

# Electronics for Model Railways



## Chapter 27

### Pocket Money Projects

By Davy Dick

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In memory of Margaret

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# Pocket Money Projects

This chapter presents a series of mini-projects that first appeared in issues of the MERG Journal. They are designed as '*getting started*' kits for beginners, although they are also useful to all enthusiasts.

PMPs aim to meet the following requirements:

- Cheap** Projects must be inexpensive, so that you can '*have a go*' without any great outlay (or any great loss if they make a mess of things!)
- Easy** Kits must be simple to build. They must use the minimum number of components and avoid fiddly parts such as surface mount devices. They should require no specialist tools or computers to build and test. The components should be mounted on a piece of stripboard, as stripboard has wide copper tracks and wide gaps between tracks. This avoids producing costly printed circuit boards and makes soldering easier, minimising shorts between tracks, etc.
- Useful** Kits must provide useful extensions to layouts, including some features not otherwise available.
- Educative** The notes must include a section on '*How it works*' that is not too technical but helps you learn a little bit more about electronics.
- Alterable** Kits will not be at the cutting edge of technology, providing every possible facility. They are fun projects with a useful item at the end. They should be capable of modification as you learn more.
- Easily available** The parts should be available from all major electronics suppliers and use no specialist components, apart from the pre-programmed PIC chips that some projects use. All the projects that follow are available as complete kits of parts to MERG members.

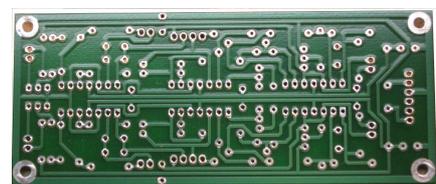
## Note

Many of these MERG kits use stripboard to mount the components, although more kits are now available with printed circuit boards.

## Using stripboard

Once you have got past the stage of buying and using ready-built equipment, you might consider tackling building a kit for your layout.

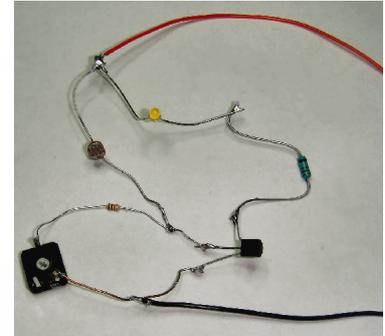
A careful read of the instructions, an evening's soldering and the kit is complete and can be tested and connected. You don't need to worry about how it works; only what it can do for you. Commercial kits usually come with a printed circuit board similar to the one shown here.



Eventually, you might think of trying to build a circuit you saw in a magazine or on the Internet – or even a simple idea that you want to try. For the great majority of projects, getting the components is easy; they can be purchased from suppliers such as Rapid, Radiospares, CPC, Bitsbox, etc., or even cheaper on eBay. But, since they are not complete kits, there will not be a printed circuit board available. PCBs are great; they tell you where to put your components, which way round they go and they make life simpler for the constructor.

Without an available PCB for your, you have a number of options.

- Solder them all hanging in mid air, as in this photograph. This will work for a very small temporary test circuit but is useless for large or permanent builds.
- Design your own PCB and have it made for you. This involves learning how to use a design package. Even worse, manufacturing one board can be expensive and if you keep making changes, you have to get the PCBs made up all over again each time..
- Design your own board and etch the PCB yourself. This still involves learning the design software. It also requires working with chemicals or sending the design off for commercial production.

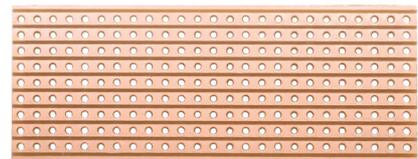


None of these are of much use to a beginner. That is where stripboard comes in.

Stripboard (originally called 'Veroboard') is designed as a prototyping board for building a one-off project. The finished project, if proven to be successful, can be put into long-term use or – if it becomes popular - PCBs might be produced for wider use.

Most stripboards use a thin sheet made from SRBP (synthetic resin-bonded paper - a paper based laminate). Higher quality versions are made from FR-4 (a fibreglass-reinforced epoxy laminate).

As the picture shows, one side has copper tracks bonded to it. The whole board is then drilled through with holes that are spaced 0.1” (2.54mm) apart. This is designed to have the same spacing as ICs, their holders, etc.



## Sizes

The most commonly used sizes by hobbyists are

25mm x 64mm - This board has 9 tracks, each track with 25 holes

64mm x 95mm - This board has 24 tracks, each track with 37 holes

The 25mm x 64mm version are used in all the Pocket Money Projects.

Vero Technologies make a large range of other sizes and details are on their website at:

[www.verotl.com/circuitboards/veroboards](http://www.verotl.com/circuitboards/veroboards)

If required, the boards can easily be cut to size with a small hacksaw.

All the circuit's components are laid on the opposite side to the copper tracks, as shown in the picture.



The wires from the components are bent, then inserted through the holes and soldered on to the copper tracks on the other side.

The copper tracks are used to make the connections between the various components. If you see a picture of a project on a stripboard, it usually has the strips underneath running horizontally.

## Cutting the tracks

To use the copper tracks to maximum efficiency, the lengths are often cut, to create smaller runs of connecting track.

In the case of the chip shown in the above picture, the track between the rows of chip pins would have to be cut; otherwise the pins would be shorted together.

You could cut the track with a sharp knife but that can be a messy – and dangerous – task.

If you are considering making a number of projects on stripboard, it might be worth investing in a stripboard spot face cutter, which quickly does a nice clean job of removing the unwanted copper. The cutter is placed in the desired hole in the copper track and rotated back and forth until a circular area of copper is removed. Check as you go, otherwise you might drive the cutter right through the board!



An alternative to a spot face cutter is a drill bit (3mm or 5mm). Turn the bit it by hand; an electric drill would rip a large hole in the stripboard in two seconds flat!

In either case, before moving on, check that there no remaining tiny strips of copper still bridging any of the track sections. Next, clean the copper strips prior to soldering the components.

## Making links

The copper tracks are not always sufficient to connect all the components. In those cases, and it can happen often, you fit wire links between the points you want connected. You can see copper wire links in the above picture.

They nearly always run vertically, bridging two section of track by jumping over the tracks in between. Any wire will do, as long it can handle the current it is expected to carry.

## Building instructions

This chapter offers ideas and suggestions for modules to improve your layout.

It also provides an overview of how the various kits work.

Full building instructions are available for each kit, with step-by-step instructions on building and testing and connecting.

# Pocket Money Projects

## Part 1

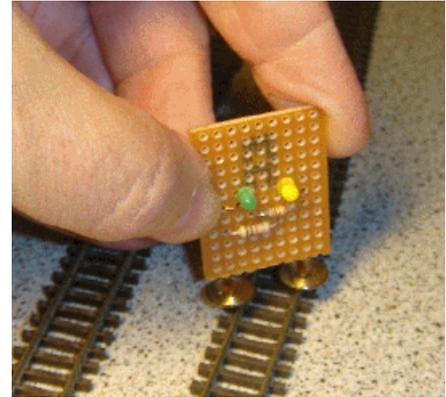
A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

## Track power indicator

There are many occasions when you need to check if a particular section of track is receiving power.

- Maybe the power to a track section is switched by relays or switches.
- Maybe the wiring or connections to a piece of track is suspect.
- Maybe you want to check if you have wired a new piece of track with the polarity the correct way round.



You could always check with a multimeter but these are inconvenient, bulky and awkward to use in tight situations.

The position of the studs on this little unit allows them to touch across 'N' gauge, 009 or '00' gauge rails.

To test, you simply touch the module's studs on to the rails, as in the picture.

- If no LEDs light, there is no power.
- If one LED lights, you have power.
- If the other LED lights, you have power in the opposite direction.
- If both LEDs light, your track is receiving DCC power.

Fancier commercial versions are available, some even with digital readouts - but they are 20 times to 100 times more expensive.

### How it works

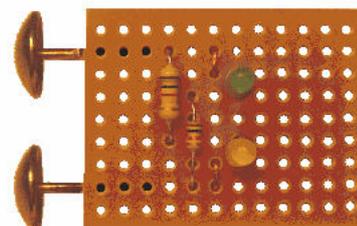
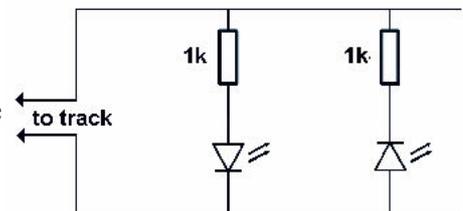
The circuit diagram is very simple.

Two LEDs (light emitting diodes) are connected across the track when the board's studs touch the rails.

The 1k resistors (known as '*dropper resistors*') are there to make sure that the high track voltage does not result in excessive current that would destroy the LEDs.

A LED only lights when it is connected across a voltage in the correct direction. If wired the other way round, it won't do any damage, but it won't light up.

You will notice that the two LEDs are wired in different directions from each other.



