E-600 Portable Radiation Monitor

Technical Manual

Eberline
A subsidiary of
Thermo Instrument
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Section 1

Overview

General Description

Eberline's E-600 was designed to replace a wide range of portable radiation measurement instruments. Its simple analog circuitry may be configured under microprocessor control to support a wide range of detectors and to display measurement results in a variety of units and formats. A single instrument may be configured to suit the needs of an experienced user or to eliminate procedural errors and experimentation by a novice operator, and this configuration may be changed as often as necessary.

When used with Eberline's smart probes, the E-600 automatically loads the appropriate setup and calibration parameters from the probe. Connecting a new probe, even of a completely different type, immediately re-configures the instrument as necessary. Operation with a specific non-smart probe is also supported. In either case, a wide selection of display units and formats is available.

Perhaps the most distinctive feature of the E-600 is not actually part of the instrument at all: The potentiometers, jumpers, DIP switches and arcane keystroke sequences used to configure and calibrate most portable instruments have been replaced by a user-friendly interface program which may be installed on any PC-compatible computer running the Microsoft Windows® operating environment. This software makes the task of setting up an instrument quick and painless. Downloading a complete new personality into the E-600 requires only a few minutes, and complete records of each instrument's parameters is saved without extra paperwork.

Specifications

Length:	9.0	inch	22.9 cm
Width:	4.1		10.5
Height:	6.0		15.3
Weight:	3.4	lbs	1.53 kg (With batteries)
Batteries:	3 Alkaline "C" cells, life typically 50 to 100 hours		
Operating Temperature:	-20° to +50° C (-4° to +122° F)		
Storage Temperature:	-30° to +70° C (-22° to +155° F)		
Operating Humidity:	0 to 95% non-condensing		

Features

- Simple, user-friendly controls, ergonomically arranged.
- Analog and digital display of measurement results.
- Easy configuration via Windows®-based interface program.
- Site administrator may pre-define available operating modes.
- Simultaneous alpha, beta-gamma and total channels.
- Ratemeter, integration, scaler and peak hold measurement modes.
- Wide selection of rate and dose display units.
- Gross or net measurements.
- Log memory for 500 measurement results.
- Automatic setup when used with Eberline smart probes.
- Internal parameter storage for one conventional probe.
- Selectable enforcement of calibration due dates.
- May be configured for virtually any type of detector.
- Rugged construction with all-aluminum case.

CAUTION

Shock Hazard

Depending upon the type of probe used with this instrument, potentials in excess of 2,000 Volts may be present on the probe connector. This voltage may remain for up to one minute after the probe is disconnected or the unit is turned off. Never insert fingers or metallic objects into the probe connector on the instrument or probe cable.

This instrument should never be disassembled except by a qualified technician who is experienced in servicing radiation measurement equipment and familiar with the E-600 design.

Battery Warning

This instrument may be powered by either alkaline or nickel-cadmium batteries, both of which contain heavy metals and other hazardous materials which must be handled and disposed of properly. Do not mix batteries of different types or charge states in the same instrument. Recharge only batteries specifically designated as rechargable, and always follow manufacturer's charging recommendations. Do not puncture, mutilate or attempt to disassemble batteries. Do not heat cells above 100°C (212°F). Eberline recommends that batteries be recycled at appropriate recycling centers or disposed of as required by local ordinances and regulations.

Section 2

Controls and Indicators

Dedicated Controls

Note: Configuration is accomplished by connecting the instrument to a personal computer on which the E-600 interface software is running. Refer to the interface program manual for detailed instructions on this procedure. Depending upon the operating modes and options enabled during instrument configuration, some of the following controls may not be active. Assuming that they are, in fact, active, the following definitions apply:

Mode Selector In addition to turning the instrument on and off, this switch selects CHECK, BACKGROUND or one of four operating modes. These modes are described in detail in sections 4-6 of this manual.

Range Up/Down These buttons (located on the front panel) increase and decrease the full-scale range of the display by a factor of ten. If necessary, the measurements are automatically adjusted as well. When automatic ranging is enabled, these switches have no effect.

Gross/Net This button toggles the display between gross and net readings, assuming that background rate data is available for the channel(s) being displayed.

Speaker Toggles the audible clicks for individual count events on or off. Audible alarms are not affected by this control.

Light When this button (located on the control handle) is pressed, the main display will be illuminated for five seconds. This short interval is necessary to extend battery life; the display backlight consumes substantial amounts of current.

Channel Steps to the next discriminator channel (if any), as defined in probe memory. Refer to section 3 of this manual for a discussion of channels.

Log When this button is first pressed, an audible 'beep' is produced and the current display reading is frozen for a period of fifteen seconds. If the key is activated again during that interval, the current value is logged to memory and a triple 'beep' sound is heard. Refer to manual section 7 for more about data logging.

Response The operator may select slow, medium or fast display response to changes in the measured radiation field. The actual time constants for each switch position are defined in probe memory to insure that each switch position represents an appropriate value for the type of probe in use.

StarKey Functions

Located on the instrument handle, this key attempts to place the most-used function for each operating mode in a single convenient location: Directly under the operator's thumb. In the computer field, this is termed a 'soft' key because its use is defined in software rather than by hardwired connections. Note that in some modes the definition of this key may be changed during instrument configuration to suit specific needs or preferences. It is highly recommended that the same StarKey definitions be used for all E-600 instruments at any one site so that users will not be confused by different function assignments.

Note: In all modes, the StarKey is used to acknowledge alarms. If a rate or dose alarm is sounding, the first StarKey stroke will be used to silence that audible alarm indication. The "ALARM" icon on the display cannot be cancelled.

Check Mode The StarKey is used to alternately display the alarm setpoints used with rate and integrated measurements. If enabled, the displayed alarm levels may be edited.

Ratemeter Mode As configuration options, the StarKey may be assigned to either bypass the normal response time calculations and force an instantaneous display update to the current measured value, or to initiate a fixed-time scaler rate count. The latter definition, with appropriately chosen parameters, is useful for quantifying suspected contamination located during rapid frisking.

Integrate Mode Depending upon the option selected during configuration, the StarKey will either reset the accumulated information to zero or provide a temporary ratemeter display without disturbing the integration process.

Scaler Mode Pressing the StarKey resets the displayed value to zero and initiates a new scaler count cycle.

Peak-Trap Mode The StarKey resets the display to the currently measured rate value.

Background Mode Pressing the StarKey saves the current background value(s) to be subtracted from future readings in other modes. Background(s) may be captured as many times as desired; only the last value(s) captured will be retained in memory.

Main Display

Measurements are displayed simultaneously in both analog and digital formats on a high-contrast liquid crystal display screen. Both displays show the same information; one is a simulated meter scale which provides a rapid and intuitive indication of trends; the other is a more precise numeric expression of the same data.

Arrowheads at each end of the analog meter scale provide a visual cue when it is necessary for the operator to switch the instrument to the next higher or lower sensitivity range. Automatic range selection is also available, but must be enabled during instrument configuration.

Between these two displays are icons which identify the type(s) of radiation being measured. The possibilities include alpha and beta particles, neutrons, gammas and user-defined energy windows. The available channels, their icons, and the range of energies they cover are defined in probe memory. Refer to section three of this manual for a detailed discussion of this topic.

The lower right corner of the display screen contains a five-digit numeric field, the meaning of which depends upon the selected mode:

Whenever a new probe is connected to the E-600, its model and serial numbers are displayed so that the operator may verify that the instrument has correctly identified the probe and is using the correct parameters.

If the LOG key is pressed, the log point serial number under which the current reading may be saved is displayed.

In check mode, the small numeric display is used to show the probe voltage.

In integrate mode, the time over which the displayed dose has been integrated is shown. Units of seconds, minutes or hours are selected automatically.

In scaler mode, either the remaining count time (if fixed count time mode has been selected) or the current precision (in fixed precision mode) is displayed.

In background mode, the precision of the displayed background is presented as a percentage. This permits the operator to capture background(s) when the desired level of precision has been reached. Indicated precision values are stated with a confidence of $\pm 2\sigma$.

Units and Ranges

Each set of probe parameters specifies one unit of measure; both ratemeter and integrated measurements are expressed in the appropriate forms of that unit. If rate is displayed in counts per second, for example, integrated measurements are displayed in counts. Possible unit selections include:

Ratemeter:	Bq, CPS, CPM, DPS, DPM, DPS, Bq, or DPM/100 cm^2, Sv/sec, Sv/hr , Gy/sec, Gy/hr, R/sec, R/hr, Rem/sec, Rem/hr.
Integrated:	Gy, Sv, R, Rem, counts and disintegrations.

These units may be prefixed with an appropriate multiplier, such as:

μ (micro), n (nano), m (milli) or K (kilo).

Under all circumstances, the same base units and range multipliers apply to both the analog and digital displays. As different sensitivity ranges are selected, the number of zeros at the high end of the bargraph change and the decimal point of the numeric display moves as appropriate. Note that the digital display continues to provide accurate information up to twice the range of the meter scale.

It is important to remember that the available multiplier prefixes are spaced three decades apart, and that the displays can also span three decimal places or zeros. It is therefore possible to represent some readings in two ways, such as 1 R or 1000 mR. The operator must understand the interactions between the multipliers and full-scale ranges in order to correctly interpret the displayed readings.

Other Display Icons

Several special-purpose icons along the left side of the display window indicate abnormal conditions such as alarms, detector overrange conditions, low battery voltage, etc.

Audible Indications

The E-600 produces tones of two frequencies, 600 and 2400 Hz, which may be heard either through the built-in speaker or through an optional headset. These tones are used independently for particle clicks or together to indicate other conditions.

Particle clicks may be enabled or disabled by pressing the SPEAKER key on the front panel. When enabled, the lower pitch is used to annunciate events detected in the upper energy window (eg. alpha counts) and the higher pitch annunciates events detected in the lower window (eg. beta counts).

Caution: The maximum click rate for each channel is limited to 75 clicks per second. Do not rely entirely on audible clicks for warnings of dangerous radiation fields!

The two tones are heard in rapid alternation when an alarm threshold (either rate or dose) has been exceeded. Pressing the StarKey will silence the audible alarm, but will not turn off the ALARM icon. The higher-pitched tone is also heard as short pulses when the instrument's range increases or decreases. This is particularly useful when automatic range selection is enabled as a warning to the operator that there has been a significant change in field strength. When configuring the instrument the user may choose to disable the audible indication of range change when automatic range selection is enabled.

Section 3

Probes

Smart Probes

Eberline offers a family of "Smart" probes which may be used with the E-600 and other instruments. These probes contain a non-volatile memory which carries information about the probe, including all of its operating parameters. All values which are referred to as being taken from "Probe memory" are in fact read from this device when a smart probe is first connected to the instrument. Parameters are entered into the memory of a smart probe only during calibration, which requires the use of a host computer. It is not possible to alter any probe memory contents from the E-600 control panel.

Up to three probe 'setups' may be stored in probe memory, each of which defines the parameters used to count one or more type(s) of radiation. These three setups may be independent (ie. three user-defined energy windows used to identify three specific isotopes) or they may operate together to define (for example) alpha, beta/gamma and total activity channels for a single gas-proportional probe. If the three setups are compatible (which requires that they all specify the same probe voltage, discriminator thresholds, calibration constants and display units), counts are simultaneously collected for all channels and the operator may switch freely among them without interrupting the counting process. If different high voltages, thresholds, units or cal constants are required, the accumulated total counts are zeroed whenever the CHANNEL key is pressed. The "HV" indication may flash for a few seconds while the instrument's power supply adjusts to a new setting.

In addition to the probe voltage and thresholds, each setup specifies rate display units, efficiency values used to convert from raw counts to either source activity or tissue dose, and both rate and dose alarm setpoints. As a setup option, the operator may be permitted to temporarily edit the alarm levels. Any changes made to these values will NOT be stored in probe memory and will be lost if a different smart probe (as identified by its serial number) is connected to the instrument. Edited values will be retained if the same probe is disconnected and then re-connected (if no other probe is connected first).

Conventional Probes

For operation with conventional probes (ie. those without built-in memories), the E-600 contains an internal non-volatile memory of its own in which may be stored one complete set of probe information as described above. Whenever a probe is connected to the instrument via a special conventional probe cable assembly, the setup information from this internal memory will be used.

Operation using parameters from internal memory is identical in all respects to that using information from the memory of a smart probe. The same set of three detector channels may be defined in either type of memory, along with other probe data including calibration dates. In neither case may probe parameters be permanently changed by the operator.

CAUTION: It is up to the operator to insure that the conventional probe connected via this cable is indeed the one for which the E-600 has been calibrated. The instrument cannot verify which type of probe is in use or whether the parameters stored in its internal memory are appropriate for that probe. Connecting a different probe may result in inaccurate readings or destruction of the probe due to the application of excessive voltage. If in doubt, leave the E-600 in CHECK mode until the probe identity is verified; high voltage is not applied until one of the measurement modes is selected.

Changing Probes

Whenever a probe is initially connected to the instrument, or when the unit is first powered on, the probe model and serial numbers will be shown briefly in the lower right corner of the display window. The operator may compare this information against the probe's actual model and serial numbers to verify that the E-600 has correctly identified the probe. If these numbers contain alpha characters which cannot be represented on the numeric display, they will be replaced with dashes. Pressing the STAR key bypasses this display sequence.

Probe memory also carries the due date for probe calibration. If an out-of-calibration probe is connected to the instrument, the message "PROBE OUT OF CAL" is shown and the instrument will not operate. This feature may be defeated during instrument configuration, enabling the operator to ignore calibration dates. In this situation, pressing the STAR key will permit operation past the probe's calibration due date, however the warning message will remain on.

Crossover Correction

When using the E-600 with all alpha/beta probes there is both an alpha-to-beta channel crossover component (alpha radiation which shows up in the beta channel) and a beta-to-alpha channel crossover component (beta radiation which shows up in the alpha channel) which is always present at some level. The existence of this crossover can lead to a misinterpretation of readings. The E-600's reading is most confusing when one displays the beta channel while monitoring an alpha source. Alpha-to-beta crossover can lead one to believe that beta contamination exists where none is present.

The crossover component can be reduced by applying a software correction. To do so, each channel in the E-600 (e.g. alpha, beta alpha/beta) contains crossover correction factors for each of its two windows. These correction factors are included in the probe channel parameters and may be edited using the Windows E-600 interface software. See the Windows E-600 software manual for more information.

The following method of crossover correction has been implemented to prevent falsely enhancing the beta measurement when the alpha signal is creating noise in the beta channel.

Corrected Net α ***Rate = (Net*** α ***Rate - (Lower to Upper Crossover x Net*** β ***Rate))***

Corrected Net β ***Rate = (Net*** β ***Rate - (Lower to Upper Crossover x Net*** α ***Rate))***

A calibration routine included in the Windows E-600 software can be used to determine the appropriate crossover factors for a particular probe. See the Windows E-600 software manual for more information.

Section 4

Check Mode

Power-On Diagnostics

When the E-600 is initially powered on, the instrument performs a number of internal self-tests. These are invisible to the user and no test results are displayed. If any of the tests fail, the unit simply indicates "FAIL" and refuse to operate.

One of the diagnostic checks is a comparison of the instrument's calibration due date (stored in configuration memory) against the present date. If the due date has passed, an OUT OF CAL message will be displayed. Depending upon the option selected at configuration, this may either prevent any further operation or the operator may be permitted to continue by pressing the STAR key. In this case, the above message will remain on the display until the unit is re-calibrated.

Once the instrument has verified its own integrity, it will read probe parameters from either the probe (if it is a smart probe) or from internal non-volatile memory. The probe parameters (including calibration due date) will be checked as if the probe had just been connected to the unit.

Display Screens

When CHECK mode is first entered, whether through the power-on sequence or by switching from another mode, the first information displayed is battery status. The BATTERY icon is turned on to identify the display and voltage is presented as a percentage on both the analog meter scale and the small numeric display. A reading of 100% indicates a new set of batteries; 0% means that there is little or no energy available. Note that batteries are temperature sensitive; even new cells may read less than 100% if they are very cold. Some brands of alkaline or carbon cells may produce less than 1.5 Volts, even when new. These will also indicate less than 100%.

Note: Nickel-Cadmium cells have a nominal output voltage of approximately 1.2-1.3 Volts per cell during most of their useful life. For this reason, they will never give a reading of 100%, even when fully charged. Avoid operating NiCad cells after they reach 0% on the display; doing so may damage the batteries.

Pressing the CHANNEL key will advance to the next display, which shows the first defined probe setup. If additional setups are available, they may be viewed in sequence by repeatedly pressing CHANNEL. Each setup is identified by the icon(s) for the activity type(s) it measures, and the probe voltage for that setup is shown in the lower right corner of the display.

The current alarm setpoint for the selected setup is presented on the large numeric display, expressed in the appropriate units. If enabled (a configuration option) the alarm setpoint may be edited with the RANGE UP and RANGE DOWN keys. As described in the previous section, edited values will remain in effect until a different probe is connected to the instrument. If both rate and integration alarm setpoints are defined for the probe, the user may switch back and forth between these two values by pressing the STAR key. Note that the type of setpoint (rate or integrated) selected is identified by the units in which they are displayed.

Note: Setting the rate alarm setpoint to zero disables alarm checking for all modes that are computing a rate. Similarly, settting the integration alarm setpoint to zero disables alarm checking for all modes that are computing dose.

If a background count rate has been stored for the channel being displayed, it may be viewed by pressing the GROSS/NET button.

Pressing CHANNEL again will display the instrument's network address, which may be edited with the RANGE UP and RANGE DOWN keys. This parameter is used when multiple instruments are connected in a network as area monitors; if this use is not anticipated, the value is unimportant.

Note: All E-600s will respond to commands sent to address zero. This makes it easy to communicate with a single instrument connected to a computer. If an E-600 with this address is ever included in a network, however, all others in the net will attempt to respond to messages intended for that one.

After all of the above screens have been viewed, pressing the CHANNEL key will turn on all display segments for inspection.

Pressing the LOG key in CHECK mode will display the next available log point number. If this number is not equal to one, the instrument's memory contains data which may need to be read out. Press STAR to exit this display.

Section 5

Operating Modes

Ratemeter Mode

In this mode the E-600 operates as a basic ratemeter. Results are displayed in the units specified in probe memory, which may be simply counts per unit time or, if the probe has been appropriately calibrated, source activity or dose rate. The rate alarm limit, which is also read from probe memory, is used in this mode.

If multiple channel setups are defined in probe memory, the CHANNEL key may be used to switch among them. If the available channels are compatible (ie. if they use the same probe voltage, discriminator threshold settings, cal constants and display units), the change will be immediate and smooth. If changes in high voltage or threshold settings are required, there will be a momentary discontinuity while the new voltages settle and the selected response time constant is applied to the new readings.

During instrument configuration, the StarKey may be assigned either of two functions in ratemeter mode. The first is to immediately display the currently measured instantaneous rate, bypassing the normal time constant calculations. Alternatively, it may initiate a fixed-time or fixed precision count cycle depending on the chosen scaler count mode to obtain a rate measurement of known precision. This option is particularly useful when the instrument is used for frisking; it provides a convenient means for accurately characterizing an area which attracts attention during a rapid scan. Pressing the StarKey a second time will return the E-600 to normal ratemeter mode.

As in all modes, if an alarm is sounding, the first press of the StarKey will silence the audible alarm. Thereafter, the key will revert to its normal function.

Integrate Mode

An integrated measurement (eg. counts, R, Sv or disintegrations) is acquired in this operating mode, starting at zero when integrate mode is first selected. If the integrate alarm limit specified in probe memory is exceeded, an alarm indication is posted. As always, the StarKey may be used to silence the audible alarm.

In this mode, the numeric field in the lower right corner of the display window is used to show the total time over which the integrated counts, disintegrations or dose have been accumulated. Units of seconds, minutes or hours will be selected automatically.

If all of the defined probe channel setups are compatible, the user may switch among them without interrupting the integration process. In this situation, all channels are counted continuously, and the CHANNEL key merely selects which is displayed. If the defined setups are not compatible, selecting a new channel will reset the accumulated dose to zero and begin a fresh integration process once the probe voltage and thresholds have stabilized.

As a configuration option, the StarKey may be defined to perform either of two functions in integrate mode. The first is simply to reset the integrated value and running time to zero. The second available StarKey function is to provide a temporary ratemeter readout without exiting from integrate mode. This alternate display will last only while the key is held down, and integration will continue without interruption or loss of data.

Scaler Mode

In this operating mode, the StarKey is used to initiate a timed count cycle. Depending upon the option selected during instrument configuration, the results of this count may be displayed either as total counts or dose, or as activity or count rate averaged over the count time. In either case, the applicable alarm limit from probe memory will be used to determine whether an alarm is posted.

As a second configuration option, the scaler mode count time may be specified as a fixed interval, or else a required measurement precision may be entered. In the latter case, the E-600 will count until the specified precision is attained. In fixed count time mode, the remaining count time will be displayed on the small digits in the lower right corner of the display window. If a fixed precision is specified, the current measurement precision will be displayed as counts are accumulated. The confidence level of displayed precision values is $\pm 2\sigma$.

If the defined probe channels are compatible, pressing the CHANNEL key after a count has completed will display the scaler count totals for the next channel. If the channels use different high voltages or thresholds, pressing CHANNEL will step to the next defined channel and, after a delay to permit the voltages to settle, start a new scaler count.

Peak-Trap Mode

This is identical to ratemeter mode, however the highest measured rate is held on the display until manually reset by pressing the StarKey. The units and alarm limit specified in probe memory for ratemeter mode are also used in peak-trap.

Section 6

Background Mode

Gross/Net Display Selection

In any of its four operating modes, the E-600 offers the option of background subtraction. This feature is toggled on or off by pressing the GROSS/NET key on the front panel; the "NET" icon on the display is turned on whenever background is being subtracted. Alarm setpoints reference the displayed reading, regardless of whether that value is gross or net. Background mode must be enabled (during instrument configuration) to permit the display of net measurements.

Note that background values are stored in non-volatile memory, and will therefore be retained even after the instrument has been turned off. This permits the user to take a background reading in a location far from any contamination, then use that background to obtain true net counts for as long as desired. Background values will be zeroed only when a new detector is connected to the E-600.

Accumulating Background Values

When switched into background mode, the E-600 begins counting background. The value displayed in this mode is simply a long-term average of counts per unit time, and is not computed with the same response time algorithm used in rate mode. While the large numeric display and bargraph show count or dose rate, the small numbers in the lower right corner of the display window show the precision of this rate value. When the precision reaches an acceptable level, the user may capture the displayed rate value by pressing the STAR key. The last value captured before exiting background mode will be used for future net rates.

If the defined probe channel setups are compatible, as will generally be the case with energy-proportional probes, all channels will be counted simultaneously in background mode, and a value will be stored for each when the STAR key is pressed. If the probe channels require different high voltage, threshold settings, calibration constants or display units, only the background for the currently displayed channel will be stored.

Section 7

Data Logging

How to Log a Data Point

In any of the four operating modes (ratemeter, integrate, peak-trap and scaler), the user may invoke the data logging function by pressing the LOG key. The display will immediately be frozen to permit the operator to verify that it is indeed the value he wishes to record, or to enter a location identifier via a barcode reader. The small numeric display will, at this time, display the log point number under which the data will be stored.

