ILT *Incubator Light*

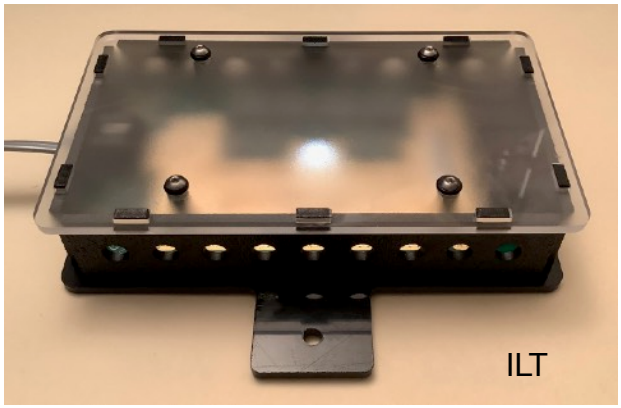
The *Incubator Light* produces Red, Green, Blue, and Warm White LED illumination for rhythm entrainment and stimulation testing of animal behavior. The intensity of each color may be set over a dynamic range of 1 to 2000, and ramped on or off over a span of 0.1 seconds to 12 hours by the DAMSystem3 host control software.

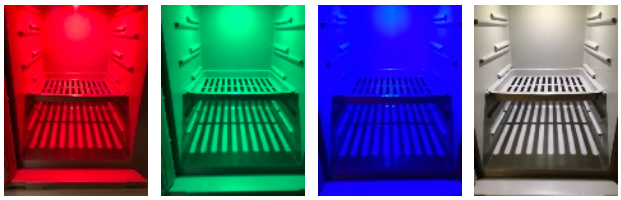
Complex on/off pulse sequences of seconds, minutes, hours, or days may be generated, including random trains and periodic pulses of increasing or decreasing amplitude for stimulus response and arousal testing.

Full power optogenetic pulses may be produced with programmable period and on time from 1 msec to 2 seconds.

The unit is housed in a small plastic enclosure and is suitable for mounting to an incubator shelf or chamber wall by its two mounting tabs.

Light output is bright at full power; beware long-term direct viewing.





Specifications

- Nominal Wavelength and brightness
  Red: 625 nm, 175 lumen
  Green: 530 nm, 280 lumen
  Blue: 460 nm, 40 lumen
  White: 2950K, 280 lumen
- Thermal Power: 4.0W max
- Dimensions: 13.7 x 8.2 x 2.8 cm LWH (width 13.2 cm with mounting tabs)
- Mass: 160 g
- Connections: 1 input jack for cable to PSIU9, 4 output jacks for cables to activity monitors
- Software control from DAMSystem3 in lieu of LC4 Light Controller
- Case material: ABS and acrylic plastic
- Includes CAB2 monitor cable

Features

- 4 independent LED outputs: red, green, blue, warm white
- On pulse duration: 0.1 second to 99 hours
- Intensity control: 0.05 to 100.00%
- On/Off ramp time: 0.1 sec to 12 hours
- Single, periodic, or random pulse repetition
- Pulse combinations allow periodic pulse trains of increasing amplitude for stimulus response and arousal testing
- Rapid pulse mode produces full power optogenetic pulse trains with 1 msec to 2 second programmable on time and period
- Mounting tabs allow easy suspension from incubator shelf or chamber wall
- 4 output jacks connect activity monitors to DAMSystem network

TRIKINETICS

ILT Operation

The *Incubator Light* connects to a PSIU9 Power Supply Unit via CAB2 or CAB10 cable from its single input jack. Activity monitors may be optionally connected to its 4 output jacks to minimize wiring inside a test chamber. As the LC4 Light Controller occupies the same software space as the ILT, only one or the other of these may be used on a system. If both are needed, a second PSIU9 may be used to form a parallel independent control path.

The two mounting tabs on the ILT allow it to be attached to the underside of an incubator shelf to illuminate activity monitors below. If a picnic cooler or resin deck box is used as a passive test chamber, the mounting tabs can hold the ILT to the inside top or side of the chamber to illuminate the interior.

