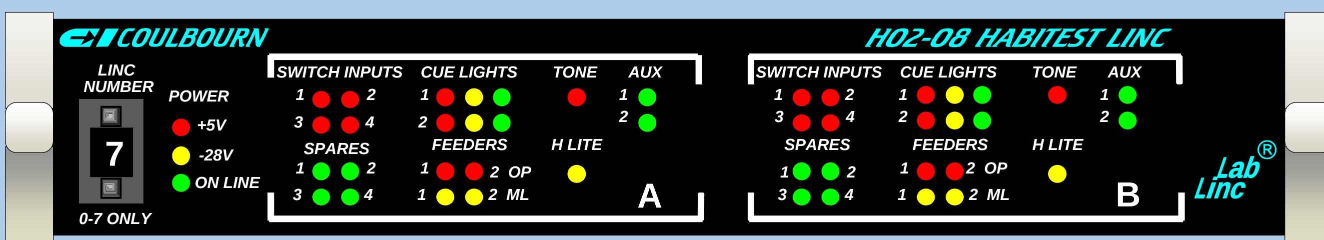
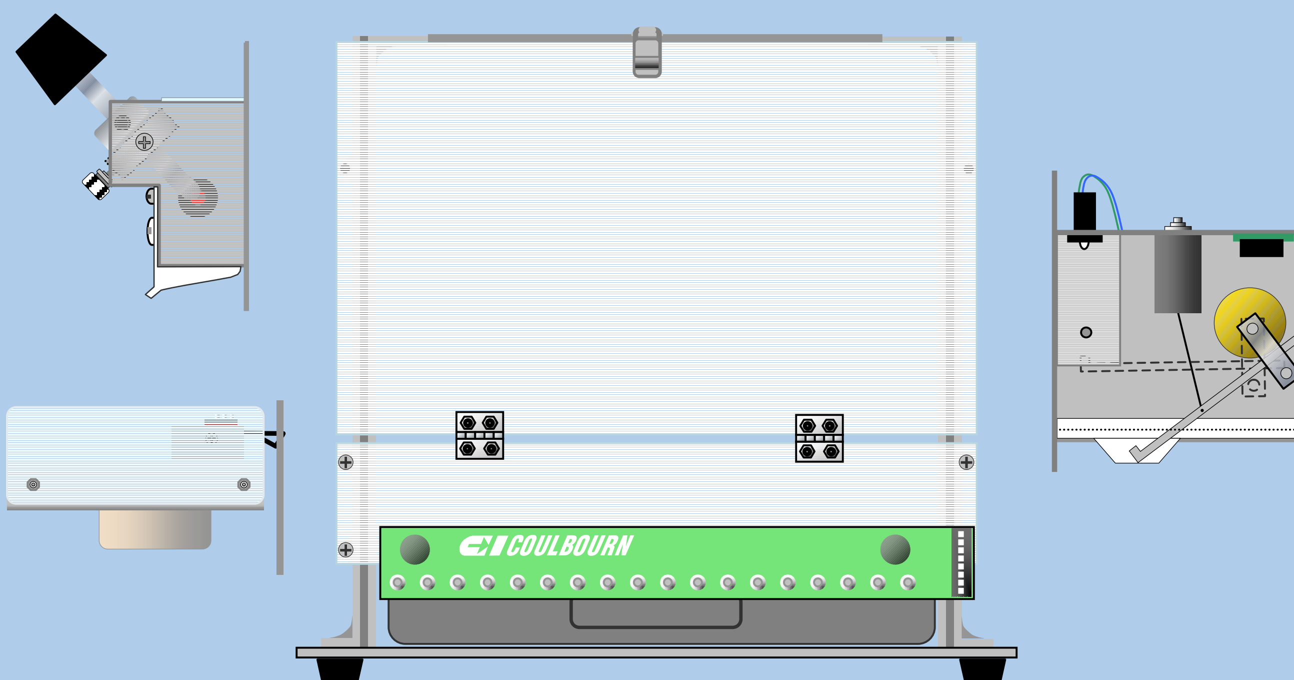
THE HABITEST® SYSTEM

MODULAR ANIMAL BEHAVIOR TEST SYSTEM

H-SERIES USER'S GUIDE





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COULBOURN INSTRUMENTS CE

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DEFINITIONS and TERMINOLOGY

ARENA - Arenas are the ***confining space*** in which the animal works, including **cages** and **hubs** that have tracks to hold stimulus presentation and response sensing modules the computer uses to interact with the subject.

CHAMBER - A total experimental environment consisting of a test ***arena*** (above) placed ***inside*** of an optional isolation ***cubicle*** (below) to block extraneous stimuli when and where necessary.

CUBICLE - An ***optional enclosure*** into which to place a test arena in order to block visual stimuli and to attenuate auditory stimuli.

ECB – (See **E**nvironment **C**onnection **B**oard.)

ENVIRONMENT - The total environment includes arenas with stimulus and response modules, runways, hide boxes, running wheels, and cubicles in which arenas are placed.

ENVIRONMENT CONNECTION BOARD or ECB - The printed circuit board in the environment to which the stimulus and response modules are connected. This board connects to the Habitest Linc via multi-conductor ribbon cables. The Linc *receives* switch-input signals representing responses and *sends* output signals to turn on stimuli via the cables and board to the connectors on the S/R modules.

EVENTS – **Switch events**, or response **input events** to the ECB and the Habitest Linc and ultimately the Graphic State Notation program are the industry-standard -28-Volt response-sensor signals from the Habitest (or other) environment's levers, photocells etc. All of the words; **"response", "response input", "switch", "input", "switch input", "event", or "event input", are used interchangeably** in this manual. They refer to the **inputs** on the ECB to which the Habitest response sensing modules are connected on the environment connection board, and to the corresponding inputs and indicator lights on the Habitest Linc.

INPUTS - See "EVENTS"

MODULES, STIMULUS & RESPONSE- The panels that hold the stimulus-producing and response-sensing devices for the Habitest system. The panels slide into the tracks of the arenas to form the walls.

LINC - The Habitest Linc is the interface module that connects the environment to the computer.

RESPONSE - See also - "EVENTS". **Any behavior** of the animal that is **above the threshold** of one of the system's input sensors **and is therefore measured** (a reported behavioral event). This may include responses the animal makes on an operandum or a behavior recorded by an incidental response sensor like a ceiling-mounted activity monitor or an ergometric force platform.

STATION - A station is the **total set of environmental hardware dedicated to running one animal.** It **includes the arena with stimulus and response modules** in which each animal is run **and the interface hardware** necessary to present the stimuli and the input sensors to register response events for one subject and communicate with the computer.

STIMULI - Stimuli are physical properties of the environment that are above the subject's threshold of sensation. Controlled stimuli are those that are turned on and off by the program via the Habitest Linc, cables and ECB using the industry-standard, -28Volt control signals.

SWITCH - The name for the input on the Environment Connection Board (ECB) to which response sensing modules are connected. (This a carryover from early days when all response sensors were simple switches.) See also - "EVENTS".

THE HABITEST™ SYSTEM

HABITEST is a modular animal behavior test system. The test cages and other working arenas are constructed using a system of open bays with slotted tracks as wall sections. Each section holds slip-in Stimulus-Response modules and blank panels to close each wall section.

The system includes four modular test cages. There are two large ones (three bays facing three bays and one bay facing five bays) for rats, pigeons, small primates and other similar sized animals; and two small ones for mice, gerbils etc. There is a complement of narrow S/R modules for the small cages and wider modules for the larger cages; these are for feeding, drinking, operant and other test procedures.

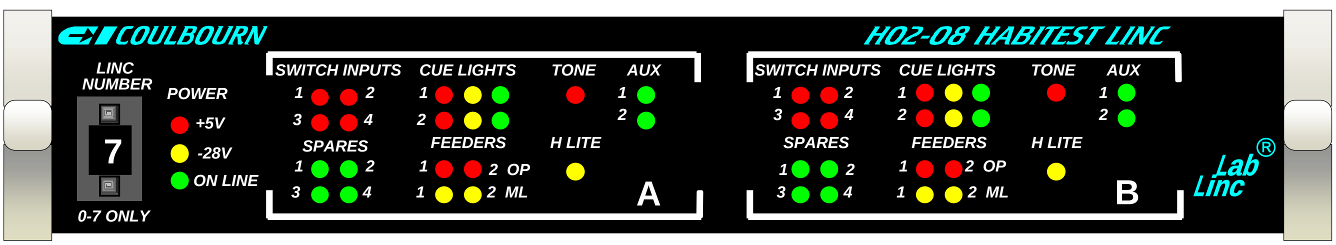
There are also four modular shuttle cages, two for rats (one has a blacked-out compartment on the left for "passive avoidance") and the other two for mice. These are used for avoidance, place-preference, feeding, drinking, operant, and other applications.

The system also features other arenas for both rat- and mouse-format modules. These include a square hub, a hexagon hub, an octagon hub, a dodecagon hub (in the rat size only), an instrumented running wheel (in the rat size only), as well as interconnecting runways and goal boxes for both. These hold the same S-R modules as the respective sized cages above. The runways may be used to connect any of the large cage or hub arenas or to build a variety of linear, angular and radial arm mazes. The runways are built using module plates as the end walls so that they may be slipped into any wall section. Runways may be fitted with either one or two guillotine doors to allow the experimenter to control access to and from any runway, hub, cage, wheel, or other device.

Hubs (especially the octagon) may be used as multi-bay operant cages to hold more levers, feeders, and other S-R modules; or they may simply act as runway intersections for a nearly infinite variety of mazes.

CONNECTION and CONTROL

THE HABITEST LINC



THE H02-08 HABITEST LINC MAY BE RUN AS A SINGLE STATION, AS 2 STATIONS OR IT MAY BE GROUPED WITH UP TO 3 OTHER LINCS FOR A VERY COMPLEX STATION

***INFORMATION ON SETTING UP THE LINCS ON THE POWER BASE AND CONNECTING THE SYSTEM TO THE COMPUTER IS FOUND IN THE* "GRAPHIC STATE NOTATION USERS GUIDE".**

All inputs to the Habitest Linc interface are simple switch closures and all outputs are -28V stimulus control signals. You do not have to worry about adding switch input buffers or stimulus output power drivers associated with each stimulus and response device, nor any other electronics as you add new S-R devices to your system; they are already there built into the Habitest Linc interface module.

Each S-R module plugs into an environment connection board (ECB) which is connected to the Habitest Linc so there is no wiring; just slip a module into the wall track and plug its connector into the board (see page 10). The special electronics for the more complicated response sensors and stimuli are on the stimulus or response module itself or in a small box in the connector line; no special interface modules are needed. No special wiring or hookup is necessary, just plug them to the ECB in and use them as if they were simple lamps or switches.

MODULE CURRENT DRAW AND THE MAXIMUM LINC POWER OUTPUT

Each Linc can provide 3 Amps of –28VDC to power modules. Most modules don't draw enough power to be of concern. For example, each of the colored lights (an LED or Light Emitting Diode) on any of the visual stimulus modules draws only about 20 milliamps. However there are some modules that have motors, like the feeders, retractable levers and guillotine doors that draw significant power, though only for a short time (when they are actually moving). **The high-current modules have the current draw highlighted next to the name and model number throughout this manual.**

THE ENVIRONMENT CONNECTION BOARD (ECB)

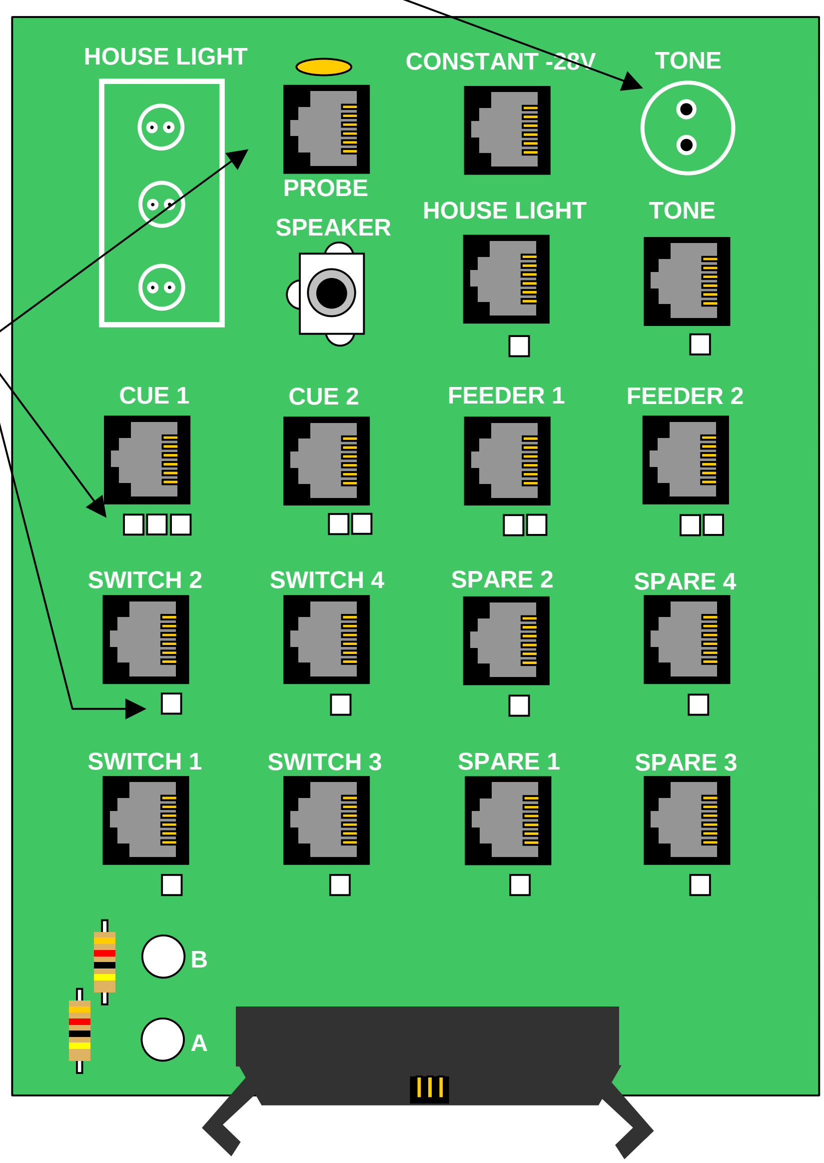
The ECB features an on-board house light that operates in parallel with the modular house light. If you are using an S-R module house light and do not want this one to come on, simply remove it. A spare bulb is provided in the "extra" location of the house light group. There is also provision for an optional, non-modular tone device. It mounts directly on the board. The board-mount unit is not as loud as the S-R module but it is very economical and adequate for audio cueing. The modular unit has low and high amplitude settings, the latter loud enough for aversive conditioning. If you have both types connected, they will both be on when commanded because there is only one control circuit.

We've also provided a constant -28V connector so that any single stimulus module may be constantly powered as long as the Linc or connection panel is powered. For example, the fan or house light could be on any time the interface is powered. You may want to do this to free up one of the spare connectors to power an extra retractable lever, tone or other device.

There are also **test points** for each and every stimulus device. These small circuit pads under each connector are in electrical parallel with each stimulus or response device connected to the connector and labeled in smaller type – SWITCH, FEED, MAG (magazine lite), CUES - R, Y, G, TONE etc. There is also a connector on the top of the board labeled " Probe". The **test probe** (one is provided with each System Power Base) is attached via a short wire to its connector so that you can plug it in and **touch the probe tip to any of the pads to test the stimulus device or response input.** This can save a lot of time in testing modules because **you don't have to run a program to turn them on.**

The two **blue LEDs** at the bottom indicate to which half of the Linc the board is connected, 1 light = A, 2 lights = B.

The **speaker connector** is connected via 2 wires in the ECB cable, to the same type of **audio jack** on the rear of the Linc module.

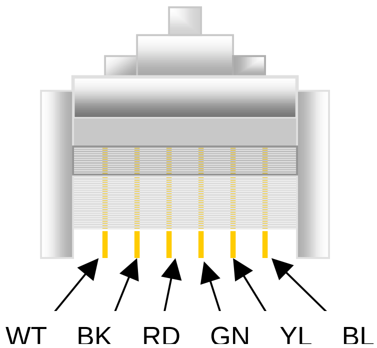


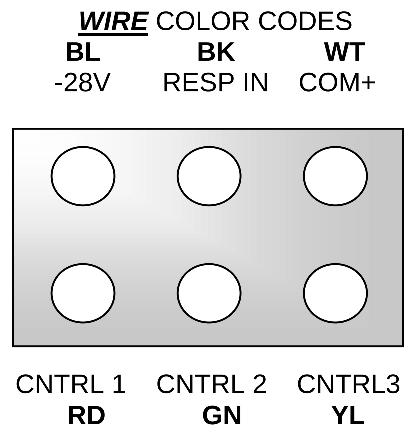
MODULE ELECTRICAL CONNECTIONS

Each module connects to the ECB via a telephone-type connector on the end of the small cable connected to the module. For those who wish to connect other S/R devices to our system or ours to other systems, the **technicians' diagrams** are shown at the top. The **user-diagrams below simply show functionality** in a convenient spatial layout to visually separate power, the switch connection and the 3 stimulus control lines.