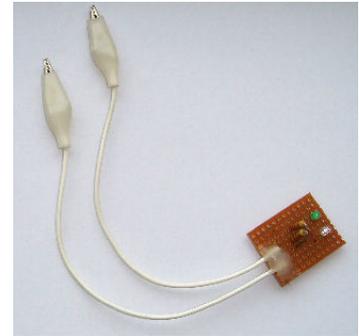
So, if the track voltage is one polarity, one LED lights up. If the track voltage wired in the opposite polarity, the other LED lights up. That way, you can still test for track power regardless of whether the controller is set to forward or reverse.

If you have a DCC system, your track voltage is constantly switching polarity at a very fast rate, so both LEDs will light up if DCC power is detected.

To check for a break in the track, run the studs along the track. When the LED(s) goes out, you have just passed the break. Look for a broken dropper or a loose fishplate.

You may want to have the module connected to a stretch of track while you check the layout wiring, switches, connectors, etc.

If your layout has track sections that are switched by control panel switches or relays, an alternative to studs is to solder two short lengths of wire with clips soldered to their ends. The tester can then be clipped across the track while tests are carried out.



If you are a MERG member, this is available as a kit - PMP1 Part No: 801.

# Pocket Money Projects

## Part 2

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using stripboard

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## Train detector

This circuit detecting changes in light levels and it is has many uses in model railways.

A light sensor is positioned between track sleepers and the light to it is blocked when a train goes over the sensor. This triggers an output from the module (in our case lighting a LED).



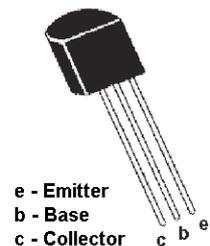
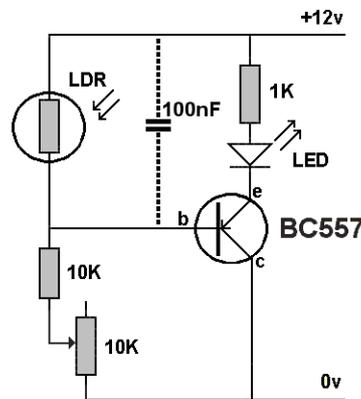
### Possible uses include:

- A train stops in a marshalling yard and yard lights come on.
- A light comes on in the control panel when a train reaches a required point on an obscured section of track.
- Control panel lights indicate which hidden sidings are occupied.
- Triggering events in other modules such as a sequencer, a timer, a CBUS or EzyBus input module.

### How it works

Here is the circuit diagram for the light detector. It is powered from a 12v supply since that is a common voltage on model railways. However, it can also be operated by a 5v supply.

It uses a transistor to light the LED. A transistor is a small 3-wire semiconductor device that was originally mainly used as an audio or radio frequency amplifier, like those in an old transistor radio. Depending on the voltage fed to them, they can also act like a switch, as in this project.

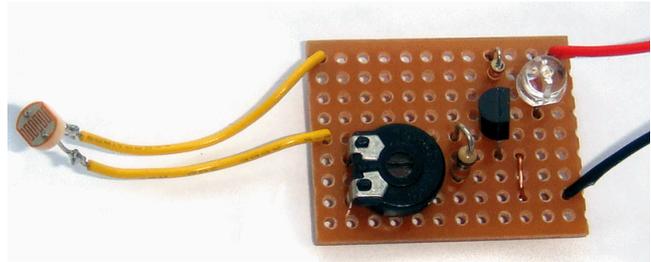


The main flow of electrical current in a transistor is through its collector and emitter wires. That current is used to light the LED. The 1k resistor that is wired in series with the LED protects the LED by limiting the current flowing through it.

The amount of current through the transistor depends on what happens at its 'base' connection. It acts like a tap, controlling the amount of current flow.

The light sensor used in this project is called a light dependent resistor (LDR) because its resistance varies with the amount of light shining on it. The one shown has a resistance of between 8kohms and 24kohms when exposed to light (at 10 lux), rising to 1Mohm when in darkness. Its resistance values varies between those two extremes, as the light value alters.

There is an LDR, a 1k resistor and a 10k preset potentiometer (a small variable resistor) all in series across the 12v supply. The base of the transistor is connected to the junction of the LDR and the 1k resistor. The voltage at the transistor base will vary depending on the resistance of the LDR (which, in turn, varies with the amount of light shining on).



When exposed to light, the LDR has a low resistance and the voltage at the transistor base will be high. This will turn the transistor off and the LED will be unlit.

When in darkness, the LDR has a very high resistance and this lowers the voltage at the transistor's base. This switches on the transistor and the LED lights.

## Setting up

The variable resistor can be adjusted with a small screwdriver, to set the point at which you module switches the LED on and off with changes in light level. This setting will be depend on the ambient light in your railway room and where the LDR is located.

When the correct setting is found, it is possible to remove the preset, read its value and replace it in the circuit with an ordinary resistor of the same value.

Usually, however, it is best to leave the preset on the board, as it allows for any future alterations.

In situations of very bright lighting, you may need to partially shield the LDR by placing it in a small length of tubing, although this is not normally needed.

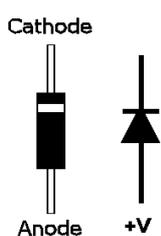
If the LDR is placed in a particularly gloomy area of the layout (e.g. in a tunnel or behind tall buildings), you may have to use an auxiliary source of lighting, such as a lamp suspended above the track.

## Modifications

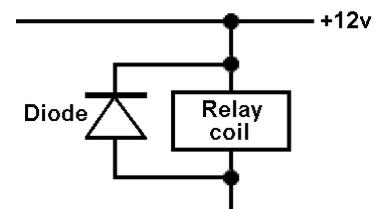
The LDR can be mounted on the stripboard if necessary, although most operators prefer it to be connected to the board by a a length of wire to allow easier placement.

Similarly, the LED can be fitted to the board, or can be fitted to a remote place (e.g. the operator's control panel, on top of a yard lamp) using wires from the board to the LED.

The circuit shows a 100nF capacitor wired across the LDR. This is only required where the circuit is feeding into a CBUS, EzyBus or computerised system, to prevent any possible stray pulses from the loco's motor or the DCC signal on the track from generating unwanted pulses.



Lastly, the LED and its 1k resistor can be replaced by a 12v relay, if required. You can connect the relay's coil either way round, although the diode (a 1N4001 type is sufficient) has to be wired the correct way round, as in these diagrams.



If you are a MERG member, this is available as a kit - PMP2 Part No: 802.

# Pocket Money Projects

## Part 3

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by Davy Dick M1853

## Servo controller / tester

Servos have become very popular in model railways in the last few years.

They are used for operating points, signals, crossing gates and barriers, cranes, and a variety of lineside animations.

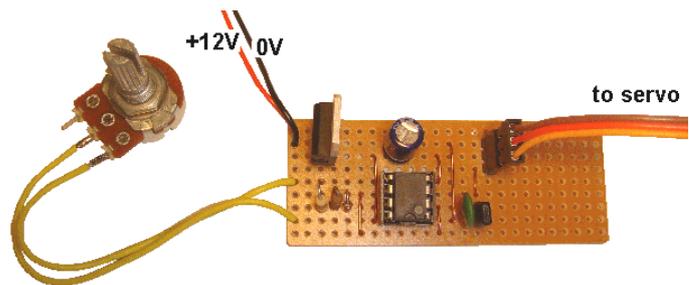
The MERG Servo4 kit is mostly used to control servos, with one kit being able to handle four separate servos. It is designed to move a servo's arm between two fixed points and at fixed speeds set by the user.

Of course, a servo arm can be rotated to many different positions, and at different speeds each time - if a manual control is used.

That is what this project is for. Turning the spindle of the variable resistor (called a '*potentiometer*' or '*pot*') rotates the servo arm. You can turn the pot really slowly, or as fast as you want; the servo will respond accordingly.

