

DVC-350A

HAND-HELD, BATTERY-POWERED VOLTAGE CALIBRATOR

FEATURES

- Hand-held, lightweight 11 ounces (342 grams)
- Laboratory accuracy of $\pm 0.015\%$ of FSR at $+25^{\circ}\text{C}$, traceable to the National Bureau of Standards
- 4 1/2 Digit LCD display
- 100 μV increments
- Two output voltage ranges:
 - Decimal: $\pm 1.2\text{V}$ dc, $\pm 12\text{V}$ dc
 - Hexadecimal: $\pm 1\text{V}$ dc, $\pm 10\text{V}$ dc
- Up to 20 mA source or sink current capability
- Rated accuracy down to 6.5V battery level using rechargeable 7.2V battery or conventional 9V battery
- Right and left binary shift for hexadecimal calibration of A/D or D/A converters
- Convenient, easy-to-use membrane keyboard with audible feedback
- Finger-touch cursor control with automatic voltage increment or decrement
- Dual voltage output capability: absolute 0 volts (with current limiting) and entered value
- Automatic current limiting and low battery indication
- AC adapter/charger operation (optional)
- Rechargeable 7.2V battery (optional)

GENERAL DESCRIPTION

The DVC-350A's accuracy and portability makes it the calibrator of choice for precise adjustment of analyzers, recorders, controllers, data acquisition system computers, and many other lab and field applications.

INTRODUCTION

The DVC-350A is a hand-held, microprocessor-based voltage source that provides the user with two entry modes of operation and four output voltage ranges. The outputs have an unprecedented 0.015% accuracy commonly found only in laboratory-type calibrators.

Complementing the DVC-350A's portability and flexibility is an outstanding array of features and the large 4 1/2 digit LCD display. Mode of entry is switch-selectable as either decimal or hexadecimal. Decimal mode output ranges are $\pm 1.2\text{V}$ dc in 100 μV increments and $\pm 12\text{V}$ dc in 1mV increments. Hexadecimal mode offers output voltage ranges of $\pm 1\text{V}$ dc in 244 μV increments and $\pm 10\text{V}$ dc in 2.44 mV increments.

The hexadecimal mode is notably useful for computer-oriented calibration of digital panel meters, A/D's, and data acquisition systems. It eliminates the need for tedious hexadecimal-to-decimal number conversion; the DVC-350A does it all automatically. The DVC-350A accepts and converts hexadecimal numbers up to FFF hex.



4
3
5
3

APPLICATIONS

The DVC-350A is a universal field and laboratory voltage calibrator with outstanding accuracy and stability.

In the lab, the DVC-350A is an ideal voltage source for engineering prototypes, breadboards and test setups without competing with other instruments for space and AC outlets.

Size and portability, however, make the DVC-350A an outstanding field instrument. It easily fits into a coat pocket or attache case. It makes remote site calibration easy and accurate. The DVC-350A is extremely effective for calibrating A/D converters, V/F converters, DPM's and transducers (load cells, strain gages, LVDT'S, etc.).

FUNCTIONAL DESCRIPTION

The DVC-350A owes its accuracy to the precision and stability of the power supply, the analog output circuitry, and its high performance, 14-bit CMOS digital-to-analog converter, characterized by its precision and lower power consumption. As shown in Figure 1, the 14-bit digital input to the DAC is routed by the 8-bit CMOS microprocessor which also takes the entered data from the keyboard and updates the 4 1/2 digit LCD display.

The DVC-350A uses an extremely stable switching power supply. The power supply circuitry incorporates the latest power supply technology, operating with battery potentials from +20V dc down to +6.5V dc without degrading performance. The low battery indicator on the display turns on at a +6.7V dc battery potential.

The DVC-350A uses one standard +9V alkaline battery or a rechargeable Nickel-Cadmium battery. The calibrator may also operate using an optional AC adapter/charger when a Ni-Cd battery is installed. **When using an alkaline battery, remove the battery before using the adapter.**

The low output impedance amplifier of the DVC-350A will source or sink up to 20mA over the specified output voltage ranges without compromising its performance and accuracy.

The device begins current limiting at 22mA, turning on an overload symbol on the display. At higher current loading, the calibrator's accuracy will be somewhat degraded until such time as its short-circuit protection circuit shuts down the output at 33mA. The overload circuitry protects the calibrator from external loads lower than 480 ohms on the 12V scale or 48 ohms on the 1.2V scale.

