BC Biomedical
A UNIT OF BC GROUP INTERNATIONAL, INC.

ELECTRICAL SAFETY ANALYZER

SA-2000

SA-2000-INTL

SA-2000-AUS

USER MANUAL

BC BIOMEDICAL
SA-2000 SERIES
TABLE OF CONTENTS

This User Manual covers the following units:

- SA-2000 & SA-2000-R
- SA-2000-INTL & SA-2000-INTL-R
- SA-2000-AUS & SA-2000-AUS-R

WARNING - USE

The SA-2000 is intended for testing only and should never be used in diagnostics, treatment or any other capacity where they would come in contact with a patient.

WARNING - CONNECTIONS

All connections to patients must be removed before connecting the DUT to the SA-2000. A serious hazard may occur if the patient is connected when testing with the SA-2000. Do not connect any leads from the patient directly to the SA-2000 or DUT while it is powered by the SA-2000

WARNING - MODIFICATIONS

The SA-2000 is intended for use within the published specifications. Any application beyond these specifications or any unauthorized user modifications may result in hazards or improper operation.

WARNING - CLEANING

Disconnect Line Power to the SA-2000 before attempting to clean it. Do not immerse. The SA-2000 should be cleaned by wiping gently with a damp, lint-free cloth. A mild detergent can be used if desired.

WARNING - LIQUIDS

Do not submerge or spill liquids on the SA-2000. In the event of a spill onto the SA-2000, do not operate the SA-2000 regardless of fluid type.

CAUTION - USAGE

The SA-2000 is not a continuous duty device, it is intended for short duration testing within the current limits and duty periods specified. Do not leave the DUT connected to the SA-2000 for extended time periods.
Do not to drop the SA-2000.

CAUTION - ENVIRONMENT

Exposure to environmental conditions outside the specifications can adversely affect the performance of the SA-2000. Allow SA-2000 to acclimate to specified conditions for at least 30 minutes before attempting to operate it.

CAUTION - INSPECTION

The SA-2000 should be inspected before each use for obvious signs of abuse or wear. The SA-2000 should not be used and should be serviced if any parts are in question.

CAUTION - SERVICE

The SA-2000 is intended to be serviced only by authorized service personnel. Troubleshooting and service procedures should only be performed by qualified technical personnel.

CAUTION - FUSE

Only replace the SA-2000 fuse with the specified type and rating.

NOTICE – SYMBOLS

Symbol	Description
	**Caution** (Consult Manual for Further Information)
	**Electrical Caution** (Consult Manual for Further Information)
	Per European Council Directive 2002/95/EC, do not dispose of this product as unsorted municipal waste.

NOTICE – ABBREVIATIONS

Amp	**Ampere(s)**
AAMI	**Association for the Advancement of Medical Instrumentation**
C	**Celsius**
cm	**centimeter(s)**
°	**degree(s)**
DUT	**Device Under Test**
Euro	**European**
ft	**feet**
FS	**Full Scale**
Hz	**hertz**
IEC	**International Electrotechnical Commission**
kg	**kilogram(s)**
kHz	**kilohertz**
kΩ	**kilohm(s)**
LED	**Light Emitting Diode**
MHz	**Megahertz**
µA	**microampere(s)**
mA	**milliampere(s)**
mm	**millimeter(s)**
NEMA	**National Electrical Manufacturers Association**
Ω	**Ohm(s)**
PC	**Personal Computer**
Lbs	**pounds**
RH	**Relative Humidity**
RMS	**Root Mean Square**
USA	**United States of America**
V	**Volt(s)**
VA	**Volt-Ampere(s)**
VAC	**Volt(s) Alternating Current**
W	**Watt(s)**

NOTICE – PERFORMING TESTS

REFER TO DUT MANUFACTURER'S SERVICE MANUAL FOR TEST PROCEDURES AND MEASUREMENT LIMITS.

