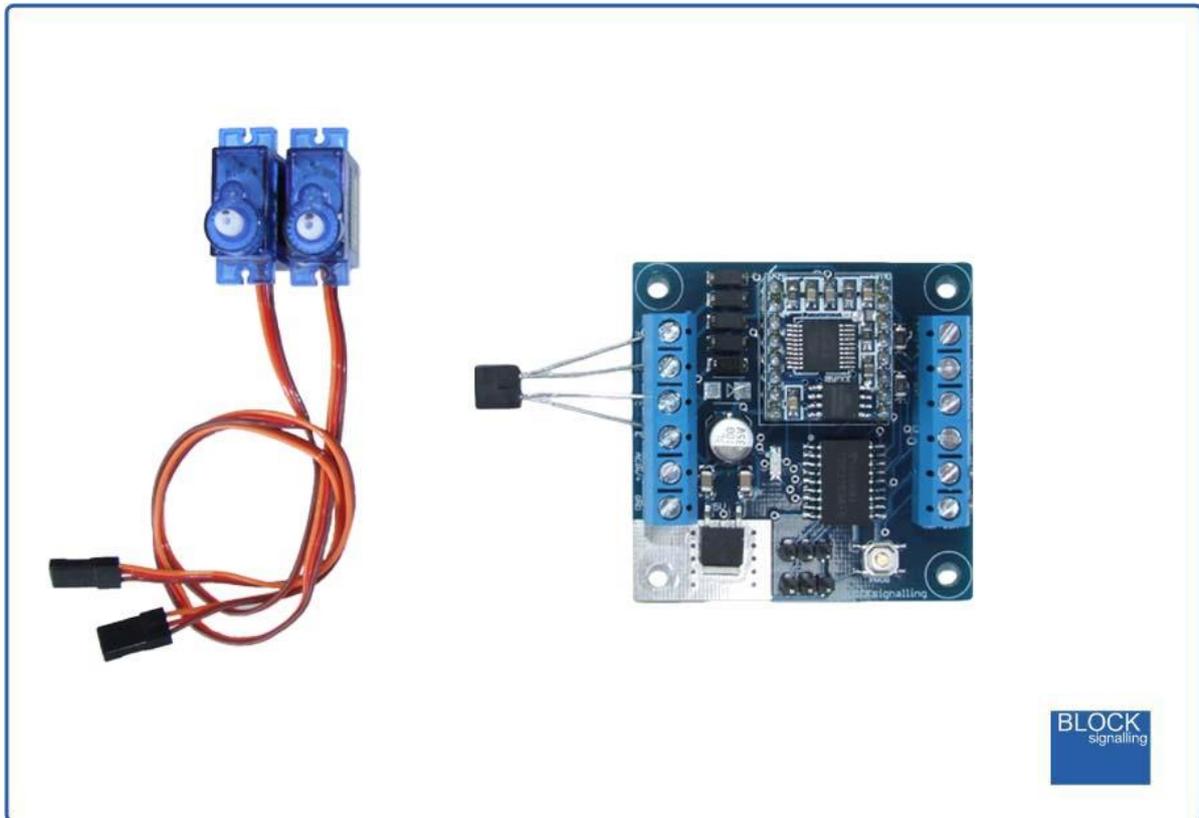


LEVEL CROSSING WITH SERVOS LCS5



Fully Flexible Controller with Servo Motors for Barriers or Gates

- Automatically detects trains using an infra-red sensor mounted below the track bed
- Operates attached yellow and red leds on level crossing signs (not included)
- Operates two servos (included) for connection to barriers or gates
- Once train has cleared the sensor, the barriers return to their start positions automatically
- Built-in programs to cover most UK crossing style

Model railway layouts often incorporate a level crossing, and the LCS5 module is designed to add movement to these crossings, with automatic detection of an approaching train triggering the operation of gates or barriers. If yellow and red leds are connected, these will also operate automatically.

The control system is built and tested, ready for connection to the chosen warning light signals and barriers or gates.

Each servo operates automatically between their start and stop positions, which have been pre-programmed for ease of use.

The LCS5 is triggered by infra-red sensors mounted beneath the track and works equally on DC or DCC layouts.

Servo Motors

Servo motors consist of a small dc motor and gearbox combination, designed to drive an externally mounted arm (horn) through a limited range of angles. The motor operates at high speed, and the gearbox reduces the speed to a more appropriate level and so increases the torque significantly. An in-built control circuit varies the motor direction and speed to allow the output shaft to turn to the desired position.

Servos are compact and easy to mount. The barrier or gate can be directly attached to the servo by fixing a wire into the centre of the output shaft with epoxy, or a variety of horns can be mounted on to the output shaft and then extended with thin modelling wire to connect to gates, barriers and signals, etc.

The Level Crossing Controller LCS5 drives two servos from their parked position (START position) to their destination (STOP position). For ease of use, the start position and stop positions are pre-programmed to cover an arc of approximately 90 degrees (for use with barriers or gates). This can be varied if required.

Default Operation

When the level crossing module is triggered by a train, it commences operating the standard lights sequence (note, it is not necessary to connect lights, and this part of the program can be bypassed when barriers are being used without lights).

Once the module enters the phase of the flashing reds, it commences the movement of servo 1. Depending on the programme selected, servo 2 may move at the same time as servo 1, part way through the movement of servo 1, or after servo 1 has fully completed its movement.

This allows the modelling of the following types of level crossings:

1. level crossings where there are pairs of gates, which are operated sequentially, and would collide if operated together
2. level crossings where both barriers fall at the same time

3. level crossings where the second barrier commences lowering part way through the lowering of the first barrier

4. level crossings when the second barrier falls only after the first barrier is completely lowered

When the train has cleared the crossing, the two servos either operated simultaneously back to their park position (for barriers) or operate sequentially (for gates).

