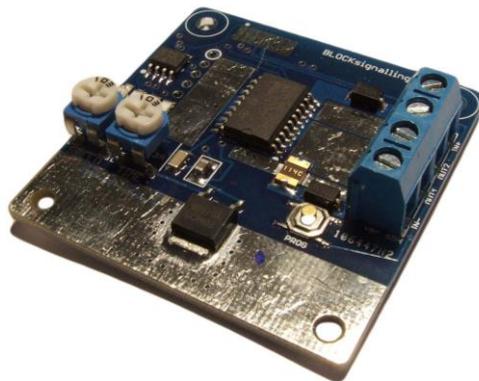# DC SHUTTLE WITH SPEED CONTROL SS2A

DC Shuttle Train Controller with Adjustable Delay and Built-in Speed Controller

- Automatically operates a train backwards and forwards along a single line

- Waiting time at the ends can be varied with a simple screwdriver adjustment

- The module includes speed control, so a separate controller is not required

- An acceleration function is also included for trains departing for a more realistic operation.

- An led on the PCB shows when the train is moving forwards, and flickers when it is reversing

- Fixed and random delays can be programmed easily for realistic operation

- Microprocessor controlled for accuracy

- Simple wiring and operation

The SS2A is one of our new range of DC shuttles, designed to add variety and interest on a layout by operating a model train back and forth along a section of line.

The train stops when it crosses a track gap at the end of the line, cutting off power to the locomotive. A diode fixed across the gap and allows the train to run in the opposite direction when the module changes the polarity to the track. Two diodes are supplied to fix across the track breaks.

The waiting time can be set between 1 second to 10 minutes using the simple adjustment on the module.

This model has a built-in DC throttle, so you can set the speed of the train, whilst saving the cost of an additional DC throttle to control your shuttle trains.

There are a number of additional functions which you can program if you wish to vary more than just the train speed and waiting time. These are covered in the sections below.
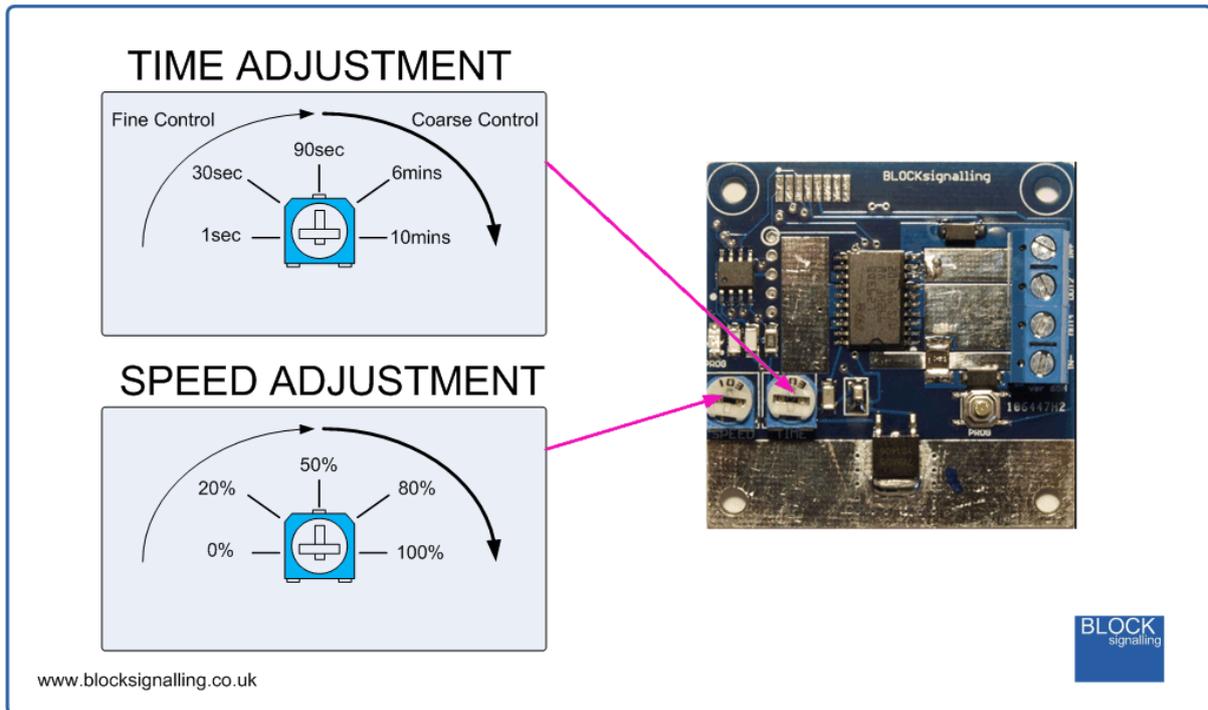
Timing Adjustment (Shuttle with Track-break Diodes)

The timing is adjusted with a small screwdriver, which fits into a slot in the adjuster mounted on the PCB.

The adjustment is very fine for the first half of the rotation, setting the timing between 1 second and 90 seconds and then becomes more coarse up to the maximum setting of 10 minutes.

The time set is the interval between each change of the polarity of the feed to the track. It needs to be set to allow the train to reach the end of the line past the diode, and also allow for the required waiting time.

If the setting too low, the train will not reach the end of the line before changing direction.