FUNCTIONAL SPECIFICATIONS

(Typical at +25°C unless otherwise noted)

Performance

Accuracy Within ±0.015% of full scale
Resolution 12V scale; 1 mV increment
 1.2V scale; 100 µV increment
 10V scale; 2.44 mV increment
 1V scale; 244 µV increment

Temperature Drift of Zero
 12V scale Within ±10µV/°C
 1.2V scale Within ±1µV/°C

Temperature Drift of Calibration
 +15°C to +35°C ±10ppm of setting/°C
 0°C to +50°C ±15ppm of setting/°C

Temperature Ranges
Operating 0°C to +50°C
Storage -25°C to +85°C
Output Noise 150 µV peak-to-peak, wideband (+12V dc scale)

Voltage Output

Ranges
Decimal 0 to ±1.2V dc, 0 to ±12V dc
Hexidecimal 0 to ±0.99975V dc
 0 to ±9.9975V dc (Hex = FFF)
Zero Volts Output Error +100 µV

Output Type Low impedance dc voltage, current limited

Current Capability Output will sink or source 20 mA maximum over the full scale ranges

Output Overload Greater than +20 mA current will turn on the "OVERLOAD" indicator and output accuracy will degrade

Output Impedance 30 milliohms
Capacitive Load No limitation
Output Connector Type Two banana-type jacks, 0.75" spacing on centers

Output Protection

Current 33 mA short circuit-proof (will shut down at this point)
Voltage 15V (dc or AC, pk to pk) maximum (Damage to output circuitry might result when exceeding this value)
Output Settling Time 5 seconds to rated accuracy, 2 seconds to 99% of final output

Power Requirements

Battery Supply Voltage Range 20V dc to 6.5V dc (no effect on performance)
Supply Current 20mA (no load) at +9V
Battery Type 9V alkaline or Ni-Cd
Battery Life (GC9B NiCd) Min.* Typ. Units
 (before requiring recharging) 1.0 4 hours
 *12V at 20 mA output would require an input current of 55 mA at 9 V

Physical Demensions

Size 5.75"L x 3.6"W x 1.29"H
 146 x 91 x 33mm
Weight 11 ounces (342 grams)
Case Material ABS plastic
Keyboard Life 10 million cycles per switch (minimum)
Key Operating Force 4 to 8 ounces, 124 to 248 grams

3

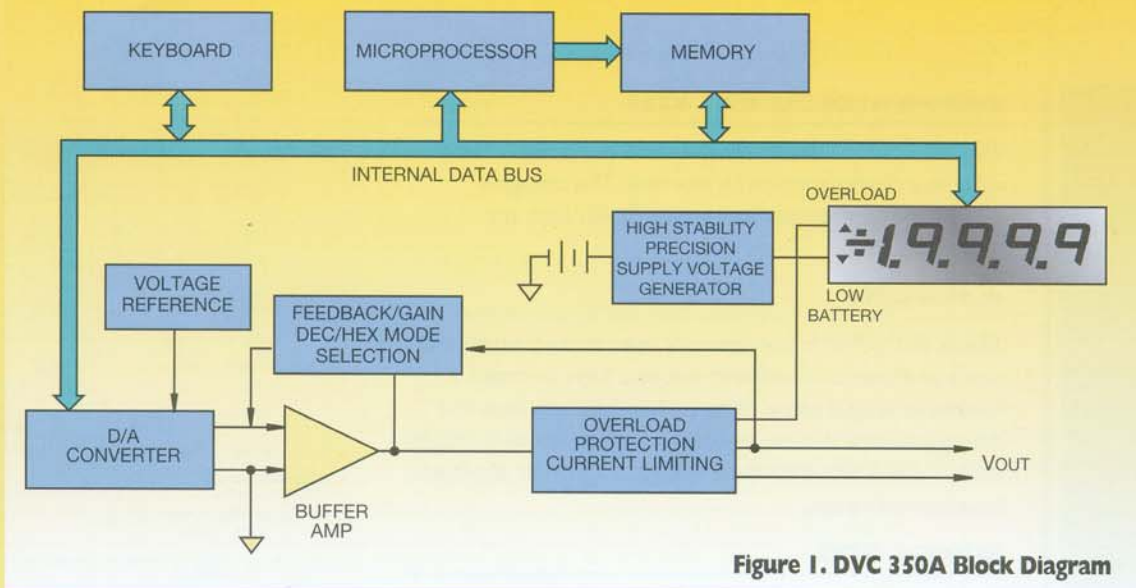


Figure 1. DVC 350A Block Diagram

SWITCHES AND INDICATORS

(Refer to Figure 2)

Power, output polarity, range, and decimal/hexadecimal mode switches are located above the keypad; each is clearly labeled. Decimal and hexadecimal mode selection is switch-selectable.

