



# **LCC2-33 Dual-Channel Liquid-Crystal Controller**

## **User's Manual**

Manual revision  
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## ***Description & Specifications***

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The LCC2-33 is a versatile, dual-channel liquid-crystal controller, designed to run continuously-variable liquid crystal (LC) devices such as variable retarders, polarization switches, shutters, attenuators, and tunable color filters. LC voltages up to 33 V<sub>RMS</sub> are controlled by two amplitude knobs. The rugged output stages of the LCC2-33 can drive cells up to 900 nF capacitance, and will withstand continuous shorts while recovering automatically when the short is removed. Outputs can be toggled between two preset amplitudes by either external or internal trigger.

### **Features**

- 2 kHz balanced AC waveform generation up to 33 V<sub>RMS</sub>
- Drives large-area cells up to 900 nF of capacitance
- Two 10-turn front-panel knobs for amplitude control
- Dual BNC and SMA connectors for LC outputs
- Automatic full-recovery short-circuit protection on LC outputs
- Switch-selectable External or Internal Modulation; Internal Modulation rates from 0.5 to 50 Hz
- RoHS compliant

### **LC OUTPUT & INTERFACE**

Number of LC channels	Two, with dual-connector outputs
Output waveform	Bipolar DC-balanced square wave
Carrier frequency	2.00 ± 0.02 kHz
Amplitude range	0.0 to 32.0 V <sub>RMS</sub> guaranteed
Amplitude control	Two 10-turn amplitude knobs, assignable to either LC output. Toggling between amplitude configurations determined by operating mode.
Residual DC	< 5mV at any amplitude level
Operating modes	<ul style="list-style-type: none"><li>• Manual</li><li>• Internal Modulation (rate controlled by Internal Frequency knob)</li><li>• External Modulation (with external TTL logic-level source)</li></ul>
Internal Modulation rate	0.5 to 50 Hz, 50% duty cycle
External Modulation	TTL logic-level controlled (arbitrary duty cycle), asynchronously to 500 Hz. Logic HI = “straight-thru” configuration, logic LO = “crossed” configuration
External Modulation latency & jitter	Configuration switching latency less than 200 ns after External Modulation logic-level change, jitter less than 20 ns

Drive capability	Outputs can drive cells up to 900 nF capacitance
Short circuit	<ul style="list-style-type: none"> <li>• Full-recovery short-circuit protection on LC outputs</li> <li>• Front-panel “Fault” LED will illuminate when output is shorted</li> </ul>

## PHYSICAL

Dimensions	5.5 in W x 6.0 in L x 1.6 in H (14.0 cm W x 15.5 cm L x 4.1 cm H)
Weight	2.0 lbs (0.9 kg), controller + power supply
Chassis material	<ul style="list-style-type: none"> <li>• Black anodized aluminum, rubber bottom feet</li> <li>• Machined aluminum front &amp; back panels, black-anodized and laser-etched</li> </ul>
Front panel	<ul style="list-style-type: none"> <li>• Power and Fault LEDs</li> <li>• Two 10-turn amplitude knobs</li> <li>• Two-position amplitude crossover switch (selects amplitude configuration in manual mode)</li> <li>• Internal Frequency knob (three-quarters turn, controls toggle rate in Internal Modulation mode)</li> </ul>
Back panel	<ul style="list-style-type: none"> <li>• Two 50-ohm BNC female bulkheads for LC voltage outputs (primary)</li> <li>• Two 50-ohm SMA female bulkheads for LC voltage outputs (secondary)</li> <li>• Two-position Internal/External Modulation toggle switch</li> <li>• 50-ohm BNC female bulkhead for External Modulation TTL logic-level source</li> <li>• 2.1 mm power jack receptacle</li> <li>• 12VDC power ON/OFF switch</li> </ul>
RoHS compliance	100% compliant (no exemptions used)
CE compliance	Certification to FCC Class A emissions level upon special arrangement.
Operating temperature	5 to 45 °C
Power supply	<ul style="list-style-type: none"> <li>• Separate, supplied with controller</li> <li>• International +12VDC, 18W, 100-240VAC 50-60Hz input, UL/CE listed</li> <li>• 2.1 x 5.5 mm center-positive plug</li> </ul>
Warranty	One year

In keeping with our commitment to continuous product improvement, these specifications are subject to change without notice.