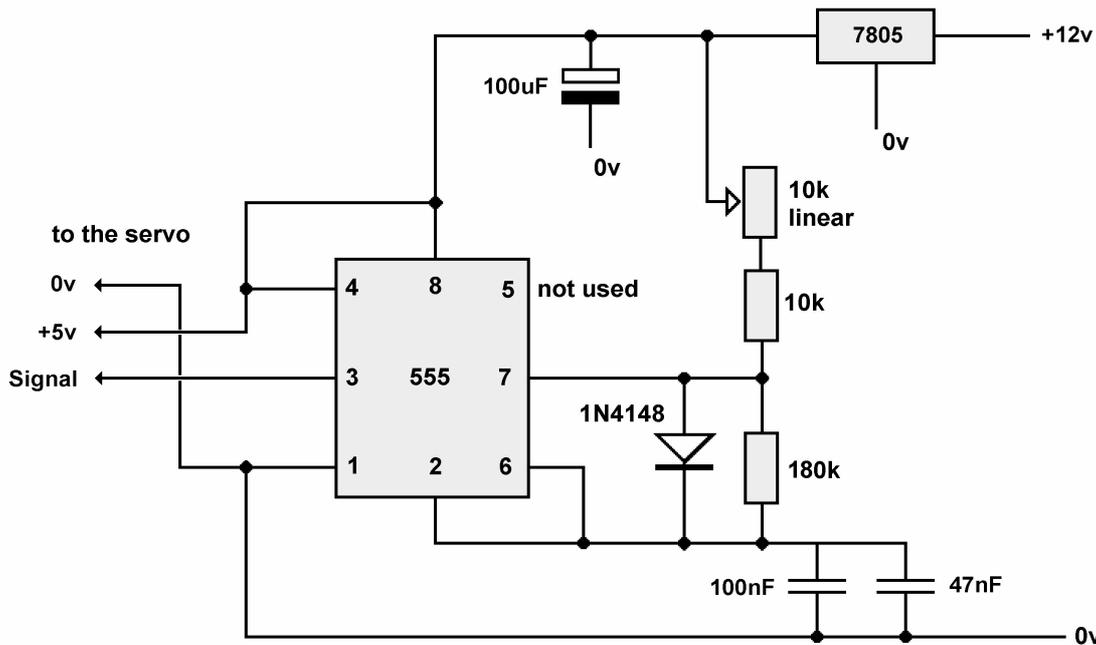
Its uses include:

- A cheap introduction to playing with servos.
- A module to test servos before fitting them on a layout.
- Manual control of aerials, radar heads, guns (great for kids).
- When you need to move to intermediate positions (e.g. a flag at half mast)
- Mounting a cam on the arm, so you can scan a hidden area of the layout.
- An asymmetric turntable for smaller gauges (the pivot point is near one end rather than the centre).
- Any manual control for occasional use.



### How it works

This project uses a tried and tested circuit. The 555 chip is a timer IC which is just what we need for this project. Servos expect to receive regular pulses on their '*Signal*' wire (the other two wires on the servo are for our 5v power). The width of the pulse decides what position a servo arm will move to.



If a pulse is 1mS long, the arm will move fully in one direction, while a 2mS pulse duration rotates the arm fully in the opposite direction, Any pulse width between 1mS and 2mS results in an intermediate position (e.g. a 1.5mS pulse will move the servo arm to mid position).

The 180k resistor and the 100nf and 47nf capacitors are used to control the time between pulses, while these same capacitors are used in conjunction with the two resistors and 10k pot to control the length of the pulses. So, varying the resistance of the pot controls the servo arm's rotation.

The module is designed to work from a standard 12v DC supply and uses a 7805 voltage regulator to bring the voltage down to 5v for the chip and the servo.

If you are a MERG member, this is available as a kit - PMP3 Part No: 803.

# Pocket Money Projects

## Part 4

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easy to build projects  
using stripboard

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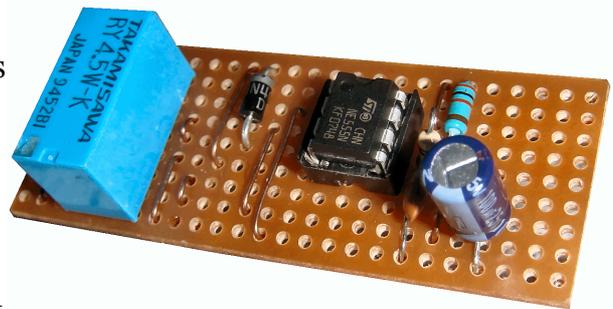
## Simple shuttle

The definition of a shuttle is “*a form of transportation that travels regularly between two places*”. On our layouts, that could be a loco or maybe a tramcar.

The loco runs to the end of the track and stops for a set time. It then reverses to the other end of the track before stopping once more. This cycle repeats indefinitely.

The uses for a shuttle include:

- Emulating a tramcar service.
- Emulating a country line, with tunnels at both ends (using longish waiting times at both ends).
- Emulating an industrial shuttle – e.g. ferrying material from mines to the docks or loading bays.
- Maintaining visitor interest at exhibitions, during back operations. People have something to watch while trains are assembled behind the scenes.
- Running in or warming up a motor, using short waiting times. The loco is constantly being exercised.
- Testing a loco before placing on a layout.



Ready-built commercial modules are available, such as the Gauge master SS-1, or the Just for Electronics Shuttle. These are fine for a basic shuttle, although our project carries out the same functions at a fraction of the cost.

More complex modules provide acceleration and deceleration, such as the Heath cote SA1 (although this module needs loco detectors) or the MERG Automatic Train Controller kit. As you would expect, you pay more to get these features.

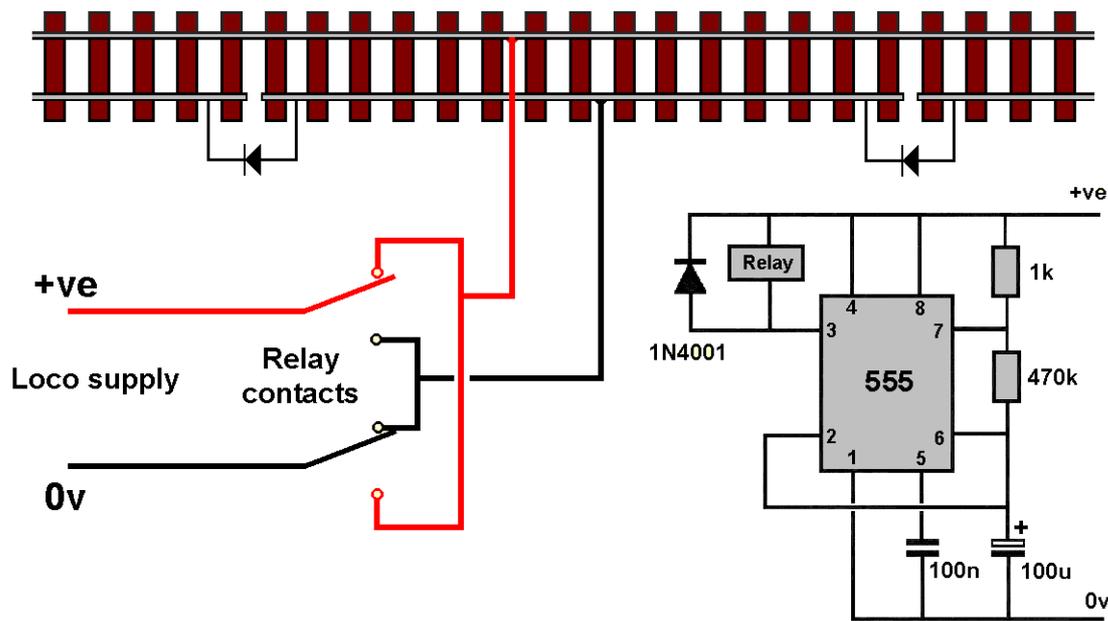
Most shuttle modules are for DC working, as DCC operations require more than just reversing the voltage on the track.

## How it works

This is a tried and tested circuit. It is used a 555 chip in '*astable*' mode which means that its output constantly switches between a high and low voltage. The rate at which it changes depends on the values of the resistors and the large capacitor.

For our project, there are long on periods and long off periods.

The 555's output (pin 3) makes a relay switch on and off at regular intervals and the relay's contacts reverse the voltage on the track.



The diagram shows that the track is split into three sections, with a long middle section and a shorter section at each end. The cuts in the track isolate the three sections from each other. One rail is continuous the entire length of the track. The centre section of track is constantly powered from a DC source, while the other sections have a diode wired across the gaps. Being diodes, they only allow current to pass in one direction.

The operating sequence is as follows:

- When pin 3 is high, the relay is not energised (it has a high voltage at each end of its coil).
- The relay contacts are as shown in the illustration, connecting the loco supply's positive to the upper rail and 0v to the lower middle section of rail.
- The loco moves leftwards and enters the left section until its rear wheels leave the middle section and power is lost.
- The train remains in the left section until pin3 of the 555 eventually switches low.
- The relay switches (it has a high voltage at one end and a low voltage at the other end).
- The relay contacts switch such that the positive supply is connected to the lower middle rail with 0V on the upper rail.
- The loco runs in reverse (because the diode allows the current to flow into the isolated left rail). It reverses into the middle section and then enters the right isolated section.
- When the loco wheels leave the middle section, it stops as it has no power.
- When pin 3 eventually switches high again, the relay drops out and its contacts return to the state shown in the illustration.
- The loco moves forward again out of the right section and into the middle section to start the cycle all over again.

The 555 chip can operate on a voltage range of around 4.5V to 14V and the time delays are independent of the voltage used.

The timer circuit can be powered from a 12V DC source, in which case, the relay should be a 12V type. Alternatively, the circuit could be fed from a 5V supply, using a 5V relay.

The loco supply voltage should match that required by the loco being used.

### **Setting the timings**

The circuit does not know how fast the loco is moving or how long the track section is.

It is up to you to use components that provide the delays that you need. As a minimum, the delay before switching should be long enough to allow the loco to get from one end of the track to the other.