The three-position polarity switch on the keyboard allows “+” or “-” polarity output selection as well as a 0V dc output.

An alternately flashing “+” and “-” sign indicates that the calibrator is producing a 0 volt output. In this mode, the display still reads the last keyboard entry which becomes an output when the switch moves from the center position to the left (-) or right (+).

KEYBOARD

(Refer to Figure 2)

The DVC-350A’s touch-sensitive membrane keyboard consists of 24 decimal, hexadecimal, and function keys. A minimum force of 4 ounces activates the keys. An internal buzzer provides audible feedback for all keypad entries (except the increment and decrement key).

CURSOR LEFT/RIGHT KEYS

The cursor keys move the cursor left and right to select the desired digit to be incremented or decremented by the Increment/Decrement keys. The cursor is not visible on the display and the user must use the Increment/Decrement keys to find the cursor position. The device provides an audible feedback when using the Cursor Left/Right keys until the cursor position is at either end of the display.



Figure 2. DVC-350A Keys, Indicators and Switches

INCREMENT/DECREMENT KEYS

These keys allow the user to increase or decrease the value in a display position by one unit. The change is immediately present on the output. These keys are always active.

ALPHA KEYS

The A, B, C, D, E, F keys are only used in the hexadecimal mode and are combined with numeric keys to create a valid hexadecimal entry. Figures 3 and 4 clarify how the device converts decimal numbers to hexadecimal numbers while Table 1 lists equivalent voltage outputs for displayed hexadecimal values.

NUMERIC KEYS

The numeric keys allow entering decimal values within the decimal and hexadecimal ranges. Out-of-range values result in a 'bad entry' indication.

DECIMAL POINT KEY

This key is used to enter a decimal point when in decimal mode.

CLEAR ENTRY KEY

Pressing this key while in the decimal and hexadecimal modes clears the keyboard entry and the display.

ENTER KEY

Pressing the ENTER key permits the newly-entered decimal value to appear at the output connectors of the calibrator. This key must be used when entering a decimal number from the keyboard. The ENTER key does not need to be pressed when using the increment and decrement keys, since the output of the calibrator changes automatically with the use of these keys.

HEX SHIFT KEY

Pressing the HEX SHIFT key changes the function of the increment/decrement keys. After enabling this function, the increment key multiplies the displayed hexadecimal value by 2 and the decrement key divides the entered hexadecimal value by 2. A second depression of the HEX SHIFT key disables the function. The display shows 4 decimal points to indicate that the HEX SHIFT function is active. This key is only valid in the hex operation mode.

NOTE: In hexadecimal, B and D are displayed as lower case LCD characters, b and d respectively. Note the difference between the letter b and the number 6.

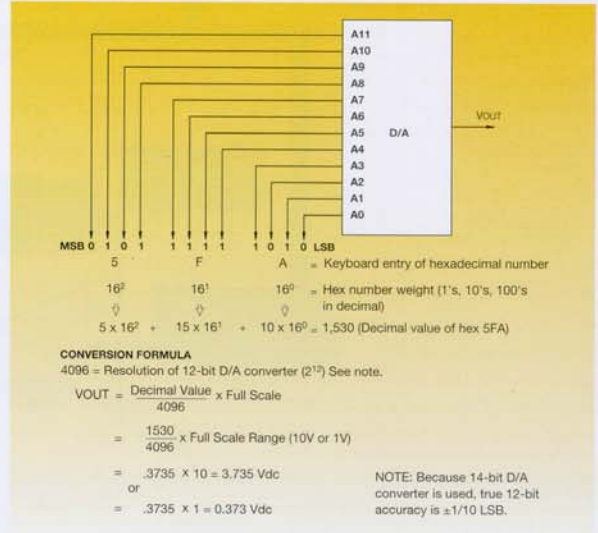


Figure 3. Hexidecimal Mode Operation

	DECIMAL	BINARY	HEXADECEIMAL
0	0000	0	
1	0001	1	
2	0010	2	
3	0011	3	
4	0100	4	
5	0101	5	
6	0110	6	
7	0111	7	
8	1000	8	
9	1001	9	
10	1010	A	
11	1011	B	
12	1100	C	
13	1101	D	
14	1110	E	
15	1111	F	