TIME ADJUSTMENT

Fine Control — Coarse Control

90sec
30sec — 6mins
1sec — 10mins

SPEED ADJUSTMENT

50%
20% — 80%
0% — 100%

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The module reads the time setting when the power is applied, and each time the direction changes.

Generally, it is easiest to set the approximate time using the diagram above then switch off the power for 10 seconds or so. When the module is re-powered, it will read the setting and commence its operation.

Minor adjustments can be made whilst the unit is running, and they will be used at the next opportunity.

To select random timing, see below.

Power Supply

The module requires a 12V DC power supply, with a minimum recommended capacity 0.5A for N and Z scale and 1.0A for OO and HO scale.

One of the wall socket type 12V DC power supplies is ideal. DO NOT use your existing DC Throttle or Train Controller as this will damage the SS2A.

The module is also provided with a 2.1mm jack (centre pin positive) as an alternative to using the terminals to connect the power supply.

It is important to connect the power with the right polarity; otherwise the module will not operate.

No damage will be caused by incorrect polarity connection, or using a power supply of other than 12V, although the module may get warm and shutdown to protect itself.

Connecting Up

If you are using diodes to stop the train at the end of the track, a small break is required in one rail to allow diodes to be connected (the diodes are included with the module).

The break can be cut with a small hacksaw or dremel. It is suggested that the gap is filled with a small amount of epoxy glue to prevent debris shorting the gap over time.

When the train passes the break in the track, the diode prevents traction current reaching the train until the polarity is reversed by the module.
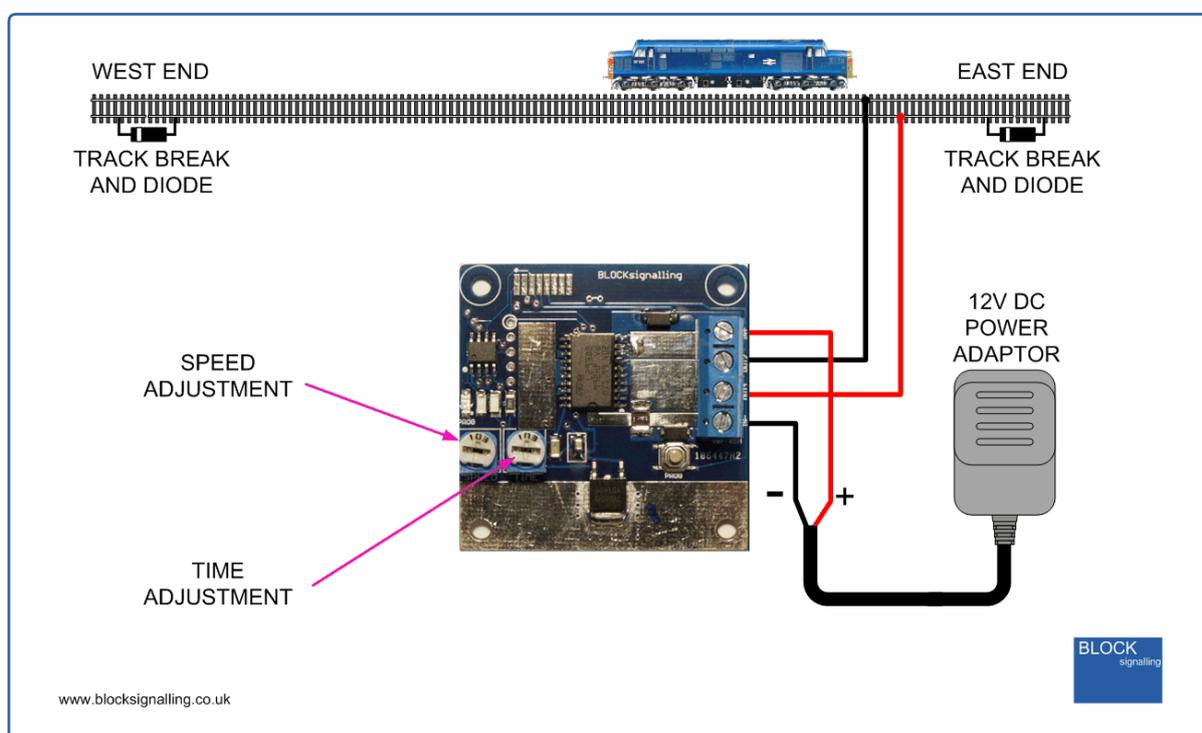
Led Operation

There is a small red led on the module which lights to indicate which direction the train is running (and is also used during the programming procedure).

When the train is moving forwards, the led is mainly lit, only turning off briefly once a second to indicate the operation of the module timing.

When the train is moving backwards, the led is lit for 0.5 seconds on and 0.5 seconds off.

Programming Additional Functions Function

The module includes a number of functions and settings which can be adjusted by programming memory locations in the module with different values to tell the module to operate in a certain way.

To do this, the module has a number of memories (M1,M2,M3, etc) which can be programmed to different values to change the operation of the module. The programming procedure is explained later.

Speed Control and Shuttle Function

The module includes a speed controller which provides a switched 12V output to the rails which is varied (pulsed) to control the speed of the train.

The operating frequency of the pulsing (26kHz) has been chosen to be kind to motors and to be inaudible to humans.

Lower frequencies can result in noisy motors, either humming or whining. Both these noises are caused by the minute vibrations of the motor and its coil windings, and can cause damage in the long run, as well as being distracting to the operator.