The values shown in the illustration provide a delay of just over 30 seconds. Replacing the 470k resistor with a 820k resistor gives a delay of about 1 minute, while a 2M7 resistor gives a delay of around 3 minutes.

Changing the other resistor or the capacitor also has an effect on the on and off pulse widths.

There are formulae to work out the delays but you can use a simple calculator like the one at

<http://acetylcholinesterase/haematite/resource/handy/pinouts/555/>

If you are a MERG member, this is available as a kit - PMP4 Part No: 804.

# Pocket Money Projects

**PMP 4a**

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using stripboard

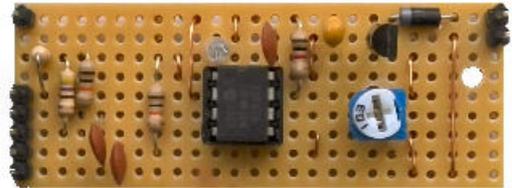
by Davy Dick M1853

## An automatic point changer for multiple trains

The Simple Shuttle kit (PMP4) provides a cheap and basic back-and-forth shuttle of a train from A to B and back. Useful but limited.

However, if we add a point at one end, we could have two trains traversing the main track.

This add-on provides automatic switching of the point.



### How it works

The Simple Shuttle is described above.

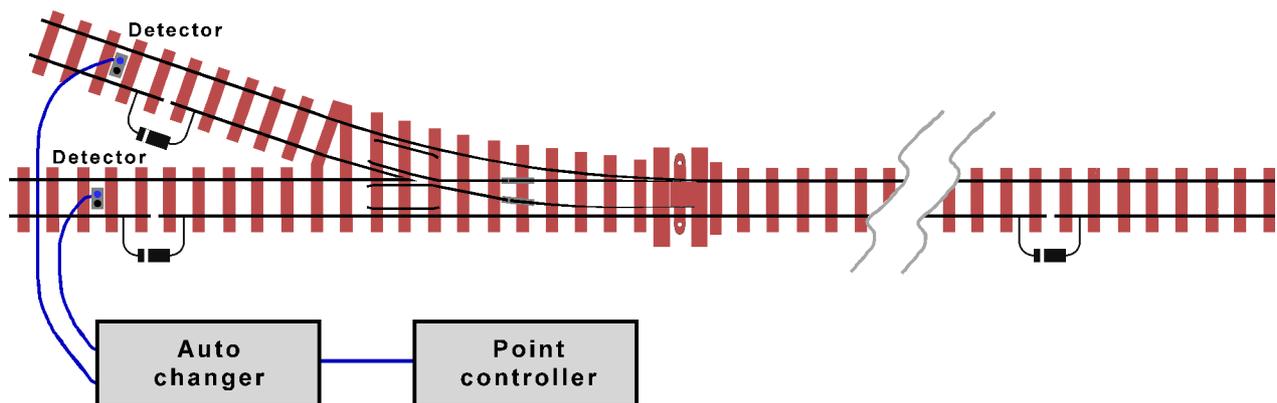
If you add a point and an extra diode, you have two trains available for shuttling.

The auto point changer module uses an infrared detector on each siding, so the module knows when both sidings are occupied – and switches the point accordingly.

For example, the module may change the point to the upper siding allowing the train to run to the other end of the track.

On its return, it is stopped in the upper siding and the point is changed to the lower siding – and so on.

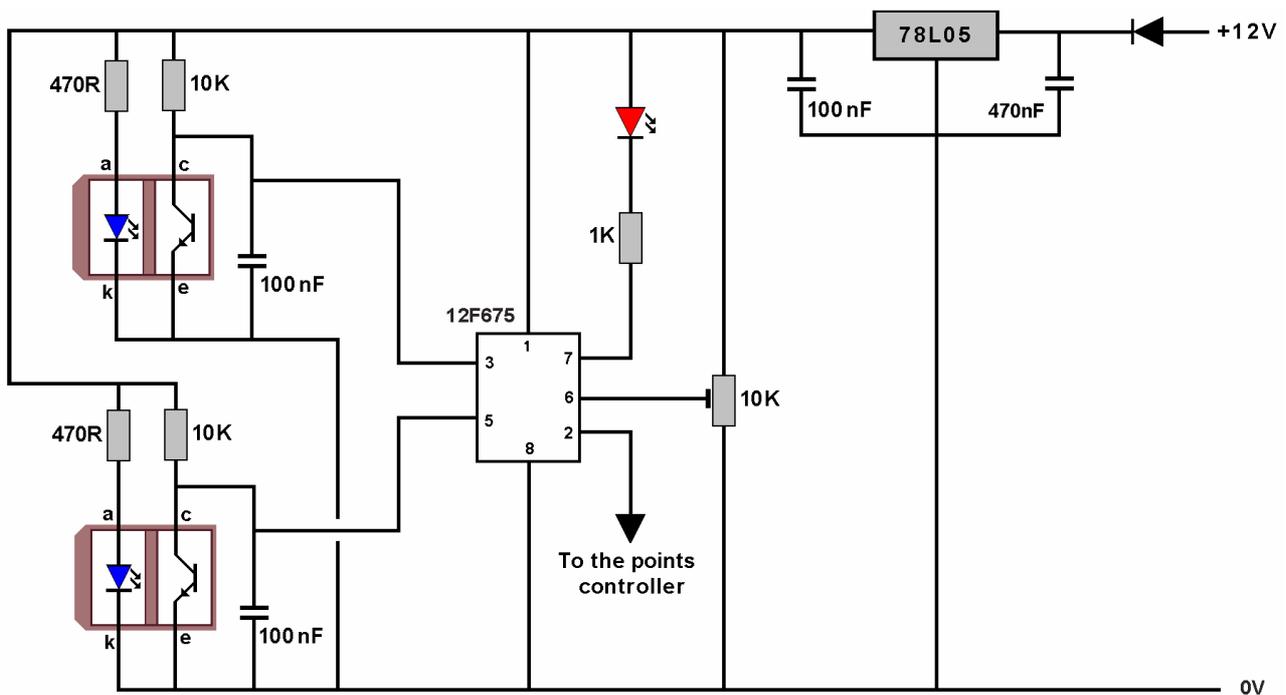
Here is how the system is arranged.



Here is the circuit for the module. It uses a pre-programmed PIC chip that is included in the kit. The chip has two inputs, from each of the two infrared detectors.

It is powered from your 12V DC supply.

The module's output on pin 2 directly connects to the input pin of an EzyPoints module or of a Servo 4 input (see later).

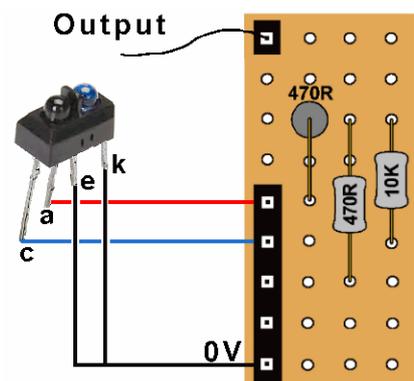


## Wiring the detectors

The TCTR5000 infrared detectors should be fitted at the point where the train stops in the sidings. They could be placed between the sleepers pointing upwards, or could be placed at the side of the track. The specification for the TCRT5000 sensor quotes a maximum distance of 15mm but it would be best to ensure that reflected distance between the loco and the sensor does not exceed 8mm or 10mm.

They are designed to detect light reflections that are bounced back from the loco, so work best with a reflective surface on the side of the train. If your loco is a dark colour, it would be beneficial to add a piece of white tape or white label to the side of the loco.

The unit has four leads – two for the power to the infrared emitter and two for the photodetector. The 'e' and 'k' leads both connect to the module's 0V, so each module only need three wires to connect to the module. The illustration here shows the wiring of Detector 1. Detector 2 is similarly wired.

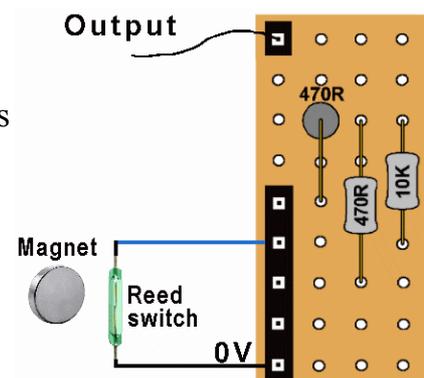


## Alternative inputs

This kit uses infrared detectors as its inputs. There are alternative inputs if you prefer. This could be as simple as small but powerful Neodymium magnets attached to the locos and reed switches replacing the infrared detectors.

This image shows the reed switch wired between the 'c' connection and the 0V connection on the board.

The second reed switch would connect between the other 'c' connection and 0V. Other options include the Laser TOTI (PMP 22) and the Hector.