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BC BIOMEDICAL
SA-2000 SERIES
ELECTRICAL SAFETY ANALYZER

The Model SA-2000 is a Microprocessor based Electrical Safety Analyzer. The following are highlights of some of the main features:

SA-2000:

- DEVICE UNDER TEST CURRENT MEASUREMENT
- EARTH / GROUND LEAD RESISTANCE
- EARTH / GROUND LEAKAGE CURRENT
- CHASSIS LEAKAGE CURRENT
- TRUE RMS MEASUREMENTS
- 90 TO 264 VAC OPERATION
- 20 AMP RATING (SA-2000 and SA-2000-INTL Models)
- 10 AMP RATING (SA-2000-AUS Model)
- TOUCH CONTROL KEYS – NO KNOBS
- LED STATUS INDICATORS
- AUDIO FEEDBACK
- EXTERNALLY REPLACEABLE GROUND FUSE
- AUTOMATIC LOAD REVERSAL DELAY

AVAILABLE MODELS:

- SA-2000 – STANDARD MODEL WITH HOSPITAL-GRADE NEMA 5-15P LINE PLUG AND HOSPITAL-GRADE NEMA 5-20R DUT TEST RECEPTACLE FOR USE IN THE US AND OTHER COMPATIBLE COUNTRIES

- SA-2000-INTL – INTERNATIONAL MODEL, IEC C20 RECEPTACLE PIGTAIL (MUST USE COUNTRY-SPECIFIC LINE CORD – SEE ACCESSORIES SECTION) AND UNIVERSAL DUT TEST RECEPTACLE THAT WORKS WITH THE FOLLOWING COUNTRY-SPECIFIC PLUGS:
  - NEMA 5-15P, NEMA 5-20P, NEMA 6-15P and NEMA 6-20P (US/NORTH AMERICA)
  - UK1-13P and UK3-5P (UK)
  - SW1-10P (SWITZERLAND)
  - IT1-10P (ITALY)
  - IS1-16P (ISRAEL)
  - JA1-15P (JAPAN)
  - EU1-16P (EURO) CEE 7/7 “SCHUKO” (NOTE: MUST USE SCHUKO GROUNDING ADAPTER TO PERFORM LEAKAGE MEASUREMENTS, SEE OPTIONAL ACCESSORIES SECTION)
  - DE1-13P (DENMARK) (NOTE: NO EARTH/GROUND PIN, THEREFORE LEAKAGE MEASUREMENTS NOT APPLICABLE)
  - EUROPLUG CEE 7/16 (NOTE: NO EARTH/GROUND PIN, THEREFORE LEAKAGE MEASUREMENTS NOT APPLICABLE)

- SA-2000-AUS – AUSTRALIAN MODEL, AU1-10P LINE PLUG AND AU1-10R DUT TEST RECEPTACLE FOR USE IN AUSTRALIA/NEW ZEALAND AND OTHER COMPATIBLE COUNTRIES

OPTIONS

- -R ADDS RS-232 SERIAL COMMUNICATIONS
  AVAILABLE MODELS:
  - SA-2000-R
  - SA-2000-INTL-R
  - SA-2000-AUS-R

STANDARD ACCESSORIES:

- BC20-20110 8 FT CHASSIS TEST LEAD (BLACK)
- BC20-30107 SOFT-SIDED CARRYING CASE
- UF-0250-01 REPLACEMENT GROUND LEG FUSE
- BC20-204XX (SA-2000-INTL ONLY) – REFER TO PAGE 6

OPTIONAL ACCESSORIES:

- BC20-20112 16 FT CHASSIS TEST LEAD (BLACK)
- BC20-20221 SCHUKO GROUNDING ADAPTER
- BC20-41337 RS-232 COMMUNICATIONS CABLE (DB-9M TO DB-9F)
- BC20-41339 USB COMMUNICATIONS ADAPTER (DB-9M TO USB-A) FOR USE WITH BC20-41337
- CS-2000-U 1 AMP CURRENT SOURCE – USA/NORTH AMERICA
- CS-2000-E 1 AMP CURRENT SOURCE - EURO (SCHUKO)