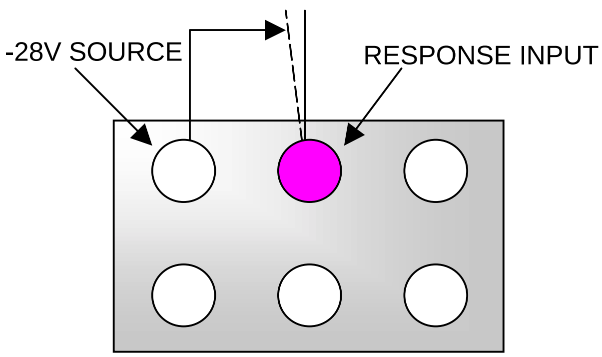
TECHNICIAN'S DIAGRAMS FOR MODULE WIRING CONNECTIONS

CONNECTIONS AT THE PLUG END

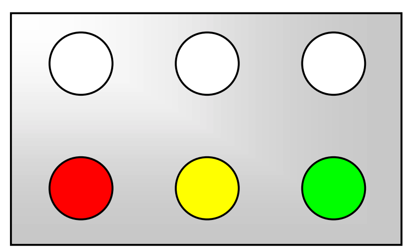




USER DIAGRAMS FOR MODULE FUNCTIONALITY ILLUSTRATED IN THE STATE GRAPHIC



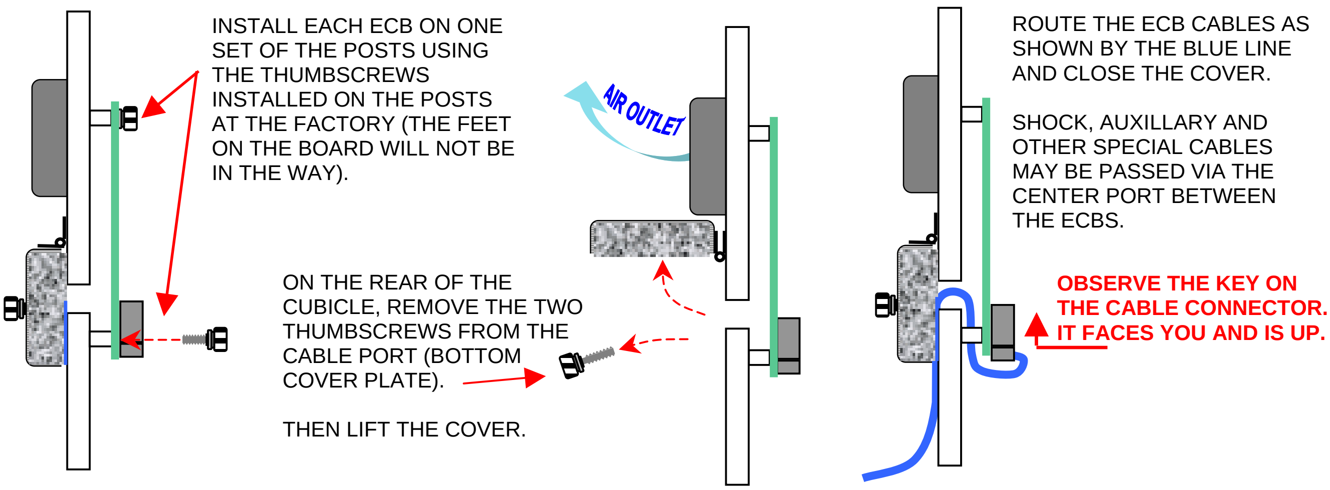
RESPONSE SWITCH
INPUT CONNECTIONS



TRIPLE OR TRI-COLOR CUES
AS SHOWN IN **STATE GRAPHIC**

IMPORTANT NOTE! *The H02-08 Linc interface and the new H-series Habitest system are not designed to drive heavy loads in S/R modules directly.* ***The Linc's maximum output current for each command line is 100 milliamps.*** *This is adequate to drive all stimulus lights, small electromagnetic coils and devices that are "active" in that they have onboard electronics that derive their main operating power from the -28VDC power bus on the H-series ECB. Examples of these devices are the Pellet Feeder, guillotine doors and the retraction circuit of the Retractable Lever.* ***Other heavy loads such as dippers are "slaved"****. This means that the* ***command signal operates a relay on the device, which in turn operates the coil of the device*** *by passing -28 Volts via its contacts, from the* ***power bus (up to 3 Amps)*** *on the ECB, to the coil.*

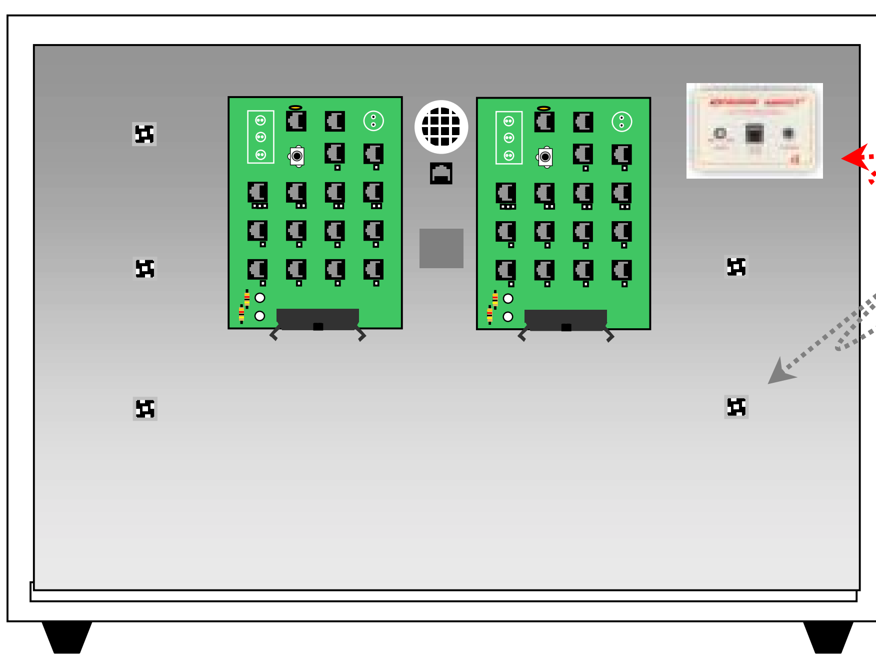
SETTING UP THE ISOLATION CUBICLE

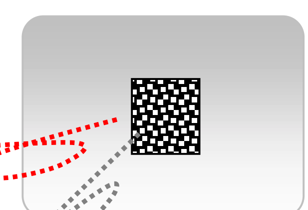


Cables from the Habitest Linc connect to the **Environment Connection Boards** (ECBs) via a feed-through that is under the gray (hinged) panel on the rear of the cubicle. Route the ECB cable through the slot behind the ECB and connect it to the bottom of the ECB. The cubicle can accommodate **two** ECBs so that a single Linc may be fully dedicated to a single arena in the cubicle using its full complement of 8 response inputs, four feeders and all of the rest of the stimulus outputs. To mount an ECB, just remove 4 thumbscrews from the mounting posts in the left or right position. Place the board over the posts and replace the screws. The feet installed on the board for tabletop use will not be in the way.

An **exhaust fan** powered by -28Volts **is built into the cubicle.** It is wired to a standard module connector mounted just below the fan. The fan may be **run continuously from one of the "Constant -28V" connectors** on an ECB **or** be **run under program control from a "Spare"** or other stimulus-control outputs.

Cables and wires to devices not provided for on the ECB may **be routed into the cubicle via the opening below the exhaust fan.** This is for connections like the analog lead from the PROG stimulus output on the back of the Linc, **shock** cables or **electrode connections,** and for **power** cables for special devices such as the Transducer Monitor.
Boss





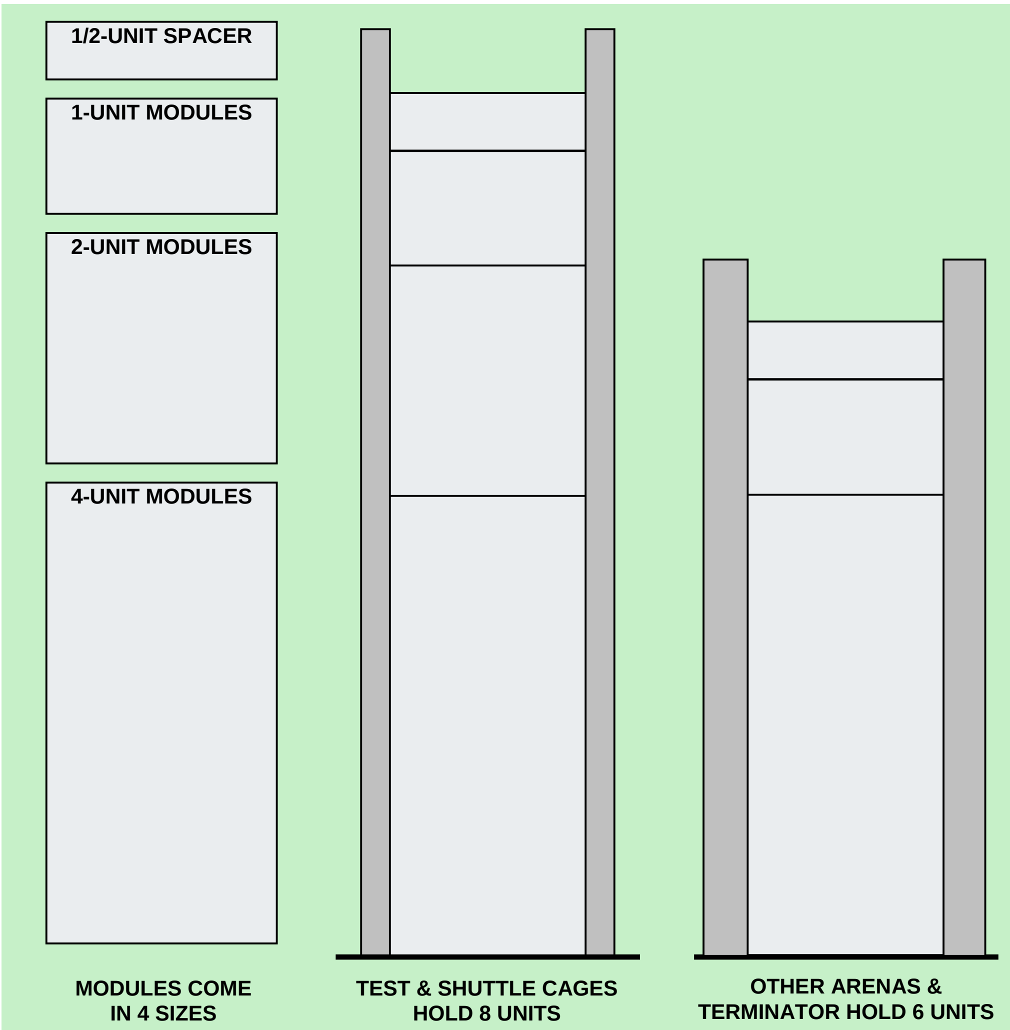
INLINE S/R DEVICES like the Noise Generator, Cue-Color Control, Tone Generator and others are supplied with Velcro®. Modules may be mounted on the cubicle's walls by applying the soft patch to the module's back plate and the hard patch to the rear wall (as illustrated) or one of the side walls. Press the module to the hard patch to mount it on the wall. (The high attenuation cubicle has strips on the LAG wrap for this purpose.)

STIMULUS / RESPONSE MODULES – GENERAL IN FORMATION

MODULE SIZES

There are **four heights** of module panels: one-half unit, one unit, two units, and four units in height. Each of the S-R devices is built on one of the larger three. All 4 sizes are also available as blank panels; the smallest size is offered as a blank only and serves to provide more flexibility in “fine tuning” the vertical spacing of the S-R modules. There are **two widths** of each, one for **mouse cages and** one for **rat cages.**

The **test cages and shuttle cages** hold modules totaling **eight units of height.** The **hubs and terminator** hold modules totaling **six units of height.**

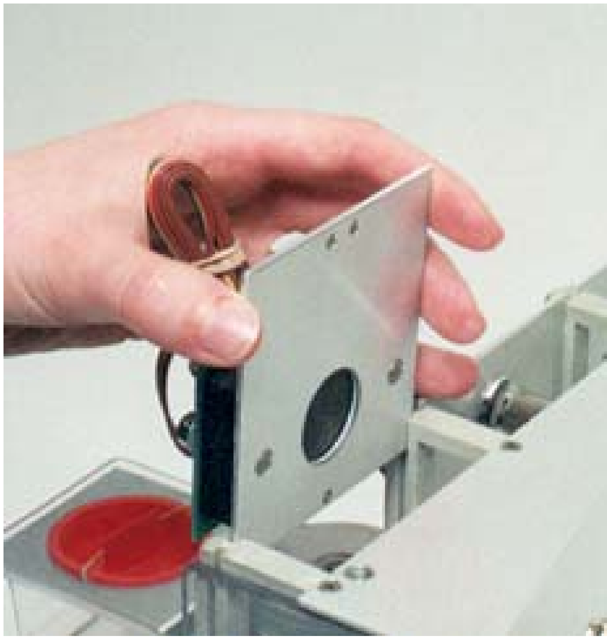


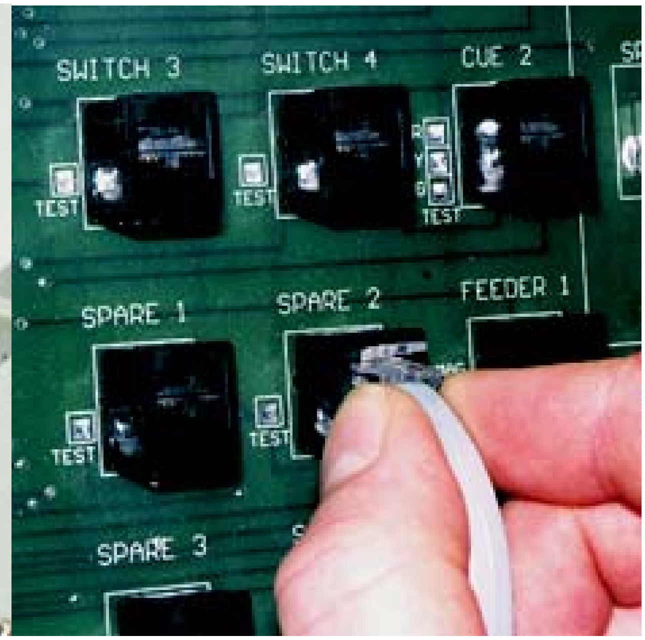
MODULE FIT

With <u>a few exceptions</u>, any module may be placed in any position *in the bay and any module may be placed in an adjacent bay next to any other module. Excepting a few modules like the runways and the Nest Retreat Box, all modules' structural components are contained within a rectangle defined by the rearward projection of the perimeter of the module-face outline.* ***Restrictions on placement apply only to the 6-bay test cages*** *because the 3 bays on each side of the cage are in a flat (planar) array.* ***Any module will fit next to any other in the radial array of any hub*** *where the bay tracks are wider and the modules "angle away" from each other creating even more clearance.*

INSTALLING MODULES

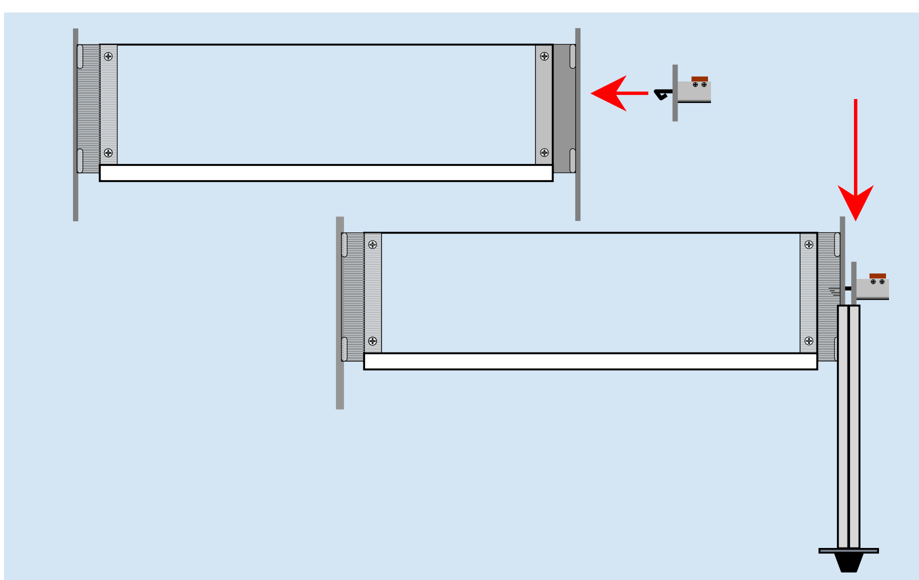
To install modules, remove the cover plates of the 6-bay test cage or the lid of the hubs. Just slip the modules down into the grooves of the tracks that form each module bay. You may use any size blank module panel (metal or clear plastic) to space modules at the desired height from the floor or from the module below. After the module is installed, connect it to the ECB in an appropriately named connector.





To place a terminator at the end of a runway, place the runway, along with any module or blank panel that you want at the end of the runway, in the double tracks of the terminator. Then, to make it easy to install the whole runway arm, lift the entire assembly (terminator, modules and all) and slide the other end of the runway into the tracks of the cage or hub.

If you are using **a module with a part that protrudes** from the front panel like the paddle on the lever shown below, **place the module and the runway end plate together, face-to-face, with the protrusion fitting into the open space** at the end of the runway. Then **hold them together and place both into the tracks** of the terminator at the same time. Protrusions will not clear the top of the doorway on the plate comprising the end of the runway if you try to install them one at a time.

