When Quality Counts, Count on...
COULBOURN INSTRUMENTS

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H13-15 PRECISION-REGULATED SHOCKER
With grid floor scanner

H13-16 (REV A) PRECISION-REGULATED PROGRAMMABLE SHOCKER
With grid floor scanner and programmable shock levels

These shockers are identical with one exception. The H13-16, in addition to offering manually settable current levels, also includes a programmable shock level control. All specifications and operation are otherwise the same.

The shocker is totally isolated (floating output) for operator and subject safety, as well as isolation from other sources of electrical stimulation such as physiological stimulators that may be in use concurrently. The unit can function as a two-pole (bipolar) current reversal “square wave” output, or as a scanner distributing the polarity reversal across an 8-pole output for grid floor applications. Control of the mode is by a switch on the back panel. The grid outputs are direct “Form C” semiconductor switches. The “off” grids have zero resistance so the subject receives the same current regardless of the number of grids contacted.

The H13-16 may also be programmed from 0 to 5 milliamps in 20 microamp increments by a 0-2.5 Volt signal via the "PROG. INPUT" on the back of the case. The signal is generated by the Graphic State Notation control program and comes from the "PROG. OUTPUT" on the back of the Habitest Linc (you may also use your own D/A converter output). **Specifications pertaining to the H13-16 only are in red type.**

With the "Two Pole/Scanned" switch (located on the rear of the cabinet) in the "two pole" position, the unit functions as a two-pole shocker with a two-pole (bipolar) current polarity reversal “square wave” output. Since three equal time intervals (+, -, off) constitute a stimulus cycle, the repetition rate is 40 Hz for a line frequency of 60 Hz and 33.33 Hz at 50 Hz. Placing the switch in the "scanned" position expands the number of output poles distributing the polarity reversal across an 8-pole output (which is repeated every 8 grids at the shock floor of the arena or runway).

SPECIFICATIONS

Power On/Off Switch:	On rear panel
Remote/Manual Switch:	**Remote (Up) -** enables external operate. **Off (Center) -** disables remote operate. **Manual (Down) -** operates shocker manually.
Remote Operate Input:	Turns shocker on when external voltage is applied.

Meter Range Switch:	5-position switch selects meter range.
Manual-Set Shock:	Set shock manually while reading the meter.
Shock Routing:	**Set/Test** Routes shock to a dummy load for setting or to subject.
Calibrate Load:	50K Ohms (simulates a very high value of subject resistance for more precise setting and more accurate delivery over resistance changes)

Max Prog. Control V In:	5 Volts (0-2.5 volts = 0 - 5 milliamps maximum output)
Maximum Output Current:	5 milliamps into 75K Ohms
Maximum Output Voltage:	450 volts
Output Waveform:	Square pulse
Regulation:	At 500 microamps - 2% at 0 to 900K Ohms At 1 milliamp - 2% at 0 to 450K Ohms At 2 milliamps - 2% at 0 to 225K Ohms
Calibrate Load:	47K Ohms
AC Switching:	Zero Crossover

Scanner Section: The grid outputs are semiconductor (bipolar MOSFET) switches. The "off" grids have zero resistance so the subject receives the same current regardless of the number of grids contacted.

AC Switching:	Zero Crossover
Indicators:	Power On, Shock Test Load, and Shock Subject
Dimensions:	10" W x 7" D x 3-1/4" H
Electrical:	110/120 VAC 50-60 Hz or 220/240 VAC 50-60 Hz (specify on order)

INSTALLATION

1. Attach the AC (mains) power cord to the AC input on the rear of the shocker and plug the cord into an appropriate AC (mains) outlet.
2. Attach the electrodes or shock cable to the 8-Pin connector on the rear of the shocker.
3. Turn the AC power switch on the back of the shocker to "ON".

OPERATION

Power On/Off Switch: On rear panel
Remote/Manual Switch: Up - Enables an external signal to operate the shocker; Center - Disables remote operate; Down - Operates shocker manually for duration of depression. (The down position of the switch is spring-loaded to return to center when released.)
Remote Operate Input: On back panel - turns shocker on when external voltage is applied (5 to 30 VDC at 20 milliamps).
Mode/Range Switch: 5-position switch selects three ranges in the programmed mode, two ranges in the manual mode.