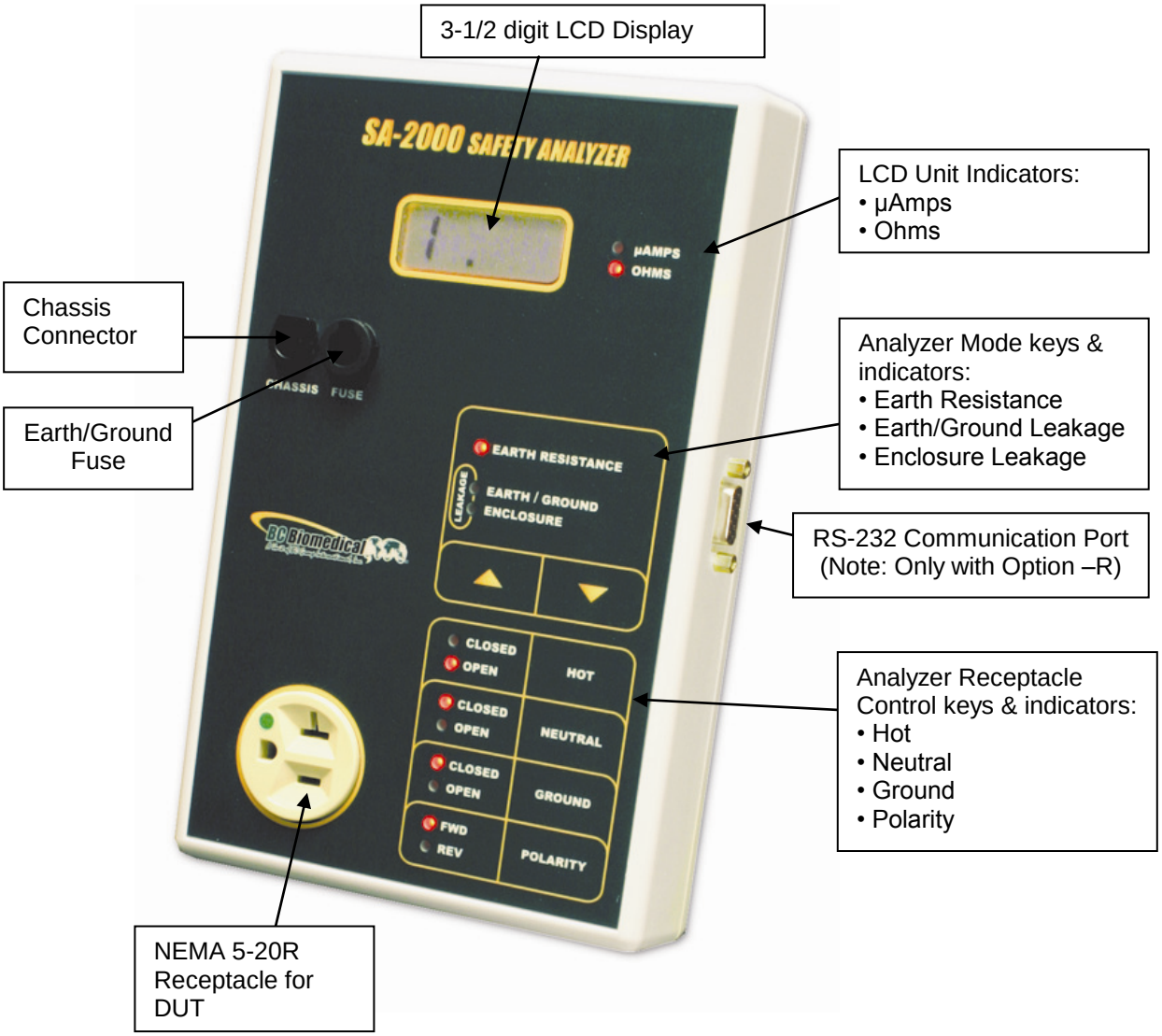
SA-2000-INTL LINE CORDS: (REFER TO PAGE 6 FOR DETAILS)

- BC20-20400 NEMA 5-20P PLUG LINE CORD (USA/NORTH AMERICA)
- BC20-20401 JA1-15P PLUG LINE CORD (JAPAN)
- BC20-20402 UK1-13P PLUG LINE CORD (UK)
- BC20-20403 CEE 7/7 “SCHUKO” PLUG LINE CORD (EURO)
  NOTE: INCLUDES BC20-20221 GROUNDING ADAPTER
- BC20-20409 BSS546A PLUG LINE CORD (INDIA/SOUTH AFRICA)
- BC20-20410 SW1-10P PLUG LINE CORD (SWITZERLAND)
- BC20-20412 IT1-10P PLUG LINE CORD (ITALY)
- BC20-20416 AUSTRALIA PLUG LINE CORD

LAYOUT

This section looks at a SA-2000 layout and gives descriptions of the elements that are present.

The user controls all Analyzer functions via 6 light touch keys. There is an audio click when any key is depressed, while a “Razz” or error tone consisting of a rapid succession of beeps is sounded if an invalid key is depressed. There are 13 LEDs to provide the user with full information about the test that is being performed and the current setup. A 3-1/2 digit LCD display conveys DUT test results to the user. The following is a review of the layout and operation of each of the elements.



SA-2000 Layout (SA-2000-R shown)

SA-2000-INTL Layout

SA-2000-AUS Layout

The SA-2000-INTL and SA-2000-AUS Model Layouts are shown above, note that the only differences from the standard model are the Line cords and the DUT test Receptacles.