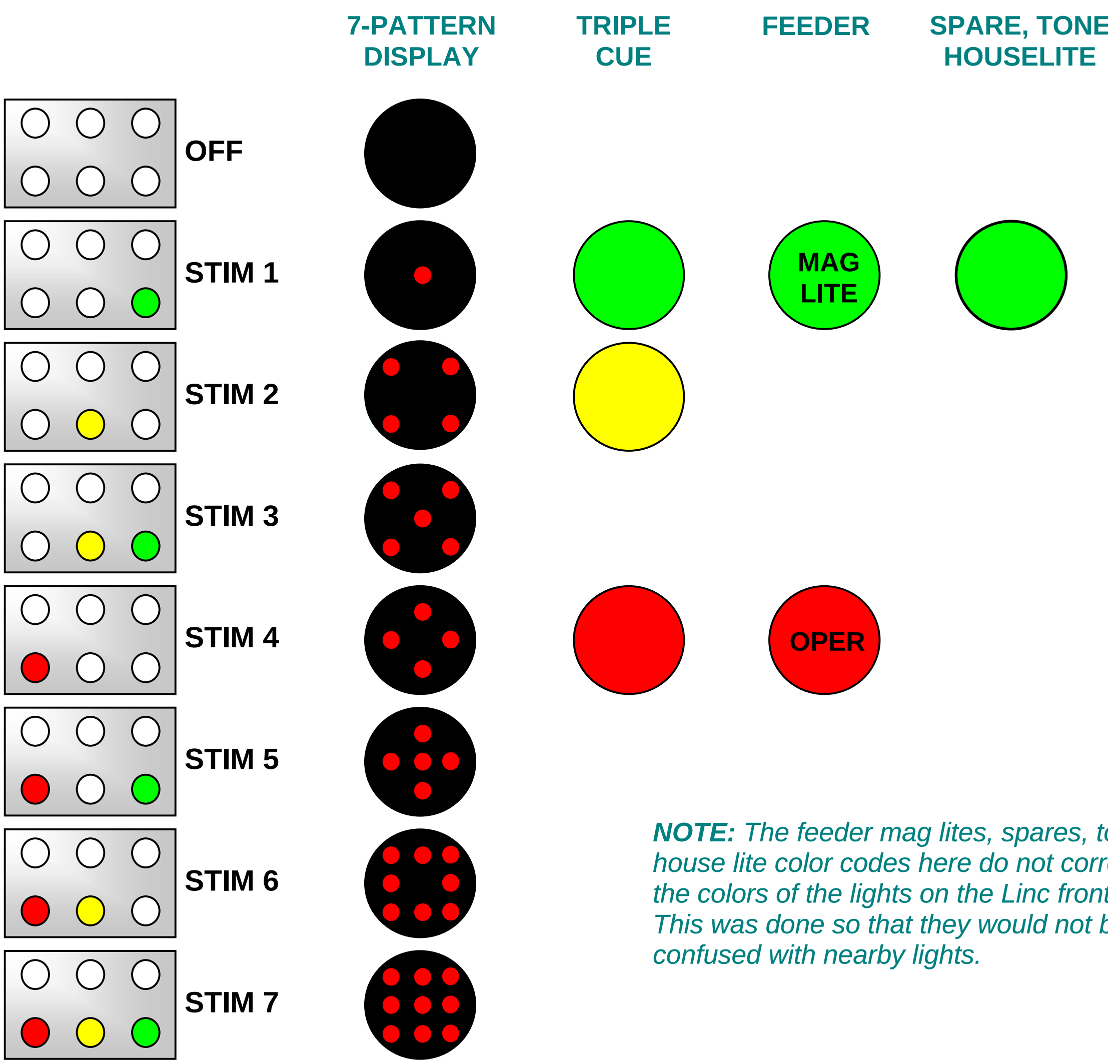


STIMULUS MODULES – VISUAL STIMULI – H11-SERIES

All visual stimuli in the Habitest system are controlled via a "Spare", "House Lite" or a "Cue" connector. The Cue connector has 3 circuits to control up to 3 stimuli. The Spare and House Lite connector have a single circuit to control a single stimulus (on the same pin as the "red" stimulus on the "Cue" connector – see below). There are 4 Cue circuits and 8 Spare circuits in each Habitest Linc; there are 2 and 4 of these respectively, available on each of the 2 ECBs for each Linc. As discussed earlier, these two connector types can control all stimuli, not just the visual stimuli (see page 7). (To control intensity or color see A21-10 LIGHT INTENSITY (AND COLOR) CONTROLLER on page 37.)

NOTE: *All of the connectors in the H-series environment are six pin connectors and we have wired them to use the same pins for **–28V, Ground** (common positive), **Response Report,** and the remaining **3 pins for Control (command).** You may use a Cue connector to control any of the single-stimulus devices and a Spare connector to control a specific one of the 3 cues in a triple cue device*.

To activate a single-visual-stimulus device, select any one of the "Spare" stimulus buttons in the state graphic in the GSN program, being sure the device (House Lite or Single Hi-Bright Cue) is plugged into the connector you select. The diagram below shows the connections for all of the visual stimuli controlled by the (Triple) Cue connectors. Next to the diagrammatic representation of the connections on the left, there is a column for the 7-Pattern displays, the Triple Cues and the Tricolor Cues. Note that the decimal stimulus numbers represent the binary coding of the 3 (stimulus) bits. The control line in the spare connector is the same conductor as the one controlling the green stimulus in the Cue connector (it is the least-significant bit). If you use a Spare command for a three-stimulus module, it will light the green light or the single dot in the 7-pattern display.



NOTE: *The feeder mag lites, spares, tone and house lite color codes here do not correspond to the colors of the lights on the Linc front panel. This was done so that they would not be confused with nearby lights.*

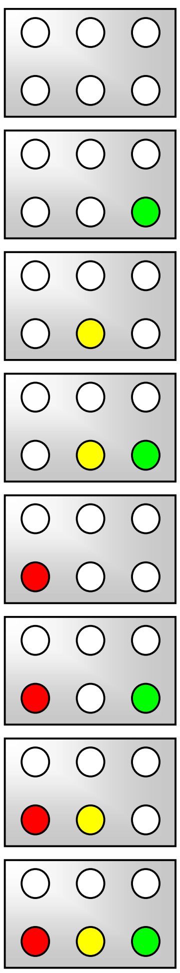
STIMULUS MODULES – AUDITORY STIMULI – H12-SERIES

The auditory module group, like the visual-stimulus module group on the previous page, uses either “Spare” connectors or “Cue” connectors. As with the visual group, auditory stimuli may be operated by either type connector. Single-stimulus modules (the Board-Mount, the High-Power modular types and the in-line Noise Generator) are operated via any one of the “Spare” connectors or the Green control line of any one of the (triple) Cue connectors. (See page 7.)

The in-line Tone Generator board and the in-line Attenuator board are operated to their full capability by using a “Cue” connector. Select the frequency or attenuation level in accordance with the color codes shown on page 7 and below in conjunction with selection of the matching color in the state graphic. Either may be operated via a “Spare” connector, but the Tone generator can produce only a 1KHz tone and the attenuator can produce only 3dB of attenuation. (The case for all 3 auditory modules is shown at bottom – see page 8.)

The speaker may receive signals from the audio pass-through on the ECB, which passes nominal 1Volt RMS audio signals via the jack on the back of the Linc from an outside source. The speaker is also used to reproduce the tone signal from the Tone Generator by connecting it directly to the output of the Tone Generator.

The signals from the Tone Generator, Noise Generator or the ”pass-through” jack on the ECB may be routed to the speaker via the Attenuator (“in series”) to afford program control over the amplitude of the signal.



	TONE GENERATOR	ATTENUATOR	TRIPLE CUE	FEEDER	SPARE, TONE HOUSELITE
	OFF	**NONE**			
	1KHz	**-3dB**		**MAG LITE**	
	1.5KHz	**-6dB**			
	2KHz	**-9dB**			
	2.5KHz	**-12dB**		**OPER**	
	3KHz	**-15dB**			
	3.5Khz	**-18dB**			
	4KHz	**-21dB**			

STIMULUS DEVICES – ELECTRICAL SHOCK STIMULI – H13-SERIES

H13-01 2-POLE SHOCKER Resistance-regulated

!THIS SHOCKER IS NOT FOR USE WITH HUMAN SUBJECTS!

The H13-01 is an economical, series-resistance-regulated shocker for small animals. The set accuracy is 5% and the regulation is +/- 20% over a 10K to 30K ohm subject resistance range. It is fully isolated for subject and operator safety using the same shielded and grounded transformer as our feedback-regulated research model (H13-16 below). The operate control input is optically isolated to simplify operation from any signal source from 5 to 30 VDC.

It is designed for student lab applications and other protocols where precise current control over wide ranges of subject resistance is not required.

Series resistance-regulated shockers can never deliver more current than the total circuit resistance predicates. The current output IS therefore inherently overshoot limited and the shocker may be used in applications where continuity is broken during shock administration. This means that it may be used with small animals in any (attached or unattached electrode) two-pole applications, as well as with test cage grid floors using alternate grid bar connections where precise stimulus parameters are not required. However, it **should be noted that it is possible for animals to avoid being shocked** by learning to stand on alternate grids since grids do not change their relative polarity as they do in scanned output shockers. **H93-07-25 and H93-07-50 shock cables** have two pins on the shocker end for this shocker, and jumpered 8-pin connectors for alternate grid connection on the other. See next page.

SPECIFICATIONS

Power On/Off Switch:	On front panel
Remote/Manual Operate:	**Remote (Up) -** enables external operate.
	Off (Center) - disables remote operate.
	Manual (Down) - operates shocker manually.
Remote Operate:	Turns shocker on when external voltage is applied.
Set Current:	Sets current from .05 milliamp to 2.0 milliamp.
Shock Light:	On for duration of operation
Number of Outputs:	2
Maximum Current:	2 milliamps into 10K Ohms
Maximum Voltage Output:	280 VAC 60 Hz
Waveform:	50 or 60 Hz sine depending upon line (mains) frequency.
Regulation:	+/- 20% over 10 to 30K Ohms
Dimensions:	3-1/4 in. H x 10 in. W x 7 in. D
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 binding posts on the rear of the shocker.
3. Set the desired shock amplitude by adjusting the "SET SHOCK LEVEL" on the front of the shocker. (Range = 50 microamps to 2 milliamps.)
4. Turn the AC power switch on the front of the shocker to "ON".

OPERATION

Remote/Manual Operate: 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.)

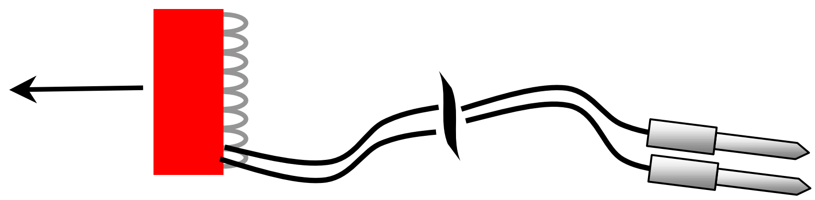
Remote Operate: On the back panel - turns shocker on when external voltage is applied (5 to 30 VDC at 20 milliamps). In our Habitest system, use an "auxiliary" output and follow the color code, blue to blue (-28 V command) and black to black (common - ground). In the Graphic State program, select the “Aux” output in the state you want to present shock. When the shocker is wired for remote operation, you may prevent it from being operated (manual override of remote signals) by placing the "OPERATE" toggle switch on the front of the H13-01 to the "OFF" position.

Shock Output: 2 terminal posts on the rear of the cabinet. Connect the shock cables to these posts and then to the grid floor, drink tube, tail shock apparatus, etc.

CABLES FOR H13-01 SHOCKER

H93-07-25 2-CONDUCTOR CABLE FOR ALTERNATE GRIDS – 25 FT.
H93-07-50 2-CONDUCTOR CABLE FOR ALTERNATE GRIDS – 50 FT.
(FOR ALTERNATE-GRID, 2-POLE SHOCK)

TO GRID FLOOR OF CAGES
OR
TO H93-30 FOR HUBS

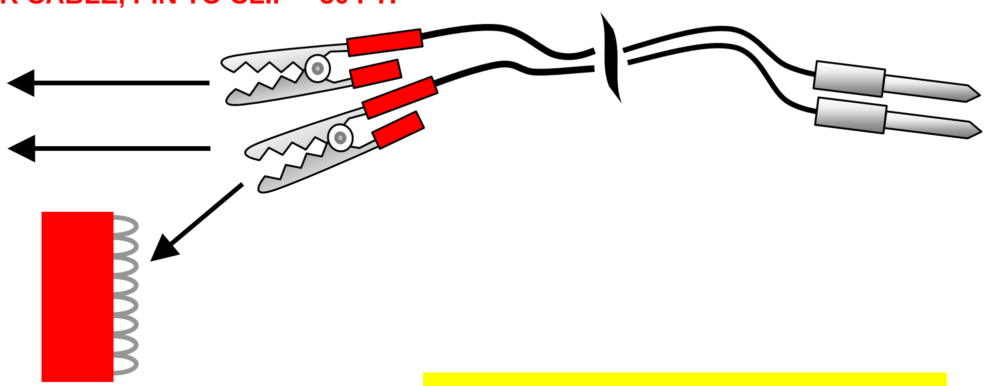


25 OR 50 FT.

H93-09-25 2-CONDUCTOR CABLE, PIN TO CLIP– 25 FT.
H93-09-50 2-CONDUCTOR CABLE, PIN TO CLIP – 50 FT.

FROM SHOCKER OUTPUT

TO ANY TWO OBJECTS



FLOOR CAN BE
ONE OBJECT

!THESE SHOCKERS ARE NOT FOR USE WITH HUMAN SUBJECTS!

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 2 model numbers are based on the same basic shocker. The H13-16 is simply a H13-15 with a programmable shock level control added. 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.*

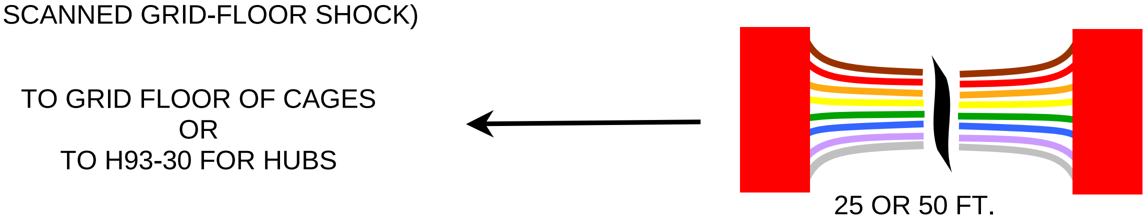
2-POLE VERSUS SCANNER OPERATION

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 9th 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.

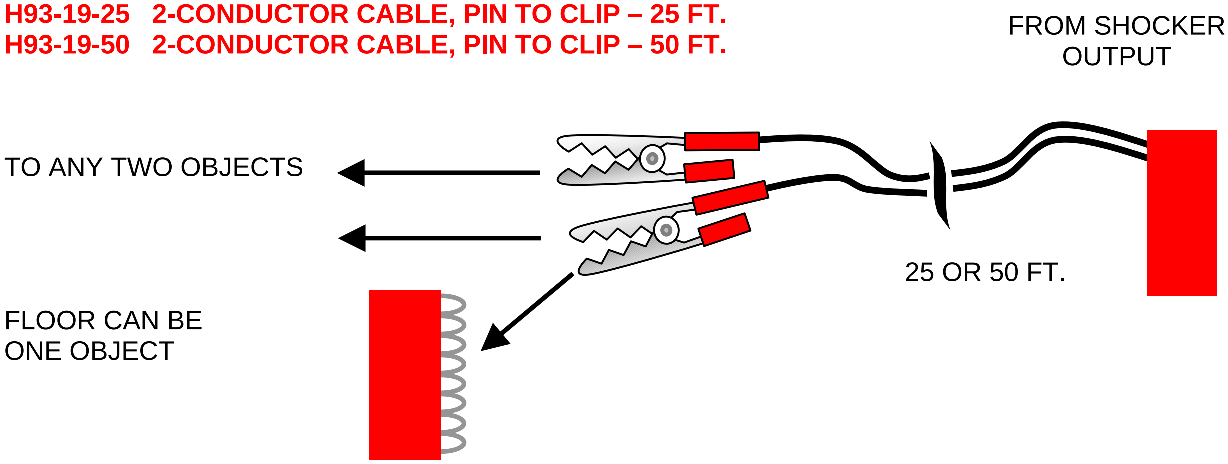
*However, do not infer that the shock is diminished perceptually by a similar fraction; it is not! It is the instantaneous current in a pulse that correlates most closely with perceived aversiveness. Set-Point Current is only an indication of the relative aversiveness of a shock (and the resulting behavior) 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

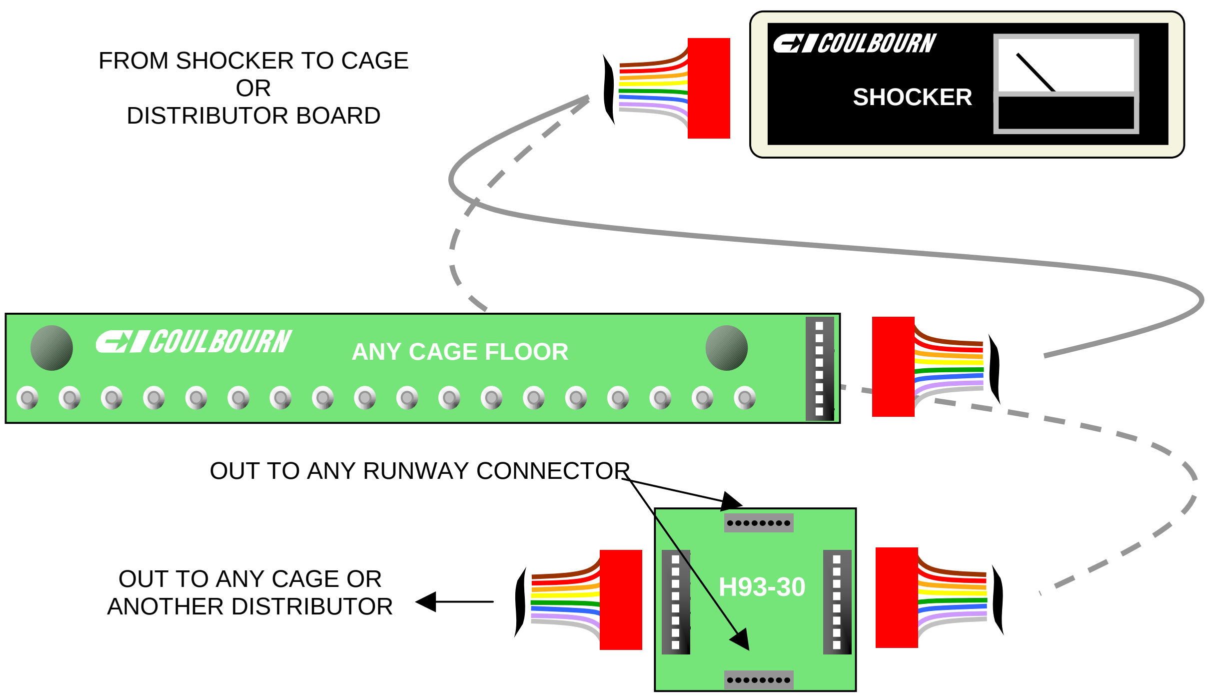
H93-01-25   8-CONDUCTOR RIBBON CABLE FOR ALTERNATE GRIDS – 25 FT.
H93-01-50   8-CONDUCTOR RIBBON CABLE FOR ALTERNATE GRIDS – 50 FT.
(FOR SCANNED GRID-FLOOR SHOCK)