As well as operating as a shuttle (swapping the polarity of the feed to the track) the module can also operate as a normal DC throttle. In this mode, the polarity of the feed to the track does not vary.

If you want to operate the module as a simple speed controller, and turn off the shuttle function totally, then you can set memory M2 to a value of 2.

When powered on the loco will accelerate up to the speed set on the adjuster and then stay at that setting. The SPEED control on the module can be adjusted at any time to vary the speed.

To return the module to the shuttle function, reprogram memory M2 to a value of 1.

Setting the Running Time to Fixed or Random

As supplied, the shuttle uses the same fixed timings on each run, set by the TIME control on the module.

There is an option to switch on random timings, where on each run the timing will be set to between 25% and 100% of the time set by the TIME adjustment. So, for instance, if the timing is set to 4 minutes each run will vary between 1 minute and 4 minutes.

To use to random running times, set memory M5 to a value of 2. Setting it to a value of 1 returns the module to fixed times.

Setting the Acceleration Rate

As supplied the module and advances the power from off to the set speed on the SPEED adjustment over a period of about 5 seconds.

The acceleration function is used to start the train's movement smoothly, building up to full speed.

The smoothness of the acceleration will depend to an extent on the motor fitted and the smoothness of the drive components of the locomotive used.

If the time set on the module is set below the time required for the locomotive to reach the stopping diode or the end of the track, then the train will also smoothly decelerate.

The rate of acceleration can be varied with memory M4, which has a default value of 5 and can be set between 1 and 60 (where 60 is the slowest rate of acceleration). The value set is the approximate time to accelerate, so a setting of 5 means it will take approximately 5 seconds for the loco to accelerate from stationary up the speed set on the SPEED adjuster.

Waiting Time

Normally, the loco will run to the end of the track and be stopped by the diode. It will reverse direction when the track voltage reverses.

If you want to use the loco on a long track without diodes, the loco will slow to a stop, and then after a second move off in reverse.

If you want the loco to wait for a period, at a platform for example, then you can set memory M6 to the required waiting time.

If you want this waiting time to be random, where on each run the timing will vary between 25% and 100% of the time set in memory M6, then you can set memory M7 to a value of 2. Setting memory M7 to a value of 1 will make the waiting times fixed.

Antistiction

It takes more force to move a stationary locomotive than to keep one running. Occasionally a loco may be found which moves off smoothly, but then races away once it is moving.

To help with this, it is possible to provide a high energy pulse to the locomotor to get it moving, before reducing the voltage and proceeding to accelerate the loco up to the speed set on the adjuster.

The duration and amplitude of the pulse are adjustable, as is the starting voltage for the acceleration ramp (see diagram below). Trial and error will be required to determine the required settings for any particular loco. It is only recommended to turn on this pulse if you are having particular problems with a loco racing off once it is moving.

Three memory settings control the pulse:

M8 sets the pulse width – a setting of 1 turns the pulse off. Settings above 1 increase the pulse duration from 100ms in steps of 50ms. The maximum setting is 250 (ie 12.5 seconds)

M9 sets the Pulse Amplitude – available settings are 1 (minimum) to 10 (maximum). These levels are with respect to the possible output of the module, not the setting of the SPEED adjustment on the module. The default setting is 1.

M10 sets the amplitude at commencement of the acceleration ramp. Available settings are 1 (minimum) to 10 (maximum). These levels are with respect to the possible output of the module, not the setting of the SPEED adjustment on the module. The default setting is 1.
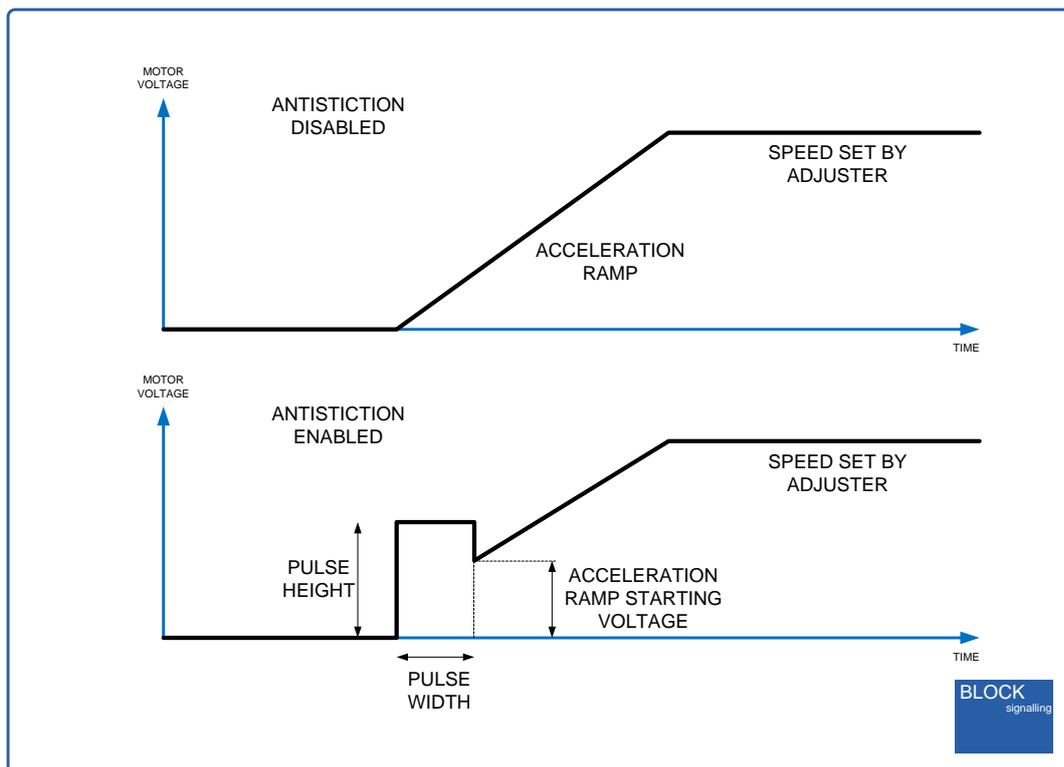
The recommended method to set the pulse is to initially set a wide pulse width, say a second, by setting memory M8 to a value of 20. Then set memory M9 to a value of 5, so it will be fairly certain that the loco will have enough power to move off.