## **Safety Considerations**

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The following safety and maintenance considerations should be observed:

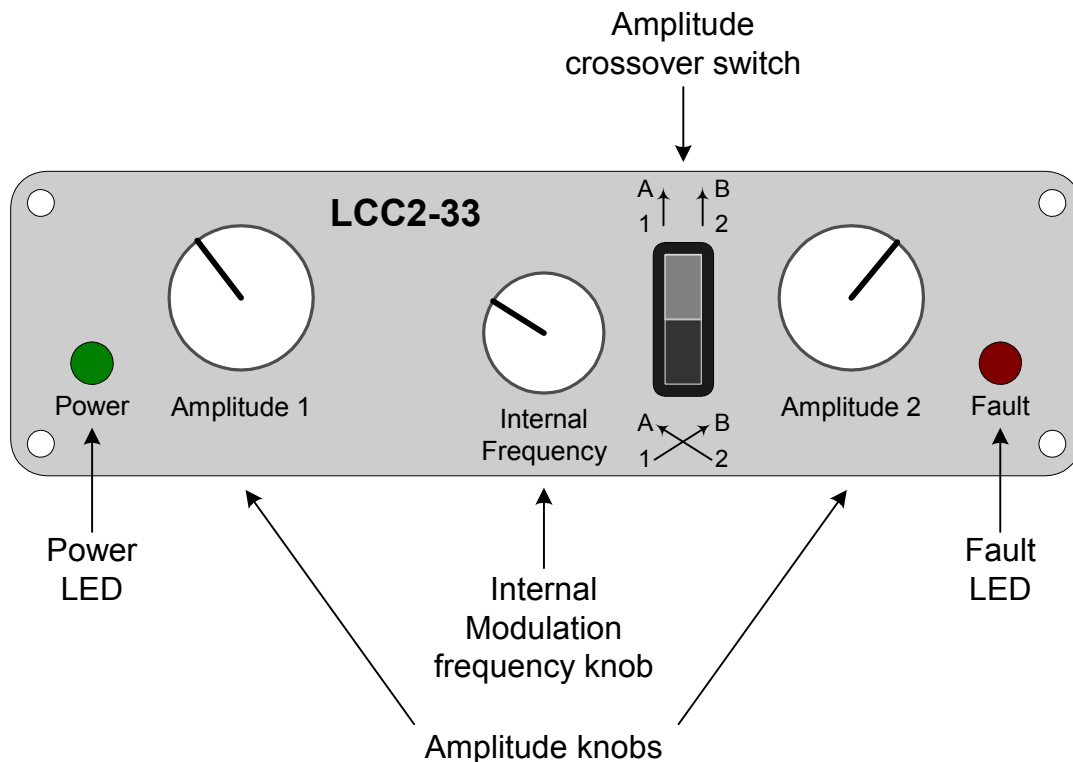
- The controller is for indoor use only, and not to be used in wet or moisture-laden environments. The controller should only be operated in relative humidities between 20-80% non-condensing, and at temperatures between 5 to 45 °C.
- $12V\text{---}1.5A$  The electrical input rating of this device is 12VDC/1.5A. Use only with supplied AC mains adaptor (international power supply).
- The LC output cables should be jacketed, with a 150 V minimum insulation rating. RG 58 C/U BNC-to-alligator-clip adapter cables (e.g. Pomona 4532-C-36) are suitable for use.
- The interior of the controller is not designed to be user accessible, and there are no user-serviceable parts inside. Contact Optical Finesse directly and return controller if maintenance or calibration is required.
- Clean the exterior of the unit with a soft dry cloth only.
- The controller should be operated upright on a sturdy table or workbench, with clear access to both front & back panels.

## Front & Back Panels

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A brief description of the front & back panel controls and connections follows.