If the displayed measurement value is acceptable, and the log ID Source has been set to internal/Aux or Internal only, pressing LOG again will store the date, time, instrument and probe serial numbers, reading and location code (if any). Measurement units, operating mode, channel type and gross/net reading information are also saved for each log point. Pressing the STAR key or waiting for fifteen seconds will cause the instrument to return to normal operation. Note that this feature may also be used to hold the display while readings are manually copied.

As an instrument configuration option, the user may choose the means of identifying log data points. Selecting internal ID mode means that the log data will be identified by the log point number displayed on the small numeric display when the LOG key is pressed. Selecting auxiliary ID mode means that a barcode reader input will be used to identify the log data. Using the Windows E-600 interface program, the LOG ID source may be selected as Internal/Aux, Internal only or Aux only. Internal/Aux allows internal or auxiliary ID mode, Internal only allows internal ID mode, and Aux only allows Auxiliary (bar code) ID mode. If the instrument log ID Source is configured as internal only and the user attempts to use a barcode reader, the display will remain frozen for 15 seconds or until the STAR key is pressed. No data is logged. This also happens when the instrument Log ID is configured as Aux only and the user attempts to complete a log cycle by pressing the LOG key a second time.

Barcode Inputs

If a barcode reader is connected to the E-600, and the log ID Source has been set to Internal/Aux or Aux only, it may be used to input location identifiers which will be saved along with measurement results. Successfully reading a location code will also complete the logging operation and store the reading to memory, eliminating the need to press the LOG key a second time.

Data Retrieval and Display

Measurement data from the E-600's log memory is read out by connecting the instrument to a host computer on which the interface program is running. Details of this process are included in the software manual and the on-line help functions included in the interface program itself.

Troubleshooting

Low Battery

The E-600 is powered by three alkaline "C" batteries, which start out at a nominal 4.5 Volts when new. Operation will continue until this voltage falls to about 3.0 Volts. The battery icon on the display will come on when the batteries fall below 3.15 Volts, and will begin to flash at 3.08 Volts. Because batteries degrade rapidly once they fall below approximately 60% of their initial voltage, it is advisable to replace them soon after the battery icon first appears. Dead batteries may also leak; remove them from the instrument to prevent corrosion.

Battery life is significantly decreased at low temperatures. Cells which give a mid-scale voltage reading in a warm building may fail rapidly if the instrument is then operated outdoors in winter.

Out of Calibration

When the E-600 is first powered on, the calibration due date stored in its memory is compared against the current date. If the instrument is past due for calibration, the Out of Calibration icon is turned on and normal operation is inhibited. If enabled (as a configuration option), the user may bypass this indication and use the instrument by pressing the STAR key while in check mode.

In a similar manner, the probe's calibration due date is checked when the E-600 is powered on or when a new probe is connected. The ability to continue operation with an out-of-calibration probe by pressing the STAR key is also a configuration option.

Probe Failures

If no probe is connected to the E-600, it will display a "PROBE FAIL" message. This indication is also given when the memory contained within a "Smart" probe is not readable, or if its contents do not appear valid. Specific problems which may result in this indication include probe memory failure, broken wires or poor connections in the probe cable, or damage to the components within the instrument which communicate with the probe connector.

High Voltage Failures

This message is displayed when the instrument's high voltage power supply goes out of tolerance. It is most often caused by a shorted probe which loads the supply beyond its capacity. If the same failure is indicated with different probes, it is probable that a component within the supply has actually failed.

If probe memory contains definitions for channels with different high voltage settings, an indication of "HV" may be displayed briefly when the CHANNEL key is pressed. This is normal and simply indicates that the high voltage supply has not yet stabilized at its new voltage setting.

Instrument Failures

If the 'Fail' icon alone is displayed, the E-600 has detected an internal component fault which prevents normal operation or a situation which the software cannot correctly handle. The most common cause of this 'failure' is an invalid setting of the clock/calendar circuit used for timestamping logged data and verifying calibration dates. Before returning the instrument for service, use the interface program to re-initialize the instrument's clock.

Section 9

Instrument Configuration

Purpose

In the design of an instrument such as the E-600, versatility must be traded off against simplicity and ease of use. Adding more controls increases the number of instrument parameters which may be adjusted and hence the range of functions which the unit can perform. Doing so, however, complicates operation and invites operator errors. The opposite design philosophy results in instruments which require less skill, attention and understanding to operate, but which support only a small number of applications.

The E-600 strikes a balance between these two extremes by including a wide range of capabilities, but omitting some of the physical controls used to select and adjust them. Instead, these options are selected before the instrument is placed in service, during the configuration procedure. In effect, configuration permits the 'design' of a 'custom' instrument with just the correct set of features for the application in which it will be used and the operator who will use it.

The E-600 Interface Program

Configuration, calibration and other E-600 utilities are performed by a program which runs under Microsoft Windows® on an IBM®-compatible personal computer. The functions provided by this software include configuration options such as the available operating modes and StarKey definitions. In addition, parameters for one "Dumb" probe may be loaded into the instrument's memory.

Other utilities in the same software package permit calibration of both the E-600 and any "Smart" probe connected to it, retrieval and display of measurement data from the instrument's log memory, and a number of utilities for testing both instruments and probes. A detailed manual is provided with this software.

Section 10

Hardware Reference

Replacing Batteries

The E-600 is powered by three "C" cells, which are located in a compartment on the bottom of the instrument. Replacing the batteries involves simply loosening the single screw which secures the battery door, removing the old batteries (if present) and inserting three new cells. The positive terminal of each battery holder is marked both by a red terminal ring and by a "+" mark stamped on the bottom of the holder. It is recommended that the instrument be switched to "OFF" before changing batteries.

Although rechargable or low cost zinc-carbon batteries may be used in this instrument, alkaline batteries are recommended for longest battery life. All batteries in a set must be of the same type and at the same charge level; do not mix different types or new and partially discharged cells.

Disassembly and Re-Assembly

The following sequence should be followed to disassemble an E-600; reverse the procedure to re-assemble:

1. Power the instrument off, open the battery door and remove the batteries.
2. Remove the lower end plate (including the handle assembly) using a 9/64 Allen key. Slide the circuit boards out just far enough to disconnect the switch and audio connectors.
3. Remove the front end plate and slide the circuit boards out through the front of the case. Note that the end plate is attached to the upper circuit board by two connector harnesses; avoid excessive flexing of the solder connections where these harnesses connect to the board.
4. The two circuit boards may be separated by pulling them apart. Do not lose the floating header strip which connects the boards together.

Caution: When re-assembling the instrument, insure that the wires leading from the upper circuit board to the front end plate connectors fit inside the cutouts along the edges of the board and are not pinched or cut as the board slides into the case.

Caution: These boards contain numerous CMOS components which may be damaged by static discharge. Disassemble the instrument only when necessary, and then only at an anti-static work station.

Caution: When re-assembling, do not permit the mylar ribbon cable from the handle control switches to become pinched or folded between the endplate and case. Sharp folds will destroy the silver traces which are painted onto the mylar.

Caution: Do not permit the wire harness connected to the mode control rotary switch and response time selector switch to snag the pins of J7 when removing the boards from the case. These pins are very small and easily broken.

Circuit Description

Power for the E-600 is provided by three "C" batteries, which may vary from 1.5 Volts to below 1.0 Volts each during their useful life. To obtain maximum efficiency over this voltage range, a DC-DC inverter is implemented by IC A102 and its associated components on the battery board. The output of this circuit is approximately 5.7 Volts, which is then regulated down to 5.0 V by A101. Because the main function selector switch has a grounded common terminal, the negative side of the battery stack is switched rather than the positive voltage.

The instrument is controlled by a conventional microprocessor circuit based on the Dallas Semiconductor 80C320 processor chip. In addition to parallel I/O ports which interface to the instrument's panel controls, the processor bus also includes a 4-wire RS-232 serial interface (A18), non-volatile EEPROM for parameter storage (A1), a 10-bit A/D converter which measures battery voltage (A3), and a quad D/A converter (A22) which controls the high voltage power supply and two detection thresholds.

32K Bytes of RAM is provided (A16), both as working memory for the processor and for logging of measurement results. This chip is installed in a "Smart" socket which contains a lithium battery for data retention when the instrument is powered off and a real-time clock/calendar chip used to timestamp logged data. The processor's crystal frequency of 2.4576 MHz is divided down by a 14-stage ripple counter (A23) to obtain both a 150 Hz clock interrupt input and the two audio frequencies used for particle 'clicks.'

Three logic-level signals are present in the "Smart" probe connector; two of these sense the type of probe connected, while the third is a bi-directional serial data line connecting the microprocessor to the probe's memory. These three signals are protected against static discharges or the possibility of an arc from the high voltage supply. All of these signals are buffered by a Schmidt trigger (A2).

All of the instrument's analog circuitry is located on a custom hybrid circuit (A5) which includes a two-stage amplifier, two threshold comparators, pulse shapers, and the feedback loop which regulates the high voltage power supply. This supply is located on the battery PCB. Its output is connected to the main board via a banana plug.

Calibration of the high voltage supply may be accomplished by adjusting a potentiometer (R8) until the output (measured at C109 or the banana plug) agrees with the indicated probe voltage. A ground reference is available on un-masked traces along both edges of each circuit board. It is strongly recommended that 1250 volts be used as a calibration point since most other nominal voltages cannot be attained due to roundoff errors.

Schematic

The accompanying diagrams include schematics and component placement diagrams for both of the E-600 circuit boards. Note that A5, the custom hybrid circuit module which contains virtually all of the analog components, is a non-repairable component and is simply shown as a block on the schematic.

Parts List

The following tables list the electronic components used in the E-600 and should contain sufficient information for obtaining replacement parts. Unless otherwise specified, specific manufacturers and part numbers listed may be considered examples only and not restrictions against using equivalent components with the same characteristics from other vendors. When ordering parts from Eberline, specify the model and serial numbers of the instrument and reference designator(s) and/or descriptions of the parts required. Eberline will automatically substitute equivalent parts if the original source is no longer available.

Main PC Board

Reference Designation	Part Name	Part Description	Manufacturer and Part Number	Eberline Part Number
(None)	Circuit Board	Main PCBA	Eberline	ZP11581003
C3,5,7,10,11, 13-18, 22-34	Capacitor	0.1 uF, 50V	Centralab CW20C104K	CPCE104P3N
C4	Capacitor	1000 uF, 100V	Centralab CN20A102K	CPCE102P3P
C21	Capacitor	22 pF, 200V	(Any) CK05BX220K	CPCE220P3R
C20	Capacitor	33 pF, 100V	(Any) CK12BX330K	CPCE330P3P
C2	Capacitor	220 pF, 3KV	Centralab DD30-221	CPCE221P3Y
C6,8,9,12,19, 35,36	Capacitor	10 uF, 16 V Tantalum	Sprague 199D106X0016CA1	CPTA100M4X
R5,7,10	Resistor	100 Ohm, 5%	(Any) Carbon Film, 1/4 W	RECC101B22
R11,13,15	Resistor	1K Ohm, 5%	(Any) Carbon Film, 1/4 W	RECC102B22
R17	Resistor	2.2K Ohm, 5%	(Any) Carbon Film, 1/4W	RECC222B22
R4,6,9	Resistor	4.7K Ohm, 5%	(Any) Carbon Film, 1/4W	RECC472B22
R16,18, 19	Resistor	10K Ohm, 5%	(Any) Carbon Film, 1/4W	RECC103B22
R3	Resistor	1M Ohm, 5%	(Any) Carbon Film, 1/4W	RECC105B22
RPK1,2	Resistor Network	9 x 10K Ohm Pin 1 Common	CTS 750-101-R10K	REAR103B21
R8	Pot	100K Ohm	Spectrol 64X104	PTCE104B83
CR4,6	Diode	Switching	(Any) 1N4148	CRSI1N4148
CR1,2,3,5	Diode	Zener, 4.7V	(Any) 1N5230B	CRZR1N5230
Q1,2,3,5	Transistor	FET	(Any) 2N7000	TRMN2N7000
XA1,3	IC Socket	8-Pin DIP	T.I. C9308-02	SOIC308
XA2,4,7,8	IC Socket	14-Pin DIP	T.I. C9314-02	SOIC114
XA17,23	IC Socket	16-Pin DIP	T.I. C9316-02	SOIC116
XA18	IC Socket	18-Pin DIP	T.I. C9318-02	SOIC118

Reference Designation	Part Name	Part Description	Manufacturer and Part Number	Eberline Part Number
XA14,19-22	IC Socket	20-Pin DIP	T.I. C9320-02	SOIC120
XA15,16	IC Socket	28-Pin DIP	T.I. C9328-02	SOIC128
XA13	IC Socket	40-Pin DIP	T.I. C9340-02	SOIC140
A7,8	IC	Quad NAND	(Any) 74HC00	ICHCA00
A2,4	IC	Hex Schmidt	(Any)74HC14	ICHCA14
A17	IC	3-to-8 Decode	(Any) 74HC138	ICCMAHC138
A14,19,20	IC	Octal Buffer	(Any) 74HC373	ICHCA74373
A21	IC	Octal D-Latch	(Any) 74HC374	ICHCA74374
A23	IC	Ripple Ctr.	(Any) 4060B	ICCMA4060B
A5	Hybrid	Custom	Eberline	VEBD14
A9	IC	5-V Regulator	National LP2950CZ-5.0	ICAVA2950C
A3	IC	A/D Convert.	Linear Tech LTC1091CN8	ICCM1091
A1	IC	EEPROM	Atmel AT93C66	ICCM93C66
A13	IC	Micro-Processor	Dallas Semiconductor DS80C320-MCG	ICCM80C320
A15	IC	EPROM	Eberline (Programmed)	ICCM27C512R
A16	IC	RAM	NEC D43256AC-15L	ICCM43C256
A22	IC	Quad D/A	Maxim MAX506BEPP	ICCMMAX506
A18	IC	RS-232	Maxim MAX424EPN	ICXXMAX242
J1	Connector	2 x 5 Recept.	Samtec SSW-105-01-G-D	COMR1610
J3	Connector	7-Pin Header	Molex 22-11-2072	COMR1007
J4	Connector	10-Pin Thru-Board Recept.	Samtec BSW-110-24-S-S	COMR1510
J5	Connector	8-Pin Header	Molex 22-11-2082	COMR1008
J7	Connector	5-Pin Header	Samtec TMS-105-01-G-S	COMR1505
J8	Connector	5-Pin Header	Molex 22-11-2052	COMR1005
J2	Connector Assembly	Smart Probe Harness	Eberline (custom connector)	YP11579050

Reference Designation	Part Name	Part Description	Manufacturer and Part Number	Eberline Part Number
J6	Connector Assembly	Serial Data Harness	Eberline	YP11581050
X1	Crystal	2.4567 MHz	M-Tron MP-1	CYOS21
(None)	Display	LCD	Eberline	OPDS33
(None)	Spacer	4-40 x 1/2"	H.H. Smith #4306	SPHN4408
(None)	Connector	Banana Jack	H.H. Smith #101	COMI14
XXA16	IC Socket	"Smart" Watch	Dallas Semiconductor DS1216C	ICXX26

Battery Board

Reference Designation	Part Name	Part Description	Manufacturer and Part Number	Eberline Part Number
(None)	Circuit Board	Battery PCBA	Eberline	ZP11581005
BT101,102, 103	Battery Holder	Single "C" Cell Holder	Keystone #173	BTBH20
BT101,102, 103	Polarity Marker	Red Plastic	Keystone #59	BTBH13
P4	Connector	10-Pin Thru-Board Recept.	Samtec BSW-110-24-S-S	COMR1510
A101	IC	Low-Drop +5V Voltage Regulator	SGS L4941BV	ICAVAL4941
A102	IC	DC-DC Converter	Linear Technology LT1111	ICAV1111
XA102	Socket	8-Pin DIP	T.I. C9308-02	SOIC308
L101	Inductor	100 uH Choke	GFS Magnetics ACS100	INFI5
T101	Xfmr.	High Voltage	Microtran M8149	TFHV5
CR101-103	Rectifier	VA25	Electronic Devices HX25PD	CRSIVA0025
CR104	Diode	Schottky	(Any) 1N5817	CRSC1N5817
Q101	Transistor	Silicon	(Any) 2N4234	TRSP2N4234
C104	Capacitor	.001 uF, 3KV	Sprague 30GA-D10	CPCE102P3Y
C105-107	Capacitor	.01 uF, 3KV	Sprague 30GA-S10	CPCE103P4Y
C109	Capacitor	.047 uF, 4KV	ASC X675HV	CPPF503PXY
C103	Capacitor	.01 uF, 80V	Sprague 192P1039R8	CPPF103P3O
C102	Capacitor	.27 uF, 50V	Centralab CW30C274	CPCE274P4N
C101,110	Capacitor	10 uF, 16V Tantalum	Sprague 199D106X0016CA1	CPTA100M4X
C108,111	Capacitor	33 uF, 25V Tantalum	Sprague 199D336X0025EE2	CPTA330M3J

C112	Capacitor	.1 uF, 50V	Centralab CW20C104K	CPCE104P3N
R104	Resistor	100 Ohm, 5%	(Any) Carbon Film, 1/4W	RECC101B22
R101	Resistor	270 Ohm, 5%	(Any) Carbon Film, 1/4W	RECC271B22
R106	Resistor	93.1 K Ohm, 1%	(Any) RN55D	RECE933B12
R105	Resistor	332 K Ohm, 1%	(Any) RN55D	RECE334B12
R102,103	Resistor	10 M Ohm, 5%	(Any) Carbon Film, 1/4W	RECC106B22
(None)	Connector	Banana Plug	H.H. Smith #145	COMI13

Miscellaneous

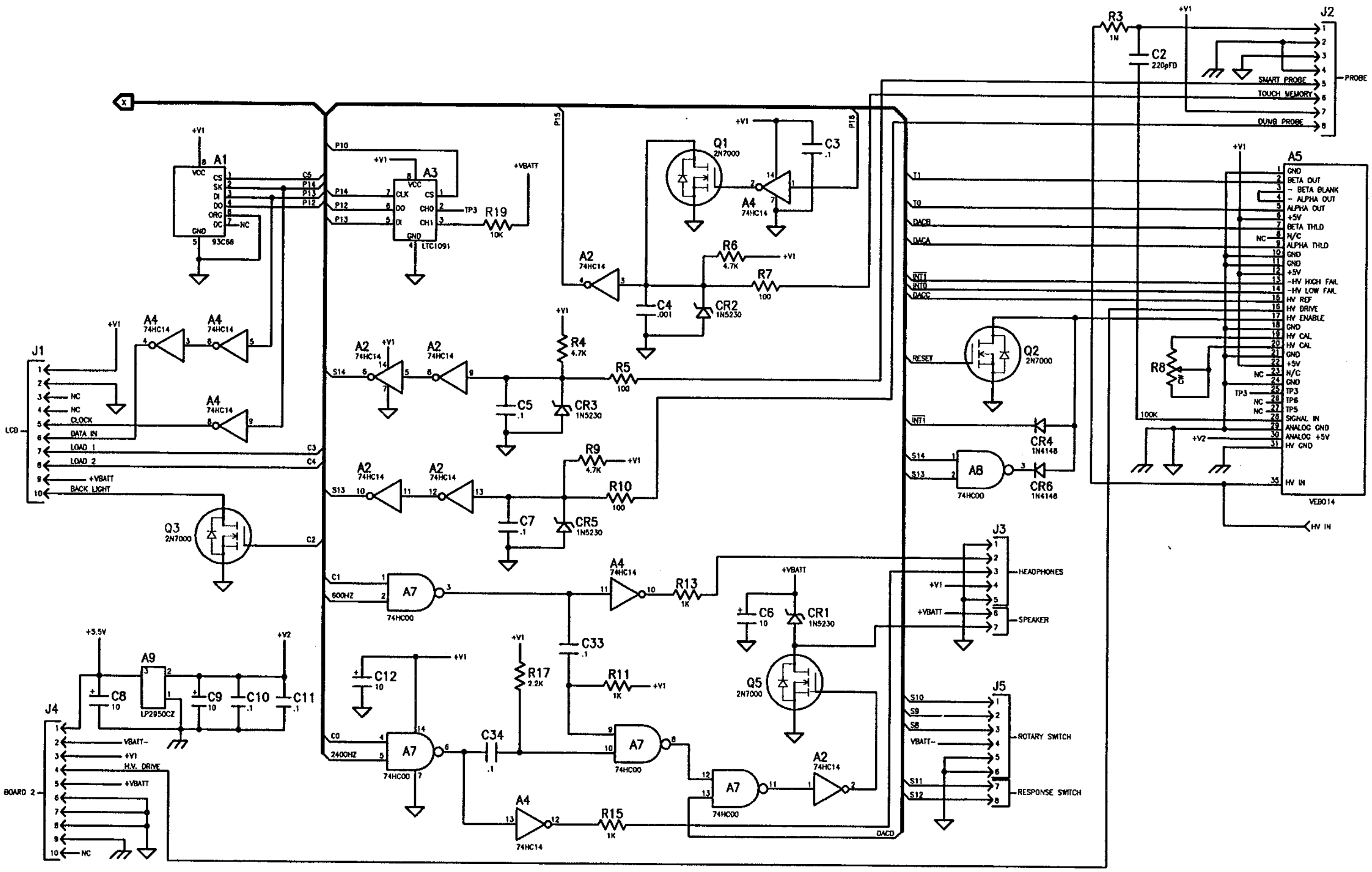
Reference Designation	Part Name	Part Description	Manufacturer and Part Number	Eberline Part Number
(None)	Switch	Rotary Encoder	Grayhill 26ASD22-01-1-AJS	SWRO59
(None)	Switch	SPDT Toggle	C&K 7103SHZBE	SWTO40
(None)	Switch Boot	Miniature Toggle	APM-Hexseal N-5030S-Black	SWHD22
(None)	Knob	Encoder	Rogan NK-89	HDKN30
(None)	Adapter	Knob Shaft	Alco KR-1	HDKN41
(None)	Speaker	1" Sealed	Speco U101	ADSP4
(None)	Connector	Headphone	LZR LJ0350A	COAF26
(None)	Gasket	Front Plate	Eberline	ZP11581025
(None)	Gasket	Rear Plate	Eberline	ZP11581026
(None)	Gasket	Battery Door	Eberline	ZP11581030
(None)	Connector	Floating Interboard	Samtec ZW-10-10-G-S-250-290	COMR1710

Diagrams

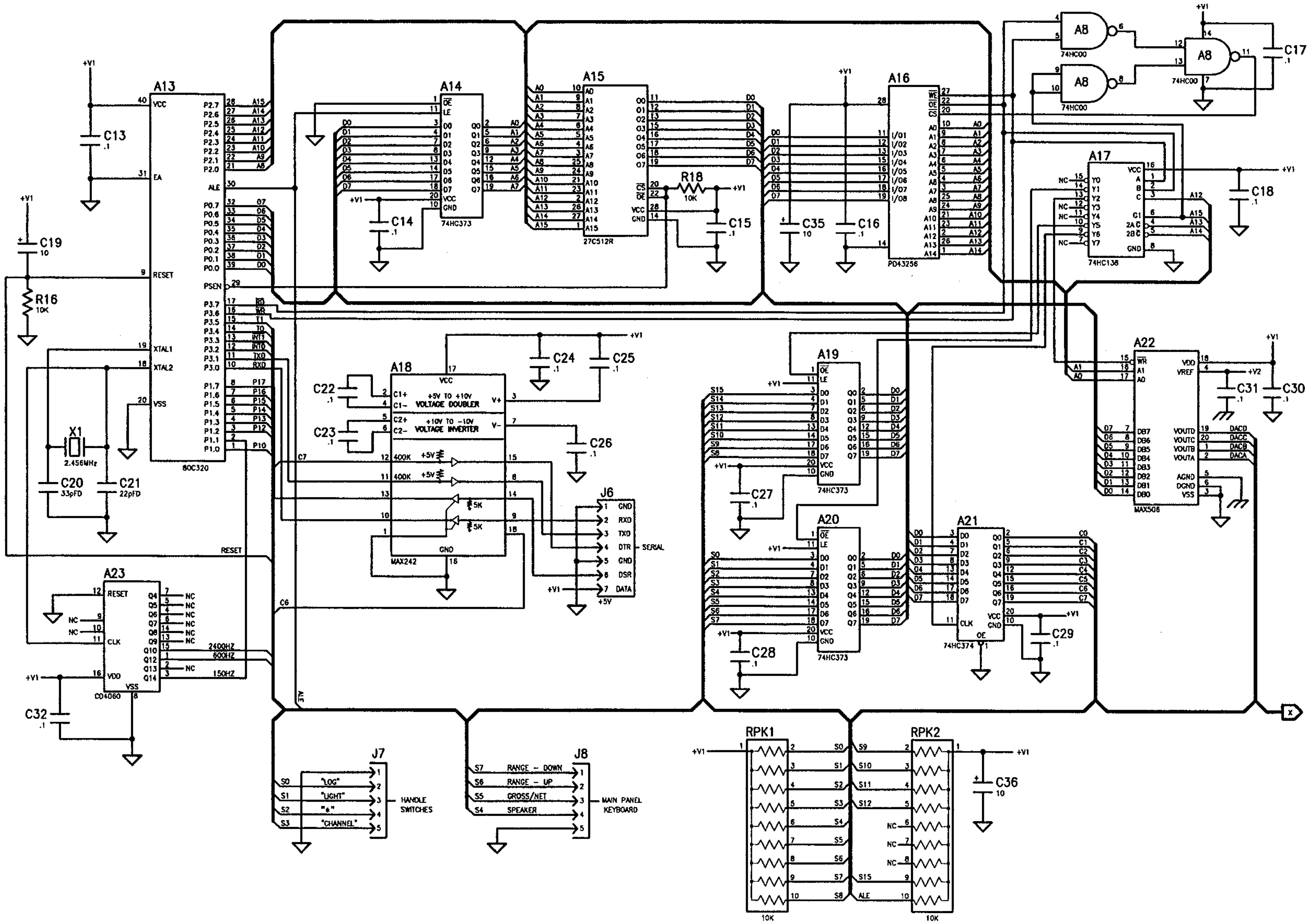
The following schematic and assembly diagrams are included for repair and troubleshooting purposes. Component reference designators refer to the parts lists in the previous section of this manual.