Repower the module and check the loco moves off. Reduce the value of M9 to reduce the amplitude of the pulse to a level where the loco just perceptibly moves off. It will probably stop after a second; this is when the initial pulse has finished.

Now set the ramp to begin at the same value as the pulse amplitude, ie set M10 to the same value as M9.

You can now reduce the pulse duration if required.

Some trial and error may be required to obtain settings which are realistic.

Factory Reset

To reset the module back to factory settings, switch off the power to the module and hold down the Push Button. Apply the power and continue holding the push button until **1 flash** of the led is 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 seen **1 flash** press the button (hold the button down for a second and then release). You will see a long flash of five seconds and then 10 rapid flashes. The reset procedure is then complete and the module will restart with factory default settings. If you make a mistake programming, simply repeat the process.

Program Flow Diagram

The module has a number of memories (M1,M2,M3, etc) which can be programmed to different values to change the operation of the module.

Programming is performed by 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 for the memory location being programmed, the button is released. At this point the led comes on for five seconds to confirm the memory location is selected.

The led then starts flashing again, and this time the button needs to be pressed to store the value for that memory location (hold the button down for a second and then release).

Now the memory location and value to be stored have been entered and the led flashes 10 times rapidly to indicate the programming is complete. The module starts operating.

If you make a mistake, you can perform a Factory Reset to return all the memories to their default value.

Following the diagram shows all the memory locations for this module.

APPLY POWER

1=SELECT
FACTORY RESET   1=PERFORM RESET

2=SELECT MODE
                                    1=SHUTTLE FUNCTION

                                    2=SPEED CONTROLLER FUNCTION

4-ACCELERATION   SET TIME TO ACCELERATE
RATE   DEFAULT 5 (SECONDS)
                        MINIMUM TIME 1, MAXIMUM TIME 60