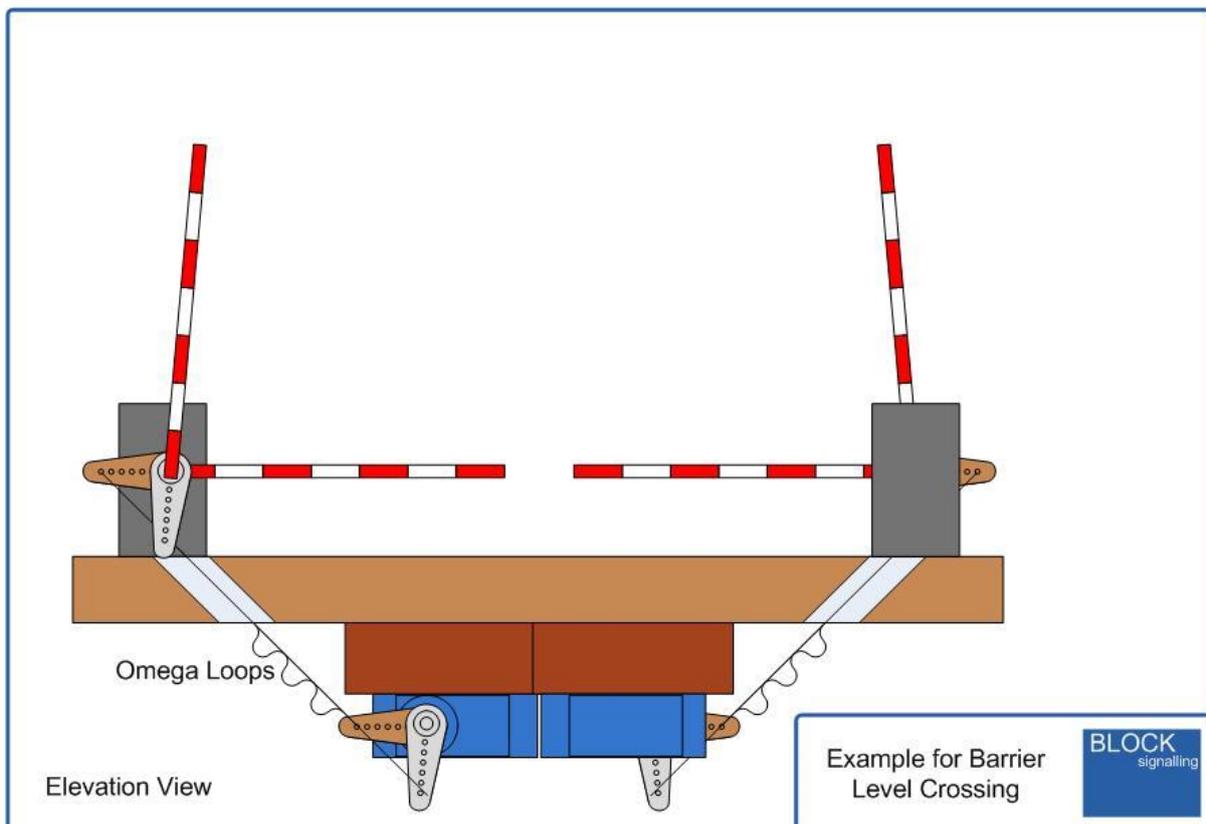
The default range of operation of the servos as supplied is approximately 90 degrees.

Connecting Up Servo Linkages

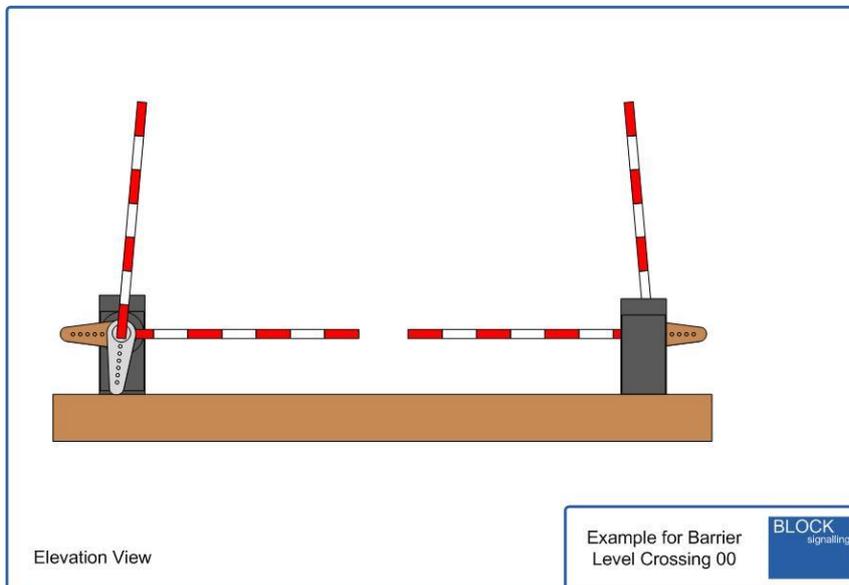
Here are some ideas for connecting up barriers and gates on model level crossings.

In each case, the servo is set to provide approximately 90 degrees of movement.