Main P.C. Board Schematic	Drawing # 11581-D01
Hybrid Schematic	Drawing # 11543-D08
Main P.C. Board Component Assembly	Drawing # 11581-D04
Battery P.C. Board Schematic	Drawing # 11581-D02
Battery P.C. Board Component Assembly	Drawing # 11581-D06
Overall Interconnect Diagram	Drawing # 11581-D76
Case Assembly	Drawing # 11581-D07
Endplate Assembly	Drawing # 11581-D08
Batery Door Assembly	Drawing # 11581-C09
E-600 Overall Assembly	Drawing # 11581-D55

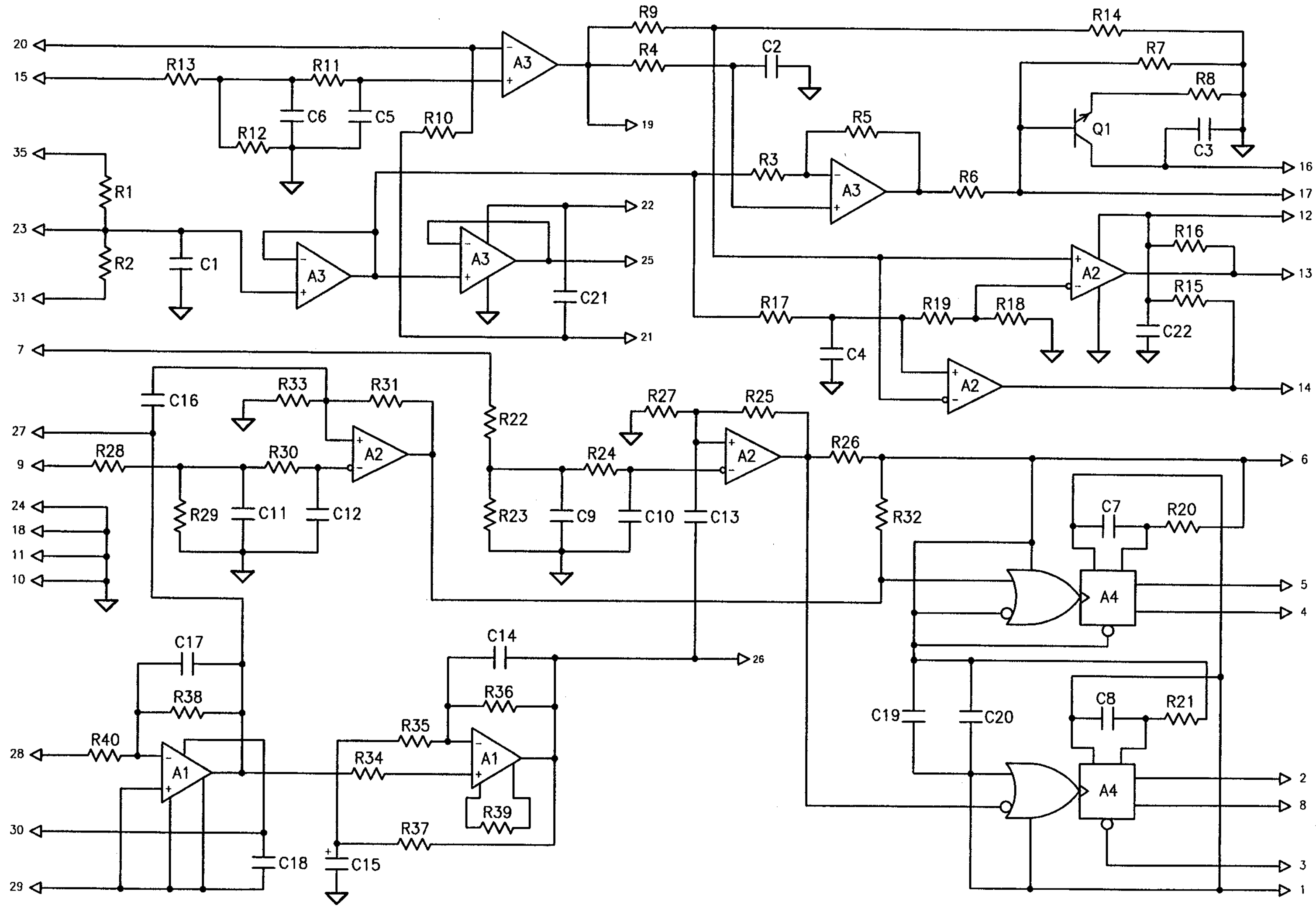
Main PCBoard Schematic, E-600, 11581-D01b sheet 1 of 2



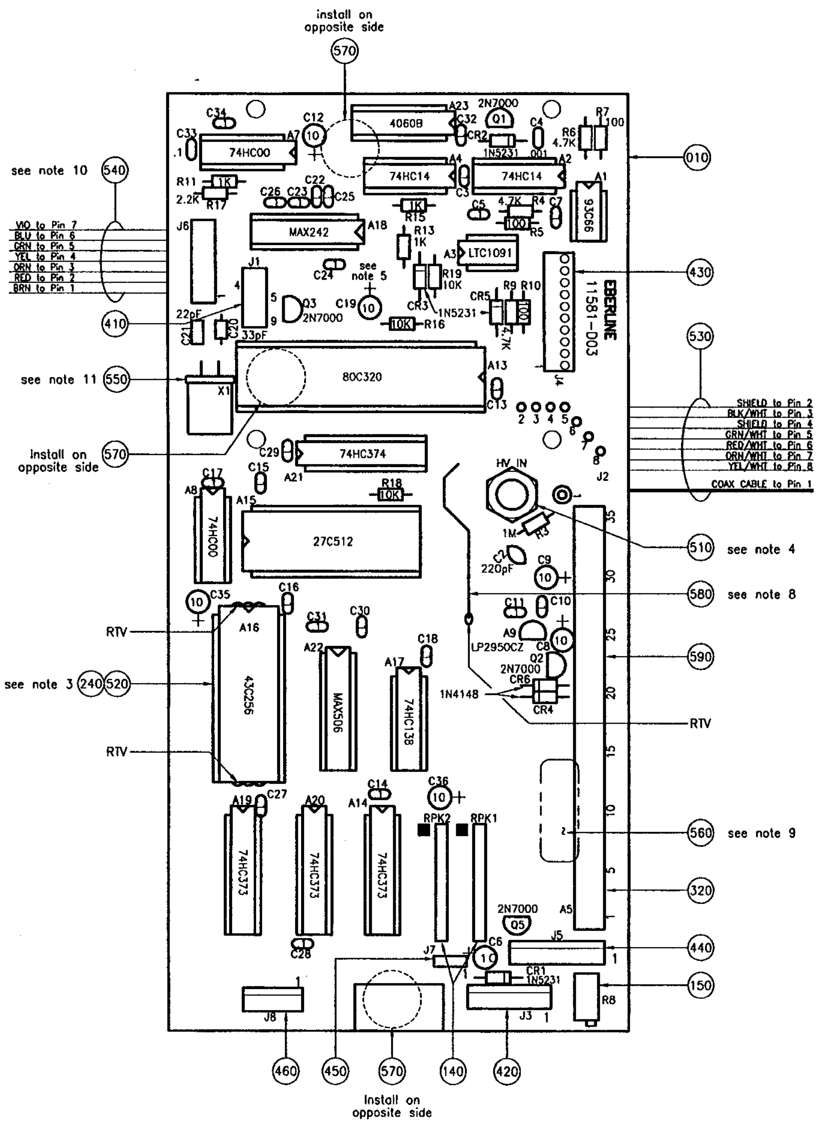
Main PCBoard Schematic, E-600, 11581-D01b sheet 2 of 2

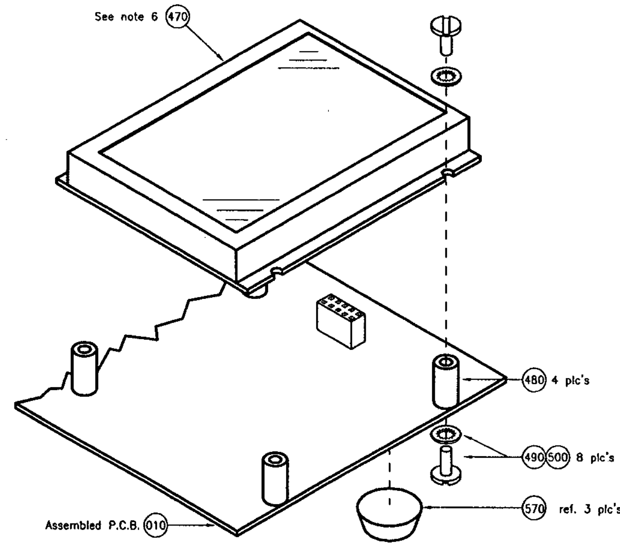


Modular Detector Hybrid, Schematic, 11543-D08a



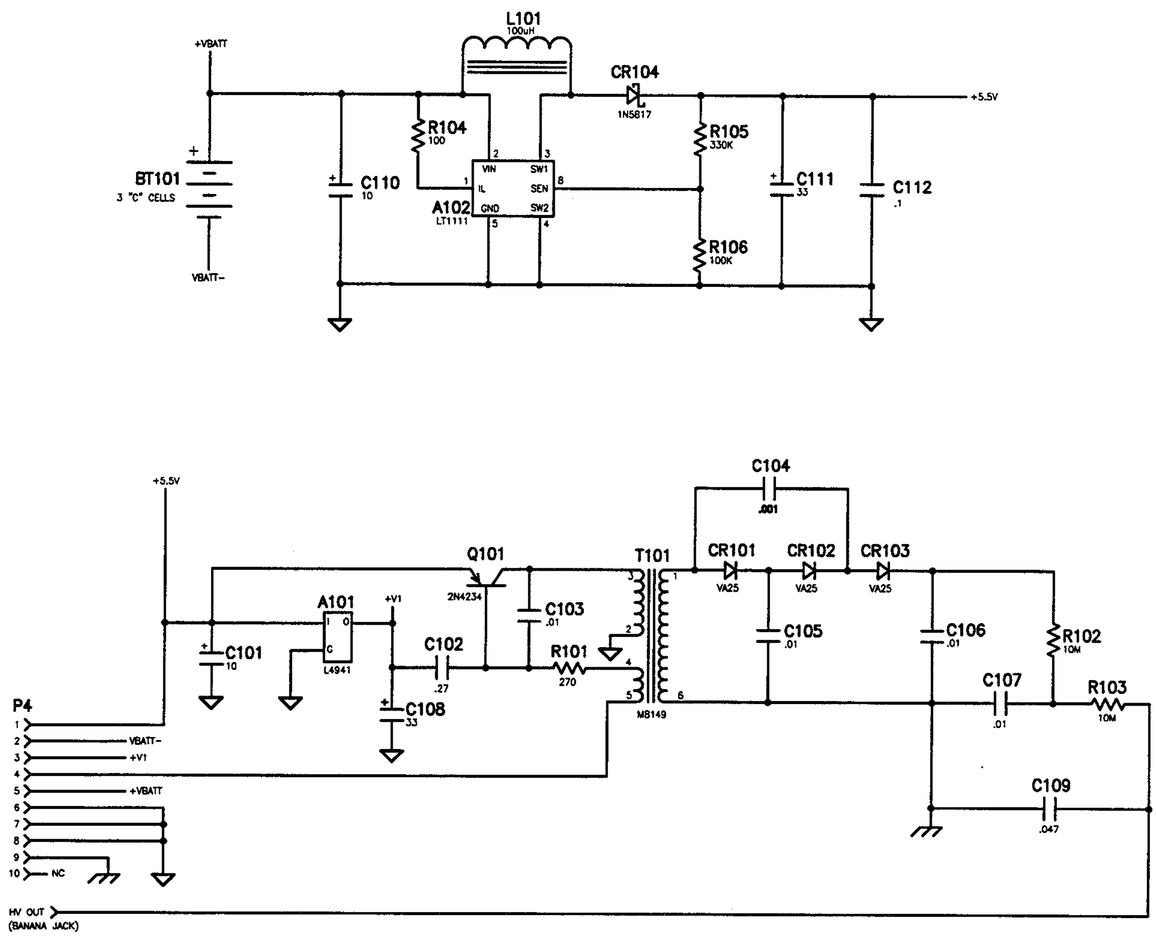
Component Assembly, Main PCB, E-600, 11581-D04d





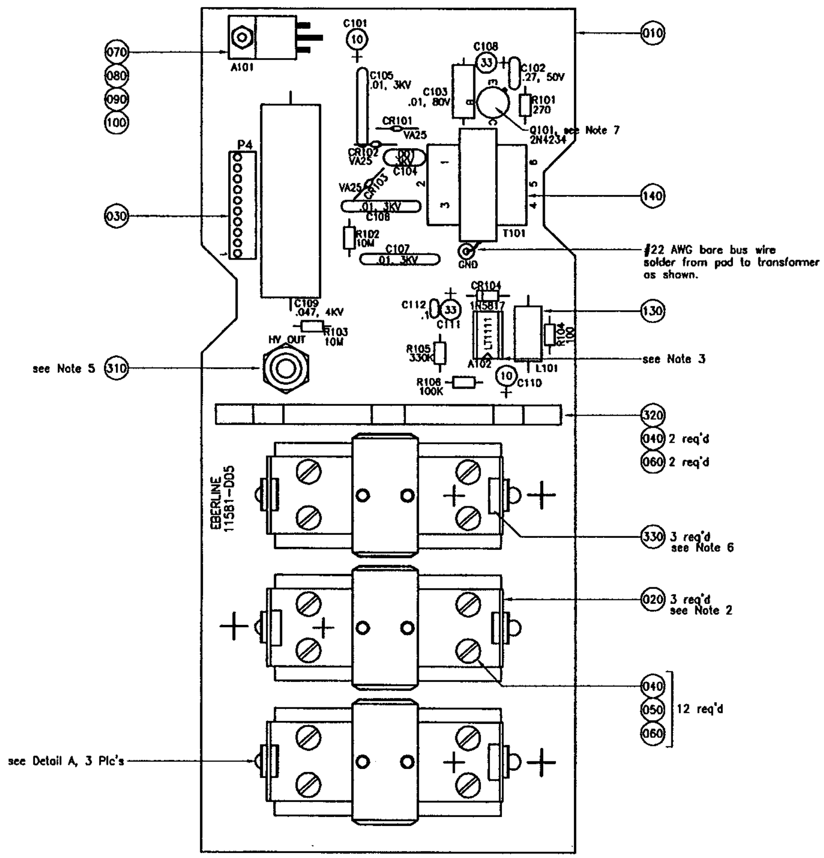
NOTES:

1. Encircled numbers refer to line item numbers on B.O.M. YP11581003.
2. Solder all discrete components and I.C. sockets into P.C. board first.
3. Install Smart Watch Socket, item 520, into I.C. socket at location A16; use a small amount of RTV to attach the Smart Watch Socket, prevent RTV from coating pins.
4. Install the Banana Jack, item 510, from the opposite side.
5. Insert all I.C.'s into I.C. sockets.
6. The Display, item 470, is to be mounted to Main P.C. board after all other components have been installed. Be sure to follow the "Caution" instructions that accompany this Display; note that the Display can only be mounted one way.
7. Resistors are 1/4 watt, 5% unless noted otherwise. Capacitor values are in microFarads unless noted otherwise.
8. Solder Noise Shield, item 580, directly to P.C. board trace, in location shown. Use RTV to secure lower (unsoldered) end of Shield.
9. Apply a 1/4" tall bead of RTV behind lower end of Hybrid A5, item 320, to prevent lead flexing; approximate location shown.
10. Solder wires from items 530 and 540 to solder side of P.C. board, in location shown. Apply approximately 1/8" of RTV around solder joints to reduce flexing of wires.
11. Use a small amount of RTV or foam tape to secure the Crystal, item 550, to P.C. board. Mount crystal parallel to PCB.



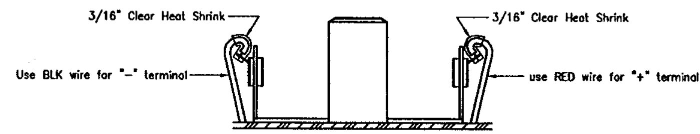
Battery PCBoard Schematic, E-600, 11581-D02a

Battery P.C. Board Component Assembly, 11581-D06, Rev. B

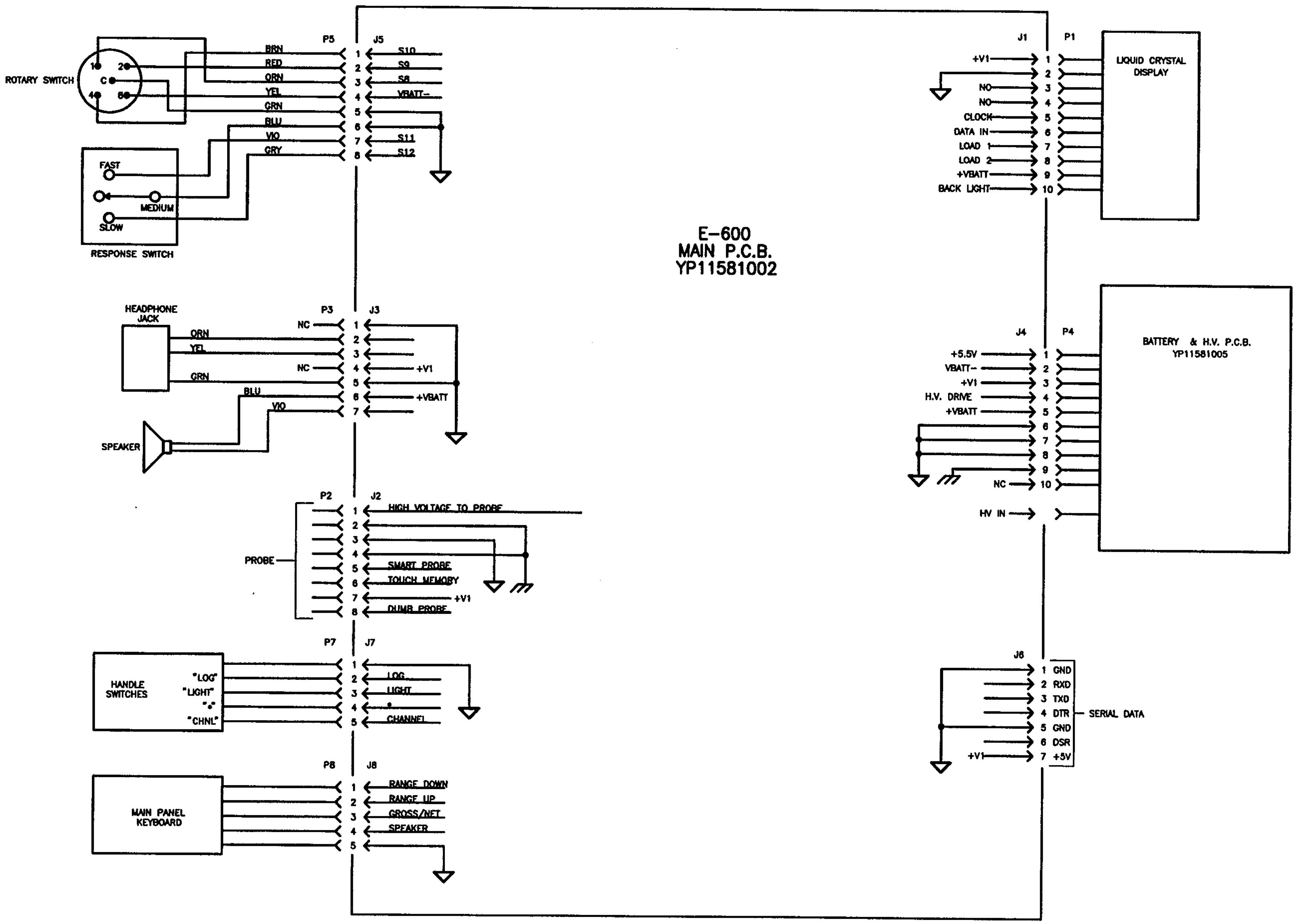


NOTES:

1. Encircled numbers refer to line item numbers on B.O.M. YP11581005.
2. Observer correct orientation of Battery Holders (item 020).
3. I.C. A102 is inserted into an I.C. socket after all other components have been soldered to the P.C. Board.
4. Resistors are 1/4 watt, 5% tolerance. Capacitor values are in microFarads.
5. Mount "Banana" Plug (item 310) from solder side.
6. The red Caps (item 330) shall be placed on the "+" (positive) end of each battery holder as shown. Thesee caps are pushed on over the round terminal.
7. Apply heat shrink tubing over Q101.