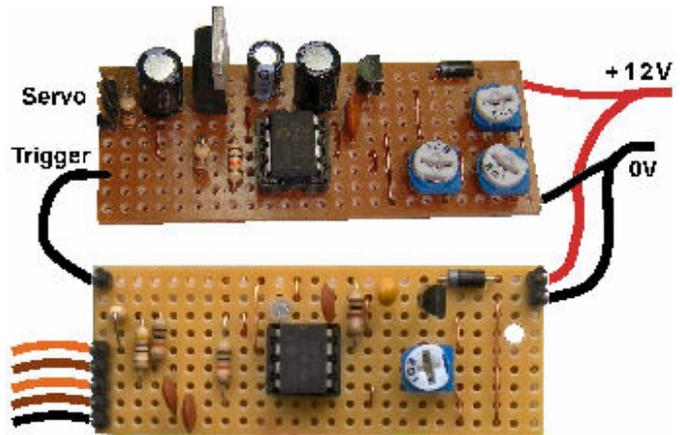


## Fitting

The auto changer and the point controller should share the same 12V supply. A single wire can then connect the output of the auto changer to the input of the point controller. The example shows connecting to an EzyPoints controller.

A demonstration of the kit can be viewed on YouTube here:

<https://youtu.be/dgTfWl2CN1U>



## Modifications

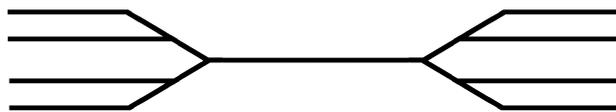
Why not fit a point at the other end of the shuttle line? That way, you can have three trains going back and forth.



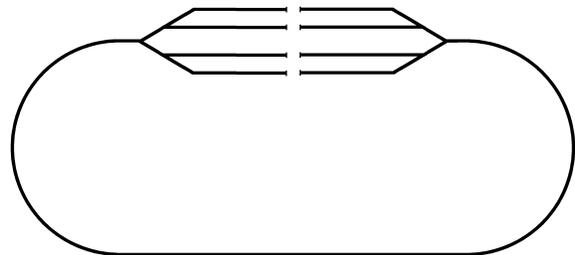
Ideal for a tramway addition to a layout, with the left hand sidings inside the tram shed and the right hand siding hidden behind a building.

The three way system above is implemented using another set of auto changers and servo controllers at the other end of the track.

However, extending it even further could be achieved by fitting yet more points and modules at each end and have multiple trains traversing the shuttle line.



Or you can redraw the configuration this way. Possible a handy addition to an exhibition layout. Stock up the sidings and there will be multiple trains always running 'round' the layout. Keeps the visitors amused while everyone fiddles around in the main layout's fiddle yard at the rear!



If you are a MERG member, this is available as a kit - PMP4 Part No: 804a.

# Pocket Money Projects

## Part 5

A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

## A logic probe

Many enthusiasts own multimeters, which are extremely useful tools for testing and fault-finding on layouts and on electronic modules. The ability to read different voltage levels helps trace bad joints, etc.

But, when dealing with modules that work on digital inputs and outputs, you only want to know whether a particular point in your circuit is at +5v or at 0v.

These circuits act like electric switches where much of the operation only works with ONs and OFFs, sometimes also called HIGHS and LOWs.

Examples uses of a logic probe are to:

- Check the supply pins of a chip. Is it getting both the +5v and the 0v?
- Check the output from a track detector – is it changing when a loco passes?
- Check the input to a circuit that is coming from a switch – is it going from +5v to 0v, or 0v to 5v, when the switch is operated?
- Check whether the inputs and outputs of CBUS and other digital modules are producing the expected results.

The internal circuits in lots of electronic modules work on 5v, even when they are connected to a 12v or other voltage supply. This project is for a very useful tool that tells you whether a point in the circuit is at +5v or at 0v.

You could ask why not just use a multimeter? You could connect the -ve lead of your meter to the 0v line of your module. Then you could tap various parts of the circuit with the other lead. If you have +5v on that point, you will get a reading. But – and here is the catch – if you do not get a reading, it does not mean that you have 0v at that point. You might just have a broken wire that is not connected to anything. To check for connections to 0v, you would have to connect the meter's +ve lead to the 5v line and then test with the other lead's probe. You would have to reverse your meter connections every time you wanted to check for +5v or 0v.

That is where a logic tester is handy. This, project, like the commercial versions, works by connecting the unit to the +5v and 0v of the module you are checking. Then you touch any point in the circuit. If +5v is on that point, a green LED lights up. If there is 0v at that point, the red LED lights up. All other voltages, or points not connected to anything, either keep the LEDs unlit or dimly lit.



Fancier commercial versions of our little tester are available - but they are about 20 times more expensive.

## How it works

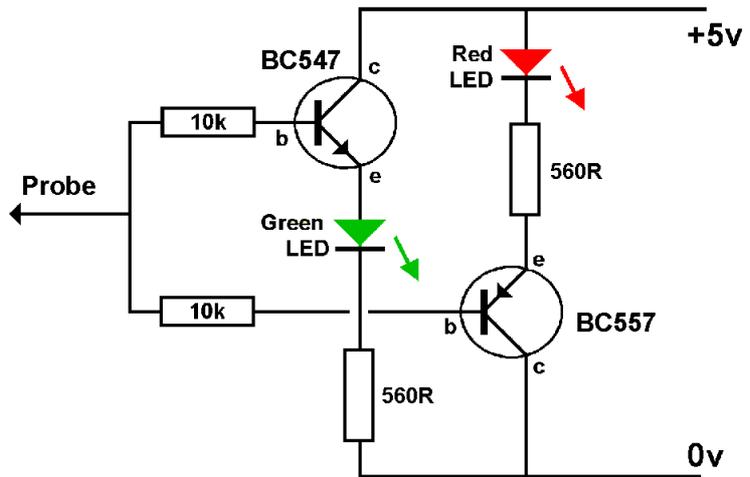
Here is the circuit diagram for the logic tester.

It uses just eight components.

It is really just two almost identical sections; one to light the red LED and one to light the green LED.

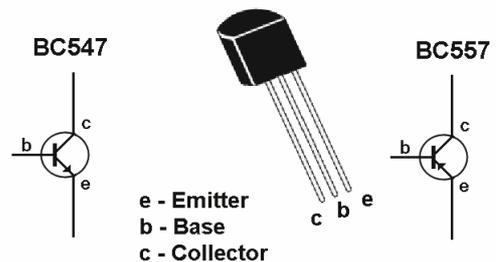
It uses a transistor to light each LED. A transistor is a small semiconductor device that was originally mainly used as an amplifier, like those used in an old transistor radio.

Depending on the voltage fed to them, they can also act like a switch, as in this project.



In normal operation, a small increase in current through the transistor's base results in a larger current through its collector. The total resistance of the LED and resistor means that there is a maximum current that can flow through the emitter/collector. When this point is reached, increasing the base current has no further effect. The transistor is said to be in '*saturation*'. The 10k resistors limit the base current to be sufficient to switch the transistor fully saturated.

The two transistors use different semiconductor layers in their construction. This means that the BC547 allows current to flow from its collector to emitter when its base is at a higher voltage than its emitter. The BC557 allows current to flow from its emitter to collector when its base is at a lower voltage than its emitter. That's why the red LED lights on 0V while the green LED lights on 5V.



If you are a MERG member, this is available as a kit - PMP5 Part No: 805.

# Pocket Money Projects

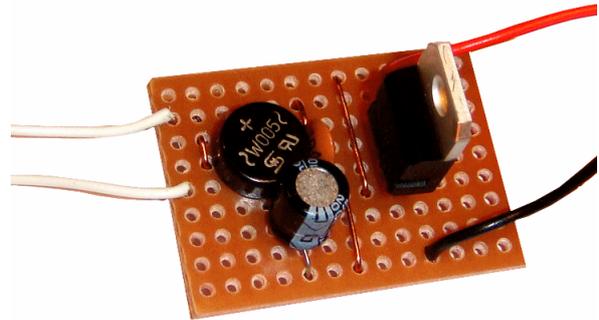
## Part 6

A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

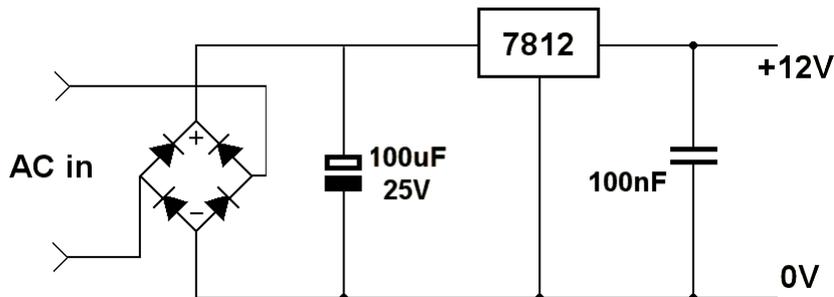
## A 12V output from a 15V AC supply

Many of the Pocket Money Projects are designed to work from a 12V DC supply. However, a number of loco controllers provide an auxiliary 15V AC output. This little module converts the 15V AC into a constant regulated 12V DC output.



### How it works

Here is the circuit diagram of the 12V regulator.