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

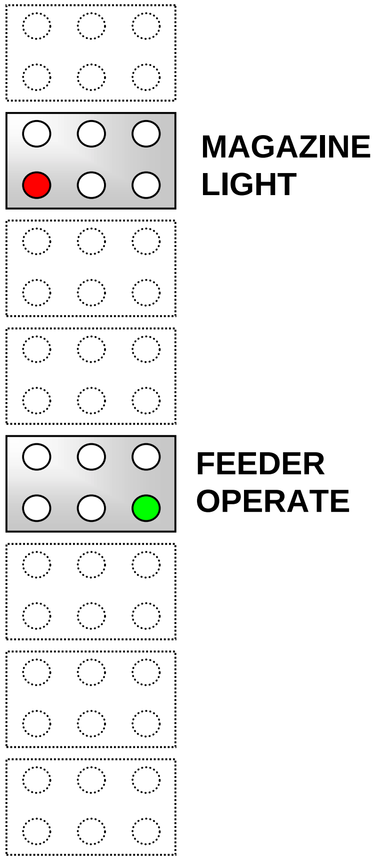


NOTE: RUNWAYS HAVE A CONNECTOR ON EACH SIDE TO ALLOW "DAISY-CHAIN" CONNECTIONS FROM RUNWAY TO RUNWAY USING ONLY H93-31-32 SHOCK CABLES

STIMULUS MODULES – GUSTATORY STIMULI – H14-SERIES

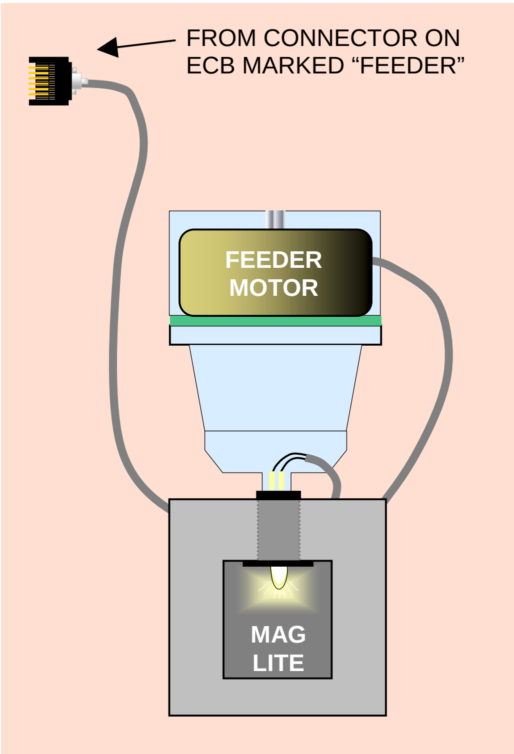
FEEDER MODULE ELECTRICAL CONNECTIONS

All feeders in the Habitest system are operated via the same two pins in the connector. The magazine light is operated by the same pin that controls the red cue light, and the mechanism that controls the food or liquid delivery presentation is operated by the same pin that controls the green light. The diagram to the right illustrates this and makes it obvious that any feeder can be operated by a “Cue” connector on the ECB in the (very unlikely*) event that you must control more than 4 feeders from a single Linc. Conversly, (and more likely) you may control the red and green lights (or a corresponding pattern or cue function) by using the “Feeder” connectors.



NOTE: *In the state graphic window in the Graphic State Notation program, and on the Linc front panel, the magazine light is shown yellow and the operate command is shown as red. This was done in the interest of clarity when looking at the display.*

**Considering that you can combine 2 or even 4 Linc’s to serve a single station, this is unlikely to ever be a necessity. Even if you split Lincs to serve 2 stations each, you will still have 2 feeders per station. But you can still run 2 more in each station by using the 2 Cue control’s in each half of the Linc. The limit would then depend upon the power supply in the base and (probabilistically) how often each is operated – after all, this would be 4 feeders in each of 16 stations, or a total of 64! This is generally O.K. considering that most conceivable protocols only operate one feeder at a time making 16 the worst case. Still, this is too many - you can operate about 12 feeders at the same time, so don’t use a yoked protocol for more.*



The diagram above covers the following modules:

H14-01M & R Pellet Delivery Trough
H14-04M & R Liquid Solenoid Valve
H14-05M & R Liquid Dipper
H14-06R Combination Dipper/Pellet Trough
H14-10R Grain Feeder
H14-22M-20 & R-45 Pellet Feeders

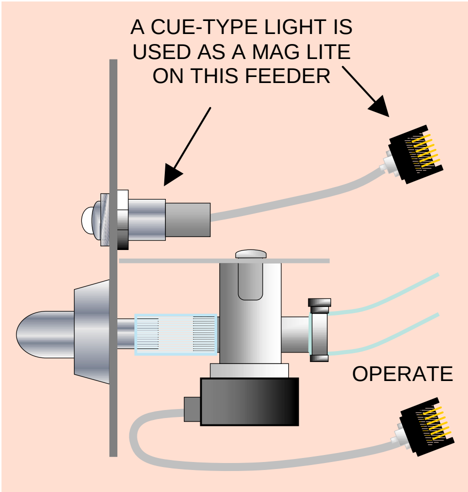
All feeders are operated via one of the Feeder connectors on the ECB.

Magazine light "Pass-through" connections for:
H14-01M & R Pellet Delivery Trough and
H14-06R Combination Dipper/Pellet Trough

When using a pellet feeder with a pellet trough or a combination dipper/pellet trough, the pellet feeder is operated via the connector coming from the trough. The trough is connected to one of the “Feeder” connectors on the ECB. The wiring from the board powers the magazine light in the trough. The rest of the wires "continue along" to the feeder carrying the "operate command" line and the power lines to the feeder via the "daisy chain" arrangement. (See next page for mounting.)

H14-03M, H14-03R LIQUID DELIVERY RESERVOIR

This is the same delivery reservoir used in the H14-04M and R (below). It is fitted with needle tubing on the rear to receive a catheter-type tube. Fluid is delivered by an infusion pump rather than by the gravity-feed reservoir with a solenoid valve of the model below. It is used for greater precision or when only small volumes of fluid are available owing to their great cost. No magazine light is available because this is not an "active" feeder module but you may use an H11-Series cue above the reservoir in place of a magazine light if necessary.



H14-04M, H14-04R LIQUID SOLENOID VALVE – 400mA

The Liquid Solenoid Valve should be used with water or solutions in which all ingredients will evaporate. If used with solutions that leave a residue such as salt or sugar, it must be flushed with water after use.

The fluid must be fed from a gravity-feed supply such as the bottle supplied with the unit, or a reduced pressure feed line. **Never attempt to connect the feed tube to a mains-fed faucet,** the pressure is too great for the connections. Turning down the flow rate from a main line supply **will not** reduce the pressure.

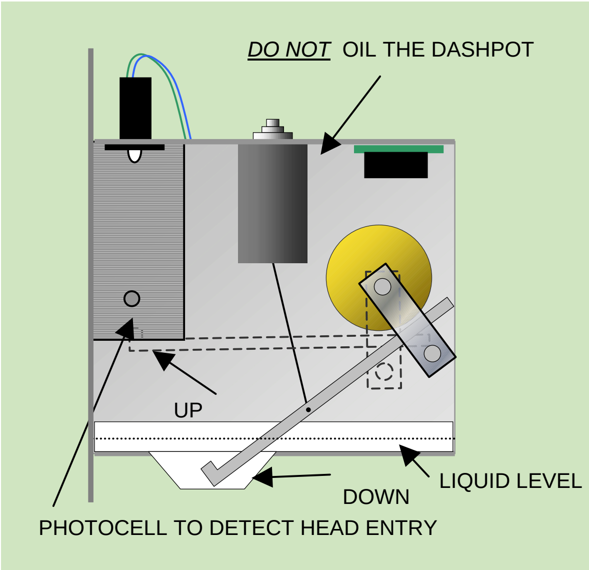
When using the bottle supplied with the unit, place the bottle above the module. Connect the 6-pin connector to a "feeder" connector on the ECB. To set up a delivery quantity, you must **adjust flow rate** and **time-of-actuation of the valve.** The slower the flow rate, the longer the valve must be open to deliver the same quantity. Adjust the flow rate with the hose clamp provided with the unit. Then set your software to deliver the desired volume by adjusting the feeder command time output. **Do not move the bottle to a different elevation after setup, it will change the flow rate due to the change in head pressure.**

SOLENOID VALVE SPECIFICATIONS

Voltage: 24 to 30 Volts (28 Volts nominal)
Coil Operating Current: 400 mA at 28 Volts
Lamp Operating Current: 40 mA at 28 Volts
Quiescent Current: None
Duration: Timed for desired access
Reservoir (Bottle) Capacity: 1 Liter

H14-05M, H14-05R LIQUID DIPPER - 375mA

(This module has provision for mounting an H20-93 photo detector to report head entry.)



Either the Liquid Dipper or the Combination Dipper/Pellet Trough may be used with almost any fluid of appropriate viscosity. It works well with water, alcohol, sugar solutions, milk, and just about everything else.

Connect the 6-pin connector to a "feeder" connector on the environment connection board. The feeder coil (operate signal) must be timed by software for the time necessary for the animal to enter the magazine port and lick the liquid from the end of the dipper arm. It may be desirable to use the detector heads H20-93 Single-Photocell Sensor to detect head entry after turning the feeder coil on and then begin timing after entry to assure consistent "availability" of the reinforcer.

When using a dipper in a cage in a cubicle, it is convenient to put it on the right-hand wall (as viewed from the cubicle door) as the intelligence wall (if only one wall is to be used). This will place the reservoir tray such that the tray may be removed from the side you are facing (the view in the diagram above).

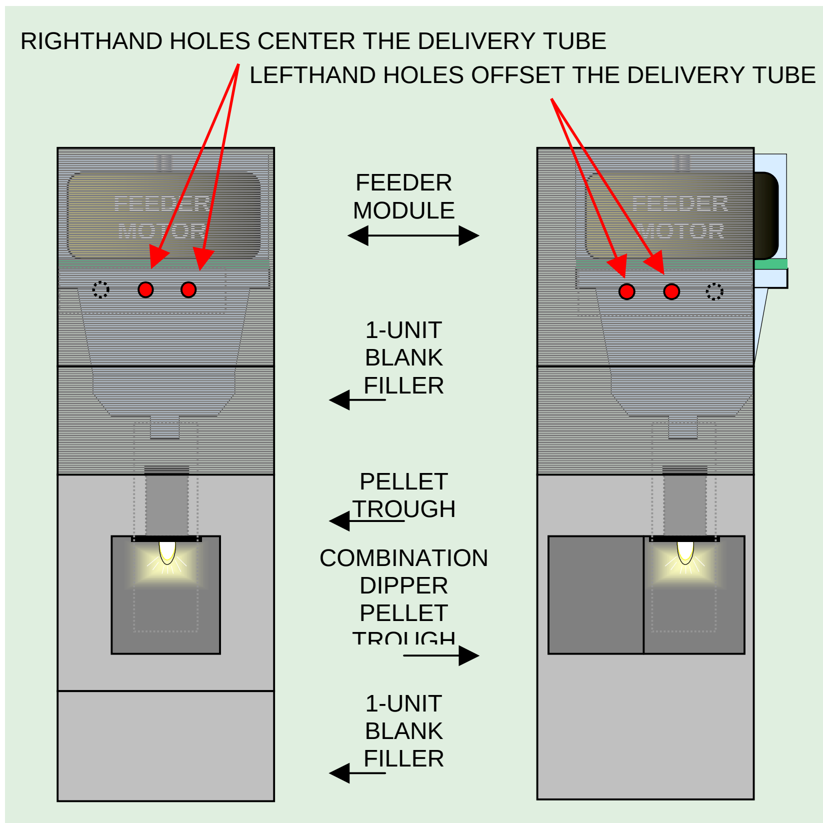
DIPPER SPECIFICATIONS
Voltage: 24 to 30 Volts (28 Volts nominal)
Coil Operating Current: 375 mA at 28 Volts
Lamp Operating Current: 40 mA at 28 Volts
Quiescent Current: None
Duration: Timed for desired access
Reservoir Capacity: 50 cc (usable)

H14-06R COMBINATION DIPPER/PELLET TROUGH - 375mA

(This module has provision for mounting an H20-93 photo detector to report head entry.)

The combination dipper and pellet trough is designed for use when 2 levers are used with both pellet and liquid reinforcements. It permits the centering of both, with the levers on either side. Each access port is the same size as in the H14-01R and H14-05R. The ports are separated with the liquid to the left. The 2 magazine lights are operable independently.

When using an H14-01R Pellet Delivery Trough with an H14-22R-45 Pellet Feeder, the feeder must be centered on the module because the pellet chute is in the center of the pellet trough module. When you want to use the H14-06R Combination Dipper/Pellet Trough with the feeder, you must offset the feeder mechanism on the feeder panel so that the drop tube may be inserted in the pellet chute when you install the feeder module above it.



There are two screws in the center of the panel and three tapped (threaded) holes in the bracket which are used to secure the mechanism to the panel. Remove the screws and screw them into the proper two holes (shown at the top right) for the type trough you are using.

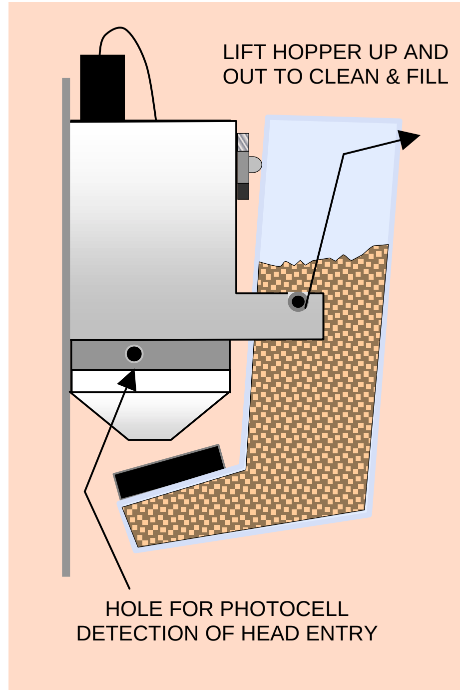
Also note that the H14-01R Pellet Delivery Trough is a 2-unit high module and requires a blank filler module above to space the drop tube properly. The blank at the bottom brings the magazine opening up to “standard” height.

DIPPER CUPS H14-06-CP series

The dipper arm used in the H14-05M, -05R and H14-06R dippers is finished with a .01 cc volume cup machined directly into the end of the arm. For larger than this standard volume, the interchangeable cups may be ordered and attached to the end of the arm. They slip over the end of the arm and are held in place by a small, recessed set screw. The cup and screw are stainless steel. An Allen wrench is provided with the cups. ***Do not remove the dipper arm to install the cups – the arm not only moves upward when operated, but also shifts laterally because the solenoid pulls in and rotates due to its design.*** It is difficult to align the arm if it is removed (it’s a 3-handed job for the inexperienced!).

H14-10R GRAIN FEEDER – 750mA

(This module has provision for mounting an H20-93 photo detector to report head entry.)



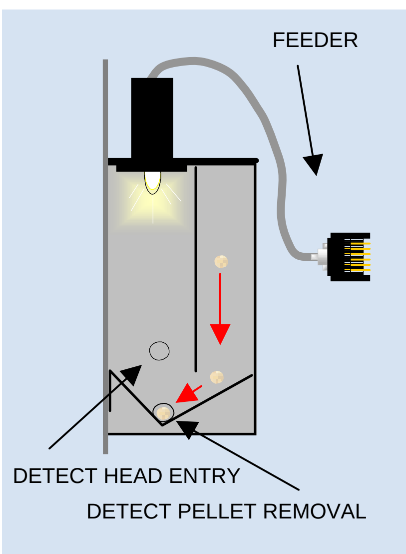
The Grain Feeder is capable of delivering almost any dry food of small, granular structure. It is commonly used for bird seed or extruded, pelletized feed commonly formulated for pigeons. It may also be used to deliver small pieces of other dried feeds such as shrimp.

To operate the feeder, connect it to one of the "Feeder" connectors on the ECB and time the operate signal, allowing sufficient time for the animal to consume the desired amount of food. You may find it behaviorally advantageous to mount detector heads on the unit to permit bringing up the feeder with an operate and starting a timed interval upon head entry to delay the drop to allow the desired access time after head entry. It can be used for monitoring ad lib. feeding when used with the photo detector.

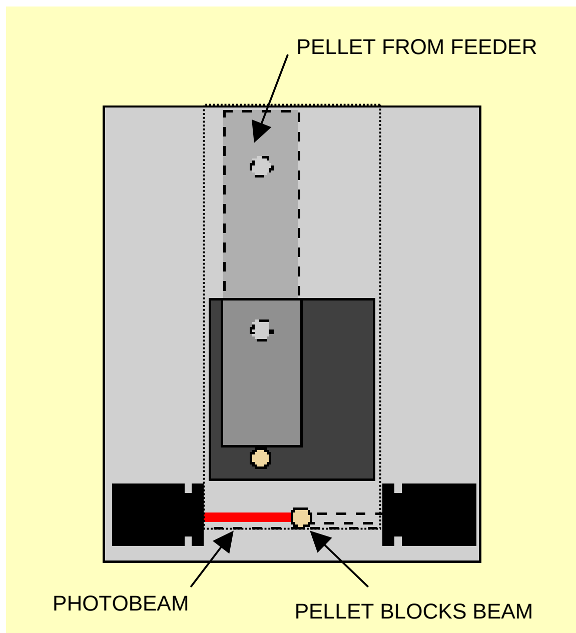
The entire food hopper lifts off for filling and cleaning. Simply lift up until the pivot pin clears the pivot groove in the arm. Then move it rearward so that the bottom is clear of the trough and the hopper is balanced properly.