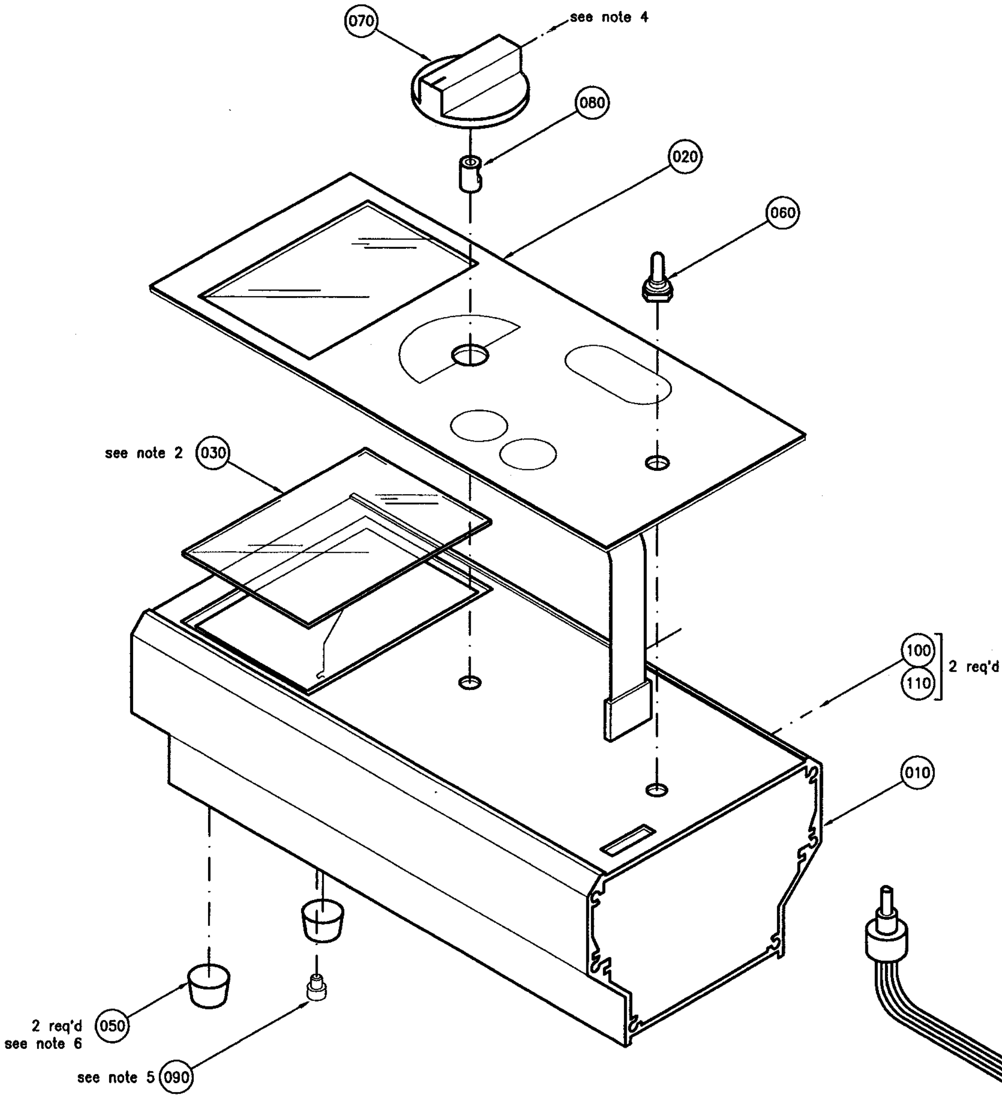


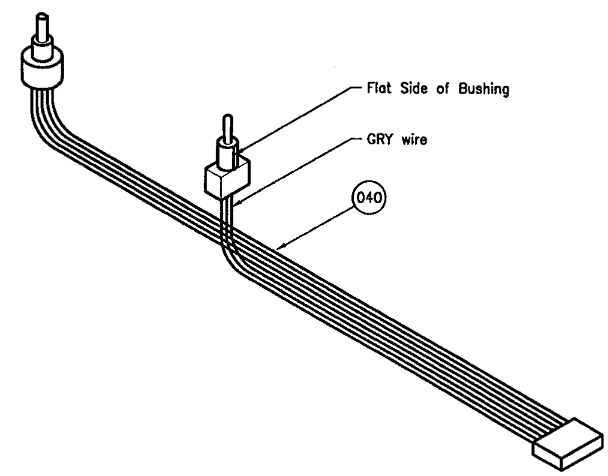
Detail A:
Not to Scale



Overall Interconnect Diagram, 11581-D76

Case Assembly, 11581-D07, rev. B

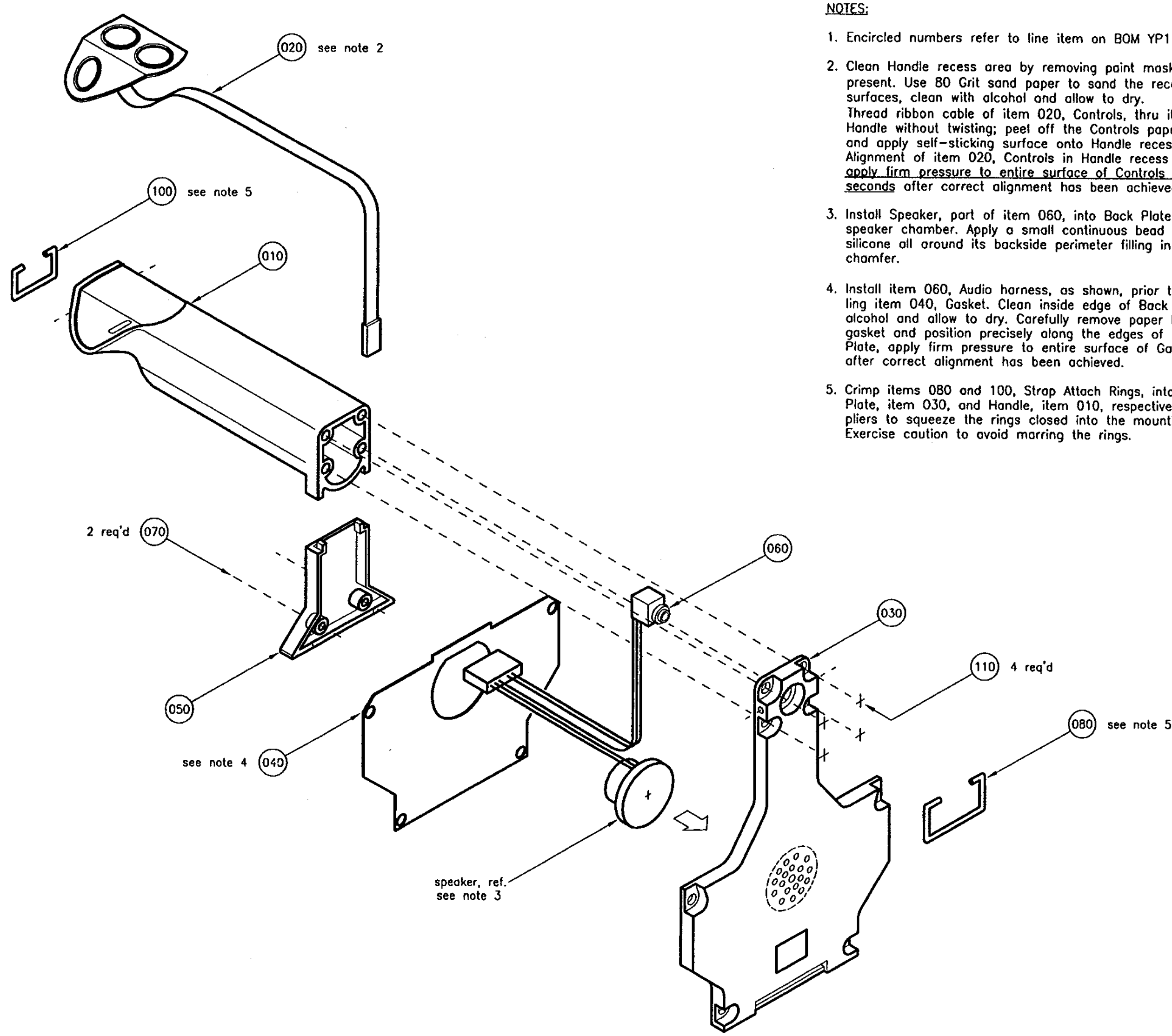




NOTES:

1. Encircled numbers refer to line item on BOM YP11581007.
2. Wipe clean/insure item 030, Display Window, is dust free. Clean item 010, Extrusion entire top surface with alcohol and allow to dry; remove paper liner from item 020, Top Panel and align over Extrusion recessed area, apply firm pressure to the entire surface only after correct alignment has been achieved.
3. Insert item 040, Switch Harness, onto item 010, Extrusion, as shown, observe orientation and insure that Switches are protruding as much as possible from the Extrusion.
4. Install item 080, Adaptor, into item 070, Knob, and tighten Knob set screw sufficiently to retain Adaptor. Place: Knob and Adaptor over Switch shaft and tighten set screw against flat side of shaft. Verify that pointer line on Knob can be rotated to each position labeled on Panel, but no further. Pointer line should align with function labels on Panel.
5. Apply Loc-tite to threads of item 090, Screw, and tighten.
6. Clean circular recessed areas on Extrusion underside with alcohol and allow to dry prior to installation of adhesive-backed feet, item 050; apply firm pressure.

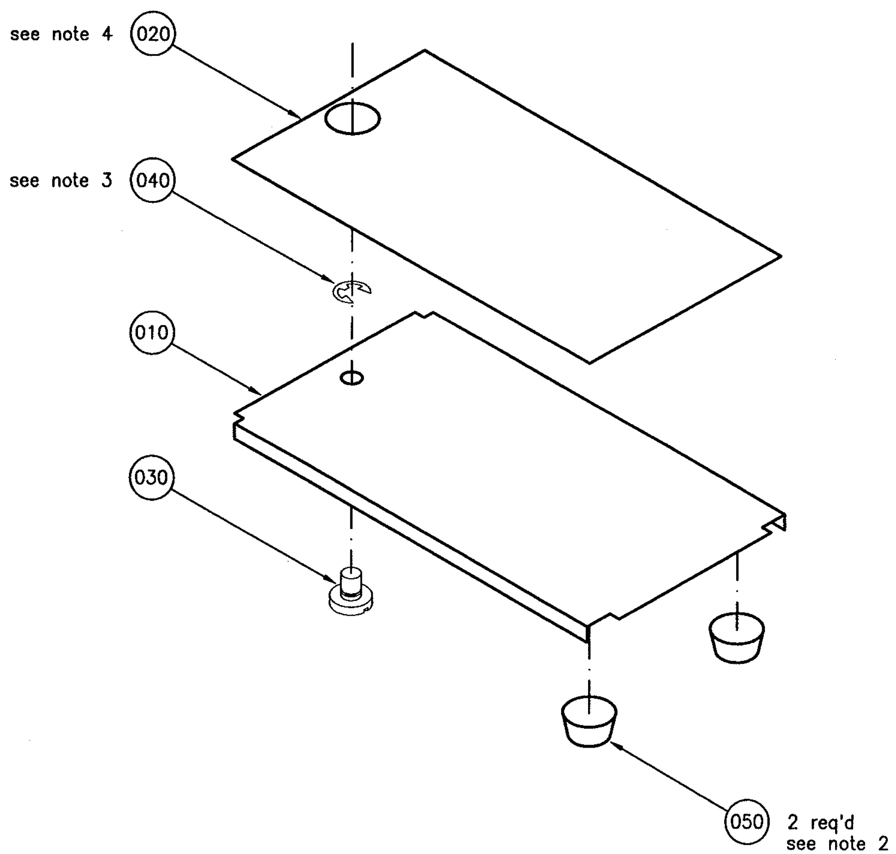
Endplate Assembly, E-600, 11581-D08b



NOTES:

1. Encircled numbers refer to line item on BOM YP11581008.
2. Clean Handle recess area by removing paint mask when still present. Use 80 Grit sand paper to sand the recessed area surfaces, clean with alcohol and allow to dry.
   Thread ribbon cable of item 020, Controls, thru item 010, Handle without twisting; peel off the Controls paper backing and apply self-sticking surface onto Handle recessed area. Alignment of item 020, Controls in Handle recess is critical, apply firm pressure to entire surface of Controls for 3 to 5 seconds after correct alignment has been achieved.
3. Install Speaker, part of item 060, into Back Plate, item 030, speaker chamber. Apply a small continuous bead of RTV silicone all around its backside perimeter filling in the radial chamfer.
4. Install item 060, Audio harness, as shown, prior to installing item 040, Gasket. Clean inside edge of Back Plate with alcohol and allow to dry. Carefully remove paper liner from gasket and position precisely along the edges of the Back Plate, apply firm pressure to entire surface of Gasket only after correct alignment has been achieved.
5. Crimp items 080 and 100, Strap Attach Rings, into the Back Plate, item 030, and Handle, item 010, respectively, using pliers to squeeze the rings closed into the mounting holes. Exercise caution to avoid marring the rings.

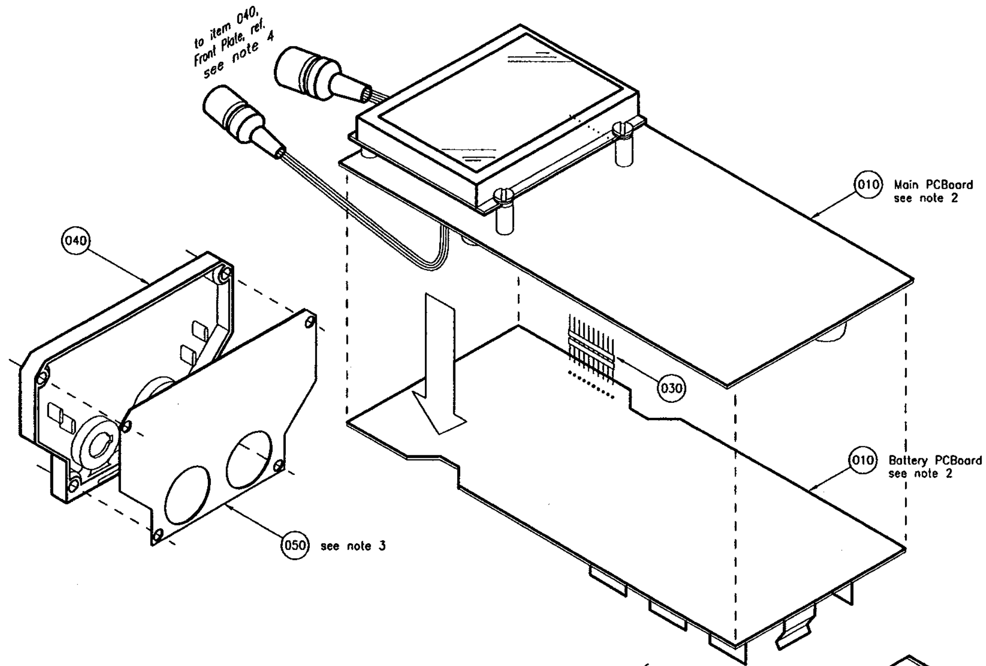
Battery Door Assembly, 11581–C09

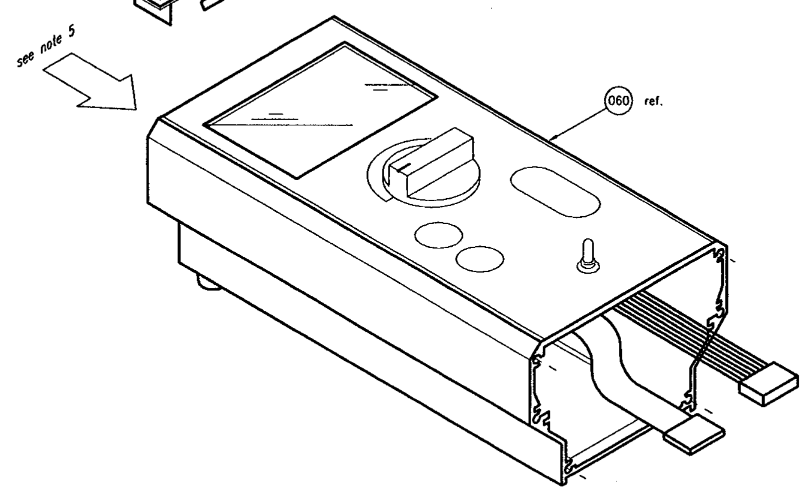


NOTES:

1. Encircled numbers refer to line item on BOM YP11581009.
2. Recessed surfaces of item 010, Battery Cover Plate, are to be cleaned with alcohol and allowed to dry prior to installation of adhesive–backed Feet, item 050.
3. Install item 040, Retainer Ring, onto item 030, Screw, securing both items to Battery Cover.
4. Battery Cover surface mating with item 020, Gasket, is to be cleaned with alcohol and allowed to dry prior to Gasket installation. Remove paper liner from Gasket and align along all edges of Cover prior to applying pressure.

Overall Assembly, E-600, 11581-D55c, sheet 1 of 2

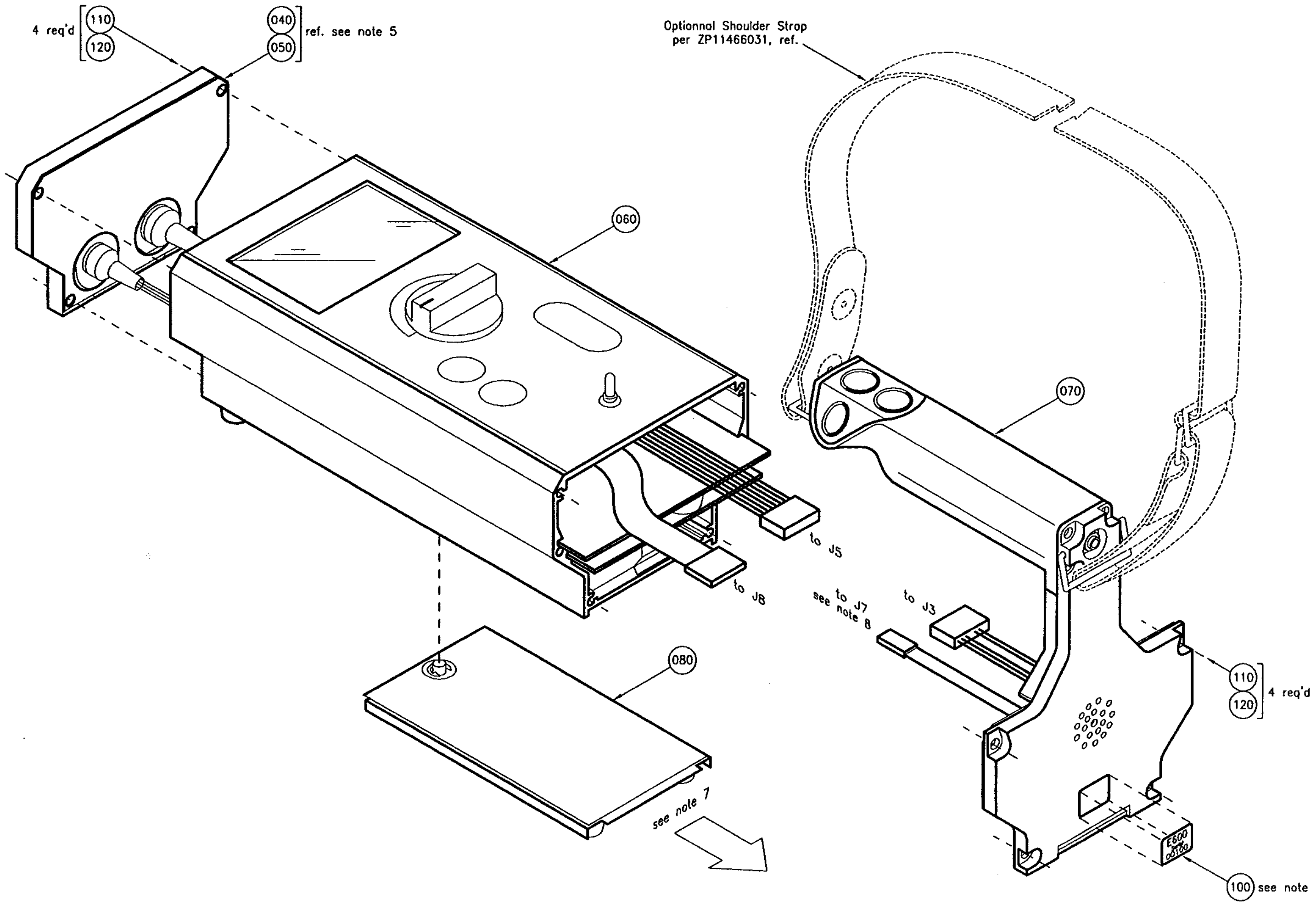




NOTES:

1. Encircled numbers refer to line items on BOM E600–Basic.
2. Insert item 030, Double Ended Header, into Main PCBoard, item 010, and again into item 010, Battery PCBoard, as shown; wires from Main PCB going down on each side of Battery PCB cutouts.
3. Clean inside edges of Front Plate, item 040, with alcohol, allow to dry. Carefully remove paper liner off Gasket, item 050, and position precisely along the edges of the Front Plate, apply firm pressure to entire surface of Gasket only after correct alignment has been achieved.
4. Install both Connector Bodies of Main PCBoard, item 010, into Front Plate using C clips provided with connectors.
5. Carefully insert PCBoard Assembly, items 010 through 050, into guide channels of item 060, Case, making sure that wires are passing thru Battery PCBoard properly and that they are not pinched against the Case walls. Push the PC Boards thru the Case until connectors are accessible at opposite end. Connect J3, J5, J7 and J8 then reposition PCBoards flush with Case and secure Front and Rear End Plates assemblies.
6. Clean small recess area of item 070, Endplate Assembly, with alcohol and allow to dry. Remove paper liner off of item 100, Serial Label and position onto recessed area. Apply firm pressure to entire surface only after correct alignment has been achieved.
7. Install item 080, Battery Cover Assembly, by first inserting end with tab feature into mating slot in End Plate, item 070, until bottomed in slot. Press firmly against extrusion bottom surface and tighten, fastening screw snugly.
8. When attaching item 070, Endplate Assembly to item 060, Case do not pinch mylor tail from handle switches between Endplate and Case extrusion; painted traces on mylor will be destroyed if tail is folded.

Overall Assembly, E-600, 11581-D55c, sheet 2 of 2



E-600 Accessories

Probe Cables

Cables for Eberline smart probes: These cables have Eberline's proprietary probe connectors on both ends and must be used with smart probes to permit retrieval of parameters stored in probe memory.

36 inch Smart-Smart	Order # E600OPT12
60 inch Smart-Smart	Order # E600OPT13

Cables for use with conventional probes: Cables in this group adapt probes with the indicated connector type to the E-600's smart probe connector. Note that the same cable may be used to adapt smart probes for use with instruments which have conventional connectors.

36 inch BNC-Smart	Order # E600OPT8
60 inch BNC-Smart	Order # E600OPT9
36 inch MHV-Smart	Order # E600OPT10
60 inch MHV-Smart	Order # E600OPT11
36 inch CP-1-Smart	Order # E600OPT14
60 inch CP-1-Smart	Order # E600OPT15

Probe Brackets

These bracket assemblies provide a convenient means of attaching probes to the instrument for easy carrying and to prevent damage to the probe.