Software Settings

The Light Control panel of the DAMSystem3 data collection program contains settings for the ILT, including 8 on/off pulses which may be applied in combination to the 4 available light channels: Red (1), Green (2), Blue (3), and White (4). Pulses are applied to the output channels via the selection matrix, with 'x' and '+' indicating the method of combination when multiple pulses are applied to a single channel.

Pulses applied with '+' are combined with 'or' logic: the channel will be on when any of the applied pulses is on. Pulses applied with 'x' are combined with 'and' logic: the channel will be off when any of the applied pulses is off. If both '+' and 'x' are applied to a single output channel, the '+' pulses will be combined with 'or' logic and then the 'x' pulses will be applied with 'and' logic.

Output pulses may be initiated only at the reading interval, so quickly-repeating or random output pulse trains will require short reading intervals. (Rapid Pulse mode produces automatic pulse trains which are independent of the reading interval.)

The ILT may be operated in Intensity Ramp mode, Rapid Pulse mode, or neither, in which case the intensity will default to maximum and the ramp time to brief.

Maximum output power

To control power dissipation, the combined instantaneous total intensity of all 4 LED outputs is limited to 100% (10000.) So if all 4 outputs are scheduled to be simultaneously on at 100%, the hardware will restrict each to 25% intensity to preserve the 100% total maximum.

The maximum output intensity for each channel over each reading is saved to the MonitorLC.txt file so that such power restrictions are visible.

Precautions

Thermal power dissipation in the ILT will approach 4 watts at maximum brightness. This heat load may be enough to raise air temperatures inside a small passive chamber, so lower intensity illumination may be necessary to reduce this heating.

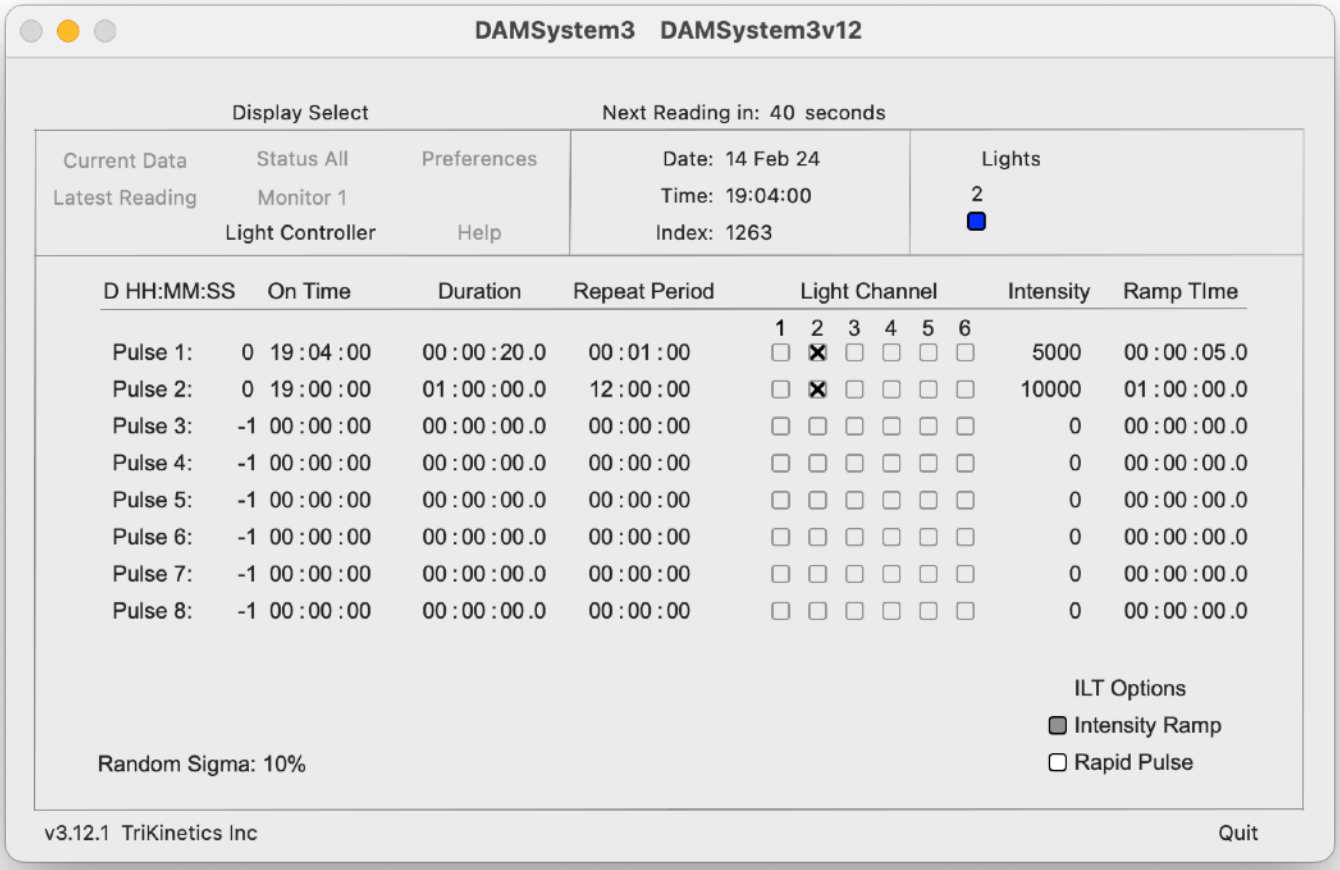
The RGBW led outputs are quite bright at full intensity, so use caution in direct viewing of the unit.