Manually Setting V.S. Programming the Shock Level

Programmed Positions: Use one of these 3 switch settings when using the shocker in the programmed mode where the protocol determines the level of shock for each presentation.
Range: A program-generated 0 to 2.5 Volt control input on the programmed control input on the rear of the case will control the level of shock from 0 milliamps to 5 milliamps. Select one of the 3-meter ranges below for ease of reading according to the range of shock level to be used.
Prog/1 Position: Meter reads 0 - 1000 microamps on upper scale.
Prog/3 Position: Meter reads 0 - 3 milliamps on lower scale.
Prog/10 Position: Meter scaled 0 - 10 milliamps on upper scale (max. output about mid-scale).

Programmable Current Control : Setting the output in milliamps directly in the "Prog" window presented by the Graphic State Notation program when you select the stimuli in protocol creation will produce the zero to 2.5 volt signal from the Habitest Linc's "Prog" output which will in turn produce a zero to 5 milliamp shock output when it is present. You may also use any D/A converter that can produce a 0 to 2.5Volt signal if you are using another control system. The program control voltage must be present to set the shock level to the selected current value. **The remote operate input must *also* be activated** by an output from one of the Habitest Linc's "AUX" outputs (or other 5 to 30 Volt signal) for the shocker output to be on at the selected level. To select the value for the shock in any state in the Graphic State Notation program, double click on the "Prog" button in the state graphic and select using the window.

NOTE: *With the **H13-16 REV A** you need not use "AUX" 1 with "PROG" 1, and "AUX 2 with "PROG" 2 in order to latch new values upon state change as with the H13-16. The H13-16 (REV A) automatically latches new values. **Revision of your H13-16 to H13-16 REV A will be done at no charge.** This revision was made to allow more robust control of the shocker (and other analog devices coming in the future) in **Graphic State 2.100.** See the "Graphic State Notation Users Guide" for details.*

Manual Positions: Use one of the 2 switch settings below when using the shocker in the manually set mode to deliver the same shock for each presentation.
Man'l/Lo Position: To set 0 to 0.5 milliamps, use the "Lo" range position and read the 0 - 1 (upper) meter scale.
Man'l/Hi Position: To set 0 to 3 milliamps, use the "Hi" range and read the 0 - 3 (lower) meter scale.

To set values above 3 mA, use the "LO" range and set 0.3 to 0.5 milliamps while reading the 0 - 1 (upper) meter scale, **then set the range to "HI" before delivery**. Over-ranging the meter to 5 will not damage it.

Shock Routing Switch:

Set Test: Routes shock to a dummy load (resistor) for setting shock manually or checking and testing the external program control signals via the optional programmed level control. Shock is not connected to subject output cables when the switch is in the "set test" position. The green light indicates that the shocker is being operated with shock being routed to the test/calibrate load. When you create a protocol in Graphic State, you may want to run it in the "Pilot" mode to check functioning of the program. This is a good time to check the shock output levels you programmed in the protocol. Just set the switch to the "Set/Test" position for the pilot run and read the meter.

Subject: Routes shock to the subject output cable in this position. The yellow light indicates that shock is being routed to subject. **NOTE: When the switch is in the "Subject" mode, the reading will be significantly less – see below!**

VERY IMPORTANT NOTE: *– WHAT DOES THE METER READING REALLY MEAN?*

*When setting the shock output, the routing switch is in the set position and the current level is set while reading the meter. The **unpulsed** shock source is fed directly **to the meter**, which measures current **constantly** applied to the test/set load. When the shocker is in the use mode (routing to subject), the level of current **during the "pulse-on" portion of the cycle** is the **same as was originally set, or programmed** in the set mode. (See above for meter ranging.)*

*When the shocker is in use with a subject, the current is **off one-third of the time** (across a given pair of grids). Thus, the **meter reading** when **in use** with a subject **is lower** than when it was set due to its mechanical integrating properties, **but the current**, at any instant when it is flowing **is exactly as it was set or is programmed.***

Also consider the fact that the animal may or may not be contacting the grids at any given moment, reducing even further the average reading in the use mode. For example, if the rat is standing on two grids, current is only flowing two-ninths times one-third of the time. If the rat is jumping at random intervals and landing for some unknown fraction of time on an unpredictable number of grids, then one cannot expect the meter to indicate any more than a general range of average (time-density) current. The meter *will simply "jitter" around a reading, which is a fraction of the set value. Remember, the meter is used to precisely set or test the magnitude of the* ***pulsed*** *stimulus current as it* ***will be*** *delivered to the subject. It is impossible (or very expensive) to measure stimulus administration as it is delivered unless attached cutaneous electrodes are used on a restrained subject. In spite of all of the variables, aversiveness is highly correlated with instantaneous current (the pulse-on cycle), which is the value the meter reads in the set/test mode. Use the meter to manually set or to test the current provided by a programmed level code. In the use mode, the meter will verify that the stimulus is reaching the animal.*

