified electronics technician or engineer trained on this equipment.

TENSIONS MORTELLES. AC source peuvent fournir 425 V maximum à leur sortie. Tout contact peut entraîner la MORT si les circuits ou bornes de sorties connectés à la sortie sont touchés lorsqu'ils sont sous tension. Ces procédures doivent être réalisées par un ingénieur ou technicien en électronique qualifié formé sur l'équipement.

Summary of front panel calibration menu

The **Entry** keypad is used for calibration functions.

Entry key press	Function key press	Display	Command function
Shift **Calibration 7** Press to access the calibration menu.	Use ▲ or ▼ to navigate between the **Calibration** function commands	CAL ON <value>	Turn the calibration mode on when the correct password value is entered.
		CAL OFF	Turn the calibration mode off.
		CAL:LEV <char>	Advance to the next step in sequence (P1, P2, P3, or P4).
		CAL:DATA <value>	Input a calibration measurement.
		SHUNT <value>	Enter a value for the external current shunt in ohms.
		CAL:VOLT:OFFSET	Begin voltage offset calibration.
		CAL:VOLT:DC	Begin DC voltage calibration sequence.
		CAL:VOLT:AC	Begin AC voltage calibration sequence.
		CAL:VOLT:PROT	Begin voltage protection calibration.
		CAL:VOLT:EXT	Begin external voltage calibration sequence.
		CAL:CURR:AC	Begin AC current calibration sequence.
		CAL:CURR:MEAS	Begin current measurement calibration sequence.
		CAL:CURR:EXT	Begin external current calibration sequence.
		CAL:IMP	Begin output impedance calibration sequence.
		CAL:SAVE	Saves the calibration constants in non-volatile memory.
		CAL:PASS <value>	Set new calibration password.

Enable calibration mode

Action	Display
1 Reset the unit by pressing **[Shift] [Output]**, and then press **[Enter]**.	*RST
2 Press **[Shift] [Calibration]**, enter the calibration password from **Entry** keypad, and press **[Enter]**. If the password is correct, the **Cal** annunciator will come on. (If no password has been set, just press **[Enter]**.)	CAL ON 0.0

Calibrating and entering Power Analyzer voltage calibration values

Action	Display
3 Connect a Keysight 3458A DMM (in synchronous AC volts mode) to the ac source output terminals. Short the Power Analyzer voltage terminals (V SENSE) to ensure no DC offset error.	*RST
4 Press **[Shift] [Calibration]**, scroll to **CAL VOLT EXT**, and press **[Enter]**.	CAL:VOLT:EXT
5 Leave the ac source on and remove the short from the Power Analyzer voltage terminals.	
6 Connect the Power Analyzer voltage sense terminals to the Main Output terminals of the ac source (see part A in Figure E-6).	
7 Press **[Shift] [Calibration]**, scroll to **CAL LEV P1** and press **[Enter]**. The ac source will output 300 Vac 60 Hz sine wave.	CAL:LEV P1
8 Press **[Shift] [Calibration]**, scroll to **CAL DATA**, and use the **Entry** keypad to enter the voltage value displayed on the Keysight 3458A DMM.	CAL:DATA 0.00

Action	Display
9 Press **[Shift] [Calibration]**, scroll to **CAL SAVE** and press **[Enter]**.	CAL SAVE

Calibrating and entering Power Analyzer current calibration values

Action	Display
10 Short the Power Analyzer current sense terminals (I SENSE) to ensure no DC offset error.	
11 Press **[Shift] [Calibration]**, scroll to **CAL CURR EXT** and press **[Enter]**.	CAL:CURR:EXT
12 Leave the ac source on and remove the short from the Power Analyzer current terminals.	
13 Connect the Power Analyzer current terminals to the output of the function generator (see part B in Figure E-6). Set the function generator output to 50 mV, 60 Hz.	
14 Connect the Power Analyzer current terminals to the Keysight 3458A input terminals. Note that the Keysight 3458A must be in synchronous ac volts mode and a 1.0 µF capacitor must be installed across the Keysight 3458A input terminals.	
15 Press **[Shift] [Calibration]**, scroll to **CAL LEV P1**, and press **[Enter]**.	CAL LEV P1
16 Press **[Shift] [Calibration]** and scroll to **CAL DATA**. Use the **Entry** keypad to enter the voltage value displayed on the Keysight 3458A DMM.	CAL:DATA 0.00
17 Change the function generator output setting to 500 mV.	