Figure 4. Decimal, Binary and Hexadecimal Conversion Chart

KEYBOARD ENTRY	INPUT STATUS OF D/A	DISPLAY STATUS and VOLTAGE OUTPUT	DESCRIPTION
EXAMPLE 1 Enter 5C4 followed by HEX SHIFT key	MSB 0 1 0 1 1 1 0 0 0 1 0 0 LSB 5 C 4	 Vout = 0.3605 Vdc ±244µV (1V scale)	Four decimal points indicate that the HEX SHIFT function is enabled.
Shift left 5C4	MSB 1 0 1 1 1 0 0 0 1 0 0 0 LSB B 8 8	 Vout = 0.72070 Vdc ±244µV (1V scale)	When a shift left is performed, it is like multiplying 5C4 by two.
Shift right 5C4	MSB 0 0 1 0 1 1 1 0 0 0 1 0 LSB 2 E 2	 Vout = 0.18017 Vdc ±244µV (1V scale)	When a shift right is performed, it is like dividing 5C4 by two.
EXAMPLE 2 Enter 0 followed by HEX SHIFT key	MSB 0 0 0 0 0 0 0 0 0 0 0 0 LSB 0 0 0		When a shift left of 0 is performed, the DVC-350A automatically shifts a 1 into the LSB position.
Shift left	MSB 0 0 0 0 0 0 0 0 0 0 0 1 LSB 0 0 1		

Hex shift is activated by pressing the HEX SHIFT once; pressing the HEX SHIFT button a second time disables the hex shift mode.

Figure 5. HEX SHIFT Key Operation

EXAMPLES OF 350A ENTRY

DECIMAL MODE

Power On
 Mode DEC (decimal)
 Range 12V dc
 Polarity +
 Enter 9.354

Press the decimal number and decimal point keys, reading from left to right, followed by the ENTER key. The display will indicate a value of +9.354 and an analog voltage of +9.354V dc will be present at the output of the unit.

HEXADECIMAL MODE

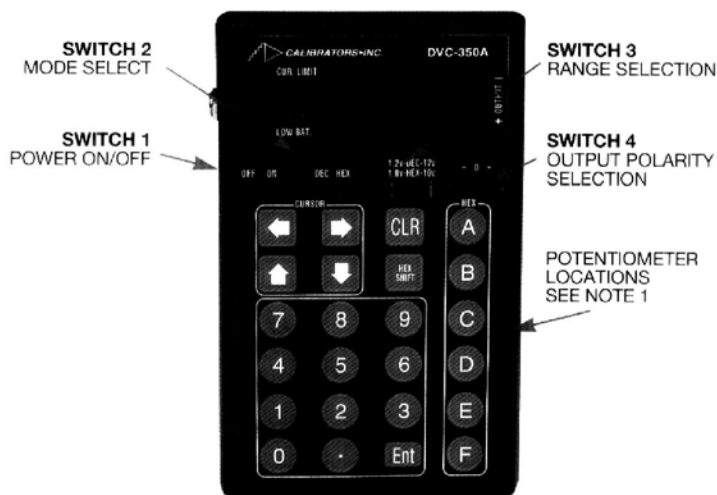
Power On
 Mode HEX (hexadecimal)
 Range 10V dc
 Polarity +
 Enter IFA

Follow the same procedure described in the earlier example with the addition of using the hexadecimal ALPHA keys. After pressing the ENTER key, the display will read IFA with a corresponding output voltage of +1.235V dc. The DVC-350A automatically converts the hexadecimal number entry into a decimal equivalent voltage output (see the conversion formula presented in Figure 3).

Table I. DVC-350A Coding Table

Displayed Hexadecimal Values	Decimal Voltage Output Equivalent	
	10 V scale	1 V scale
FFF	9.9975	0.99975
.		
.		
800	5.0000	0.50000
.		
.		
400	2.5000	0.250000
.		
.		
100	0.6250	0.06250
.		
.		
010	0.0390	0.00390
.		
.		
002	0.00488	0.00048
001	0.00244	0.00024
000	0.00000	0.00000

Figure 8



NOTE 1: THE USER MUST OPEN THE CASE TO ACCESS THE POTENTIOMETERS.
 1) REMOVE THE FOUR SCREWS LOCATED ON THE BACK OF THE CASE
 2) REMOVE THE THREE SCREWS LOCATED INSIDE OF THE CASE
 3) LIFT INTERNAL SUB-ASSEMBLIES SLIGHTLY UPWARDS TO ACCESS POTENTIOMETERS.