GRAIN FEEDER SPECIFICATIONS
Voltage: 24 to 30 Volts (28 Volts nominal)
Coil Operating Current: 750 milliamps at 28 Volts
Lamp Operating Current: 40 milliamps at 28 Volts
Quiescent Current: None
Duration: User controlled for desired access time
Hopper Capacity: 230 cc

H14-01M, H14-01R - PELLET DELIVERY TROUGH



(This module has provision for mounting an H20-93 photo detector to report head entry *or pellet removal for automatic take-and-replace feeding monitoring*.)



DETECTING PELLET REMOVAL

The pellet trough is a recessed cup, baffle, and chute which receives the pellet feeder delivery spout. The access port for the rat model is 1-3/8 inches wide by 1-5/8 inches high. Opening dimensions for the mouse model are proportionally smaller. The ports for both are 1" deep with a depression in the center where the pellet comes to rest for easiest access by the subject. A magazine light is installed inside the top of the opening. The unit has two locations to mount the photo detector of the H20-93 - one to detect entry of the subject's head, and the other to detect pellet removal. When a pellet is removed, the detector reports the event for recording and replacement of the pellet. This method is far superior to the load-cell-scale and A/D-converter method commonly employed in many labs today.

H14-22M-20, H14-22R-45 PELLET FEEDERS - 495mA dispensing, 85mA quiescent

The H14-22M-20 uses 20-milligram pellets (or tablets), and the H14-22R-45 uses 45-milligram pellets (or tablets). These sizes are appropriate for mice and rats respectively. The disk in the bottom of the pellet hopper turns ¼ turn for each "dispense" command signal and brings one of 4 holes over the drop tube to drop a pellet into either the Pellet Trough or the Combination Liquid Dipper/Pellet Trough.

The Pellet Feeders require **at least a one-millisecond pulse** at -24 to -30 Volts (-28 Volts nominal) to deliver a single pellet. When used with a Pellet Trough or Combination Liquid Dipper/Pellet Trough, the Pellet Feeder is operated via the "pellet feeder" connector coming out of either as is shown on page 19.

The Pellet Feeders **can be operated continuously** in applications that require the **delivery of multiple pellets**. The control command to deliver a single pellet must be a minimum duration of one millisecond. A one "unit" state duration of 20, 50, or 100 milliseconds in Graphic State Notation will deliver 1, and only one, pellet. To determine the signal duration needed to drop additional pellets (to be in a continuous "burst"), multiply the number of pellets by 560 milliseconds (e.g., 2 pellets requires 1.12 seconds of operation, 3 pellets requires 1.68 seconds, etc.). The number of pellets in each "slew" or "burst-operation" of this type must not exceed 25 with at least a 10-second rest (off time) before the next burst.

PELLET FEEDER SPECIFICATIONS
Voltage: 24 to 30 Volts (28 Volts nominal)
Motor Operating Current: 495 milliamps at 28 Volts
Quiescent Current: 85 milliamps at 28 Volts
Lamp Operating Current: 40 milliamps at 28 Volts*
Duration: 1 millisecond for a single pellet delivery
Motor Frequency: 200 Hz
Hopper Capacity: 2000 minimum (45 mg)
*For lamp in trough or in combination dipper/trough.

NOTE: ***ROUTINE CLEANING OF PELLET DUST***
The feeder must be empty before cleaning. Remove the motor-plate mounting screws on the plate on either side of the motor that attach it to the top plate of the hopper. Lift the motor assembly from the hopper. Clean the hopper and disk with a small brush. Reinstall the motor assembly (on the same hopper, if you are cleaning many units at the same time) making sure the pellet occluder post is toward the front panel.

DUSTLESS PRECISION PELLETS

Bio-Serv
One 8th Street – Suite 1
Frenchtown NJ 08825
TEL: 908 996-2155, FAX: 908 996-4123

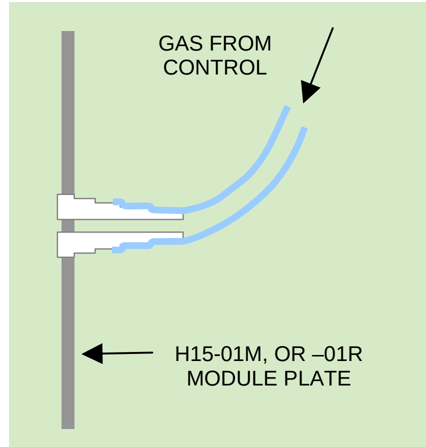
Bio-Serv's Dustless Precision Pellets are nutritionally balanced and virtually dust-free, resulting in hassle-free performance in CI feeders. They are available in both grain-based and purified formulations, and in banana and chocolate flavors in both 20 and 40mg sizes. Nutritional assays and chemical screens are provided to ensure product consistency. Test substances can be added and you can choose from a wide variety of custom flavors, colors and formulations.

In the interest of freshness, Coulbourn Instruments does not stock Bio-Serv products. To order, please contact Bio-Serv directly.

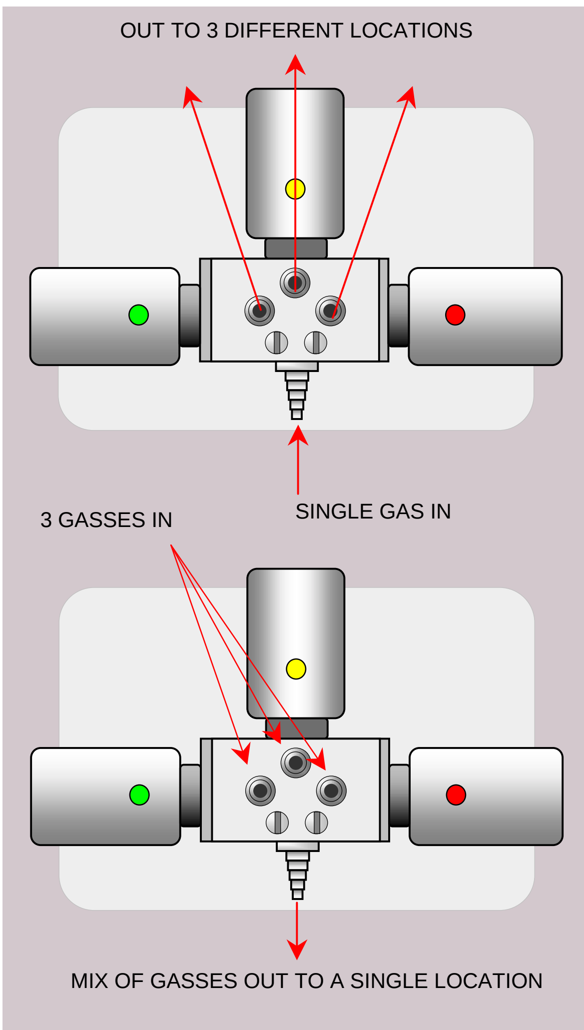
STIMULUS MODULES – OLFACTORY STIMULI – H15-SERIES

All connections for items on this page are push-on barbed nylon fittings for 1/8 inch inside diameter tubing.

H15-01M, H15-01R OLFACTORY STIMULUS INJECTION MODULE



This module consists of a module plate with a small, flush-mount fitting that accepts the tubing from the H15-03 on the rear of the module and allows gases to pass into the animal's working area. It can be mounted in the bottom module position below the floor plane or in any other position. Use an H29-05R Fan Module (page 35) for exhausting arenas.



H15-03 OLFACTORY STIMULUS CONTROL

This unit can **also be used to deliver aversive air puffs** into up to three locations from a common supply. **110mA** for each coil.

The H15-03 contains a 3-unit solenoid valve manifold that permits individually gating or mixing up to 3 gasses (or 2 gasses plus flushing air). Low dead space in the manifold means minimum mixing when changing from one line to another permitting rapid flushing. The manifold is machined from Teflon®.

The solenoids are operated by a stimulus "Cue" from the ECB and each solenoid is marked with a color dot corresponding to the color that operates that valve.

There are 3 tube connection inputs and a common output so that **a single gas, or a mix of 2 or 3, gasses may be routed to 1 location.** The outputs may be connected to the H15-01M or R above, to any feeder magazine or to the H21-09M or R Nose Poke modules to supply gases as discriminative stimuli). The **inputs and outputs can be reversed so that a single supply gas may be selectively delivered to 1, 2 or 3 locations**.

Fittings are available for user installation – contact us for details.

H15-20 INLINE OLFACTANT EVAPORATION CHAMBERS

These chambers have an inlet and outlet barb so that clear air (or other gas) may be passed through them. The volume is sufficient to minimize flow-through dilution gradients for typical cueing presentations.

A small amount of liquid or a swab of cotton with the proper amount of olfactant is placed in the chamber. The olfactant evaporates into the air in the chamber. When the solenoid valve is opened, air (or other gas), bearing the (solute) olfactory stimulus is delivered. With a small percentage of the total volume delivered, the concentration gradient over the flow interval is minimized.

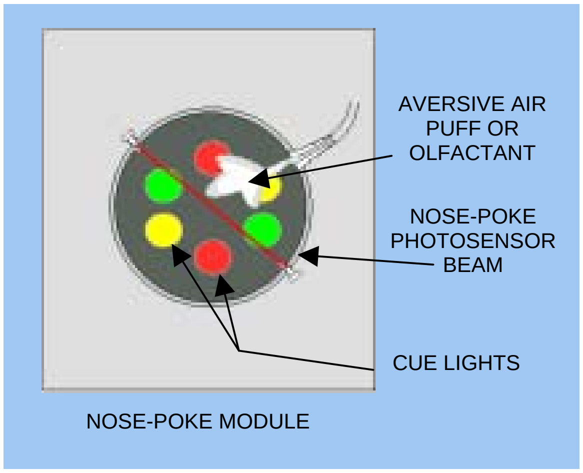
A check valve is supplied with each chamber to be used to prevent back-flow cross contamination of the olfactants in each chamber.

The 3 valved ports connect with a 4th non-valved port in a common, very low-volume chamber. Gases may flow in either direction. You may take 3 gas sources into the 3 valved connections and route a selected single gas or a any mixture of the 3 out of the 4th connection. There are of course 3 single gases and 4 combinations of gases that may be routed to a single location. See page 12 for the use of binary color codes for the state graphic in the software that controls the device.

When using gases as discriminanda in the select/mix mode, generally one of the 3 is plain air for flushing the common chamber, connection lines, and presentation devices (like the nose poke module) or the entire arena if you are using the injection module plate

*The **Olfactory Injection Module** plate is on a single-unit height module plate so that it may be mounted in the bottom position, below the floor so that it does not use up valuable S/R module "working" area (below a lever for example).*

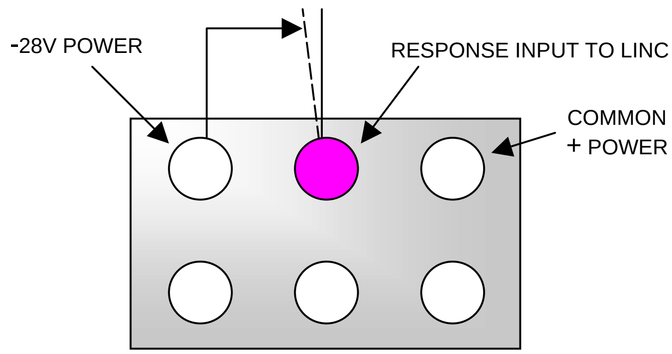
*Gases may be routed to either **Nose Poke** module to present them in a confined area so that the animal must make a response spatially localized with the stimulus. It may also be used to fill a runway and make a task where the animal must "track" an olfactant to the "source" and confirm his tracking by making the beam-breaking nose poke (an operant response).*



RESPONSE SENSORS GENERAL INFORMATION
(INPUT-EVENTS FOR THE ECB AND GRAPHIC STATE NOTATION)

All response detection signals (or input events) generated by the Habitest system are –28 Volt signals. The signal is reported via a “Switch” input jack on the ECB to the Habitest Linc.

Some of the response sensors detect responses using a simple mechanical switch (many years ago *most* of them did; thus the continuing designation on the ECB). Others sensors use modern electronic sensors and signal conditioning of varying degrees of complexity.



RESPONSE SWITCH INPUT CONNECTIONS

The same connector/jack is used as is used for the “Cue” and “Spare” outputs that come out on the bottom 3 pins. One side of the switch is connected to the top-left (–28V) pin and the other side of the switch is connected to the top-center pin to report to the Linc. The top-right pin is the other side of the 28-Volt power supply and provides the common positive for the electronic response sensors as well as the stimuli.

Response sensors are generally “on” for the **duration that the sensor is being acted upon**. For example, when a nose is in an H21-09M or –09R Nose Poke, or an animal’s head is in a feeder magazine which has been fitted with an H20-93 Single-Photocell Sensor and the photo-sensors on either of them are set in the “Continuous” mode. When an animal is in a Nest-Retreat Box or a lever is being held down, the output is also a continuous signal.

Other response sensing devices generate pulses rather than steady signals. They include the Ceiling-Mount Activity Monitor, the Transducer Monitor, and the H21-09M, or –09R Nose Poke or H20-93 Single-Photocell Sensor mentioned above, when their photo-sensor circuits are set in the “Pulse” mode.

BUILT-IN RESPONSE SENSING (POSITION) IN SHUTTLE CAGES

H10-11M-PA MOUSE PASSIVE AVOIDANCE CAGE – Door lifting – **700mA**, holding up, **- 230mA**
H10-11M-SC MOUSE SHUTTLE CAGE – Door lifting – Door lifting – **700mA**, holding up, **- 230mA**
H10-11R-PA RAT PASSIVE AVOIDANCE CAGE – Door lifting **– 800mA**, holding up, **- 128mA**
H10-11R-SC RAT SHUTTLE CAGE – Door lifting – **800mA**, holding up, **- 128mA**

Animal transit and position are sensed and reported by a photocell system built into the cages. You may select “automatic” position-detection and shock-routing to simplify programming, or you may use the E20-95 Photocell Sensor Bar output and create states in your program to “follow” the animal and then operate the shock transfer relays from the states you use to determine its location. The former (“automatic”) is considerably simpler, and the connections for this option are made when the cages are shipped.

When used in this mode, the report switches are relay outputs from the built-in automatic "animal following" logic circuitry, they are **not the direct outputs of the E20-95 Photocell Sensor.** Transit in a shuttle cage is reported uniquely **only when the animal *is* in the "new" side <u>and</u> is *not* in the "old" side** (i.e. not in both sides *during* the time of transit). **Shock is also routed automatically to the side the animal is in.**

A **reset switch** is provided to **clear the memory for the animal-following circuit**. It is mounted on the top of the cage. If the cage is not “turned off”, (that is unpowered) between subjects it will remember where the last subject was. If the next subject is placed in the same side, no change will be registered to initiate state flow if your protocol is designed to “auto start” in this manner.

RESPONSE SENSING, (THE OPENING OF) THE COUPLER W/ LOCKABLE DOOR

H10-37R-LD COUPLER W/ LOCKABLE DOOR – 295mA

This arena and runway coupler has a switch to report the animal's pushing on the door. The switch report (see previous page) is activated when the door is in any position other than "free-hanging" straight down. The report is made either when locked by the latch and pushed, or when it is free and the animal passes through. The switch report can be used to activate the latch (see page 11) when the animal tries to pass. This allows the "correct" door to be "set up" so the sound of the latch operation at the beginning of a trial will not cue the "correct" door. The switch can also be used to report attempts at a "incorrect" or locked door.

The H10-37R-LD Coupler with Lockable Door is an **alternative to the guillotine door** to control access between arenas with the **advantage that it can be locked to prevent passage while at the same time be monitored to record attempts to pass.**

RESPONSE SENSING (TURNING) IN THE RUNNING WHEEL

H10-38R SHOCKABLE RUNNING WHEEL

(Use H10-37R-DP-09W for Extra Drop Pans)

The running wheel features a shockable grid floor, a revolution sensing circuit to count turns, and a drag brake on the axle to allow for control of the force necessary to turn the wheel. The brake is controllable for "on" or "off" by a spare stimulus output of the Habitest Linc.

Revolution counting is accomplished by a magnetic reed switch reporting to the Habitest Linc via a standard response **"Switch" input connector on the ECB.**

The printed circuit board wheel carries the shock stimulus from commutators near the hub to the grid bars around the circumference of the wheel. The grids are the same as all of the rat grid shock floors in the system. Connection is made using a two-pole shock cable for either the H13-01 or the H13-16 shockers.

When the **brake control input is operated by a "Spare" stimulus output** from the ECB, the force necessary to run the wheel is increased from approximately 7 grams to approximately 30 grams (at 30 rpm) at the circumference of the wheel. This force is not an absolute brake to stop the wheel, but represents an effective resistance (in the range of sustainable activity) that increases the effort required to turn the wheel. The resistive (drag) braking force is generated by feedback from the magnetic interaction of the windings of the motor when it is turning. Resistance is proportional to speed, reaching about 30 grams at 30 rpm.

The running wheel may be joined to any runway or the coupler (with or without the lockable door). The coupler *with* the lockable door (H10-37R-LD) may be used to control access. **If you use either of the couplers you can connect a rat test cage directly to the wheel and the two *will* fit in a cubicle.** Access to the wheel may also be controlled by using a guillotine door at one or the other end of a runway.

RESPONSE SENSING MODULES

H10-39R NEST-RETREAT BOX

The Nest-Retreat Box has a floor switch to determine if the animal is in the box. A composite floor stands 1/2" off of the bottom and rests on an adjustable force switch. Weight sensitivity is adjustable by a spring and screw. Adjustment need only be made if the weight of bedding (if available to the animal) or the weight of pups in a maternity protocol, exceeds the weight set at the factory.