Action	Display
18 Press **[Shift] [Calibration]**, scroll to **CAL LEV P1** command, on the **Entry** keypad, use ▼ to scroll to the **P2** parameter, and press **[Enter]**.	CAL:LEV P2
19 Press **[Shift] [Calibration]** and scroll to the **CAL DATA**. Use the **Entry** keypad to enter the voltage value displayed on the Keysight 3458A DMM.	CAL:DATA 0.00
20 Press **[Shift] [Calibration]**, scroll to **CAL SAVE** and press **[Enter]**.	CAL SAVE

E   Option 020

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F   Option 026

KEYSIGHT
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Auxiliary Output Capability

The Keysight Technologies Auxiliary Output Option 026 is available on the following ac sources:

– Keysight 6812C AC Power Source (750VA)

– Keysight 6813C AC Power Source (1750VA)

Option 026 consists of an auxiliary 26 V_{rms} output located on the rear panel of the ac source. This is a programmable output with a maximum output current of 100 mA_{rms}. The output frequency tracks the frequency of the main output of the ac source. Option 026 adds the following capabilities to the above listed ac source models:

– AC voltage and phase are programmable, in immediate mode only.

– Software calibration is available for both voltage and phase. Calibration is performed at a single frequency (400 Hz). Note that there is no compensation for frequency-dependent voltage variation or phase shift.

– The auxiliary output waveform and frequency are always the same as the main output.

– For a sine wave output, the maximum programmed rms voltage value is 26.02 V. For any waveform, the programmed rms voltage value may not result in a peak voltage of more than 36.8 V.

– Current limit is not programmable.

– DC voltage is not available.

Front Panel Menus – Additions

The following menu commands have been added to let you program the auxiliary output. In most cases you will need to press the ▲ or ▼ on the Function key pad to access the menu item. Press ▲ or ▼ on the Entry key to access the parameter.

Function key press		Description
Current **Voltage** Use ▲ or ▼ to navigate between the **Voltage** function commands	VOLT:AUX <value>	Set auxiliary output voltage.
Shift **Phase** **Freq** Use ▲ or ▼ to navigate between the **Freq** function commands.	PHASE:AUX <value>	Set auxiliary output phase.

Rear Panel Connections

Auxiliary output with
removable connector

Figure F-1   Rear panel - overall view

Installation

Turn the unit off before connecting any wires.

The auxiliary output has a HI and a LO connection. Two pins are designated HI and the other two pins are designated LO. The maximum isolation voltage to ground is 300 Vac ($\pm$ 425 V_{dc}).

NOTE	You should always use both pins of the HI and the LO outputs. This promotes current sharing among the output pins.

Front Panel Programming

Setting the auxiliary output

The following steps describe how to set the auxiliary output voltage and phase.

Action	Display	
1 Set the auxiliary output voltage by pressing **[Voltage]**. Then scroll to the **VOLT:AUX** command. Use the numeric keypad to enter a voltage and press **[Enter]**.	VOLT:AUX	10
2 Set the auxiliary output phase by pressing **[Shift]** **[Phase]**. Then scroll to the **PHASE:AUX** command. Use the numeric keypad to enter a phase and press **[Enter]**. The deviation frequency must be less than the programmed output frequency by at least 0.001 Hz. Otherwise, it will result in Error 613.	PHASE:AUX	25
3 Enable the auxiliary output by pressing **[Output On/Off]**.		

Auxiliary Output Specifications

Table A-1 lists the specifications of the Keysight Auxiliary Output Option 026. Performance specifications are warranted over the ambient temperature range of 0 to 40 °C Unless otherwise noted, specifications are for a sine wave with a resistive load at a frequency range of 400 Hz.

Table F-1   Performance specifications

Parameter	Option 026
Maximum output ratings	
RMS voltage	0 to 26 V
RMS current	100 mA
Frequency[a]	400 Hz

[a] The frequency of the auxiliary output tracks the main output.

Table F-2   Supplemental characteristics

Parameter	Option 026
Short circuit current (sustainable indefinitely)	$>100\ mA_{rms}$
Phase	
Offset relative to main output	≤1 degree
Phase control range	±360 degree
Programming resolution	
Output voltage	10 mV
Output phase	0.1 degree
Net weight	30 kg (66.1 lbs)
Shipping weight	34.49 kg (76.04 lbs)

Calibration Procedure

This section includes calibration procedures for the Auxiliary Output Option 026. Add these procedures to those described in Appendix B.