### Front panel

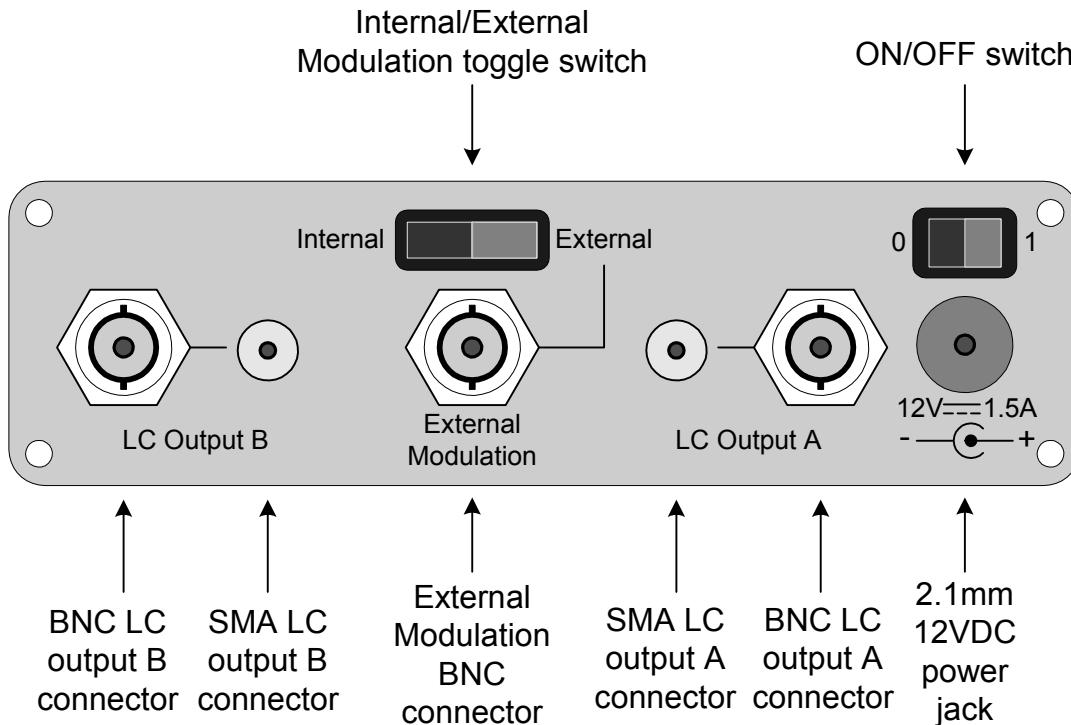


- Power LED: lit green when controller is connected to 12VDC power supply and switched ON (normal operation).
- Fault LED: In normal operation, this LED is off. Will be lit red when a short-circuit or other fault condition exists on a LC output. When the short-circuit or fault is removed, this LED will automatically turn off.
- Amplitude knobs: 10-turn knobs that control the voltage amplitudes. Rotating the knobs clockwise increases the amplitude. Amplitudes can be assigned to either of the two LC outputs, as controlled by the amplitude crossover switch in manual mode.
- Amplitude crossover switch: Controls assignment of amplitudes to LC outputs in manual mode. When the switch is in the up (“straight-thru”) position, amplitude 1 is assigned to LC output A, and amplitude 2 is assigned to LC output B. When the

switch is in the down (“crossed”) position, the assignments are reversed—amplitude 1 controls LC output B, and amplitude 2 controls LC output A.

- Internal Modulation frequency knob: when Internal Modulation is selected, sets rate of toggle for amplitude crossover. Full counter-clockwise is the slowest rate (~0.5 Hz); full clockwise is the fastest rate (~50 Hz). The duty cycle for internal modulation is always 50% straight-thru/crossed configurations.