An AC voltage is called an alternating current because its polarity is constantly changing. The voltage rises from zero to a maximum value in the positive direction, before falling back to zero again. It then rises to a maximum value in the negative direction, before returning to zero. It does this 50 times every second (50Hz).

The bridge rectifier ensures that its output is always positive-going.

The 100uF capacitor is used as a reservoir, to keep the voltage that feeds the 7812 at a fairly constant level.

The circuit can handle a maximum output current of 1.5A, although in that case you ought to fit a heat sink to the 7812 to prevent it overheating.

The circuit does not use fuses or cutouts, but the 7812 has built-in overload protection.

The 7812 has an internal voltage loss of 2.5V, so needs a minimum of 14.5V DC input to ensure a smooth regulated output.

If you are a MERG member, this is available as a kit - PMP6 Part No: 806.

# Pocket Money Projects

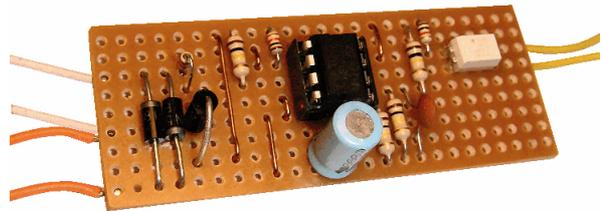
## Part 7

A series of small, cheap, easy to build projects using stripboard

by Davy Dick M1853

## A DCC train detector

Part 2 of the series looked at a train detector that reacted to changes in light levels when a train passed over a point in the track. It could be used on both DC and DCC layouts but it only produced a change of output while the train blocked the light.

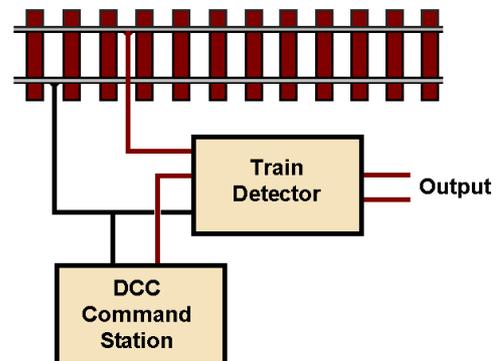


This circuit is only for DCC systems but it will maintain a changed output as long as the train remains in a section of track. Its output is normally at a high resistance but this changes to low resistance when a train sits anywhere on that track section – either moving or stationary.

Possible uses include:

- A train enters a marshalling yard and the yard lights come on.
- Control panel lights indicate which hidden sidings, or obscured sections of track, are occupied.
- Triggering events in other modules such as the Servo4 or CANACE8C.

The track section to be detected has to be isolated from the rest of the layout track, probably by using plastic rail joiners at each end. The DCC power is fed to this track section as shown in the illustration. Both leads from the command station are taken to the train detector board, with one of the leads passing through the circuit on the board before being wired to the track.

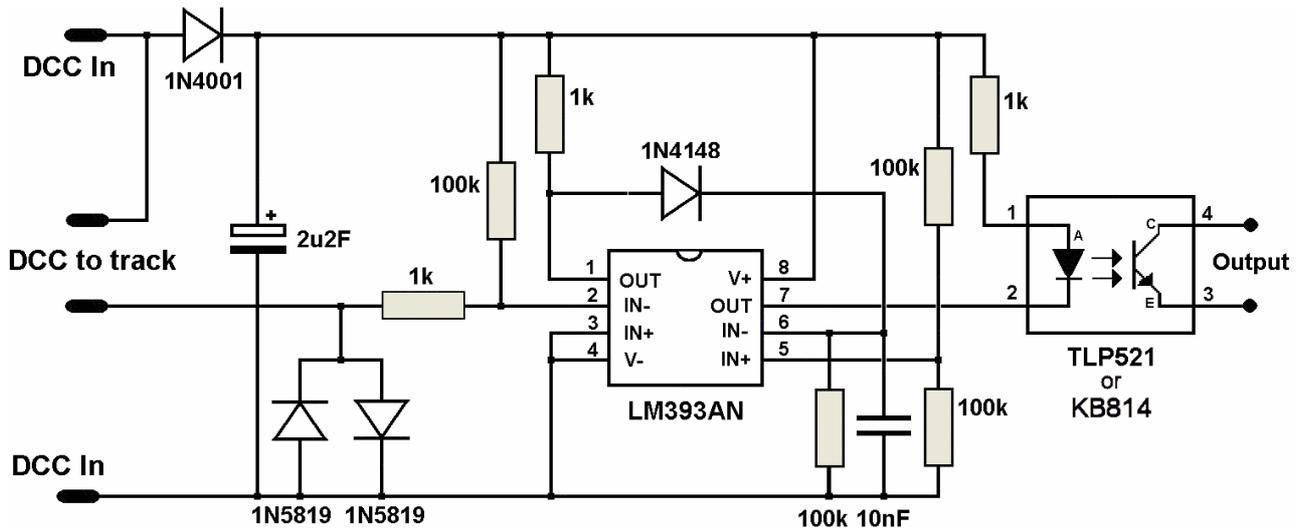


This allows the circuit on the board to detect any current flowing between the command station and a train on the track.

It needs no separate power supply as its gets its power from the DCC supply.

### How it works

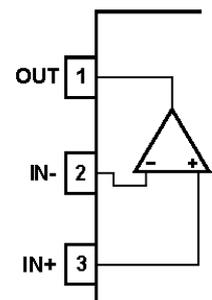
Here is the circuit diagram of the DCC train detector, as designed by MERG member Trevor Stockill.



The KB814 is the more easily available alternative to the TLP521, as is the Sharp EL817 and others.

The voltage from a DCC command station alternately swings positive then negative, in what is described as *'bipolar DC'*. The 1N4001 diode only passes the positive-going pulses which are then smoothed out by the 2.2uF (2u2F) capacitor. The voltage across this capacitor provides the DC supply for rest of the circuit.

The LM393 is a 'dual comparator' chip. This means that it contains two separate comparator circuits inside the chip. This illustration shows one of the comparators. Current is able to flow through the OUT pin when the voltage on the IN- pin is higher than the voltage on the IN+ pin.



As you can see from the above circuit diagram, the supply from the command station passes through the diodes on its way to the track.

A stationary loco on that track will draw a tiny current to power its decoder, while a moving loco will draw even greater current. In both cases, the current produces a stream of voltage pulses across the diodes. These pulses are fed to pin 2 and result in the output pin 1 having a pulsed output. The pulses are routed via the 1N4148 diode and increase the charge on the 10nF capacitor until it reaches approximately half the supply voltage. At this point the second comparator turns on and switches on the optoisolator.

When the train leaves the track, there are no further pulses to maintain the charge on the capacitor. It then slowly discharges through the 100k resistor and its potential eventually drops below the comparator level and switches off the LED in the optoisolator.

The values of the 10nF capacitor and the 100k resistor across it determine the switching delay.

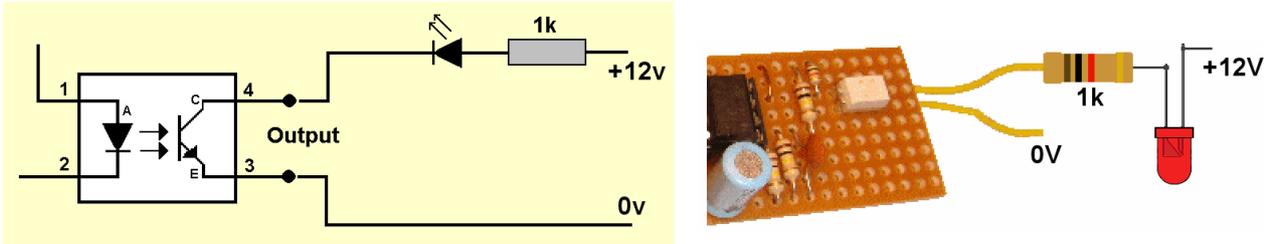
When output pin 7 goes low, current flows through the LED in the KB814. The light from the LED falls on a photo-transistor and its resistance drops. The change in resistance across pins 3 and 4 is then available to switch other circuits (see later). The KB814 isolates the train detector from other circuits, preventing potential problems from interference or voltage differences.

## Examples of use

Here are some typical examples of how you could use the project to improve your layout.

### Lighting a LED

A simple but useful facility. The output wires could be taken back to a control panel and used to illuminate a LED when a train occupied the track section. No need to guess whether track sections that are out of sight, or a hidden sidings in a tunnel, are occupied.



Since the KB814 output is isolated from the rest of the circuit, a separate power supply is needed to provide the 12v that lights the LED.

A 12v supply is shown above since most layouts already use a 12v power supply. If you are using a 5v supply, you could reduce the value of the resistor to around 560 ohms.