The output of the ac source must be enabled during calibration, as such, proceed with caution since voltages and currents will be active at both the auxiliary and the main output terminals.

NOTE	Perform the verification procedures before calibrating your ac source. If the ac source passes the verification procedures, the unit is operating within its calibration limits and does not need to be re-calibrated.

WARNING	LETHAL VOLTAGES. AC sources can supply 425 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. These procedures must be performed by a qualified electronics technician or engineer trained on this equipment. TENSIONS MORTELLES. AC source peuvent fournir 425 V maximum à leur sortie. Tout contact peut entraîner la MORT si les circuits ou bornes de sorties connectés à la sortie sont touchés lorsqu'ils sont sous tension. Ces procédures doivent être réalisées par un ingénieur ou technicien en électronique qualifié formé sur l'équipement.

Equipment Required

The equipment listed in the following table, or the equivalent to this equipment, is required for verification and calibration.

Table F-3   Equipment required

Equipment	Characteristics	Recommended Model
4-pin connector plug	This connector is supplied with the ac source when ordered with Option 026.	1252-1488
Digital voltmeter	Resolution: 10 nV at 1 V Readout: 8.5 digits Accuracy: better than 20 ppm	Keysight 3458A
Universal Counter		Keysight 53132A or equivalent
10:1 probes (2)		
GPIB Controller	Full GPIB capabilities	HP Series 200/300 or equivalent

Summary of Front Panel Calibration Menu

The **Entry** keypad is used for calibration functions.

Entry key press	Function key press	Display	Command function
Shift **Calibration 7** Press to access the calibration menu.	Use ▲ or ▼ to navigate between the **Calibration** function commands	CAL ON ‹value›	Turn the calibration mode on when the correct password value is entered.
		CAL OFF	Turn the calibration mode off.
		CAL:LEV ‹char›	Advance to the next step in sequence (P1, P2, P3, or P4).
		CAL:DATA ‹value›	Input a calibration measurement.
		SHUNT ‹value›	Enter a value for the external current shunt in ohms.
		CAL:VOLT:OFFSET	Begin voltage offset calibration.
		CAL:VOLT:DC	Begin DC voltage calibration sequence.
		CAL:VOLT:AC	Begin AC voltage calibration sequence.
		CAL:VOLT:AUX	Begin auxiliary voltage calibration
		CAL:VOLT:PROT	Begin voltage protection calibration.
		CAL:VOLT:EXT	Begin external voltage calibration sequence.
		CAL:CURR:AC	Begin AC current calibration sequence.
		CAL:CURR:MEAS	Begin current measurement calibration sequence.
		CAL:CURR:EXT	Begin external current calibration sequence.
		CAL:IMP	Begin output impedance calibration sequence.
		CAL:PHAS:AUX	Begin auxiliary phase calibration
		CAL:SAVE	Saves the calibration constants in non-volatile memory.
		CAL:PASS ‹value›	Set new calibration password.

Enable calibration mode

Action	Display
1 Reset the unit by pressing **[Shift] [Output]**, and then press **[Enter]**.	*RST
2 Press **[Shift] [Calibration]**, enter the calibration password from **Entry** keypad, and press **[Enter]**. If the password is correct, the **Cal** annunciator will come on. (If no password has been set, just press **[Enter]**.)	CAL ON 0.0

Calibrating the auxiliary output voltage

Action	Display
3 Disconnect all loads from the ac source. Connect the DMM across the output terminals of the auxiliary output using the 4-pin connector provided. Make sure the DMM is operating in AC voltage mode.	
4 Press **[Shift] [Calibration]**, scroll to **CAL VOLT AUX**, and press **[Enter]**.	CAL:VOLT:AUX
5 Press **[Shift] [Calibration]**, scroll to **CAL LEV P1**, and press **[Enter]**.	CAL:LEV P1
6 Press **[Shift] [Calibration]**, scroll to **CAL DATA**, and use the **Entry** keypad to enter the AC voltage value displayed on the DMM. Then press **[Enter]**.	CAL:DATA 0.00
7 Press **[Shift] [Calibration]**, scroll to **CAL SAVE**, and press **[Enter]**.	CAL:SAVE
8 Press **[Shift] [Calibration]**, select **CAL OFF**, and press **[Enter]** to exit calibration mode. ***RST** and ***RCL** will also set the calibration state to OFF.	CAL OFF