5=RUNNING TIME   1=FIXED RUNNING TIME (DEFAULT)
RANDOM   2=RANDOM RUNNING TIME

6=WAIT TIME   WAIT TIME IN SECONDS
                        DEFAULT=1
                        MAXIMUM=250

7=WAIT TIME RANDOM   1=FIXED WAITING TIME (DEFAULT)
                        2=RANDOM WAITING TIME

8=ANTISTICTION   SET WIDTH
PULSE WIDTH   DEFAULT=1
                        SEE TEXT

9=ANTISTICTION PULSE   SET AMPLITUDE
AMPLITUDE   DEFAULT=1
                        SEE TEXT

10=START OF   SET AMPLITUDE
ACCELERATION RAMP   DEFAULT=1
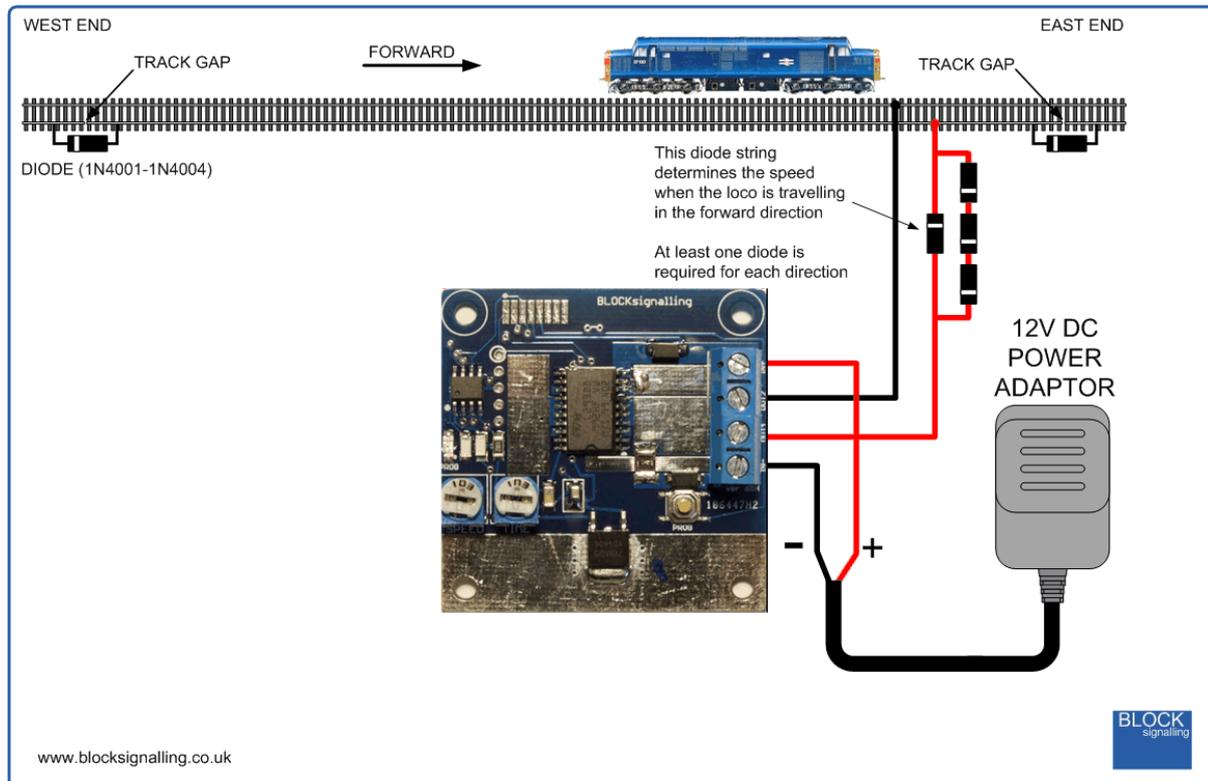   SEE TEXT

SS2A
DC SHUTTLE
MEMORY SETTINGS

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Other Ideas

Trains can be operated at different speeds by inserting one or more diodes in the feed to the track. Each diode has an approximate 0.7V voltage drop.

Use a different number of diodes in each direction to create different speeds in each direction. You need at least one diode for each direction.

WEST END
TRACK GAP
FORWARD
EAST END
TRACK GAP
DIODE (1N4001-1N4004)

This diode string determines the speed when the loco is travelling in the forward direction

At least one diode is required for each direction

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12V DC POWER ADAPTOR
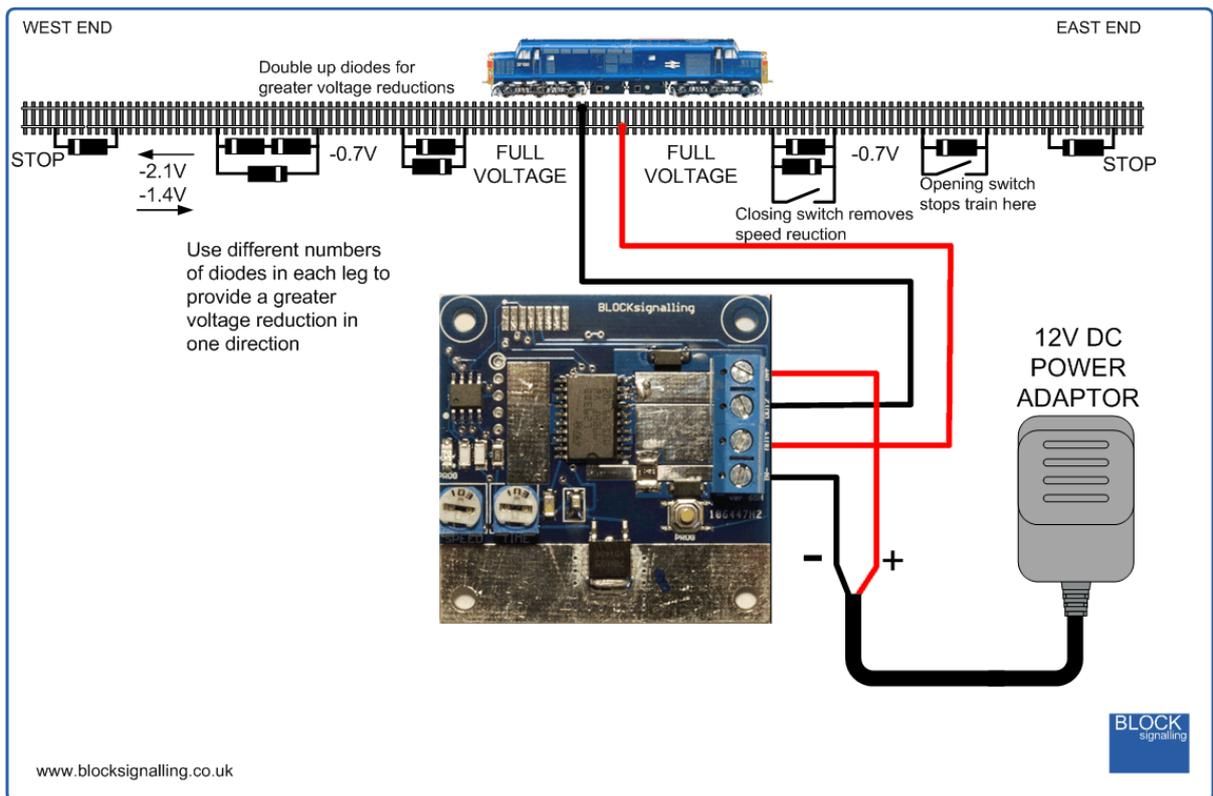
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Creating additional track gaps, with associated diodes, allows differing voltages along a length of track, and so different operating speeds in each section.

Use one diode in each direction to drop the speed in the following section by equal amounts.

Use a different number of diodes in each direction to create different speeds in each direction. You need at least one diode for each direction.