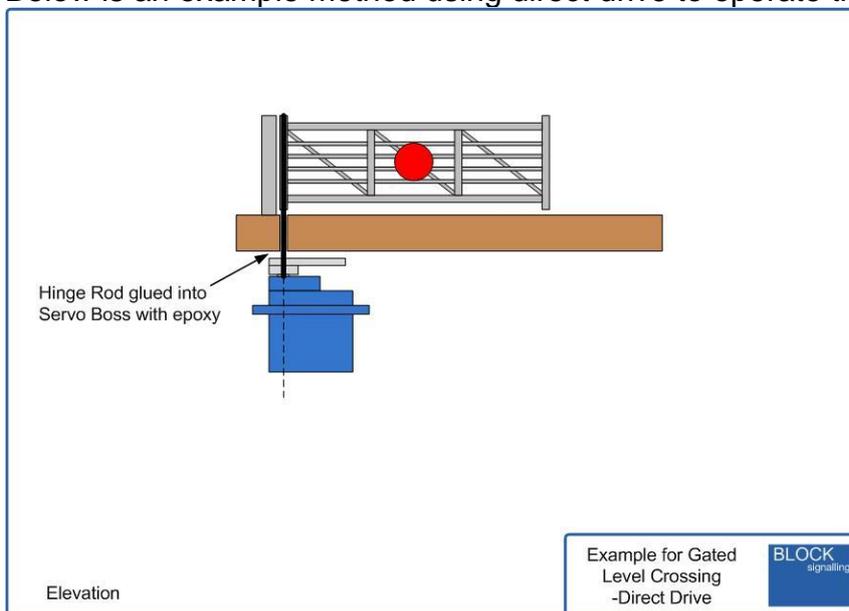
Each build should be designed so that damage will not occur to the model should the servo be accidentally operated beyond its intended operating throw. Possible ways include the use of minimum diameter operating wire with omega loops bent into the wire which will open out or close up at the maximum extents of the servo throw, or using mechanisms which can operate over a larger range than their normal operating range without damage, or loosely fitting control wires which will pull-out of place if overstressed.



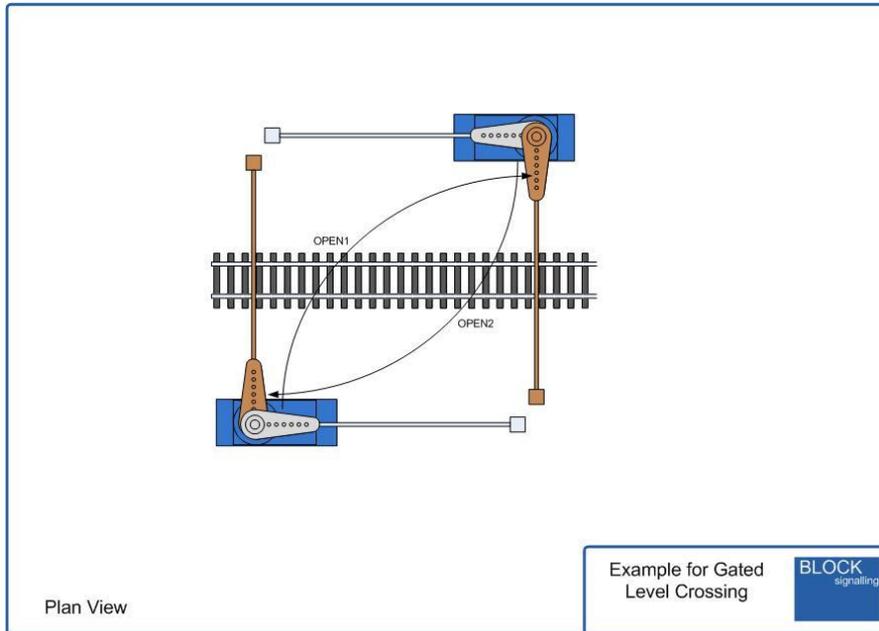
On larger scales, the servos can be mounted above the baseboard and painted a more appropriate colour.



Below is an example method using direct drive to operate the gates.

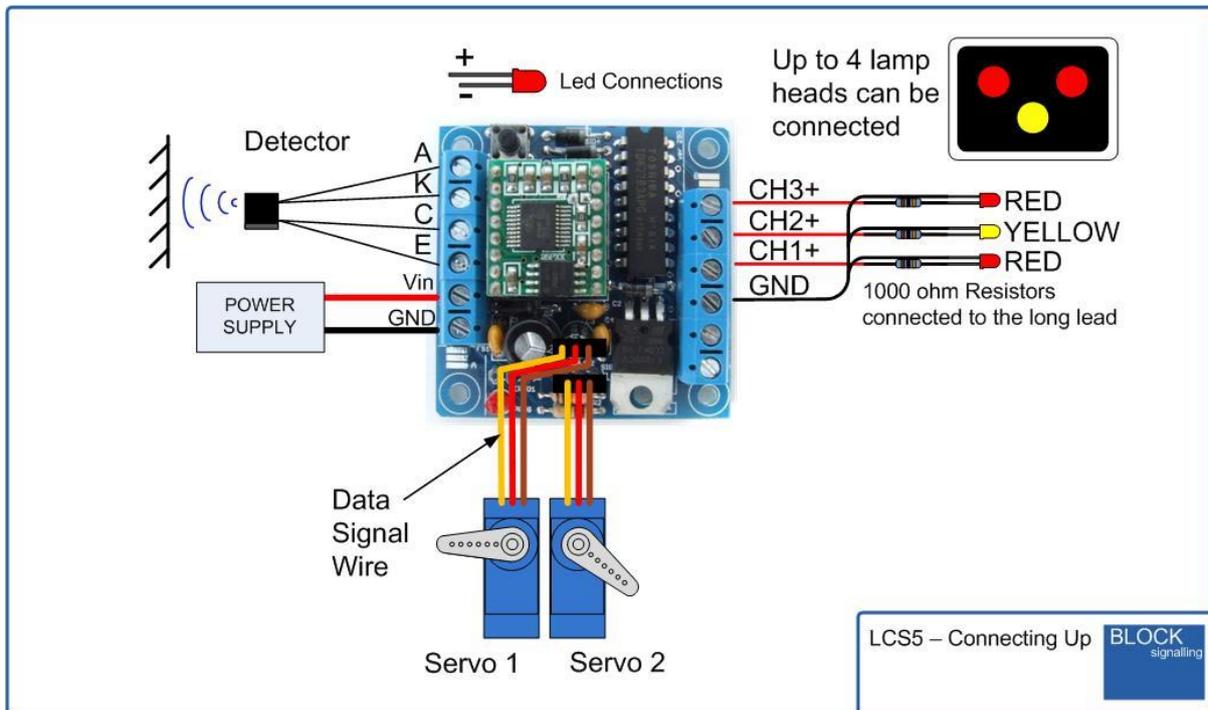


Below, the two servos have been set to operate the gates consecutively, preventing them from clashing.