Note: The RS-232 connector isn't shown above for these two models, but is an available option for both (see previous section).

Display

The main information in the system is presented in the 3-1/2 digit LCD display. This data is provided as simple meter readings with the measurement units indicated to the right by one of the two LEDs.

Function Selection

Three LEDs and two keys make up the Function Selection Section. The keys are up and down arrows. When depressed, they step the Analyzer through the available options. The LED next to the currently selected option is illuminated.

Analyzer Test Receptacle Control

There are four keys and 8 LEDs in the Analyzer Test Receptacle Control Section. They allow the manual control of the power connections that are made to the DUT. Internally, a series of relays are switched by the microprocessor based on the keys that are depressed. The LEDs indicate the current state of the power connections to the Receptacle.

Note: The Forward/Reverse Polarity key has a safety delay feature, preventing damage to the internal relays and the DUT. When the key is depressed, the DUT power is disabled and the safety delay is activated. When this delay is complete, the internal relays switch the polarity to the DUT and apply power. This delay allows any reactive power stored in the DUT to self-discharge before the polarity is reversed.

Note: The unit will power up with the Neutral and Ground Closed, in Forward Polarity and with the Hot Open. It is recommended that the unit be returned to this condition when plugging and unplugging the DUT.

Connectors

There is a connector for the Chassis test lead. There is a release pin on the lead plug that must be depressed to remove the lead.

Fuse

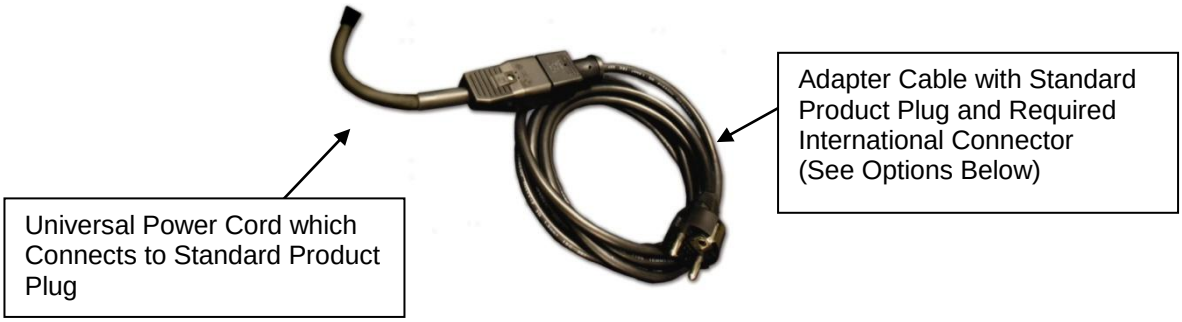
There is a fuse in the ground leg of the Analyzer Test Receptacle. This is to help prevent damage from excess ground current. It is located on the face for ease of replacement.

Test Receptacle

This receptacle is for the connection of the DUT. The Receptacle Rating depends on the specific Analyzer model. SA-2000 models use a Hospital Grade North American/USA standard NEMA 5-20R receptacle rated 20 Amps @ 125 VAC. SA-2000-INTL models use a universal international receptacle rated 20 Amps @ 250 VAC. SA-2000-AUS models use an Australian-specific AU1-10R receptacle rated 10 Amps @ 240 VAC. An external patch cord may be necessary to connect devices utilizing different types of plugs to the Analyzer receptacle.

Power Cord

The Power Cord, which is connected internally, provides power to both the Safety Analyzer and the DUT through the Test Receptacle. The Power Cord varies depending on the Analyzer model. SA-2000 models use a NEMA 5-15P plug designed to plug into a NEMA 5-15R or 5-20R Receptacle. SA-2000-INTL models have a short IEC C20 plug for which a country-specific adapter cable must be connected – See the following section for this information. SA-2000-AUS models use an Australian AU1-10P plug intended for operation with Australian and New Zealand AU1-10R Receptacles.



Communications (Optional)

On Analyzer models with the –R option, a DB-9 RS-232 Communications port is provided to interface the analyzer with a PC. Data from the Analyzer display may be transferred over this communications link as well as full control over all analyzer functions and settings. For further details, see the Communication Protocol section.

TESTING

The Model SA-2000 allows the user a great deal of flexibility in testing. Several basic tests can be run, and in almost any sequence. The information in this section presents a systematic approach that is just one way to proceed. It is only presented as a guide and it is the responsibility of the user to establish which tests are required.