## Back panel



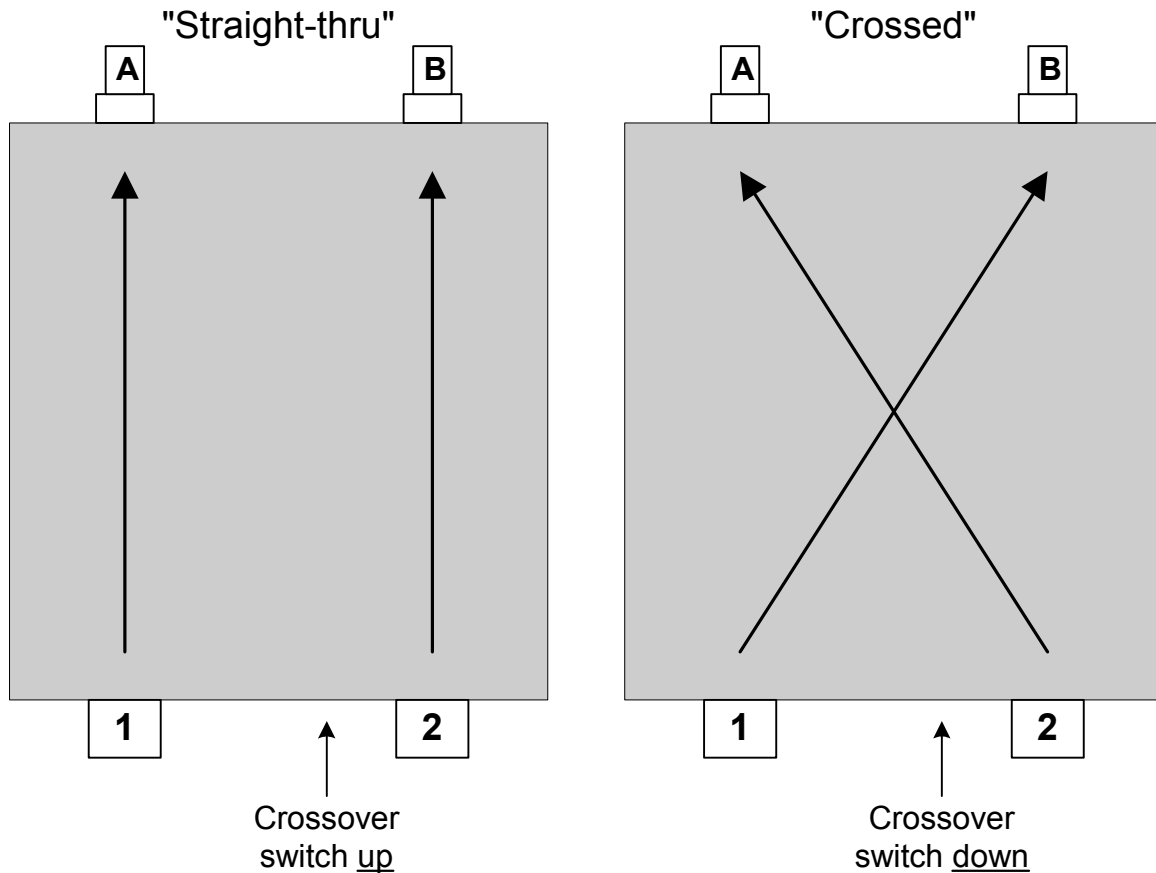
- 2.1mm 12VDC power jack: accepts 2.1mm output power connector of supplied external 12VDC international power supply.
- ON/OFF switch: switches 12VDC power from external power supply ON/OFF.
- BNC LC output A|B connectors: primary LC voltage output connections for the two channels of the controller.
- SMA LC output A|B connectors: secondary LC voltage output connections. These connectors are tied internally to the respective BNC LC A|B outputs. If desired, either the primary or secondary LC output connectors may be connected to an external true root-mean-square (RMS) voltmeter for monitoring of the output voltage levels.

- Internal/External Modulation toggle switch: selects mode of operation. When set to External (to right), permits manual toggling of amplitudes by front-panel amplitude crossover switch, or permits use of a TTL-compatible External Modulation source. When set to Internal (to left), permits Internal Modulation, whose rate is controllable by the front-panel Internal Frequency knob.
- External Modulation BNC connector: left open for use in manual mode or for Internal Modulation. For External Modulation mode, accepts 0-5V TTL-compatible logic signal, for asynchronous amplitude toggling at arbitrary duty cycles. External Modulation is logic-level controlled: a logic HI selects the “straight-thru” configuration, a logic LO selects the “crossed” configuration.

## Operation

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The LCC2-33 outputs two DC-balanced 2 kHz bipolar square waves suitable for driving various liquid-crystal devices. The amplitudes of the square waves are controlled by the two front-panel knobs. These amplitudes are assigned to the LC outputs in one of two configurations most easily understood by envisioning the controller from above.



In the “straight-thru” configuration, LC output A is controlled by the amplitude 1 knob, and LC output B is controlled by the amplitude 2 knob. In manual mode, the “straight-thru” configuration is selected by setting the front-panel crossover switch up.

In the “crossed” configuration, the LC output assignments are reversed. LC output A is controlled by the amplitude 2 knob, and LC output B is controlled by the amplitude 1 knob. In manual mode, the “crossed” configuration is selected by setting the front-panel crossover switch down.