The DVC-350A hand-held voltage calibrator is designed for field and laboratory use. therefore, recalibration is not frequently required. However, due to normal component aging and unforeseen physical stresses and shock, vibration and temperature, cycles during field and laboratory use. the precision of the instrument should be checked every 6 months. If the accuracy of the instrument is not within specification, recalibration is needed.

RECALIBRATION EQUIPMENT:

Use any standard digital voltmeter with a resolution of ± 10 microvolts (μV) and overall known accuracy of 0.001% or better. Due to its unique design, the DVC-350A requires an exceptionally short "warm up" time of 5 seconds before starting recalibration.

1) ZEROING THE INTERNAL REFERENCE DAC

- 1.1 DVC-350A switch settings (see figure 8).
 SWITCH 1 (POWER): ON SWITCH 2 (MODE): DEC
 SWITCH 3 (RANGE): 12V SWITCH 4 (POLARITY): +
- 1.2 Press the CLR key to clear the display.
- 1.3 Connect a Volt Meter's positive (+) lead to the DVC-350A's PIN POST terminal (see figure 9). Connect the meters negative (-) lead to the DVC-350A's negative output terminal.
- 1.4 Adjust R2 (see figure 9), until the meter reads 0 volts ± 10 microvolts.

2) ZEROING THE OUTPUT

- 2.1 Same switch settings as step 1.1
- 2.2 Connect the volt meters Positive (+) lead to the DVC-350A's Positive (+) output terminal and adjust R12 until the output reads 0, ± 50 microvolts.

3) +12 VOLT OUTPUT FULL-SCALE ADJUSTMENT

- 3.1 Same switch settings as step 1.1
- 3.2 Enter 12.000 via the DVC-350A keyboard.
- 3.3 Adjust R8 until the voltmeter reads +12 volts dc, ± 100 microvolts (+11.9999 to +12.0001).

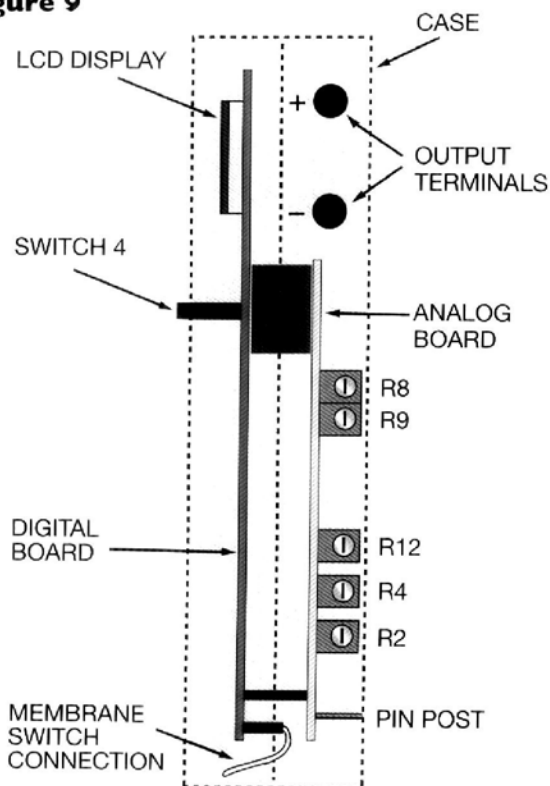
4) +1.2 VOLT OUTPUT FULL-SCALE ADJUSTMENT

- 4.1 Move the Range SWITCH (3) to the 1.2V dc scale.
- 4.2 Adjust R9 until the voltmeter reads +1.2000V dc, ± 10 microvolts.

5) HEX MODE OUTPUT FULL-SCALE ADJUSTMENT

- 5.1 Move the MODE SWITCH (2) to the "HEX" position.
- 5.2 Enter FFF via the keyboard.
- 5.3 Move the RANGE SWITCH (3) to the "10V" position.
- 5.4 Adjust R4 until the voltmeter reads +9.99756 dc, ± 100 microvolts (+9.99746V to 9.99766V dc).