It may be mounted in any hub, at the end of a runway, in the rat shuttle cage or test cage. However, owing to its large size, it cannot be mounted with most other modules in the adjacent bays in either of these cages because, unlike the radial array of module bays in the hubs, the bays in the cages are in a single plane. The back wall and floor assembly is removable simply by opening two catches for access to the animal, cleaning, tending and monitoring of pups, or replacement of nest material.

H20-93 SINGLE PHOTOCELL SENSOR

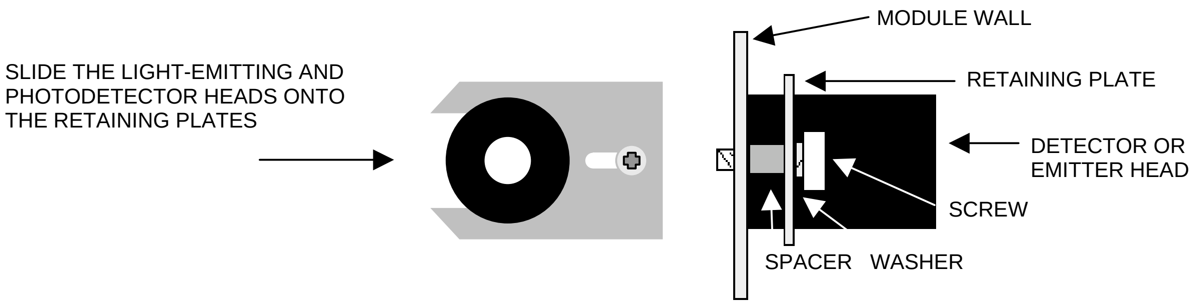
The single-photocell beam-break detector connects to any switch input on the environment connection boards. The board contains all the necessary circuitry to power the infrared LED source and photodetector. Beam breaks are reported as standard switch closures.

An onboard jumper may be positioned by the user to select different modes of operation for each application. You may select a pulsed switch closure at the onset of a beam break for licks using the optical lickometer or a continuous switch closure for the entire duration of the break to sense animal position. You may also select a delayed opening to detect a pellet removal while ignoring bounce upon initial delivery. **The "Delayed" jumper must be in place in *addition* to the "Continuous" jumper.**

The light source and photodetector cell operate in the invisible infrared region (940nM) and each is enclosed in a small, grooved, cylindrical "head" which mounts on the following CI devices:

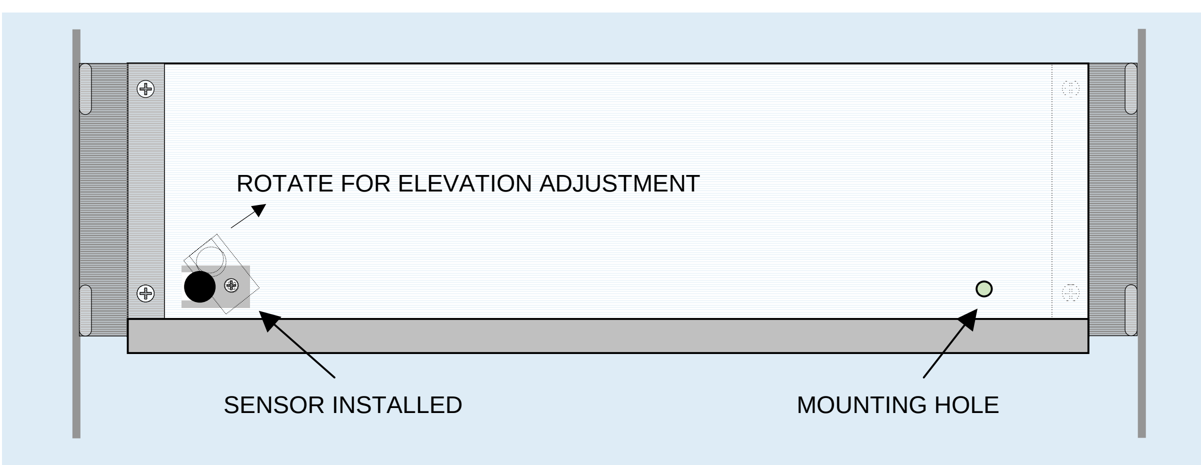
H10-37R-XXX	All Runways
H24-01M or R	Optical Lickometers
H14-01M or R	Pellet Troughs
H14-05M or R	Liquid Dippers
H14-06R	Dipper/Trough
H14-10R	Grain Feeder

NOTE: The H20-93 is part of the H21-09M & -09R Nose Poke modules and need not be ordered separately.



INSTALLATION OF PHOTOBEAM AS TRANSIT DETECTORS ON RUNWAYS.

You may use photobeam detectors to detect entry or passage into a runway. To do this, place the screw supplied with the sensor head through the runway wall from the inside. Then from the outside, place the spacer over the screw followed by the lock washer, the retaining plate and finally the nut. Tighten the nut. Slip the light-source head into the slot on the bracket on one side and the sensor head into the bracket across the runway from the light source. Rotate them to the desired elevation but note that the source and sensor must be at the same angle so the beam is aligned.



H20-95 PHOTOCELL SENSOR BAR

This device consists of separate emitter and detector bars. There are five beams on one-inch centers. The detector bar connects to any "Switch" input on the ECB like any switch-type response sensor. Beam breaks are reported as standard -28V signals if any one of the 5 beams is broken. The LED emitter (light source) bar connects to a -28 V connector.

Because this unit is used only to report animal position, it operates in a continuous mode for the entire duration of the break. No pulse or delayed mode are available as in the H93-03 above.

NOTE: The H20-95 is part of the Rat and Mouse Shuttle Cages and need not be ordered separately.

H21-03M, H21-03R RESPONSE LEVER

This manipulandum is designed for small mammals. H21-03R is suitable for rats, as well as squirrel monkeys and the H21-03M for mice. The switch is a high-reliability, sealed unit. The minimum actuating force of the H21-03R is 25 G, and the H21-03M is 4 G.

H21-05R OMNIDIRECTIONAL RESPONSE LEVER

This is similar to the H21-03R lever except that it can be actuated by pressing off-center in any direction in a full 360^{o} circle. The actuation member is a stainless steel tube protruding .75-inch past the front panel. Actuation force is comparable to the standard H21-03R lever.

H21-09M, H21-09R NOSE POKE OPERANDUM

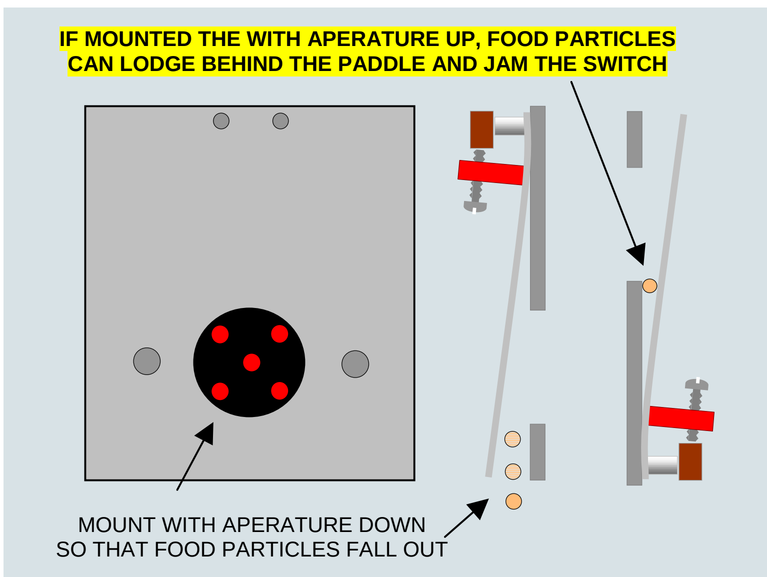
The electronics of the H20-93 SINGLE PHOTOCELL SENSOR above are built into the module. Response detection is by the invisible (940-nM) infrared photo beam across the opening of the hole at the front of the cylinder. The printed circuit board on the module has all of the features provided in the H20-93. A 28-Volt signal is provided to report nose entry to any "Switch" input of the ECB.

Both modules have red, amber, and green LED **cue lights** that are mounted on the rear of the cylindrical chamber behind the key. They are **operated by a "Cue" output of the ECB.** The inside of the chamber is white plastic to scatter the cue light and make it visible from a side-angle view. A gaseous olfactory stimulus connection is affixed to the chamber to receive tubing from the H15-03 Olfactory Stimulus Control.

H21-15R BIRD PECKING KEY
H21-17R KEY W/ 3-COLOR CUE
H21-19R KEY W/ 7-PATTERN DISPLAY

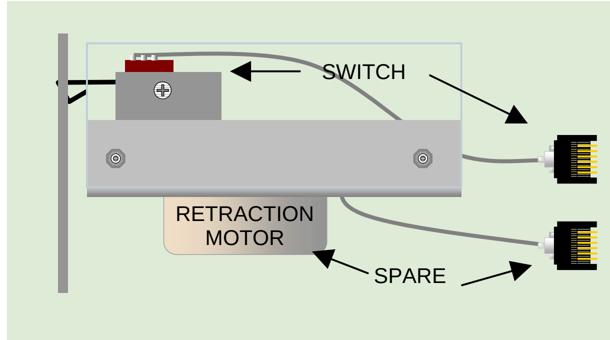
These response keys are fabricated from transparent plastic and fitted with travel adjustment screws. The same module panel is used for all 3 numbers listed. A rear projection screen backs the H21-15R key paddle. The switch is a sealed, highly reliable microswitch type. The minimum force required to actuate all keys is 13 grams.

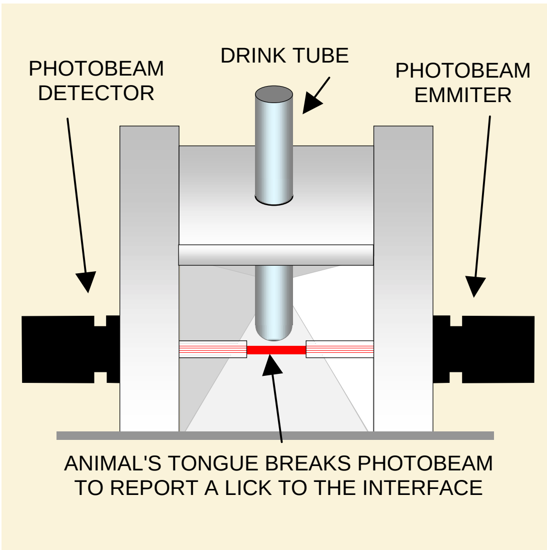
The tricolor cue lights and 7-pattern display lights (shown) both activate on 28 V from a "Cue" output. Refer to the visual stimulus displays on page 11 for patterns.



H23-17M, H23-17R RETRACTABLE LEVER
RAT – 325mA moving, **65mA** quiescent
MOUSE - 110mA moving**, 25mA** quiescent

These levers incorporate the same paddle, switch, force, and throw characteristics as their fixed counterparts (H21-03M, H21-03R - see above). They are fitted with high-speed stepping motors that extend and withdraw the lever. Retraction is activated by a 28 VDC signal via a "Spare" stimulus output. **When the control output is "on" the lever is retracted.**



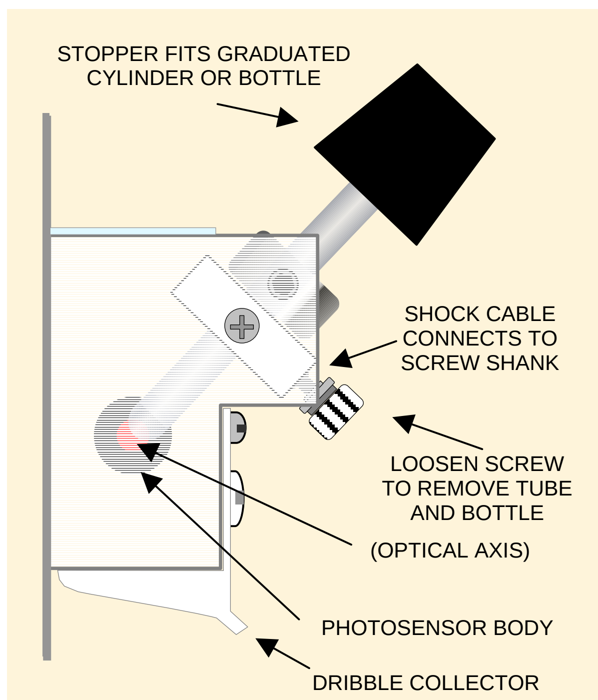


H24-01M, H24-01R OPTICAL LICKOMETER (use also as free access water bottle) **U.S. Patent No. 4373471**

The optical lickometer is used to measure licking/drinking from a standard drinking tube. It is to be used with water or water with solutes that do not significantly change the water's optical density or its viscosity. It requires an H20-93 Photocell Buffer (see pg.28 for mounting). The photo detector's LED source and sensor are mounted on either side of the module. The light beam is "piped" via glass rods to the tip of the drink tube across a gap at the end of the tube. The animal's tongue breaks the beam on each lick. The H20-93 must be set in the pulsed mode for use with the lickometer so that the capacitive coupling can pass relative changes in optical density to assure that licks are recorded even if there is a meniscus from the lips to the tube. Twenty licks per second can be recorded with a formed meniscus in liquids translucent at 940 nM.

The drink tube is mounted in a nylon block and is electrically isolated from the rest of the module. Aversive shock may be delivered through the drink tube for the Vogel procedure (shock/lick suppression) without electrifying the module face or the rest of the cage. Use one of the two-pole shock cables discussed in the shocker section that has the clips on the end. Connect one pole to the tube, and one to the floor with the shorting block provided with the cable.

Licks may be measured while shock or any electrical stimulus is being delivered without spurious current paths or interference.



MOUNTING THE PHOTO DETECTOR ON THE LICKOMETER BODY.

Refer to page 28 for an illustration of the general mounting configuration. For this unit, the mounting screw should be fully at the end of the slot away from the U-shaped detector-head retaining slot in the mounting bracket. After mounting the bracket, tighten the screw slightly and rotate the plate to align it to center the U-slot over the glass rod.

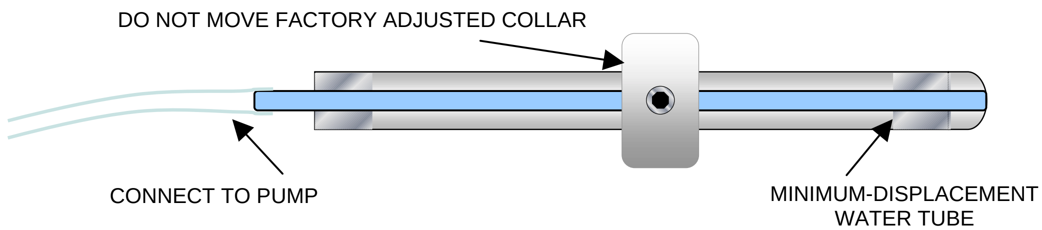
Install the head in the U-slot sliding it fully to the bottom of the slot. Then tighten the screw firmly being careful to not change the alignment.

H24-01-TB-01 SINGLE-LUMEN CONTROLLED-FLOW DELIVERY TUBE
H24-01-TB-03 TRIPLE-LUMEN CONTROLLED-FLOW DELIVERY TUBE

These tubes replace the standard gravity flow tube and bottle. For precision flow control and conditional availability to the animal, fluid is pumped on demand from an infusion pump.

The -TB-01 model has a single, reduced diameter lumen. The -TB-03 model has three reduced lumens in a single standard-outer-diameter tube so that three different fluids may be delivered via the same tube. The tip of the controlled-flow tubes are as close in shape as possible to the standard tube both for behavioral and response measurement reasons.

They differ from the free-flow type tube in that they have needle tubing inside the standard drinking tube with a very small inside diameter to prevent air-replacement flow. The result is that when fluid is not pumped, no fluid may be taken. The outer dimensions are the same however, to insure that the lick topography and the counting of licks are comparable to the standard tube.



OPTICAL LICKOMETER APPLICATION NOTES:

The drink tubes are mounted in a Delrin block and electrically isolated from the rest of the module. Conflict, Lick Suppression (Vogel Procedure), Conditioned Suppression, or other protocols involving shock via the drink tube, are easy to accomplish. Aversive shock may be delivered through the drink tube without electrifying the module or cage walls. To do this, connect one pole of a shocker to the drinking tube with an alligator clip attached to the tube-retaining thumbscrew and the other pole to the (shorted) grid bars of the floor. (See shock cables on page 14, H93-09-25 or –50 and page 18, h93-19-25 or -50.) ***Licks may be measured while tongue or foot shock (or any other electrical stimulation) is being delivered, <u>without spurious current paths</u> or interference because the response is measured optically.***

The tube-holding block and indexing collar are factory-adjusted to place the tip in position relative to the light path for best performance of lick sensing with rats and mice. *The collar on the tube is locked in place so that the bottle and tube may be returned to the same position each time it is removed for filling.* ***IT SHOULD NOT BE REMOVED.*** *The tube, with the attached stopper and bottle, are retained by the tube-retaining thumbscrew in the plastic block. To remove the assembly, loosen the knurled thumbscrew. Remove the stopper and tube assembly from the bottle and fill the bottle. Then replace the assembly, making sure that the locking collar is fully against the Delrin block to properly index the tip of the tube. Then re-tighten the thumbscrew. The tip of the drink tube will be in the same position even if the stopper is neither on the tube, nor in the bottle, in the same position.*

Adjustment is possible in case you are using other species with grossly different response topographies. It is accomplished in two dimensions. One dimension controls the depth of the drink tube protrusion past the Delrin isolation block. The other, rotation, controls the radial position of the tube tip determined by the angle of the block (see the side view illustration). The rotational aspect is locked by means of the two holding screws on either side of the block. Depth is adjusted by means of the locking collar that mounts on the drink tube. The collar is locked into position with a set screw.