The LCC2-33 can be used in three different ways:

1. Manual mode: the two amplitudes are assigned to LC outputs as determined by the front-panel amplitude crossover switch.
2. Internal Modulation mode: internally toggles the amplitudes between the “straight-thru” and “crossed” configurations, at a frequency set by the front-panel Internal Frequency knob.
3. External Modulation mode: toggles the amplitudes between “straight-thru” and “crossed” configurations under the control of an external function generator or other trigger source.

## Preliminaries

Connect the external international power supply to AC mains with supplied AC power cord. Connect 2.1mm power connector to 12VDC power jack. Insure both front-panel amplitude knobs are rotated full counter-clockwise. Switch ON/OFF switch on. The front panel green LED should be lit.

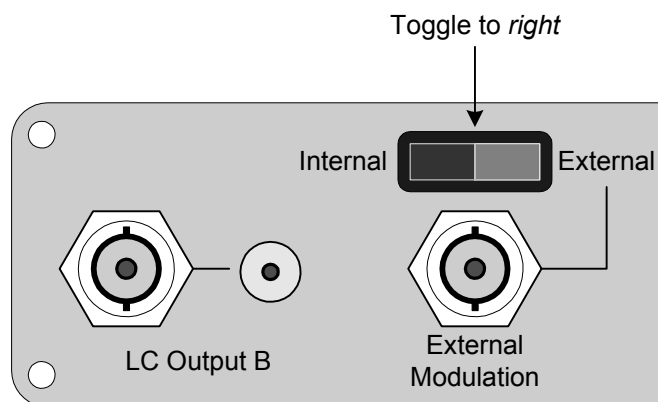
Connect jacketed cables to either the SMA or BNC LC output connectors. These connectors are connected internally, and either one or both may be used to drive LC devices. RG 58 C/U BNC-to-alligator-clip adapter cables (e.g. Pomona 4532-C-36) are suitable for use in a test or production environment to connect to the ITO tabs or flying leads of an LC device.

Note that both LC outputs need not be used on the LCC2-33; if only one output is used, the LCC2-33’s switching behavior is identical to the LCC1-33. If desired, the unused LC output connectors (SMA or BNC) may be connected to an external true root-mean-square (RMS) AC voltmeter (e.g. Fluke 45 or equivalent) for monitoring the LC output levels.

## Manual mode

This is the basic operating mode of the controller. In this mode, the front-panel amplitude crossover switch controls the assignments of amplitudes to LC outputs.

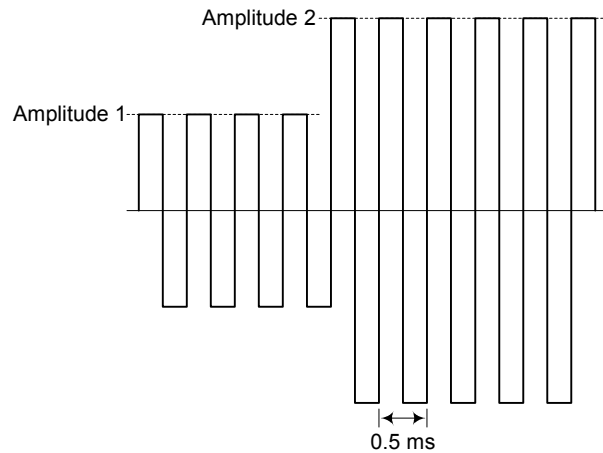
Set the back-panel Internal/External Modulation switch towards the right (External). With no external



modulation source attached to the External Modulation connector, this will enable manual mode.

With a single LC cell, the front-panel amplitude crossover switch can be used to toggle between one of two amplitudes presented to the cell. With two cells, it is often best to leave the amplitude crossover switch in the “straight-thru” position for independent control of each cell. Certain cell configurations may require the exchange of voltage amplitudes, which is accomplished by the crossover switch.

An example LC waveform is shown at right for LC output A, for the case in which amplitude 1 happens to be less than amplitude 2. The 2 kHz AC carrier is shown, along with the two preset amplitudes. The change in amplitudes shown coincides with a manual toggling of the crossover switch from up to down.