NOTICE – PERFORMING TESTS

REFER TO DUT MANUFACTURER'S SERVICE MANUAL FOR TEST PROCEDURES AND MEASUREMENT LIMITS.

The Analyzer requires a good Earth/Ground connection for operation. It should be plugged into a "Hospital Grade" receptacle where available. This is necessary for both good test results and personal safety.

Earth Resistance

With the Earth Resistance function selected, the display will show the resistance between the Chassis Test lead and Receptacle Earth/Ground. This resistance is a combination of the resistance within the DUT enclosure and the resistance in the Earth/Ground Lead in the DUT power cord.

NOTE: This test has no meaning for equipment that does not use a grounded cord.

The test requires that the Chassis Test lead be plugged into the Chassis Connector. The other end should be connected to a solid ground point on the DUT.

The display is in hundredths of Ω and will read to 19.99 Ω. Overrange shows as "1_ _ _".

Earth/Ground Leakage Current

With the Earth/Ground function selected and the Ground-Open, the display will show the leakage current in the ground wire of the DUT. The display is in µAmps and will read from 0 to 1999.

NOTE: This test has no meaning for equipment that does not use a grounded cord.

Selecting this function automatically opens the connection to Earth/Ground and passes any leakage current through the 1000 Ω load with AAMI ES1-1993 frequency compensation.

Enclosure Leakage

With the Enclosure function selected, the display will show the leakage current between the Enclosure (Chassis) and Earth/Ground. The display is in µAmps and will read from 0 to 1999.

The test requires that the Chassis Test lead be plugged into the Chassis Connector. The other end should be connected to a solid ground point on the DUT.

NOTE: If a non-conductive enclosure is used, a 200 cm^2 conductive foil pad should be used. This foil is to be placed in close contact with the enclosure and connected to the Chassis Test lead.

Any leakage current will flow through the Chassis Test lead and then through the 1000 Ω load with AAMI ES1-1993 frequency compensation.

COMMUNICATION PROTOCOL

The communication protocol provides a means to completely configure and use the Analyzer from a PC or other device with RS-232 communications interface. This provides for hands free or automated operation of the equipment.

Communication Port

The Serial port is configured as 115,200 Baud Rate, 8 Data Bits, 1 Stop Bit, and No Parity.

Command Syntax

The command description is broken into columns; the KEYWORD, the NODE and the VALUE.

The KEYWORD provides the name of the command. The actual name of the command consists of one or more keywords since SCPI commands are based on a hierarchical structure, also known as a **tree system**.

In such a system, associated commands are grouped together under a common node in the hierarchy, analogous to the way leaves at a same level are connected at a common branch. This and similar branches are connected to fewer and thicker branches, until they meet at the root of the tree. The closer to the root, the higher a node is considered in the hierarchy. To activate a particular command, the full path to it must be specified.

This path is represented in the following tables by placing the highest node in the left-most position. Further nodes are indented one position to the right, below the parent node.

The highest level node of a command is called the Keyword, followed by the Node, and then the value.

Some commands allow for reading and writing data and some commands are Read Only. To indicate a read function, a question mark (?) is placed at the end of the command path. For example, to change the mode to Earth Resistance measurement, “CONFigure:MODE ERESistance<cr>”, where <cr> indicates a carriage-return. To read the current operating mode of the device, a mode read command would be “CONFigure:MODE?<cr>”, which would return the current operating mode of the device.

Lowercase letters indicate the **long-form** of the command (for example, **CONFigure:MODE ECGwaveforms**) and can be omitted for simplification. Uppercase letters indicate the abbreviated, or **short-form,** of the commands and must be included (for example, **CONF:MODE ECG**).

All commands sent to the unit are terminated with a Carriage Return.

NOTE: Commands can be entered in either upper or lowercase or a mixture of the two, uppercase and lowercase. Commands sent to the device are not case sensitive. Upper

case characters in the command summary table below are used to show the shortened versions of the commands if available.