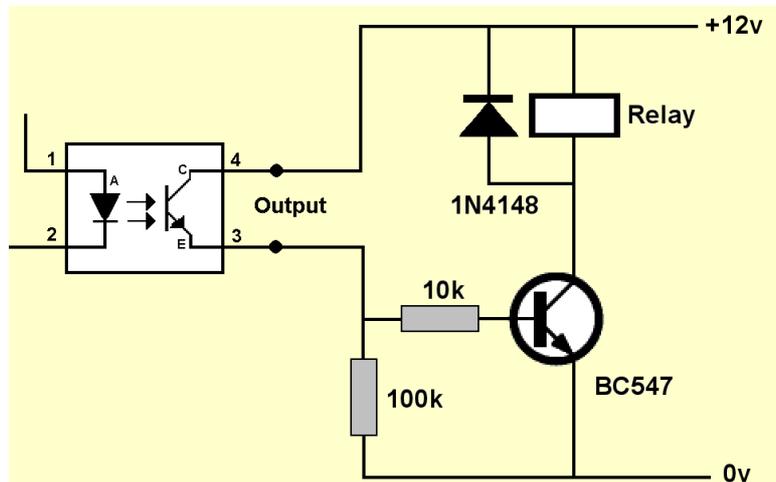
This circuit is not suitable for handling for high-power LEDs since it – not enough current without a separate driver circuit.

The LED need not be placed in your control panel. How about a factory's loading bay light coming on when the train pulls in; or station lights, or yard lamps.

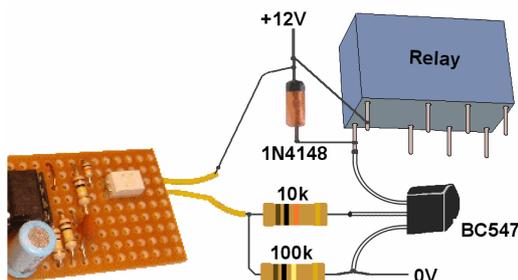
### Switching a relay

The maximum current that the KB814 can pass is 50mA. If you want the train detector board to switch a high-current device such as a motor, solenoid or high wattage lamp, you can use a relay to switch the higher currents.

A simple circuit is shown here using easily-obtained components. With a bit of repositioning, you could fit most of the parts on the stripboard.

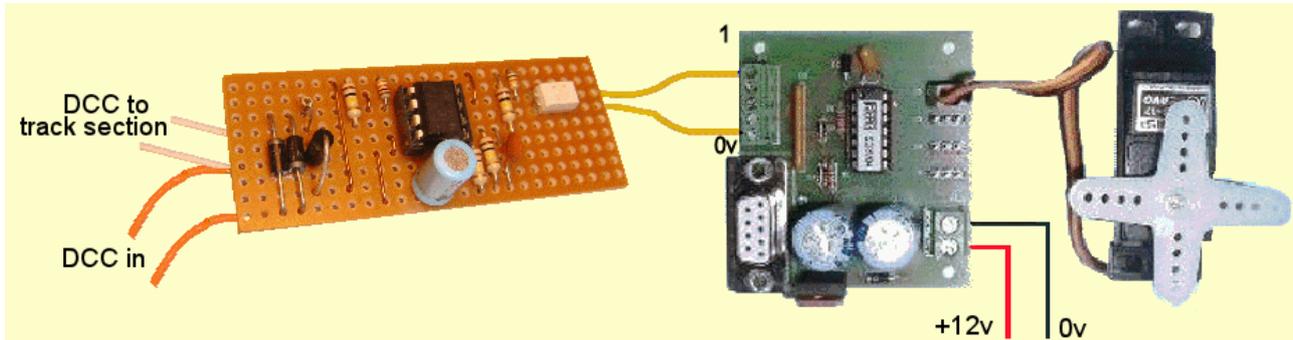


The transistor can pass a maximum of 100mA which is more than sufficient for most relays.



## Operating a Servo4 channel

If the output from the train detector is fed into a Servo4, you can have activities that happen automatically as soon as a train enters the track section. Examples might include automatic crossing gates, barrier gates, semaphore signal arms, cranes, etc.



The image shows how the detector's output connects across the Servo4's 0v terminal and the input that you choose to switch (in this case input 1). As simple as that. When the track section is entered, the loco is detected, the TPL521's resistance drops and the servo moves to the new pre-set position. When the loco leaves the section, the resistance increase once more and the servo returns to its previous pre-set position.

## Further enhancements

Why stop at a single detector. The circuit uses a single LM393 and a single KB814 to create one train detector module. However the KB844 is a 16-pin device that is four different opto-isolators in the one package. Likewise, the LM339 is a 16-pin chip that is essentially two LM393's in the one package.

Why not design a board with these devices and have two detectors on the one board.

If you are a MERG member, this is available as a kit - PMP7 Part No: 807.

# Pocket Money Projects

## Part 8

A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

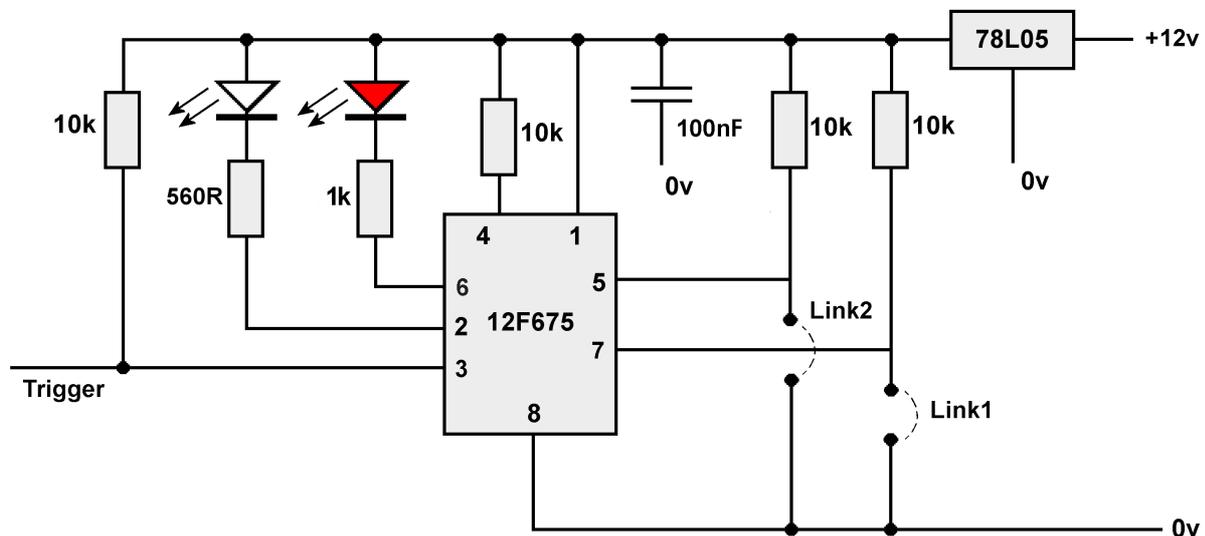
## Multi-purpose flasher

This easy to build project has four possible uses:

- To simulate a welding machine. Every 15 seconds, there is a burst of flashes from a LED to give the impression of a welding operation. With a large LED, it could be situated inside an engine shed or machine shop. With a small surface mount LED, it could be used 'outdoors' on a construction site or at trackside repairs. A red LED illuminated during the flashing period then slowly dims, providing an 'afterglow' effect. You simply position both LEDs for optimum visual effect.
- To simulate the arcing from a tram's trolley pole or an electric loco's pantograph pickup. Every 5 seconds, there is a random number of flashes from an SMD LED placed on top of the trolley pole or pantograph close to the catenary wire.
- To simulate the flickering of a fluorescent tube on start up.
- To simulate the pulsing aircraft warning lights that are fitted on tall structures (buildings, TV masts, power pylons, bridges, etc.)

## How it works

Here is the circuit diagram for the simulator.



Two wire links are used to select the mode of operation.

All the timing, decision making, etc. take place within the 12F675 PIC chip.

A PIC is a chip that can be programmed using special hardware and software.

The PIC chip senses the voltages on these pins and decides the mode in which to operate.

The options are:

- No links fitted – welder simulation
- Only link 1 fitted – pickup arcing
- Only link 2 fitted – fluorescent tube start up
- Both links fitted – pulsing warning light

Pin 6 is unused.

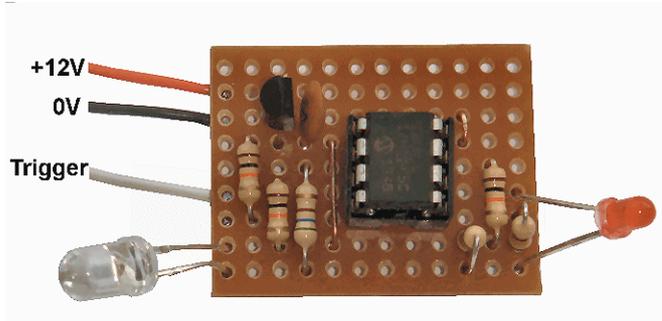
When in fluorescent tube mode, pin 3 is held high by a 10K resistor and the LED does not light. When the 'trigger' input on pin 3 is brought down to 0V, the LED sputters before remaining fully lit. Removing the 0V from pin 3 extinguishes the LED once more. The trigger input could come from a switch, relay contacts, CANACC8 or EzyBus outputs, etc.