With no animal in the circuit, the meter should show little or no movement. If it does, you have a short or a resistive path in the cage. Check the floor for droppings bridging the grids or moist debris on the grid floor circuit board. Very close inspection of the meter may reveal a very slight trepidation of the meter movement within an "open circuit", clean cage. This is due to the resistive equivalence of capacitance in the delivery cable. This capacitive impedance factor is of negligible consequence as an alternate path when a subject is in the cage. It does not affect the stimulus parameters from a perceptual or behavioral standpoint.

NOTE WELL: *You must take all of the above variables into account when replicating other studies using shockers that may read the shock after the scanner resulting in a very low reading due to the meter's mechanical integrating properties. The specifications of the shock pattern, waveform (sine or "square" pulse), or how the current is read are rarely reported in (recent) publications. If you have read that 0.1 to 0.3 milliamps is sufficient to produce reliable avoidance behavior in shuttle or passive avoidance designs, chances are it was measured post-scan and/or with the animal in the circuit. If so, the pulse current was actually much higher than the reported value. This shocker reads the unpulsed, DC current level through a calibrating resistor for precise setting.*

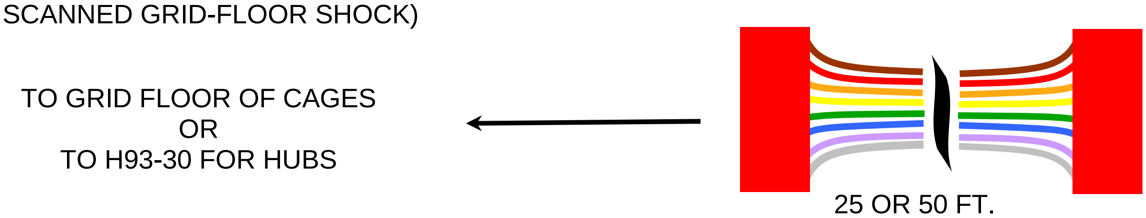
2-POLE VERSUS SCANNER OPERATION

If a two-pole cable is used with the "Two-Pole/Scanned" switch in the "scanned" position, the shock stimulus output on the two-pole cable will have only 2/9 the shock-time/density it would have with the jumper in the "two-pole" position. This is because placing the jumper in the "two-pole" position changes the reset point on the distribution counter from position 9 to position 3, causing the counter to scan only 2 instead of all 8 grids (plus the 9^{th} or home position). An effective shock will be delivered but does not have as great a time/density pattern as with the jumper in the "two-pole" position. Note also that the meter, again due to its mechanical integrating properties, will read even lower in approximate proportion.

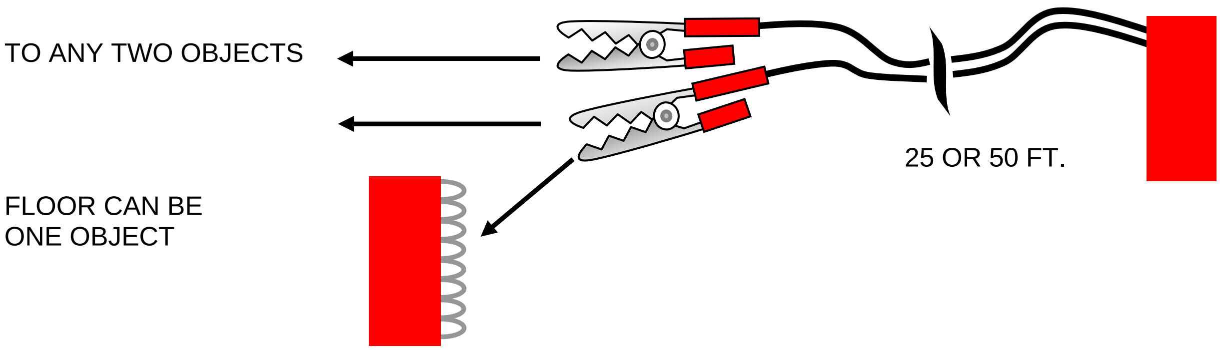
However, do not infer that the shock is diminished perceptually by a similar fraction; it is not! It is the instantaneous current in a pulse that correlates most closely with perceived aversiveness. Set-Point Current is only an indication of the relative aversiveness of a shock (and the resulting behavior) when: time/density, inter-pulse interval (relative to nerve and muscle absolute refractory periods), electrode pattern, and route-of-administration variables are constant. Administration variables include electrode contact area, cutaneous sensitivity at the site(s), volumetric density of all tissue in the path, and the fractional volume of muscular tissue in that path. In short, it is a chaotic system in which current set points are generally monotonic with respect to aversiveness in commonly used laboratory procedures employing grid floors or attached electrodes, and ***timed durations of administration*** *long enough to* ***insure that several pulses reach the animal.*** *A* ***100 millisecond*** *operate time* ***insures one scan of the grid floor;*** *20 milliseconds assures one alternation of the two-pole output at 60 Hz.*