For probe type AC-3	Order # E600OPT1
For probe type SPA-3	Order # E600OPT2
For probe type SPA-8	Order # E600OPT3
For HP-300 series probes	Order # E600OPT4

For probe type HP-100B	Order # E600OPT5

Other Accessories

Software: Two versions of the E-600 Interface Program, as described in this manual. Additional documentation is provided with this software. Runs on an IBM® PC compatible computer running Microsoft Windows®. Requires an E-600 data cable for connection to the instrument.

Basic interface program	Order # E600OPT7
With Rad Mapping capability	Order # E600OPT17
E-600 data cable	Order # E600OPT20

Barcode pistol: Permits automtatic entry of measurement location or sample identifier numbers from barcode labels.

Barcode pistol	Order # E600OPT6

Carrying case: Black hard case to protect the E-600 during transport.

Carry case	Order # E600OPT18

Headset: Lightweight stereo headset with 3.5 mm plug.

Headset	Order # E600OPT16

Carrying strap: Black nylon shoulder strap.

Carry strap	Order # E600OPT19

Smart Probes

Probes in this group contain parameter memories and require cables with the Eberline smart probe connector.

SHP-270	Energy compensated GM detector, 0-3 R/Hr
SHP-290	Energy compensated GM detector, 0-100 R/Hr
SHP-330	Sealed gas proportional survey/frisking probe
SHP-350	Alpha/Beta scintillator survey/frisking probe, rectangular
SHP-360	Pancake GM survey/frisking probe
SABP-100	Alpha/Beta scintillator survey/frisking probe, square

Additional smart probes are currently under development; contact Eberline Sales for availability and prices.

Conventional Probes

As described in this manual, conventional probes may be used by entering their operating parameters into the instrument's internal memory. Appropriate cables to adapt from BNC, MHV or CP-1 probe connectors to the E-600 are listed above.

HP-100 series	100 cm^2 Gas flow proportional (MHV)
HP-190A	End window GM detector (BNC)
HP-210 series	Pancake GM detectors (BNC)
HP-220A	Shielded/directional GM detector (BNC)
HP-270	Energy compensated GM detector, 0-3 R/Hr (BNC)
HP-280	Neutron sphere, 3 inch diameter (MHV)
HP-290	Energy compensated GM detector, 0-100 R/Hr (BNC)
HP-360	Pancake GM detector (BNC)
HP-320	Sealed gas proportional (MHV)
LEG-1	Low energy Gamma scintillator (CP-1)
PG-2	Low energy Gamma/X-Ray scintillator (CP-1)
ABP-100	Alpha/Beta scintillator (MHV)
AC-3-7, AC-3-8	Alpha scintillators (CP-1)
NRD-1	Neutron sphere, 9 inch diameter (MHV)
SPA-1A	Alpha scintillator for particulate and swipe samples (MHV)
SPA-3	High sensitivity Gamma scintillator (CP-1)
SPA-6	Medium sensitivity Gamma scintillator (MHV)
SPA-8	Gamma scintillator (MHV)
SPA-9	Gamma scintillator for Iodine (MHV)

E-600 Calibration

This procedure is designed to calibrate an E-600 with the many hand probes available from Eberline. Select a probe from the list below then go to the corresponding page.

EQUIPMENT REQUIRED:

IBM PC/AT 386 Compatible Computer, Windows 3.1 capable.
Windows program for E-600 (part of E600OPT7 or E600OPT17)
CA-104-60 Data Cable and appropriate detector cable.
Graphics capable printer.
Calibration standard sources, isotope and type vary with probe.

REFERENCE:

E-600 PC Windows Technical Manual (MA-WINE600)

A. ABP-100, SABP-100

Calibration in dps, dpm, cps, cpm, Bq, dps/100cm^2, dpm/100cm^2, Bq/100cm^2

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time.*

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	5
Probe Area (cm^2)	100
Max. High Voltage	1100
Overrange (cps)	75000
Radon Alarm (cps)	0

Channel Parameters			
Channel Number	1	2	3
Channel Type	Alpha	Beta	A/B
Units	cpm	cpm	cpm
Selected Window	Upper	Lower	Both
High Voltage	752	752	752

Window Param's	**Lower**	**Upper**
Threshold (mV)	2.00	20.0
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit, Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date" parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau* from the sub-menu. Click on the *Channel 1* button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	20
Starting Voltage	752
Ending Voltage	1055
Voltage Step	10
Max. Count Rate (cps)	5000*
Graph Name	ABP-100
File Name	ABP100.GRF

* Depends on source activity.

5. Expose the probe to a ^{99}Tc 10K to 200K cpm (or ≈20K to 400K dpm) plated source. Position the source disc with the active side facing the probe. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached extend the ending voltage as necessary to complete the plateau.

6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the plateau. The operating voltage is normally set at a point where the voltage is as high as possible with less than a 1% beta to alpha crossover. The black vertical bar turns red when the beta to alpha crossover exceeds 1%. Once it turns red, move the bar back until the alpha counts (upper window) is ≤0.1 cps to obtain the optimum operating voltage. Save the desired high voltage setting for channel 1 by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau. Click on the *Channel 2* button on top and then the *Set HV* button to set the same HV for channel 2. Repeat the same for Channel 3.

7. Both alpha and beta backgrounds must be established prior to determining the calibration constant and crossover correction factor for each window. Begin by selecting *Calibration,* then *Determine Calibration Constant*. Verify Channel 3, <u>Upper Window</u>, and Background buttons are selected with the count time set to 180 seconds. Place the probe in a low background area and then click on the *Start* button to begin the background count. The Alpha background should be less than 10 cpm. If the background is too high, try decreasing the high voltage, (refer to the previously run plateau).

Click on the Lower Window button to display the beta background. The beta background should be less than 500 cpm.

8. Next determine the calibration constant and crossover factor for the Beta (lower) window. Select Channel 3, Lower Window, Cal. Const. and the Do XOver box. Enter the calibration field, which should be a 47mm ^{99}Tc source of around 50K to 100K cpm. The units must be in cpm to match the probe set up. Expose the probe to the source and click on *Start* to begin the count. The actual count time is determined by the WinE600 program.

9. Verify the determined Beta Cal. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.10 for ^{99}Tc. If within tolerance, answer Yes to the save prompt to store the CC and crossover factor. Note the efficiency (CC × 100 = % eff.) to record on the calibration report.

10. Now determine the calibration constant and crossover factor for the Alpha (upper) window. Select Channel 3, Upper Window, Cal. Const., and Do XOver. Enter the calibration field, which should be a 47mm ^{230}Th source (or ^{239}Pu if available) of around 50K to 100K cpm. The units must be in cpm to match the probe set up. Expose the probe to the source and click on *Start* to begin the count. Actual count time is determined by the WinE600 program.

11. Upon completion, verify the determined Alpha Cal. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.10 for ^{230}Th, and greater than 0.18 for ^{239}Pu. If within tolerance, answer Yes to the save prompt to store the CC and crossover factor. Note the efficiency (CC × 100 = % eff.) to record on the calibration report.

12. Unless calibration other than cpm or cps is specified, edit the cal constant to 1.00 in both the upper and lower windows of channel 3. This yields actual probe count rate, the recommended procedure for these probes. To edit the cal constant select *Edit, Smart or Conventional Probe* as applicable, then *Channel Parameters*. Jump to step 15.

13. If calibration is to source count rate (2π emissions) then jump to step 15. Do not edit the cal constants to 1.00, the previously determined values are correct for 2π emissions.

14. If units of dps, dpm or Bq, dps/100cm^2, dpm/100cm^2, or Bq/100cm^2 are desired, change the activity units and cal constant at this time. To edit the units and cal constant select *Edit*, *Smart* or *Conventional Probe* as applicable, then *Channel Parameters*. Select the desired units in channel 3. Then divide the previously determined cal constant by two, and enter the new cal constant. This must be done for both upper and lower windows of channel 3.

    For example: If the previously determined cal constant was 0.24 counts/count. Change the units to dpm, then edit the cal constant to 0.12 counts/disint. (0.24 ÷ 2).

15. Verify correct units of measure are set in the instrument. Copy the new parameters from channel 3 to channels 1 and 2 by selecting *Edit, Smart* or *Conventional Probe* as applicable, then *Channel Parameters*. Click on the *Copy* button and when prompted enter "1" as the channel to copy to. Repeat the same for channel 2. Copying channel parameters will require restoring the *Channel Type* and *Selected Window* for each channel. Channel 1 should be set to Alpha channel type, with the Upper window selected. Channel 2 should be set to Beta channel type, with the Lower window selected. Refer to the *Channel Parameters* table.

16. Calibration is complete. To print cal report, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Record the isotope and previously determined efficiency on the printed cal report. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph*.

B. AC-3-7, AC-3-8, HP/SHP-350, HP/SHP-380A

Calibration in CPS, CPM, DPS, DPM, Bq
Calibration to ^{239}Pu (or ^{230}Th if necessary) in S94 type source holders when possible, except for HP/SHP-380A.

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time.*

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	8
Probe Area (cm^2)	73 (100 for HP/SHP-380A)
Max. High Voltage	1500 (1300 for HP/SHP-380A)
Overrange (cps)	90000
Radon Alarm (cps)	0

Channel Parameters		
Channel Number	1	
Channel Type	Alpha	
Units	cpm	
Selected Window	Upper	
High Voltage	700	
Window Param's	**Lower**	**Upper**
Threshold (mV)	2.00	10.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit*, *Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date" parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	10
Starting Voltage	700 (500 for HP-380)
Ending Voltage	1250
Voltage Step	25
Max. Count Rate (cps)	2500*
Graph Name	AC-3, HP-380, etc.
File Name	AC3.GRF

* Depends on source activity.

5. Expose the probe to a ^{239}Pu (or ^{230}Th) 40K to 200K cpm (or ≈80K to 400K dpm) plated source. Position the source disc with the active side facing the probe. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached extend the ending voltage as necessary to complete the plateau, but no higher than 1300 volts.

6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the upper window plateau. Adjust up and down from this point noting the ratio of the upper window counts versus the lower window counts shown in the lower left corner. Select the point where the upper window (alpha) counts are highest and the lower window (beta) counts are lowest while still on the plateau. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau.

7. Determine background and calibration constant next by selecting *Calibration* then *Determine Calibration Constant*. Verify Channel 1, Upper Window, and Background buttons are selected with the count time set to 300 seconds. Place the probe in a low background area and then click on the *Start* button to begin the background count. The background should be less than 10 cpm.

8. Upon completion of the background count, click on the *Cal. Const.* button. Enter the calibration field, which should be a ^{239}Pu source (or ^{230}Th), of around 50K cpm (≈100K dpm). The units have to

be in cpm to match the probe set up. Expose the probe to the source and click on *Start* to begin the count. The actual count time is determined by the WinE600 program.

9. Upon completion, verify the determined cal constant (ie. 2π efficiency or counts/count parameter) for ^{239}Pu is greater than 0.28 for the AC-3-7, greater than 0.18 for the AC-3-8 and greater than 0.35 for the HP/SHP-350 and HP/SHP-380A. If within tolerance, answer Yes to the save prompt. Note the efficiency (CC × 100 = % eff.) to record later on the calibration report.

10. Unless calibration other than cpm is specified, edit the cal constant to 1.00 in both the upper and lower windows of channel 1. This yields actual probe count rate, the recommended procedure for these probes. To edit the cal constant select *Edit*, *Smart or Conventional Probe* as applicable, then *Channel Parameters*. Jump to step 13.

11. If calibration is to source count rate (2π emissions) then jump to step 13. Do not edit the cal constants to 1.00, the previously determined values are correct for 2π emissions.

12. If units of dps, dpm or Bq, dps/100cm^2, dpm/100cm^2, or Bq/100cm^2 are desired, change the activity units and cal constant at this time. To edit the units and cal constant select *Edit*, *Smart* or *Conventional Probe* as applicable, then *Channel Parameters*. Select the desired units in channel 1 and divide the previously determined cal constant by two.

    For example: If the previously determined cal constant was 0.28 counts/count. Change the units to dpm, then edit the cal constant to 0.14 counts/disint. (0.28 ÷ 2).

13. Calibration is now complete. Verify correct units of measure are set in the instrument. To print cal report, select *Calibration,* and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Record the isotope and previously determined efficiency on the printed calibration report. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the plateau is displayed in the Graph Window, select *File* then *Print Graph*.

C. HP-100A, HP-100B, HP-100AGS, HP-100BGS, SHP-100BGS

Calibration in CPS, CPM, Bq, DPS, DPM, DPS/100cm^2, DPM/100cm^2, Bq/100cm^2

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time*.

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	7.5
Probe Area (cm^2)	100
Max. High Voltage	1900
Overrange (cps)	80000
Radon Alarm (cps)	0

Channel Parameters			
Channel Number	1	2	3
Channel Type	Alpha	Beta	A/B
Units	cpm	cpm	cpm
Selected Window	Upper	Lower	Both
High Voltage	1360	1360	1360

Window Param's	**Lower**	**Upper**
Threshold (mV)	1.00	27.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Flush the probe with P10 gas for one hour (minimum) at a flow rate of 50 cc/min. During the actual plateau and counting operations, flow must be maintained at 40 cc/min or more.

4. Select *Edit, Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date" parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

5. Select *Calibrate*, then *Run Plateau* from the sub-menu. Click on the *Channel 3* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	10
Starting Voltage	1360
Ending Voltage	1660
Voltage Step	20
Max. Count Rate (cps)	2500*
Graph Name	SHP-100BGS
File Name	SHP100.GRF

* Depends on source activity.

6. Expose the probe to a ^{99}Tc* 40K to 200K cpm (or ≈80K to 400K dpm) plated source. Position the source with the active side facing the probe. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached extend the ending voltage as necessary to complete the plateau.

7. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the plateau. The operating voltage is normally set at a point where the voltage is as high as possible with less than a 1% beta to alpha crossover. The black vertical bar turns red when the beta to alpha crossover exceeds 1%. Move the bar back one position when it turns red to obtain the optimum operating voltage. Save the desired voltage setting for channel 1 by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau. Click on the *Channel 2* button on top and then the *Set HV* button to set the same HV for channel 2. Repeat the same for channel 3.

8. Both alpha and beta backgrounds must be established prior to determining the calibration constant and crossover correction factor for each window. Begin by selecting *Calibration,* then *Determine Calibration Constant.* Verify Channel 3, Upper Window, and Background buttons are selected with the count time set to 180 seconds. Place the probe in a low background area and then click on the

Start button to begin the background reading. The alpha background should not exceed 5 cpm. If the background is too high, try decreasing the high voltage. While *Background* is still selected, click on the Lower Window button to display the beta background. The beta background should be less than 600 cpm.

9. Next determine the calibration constant and crossover factor for the Beta (lower) window. Select Channel 3, Lower Window, Cal. Const. and the Do XOver box. Enter the calibration field, which should be a $100cm^2$, ^{137}Cs source. The units must be in cpm to match the probe set up. Expose the probe to the source and click on *Start* to begin the count. The actual count time is determined by the WinE600 program.

10. Verify the determined Beta Cal. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.52 for ^{137}Cs. If within tolerance, answer Yes to the save prompt to store the CC and crossover factor. Note the efficiency (CC × 100 = % eff.) to record on the calibration report.

11. Now determine the calibration constant and crossover factor for the Alpha (upper) window. Select Channel 3, Upper Window, Cal. Const., and Do XOver. Enter the calibration field, which should be a $100cm^2$, ^{241}Am source. The units must be in cpm to match the probe set up. Expose the probe to the source and click on *Start* to begin the count. Actual count time is determined by the WinE600 program.

12. Upon completion, verify the determined Alpha Cal. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.45 for ^{241}Am. If within tolerance, answer Yes to the save prompt to store the CC and crossover factor. Note the efficiency (CC × 100 = % eff.) to record later on the calibration report.

13. Unless calibration other than cpm is specified, edit the cal constant to 1.00 in both upper and lower windows of channel 3. This yields actual probe count rate, the recommended procedure for these probes. To edit the cal constant select *Edit*, *Smart* or *Conventional Probe* as applicable, then *Channel Parameters*. Jump to step 16.

14. If calibration to source count rate (2π emissions) is specified, then jump to step 16. Do not edit the cal constants to 1.00, the previously determined values are correct for 2π emissions.

15. If units of dpm, dps, Bq, $dps/100cm^2$, $dpm/100cm^2$, or $Bq/100cm^2$ are desired, change the activity units and cal constant. To edit the units and cal constant select *Edit, Smart or Conventional Probe* as applicable, then *Channel Parameters*. Select the desired units in channel 3 and divide the previously determined cal constant by two.

    For example: If the previously determined cal constant was 0.54 counts/count. Change the units to dpm, then edit the cal constant to 0.27 counts/disint. (0.54 ÷ 2).

16. Verify correct units of measure are set in the instrument. Copy the new parameters from channel 3 to channels 1 and 2. Select *Edit, Smart* or *Conventional Probe* as applicable, then *Channel Parameters*. Click on the *Copy* button, then enter "1" as the channel to copy to. Repeat the same for channel 2. Copying channel parameters will require restoring the *Channel Type* and *Selected Window* for each channel. Channel 1 should be set to Alpha channel type, with the Upper window selected. Channel 2 should be set to Beta channel type, with the Lower window selected. Refer to the *Channel Parameters* table.

17. Calibration is complete. To print cal report, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. After printing the report, enter the Alpha and Beta isotope and efficiency on the cal report. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph.*

18. The gas should now be disconnected from the probe. For **Gas Seal (GS) versions** of the probe perform the following:

    a. Seal the probe by disconnecting the inlet and then the outlet.

    b. Wait 4 hours. Measure the Beta 2π efficiency. It should be less than 5% decrease from the original value from step 10. Calculate the percent decrease with the following equation. This value should be less than 5.0 (5%):

$$\frac{Eff\ step\ 10\ -\ Eff\ step\ 18b}{Eff\ step\ 10} \times 100$$

* 100cm^2 source is preferred, but any size may be used for the plateau. If necessary, the following isotopes may also be used for the plateau: ^{137}Cs, ^{90}Sr, ^{60}Co. A 100cm^2 ^{137}Cs source is the only type that should be used to measure beta efficiency.

D. HP-190A

Section 1 - Calibration in CPM

(for R/h calibration skip to section 2)

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time.*

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	250
Probe Area (cm^2)	6
Max. High Voltage	900
Overrange (cps)	12500
Radon Alarm (cps)	0

E-600 Channel Parameters	
Channel Number	1
Channel Type	Beta
Units	cpm
Selected Window	Upper
High Voltage	900

Window Param's	**Lower**	**Upper**
Threshold (mV)	5.00	10.0
counts/count	1.0	1.0
Bkg. Weight Factor	0	0
Integrate Alarm	0	0
Rate Alarm	0	0
Click Divider	1	1

3. If R/h calibration is specified, then jump to step 10, otherwise calibration should be in CPM.

4. Place the probe in a low background area. Select *Calibration,* then *Determine Calibration Constant.* Verify Channel 1, Upper Window, and Background are selected with the count time set to 180 seconds. Click on the *Start* button to begin background count.

5. After the background has been determined, click on *Cal. Const.* Expose the probe, screen on a 1 inch plated ^{90}SrY source of less than 20K cpm. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and source activity. Upon completion, verify the determined Beta Cal. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.12. If within tolerance, answer Yes to the save prompt. Note the efficiency (CC × 100 = % eff.) to record later on the calibration report.

6. Select *Calibrate*, then *Run Linearity Check.* Click on the *Efficiency Based Linearity Check* box on top of the dialog box that appears. Enter the ^{90}SrY source count rate for the linearity fields. Sources should be 1 inch, plated ^{90}SrY of about 2K to 20K cpm and another of ≈75K to 100K cpm. Note the field entered must be in the same units (cpm) as the probe set up.

7. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions in the dialog boxes that appear. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in *System* parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it.

8. If linearity checks ok, edit the cal constant to 1.00 in both the upper and lower windows of channel 1. This yields actual probe count rate, the recommended procedure for these probes. To edit the cal constant select *Edit*, *Smart or Conventional Probe* as applicable, then *Channel Parameters*.

9. When the linearity tests are complete, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Add the linearity data to the report when prompted, prior to printing. Record the isotope and previously determined efficiency on the cal report.

Section 2 - R/h Calibration

10. Select *Edit*, *Smart* or *Conventional Probe* as applicable, then *Channel Parameters*. Change the units from cpm to R/h in channel 1and the channel type to gamma.

11. Select *Calibration,* then *Determine Calibration Constant.* Verify Channel 1, Upper Window, and *Cal. Const.*are selected. Enter the cal constant field of 0.0075R/h. Place the probe in a 0.0075 R/h (7.5 mR/h) ^{137}Cs field, side on. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and field strength. When the count is complete, click on *Save* to store the new calibration constant if within 1.15E+08 to 1.95E+08.

12. Next, click on *Dead Time*. Enter the dead time field of 0.75R/h. Place the probe, in a 0.75R/h (750 mR/h) ^{137}Cs field. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 230 to 330 µsec., then click on *Save* when prompted, to store the new Dead Time value in the instrument.

13. Select *Calibrate*, then *Run Linearity Check*. Enter the following ^{137}Cs linearity fields in the box that appears: 0.005 R/h (5 mR/h), 0.05 R/h (50 mR/h), and 0.25 R/h (250 mR/h). Note the field entered must be in the same units (R/h), as the probe set up.

14. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions in the dialog boxes that appear. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in *System* parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it.

15. When the linearity tests are complete, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Add the linearity data to the report when prompted, prior to printing.

E. HP-210, HP-260, SHP-360

Section 1 - Calibration in CPM

(for R/h calibration skip to section 2)

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time*.

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	100
Probe Area (cm^2)	15
Max. High Voltage	900
Overrange (cps)	58000
Radon Alarm (cps)	0

E-600 Channel Parameters		
Channel Number	1	
Channel Type	Beta	
Units	cpm	
Selected Window	Upper	
High Voltage	900	
Window Param's	**Lower**	**Upper**
Threshold (mV)	5.00	10.0
counts/count	1	1
Bkg. Weight Factor	0	0
Integrate Alarm	0	0
Rate Alarm	0	0
Click Divider	1	1

3. If R/h calibration is specified, then jump to step 9, otherwise calibration should be in CPM.

4. Place the probe in a low background area. Select *Calibration,* then *Determine Calibration Constant.* Verify Channel 1, Upper Window, and Background are selected with the count time set to 120 seconds. Click on the *Start* button to begin background count.

5. After the background has been determined, click on *Cal. Const.* Expose the probe to a 47mm ^{99}Tc source of less than 20K cpm. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and source activity. Upon completion, verify the determined Beta Cal. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.25. If within tolerance, answer Yes to the save prompt. Note the efficiency (CC × 100 = % eff.) to record later on the calibration report.

6. Select *Calibrate*, then *Run Linearity Check.* Click on the *Efficiency Based Linearity Check* box on top of the dialog box that appears. Enter the ^{99}Tc source count rate for the linearity fields. Sources should be 47mm, ^{99}Tc of about 2K to 20K cpm and another of ≈75K to 100K cpm. Note the field entered must be in the same units (cpm) as the probe set up.

7. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions in the dialog boxes that appear. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in System parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it.

8. If linearity checks ok, edit the cal constant to 1.00 in both the upper and lower windows of channel 1. This yields actual probe count rate, the recommended procedure for these probes. To edit the cal constant select *Edit, Smart or Conventional Probe* as applicable, then *Channel Parameters.*

9. When the linearity tests are complete, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Add the linearity data to the report when prompted, prior to printing. Record the isotope and previously determined efficiency on the cal report.