SA-2000-R Communication Command Summary

Keyword	Node	Value	Description
CONFigure	MODE	ERESistance EGROund ENCLosure	Earth Resistance Earth / Ground Leakage Enclosure Leakage
	HOT	OPEN CLOSed	Receptacle Hot Lead Open Receptacle Hot Lead Closed
	NEUtral	OPEN CLOSed	Receptacle Neutral Lead Open Receptacle Neutral Lead Closed
	GROUnd	OPEN CLOSed	Receptacle Ground Lead Open Receptacle Ground Lead Closed
	POLarity	FWD REV	Receptacle Polarity Forward Receptacle Polarity Reversed (reverse HOT/NEUTRAL)
SYSTem	UNITs?	Returns the units of Measure (uA, Ohms) [Read Only]	
	MEASurement?	Returns the latest measurement [Read Only]	
	KEY	MUP	Changes Mode Up one position
		MDN	Changes Mode Down one position
		HOT	Duplicates the HOT key press
		NEUtral	Duplicates the Neutral Key press
		GROUnd	Duplicates the Ground key press
		POLarity	Duplicates the Polarity key press
	MODel?	Returns Safety Analyzer Model [Read Only]	
	VERsion?	Returns Firmware Version [Read Only]	

MANUAL REVISIONS

Revision #	Revisions Made
Rev 01	Preliminary Manual
Rev 02	Table of Contents Updated
Rev 03	Color Overlays
Rev 04	Accessories Added
Rev 05	Specifications Updated
Rev 06	Format Updated, Communication Protocol Added, Specifications Updated, Misc. Edits

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SPECIFICATIONS

EARTH RESISTANCE		
RANGE	0 to 19.99 Ω	
ACCURACY	0 to 1.99 Ω	± 1% Range
	2.00 to 19.99 Ω	± 1% Range
CURRENT SOURCE	10 mA (Note: 1 Amp Current Source Available as an optional accessory, see description section for ordering information on the CS-2000 Series)	

LEAKAGE CURRENT		
RANGE	0 to 1999 µA, RMS	
ACCURACY	DC	± 1% Reading, ±1 digit
	25 Hz up to 1 kHz	± 1% Reading, ±1 digit
	1 kHz up to 100 kHz	± 2.5% Reading, ±1 digit
	100 kHz to 1 MHz	± 5% Reading, ± 1 digit
LEAKAGE LOAD	1000 Ω AAMI ES1-1993 Frequency Compensation	
FUSE	250 mA, 250 V, 5x20 mm, Fast Acting (Receptacle Ground Leg) BC Part No. UF-0250-01	

ELECTRICAL		
OPERATING LINE VOLTAGE	90 to 264 VAC, 50/60 Hz	
LINE PLUG	SA-2000 MODELS	NEMA 5-15P
	SA-2000-INTL MODELS	Universal IEC C20 Receptacle Pigtail Cord Must use Country-specific Line Cord (see Accessories section)
	SA-2000-AUS MODELS	AU1-10P (AS/NZS 3112)
DUT CURRENT CAPACITY	SA-2000 & SA-2000-INTL MODELS	15 Amps, 30 minutes 20 Amps, 5 minutes
	SA-2000-AUS MODELS	10 Amps, 30 minutes

ELECTRICAL (continued)		
DUT RECEPTACLE	SA-2000 MODELS	20 Amps @ 125 VAC Capacity Hospital Grade NEMA 5-20R Compatible with: NEMA 5-15P and 5-20P Plugs
	SA-2000-INTL MODELS	20 Amps @ 250 VAC Capacity International Receptacle Compatible with: ○ NEMA 5-15P, NEMA 5-20P, NEMA 6-15P and NEMA 6-20P (US/NORTH AMERICA) ○ UK1-13P and UK3-5P (UK) ○ SW1-10P (SWITZERLAND) ○ IT1-10P (ITALY) ○ IS1-16P (ISRAEL) ○ JA1-15P (JAPAN) ○ EU1-16P (EURO) CEE 7/7 “SCHUKO” (NOTE: MUST USE BC20-20221 GROUNDING ADAPTER) ○ DE1-13P (DENMARK) ○ EUROPLUG CEE 7/16
	SA-2000-AUS MODELS	10 Amps @ 240 VAC Capacity AU1-10R (AS/NZS 3112) Compatible with: AU1-10P Plugs
POWER CONSUMPTION	5 VA (5 W)	

PHYSICAL & ENVIRONMENTAL		
DISPLAY	Non-Backlit 3½ Digit LCD 0.5 inches (12.7 mm) Digit Height	
CONSTRUCTION	ENCLOSURE	ABS Plastic
	OVERLAY	Back-printed Lexan
SIZE	8.65 x 5.73 x 1.92 Inches (219.7 x 145.5 x 48.8 mm)	
WEIGHT	≤ 2.5 Lbs (1.1 kg)	
OPERATING RANGE	15 to 40 °C (59 to 104 °F) 10 to 90% RH, Non-Condensing	
STORAGE RANGE	-20 to 65 °C (-4 to 149 °F)	

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