Connecting Up

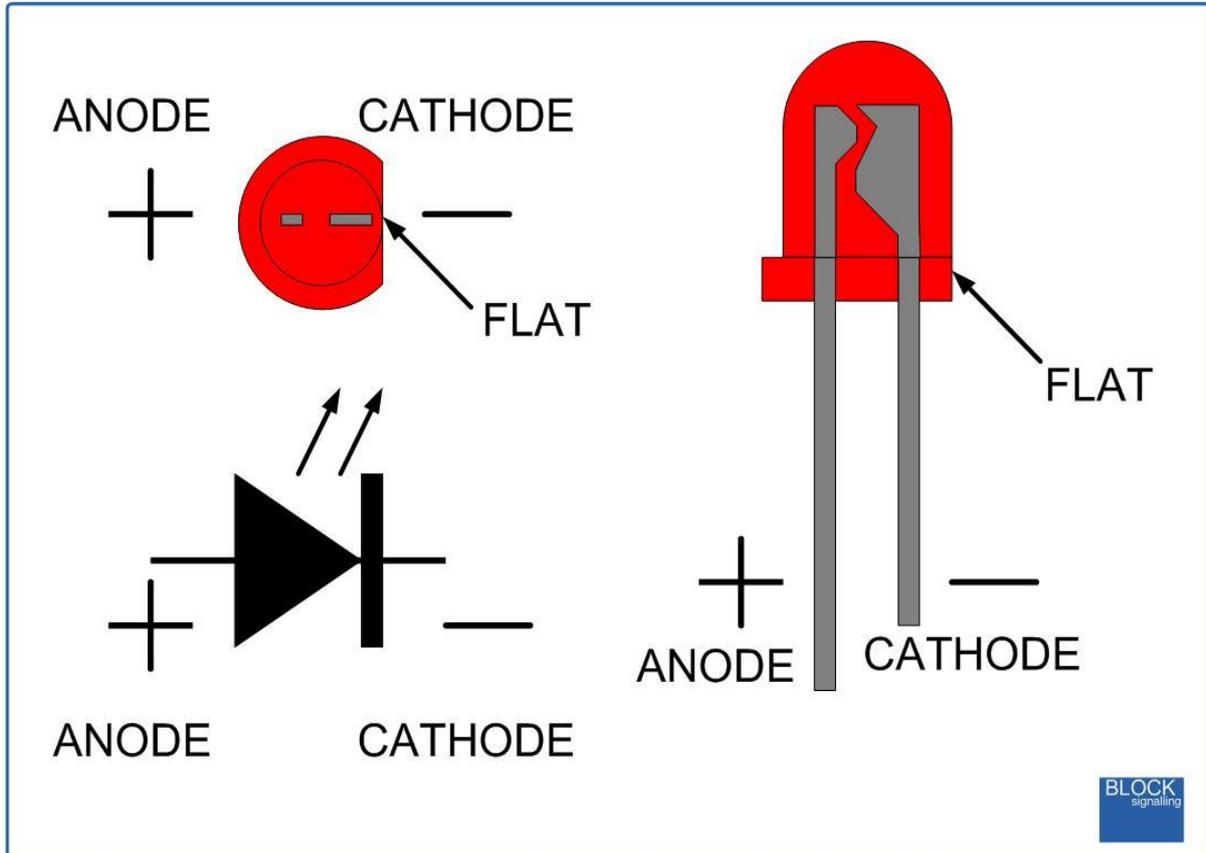
Each servo motor has a small plug, with three pins, two for power and one for the data signal which controls the servo position. For the servo to operate, the plug needs to be inserted the correct way around, with the yellow (data signal) wire next to the SIG label on the PCB. No damage will result if it is plugged in to the board in reverse, but the servo will not operate.



Led Connection

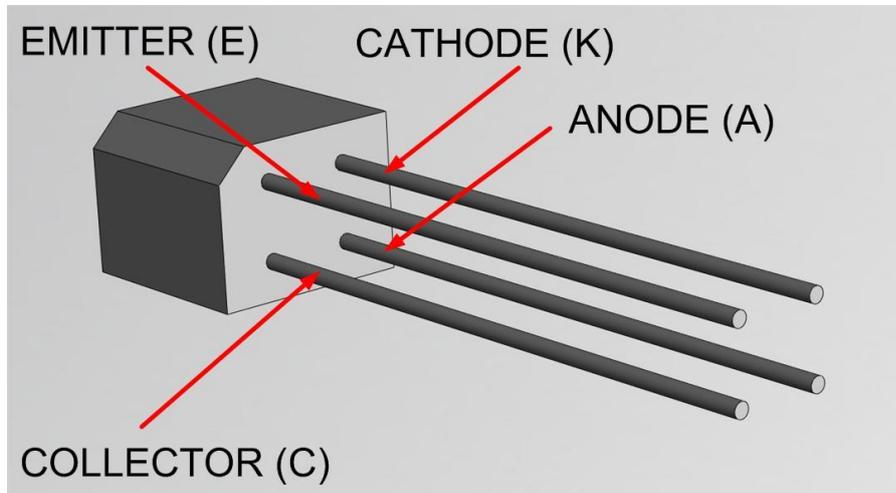
When using leds it is important to connect them the right way around.