Section 2 - R/h calibration

10. Select *Edit*, *Smart* or *Conventional Probe* as applicable, then *Channel Parameters*. Change the units from cpm to R/h in channel 1and the channel type to gamma.

11. Select *Calibration,* then *Determine Calibration Constant.* Verify Channel 1, Upper Window, and *Cal. Const.* are selected. Enter the cal constant field of 0.0075 R/h.

    NOTE

    Use 1/4" plastic (plexiglas) between source and detector, placed in contact with detector, for the following readings.

12. Place the probe in a 0.0075 R/h (7.5 mR/h) ^{137}Cs field, face on. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and field strength. When the count is complete, click on *Save* to store the new calibration constant if within 1.8E+08 to 2.4E+08.

13. Next, click on *Dead Time*. Enter the dead time field of 0.75R/h. Place the probe, in a 0.75R/h (750 mR/h) ^{137}Cs field. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 80 to 125 µsec., click on *Save* when prompted, to store the new Dead Time value in the instrument.

14. Select *Calibrate*, then *Run Linearity Check*. Enter the following ^{137}Cs linearity fields in the box that appears: 0.005 R/h (5 mR/h), 0.05 R/h (50 mR/h), and 0.5 R/h (500 mR/h). Note the field entered must be in the same units (R/h), as the probe set up.

15. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions in the dialog boxes that appear. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in *System* parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it.

16. When the linearity tests are complete, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Add the linearity data to the report when prompted, prior to printing. Record the isotope and previously determined efficiency on the printed cal report.

F. HP-220A

Calibration in R/h

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility*, then *Set Time*.

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	60
Probe Area (cm^2)	1
Max. High Voltage	600
Overrange (cps)	67000
Radon Alarm (cps)	0

E-600 Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	R/h	
Selected Window	Upper	
High Voltage	600	
Window Param's	**Lower**	**Upper**
Threshold (mV)	5.00	10.0
counts/R	1	1.50E+06
Bkg. Weight Factor	0	0
Integrate Alarm	0	0
Rate Alarm	0	0
Click Divider	1	1

3. Place the probe in a low background area. Select *Calibration,* then *Determine Calibration Constant.* Verify Channel 1, Upper Window, and *Cal. Const.* are selected.

4. Enter the cal constant field, 0.075 R/h. Place the probe in a 75 mR/h (0.075 R/h) ^{137}Cs field. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and field strength. When the count is complete, click on *Save* to store the new calibration constant if within 4.9E+07 to 9.1E+07.

5. Next, click on *Dead Time*. Enter the dead time field, 75 R/h. Place the probe in a 75 R/h ^{137}Cs field. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 70 to 100 μsec., click on *Save* when prompted, to store new value in the instrument.

6. Change the linearity tolerance to 15% by selecting *Edit*, then *System Parameters*. Next perform the linearity check by selecting *Calibrate*, then *Run Linearity Check*. Enter the following ^{137}Cs linearity fields in the box that appears: 0.750 R/h (750 mR/h), 7.5R/h, and 75R/h. Note the field entered must be in the same units (R/h), as the detector set up.

7. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions in the dialog boxes that appear. The E-600 response and percent error will be reported. Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it all together.

8. When the linearity tests are complete, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Add the linearity data to the report when prompted.

G. HP-270, SHP-270

Calibration in R/h

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility*, then *Set Time*.

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (µsec.)	90
Probe Area (cm^2)	3
Max. High Voltage	900
Overrange (cps)	60000
Radon Alarm (cps)	0

E-600 Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	R/h	
Selected Window	Upper	
High Voltage	900	
Window Param's	**Lower**	**Upper**
Threshold (mV)	5.00	10.0
counts/R	1	7.00E+07
Bkg. Weight Factor	0	0
Integrate Alarm	0	0
Rate Alarm	0	0
Click Divider	1	1

3. Select *Calibration,* then *Determine Calibration Constant.* Verify Channel 1, Upper Window, and Cal. Const. are selected. Enter the calibration constant field, 0.0075 R/h. Place the probe in a 7.5 mR/h (0.0075 R/h) ^{137}Cs field, side on, shield closed. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and field strength. When the count is complete, click on *Save* to store the new calibration constant if within 4.9E+07 to 9.1E+07.

4. Next, click on *Dead Time*. Enter the dead time field, 0.75 R/h. Place the probe, shield closed, in a 750 mR/h (0.75R/h) ^{137}Cs field. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 60 to 120 µsec., click on *Save* when prompted, to store new value in the instrument.

5. Select *Calibrate*, then *Run Linearity Check*. Enter the following ^{137}Cs linearity fields in the box that appears: 0.005 R/h (5 mR/h), 0.5R/h (500mR/h), and 2R/h. Note the field entered must be in the same units (R/h), as the detector set up.

6. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions in the dialog boxes that appear. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in *System* parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it all together.

7. When the linearity tests are complete, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Add the linearity data to the report when prompted.

H. HP-290, SHP-290

Calibration in R/h

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time*.

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	24
Probe Area (cm^2)	2
Max. High Voltage	550
Overrange (cps)	75000
Radon Alarm (cps)	0

E-600 Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	R/h	
Selected Window	Upper	
High Voltage	550	
Window Param's	**Lower**	**Upper**
Threshold (mV)	5.00	10.0
counts/R	1	5.50E+06
Bkg. Weight Factor	0	0
Integrate Alarm	0	0
Rate Alarm	0	0
Click Divider	1	1

3. Select *Calibrate,* then *Determine Calibration Constant.* Verify Channel 1, Upper Window, and Cal. Const. are selected. Enter the calibration constant field, 0.75 R/h. Place the probe in a 0.75 R/h (750 mR/h) ^{137}Cs field, side on. Click on the *Start* button to begin count. Actual count time is determined by the program and field strength. When the count is complete, click on *Save* to store the new calibration constant if within 4.50E+06 to 7.0E+06.

4. Next, click on *Dead Time*. Enter the dead time field, 25 R/h. Place the probe in a 25R/h ^{137}Cs field. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 22-35 µsec., click on *Save* when prompted to store new value in the instrument.

5. Select *Calibrate*, then *Run Linearity Check*. Enter the following ^{137}Cs linearity fields in the box that appears: 0.075 R/h (75 mR/h), 7.5R/h, and 40R/h. Note the field entered must be in the same units (R/h), as the detector set up.

6. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions in the dialog boxes that appear. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in System parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it all together.

7. When the linearity tests are complete, select *Calibration,* then *Print Calibration Report*, while still connected to the E-600 just calibrated. Add the linearity data to the report when prompted.

HP-300, SHP-300

Calibration in R/h

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time*.

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	100
Probe Area (cm^2)	53
Max. High Voltage	500
Overrange (cps)	16,000
Radon Alarm (cps)	0

E-600 Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	R/h	
Selected Window	Upper	
High Voltage	449	
Window Param's	**Lower**	**Upper**
Threshold (mV)	5.00	10.0
counts/R	1	5.00E+08
Bkg. Weight Factor	0	0
Integrate Alarm	0	0
Rate Alarm	0	0
Click Divider	1	1

3. Select *Calibration*, then *Determine Calibration Constant*. Verify Channel 1, Upper Window, and Cal. Const. are selected. Enter the calibration constant field, 0.001 R/h. Using the free air calibrator setup, place the probe in a 1 mR/h (0.001 R/h) ^{137}Cs field, side on. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and field strength. Repeat until determined cal constant is consistent. When count is complete, click on *Save* to store the new calibration constant if within 4.7E+08 to 7.0E+08.

4. Next, click on *Dead Time*. Enter the dead time field, 0.05 R/h. Follow the instructions for HP-300 probes located in the source room for source well s/n EI-152. Place the probe in the special holder above the well, and set up for a 50 mR/h (0.05R/h) ^{137}Cs field per the HP-300 instructions. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 90 to 140 µsec., click on *Save* when prompted to store the new value in the instrument.

5. Select *Calibrate*, then *Run Linearity Check*. Enter the following ^{137}Cs linearity fields in the box that appears: 0.02 R/h (20 mR/h), 0.05R/h (50mR/h), and .1R/h (100mR/h). Note the field entered must be in the same units (R/h), as the detector set up. Follow the instructions for the HP-300 probes when setting up these fields.

6. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions in the dialog boxes that appear. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in *System* parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it all together.

7. When the linearity tests are complete, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Add the linearity data to the printed calibration report when prompted.

I. HP-320, SHP-330
Calibration in CPM, CPS, DPM, DPS, Bq

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time.*

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	8.5
Probe Area (cm^2)	15
Max. High Voltage	1800
Overrange (cps)	48000
Radon Alarm (cps)	0

Channel Parameters			
Channel Number	1	2	3
Channel Type	Alpha	Beta	A/B
Units	cpm	cpm	cpm
Selected Window	Upper	Lower	Both
High Voltage	1450	1450	1450

Window Param's	**Lower**	**Upper**
Threshold (mV)	1.00	30.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit, Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date" parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau* from the sub-menu. Click on the *Channel 3* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	10
Starting Voltage	1450
Ending Voltage	1650
Voltage Step	10
Max. Count Rate (cps)	2500*
Graph Name	SHP-330
File Name	SHP330.GRF

* Depends on source activity.

5. Expose the probe to a ^{99}Tc 20K to 200K cpm (or ≈40K to 400K dpm) 47mm plated source. Position the source disc with the active side facing the probe. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached extend the ending voltage as necessary to complete the plateau.

6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the plateau. Adjust up and down from this point noting the ratio of the upper window counts versus the lower window counts. Select the point where the lower window counts are highest and the upper window counts are lowest while still on the plateau. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau.

7. Both alpha and beta backgrounds must be established prior to determining the calibration constant and crossover correction factor for each window. Begin by selecting *Calibration,* then *Determine Calibration Constant*. Verify Channel 3, Upper Window, and Background buttons are selected with the count time set to 180 seconds. Place the probe in a low background area and then click on the *Start* button to begin the background reading. The alpha background should not exceed 2 cpm. While *Background* is still selected, click on the Lower Window button to display the beta background. The beta background should be less than 50 cpm.

8. Next determine the calibration constant and crossover factor for the Beta (lower) window. Select Channel 3, Lower Window, Cal. Const. and the Do XOver box. Enter the calibration field, which should be a 47mm ^{99}Tc source of around 50K to 100K cpm. The units must be in cpm to match the probe set up. Expose the probe to the source and click on *Start* to begin the count. The actual count time is determined by the WinE600 program.

9. Verify the determined Beta Cal. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.18 for ^{99}Tc. If within tolerance, answer Yes to the save prompt to store the CC and crossover factor. Note the efficiency (CC × 100 = % eff.) to record on the calibration report.

10. Now determine the calibration constant and crossover factor for the Alpha (upper) window. Select Channel 3, Upper Window, Cal. Const., and Do XOver. Enter the calibration field, which should be a 47mm ^{239}Pu of around 50K to 100K cpm. The units must be in cpm to match the probe set up. Expose the probe to the source and click on *Start* to begin the count.

11. Upon completion, verify the determined Alpha Cal. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.20 for ^{239}Pu. If within tolerance, answer Yes to the save prompt to store the CC and crossover factor. Note the efficiency (CC × 100 = % eff.) to record later.

12. Unless calibration other than cpm is specified, edit the cal constant to 1.00 in both the upper and lower windows of channel 3. This yields actual probe count rate, the recommended procedure for these probes. To edit the cal constant select *Edit*, *Smart* or *Conventional Probe* as applicable, then *Channel Parameters*. Jump to step 15.

13. If calibration is to source count rate (2π emissions) then jump to step 15. Do not edit the cal constants to 1.00, the previously determined values are correct for 2π emissions.

14. If units of dps, dpm or Bq, dps/100cm^2, dpm/100cm^2, or Bq/100cm^2 are desired, change the activity units and cal constant at this time. To edit the units and cal constant select *Edit*, *Smart or Conventional Probe* as applicable, then *Channel Parameters*. Select the desired units in channel 3 and divide the previously determined cal constant by two.

    For example: If the previously determined cal constant was 0.24 counts/count. Change the units to cpm, then edit the cal constant to 0.12 counts/disint. (0.24 ÷ 2).

15. Verify correct units of measure are set in the instrument. Copy the new Cal. Constant and other parameters to channels 1 and 2 by selecting *Edit, Smart* or *Conventional Probe* as applicable, then *Channel Parameters*. Click on the *Copy* button and when prompted enter "1" as the channel to copy to. Repeat the same for channel 2. Copying channel parameters will require restoring the *Channel Type* and *Selected Window* for each channel. Channel 1 should be set to Alpha channel type, with the Upper window selected. Channel 2 should be set to Beta channel type, with the Lower window selected. Refer to the *Channel Parameters* table.

16. Calibration is complete. To print cal report, Select *Calibration,* then *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Record the isotope and previously determined efficiency on the printed cal report. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. When the Graph Window is displayed, select *File* then *Print Graph.*

J. LEG-1

Section 1 - Calibration in CPS, CPM - Gross Counting
(for PHA calibration skip to section 2.)

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time*.

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	8
Probe Area (cm^2)	5
Max. High Voltage	1500
Overrange (cps)	40000
Radon Alarm (cps)	0

Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	cpm	
Selected Window	Upper	
High Voltage	460	
Window Param's	**Lower**	**Upper**
Threshold (mV)	2.00	2.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit*, *Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date" parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	20
Starting Voltage	450
Ending Voltage	725
Voltage Step	25
Max. Count Rate (cps)	5000*
Graph Name	LEG-1
File Name	LEG1.GRF

* Depends on source activity.

5. Expose the probe to an ^{241}Am plated source, of ≈300k cpm (≈600k dpm). Position the source disc with the active side facing the end of the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.

6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the upper window plateau. The operating voltage is normally set at a point where the voltage is as high as possible with less than a 1% crossover. The black vertical bar turns red when the window crossover exceeds 1%. Move the bar back one position when it turns red to obtain the optimum operating voltage. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau.

7. Next select *Calibration* then *Determine Calibration Constant*. Verify Channel 1, Upper Window, and Background buttons are selected with the count time set to 300 seconds. Place the probe in a low background area, preferably in a lead shield, then click on the *Start* button to begin the background count. Note the background reading.

8. Check the ^{241}Am 60 keV gamma efficiency. Expose the detector to an ^{241}Am source of ≈600k dpm, preferably s/n 6025 and place in a shield. Use the *Background* mode to acquire a count by watching the countdown in the lower right corner, note the cpm when it is below 2%. Subtract the previously

determined background from this count. Use the following formula to determine efficiency. Note the calculated efficiency to record later on the calibration report.

$$60keV\ \gamma\ eff. = \frac{E600\ reading\ -\ Bkg \times 100}{0.357 \times Source\ DPM}$$

NOTE: Gamma per minute based on 0.357 abundance of 60 keV gamma from ^{241}Am. Ref: ICRP Publication 38, 1983.

9. Calibration is now complete. Verify correct units of measure (cps or cpm) are set in the instrument. To print cal report, select *Calibration,* and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Record the isotope and previously determined 60 keV efficiency on the printed calibration report. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the plateau is displayed in the Graph Window, select *File* then *Print Graph.*

Section 2 - PHA Calibration

10. Load the LEG-1 PHA probe parameters (*leg1pha.** file), by selecting *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters.

Probe Parameters	
Dead Time (μsec.)	8
Probe Area (cm^2)	5
Max. High Voltage	1500
Overrange (cps)	40000
Radon Alarm (cps)	0

Channel Parameters	
Channel Number	1
Channel Type	PHA
Units	cpm
Selected Window	Lower
High Voltage	460

Window Param's	Lower	Upper
Threshold (mV)	4.00	5.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

11. Select *Edit*, then *Instrument Parameters*. If necessary, enter the E-600 serial number and calibration dates in the window that appears. Likewise, enter the probe serial number and model in the *Probe Parameters* submenu of the *Smart Probe* or *Conventional Probe* as applicable.

12. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	20
Starting Voltage	700*
Ending Voltage	900*
Voltage Step	10
Max. Count Rate (cps)	20,000**
Graph Name	LEG-1, PHA
File Name	LEG1.GRF

* Plateau starting and ending voltages will vary with isotope.
** Depends on source activity.

13. Place a ^{241}Am or ^{239}Pu source (or other isotope of interest) against the end of the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.

14. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is on the peak of the <u>lower window</u> plot. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the correct desired value.

15. Calibration is now complete. Verify correct units of measure (cps or cpm) are set in the instrument. To print cal report, select *Calibration,* and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button if the Print Linearity Data dialog box appears. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph.*

K. NRD, HP-280

Calibration in Rem/h

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time*.

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	10
Probe Area (cm^2)	1
Max. High Voltage	2300
Overrange (cps)	10,000-NRD 25,000-HP280
Radon Alarm (cps)	0

E-600 Channel Parameters		
Channel Number	1	
Channel Type	Neutron	
Units	Rem/h	
Selected Window	Lower	
High Voltage	1500	
Window Param's	**Lower**	**Upper**
Threshold (mV)	2.00	60.00
counts/rem	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0	0
Rate Alarm	0	0

Click Divider	1	1

3. Temporarily edit the units of measure to cpm in channel 1 by selecting *Edit, Smart* or *Conventional Probe* then *Channel Parameters*. Place the NRD in a 10 R/h ^{137}Cs field. Select *Edit, Smart* or *Conventional Probe* then *Channel Parameters* and adjust the HV for approximately 50 cpm as read on the E-600 in Ratemeter mode. Changing the high voltage setting in the channel parameters and clicking on the *Down Load* button, will allow changes to the HV while observing the effect on count rate in Ratemeter mode. When the reading is approximately 50 cpm in a 10 R/h field, decrease the HV by 50V and verify no counts.

4. Edit the units of measure back to Rem/h, by selecting *Edit, Smart* or *Conventional Probe* then *Channel Parameters*. Next select *Calibration,* then *Determine Calibration Constant*. Verify Channel 1, Lower Window, and Cal. Const. are selected. Enter the calibration constant field, 0.027 Rem/h. Place the NRD in a 27 mRem/h field (0.027 Rem/h) then click on the *Start* button to begin calibration constant determination. Actual count time is determined by the program. When the count is complete, click on *Save* to store the new calibration constant.

5. Select *Calibrate*, then *Run Linearity Check*. Enter the following linearity fields in the box that appears: 0.027 Rem/h (27 mRem/h) and 0.2 Rem/h (200 mRem/h). Note the field entered must be in the same units (Rem/h), as the detector set up.

6. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions in the dialog boxes that appear. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in *System* parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it all together.
7. When the linearity tests are complete, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Add the linearity data to the report when prompted.

L. PG-2

Section 1 - Calibration in CPS, CPM - Gross Counting

(for PHA calibration skip to section 2.)

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time*.

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	12
Probe Area (cm^2)	12
Max. High Voltage	1300
Overrange (cps)	20000
Radon Alarm (cps)	0

Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	cpm	
Selected Window	Lower	
High Voltage	560	
Window Param's	**Lower**	**Upper**
Threshold (mV)	3.00	45.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit*, *Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date" parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	10
Starting Voltage	560
Ending Voltage	1060
Voltage Step	20
Max. Count Rate (cps)	25,000*
Graph Name	PG-2
File Name	PG2.GRF

* Depends on source activity.

5. Expose the probe to a ^{239}Pu plated source (preferably one of the Meg cpm sources). Position the source disc with the active side facing the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.

6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the plateau. The operating voltage is normally set at a point where the voltage is as high as possible with less than a 1% alpha (upper window) to gamma (lower window) crossover. The black vertical bar turns red when the alpha to gamma crossover exceeds 1%. Move the bar back one position when it turns red to obtain the optimum operating voltage. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau.

7. Determine efficiency next by selecting *Calibration* then *Determine Calibration Constant*. Verify Channel 1, Lower Window, and Background buttons are selected with the count time set to 300 seconds. Place the probe in a low background area, preferably in a lead shield, then click on the *Start* button to begin the background count. The background should be less than 60 cpm in a lead shield.

8. Expose the detector to a plated ^{239}Pu source, preferably s/n 1071 or s/n P1646 and place in a shield. Use the *Background* mode to acquire a count by watching the countdown in the lower right corner,

note the cpm when it is below 2%. Subtract the previously determined background from this count. Use the following formula to determine efficiency. Note the calculated efficiency to record later on the calibration report.

$$\gamma\ eff. = \frac{E600\ reading\ -\ Bkg \times 100}{Source\ CPM}$$

9. Calibration is now complete. Verify correct units of measure (cps or cpm) are set in the instrument. To print cal report, select *Calibration,* and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Record the isotope and previously determined gamma efficiency on the printed calibration report. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the plateau is displayed in the Graph Window, select *File* then *Print Graph.*

Section 2 - PHA Calibration

10. Load the PG-2 PHA probe parameters (*pg2pha.** file), by selecting *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters.

Probe Parameters	
Dead Time (μsec.)	12
Probe Area (cm^2)	12
Max. High Voltage	1300
Overrange (cps)	20000
Radon Alarm (cps)	0

Channel Parameters	
Channel Number	1
Channel Type	PHA
Units	cpm
Selected Window	Lower
High Voltage	700

Window Param's	**Lower**	**Upper**

Threshold (mV)	4.00	5.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

11. Select *Edit*, then *Instrument Parameters*. If necessary, enter the E-600 serial number and calibration dates in the window that appears. Likewise, enter the probe serial number and model in the *Probe Parameters* submenu of the *Smart Probe* or *Conventional Probe* as applicable.

12. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	20
Starting Voltage	700*
Ending Voltage	900*
Voltage Step	10
Max. Count Rate (cps)	20,000**
Graph Name	PG-2, PHA
File Name	PG2.GRF

* Plateau starting and ending voltages will vary with isotope.
** Depends on source activity.

13. Place a ^{241}Am or ^{239}Pu source (or other isotope of interest) against the end of the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.

14. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is on the peak of the <u>lower window</u> plot. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the correct desired value.

15. Calibration is now complete. Verify correct units of measure (cps or cpm) are set in the instrument. To print cal report, select *Calibration,* and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph.*

M. HP/SHP-340, HP/SHP-380AB

Calibration in dps, dpm, cps, cpm, Bq, dps/100cm^2, dpm/100cm^2, Bq/100cm^2

NOTE: The probe must have been closed up for at least 8 hours before attempting to calibrate. Exposing the scintillator or PM tube to light will cause the probe to be noisy.

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time*.

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* which ever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe or Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	8
Probe Area (cm^2)	73 (100 for HP/SHP-380A)
Max. High Voltage	1000
Overrange (cps)	80,000
Radon Alarm (cps)	0

Channel Parameters			
Channel Number	1	2	3
Channel Type	Alpha	Beta	A/B
Units	cpm	cpm	cpm
Selected Window	Upper	Lower	Both
High Voltage	654	654	654

Window Param's	**Lower**	**Upper**
Threshold (mV)	1.50	30.1
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit, Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date" parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau* from the sub-menu. Click on the *Channel 1* button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	20
Starting Voltage	684 (550 for HP-380)
Ending Voltage	889
Voltage Step	10
Max. Count Rate (cps)	5000*
Graph Name	SHP-340
File Name	SHP340.GRF

* Depends on source activity.

5. Expose the probe to a ^{99}Tc 10K to 200K cpm (or ≈20K to 400K dpm) plated source. Position the source disc near the center of the probe face, with the active side facing the probe. Click on the *Start* button. There may be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If there are no counts in the upper window, extend the plateau ending voltage, but no higher than 1000 volts.