Calibrating the auxiliary output phase

Action	Display
1 Disconnect all loads from the ac source. Reset the ac source by selecting **[Shift]** **[Output]**, scrolling to ***RST**, and pressing **[Enter]**. Make sure that the **Dis** annunciator on the front panel is on.	*RST
2 Use a clip lead and connect the LO terminal of the auxiliary output to the ACC terminal of the main output.	
3 Program the main output of the ac source to 26 V_{rms} at 400 Hz. Program the auxiliary output of the ac source to 26 V_{rms}. Press **[Output On/ Off]** to enable the outputs.	
4 Set the 53132A controls as follows: – Other measurement: Phase 1 to 2 – Channel 1 and 2 impedance: 1 MΩ – Channel 1 and 2 coupling: AC – Channel 1 and 2 attenuator: 10 times	
5 Connect input 2 of the 53132A to the auxiliary output with a 10:1 probe, positive lead to Hi out and negative lead to Low out (common to main output low).	

Action	Display
6 Connect input 1 of the 53132A to the main output with a 10:1 probe, positive lead to AC out and negative lead to ACC out (common to auxiliary output low). Note: The 10:1 probes must be properly compensated for the 1 MΩ inputs to ensure that the probes do not contribute a phase offset error. Compensation may be easily done by connecting both probes to the same ac source output and adjusting the compensation for one probe to produce a reading of 0.0 degrees on the 53132A counter.	
7 Enable calibration mode as previously described.	
8 Press **[Shift] [Calibration]**, scroll to **CAL PHAS AUX**, and press **[Enter]**.	CAL:PHAS:AUX
9 Press **[Shift] [Calibration]**, scroll to **CAL LEV P1** and press **[Enter]**.	CAL:LEV P1
10 Using the universal counter (or equivalent instrument), monitor the phase of the auxiliary output with respect to the main output.	
11 Press **[Shift] [Calibration]**, scroll to **CAL DATA**, use the **Entry** arrow keys (▲ or ▼) to adjust the calibration parameter until the measured phase difference is zero or as close to zero as possible. The actual phase at the instrument output changes immediately in response to the arrow keys. This is the only time that the arrow keys operate in this live mode.	CAL:DATA 0.00
12 When the measured phase difference has been adjusted to zero, press **[Enter]**.	
13 Press **[Shift] [Calibration]**, scroll to **CAL SAVE**, and press **[Enter]**.	CAL:SAVE

Action	Display	
14 Press **[Shift] [Calibration]**, select **CAL OFF**, and press **[Enter]** to exit calibration mode. ***RST** and ***RCL** will also set the calibration state to OFF.	CAL	OFF

F   Option 026

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G   Line Voltage Conversion

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Line Voltage Conversion

WARNING LETHAL VOLTAGES. AC Sources can supply 424 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. Hazardous voltages can remain active inside the unit even after it has been turned off. These procedures must be performed by a qualified electronics technician or engineer trained on this equipment.

TENSIONS MORTELLES. Source AC peuvent fournir 424 V $_{maximum}$ à leur sortie. Tout contact peut entraîner la MORT si les circuits ou bornes de sorties connectés à la sortie sont touchés lorsqu'ils sont sous tension. Des tensions dangereuses peuvent rester actives à l'intérieur de l'unité, même après l'avoir mise hors tension. Ces procédures doivent être réalisées par un ingénieur ou technicien en électronique qualifié formé sur l'équipement.

WARNING The line conversion process is for use by trained personnel only. To avoid dangerous electrical shock, do not perform any line conversion unless you are qualified to do so.

Le processus de conversion de ligne ne doit être effectué que par du personnel formé. Afin d'éviter tout choc électrique dangereux, n'effectuez pas de conversion de ligne si vous ne disposez pas de la qualification requise.

Open the unit

1 Turn off the ac power to the unit and disconnect the power cord from the power outlet.

2 Remove the four screws that secure the two carrying straps and outer cover (use a T25 Torx drive).

3 Slightly spread the bottom of the cover and pull it back to remove it from the front panel.

4 Observe the two LEDs that are visible in the cutouts on each side of the unit. **If either LED is on, there is hazardous voltage inside the unit.** Wait until the LED goes out before proceeding (this may take several minutes).

Check the jumper wire (Model 6811C/6812C only)

1 Locate the line voltage jumper wire in the cutout at the side of the unit by the line cord (see Figure G-1).

2 For 100 V or 120 V operation, install the jumper on the lug labeled:100/120. For 200 V, 208 V, or 230 V operation, install the jumper on the lug labeled: 200/220.