The negative lead (cathode) is identified by a flat on the side of the led body, and by having a shorter lead.

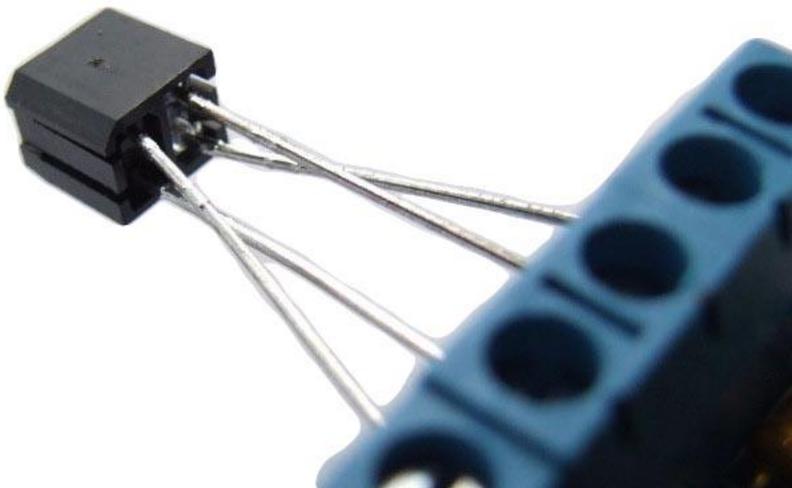


Connecting the Infra-Red Sensor

An Infra-Red source and Infra-Red detector are moulded into a single 5mm x 6.5mm package that can be located below the track bed to reflect light off rolling stock.



Identify the leads from the diagram and connect to the terminals marked A, K, C and E on the PCB.



The wires can be extended using small chocolate block and extra lengths of cable if required (not supplied).

Sensitivity Setting

The module is supplied with the sensitivity pre-set to suit most installations and should not need adjustment.

In locations such as tunnels, or when the IRTD is not being used under the track bed, then it may be desirable to adjust the detection threshold.

The sensitivity is factory set to 5, and can be adjusted from 1 to 10 (with 1 being the most sensitive and 10 being the least sensitive).

	Trigger Threshold					
	2	3	4	5	6	7
Aluminium Foil (shiny side)	170mm	125mm	100mm	95mm	90mm	85mm
A4 White Paper	100mm	65mm	50mm	45mm	40mm	35mm
Matt Black Card	55mm	35mm	30mm	25mm	20mm	15mm
Shiny Black Plastic	45mm	30mm	25mm	20mm	18mm	15mm

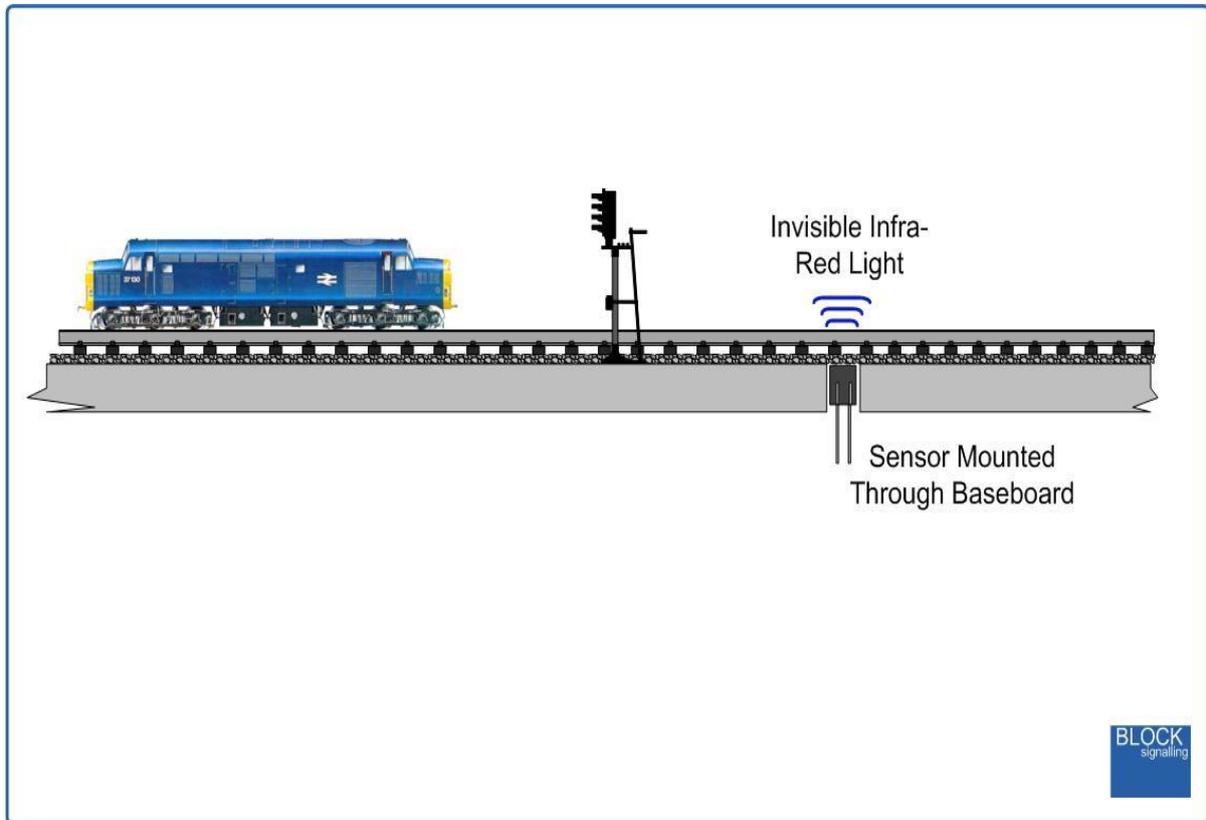
To change the sensitivity, switch off the power to the module and hold down the Push Button. Apply the power and continue holding the Push Button until **9 flashes** of the led are seen. At this point, release the button. You will see a long flash of five seconds.