Speed reductions can be removed by shorting across the diodes with a switch.

Different stop points can be created by inserting additional single diodes, and shorting across them when they are not required.

WEST END

EAST END

Double up diodes for greater voltage reductions

STOP

-2.1V
-1.4V

-0.7V

FULL VOLTAGE

FULL VOLTAGE

-0.7V

STOP

Use different numbers of diodes in each leg to provide a greater voltage reduction in one direction

Closing switch removes speed reuction

Opening switch stops train here

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12V DC POWER ADAPTOR

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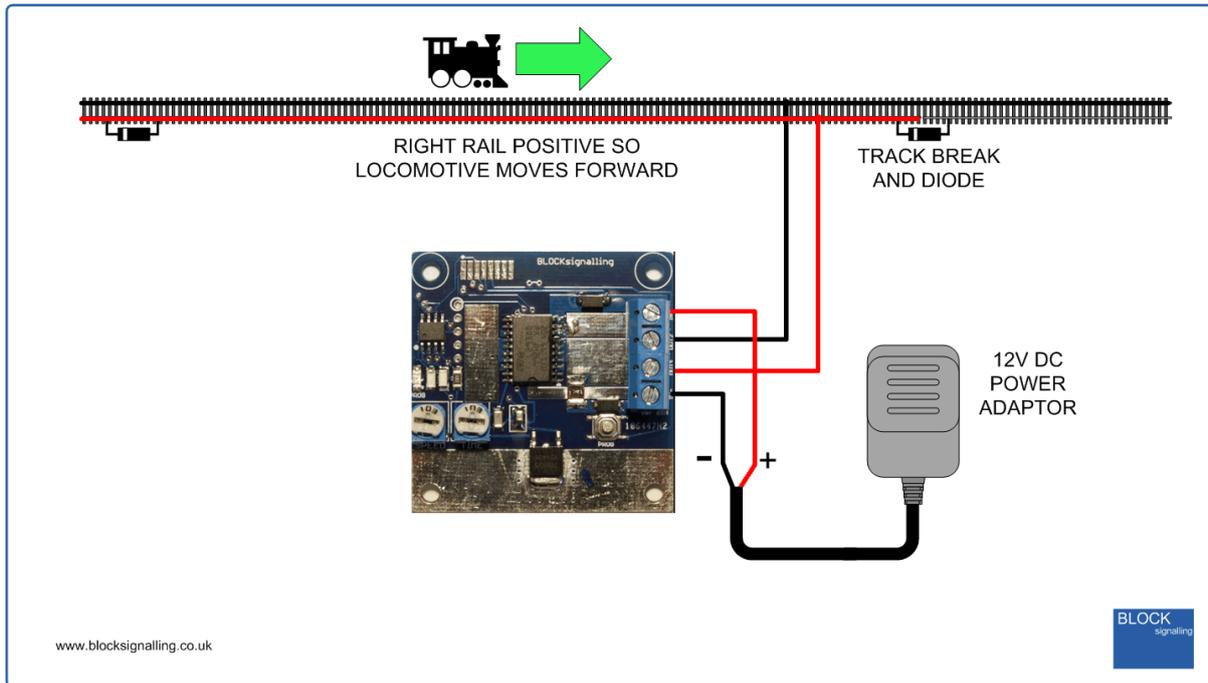BLOCK signalling

Troubleshooting

If you encounter problems getting up and running with the SS2A, this section should hopefully help solve your problems.

The function of the module is to periodically reverse the polarity of the tracks. This will cause any DC locomotive on the tracks to move forwards and backwards.
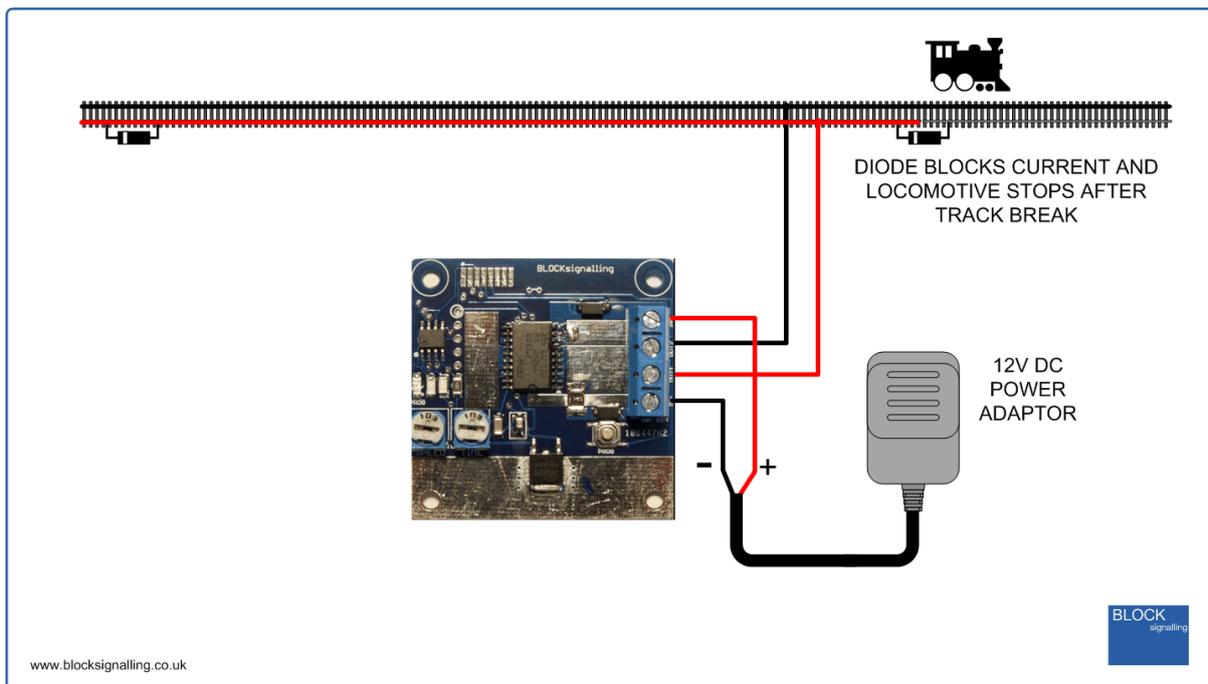
The convention is that a DC locomotive will more forwards when the right hand rail is positive and the left hand rail is negative, when viewed from the driver's position.