Green pulse train with increasing amplitude

Intensity may be specified for any pulse over the range of 5 to 10000 (0.05 to 100%), and the transition time from on to off may be specified from 0.1 sec to 12:00:00.0 hours. In the example below, two pulses are applied to the channel 2 (green) output by ‘x’ (and) logic, pulse 1 at 50% intensity (5000) and pulse 2 at 100% (10000). Pulse 1 is on for 20 seconds (duration) every minute (repeat period), and turns on and off with a ramp time of 5.0 seconds.

Pulse 2 is on for 1 hour (01:00:00.0 duration) every 12 hours (12:00:00 repeat period) with a ramp time of 1 hour (01:00:00.0), generating a 1 hour ramp to full intensity twice per day.

When these pulses are combined by ‘and’ logic, the fractional intensities will multiply when both pulses are on to produce a sequence of 20-second green output pulses every minute for 1 hour, with pulse intensities growing from 0% to 100% over the 60 pulses. This will occur twice per day.

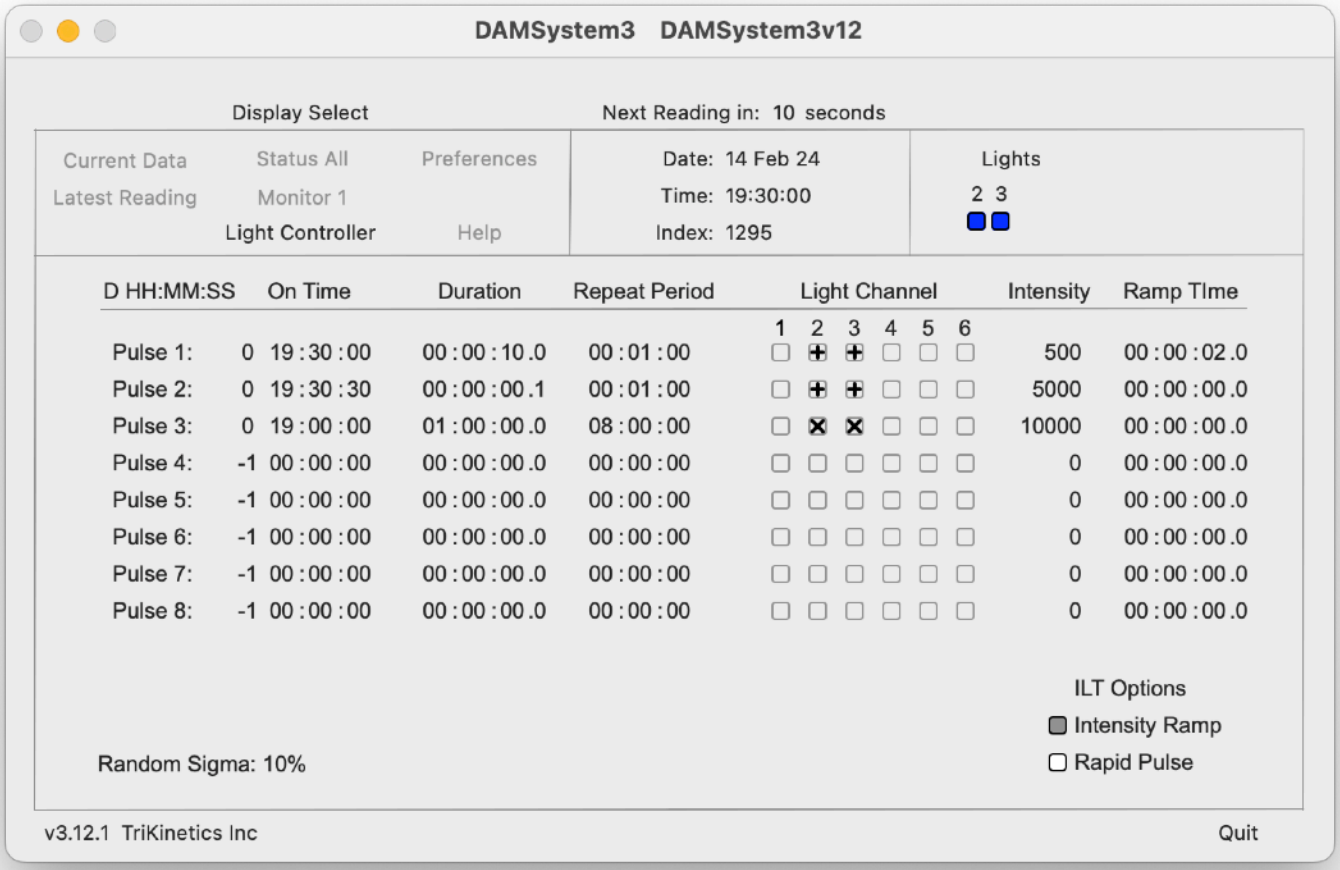


Green pulse train with increasing amplitude

Alternating dim/bright pulses

In the following example, pulse 1 produces 10-second pulses in output channels 2 (green) and 3 (blue) every minute at a low intensity of 5% (500). Pulse 2 produces bright (50% intensity, 5000) pulses of 0.1 second duration every minute also, but with an on time staggered forward by 30 seconds to prevent overlap in the same minute. The 2 pulses are combined by '+' (or) logic so that the output will be on when either is on.

Pulse 3 produces a 1-hour pulse every 8 hours, and is combined with the other two by 'x' (and) logic at an intensity of 100% (10000) to control when during the day the first 2 pulses are output to the blue and green LEDs.