The led will begin flashing again. When you have reached the desired number of flashes to set the new sensitivity, press the button. You will see a long flash of five seconds and then 10 rapid flashes. The programming is then complete and the module will restart. If you make a mistake programming, simply repeat the process.

Performing a factory reset will reset the sensitivity setting back to 5.

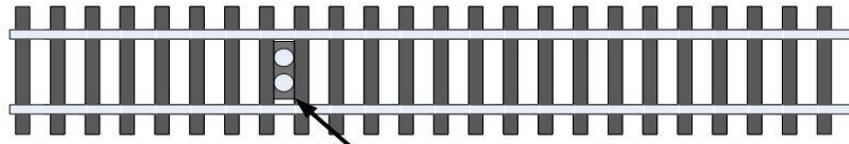
Installation

The Infra-Red sensor is normally installed below the track-bed. The detection range of the unit is up to approximately 25mm from the face of the package when normal sensitivity is set (for dark surfaces with low levels of reflectivity).



The detector can be mounted in an 8mm hole drilled through the track baseboard. If required, the detector can be held in place using a small amount of blutack, expanded polystyrene or similar.

The led diameter is 2.2mm, so on smaller scales the leds can still have a clear view between the sleepers.



Sensor Mounted Below the Track

Operating the Module

The module is fully configurable, however, to make the operation straightforward to use there are a number of presets. These program the majority of settings and allow the module to be used virtually out of the box.

When a basic preset is selected, all the module settings are changed at once. So should you wish to alter any other parameters, do this after selecting the basic preset, otherwise your changes will be lost.

It is suggested that the module is initially operated on the bench to gain familiarity. When first used, servos can operate rapidly throughout their range, and if not expected this could give rise to damage to the model.

Once configured, the module remembers servo positions, and has been programmed to avoid unpredictable operation of the servos during normal use. However, servos are high torque devices, which can rotate at high speed, and power failures, errors in configuration or interference could cause them to operate when not expected. For this reason, models should be designed so that in the rare case that this may occur, the model will not be damaged.

Upon powering, the servos move to give priority to vehicle traffic.

The main presets are as follows:

Program 1 - Play sound clips

The mode is only applicable to the LCS6, which has a built in sound module.

Program 2 - Preset Sequence: Level Crossing with Gates

This is the default program when the module is supplied.

This program is designed for level crossings with two gates, which are normally aligned across the track. When triggered by the approaching train, the yellow led lights on the warning sign on the approach road to the crossing (if fitted). After 3 seconds, the red leds flash and servo 1 operates turning approximately 90 degrees clockwise (looking towards the top of the servo).

When servo 1 has completed its full movement, servo 2 operates turning approximately 90 degrees clockwise.

The infra-red detector continues to check for the end of the train (ignoring the gaps between carriages), and once the end of the train is detected, servo 1 returns to its

start position. When servo 1 has completed its full movement, servo 2 returns to its start position.

The crossing is now ready to accept another train.

Program 3 - Preset Sequence: Level Crossing with Barriers

This program is designed for level crossings with two barriers. When triggered by the approaching train, the yellow led lights on the warning sign on the approach road to the crossing. After 3 seconds, the red leds flash and servo 1 and servo 2 operate simultaneously, turning approximately 90 degrees clockwise (looking towards the top of the servo).

The sound stops at about the time the second servo completes its operation.

The infra-red detector continues to check for the end of the train (ignoring the gaps between carriages), and once the end of the train is detected, servo 1 and servo 2 operate simultaneously to return to their starting positions.

The crossing is now ready to accept another train.

Program 4 - Preset Sequence: Level Crossing with Barriers

This program is designed for level crossings with two barriers. When triggered by the approaching train, the yellow led lights on the warning sign on the approach road to the crossing. After 3 seconds, the red leds flash and servo 1 operates turning approximately 90 degrees clockwise (looking towards the top of the servo). Part way through the operation of servo 1, servo 2 commences operation turning approximately 90 degrees clockwise.

The sound stops at about the time the second servo completes its operation.

The infra-red detector continues to check for the end of the train (ignoring the gaps between carriages), and once the end of the train is detected, servo 1 and servo 2 operate simultaneously to return to their starting positions.

The crossing is now ready to accept another train.

Program 5 - Preset Sequence: Level Crossing with Barriers

This program is designed for level crossings with two barriers. When triggered by the approaching train, the yellow led lights on the warning sign on the approach road to the crossing. After 3 seconds, the red leds flash and servo 1 operates turning approximately 90 degrees clockwise (looking towards the top of the servo). When

servo 1 has completed its rotation, servo 2 commences operation turning approximately 90 degrees clockwise.

The sound stops at about the time the second servo completes its operation.

The infra-red detector continues to check for the end of the train (ignoring the gaps between carriages), and once the end of the train is detected, servo 1 and servo 2 operate simultaneously to return to their starting positions.

The crossing is now ready to accept another train.

Previously Un-documented Presets

When the LCS6 was first designed, we included some additional experimental presets to simulate bounce of the barriers.

As a result of customers' requests, we briefly document them here. They will work best when used with metal geared servomotors, due to their reduced gear backlash.

Note program 12 is not available on units programmed before January 2015.

Program 6 : Gate operation as per program 2, but with gates bouncing at each endstop.

Program 7: Barrier operation as per program 3, but with gates bouncing when reaching the horizontal position.

Program 8: Barrier operation as per program 4, but with gates bouncing when reaching the horizontal position..

Program 9: Barrier operation as per program 5, but with gates bouncing when reaching the horizontal position.