When the output of the SS2A feeds positive volts to the right hand rail, the whole right hand rail will be positive, up until the diode across the track gap. When the side of the diode with the white stripe is more positive than the side without the stripe, the diode will block current flow.

The train travels forwards.

RIGHT RAIL POSITIVE SO
LOCOMOTIVE MOVES FORWARD

TRACK BREAK
AND DIODE

12V DC
POWER
ADAPTOR

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When the train passes the diode, such that there is no longer a positive feed
reaching its wheels, it will stop.

DIODE BLOCKS CURRENT AND
LOCOMOTIVE STOPS AFTER
TRACK BREAK

12V DC
POWER
ADAPTOR

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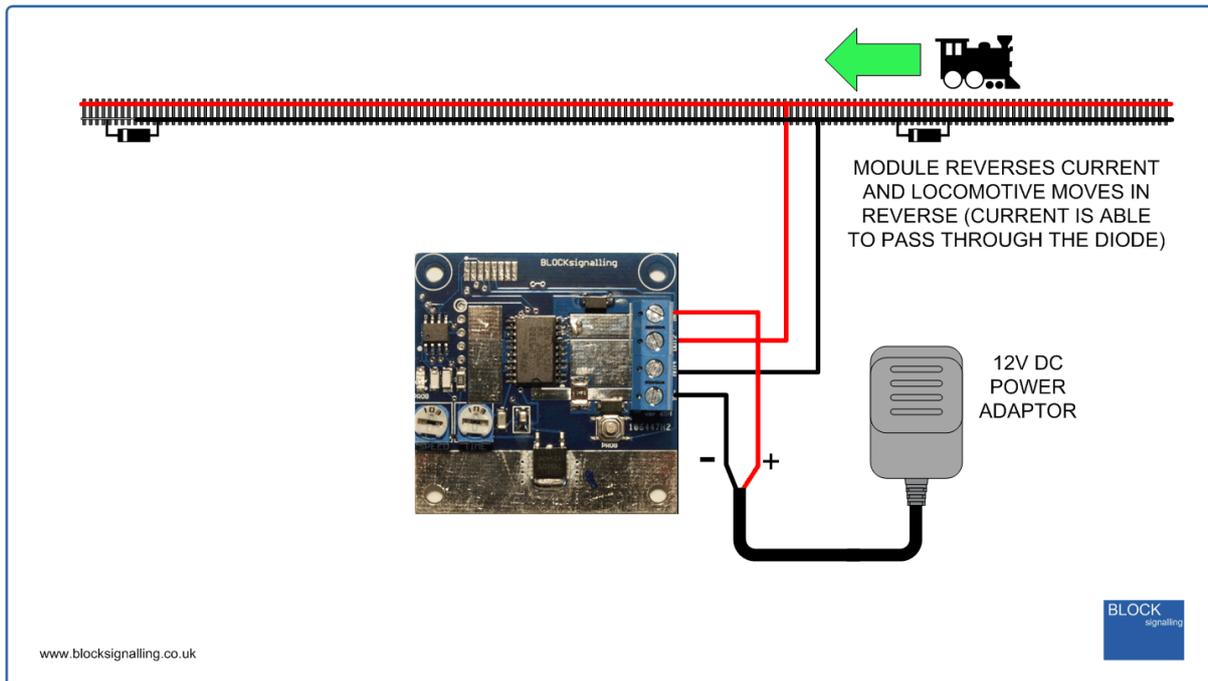
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After some time, settable by using the adjuster on the module, the SS2A reverses the current.

Now the whole left rail is positive.

The right rail is negative, up until the second diode.

The locomotive now receives power from both rails, and runs in reverse.

The process repeats at the other end.