For feeding and drinking applications, this device is less expensive than a dipper, but it can only be used when the protocol allows for free liquid access for the entire session unless one of the controlled-flow tubes *above) is used in conjunction with an infusion pump. Use of the infusion pump allows controlled delivery of liquid that can be brought under program control as a function of licking as an operant.*

This tube is purchased as an "extra" rather than as a replacement for the standard tube. This is so that animals can learn to drink from the device using the standard free-delivery tube supplied with the unit without the necessity of using an elaborate protocol involving a pump.

The control of the pump may be on a lick-pulse command basis where each lick results in a very brief command to the pump. The pump may also be controlled on an "episode" drive basis where the pump is turned on continuously for a licking "episode" where the episode definition is "no more than (T) elapsed time between licks". In other words the licks must stop for at least some brief time before the pump will be turned off.

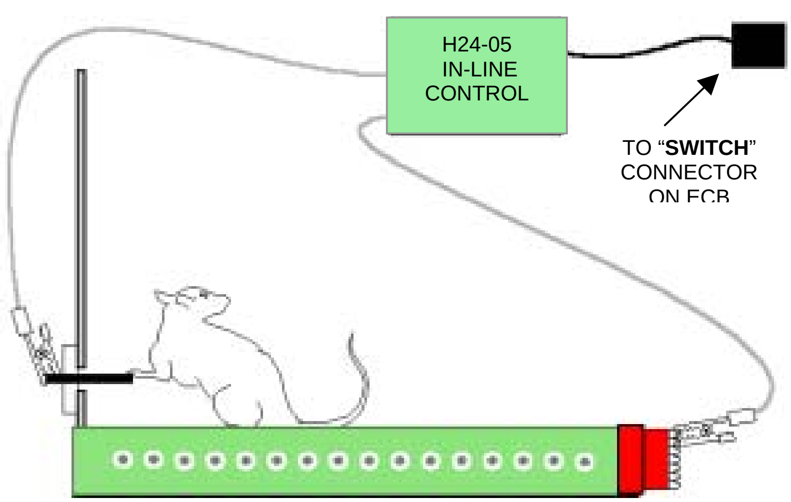
You, as the experimenter, must determine which method is appropriate for your protocol as well as the drive rates and syringe size. Among the things to consider are concepts such as intermittent reinforcement where each lick is an operant and only an "N^th^ lick" results in a drive pulse of sufficient duration to deliver a quantity of water to be ingested in a single lick. Another protocol may embody the concept of cued availability of "free-access" drinking for some period or periods of time in the experiment run and employ either the lick-pulse mode or constant drive, episode mode.

The dribble collector is generally not necessary for rats and mice as these species spill little or no liquid from this device; but it is a simple matter to place a jar lid under it to be sure.

H24-05 CONTACT SENSOR
(For both rat & mouse.)

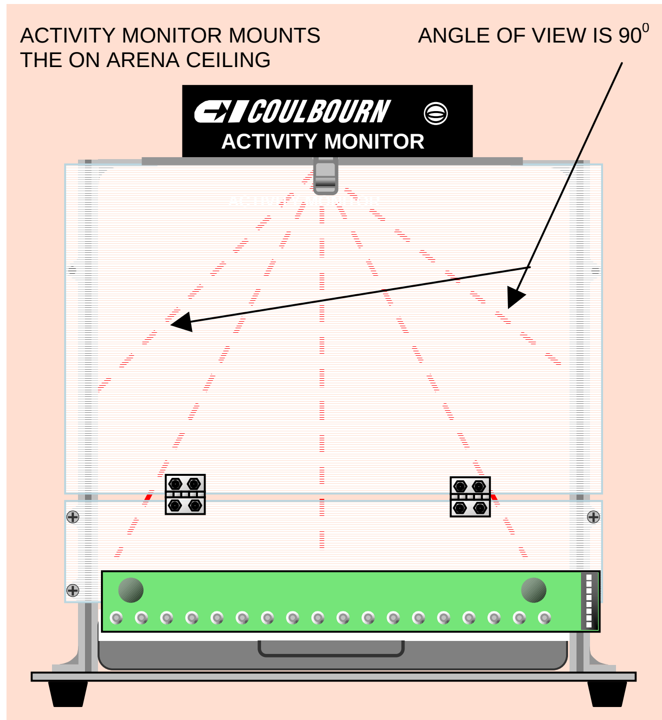
The contact sensor is an electronic switch that senses the passage of a very low current through the subject. The current level is less than 5 microamps and is well below sensation threshold. The standard response sensor connector on the unit connects to any switch input on the ECB just as do levers etc.

The sensing leads may be connected to any two conducting parts of the environment. When the subject touches both, completing contact, the switch reports the response. Generally, the grid floor is one pole (all of the grids shorted together by the special grid floor connector supplied with the unit) and another, isolated, object is the other pole. This device may be used to sense animal contact with novel stimulus devices mounted on a module. You can make your own using blank plastic module plates (H90-00R-P-2.0 or -4.0). You may also hang things from the cage ceiling, or sit them (on an isolated pad or base) on the floor.



H24-61, H24-61-MC INFRARED ACTIVITY MONITOR (For both rat & mouse.)
H24-61-MC SUSPENDED CEILING KIT FOR MOUSE CAGE

This detector mounts on the top of standard test cages, shuttle cages and the hubs. It mounts in the standard ceiling-hole array on the tops of these arenas. An optional **suspended ceiling kit is available (H24-61MC) for the mouse cage to lower the sensor for increased sensitivity.** The kit consists of a false ceiling plate to hold the H24-61and 4 blank module plates with pins to support it. The plates, like any module, may be mounted at various elevations.



The wide field of view will detect animals while rearing or leaning on a wall. It can see both rats and mice in this posture and senses movement at any elevation in the cage. For flexibility in defining the response for program control and data acquisition purposes, a selector switch permits the user to choose either of two output modes. You may choose **movement units** (brief pulses representing the minimum resolution of detection), or **movement episodes** (a continuous output for the entire duration that movement units occur with inter-event intervals of less than 400 milliseconds).

The dual element, differential detector senses the emitted infrared **body-heat image** of the subject (13nM infrared radiation) through an array of lens facets that create **a field of multiple images** on the two detector elements. Any **relative change in the energy** falling on the elements is defined as a **movement unit** and results in a 12 ms, -28V- pulse output closure (in the "unit" mode) at the output to be routed to the Linc via a "Switch" connector on the ECB.

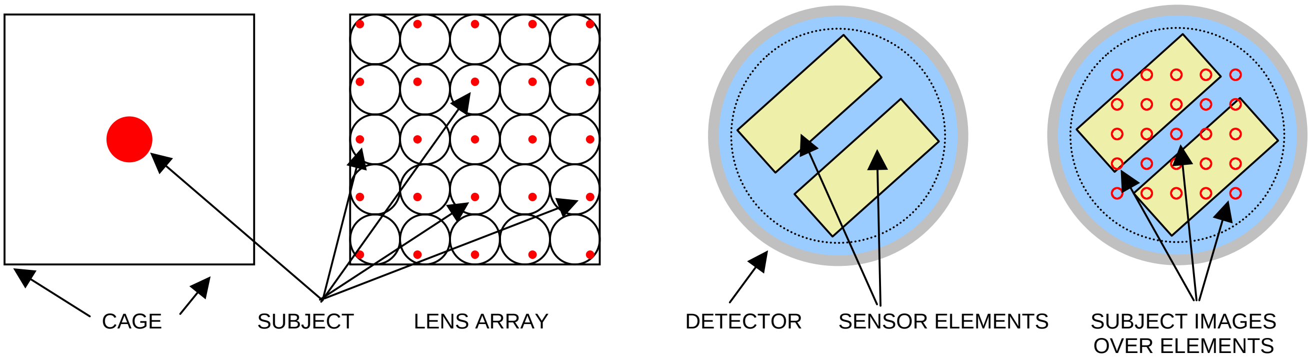
This design gives excellent sensitivity, linearity, and inter-unit consistency, because a variable pulse rate, where each pulse represents a uniformly (time - space) defined movement-unit produces the magnitude measurement (pulses per unit of time).

The clear plastic Vivak® comprising the cage walls is opaque to 13nM radiation. Therefore, interference from outside moving heat sources (e.g., the experimenter) is not a problem. All electronics are on board so that the unit connects to a standard "Switch" connector of the ECB.

Installation and Operation
The H24-61 is supplied with two thumbscrews. The sensor window is placed with the lens facing down into the cage over the large hole on the roof of the rat modular cages, the lids of the hubs, or the H24-61MC suspended ceiling for the mouse cage. The thumbscrews are inserted through the small holes near the large lens hole and then tightened to secure the unit.

Dimensions: 10.16 cm x 15.24 cm x 3.81 cm (4 inches x 6 inches x 1.5 inches).

Monitoring the change in position of its infrared body heat image is accomplished by using a dual-element, 13-nanometer infrared heat sensor in conjunction with a multiple-lens array. The array "looks at" the subject and focuses the multiple images (one for each lens in the array) on the sensor's active, heat sensitive area. Assume that the red spot in the diagram below represents an animal in the center of a cage or other "working" arena. Each lens element sees the spot from a slightly different perspective. The sensor has two far-infrared photosensor elements connected together as an AC-coupled differential amplifier so that it has maximum sensitivity to differences in the changes in light (heat) energy falling on the two elements.



With the array of images from each lens focused on the sensor, any movement results in a change in infrared energy falling on each element because each image partially or totally falls off of one, or comes onto the other, of the elements. Each image's slightly different displacement increases the relative change caused by a subject movement. The sensor's output signal is amplified and used to trigger a "movement unit" pulse for each edge transition. Since the lenses are Fresnel type and have a non-critical focus (relatively great depth of field), the unit may also be used in large-area applications including open field mazes, primate chairs and cages, and even room-sized fields with humans.

NOTE: *A movement unit is dependent upon image size and distance of the movement. The time/distance constant depends on viewing distance and the actual size of the subject (image area on the sensor), so an actual spatial velocity specification is of little use. This also means that data for grossly different sized or species of animals is not comparable.*

The H24-61 monitors movement in the x, y, and z axes. Z-axis movement is detected both because any movement up a wall is seen as radial movement, and because central vertical movement is seen as a change in size. It will detect rearing of mice (with the optional suspended ceiling kit - H24-61MC), and some smaller movements (grooming etc.) of rats.

The maximum rate of movement-unit pulses cannot exceed 50 pulses per second. A rapidly moving animal making very large movements can produce a pulse rate of up to 15 or 20 pulses per second. Even at these rates, Graphic State software can handle 16 stations simultaneously along with automatic-pellet-replacement feeding monitors and optical lickometers even while running other complex, interactive protocols.

There is also a switch to select a high sensitivity for smaller subjects such as mice, and a lower sensitivity for larger subjects such as rats. These settings are referenced to our standard cages. When using larger subjects and/or different environments, select the sensitivity that gives the best dynamic measurement range.

This activity monitor is also available for use on banks of rack-mounted home cages where there is no clearance for ceiling mounting the sensors. Special sensors with a different lens geometry are used in this system to "normalize" movements in the front and rear of the cage when it is viewed from the front.

Variability between sensors is typically less than 5% when factory adjusted using our E61-03 calibrated, motor-driven target. The target is one inch in diameter, four inches long, and held at a constant temperature of 40°C to 41°C (104°F to 105.8°F) by feedback control to simulate body heat.

H25-01 CEILING CHAIN (For both rat & mouse.)

The Ceiling Chain mounts on top of the operant cage, the shuttle cages, and the hexagon, octagon or dodecagon hubs. It may be used for a simple operant response for escape, avoidance, or positive reinforcement.

The bead-chain climbing response is ideal for escape designs. Hanging on the chain to avoid grid shock is useful in fatigue and motor studies. When the animal pulls or climbs on the chain, the switch closes and reports the response to one of the “Switch” inputs on the ECB.

The chain is corrosion- and chew-proof stainless steel; and is long enough to reach the floors of the cages and hubs. It may be cut to the desired length.

H25-06 UNIVERSAL CEILING-MOUNT BUMP ROD (For both rat & mouse.)

This unit mounts on the ceiling of the operant cage, the shuttle cages, and the hexagon octagon or dodecagon hubs in the same manner as the chain. It reports a response to one of the “Switch” inputs on the ECB any time the stainless steel rod is moved off plumb in any direction.

The rod comes down to within one inch of the floor of the test cages and shuttle cages. It may be cut for use in the hubs, which are not as tall as the cages.

ACCESSORY MODULES

H21-01 HAND (SHAPING) SWITCH (For both rat & mouse.)

The hand switch is used for experimenter control and hand shaping. It has a standard 6-pin module receptacle in parallel at the end of the cable for connecting any response sensor module in the arena if desired. This allows **either** the experimenter's switch **or** the animal's response switch to report a closure. It connects to one of the “Switch” inputs on the ECB and has an 8-foot cable so the operator may sit well back from the arena.

H21-02R, H21-02M EXPERIMENTER’S MANUAL SWITCH MODULE

This switch mounts in the bay tracks of any arena like any S-R module but the switch is on the outside of the arena where it may be pressed by the experimenter. It is connected to one of the switch inputs on the connection panel. Use this switch when the starting of an experiment must be accomplished as soon as the animal is placed in the arena rather than from the computer and Linc location.

H29-01 BALANCE ARM (FOR ALL TEST CAGES)
H29-01HP BALANCE ARM MOUNTING PLATE FOR HUBS

This device mounts directly on the roof of any H-series cage or on octagon or hexagon hubs with the mounting plate. It is used to carry electrode leads, catheters, swivels and commutators. The balance weight on the arm may be moved like a counterpoise to balance the lead or electrode weight (slightly negative) and then locked in place.

H29-05R, H29-05M FAN MODULE

The fan module is used to boost air exchange from any runway, hub, or cage. It is generally used for olfactory studies to ”flush“ air from the arena in the vicinity of controlled olfactory stimulus delivery devices or to keep ”free flow“ olfactory stimuli in multi-arena environments from mixing.

H10-37R-GDM, H10-37M-GDM RUNWAY GUILLOTINE DOORS

These manual doors consist of a metal plate with a finger hole at the top. They slide into a slot in the bracket that joins the wall to the faceplate at the end of all runways. You may use them simply as manual doors to open or block certain segments of complex working arenas by using the finger hole to lift them (see below). They are also useful when using a goal box runway as a “start” box to permit the animal to be introduced to the environment for a waiting or adaptation period and then be released into the main working environment without handling variables when the experiment starts.

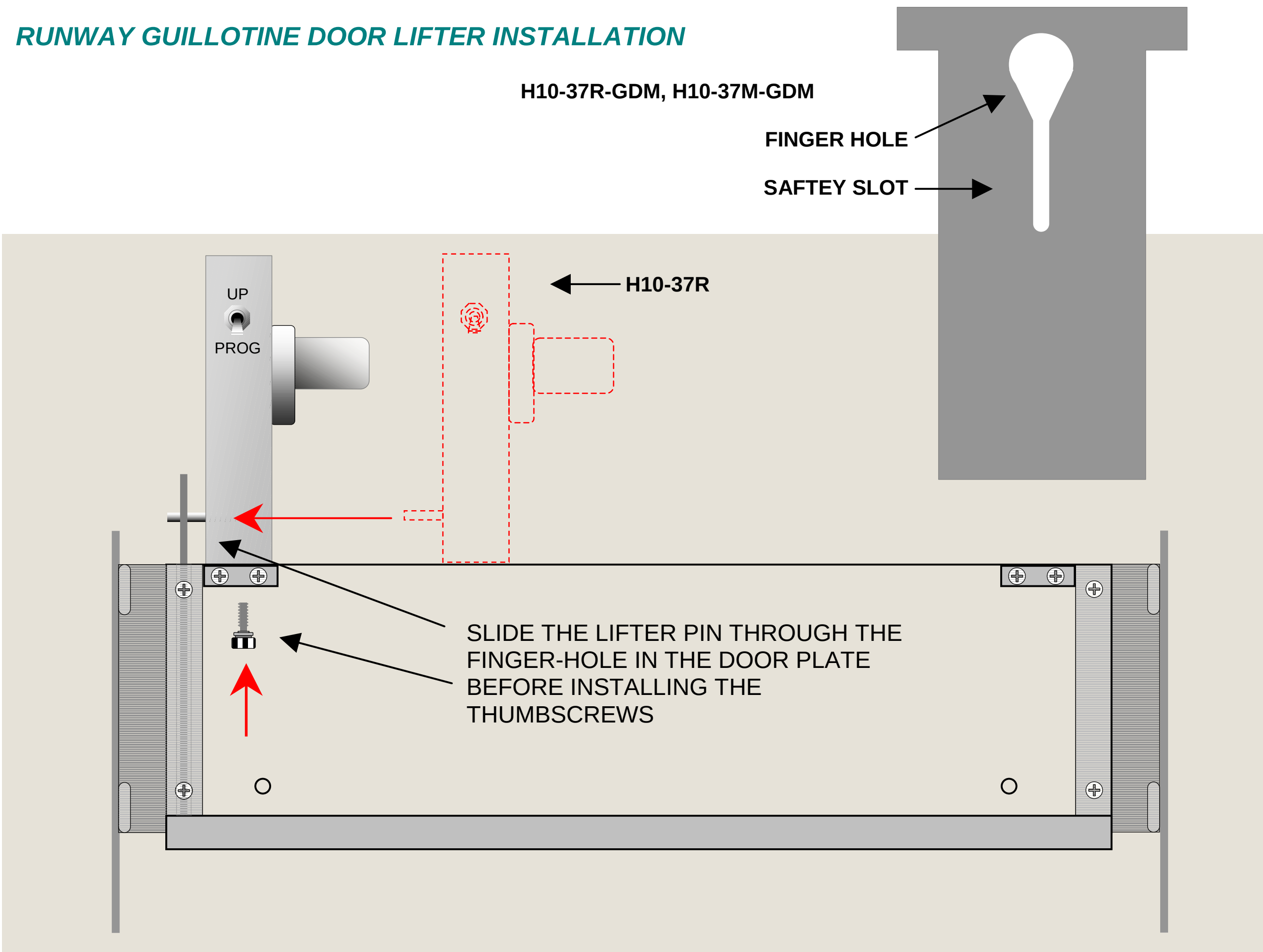
The manual doors may be lifted automatically by the optional universal door lifting mechanism H10-37 below. The lifter may be added at any time to automatically lift doors that you have been lifting manually without any change in the environment from the animal’s perspective.