Program 10: Barrier operation as per program 3, but with gates bouncing when reaching the horizontal and vertical positions.

Program 11: Barrier operation as per program 4, but with gates bouncing when reaching the horizontal and vertical positions.

Program 12: Barrier operation as per program 5, but with gates bouncing when reaching the horizontal and vertical positions.

Program Flow Diagram

Programming is performed by inserting a link between the A and K terminals (or by having the detector wired in place) and holding down the Push Button when switching on the power.

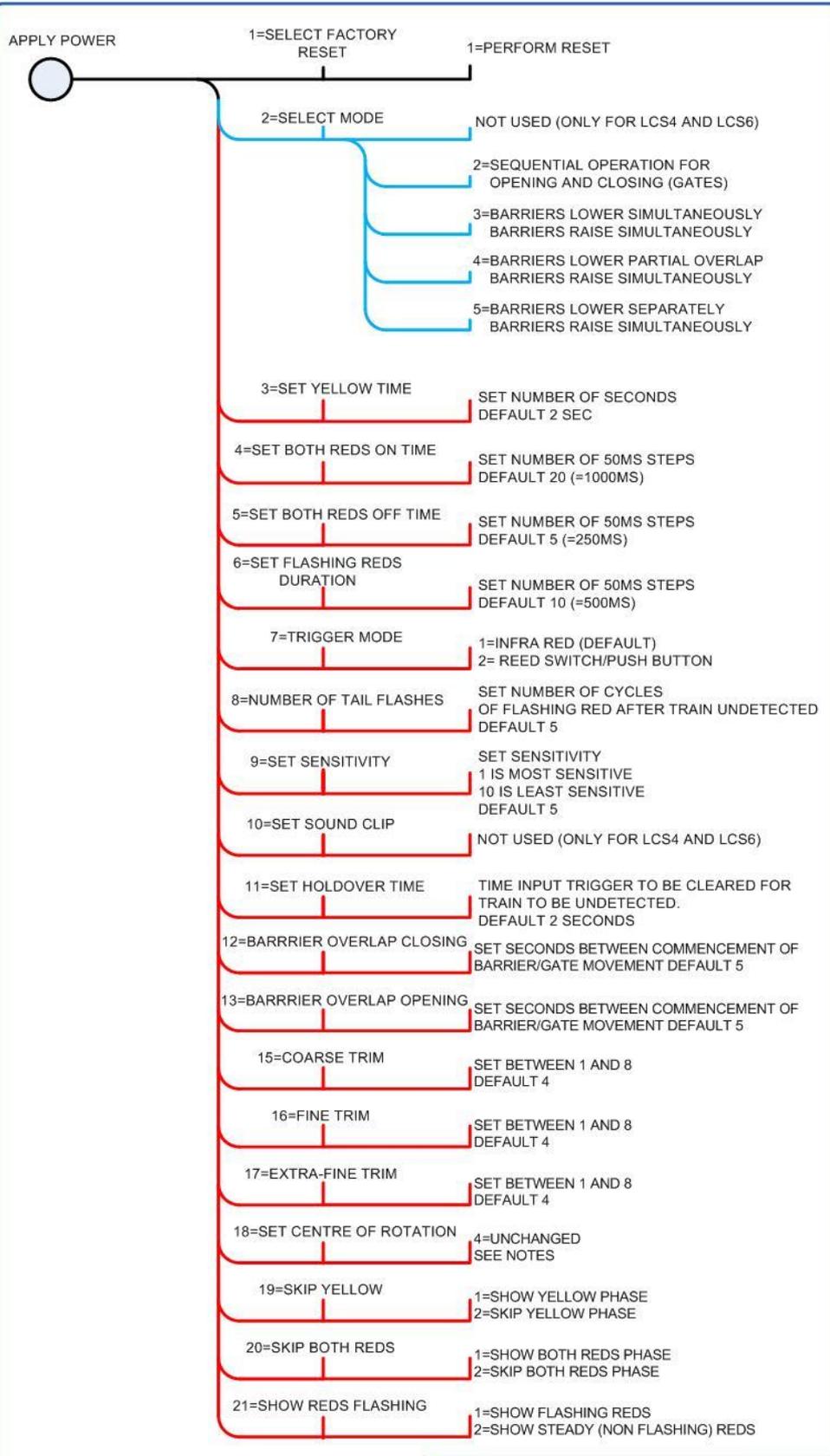
The red led on the PCB flashes at 1 second intervals. When the required number of flashes is seen (see later for the list of possible choices) the button is released to store the first value. At this point the led comes on for five seconds to confirm the value is stored.

The led then starts flashing again, and this time the button needs to be pressed to store the second value.

Once the two values to be stored are entered, the led flashes 10 times rapidly, and the module starts operating.

Most values entered can range between 1 and 255 (see below for limits). If more are seen, or the programming is aborted by switching off, then the programming must be repeated.

Following the diagram is a detailed explanation of all the settings.



PROGRAMMING DIAGRAM
LCS5 CONTROLLER VER 001



Factory Reset

By performing a factory reset, any changes which have been made to any settings will be returned to the standard factory defaults, those being for a gated crossing with yellow and red lights.

Mode 1 - Play all Sounds

The mode is only applicable to the LCS6, which has a built in sound module.

Mode 2 - Level Crossing with Gates

Selecting this mode causes the module to perform a Factory Reset, followed by setting the module up to simulate a UK level crossing where gates are used and the sounder is a bell.

Once this mode has been selected, other values can be changed if necessary.

Mode 3 - Level Crossing with Barriers

Selecting this mode causes the module to perform a Factory Reset, followed by setting the module up to simulate a UK level crossing where the barriers fall at the same time and the sounder is a Yodalarm.

Once this mode has been selected, other values can be changed if necessary.