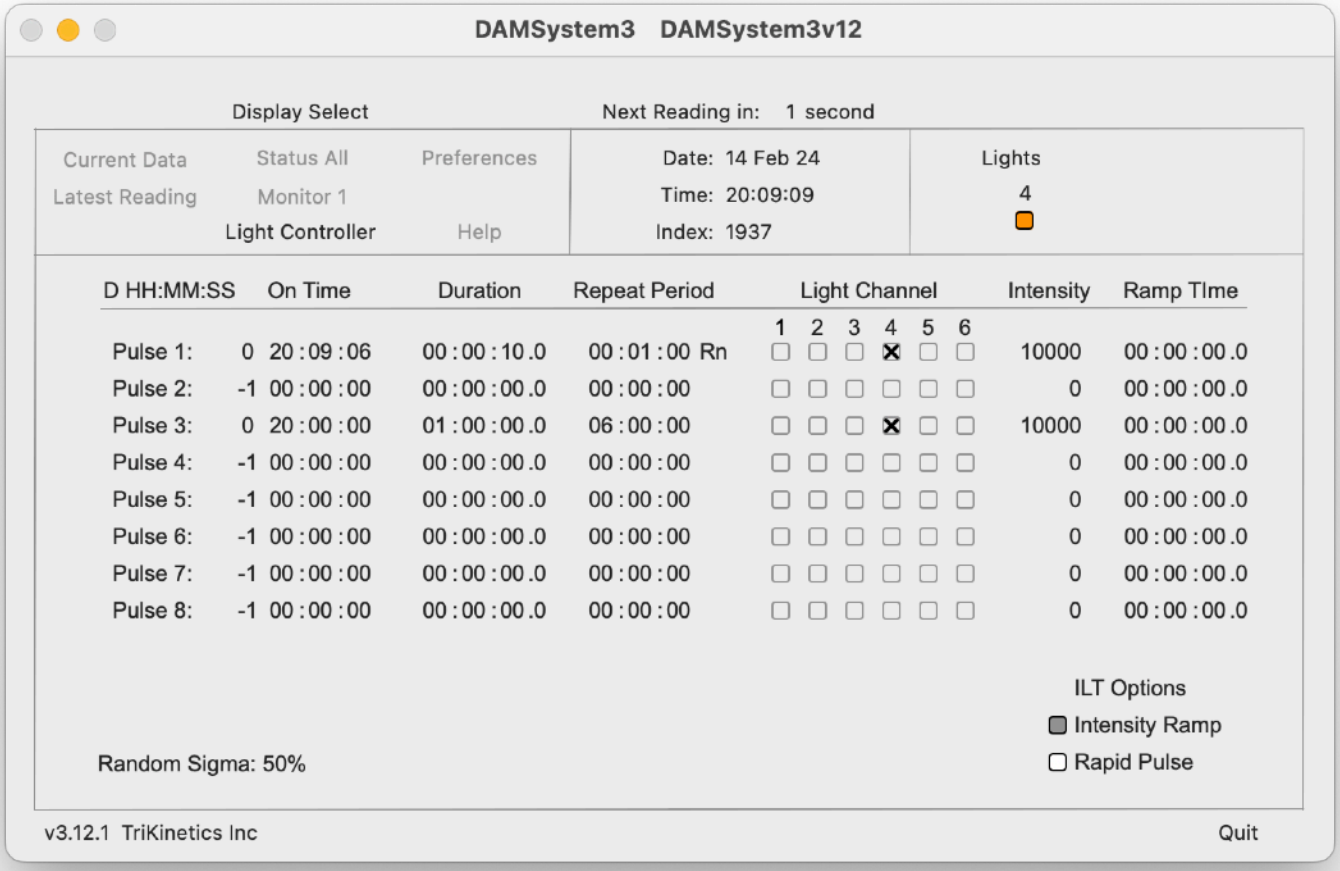


Soft blue-green pulses interspersed with short bright blue-green pulses every minute for 1 hour

Random Repeat Period

In the following example, 10-second white pulses are generated (channel 4), but with a normal (gaussian) distribution on the 1-minute repeat period. The pulses will thus not be strictly periodic, but instead random in occurrence with a nominal 1-minute repeat rate normally distributed with a deviation (sigma) of 50%. A short reading interval (3 seconds in this case) is used to allow good timing resolution of the random repeats.

A second pulse is used to restrict the output to 1 hour out of every 6 over the course of a day.