6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the desired HV set point. The operating voltage is normally set at a point where the voltage is as high as possible with less than a 1% beta to alpha crossover. The black vertical bar turns red when the beta to alpha crossover exceeds 1%. Once it turns red, move the bar back until the alpha counts (upper window) is ≤0.1 cps to obtain the optimum operating voltage. Save the desired high voltage setting for channel 1 by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau. Click on the *Channel 2* button on top and then the *Set HV* button to set the same HV for channel 2. Repeat the same for Channel 3.

7. Perform a quick check on the beta background. Remove the source from the probe and select channel 2 (Beta), Ratemeter mode. The beta background count rate should be between 150 and 300 cpm. If not, adjust the high voltage as necessary. Note: Ensure the HV is set the same on all three channels before proceeding.

8. Both alpha and beta backgrounds must be established prior to determining the calibration constant and crossover correction factor for each window. Begin by selecting *Calibration,* then *Determine*

Calibration Constant. Verify Channel 3, Upper Window, and Background buttons are selected with the count time set to 180 seconds. Place the probe in a low background area and then click on the *Start* button to begin the background reading. The alpha background should not exceed 5 cpm. While *Background* is still selected, click on the Lower Window button to display the beta background. The beta background should be less than 300 cpm. If either background is too high, try decreasing the high voltage.

9. Next determine the calibration constant and crossover factor for the Beta (lower) window. Select Channel 3, Lower Window, Cal. Const. and the Do XOver box. Enter the calibration field, which should be a 47mm ^{99}Tc source of around 50K to 100K cpm. The units must be in cpm to match the probe set up. Expose the probe to the source and click on *Start* to begin the count. The actual count time is determined by the WinE600 program.

10. Verify the determined Beta Cal. 2π efficiency or counts/count parameter) is greater than 0.12 for ^{99}Tc. If within tolerance, answer Yes to the save prompt. Note the efficiency (CC × 100 = % eff.) to record later on the calibration report. The new crossover factor is also stored into the channel parameters.

11. Now determine the calibration constant and crossover factor for the Alpha (upper) window. Select Channel 3, Upper Window, Cal. Const., and Do XOver. Enter the calibration field, which should be a 47mm ^{230}Th source (or ^{239}Pu if available) of around 50K to 100K cpm. The units must be in cpm to match the probe set up. Expose the probe to the source and click on *Start* to begin the count. Actual count time is determined by the WinE600 program.

12. Upon completion, verify the determined Alpha Cal. Constant (ie. 2π efficiency or counts/count parameter) is greater than 0.16 for ^{230}Th, and greater than 0.25 for ^{239}Pu. If within tolerance, answer Yes to the save prompt. Note the efficiency (CC × 100 = % eff.) to record later on the calibration report. The new crossover factor is also stored into the channel parameters.

13. Unless calibration other than cpm or cps is specified, edit the cal constant to 1.00 in both the upper and lower windows of channel 3. This yields actual probe count rate, the recommended procedure for these probes. To edit the cal constant select *Edit*, *Smart or Conventional Probe* as applicable, then *Channel Parameters*. Jump to step 16.

14. If calibration is to source count rate (2π emissions) then jump to step 16. Do not edit the cal constants to 1.00, the previously determined values are correct for 2π emissions.

15. If units of dps, dpm or Bq, dps/100cm^2, dpm/100cm^2, or Bq/100cm^2 are desired, change the activity units and cal constant at this time. To edit the units and cal constant select *Edit*, *Smart* or *Conventional Probe* as applicable, then *Channel Parameters*. Select the desired units in channel 3. Then divide the previously determined cal constant by two, and enter the new cal constant. This must be done for both upper and lower windows of channel 3.

    For example: If the previously determined cal constant was 0.24 counts/count. Change the units to dpm, then edit the cal constant to 0.12 counts/disint. (0.24 ÷ 2).

16. Verify correct units of measure are set in the instrument. Copy the new parameters from channel 3 to channels 1 and 2 by selecting *Edit, Smart* or *Conventional Probe* as applicable, then *Channel Parameters*. Click on the *Copy* button and when prompted enter "1" as the channel to copy to. Repeat the same for channel 2. Copying channel parameters will require restoring the *Channel Type* and *Selected Window* for each channel. Channel 1 should be set to Alpha channel type, with the

Upper window selected. Channel 2 should be set to Beta channel type, with the Lower window selected. Refer to the *Channel Parameters* table.

17. Calibration is complete. To print cal report, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button if the Print Linearity Data dialog box appears. Record the isotope and previously determined efficiency on the printed cal report. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph.*

N. SPA-1A

Calibration in CPS, CPM, DPS, DPM, Bq to ^{230}Th

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time.*

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	10
Probe Area (cm^2)	2
Max. High Voltage	1400
Overrange (cps)	15000
Radon Alarm (cps)	0

Channel Parameters		
Channel Number	1	
Channel Type	Alpha	
Units	cpm	
Selected Window	Upper	
High Voltage	430	
Window Param's	**Lower**	**Upper**
Threshold (mV)	2.00	10.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit*, *Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date" parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	30
Starting Voltage	425
Ending Voltage	725
Voltage Step	25
Max. Count Rate (cps)	2500*
Graph Name	SPA-1A
File Name	SPA1A.GRF

* Depends on source activity.

5. Expose the probe to a ^{230}Th plated source of around 10K cpm. If available ^{239}Pu may also be used. Position the source disc with the active side facing the detector. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached extend the ending voltage as necessary to complete the plateau.

6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the plateau. Adjust up and down from this point noting the ratio of the upper window counts versus the lower window counts shown in the lower left corner. Select the point where the upper window (alpha) counts are highest and the lower window (beta) counts are lowest while still on the plateau. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau.

7. Determine background and calibration constant next by selecting *Calibration* then *Determine Calibration Constant*. Verify Channel 1, <u>Upper Window</u>, and Background buttons are selected with the count time set to 300 seconds. Place the probe in a low background area and then click on the *Start* button to begin the background count. The background should be less than 30 cpm.
8. Upon completion of the background count, click on the *Cal. Const.* button. Enter the calibration field, which should be a ^{230}Th source of around 8K cpm ($\approx$16K dpm), such as s/n 10001. The units have to be in cpm to match the probe set up. Expose the probe to the source and click on *Start* to begin the count. The actual count time is determined by the WinE600 program.

9. Upon completion, verify the determined cal constant (ie. 2π efficiency or counts/count parameter) is greater than 0.60. If within tolerance, answer Yes to the save prompt. Note the efficiency (CC × 100 = % eff.) to record later on the calibration report.

10. Select *Calibrate*, then *Run Linearity Check*. Click on the *Efficiency Based Linearity Check* box on top of the dialog box that appears. Enter the ^{230}Th source count rate for the linearity fields. Sources should be 1 inch, plated ^{230}Th of less than 2K cpm and another of more than 7K cpm, such as s/n 10170 and 10001. Note the field entered must be in the same units (cpm) as the probe set up.

11. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions in the dialog boxes that appear. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in *System* parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it.

12. Unless calibration other than cpm is specified, edit the cal constant to 1.00 in both the upper and lower windows of channel 1. This yields actual probe count rate, the recommended procedure for these probes. To edit the cal constant select *Edit*, *Smart or Conventional Probe* as applicable, then *Channel Parameters*. Jump to step 15.

13. If calibration is to source count rate (2π emissions) then jump to step 15. Do not edit the cal constants to 1.00, the previously determined values are correct for 2π emissions.

14. If units of dps, dpm or Bq are desired, change the activity units and cal constant at this time. To edit the units and cal constant select *Edit*, *Smart* or *Conventional Probe* as applicable, then *Channel Parameters*. Select the desired units in channel 1 and divide the previously determined cal constant by two.

    For example: If the previously determined cal constant was 0.28 counts/count. Change the units to dpm, then edit the cal constant to 0.14 counts/disint. (0.28 ÷ 2).

15. Calibration is now complete. Verify correct units of measure are set in the instrument. To print cal report, select *Calibration,* and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Record the isotope and previously determined efficiency on the printed calibration report. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the plateau is displayed in the Graph Window, select *File* then *Print Graph*.

O. SPA-3

Section 1 - Calibration in CPS, CPM, R/h
(for PHA calibration skip to section 2)

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time*.

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	20
Probe Area (cm^2)	20
Max. High Voltage	1600
Overrange (cps)	48000
Radon Alarm (cps)	0

Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	R/h	
Selected Window	Upper	
High Voltage	410	
Window Param's	**Lower**	**Upper**
Threshold (mV)	2.00	2.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit*, then *Instrument Parameters*. If necessary, enter the E-600 serial number and calibration dates in the window that appears. Likewise, enter the probe serial number and model in the *Probe Parameters* submenu of the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	10
Starting Voltage	400
Ending Voltage	840
Voltage Step	20
Max. Count Rate (cps)	20,000*
Graph Name	SPA-3
File Name	SPA3.GRF

* Depends on source activity.

5. Place a CS-7B, ^{137}Cs (≈1μCi) check source against the end of the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.

6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the upper window plateau. At this point the lower window counts should be at their lowest also. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau.

7. Next select *Calibration*, then *Determine Calibration Constant*. Verify Channel 1, <u>Upper Window</u>, and Background buttons are selected with the count time set to 120 seconds. Calibration should be performed in an area with less than 30 μR/h background. Place the probe in a low background area, then click on the *Start* button to begin background count.

8. After the background has been determined, click on *Cal. Const.* Enter the calibration field, 0.0004 R/h. Place the probe in a 0.4 mR/h (0.0004 R/h) ^{137}Cs field, face on. Probe must be in free air, suspended on non-metallic objects at least 3 feet off the floor with no other objects within 6 feet. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and field strength. When the count is complete, click on *Save* to store the new calibration constant if within 5.0E+10 to 9.0E+10.

9. Click on *Dead Time* and enter the dead time field, 0.002 R/h. Place the probe in a 2 mR/h (0.002 R/h) ^{137}Cs field. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 16 to 26 µsec., click on *Save* when prompted, to store new value in the instrument.

10. Calibration is now complete. Verify correct units of measure are set in the instrument. If calibration is to **R/h**, jump to step 11. Otherwise, edit the units of measure to cpm or cps, and cal constant (counts/count parameter) to 1.00 in both the upper and lower windows of channel 1. To edit the units and cal constant, select *Edit, Smart or Conventional Probe* as applicable, then *Channel Parameters*. Jump to step 12 to print calibration report.

11. Select *Calibrate*, then *Run Linearity Check*. Enter the following ^{137}Cs linearity fields in the dialog box that appears: 0.0005 R/h (0.5 mR/h) and 0.001 R/h (1 mR/h). Note the field entered must be in the same units (R/h), as the probe set up. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions that appear in the dialog box. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in *System* parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it all together.

12. Print cal report by selecting *Calibration,* and *Print Calibration Report*, while still connected to the E-600 just calibrated. If linearity data was taken, click on the *YES* button when the Print Linearity Data dialog box appears. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph.*

Section 2 - PHA Calibration

13. Load the SPA-3 PHA probe parameters, by selecting *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the *spa3pha.** file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters.

Probe Parameters	
Dead Time (µsec.)	20
Probe Area (cm^2)	20
Max. High Voltage	1600
Overrange (cps)	48,000
Radon Alarm (cps)	0

Channel Parameters

Channel Number	1
Channel Type	PHA
Units	cpm
Selected Window	Lower
High Voltage	400

Window Param's	**Lower**	**Upper**
Threshold (mV)	4.00	5.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

14. Select *Edit*, then *Instrument Parameters*. If necessary, enter the E-600 serial number and calibration dates in the window that appears. Likewise, enter the probe serial number and model in the *Probe Parameters* submenu of the *Smart Probe* or *Conventional Probe* as applicable.

15. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	20
Starting Voltage	440*
Ending Voltage	500*
Voltage Step	10
Max. Count Rate (cps)	20,000**
Graph Name	SPA-3, PHA
File Name	SPA3.GRF

* Plateau starting and ending voltages will vary with isotope. Approximate plateau voltages are 440V to 500V for ^{137}Cs; 670V to 710V for ^{241}Am and 400V to 450V for ^{60}Co.
** Depends on source activity.

16. Place a CS-7B, ^{137}Cs ($\approx$1μCi) check source or other isotope of interest, against the end of the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count

begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.

17. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is on the peak of the lower window. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the correct desired value.

18. Calibration is now complete. Verify correct units of measure (cps or cpm) are set in the instrument. To print cal report, select *Calibration,* and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph*.

P. SPA-6

Calibration in CPS, CPM

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time*.

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	15
Probe Area (cm^2)	20
Max. High Voltage	1600
Overrange (cps)	50,000
Radon Alarm (cps)	0

Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	cpm	
Selected Window	Upper	
High Voltage	750	
Window Param's	**Lower**	**Upper**
Threshold (mV)	3.00	10.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit, Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date" parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	10
Starting Voltage	750
Ending Voltage	1500
Voltage Step	50
Max. Count Rate (cps)	6.70E+04
Graph Name	SPA-6
File Name	SPA6.GRF

5. Place a CS-7B, ^{137}Cs ($\approx 1\mu Ci$) check source against the end of the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.

6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the upper window plateau. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau.

7. Next select *Calibration* then *Determine Calibration Constant*. Verify Channel 1, Upper Window, and Background buttons are selected with the count time set to 60 seconds. Calibration should be performed in an area with less than 30 μR/h background. Place the probe in a low background area, then click on the *Start* button to begin the background count. Note the reading upon completion of the background count. Switch to *Background* mode on the E-600.

8. Place the probe in a 0.5 mR/h (0.0005 R/h) ^{137}Cs field, face on. Probe must be in free air, at least 3 feet off the ground with no large objects within 6 feet. Acquire a count in the *Background* mode by watching the countdown in the lower right corner. Note the CPM value when it is below 2%. Subtract the previously determined background from this value. Multiply the net cpm value by 8 and use this number as the dead time field.

9. Click on *Dead Time* and enter the dead time field, determined in step 8. Place the probe, in a 4 mR/h (0.004 R/h) ^{137}Cs field. Click on the *Start* button. The program could take several count cycles to

determine an accurate dead time. If dead time falls within 16 to 26 μsec., click on *Save* when prompted, to store the new value.

10. Calibration is now complete. Verify correct units of measure (cps or cpm) are set in the instrument. To print cal report, select *Calibration,* and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph.*

Q. SPA-8
Calibration in CPM, CPS, R/h

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time.*

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	36
Probe Area (cm^2)	5
Max. High Voltage	1500
Overrange (cps)	45000
Radon Alarm (cps)	0

Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	cpm	
Selected Window	Upper	
High Voltage	525	
Window Param's	**Lower**	**Upper**
Threshold (mV)	2.00	2.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit*, *Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date" parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	10
Starting Voltage	500
Ending Voltage	1100
Voltage Step	50
Max. Count Rate (cps)	15,000*
Graph Name	SPA-8
File Name	SPA8.GRF

* Depends on source activity

5. Expose the probe to a CS-7B, ^{137}Cs (≈1μCi) check source, preferably in a lead shield. Position the source disc with the active side facing the end of the probe. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.

6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the upper window plateau. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau. If calibration is to **μR/h** then jump to step 11.

7. Select *Calibration* then *Determine Calibration Constant*. Verify Channel 1, Upper Window, and Background buttons are selected with the count time set to 300 seconds. Calibration should be performed in an area with less than 30 μR/h background. Place the probe in a low background area, then click on the *Start* button to begin the background count.

8. Place the probe in a 0.5 mR/h (0.0005 R/h) ^{137}Cs field, face on. Probe must be in free air, at least 3 feet off the ground with no large objects within 6 feet. Acquire a count in the *Background* mode by watching the countdown in the lower right corner. Note the CPM value when it is below 2%. Subtract the previously determined background from this value. Multiply the net cpm value by 15 and use this number as the dead time field.

9. Click on *Dead Time* and enter the dead time field, determined in step 8. Place the probe, in a 7.5 mR/h ^{137}Cs field. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 20 to 65 μsec., click on *Save* when prompted, to store the new Dead Time parameter.

10. Calibration is now complete. To print cal report, select *Calibration,* and *Print Calibration Report*, while still connected to the E-600 just calibrated. Since no linearity data was taken, click on the NO button when the Print Linearity Data dialog box appears. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the plateau is displayed in the Graph Window, select *File* then *Print Graph.*

R/h Calibration

11. Edit the units to R/h by selecting *Edit*, *Smart Probe* or *Conventional Probe* as applicable, then *Channel* parameters. Change channel 1 units from cpm to R/h. Place the probe in a low background area. Calibration should be performed in an area with less than 30 μR/h background. Select *Calibration,* then *Determine Calibration Constant*. Verify Channel 1, Upper Window, and Background are selected with the count time set to 120 seconds. Click on the *Start* button to begin background count.

12. After the background has been determined, click on *Cal. Const.* Enter the calibration field, 0.0005 R/h. Place the probe in a 0.5 mR/h (0.0005 R/h) ^{137}Cs field, face on. Probe must be in free air, at least 3 feet off the ground with no large objects within 6 feet. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and field strength. When the count is complete, click on *Save* to store the new calibration constant if within 1.00E+10 to 2.00E+10.

13. Next, click on *Dead Time*. Enter the dead time field, 0.0075 R/h. Place the probe in a 7.5 mR/h (0.0075R/h) ^{137}Cs field. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 20 to 65 μsec., click on *Save* when prompted, to store new value in the instrument.

14. Select *Calibrate*, then *Run Linearity Check*. Enter the following ^{137}Cs linearity fields in the dialog box that appears: 0.0005 R/h (0.5 mR/h), 0.002 R/h (2 mR/h), and 0.010 R/h (10 mR/h). Note the field entered must be in the same units (R/h), as the detector set up.

15. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions in the dialog boxes that appear. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in *System* parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it all together.
16. When the linearity tests are complete, select *Calibration*, then *Print Calibration Report*, while still connected to the E-600 just calibrated. Add the linearity data to the report when prompted. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. When the Graph Window is displayed, select *File* then *Print Graph.*

R. SPA-9, RD-19
Calibration in CPS, CPM

1. With the E-600 OFF, connect the computer and detector cables to the instrument. Turn the E-600 to the CHECK position, then launch the WinE600 program. Set and verify correct time in the E-600 by selecting *Utility,* then *Set Time.*

2. Next load the probe parameters. Select *Edit*, *Load Setup From Disk*, then *Smart Probe Parameters* or *Conventional Probe Parameters* whichever is applicable. From the list presented, select the appropriate file for the probe under calibration. Click on the *OK* button to transfer the parameters from the disk file to the instrument. Verify the default probe parameters in the E-600 are set per the table below by selecting *Edit*, *Smart Probe* or *Conventional Probe*, then the *Probe* and *Channel* parameters. Previously calibrated smart probes will have parameters stored internally and won't require downloading from the computer.

Probe Parameters	
Dead Time (μsec.)	31
Probe Area (cm^2)	20
Max. High Voltage	1600
Overrange (cps)	50000
Radon Alarm (cps)	0

Channel Parameters		
Channel Number	1	
Channel Type	Gamma	
Units	R/h	
Selected Window	Upper	
High Voltage	575	
Window Param's	**Lower**	**Upper**
Threshold (mV)	3.00	10.00
counts/count	1.00	1.00
Bkg. Weight Factor	0	0
Integrate Alarm	0.0	0.0
Rate Alarm	0.0	0.0
Click Divider	1	1

3. Select *Edit*, *Instrument Parameters*, then enter the E-600 serial number and calibration dates in the window that appears. For "Last Cal. Date" parameter enter the actual date of calibration and "Next Cal. Date" parameter should be set to one year after last cal date. Likewise, enter the probe serial number, model, and cal dates in the *Probe Parameters* submenu of either the *Smart Probe* or *Conventional Probe* as applicable.

4. Select *Calibrate*, then *Run Plateau*. Click on the *Channel 1* radio button on top, then edit the plateau voltage parameters as shown below. Specify a graph name (up to 30 characters) and a graph file name. Note the graph file name must have a .GRF extension.

Plateau Parameters	
Count Time (sec.)	10
Starting Voltage	550
Ending Voltage	1300
Voltage Step	50
Max. Count Rate (cps)	67000
Graph Name	SPA-9
File Name	SPA9.GRF

5. Place a CS-7B, ^{137}Cs ($\approx$1μCi) check source against the end of the probe, preferably in a lead shield. Click on the *Start* button. There will be a delay before the first count begins as the high voltage settles. A graph of the source plateau will appear after the first count. When the ending voltage is reached a prompt will appear asking if the ending voltage should be extended. If the noise region of the plateau has not been reached, extend the ending voltage as necessary to complete the plateau.

6. When the plateau is complete, select the high voltage set point by clicking on the < and > symbols on the voltage plateau graph until the vertical bar is at the center of the upper window plateau. Save the desired voltage setting to the instrument by clicking on the *Set HV* button in the plateau dialog box. A prompt will appear to verify the HV set point is the desired value established during the plateau.

7. Next select *Calibration*, then *Determine Calibration Constant*. Verify Channel 1, <u>Upper Window</u>, and Background buttons are selected with the count time set to 120 seconds. Calibration should be performed in an area with less than 30 μR/h background. Place the probe in a low background area, then click on the *Start* button to begin the background count. Upon completion of the background count, click on the *Cal. Const.* button.

8. After the background has been determined, click on *Cal. Const.* Enter the calibration field, 0.0005 R/h. Place the probe in a 0.5 mR/h (0.0005 R/h) ^{137}Cs field, face on. Probe must be in free air, suspended on non-metallic objects at least 3 feet off the floor with no other objects within 6 feet. Click on the *Start* button to begin determining cal constant. Actual count time is determined by the program and field strength. When the count is complete, click on *Save* to store the new calibration constant if within 2.0E+10 to 4.0E+10.

9. Click on *Dead Time* and enter the dead time field, 0.005 R/h. Place the probe in a 5 mR/h (0.005 R/h) ^{137}Cs field. Click on the *Start* button. The program could take several count cycles to determine an accurate dead time. If dead time falls within 25 to 38 µsec., click on *Save* when prompted, to store new value in the instrument.

10. Calibration is now complete. Verify correct units of measure are set in the instrument. If calibration is to **R/h**, jump to step 11. Otherwise, edit the units of measure to cpm or cps, and cal constant (counts/count parameter) to 1.00 in both the upper and lower windows of channel 1. To edit the units and cal constant, select *Edit, Smart or Conventional Probe* as applicable, then *Channel Parameters*. Jump to step 12 to print calibration report.

11. Select *Calibrate*, then *Run Linearity Check*. Enter the following ^{137}Cs linearity fields in the dialog box that appears: 0.0005 R/h (0.5 mR/h) and 0.005 R/h (5 mR/h). Note the field entered must be in the same units (R/h), as the probe set up. Click on the *Start* button to begin the linearity check. If a LINDATA.TXT file already exists the *Overwrite* dialog box will appear. Click on *Yes* to overwrite the existing file with the new linearity data. Follow the instructions that appear in the dialog box. The E-600 response and percent error will be reported. (Note: The linearity tolerance is set in *System* parameters). Click on the *Start* button again to repeat the linearity tests or to add different fields. The *Overwrite* box that appears will allow adding to the existing linearity data file or overwriting it all together.

12. Print cal report by selecting *Calibration* ,and *Print Calibration Report*, while still connected to the E-600 just calibrated. If linearity data was taken, click on the *YES* button when the Print Linearity Data dialog box appears. Print the plateau for this probe by selecting *Calibration*, *Display Plateau* then select the appropriate file from the list in the dialog box. Verify printer is connected to the computer and ready to print. When the Graph Window is displayed, select *File* then *Print Graph.*

Eberline

E-600 Rad Mapping Program

For Microsoft Windows®

User Manual

Table of Contents

Section 1

Introduction

Eberline's E-600 portable radiation survey meter is a highly adaptable instrument which may be used with a wide range of radiation detectors in many different applications and environments.