Figure 9



7



DVC-350A INCLUDES:

- Water resistant carrying case (inside pocket for test leads and spare batteries).
- Test Leads Set: Two 3 foot, 20 AWG, leads, stackable banana plugs (with retracting hook clips)
- Certificate of NBS Traceability

ACCESSORY KIT MODEL #39-726769D

AC Adapter/Charger, UL/CSA approved
7.2V Rechargeable Ni-cd battery

LEGEND

1. DVC-350A
2. Case
3. AC Adapter (optional)
4. 7.2V Rechargeable Battery (optional)
5. Test Leads

Figure 6

Locations of the battery compartment and voltage connectors.

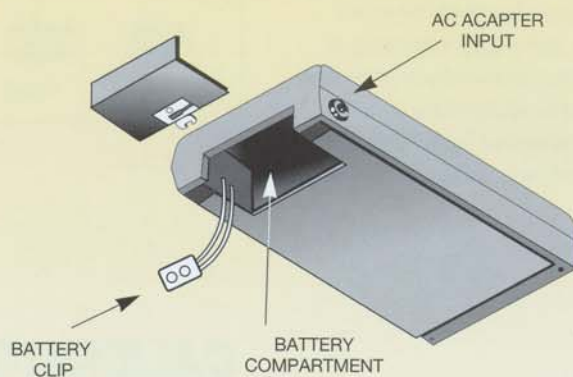
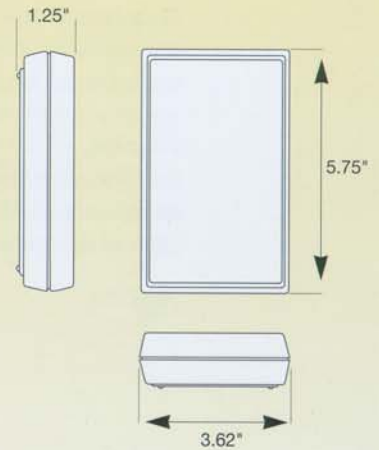


Figure 7.

DVC-350A Mechanical Dimensions



350A

WARRANTY

Calibrators Inc. warrants that all of its products are free from defects in material or workmanship under normal use and service for a period of 18 months from the date of shipment. Calibrators Inc. obligations under this warranty are limited to replacing or repairing, at our option, at our factory or facility, any of the products which within the application period after shipment be returned to us, transportation charges prepaid, and which are, after examination, disclosed to the satisfaction of Calibrators Inc. to be thus defective. The warranty does not apply to any products or equipment which have been repaired or altered, except by Calibrators Inc., or which have been subjected to misuse, negligence or accident. Under no circumstances shall Calibrators Inc. liability exceed the original purchase price.

GENERAL DISCLAIMER

In accordance with our policy of continuous product improvement, Calibrators Inc. reserves the right to make changes/improvements to our products and/or their specifications at any time without prior notice to anyone. Prices are also subject to change without notice.

Calibrators Inc. makes every attempt to ensure information provided in our technical literature is accurate and reliable. We can not, however, assume responsibility for inadvertent errors, inaccuracies, omissions or subsequent changes. We similarly assume no responsibility for the use of this information, and any and all such use of this information shall be entirely at the user's own risk.

No patent rights or licenses applicable to any of the circuits or Calibrators Inc. intellectual-property described herein are granted to any third party, either directly, by implication or any other means. Furthermore, despite our efforts to ensure otherwise, we can make no representation of any kind that the information and/or circuitry described herein is free of infringement of any intellectual-property rights or any other rights of third parties.

**LIMITATIONS ON THE USE OF CALIBRATORS INC. PRODUCTS**

Calibrators Inc. products are not designed for and should not be used, without the specific prior written consent of Calibrators Inc., in any life-support systems, nuclear-facility applications, aircraft-control applications or any other applications in which failure of the product, in any way, could reasonably result in harm to life, property or the environment.

A life-support system is defined as a product or system intended to support or sustain life and whose failure can be reasonably expected to result in significant personal injury or death. Nuclear-facility applications are defined as any application involving a nuclear reactor or the handling and processing of radioactive materials in which the failure of equipment, in any way, could reasonably result in harm to life, property or the environment.

ORDERING GUIDE

MODEL	DESCRIPTION
DVC-350A	Includes: • Case • Test leads
Accessory Kit Model #39-7267690	Includes: • AC Adapter/Charger (UL/CSA Approved) • 7.2V Rechargeable Ni-cd Battery

PAYMENT METHODS:

Net 30*



C.O.D.

* Pending credit approval



26 Oxford Road, Mansfield, MA 02048
TEL 508.337.3001 FAX 508.337.6488
EMAIL calinc@ici.net