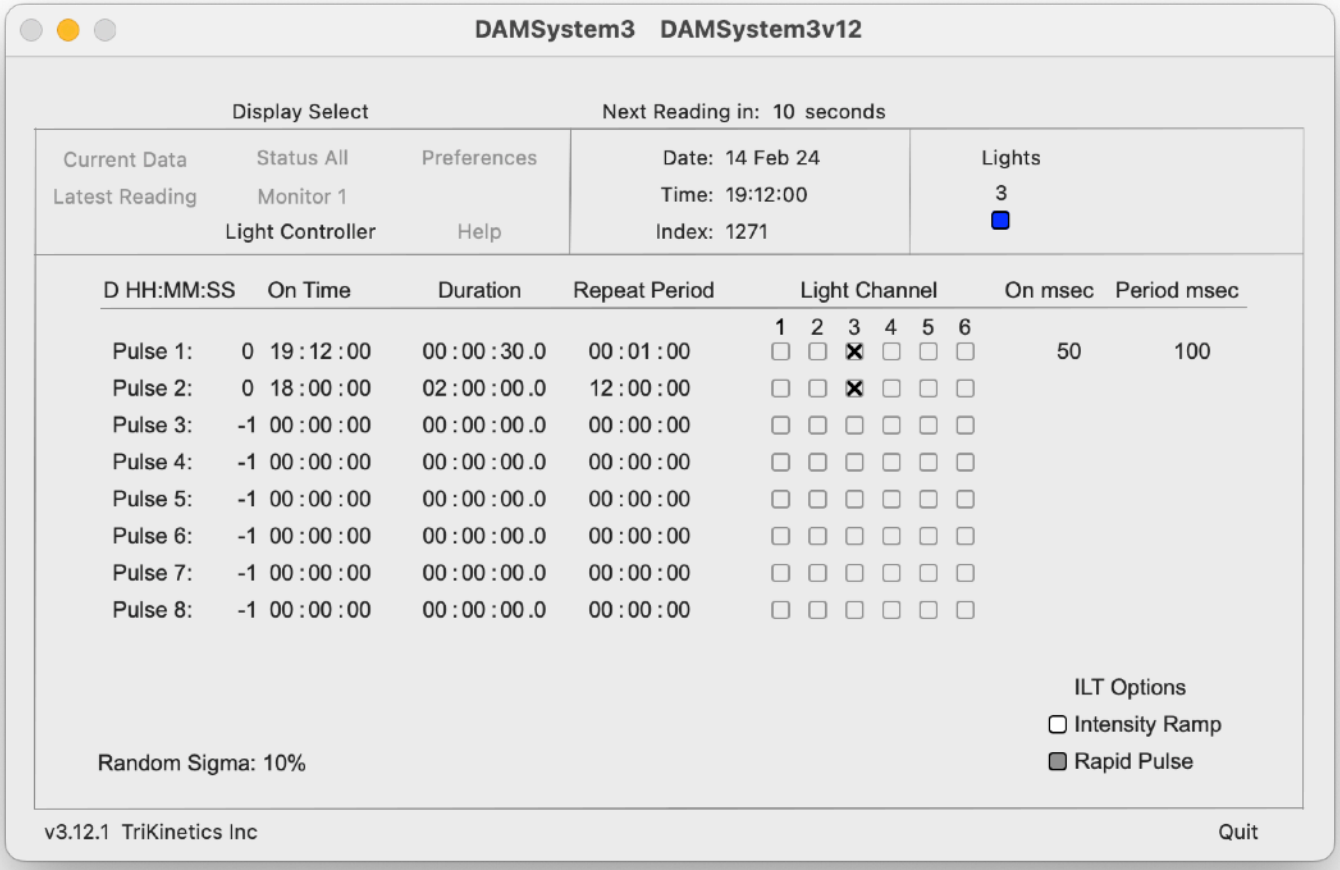
Random pulse train of white light

Rapid Pulse Mode

Rapid pulses for optogenetic stimulation may be generated at up to 500 hz by specifying the period and on time in milliseconds. Intensity is fixed at maximum when the pulse is on, there is no ramping, and only 1 of the 4 channels may be used at a time to provide maximum power output.

Pulse 1 (of 8) controls coupling of the rapid on/off sequence to the output channels, as shown in the example below. A 10 hz (100 msec period) on/off oscillation with a 50% duty cycle (50 msec on) will be coupled to channel 3 (blue) by ‘x’ (and) logic. The oscillation will be applied to the output for 30 seconds (duration) every minute (repeat period) beginning at 19:12:00 (on time).

Pulse 2 in this case is also coupled to the channel 3 output by ‘x’ (and) logic, so the oscillation will appear at the blue light when both Pulse 1 and Pulse 2 are on. Pulse 2 provides daily scheduling of the oscillating output, being on at 18:00:00 (on time) for 2 hours (duration) and repeating every 12 hours (repeat period.)



10 hz blue output pulses at 50% duty cycle

Data File Format

When the ILT is used, an entry is made to the MonitorLC.txt output data file at every reading. The same 42-column format is used as that of the activity monitors, with the first 10 columns containing the common date/time and status header information.

The 32 data columns (file columns 11-42) are as follows:

11	Channel 1 state at end of bin (1 = on, 0 = off) - same as LC4
12	Channel 2 state at end of bin
13	Channel 3 state at end of bin
14	Channel 4 state at end of bin
15	0
16	0
17	mode: 1 = RampIntensity / 2 = RapidPulse

RampIntensity

18	Channel 1 Peak intensity
19	Channel 2 Peak intensity
20	Channel 3 Peak intensity
21	Channel 4 Peak intensity
22-42	0

RapidPulse

18	Period (msec)
19	OnTime (msec)
20	Output Channel (1:4)
21	0
22-42	0