Check the two rocker switches (all Models)

1 Locate the rocker switches in the cutout at the side of the unit by the on/off switch.

2 Configure the rocker switches according to the line voltage shown in the accompanying label. When configuring a unit for 208 V, use the settings shown for 200 V.

Check the power transformer connector (all Models)

| NOTE | This procedure is only required if you are changing the input voltage between 100 V and 120 V or between 200/208 V and 230 V. |

1 Remove the screws securing the inner cover (use a T15 Torx drive).

2 Remove the inner cover.

3 Remove the screws securing the PC board behind the front panel (use a T15 Torx drive).

4 You need only to lift the board out of the way, you do not need to disconnect any cables.

5 Locate the connector in front of the power transformer.

6 For 100 V, 200 V, or 208 V operation, install the plug on the connector labeled: 200 V input.

For 120 V or 230 V operation, install the plug on the connector labeled:
240 V input.

7 Replace the PC board and inner cover.

| **NOTE** | Be sure to replace all of the screws removed in step 1 and step 3. |

Close the unit

1 Replace the outer cover.

2 Change the label on the rear panel to reflect the changed input voltage rating.

3 Reconnect the power and turn on the unit.

| **WARNING** | Ensure that all assembly parts are in proper condition after performing the line voltage conversion procedure. |

Veillez à ce que toutes les pièces de l'ensemble soient en bon état après avoir effectué la procédure de conversion de tension de ligne.

| **NOTE** | – Line voltage conversion does not require any fuse changes. |
| | – Calibration is recommended after the line voltage conversion process to ensure that the guaranteed specifications are met and that the instrument functions as intended. |
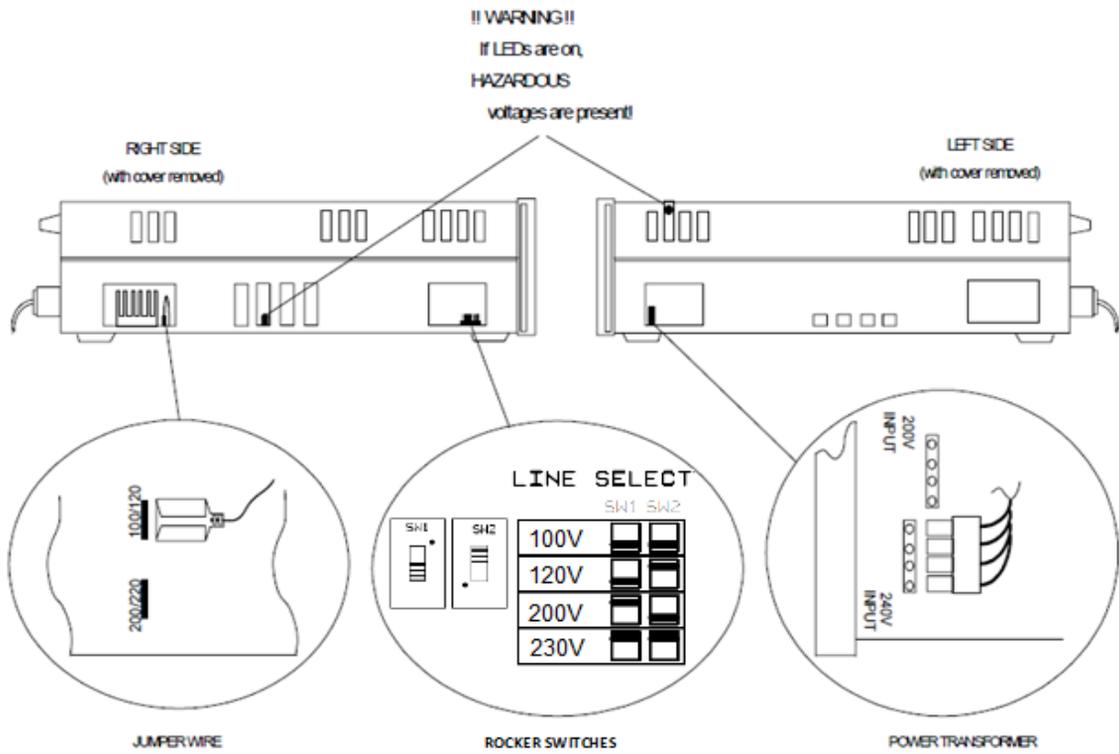
Figure G-1   Line voltage conversion components

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