H10-37 RUNWAY GUILLOTINE DOOR LIFTER

This device may be mounted on any rat or mouse runway to lift an H10-37R-GDM or H10-37M-GDM Manual Guillotine Door (above). It mounts with two thumbscrews on the bridge-bar at either (or both) end(s) of any runway. You can add the lifter at any time after you purchase the manual door. A lifting pin fits into the hole in the door to lift it; but when the door pin goes down, the door will fall freely. The slotted bottom of the hole allows enough free travel for the door to rest on the animal’s tail or back as a safety measure. It will then fall closed when the animal is clear.

The lifter may be programmed by any spare or other stimulus output (see page 11).   When the stimulus is on, the door is in the up position. By placing the switch on the side of the case in the “UP” position the door will not respond to programmed outputs and will remain in the up or open position.

RUNWAY GUILLOTINE DOOR LIFTER INSTALLATION



ACCESSORIES TO THE HABITEST & TRU SCAN SYSTEMS

A21-10 LIGHT INTENSITY (AND COLOR) CONTROLLER

This device may be used with any lamp (LED or incandescent) rated up to 1 Amp in the Habitest system. It connects to any TRIPLE CUE or a SPARE (single cue) module at the environment (see pages 7 & 11). It is controlled by a spare output (to provide –28 Volts) and an analog output (to provide the proportional signal) from the back of the Linc. (It can also be used to control magazine lights.)

The 1-Amp, -28-Volt signal provides a reference for a power driver which is driven by a retriggerable one shot driven, in turn, by a voltage controlled oscillator. The net result is that the higher the voltage is on the analog input, the faster the one shot fires. Since these things happen far faster than flicker fusion, and the period of the one shot is fixed, any lamp (LED or incandescent) driven (via a driver) from the one shot changes in brightness as the frequency goes up.

The center knob simply controls the routing of the signals. The first 3 positions route the signal from the “one” output of the one shot to the RED, YEL, and GRN lamps of a triple cue. The light varies from black to the selected color or lamp chosen. In the case of a spare with a single cue lamp, the only position that will work is the YEL position. When the last two positions a chosen, RED to YEL or RED to GRN a smooth transition from red to either one of the two colors will occur because the “zero” output of the one shot provides the complementary signal. The color shift with complementary signals will be continuous and linear (for narrow band sources like LEDs) as will the duty cycle controlling brightness of single lamps.

Since the color shift and brightness shift are used with many types of lamps and LEDs, no attempt has been made to create a table in the analog output section of the Graphic State software relating to *perceived* brightness (Stevens power function etc.). After all, this is not psychophysics it is just cueing. Rather, 0-250 Millivolts from the AD selection table will produce 0 to full duty cycle in a linear transition from 1/10,000 brightness at 0MV to full brightness at about 249 MV.

It is used in the 5-Bay test cage as a discriminanda for slight changes in brightness or color. Here five brightness controllers and five tricolor nose pokes are used for the subject to select oddity as an attention task varies stimulus properties.

Another application is the control of brightness of the start chamber of the shuttle cage in the passive avoidance task. Here the high bright cue lamp is driven by the BLK to YEL selection of the controller to vary the brightness of the start side.

These two applications illustrate the use of both LED and incandescent lamps as well as the use of modules fitted with both triple and single cue lamps.

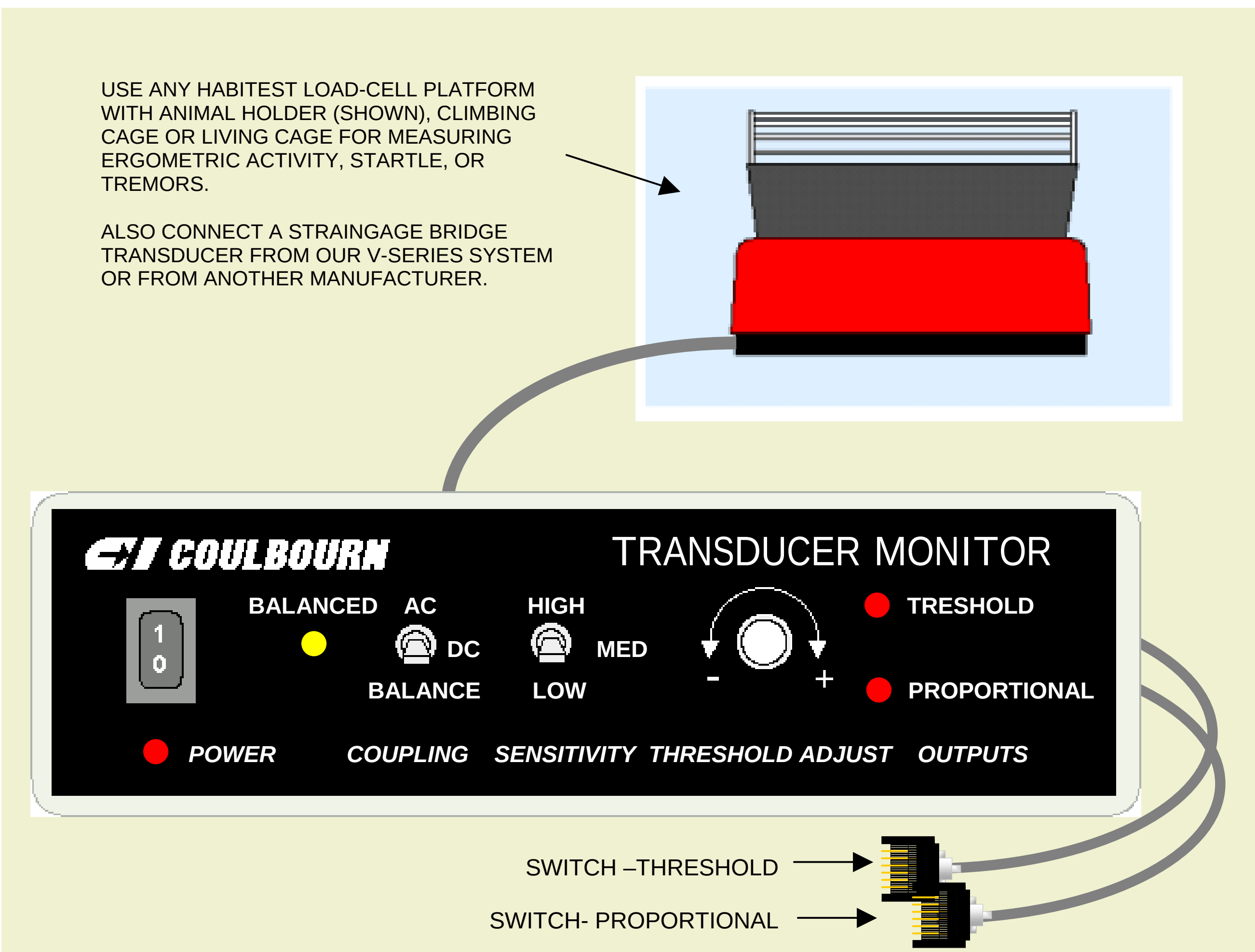
A24-72 - RESISTIVE BRIDGE TRANSDUCER MONITOR

This device allows any resistive bridge transducer to be used in the Habitest system. It has two standard response-switch outputs, one for **threshold** detection, and the other for a **serial-pulse proportional** output.

The **threshold** output is on when the transducer is above a user-selected setpoint. This function is comparable to a comparator or signal level trigger. It is used for setting force, pressure, or other threshold requirements to produce an event-type input.

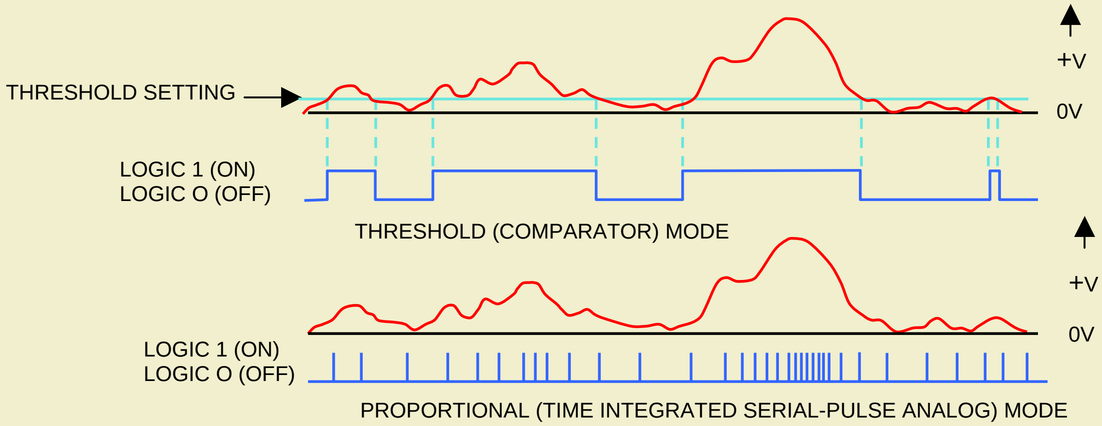
The **serial-pulse proportional** output is a serial-pulse analog-to-digital converter employing time period integration. This function is comparable to a cumulating-resetting integrator. It is used to record ergometric-aspect behaviors in a time-amplitude, integrated mode. It may be used with any bridge transducer, but is most commonly used with the Startle-Tremor platforms for ergometric activity or with a stand-mounted transducer.

The proportional output produces a pulse stream, the frequency of which is proportional to the magnitude of the signal from the transducer; more force, more pressure, etc., the faster the pulses (typically from a few per second up to a maximum of 50 per second). This is an ideal method of bringing magnitude data into a behavioral software package which is, after all, event-rate oriented for contingency structures. The output pulses represent a number of Newton/seconds of force applied (or other time integrated units for other transducers).



A24-72 - RESISTIVE BRIDGE TRANSDUCER MONITOR
Specifications
Common Mode Rejection: 100 dB Min. (DC - 60Hz).
Noise: RTI - 1 Hz - 1000 Hz, 0.4mV P-P Max.
Bridge Excitation: 5.0 Volts
Coupling / Frequency Response:
DC Coupled DC - 1500 Hz, +/- 3 dB
AC Coupled 1 Hz - 1500 Hz, +/- 3 dB
Balance Control:
Auto Balance: Pressing down initiates autobalance.
Balance Precision: ±32 mV of center of 5 V range.
”Balanced“ LED: Indicates successful autobalance.
Sensitivity Control: 3 Ranges
Accuracy: ±2%.
Digital outputs: Switch closures to -28V.

ANALOG RESPONSE SENSING NOTES



CONVERTING ANALOG SIGNALS TO EVENTS

Some of our behavioral response sensors (as well as other transducers) provide information about the (analog) magnitude of certain types of behaviors. The A24-72 Transducer Monitor reduces that analog information to a series of pulses that vary in rate so that they may be handled by the interface as event-like inputs. The pulses represent "units" of behavior and are handled the same way as if they were discrete events, like those defined by the binary (“on-off") nature of a response device like a lever.

Discrete on/off events, *specifically, lever presses, runway entries, nose pokes, etc are just like the analog* ***"threshold" events*** *in the upper "trace" of the figure on top of the page. Circuits which* ***detect the level*** *(magnitude or amplitude) of an analog (cursive or proportional) signal are variously known as* ***comparators, level detectors, Schmitt triggers or threshold detectors.*** *These events are just like lever press events except that the Transducer Coupler threshold function defines the “switching point” rather than the spring and metal contacts of a lever or the breakage of a photobeam.*

The comparator function of the A24-72 Transducer Monitor will detect the point at which an analog signal from a transducer exceeds a given (user-set) level and "trigger" giving a signal which is "on" (above the setpoint) or "off" (below the setpoint). This type of circuit is actually a one-bit analog to digital converter. The output is represented as a single bit on a single wire rather than as a multi-bit binary code using a greater number of wires. This function will convert an analog signal to a discrete “input” event for the Linc interface.

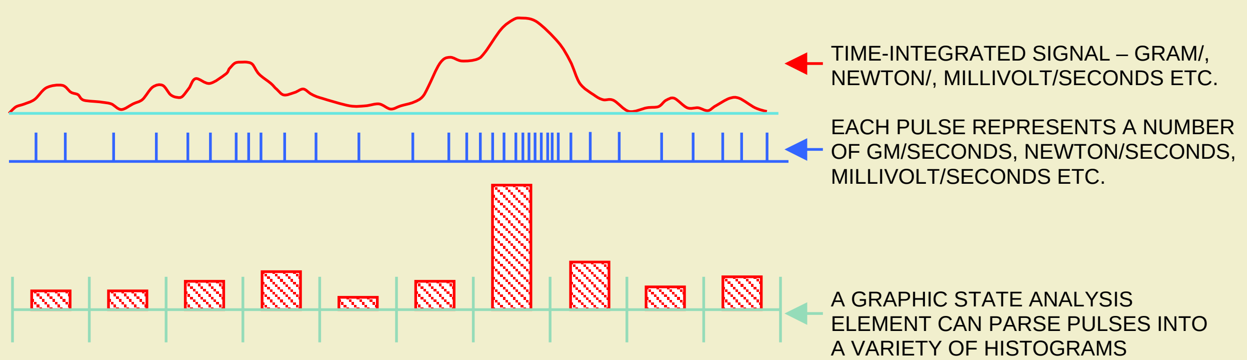
The user selectable analog level is part of the event definition, somewhat analogous to tightening a spring to increase the force required to trip the switch in a lever.

*The threshold function allows you to use Graphic State to record the **number of times the signal**, which may represent force, temperature, acceleration, etc., **went above a value of your choosing.***

Either type of event,** the mechanical threshold of a switch closure or an electronically set threshold point on an analog signal **is a "discrete" event.** If you have an **analog signal** that you wish to record with **more precision or resolution** than simply as an "above-or-below-setpoint" event, you may easily do so with the monitor. Such measures are made by using a time-integrated unit of an analog (proportional) measure as is illustrated in the lower "trace" of the figure on the previous page and in the figure below. Doing this you can easily measure the magnitude of analog signals as event pulses in an event-based behavioral control system such as Habitest. This method of analog-to-digital conversion is known as **"time-integrated, serial-pulse A/D conversion".

Converting the pulses into units of measure like gram/seconds is done automatically by Graphic State Notation. It has point-and-click tables for our platforms and transducers that you select when you create a data analysis element (computational element) to tell the program what conversion factor to use. (This is more fully covered in the "Graphic State Notation User's Guide".)

Time integral (or "serial pulse analog") measures that are useful in the analysis of behavior include things like: 1) Ergometric force applied either to a force transducer like an ergometric activity/tremor platform or to a



CONVERTING ANALOG SIGNAL REPRESENTING RESPONSE MAGNITUDE INTO DISCRETE-EVENT PULSES AND DISTRIBUTING THEM OVER TIME

climbing-cage wall. 2) Aneroid pressures. 3) Force applied to press plate, key or lever. 4) Moving an accelerometer. All can be measured as a series of pulses having an instantaneous rate or frequency (conversely, period or IET), which is proportional to the rolling average of the measure's amplitude. For proportional analog measures performed in behavior analysis, this is the preferred method because the spatial-topographic and temporal nature of overt behavioral responses are not suited to periodic, instantaneous sample by multi-bit A/D converters.

***If an event is to be proportional, it must be designated as such in the event name list and bear the "P" prefix.** To record these types of signals and present your data in units of measure corresponding to the transducer, double click on the event-name box in the top "create-a-protocol" window. Then scale your graphs by selecting the **"proportional"** option for that event (this will also append the "P"). A pop-up window will appear for you to specify the units of measure that the event represents. Here you select units such as gram/seconds or Newton/seconds for force, PSI or Pascal/seconds for pressure, g/seconds for acceleration or other amplitude-time integral units.*

*This is very simple to do when you are using **Coulbourn Instruments (or similar) transducers and our E24-72 Transducer Monitor.** In the "event type" box, click on the button labeled "proportional" to select the* *unit of measure. This will change the default unit from a discrete named event to a proportional one. It will also bring up a window with a chart of (our) transducers by model number. The chart for each has one or more units of measure for the type of energy the transducer measures along with a box to select the setting you have already made or will make on the switches on the transducer monitor.*

Here you may select the transducer model number, the units of measure desired and the sensitivity setting on the monitor. When you create a data analysis element, the data presented in your event lists and graphs will have the selected datum name and will be automatically scaled for the sensitivity and range of the transducer and the setting on the interface monitor. Your event graphs will bear the datum name you selected ("activity", etc.) with the associated proportional units of measure ("Newton/seconds" etc.).

Both our E24-72 Transducer monitor and our E24-61 Ceiling-Mount Activity Monitor are capable of pulse rates well above 10 per second. The Transducer monitor is capable of rates up to 50 per second.

A28-21 MOTOR SPEED CONTROLLER

This device was originally developed to control the speed of our Roto Rod but will be used for other motors in the future and become a general-purpose motor control as time goes on.

It may be used for any one of the three speeds available in the Roto Rod motor according to the chart below.

The spare input is the pickup for the –28 VDC that drives the motor. The analog lead that drives the control input is provided with the unit and is connected to the analog output on the back of the Linc.

The motor control lead on the motor is connected to the jack labeled "MOTOR OUTPUT" on the right of the unit.

SPEED/CONTROL VOLTAGE CHART

Q3	Q2	Q1	Analog Input (V)	(30 RPM) ~SPEED	(45 RPM) ~SPEED	(60 RPM) ~SPEED
0	0	0	0	OFF	OFF	OFF
0	0	1	.53	5	8	12
0	1	0	.75	7.5	12	17
0	1	1	1.09	10	15	26
1	0	0	1.43	15	23	35
1	0	1	1.72	20	30	42
1	1	0	2.08	23	35	48
1	1	1	2.5	25	45	60