CABLES FOR H13-16 SHOCKER

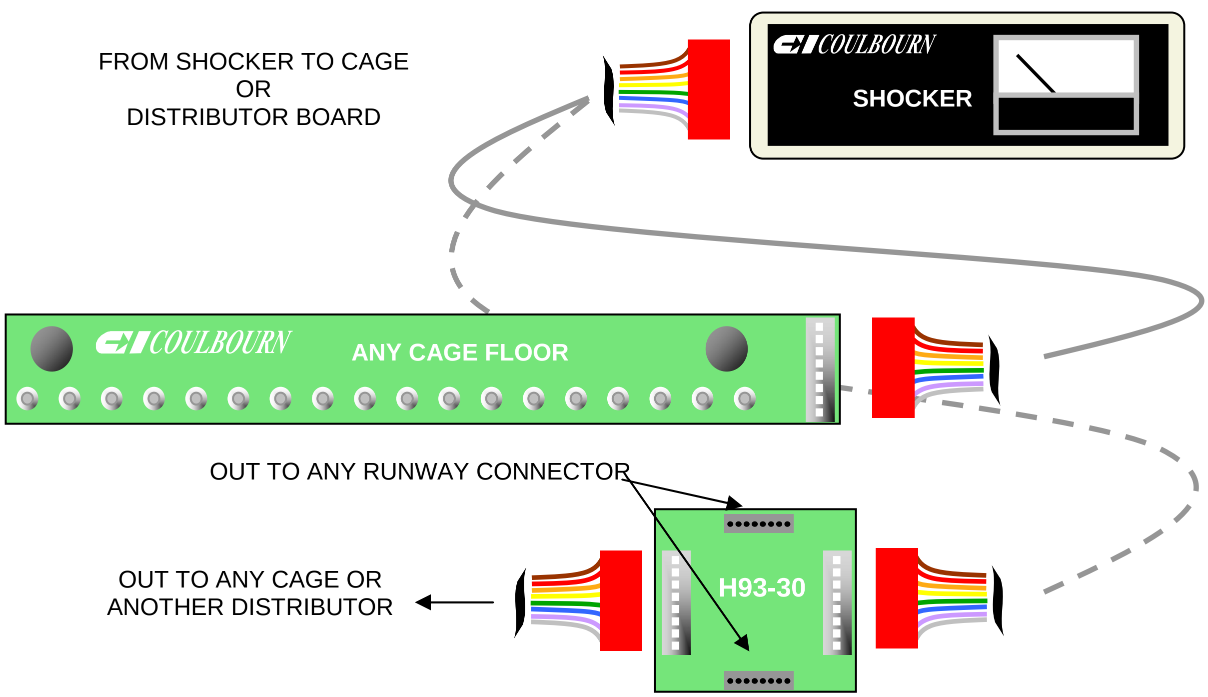
H93-01-25 8-CONDUCTOR RIBBON CABLE FOR ALTERNATE GRIDS – 25 FT.
H93-01-50 8-CONDUCTOR RIBBON CABLE FOR ALTERNATE GRIDS – 50 FT.
(FOR SCANNED GRID-FLOOR SHOCK)



H93-19-25 2-CONDUCTOR CABLE, PIN TO CLIP – 25 FT.
H93-19-50 2-CONDUCTOR CABLE, PIN TO CLIP – 50 FT.



ARENA AND RUNWAY SHOCK CONNECTIONS



NOTE: RUNWAYS HAVE A CONNECTOR ON EACH SIDE TO ALLOW "DAISY-CHAIN" CONNECTIONS FROM RUNWAY TO RUNWAY USING ONLY H93-31-32 SHOCK CABLES