In addition to the normal capabilities provided by a portable radiation monitoring instrument, the E-600 is capable of performing data logging operations which allow the operator to store readings in ratemeter, peak trap or scaler modes which can be retrieved and stored in a personal computer.

This operating manual describes the operation of the Eberline E-600 Rad Mapping program which is a Windows® application which supports collection of log data from one or more E-600 instruments, display of the survey information on user defined bit map graphics floor plans and report generation based on user specified search criteria.

Software Installation

This program will run on any IBM® or compatible personal computer under the Microsoft Windows® 3.1 or Windows® 95 operating environment. Although it is theoretically possible to install the interface software on a floppy drive computer, this is strongly discouraged; the program is intended to be run from a fixed (hard) disk drive. Although a minimal configuration can be installed in only one or two megabytes of disk space, several megabytes of free disk space should be available to accommodate data logging/storage requirements.

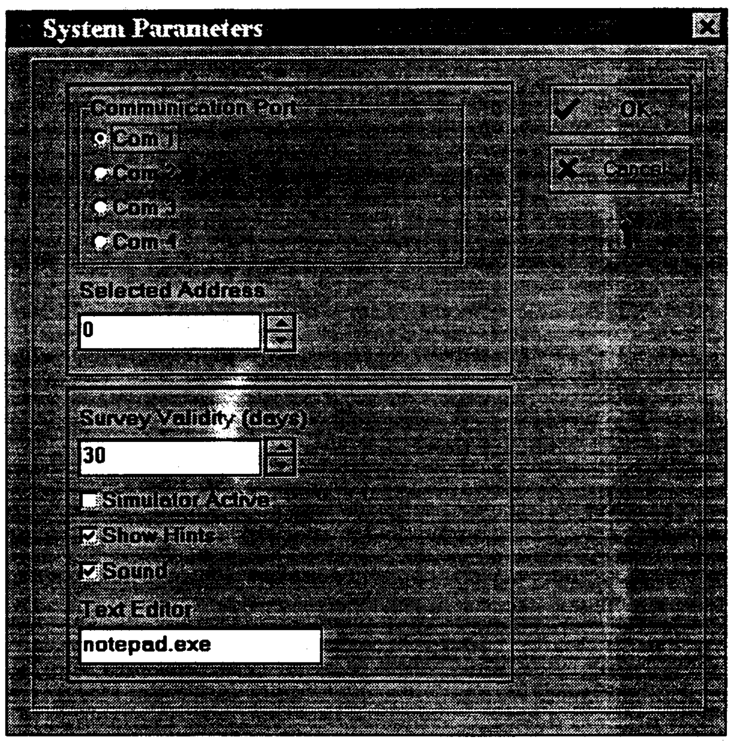
To initially install the E-600 Rad Mapping program, insert the distribution diskette in a floppy disk drive of the target computer, start Windows®, click on the *File* command (or type Alt-F), (Start button in Windows 95) then *Run* the INSTALL program on the diskette. The installation program will prompt for the desired hard disk directory into which the program will be installed.

Note that while the distribution diskette is not copy protected, each copy is licensed for use on only one computer. The license also permits one copy of the diskette to be made for backup purposes. Once installed, the interface program may be run by simply double-clicking on the E-600 icon in the Windows® program manager or from the Eberline program group from the Windows® 95 Start menu.

Hardware Setup

Communications between the host PC and E-600 instrument are established via an RS-232 serial interface. A data cable, Eberline part number CA-104-60, connects to a standard 9-pin serial port on the personal computer and to a 7-pin circular receptacle on the front of the E-600.

If the PC in use has more than one serial data port, it may be necessary to inform the program which port is connected to the E-600. This selection is made through the *Edit/System* dialogue box. To open this window, click on *Edit* to pull down the submenu, then click on *System*. It may be necessary to enter the correct level-two password to enable changes to this window.



The *Edit/System* dialogue window also contains a check box which turns the E-600 simulator on and off. If the simulator is enabled, the program will not attempt to communicate with a real E-600, even if one is connected. In this case, all data is transferred to and from an imaginary instrument. While the simulator is operating, the *Simulator On* message is displayed in the menu bar.

Note: Set the *Selected Address* value to 0 (zero) unless it is necessary to test the network address of a specific instrument. All E-600s will respond to address zero, regardless of their assigned address.

Password Protection

The E-600 interface program supports three levels of password protection. The password required for each window or dialogue box is shown as a small blue-and-gray icon which contains the number of the password level required to change values displayed in that window. Passwords may be input through the *Enter Password* command, which is in turn accessed via the *Edit* pulldown menu.

The default password for all three levels is "EBERLINE." The three passwords may be changed independently through the *Edit Password* command. This function is also accessed from the *Edit* pulldown menu.

Should the current password(s) be lost or forgotten, the defaults may be restored by deleting the file SYSFILE.DAT in the WINE600 directory. This will also reset other program parameters to their initial values. The file will be recreated whenever the program is restarted.

Data Logging

Storing Log Data

The E-600 has the capability of storing up to 500 data points internal to the instrument. Each time you press the Log button on the E-600 handle the instrument responds with a single beep, freezes the reading on the display and displays the next log data point identification number in the lower right corner of the LCD display.

At this point you may either 1) use the up and down arrows to the right of the handle to increment/decrement the location identifier 2) press the LOG button a second time which causes the log data point to be stored with the currently displayed identification number or 3) scan in a bar code location identifier if the bar code option is connected to the RS-232 port on the E-600. Once you press the log button a second time three beeps occur indicating that the log operation is complete. If you scan the location identifier in with a bar code device, the log operation is completed automatically without pressing the log button a second time.

If you decide not to store the current reading after you have initially pressed the LOG button, either wait fifteen seconds for the log operation to time out or press the STAR key to immediately return to operating mode and abort the log operation.

Retrieving Stored Log Data from the E-600

Once you have stored one or more log data points you may retrieve the log data using your PC and the E-600 Rad Mapping program.

Select *Log / Retrieve Log Data* (or *Log / Retrieve with Report*) from the main menu and the currently stored data points are retrieved and stored to a file named ALLLOG.YY where YYis the log data year. Note that the log data date is not necessarily the current date. The log data date is the date the log data was stored in the instrument, not the date it was collected at the PC.

Retrieved data is actually stored in two places. The first is the binary data file (ALLLOG.YY) described above and the second place is the binary master database file (LOGDATA.DAT) which contains the most recent survey result for each survey point. This database is memory resident (for high performance) and is used to update any displayed floor plan. In addition, if the *Retrieve with Report* menu option is selected, the log data is stored in a report format in a text file specified by the user.

The information stored for each log point is Survey Location, Log Date, Log Time, Log Mode (operating mode of the instrument), Channel Type, Reading, Gross/Net (to indicate whether or not background subtraction was enabled), Units (selected units for the stored reading), E-600 S/N and E-600 Address.

If you are using V2.00 or higher of the E-600 program, the log data also includes Stored Background (stored background for the channel), Background Units, and Status (operating status at the time this measurement was taken).

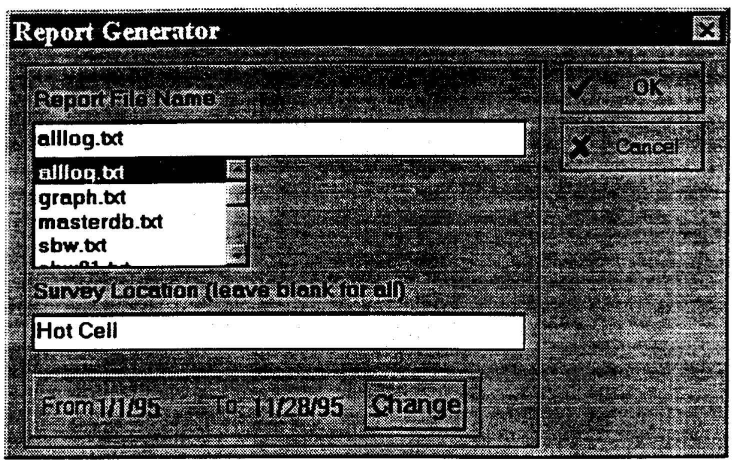
Each time the stored data is retrieved from an instrument, it is stored in the data file. For this reason, you should only retrieve data once.

Note that multiple instruments may be used to log data. In this case the log data results are all stored in the same data files, although you may generate individual survey reports for each instrument.

Using the Report Generator

The Rad Mapping program contains a built-in report generator used to extract information from the year specific binary log data files. Data may be extracted in either an ASCII report format or a quotation, comma delimited ASCII format suitable for importing into most database and spreadsheet programs.

To activate the report generator, select either *Log/SurveyReport/Report Format* (for an ASCII formatted report) or *Log/SurveyReport/Comma Delimited Format* (for an quotation/comma formatted report) from the main menu.



The report generator dialog box shown above is displayed and the user must specify the following information:

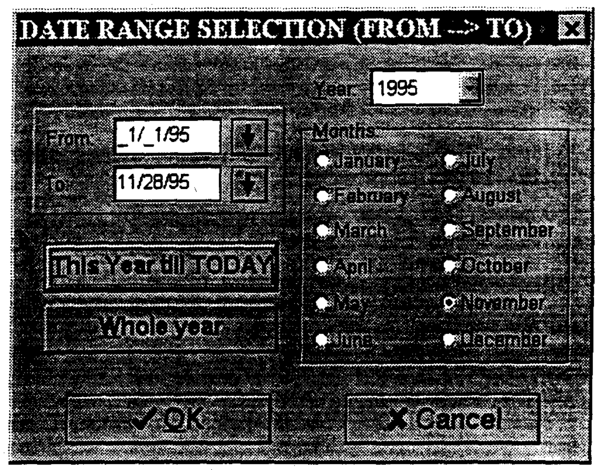
Report File — The report file name is a text file into which the extracted information is stored. If you specify an existing file name, you are asked whether or not the specified file may be overwritten.

Survey Location — The survey location field is optional. If the location identifier is left blank, the search will include all location identifiers. If a location identifier is specified, the search will exclude all others. The location identifier is case independent (upper/lower case does not matter).

Report Dates — The final entry field lets you specify the report starting and ending dates.

Note that all extracted data must be within the same year. Specify starting and ending dates of different years is not allowed. If you need to extract report data from several years, use the report generator once for each year.

The following dialog box is provided for entering the dates when the Change button is pressed.



Two buttons on the date entry dialog box are especially useful. *The This Year till Today* button lets you quickly enter the dates from January 1 until today's date. The *Whole year* button lets you specify a range of dates from January 1 until December 31 for the specified year.

Use the drop down list box for the year to specify the report year.

Resetting the Log Data Pointer

In rare cases you may wish to re-download all the log data not previously erased from an E-600. You would normally only do this if you had accidentally deleted a data file. Before you can re-retrieve the stored log data, you must reset the log data pointer in the instrument to point to the oldest stored point.

Select *Log / Reset Log Data Pointer* from the main menu to reset the pointer.

Clearing Log Data

Following data collection you will normally clear the log data stored in the E-600 to make sure no one re-retrieves the data and causes double entries in the log data file.

To clear the log data in the attached E-600, select *Log/Clear Log Data in E-600* from the main menu.

Floor Plans

Creating Floor Plans

The floor plans used by the E-600 Rad Mapping program are Windows bit mapped graphics files with a file extension of *.bmp*. You may use the Paintbrush program supplied with Windows or any appropriate bit mapped graphics file generator to create your floor plan files.

You should be aware that the size of the graphics file is limited by the display hardware of the computer which will operate the E-600 interface program. Unless you know that you will always be operating on machines with 1024 x 768 graphics resolution or better, it is best to always limit the size of the floor plan graphics file to 620 x 400 pixels. This allows you to display the floor plan on any computer with VGA resolution (640 x 480 pixels) or better. The full screen size cannot be used since there must be room left over for the menu. An example bit mapped graphics floor plan file called floor.bmp is supplied with your software. You may load this file into Paintbrush to modify as you wish.

Once you have created one or more floor plan files, simply copy these to the directory where the E-600 Rad Mapping program is to be operated from and you will have immediate access to these floor plans.

A floor plan data file (e.g. floor.dat for floor.bmp) is automatically created when you add a survey point to the floor plan. Deleting the *.dat file (e.g. floor.dat) is a quick way to remove all installed survey points on a floor plan.

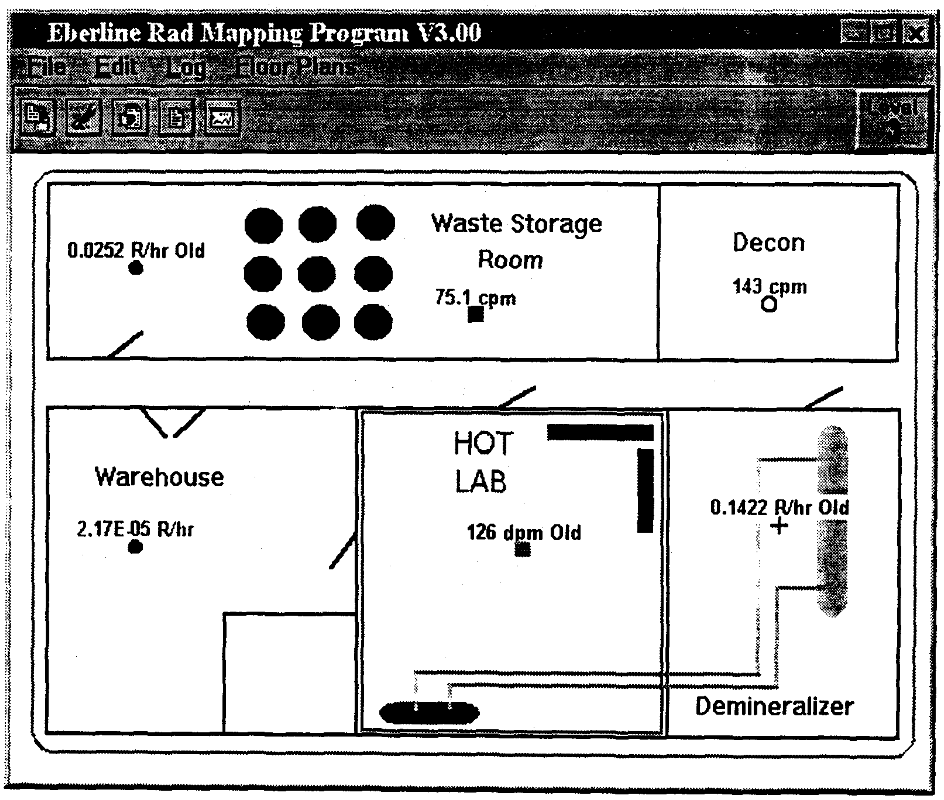
Displaying Floor Plans

Select *Floor Plans, Display Floor Plans* from the main menu to select the floor plan of choice to display.

Any survey points placed on the floor plan are shown with an E-600 icon and the most recent reading as stored in the master database. Each time log data is transferred from an E-600, the master database and any affected floor plan are updated.

To display the survey point location and last survey date/time for any survey point, click on the survey point icon with the mouse. The location title changes to a red color indicating it is selected and the survey point identifier and last survey date and time are displayed in the lower left corner of the screen. To de-select a survey point, click on an area of the floor plan where no survey point icon exists.

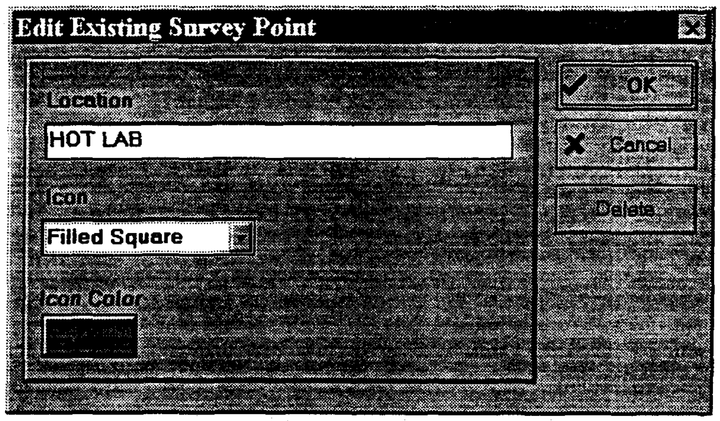
Any survey point which has not been updated within the validity period specified by the System Parameters is labeled with the word *Old* next to the survey point reading.



Adding a Survey Point

To add a survey point to a floor plan, use the right button on the mouse and click on the screen position where you want to add the point.

If the password entered is a level 2 or level 3, a dialog box appears into which you may enter the survey point location identifier for the new point. This identifier must match the identifier which will be used by the person taking the survey data. If a bar code reader is used, any ASCII string up to 20 characters may be used. If no bar code reader is used, all location identifiers must be numeric integers from 1 to 500.



A new survey point icon will appear immediately on the floor plan with the most recent reading (if available) for the new survey point.

Note that a maximum of 50 survey points may be added to each floor plan.

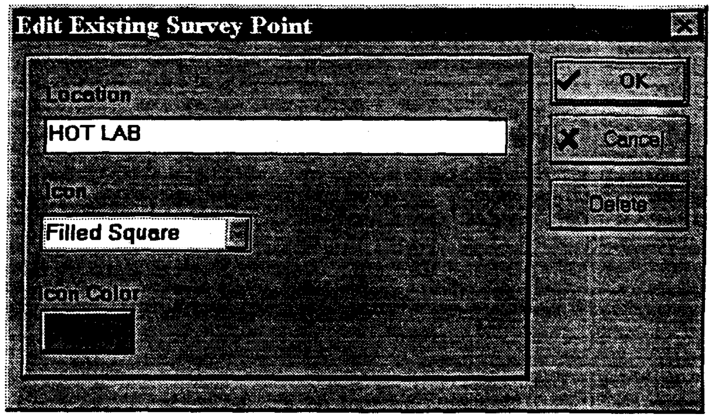
Moving a Survey Point

To move an existing survey point make sure a level 2 or level 3 password is entered and then click the right mouse button when the mouse cursor is over the center of a survey point icon.

Click and hold the left mouse button as you drag the icon to its new position on the floor plan. Release the left button and the icon will remain in its new position.

Deleting a Survey Point

To delete an existing survey point make sure a level 2 or level 3 password is entered and then click the right mouse button when the mouse cursor is over the center of the survey point icon you wish to delete.



Next, click the delete button in the survey point dialog box and then click OK. The survey point will disappear from the floor plan.

Printing a Survey Route Sheet

When you review your floor plans you may notice that many of the survey points have old survey data or no data at all. To allow you to update just those points which currently require updating, you need a survey route sheet listing just those points.

To print a survey route sheet select *Floor Plans / Print Survey Route* from the main menu. You will be given a choice of either sending the survey route form to the printer or to a file.

The survey route sheet shows the survey point identifier (location) and the current reading for each survey point which needs updating along with a place to mark off each survey point as you make your way around the route.

APPLICATION NOTE

E-600 — Eberline Instruments

Subject: **Requesting Current Data From the E-600**
Date: December 1995
Phone: (505) 471-3232
FAX: (505) 473-9221

Introduction

The E-600 supports a binary communications protocol which allows the user to connect an appropriately programmed computer and constantly poll the instrument for its current status and reading. The protocol supports uploading and downloading of many types of information, however, all parts of the communication protocol except the current data request is not available to the end user.

The binary protocol supports individual instrument addressing allowing up to 255 instruments to be connected via an RF or RS-485 bus. In addition, any connected E-600 will respond to address 0 regardless of its programmed address. This document discusses the use of address 0 in a communications message to request data from a single connected E-600 via an RS-232 cable.

Requesting Current Data

To request current data from an E-600, the following five (5) bytes must be transmitted to an E-600 with less than 100 msec of delay between characters.

0 3 0 0 240 (all bytes shown in decimal format)

The instrument will respond with a twenty (20) byte message which is explained in the following table. The response from the E-600 is normally transmitted within 20 msec of receiving the request.

Command: Get Current Status and Data *Retrieves the current data from the connected E-600*			
Byte	**Request (from host)**	**Byte**	**Answer (from E-600)**
1	Address (0)	1	Address
2	Length (3)	2	Length (18)
3	Task (0)	3	Task (0)
4	CRC (0)	4	Current Status (see below)
5	CRC (240)	5-8	Current Reading (four byte floating point)
		9	Slide Position (0=closed, 1=open; ignore if probe is not ion chamber)
		10	Channel Type (see below)
		11	Type of units (0=rate, 1=dose)
		12	Units (see below)
		13	Current Mode (0=ratemeter, 1=integrate, 2=scaler, 3=peak hold, 4=bkg update, 5=check)
		14	Current Channel (0,1,2)
		15	Gross (0) or Net (1) Reading
		16-17	Next Log Number (MSB,LSB 2 byte integer)
		18	Battery Voltage (0-100%, 1 byte)
		19	CRC (ignore if not error checking)
		20	CRC (“” “”)

Current Status

The instrument status specified in the message (byte 4) is bit mapped according to the following table. As an example, if the instrument is in alarm and the battery is low, the status byte will be 50H.

Bit 0	HV Fail (0=ok, 1=fail)
Bit 1	Probe Out of Cal (0=ok, 1=out of cal)
Bit 2	Unit Out of Cal (0=ok, 1=out of cal)
Bit 3	Probe Fail (0=ok, 1=out of cal)
Bit 4	Alarm (0=not alarmed, 1=alarmed)
Bit 5	OverRange (0=ok, 1=overrange)
Bit 6	Low Battery (0=ok, 1=low battery)
Bit 7	Unused

Channel Type

The channel type specified in the message (byte 10) is a one byte value which may have one of the following values:

Value	Channel Type
0	None
1	Alpha
2	Beta
3	Gamma
4	Neutron
5	Alpha/Beta
6	PHA
7	PHA #1
8	PHA #2
9	PHA #3

Units

The units code (byte 12) in combination with the type of units code (byte 11) specified in the message is a one byte value which may have one of the following values depending on whether byte 11 specifies dose or rate units.

Value	Rate Units
0	cps
1	cpm
2	dps
3	dpm
4	Bq
5	Sv/sec
6	Sv/hr
7	Gy/sec
8	Gy/hr
9	R/sec
10	R/hr
11	Rem/sec
12	Rem/hr
13	dpm/100 cm^2
14	dps/100 cm^2
15	Bq/100 cm^2

Value	Dose Units
0	counts
1	disintegrations
2	Sv
3	Gy
4	Rem
5	R
6	Disintegrations/100 cm^2

Floating Point Data

The current reading stored in bytes 5-8 of the response message is in IEEE single precision floating point format. The following is an example routine used to extract a four byte floating point value from a communication message.

```
{-Real4to4----------------------------------------------
--------------}
{ Function to decode single precision number from EIC
array and return}
{ it.
              }
{-------------------------------------------------------
--------------}
Function Real4to4(I:integer):single;
Var
  J              : integer;
  Pastmp         : single;

Begin
  if EIC[3] <> $FF then {valid number never starts with
$FF}
  begin
    for J := 0 to 3 do
      begin
         {get and store byte into single precision
floating point variable}
         mem[seg(Pastmp):ofs(Pastmp)+J] := EIC[I+J];
      end;
    Real4to4 := Pastmp;
  end
  else
    Real4to4 := -9999;
End;
```