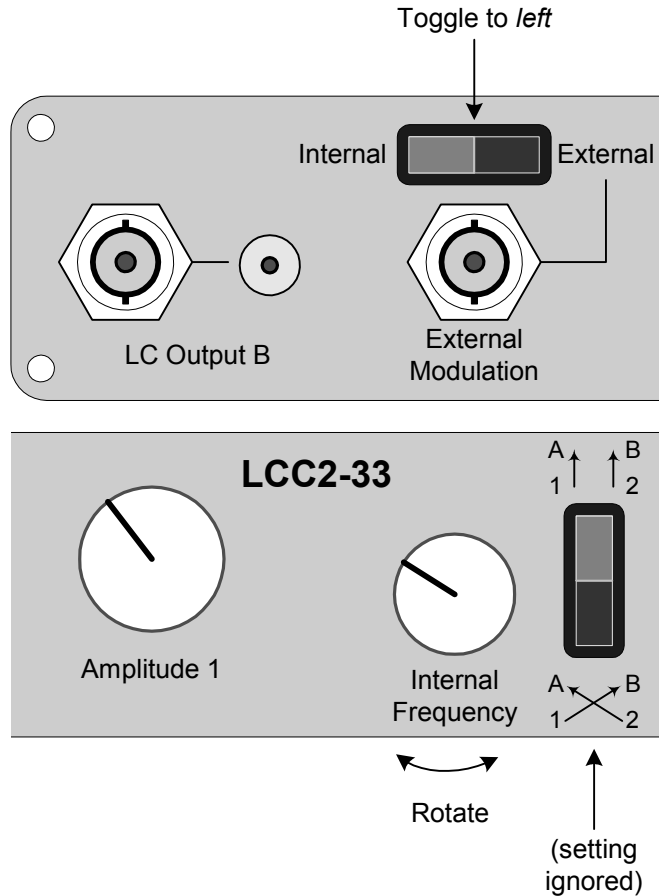
If an LC output connector is shorted to ground (e.g. if the two clips of a BNC-to-alligator clip adapter cable are contacted), the red Fault LED will turn on. A fault condition will not harm the LC outputs. Once the short is removed, the Fault LED will turn off and the controller will automatically return to the last-set voltage.

## Internal Modulation mode

In this mode, the controller automatically toggles between the “straight-thru” and “crossed” amplitude configurations, at a rate determined by the front-panel Internal Frequency knob.

To enable this mode, set the back-panel Internal/External Modulation switch towards the left (Internal). In this setting, the rate of toggle is controlled by rotating the Internal Frequency knob. Full counter-clockwise is the slowest setting (~0.5 Hz); full clockwise is the fastest setting (~50 Hz).

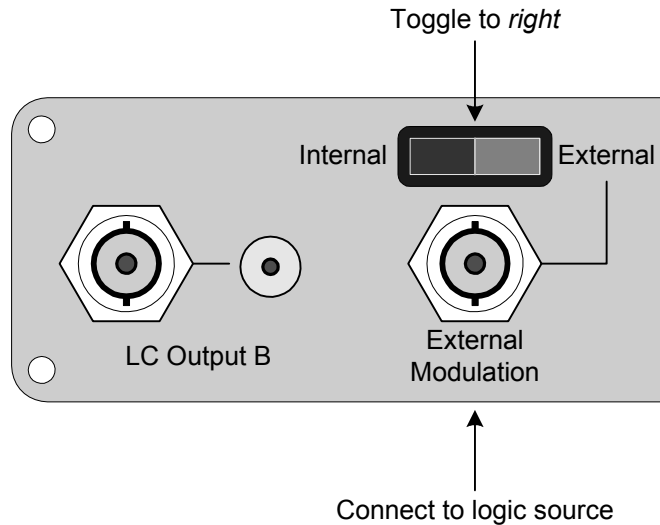
Adjustments to either amplitude knob may be made as the controller automatically toggles between them. The duty cycle between the configuration switching is always 50%.



## External Modulation mode

External modulation mode requires a TTL logic compatible source. This mode is suitable for automated test environments, where a digital output from a computer is used to control which amplitude configuration is selected. The duty cycle of the configuration switching is set by the external source and can be arbitrary.

To enable this mode, set the back-panel Internal/External Modulation switch towards the right. Connect a TTL-compatible logic source or computer logic output to the External Modulation BNC connector. Do not use the bipolar analog output of a function generator. If a function generator is to be used, many have a separate ‘sync’ or logic output that is suitable for use.



External Modulation is logic-level controlled. A logic HI on External Modulation will select the “straight-thru” amplitude configuration; a logic LO will select the “crossed” amplitude configuration. The setting of the front-panel amplitude crossover switch will be ignored. As with Internal Modulation mode, adjustments may be made to either amplitude as the controller toggles between them.