Mode 4 - Level Crossing with Barriers

Similar to mode 3, but the second barrier lowers when the first barrier reaches approximately 30 degrees above horizontal.

Mode 5 - Level Crossing with Barriers

Similar to mode 3, but the second barrier lowers when the first barrier has reached the horizontal.

Setting 3 - Set Yellow Time

Following a reset, the time that the yellow led is lit is set to 3 seconds. The duration can be changed here to between 1 and 255 seconds. See below for how to set this duration to zero so the yellow led is not shown (setting 19).

Setting 4 - Set Both Reds On Time

On UK crossings, after the yellow aspect is extinguished, both reds are shown together for approximately 1 second.

The duration can be changed here to between 50ms and 12.5 seconds, in 50ms steps.

The default value is a setting of 20 which gives a duration of $20 \times 50\text{ms} = 1000\text{ms} = 1 \text{ second}$. See below for how to set this duration to zero so that both reds are not shown (setting 20).

Setting 5 - Set Both Reds Off Time

On UK crossings, after the yellow aspect is extinguished, both reds are shown together for approximately 1 second. Then they both are extinguished.

The duration of them being extinguished can be changed here to between 50ms and 12.5 seconds, in 50ms steps.

The default value is a setting of 5 which gives a duration of $5 \times 50\text{ms} = 250\text{ms} = 1/4 \text{ second}$.

Setting 6 - Set Flashing Duration for Reds

The duration that the red leds are lit during the flashing part of the sequence can be set in 50ms steps, the default being 10 so each red led is alternately lit for 500ms (1/2 second).

See below for how to set this duration so both reds are shown steady instead of flashing (setting 21).

Setting 7 - Set Trigger Mode

The default trigger mode is infra-red. It can be changed here to triggering by a switch or reed relay. Note, keeping the switch closed will keep the barriers lowered.

For triggering by reed switch, increase setting 8 to allow the whole train to pass before the barriers are opened. This could be risky if gates are being used.

Setting 8 - Set the Number of Tail Flashes

Once the train has cleared the sensor, the lights continue to flash for a number of cycles determined by this value (default 5 cycles), before the barriers open.

Setting 9 -Sensitivity

The module is supplied with the infra-red detector sensitivity pre-set to suit most installations and should not need adjustment.

In locations such as tunnels, or when the module is not being used under the track bed, then it may be desirable to adjust the detection threshold.

The sensitivity is factory set to 5, and can be adjusted from 1 to 10 (with 1 being the most sensitive and 10 being the least sensitive).

Setting 10 - Select Sound Clip

The mode is only applicable to the LCS6, which has a built in sound module.

Setting 11 - Holdover Time

This setting determines how long a train needs to be undetected before the module considers it has passed. The default is 2 seconds and allows for the gaps between carriages.

If the module detects that a slow train has passed, when in fact it is still crossing the sensor, increase this value.

Setting 12 - Set Barrier Overlap (Closing)

This setting determines how long after the first barrier has commenced closing, the second one should commence closing. The default is 5 seconds.

A setting of 1 sets zero delay between barrier operation, and the barriers will close together.

Setting 13 - Set Barrier Overlap (Opening)

This setting determines how long after the first barrier has commenced opening, the second one should commence opening. The default is 5 seconds.

A setting of 1 sets zero delay between barrier operation and the barriers will open together.

Setting 15 - Coarse Trim

Setting 16 - Fine Trim

Setting 17 - Extra Fine Trim

The default operation is for the barrier to be open 45 degrees anticlockwise from the servo centre position, and closed 45 degrees clockwise from the servo centre position.

This occurs when the Coarse Trim=4, the Fine Trim=4 and the Extra Fine Trim=4.

Reducing the coarse trim by 1 reduces the servo movement by 20 degrees (10 degrees in each direction)

Increasing the coarse trim by 1 increases the servo movement by 20 degrees (10 degrees in each direction)

Reducing the fine trim by 1 reduces the servo movement by 4 degrees (2 degrees in each direction)

Increasing the fine trim by 1 increases the servo movement by 4 degrees (2 degrees in each direction)

Reducing the extra-fine trim by 1 reduces the servo movement by 1 degree (0.5 degrees in each direction)

Increasing the extra fine trim by 1 increases the servo movement by 1 degrees (0.5 degrees in each direction)

For example, setting Coarse=4, Fine=4, Extra-Fine=2 gives a rotational range of approximately 88 degrees.

Setting 18 - Rotational Centre

The rotational centre for the barrier is normally the the servo centre position. The default operation is for the barrier to be open 45 degrees anticlockwise from the servo centre position, and closed 45 degrees clockwise from the servo centre position.

This can be varied by changing setting 16.

If this value is set to a step less than 4, then the centre of rotation will be changed by 1 degree anticlockwise for each step below 4.

If this value is set to a step greater than 4, then the centre of rotation will be changed by 1 degree clockwise for each step above 4.

So for instance, if the centre of rotation is at the default centre of the range of the movement of the servo, then setting 19 is set to 2, then the centre of rotation will change to 2 degrees anticlockwise of the original position.

This process can be repeated for greater changes.

The program will not allow the servo to operate outside its acceptable operational range.

Setting 19 - Skip Yellow

If this setting is set to 1, the yellow led will be operational.

If it is set to 2, the yellow led will not be shown.

This setting is used to adjust the light sequence for continental level crossings.

Setting 20 - Skip Double Reds

If this setting is set to 1, the phase of the sequence when both reds are shown will be operational.

If it is set to 2, the phase of the sequence with both reds lit will not be shown.

This setting is used to adjust the light sequence for continental level crossings.

Setting 21 - Show Reds Flashing

If this setting is set to 1, the red leds will flash.

If it is set to 2, the red leds will be shown steady.

This setting is used to adjust the light sequence for continental level crossings.

Types of servo supplied and model of speaker may vary.