MODULE REVERSES CURRENT
AND LOCOMOTIVE MOVES IN
REVERSE (CURRENT IS ABLE
TO PASS THROUGH THE DIODE)

12V DC
POWER
ADAPTOR

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If the locomotive overruns the diodes at the end of the tracks, we recommend checking the diodes are connected the correct way around and the gap in the rails is clear of debris. Then swap the polarity of the connections to the rails. This should cure any overrunning problems.
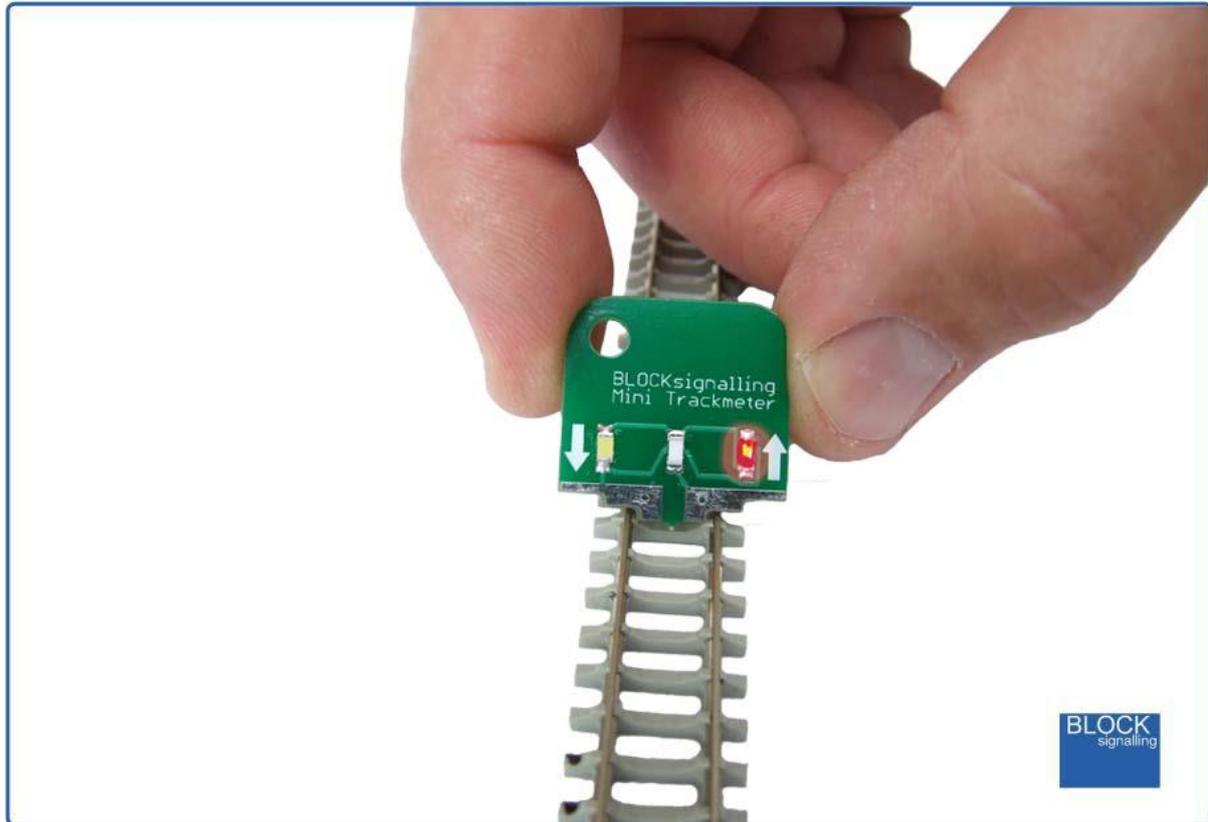
If you are still having problems, place the locomotive in the centre of the track and set the time control fully anti-clockwise and the speed control fully clockwise. The locomotive should move forward and reverse, changing direction once per second.

Now increase the time setting and the train should move forward and reverse with a greater time between reversals. You may want to reduce the speed setting slightly.

If the time is now increased so the train can completely cross one of the diodes at the end of the line, it should stop. If it doesn't, it is likely the motor connections inside the locomotive are incorrectly swapped, and although the train is traveling forwards, the polarity of the power it is receiving from the rails should really cause it to be running it in reverse.

In the drawings above, when the power is first applied to the module, with the track connections shown, the train should always move from west to east first.

If you want to confirm the track polarity, and the direction the locomotive will travel, then our Mini Trackmeter will quickly confirm the polarity.

If even after following the above you are still having problems, please follow the steps below:

1. Remove all wiring connections to module except the power supply.

2. The power supply positive connection must be to the IN+ terminal and the power supply negative supply must be connected to the IN- terminal. Alternatively, connect a DC power supply to the 2.1mm jack (centre positive). DO NOT use the output of an existing train controller to power the module as this will damage the module.

3. Turn on the power supply, and the red led on the PCB should light. It may flash, this is normal.

4. If the led does not flash, check the power supply is 12V DC and the polarity is correct. If you have a meter, you can check the supply has reached the module by measuring the voltage on the screws of the terminal block.

5. If you think it is a possibility that your power supply is faulty, you can connect a 9V PP3 battery to the terminals (this lower voltage will operate the module, but may not be able to run trains).

6. If the led is seen operating, and flashing at regular intervals, the main logic of the module is operating correctly. Switch off the module, and connect the track wiring.

7. Place a train the centre of the track run and turn on the power.

8. The train should move forward (with the positive rail to the right of the driver). If the train does not move, turn the speed control fully clockwise.

9. The train should run forwards until its wheels cross the track gap and diode. It should stop at this point.

10. If it reverses before reaching the diode, increase the time setting on the module.

11. If it crosses the diode and continues running, check the correct orientation of the diode, and that the track gap is clear of debris. Check also for the correct polarity of the track connections.

12. If you think the settings of the module may be incorrect, perform a Factory Reset, and start again.