### Using as a welder

Fit the white LED.

Do not fit link 1 or link 2.

The output pins of the PIC can pass a maximum current of 25mA and this is sufficient for fairly bright LEDs.



### Using as pickup arcing

Fit link 1 only.

Fit the white LED.

The LED used should be a tiny surface mount type, about the size of a grain of rice. It should be glued to the overhead pickup and wired down to the loco body (Kynar wire is specially thin).

Since the module has to be fitted inside a loco or tram body, it has to find a source of power.

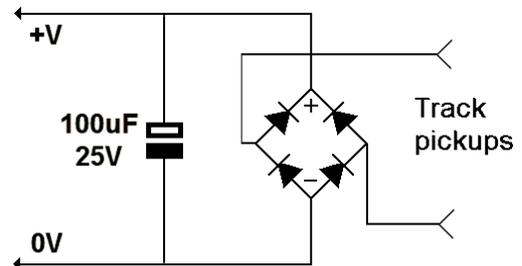
For large scale, you might consider running the module from a PP3 9V battery.

This is the easiest to wire but results in the LEDs arcing even when the motor is stationary.

Another option is to take power from the track.

The easiest way is to connect to the motor's pickups. The diagram shows the extra two parts required. It uses a 'bridge rectifier' and this produces a DC from its output, regardless of whether the motor is running forward or backwards.

The capacitor is of a large capacity, to store energy from the track and supply it to the module when there is small glitches in picking up track power.



The PIC chip expects around 5V to operate correctly, so the LED will not flash at lower speeds.

Of course, if you are using DCC, there is continual power to the track pickups and the LED will flash even at slow speeds. Unfortunately, it will also flash when the motor is stationary. However, if you have an unused output from the DCC decoder, such as a headlamp connection, this could provide a switched supply to the flasher module.

### Using as a fluorescent tube start up

Fit the white LED.

Fit link 2.

Connect the trigger pin (the yellow wire in the picture) to a switch, or other circuit, that can take the pin down to 0V. When the module is first connected to power, nothing happens until the trigger is brought to 0V. At that point, the LED will splutter before settling to

being permanently illuminated. When the 0V is removed from the trigger pin, the LED extinguishes again.

**Using as a pulsing warning light**

Fit both link 1 and link 2.

Use a red LED instead of a white LED.

When the module is first connected to power, the LED will slowly increase and decrease in brightness.

If you are a MERG member, this is available as a kit - PMP8 Part No: 808.

# Pocket Money Projects

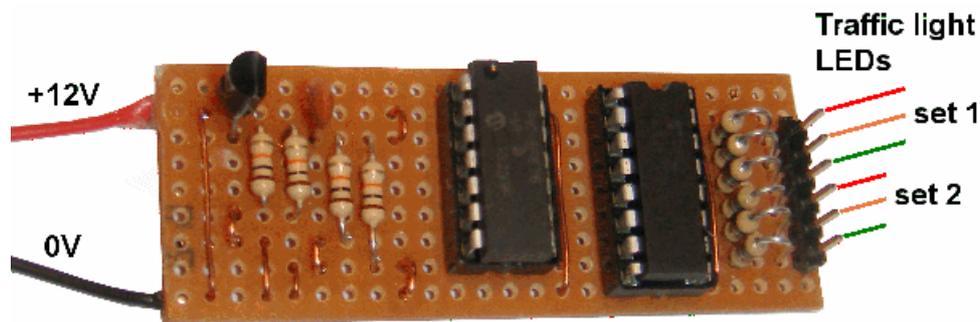
Part 9

A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

## 4-way traffic lights

This little project simulates UK or continental road traffic lights, producing the correct switching sequence for either.



It can handle four sets of lights for a full junction, or just a single set if required.

You insert or remove the links across the board's copper tracks to set the speed at which the lights change.

The eight speeds are:

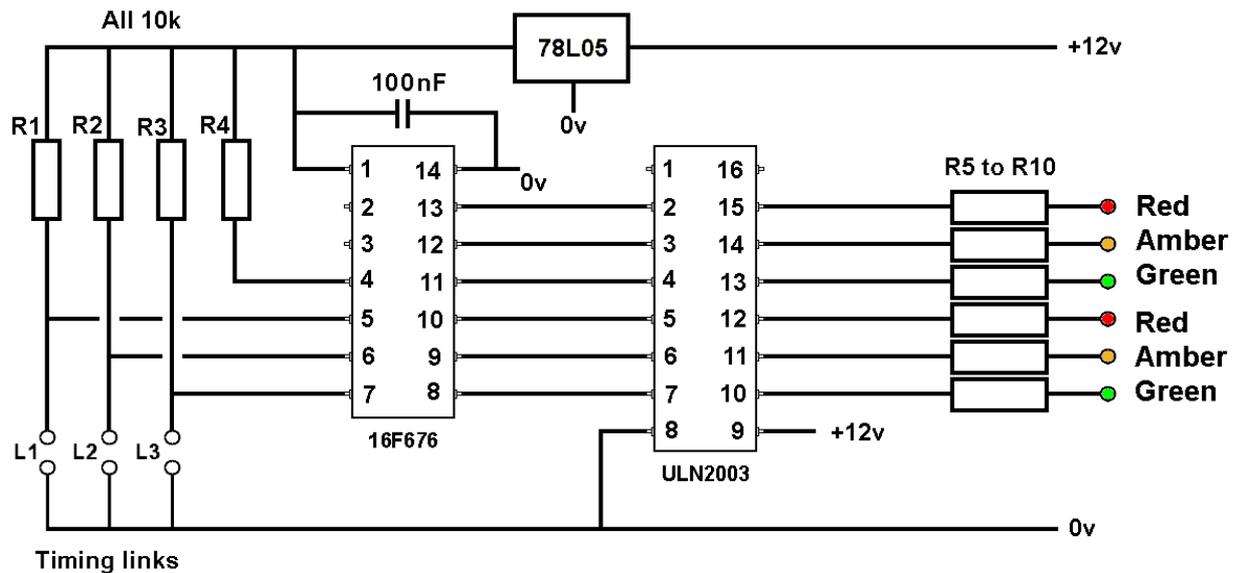
Link 1	Link 2	Link 3	Speed
IN	IN	IN	5 secs
IN	IN	OUT	15 secs
IN	OUT	IN	30 secs
IN	OUT	OUT	60 secs
OUT	IN	IN	90 secs
OUT	IN	OUT	120 secs
OUT	OUT	IN	150 secs
OUT	OUT	OUT	180 secs

The fastest speed is really to test the module after it is built. Once you know it works, you can use the links to set the speed that best suits you.

### How it works

Below is the circuit diagram for the module. All the fancy timing and switching takes place inside the 16F676 PIC chip, which is pre-programmed for you.

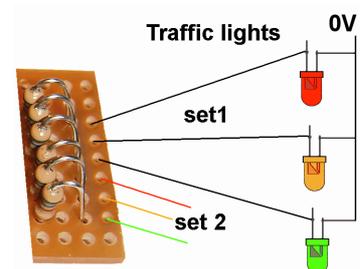
The module is intended to work from a 12v DC supply which powers both the ULN2803 and a 7805 voltage regulator. The voltage regulator reduces the 12v down to 5v which is the required voltage for the 16F676 PIC chip. In fact, the traffic light module will work over a range of supply voltages from 9v to 35v but you would have to choose the resistors for the LEDs to match any higher voltages beyond 12v.



R1, R2 and R3 ensure that pins 5, 6, and 7 on the PIC chip are kept at a high voltage, unless links are wired across to 0V. When a wire link is inserted, it pulls that pin down to 0V. The PIC knows which timing sequence to use, based on which links are made (see table above).

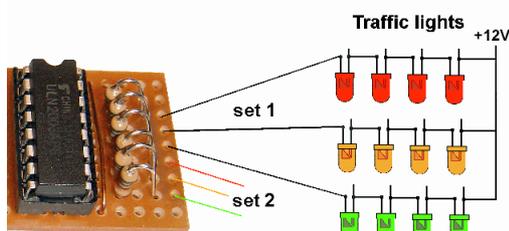
R4 makes sure that the PIC's pin 4 is kept high at all times. Pin 1 and 14 on the PIC are taken to the +5v and 0v lines respectively. These pins connect the PIC to the 5v power supply and the capacitor is used to prevent any stray voltages from upsetting the operation of the PIC.

When the module is first powered up, it looks at which links are inserted and runs the appropriate lights timing sequence. The PIC's pins 8, 9 and 10 are used to switch a set of green, amber and red LEDs, while pins 11, 12 and 13 switch another set of red, amber and green LEDs – but in the opposite lights phase (e.g. when one set has its green LED lit, the other will have its red LED lit).



As described so far, that would be enough to run a single set of lights, or even two sets if low current LEDs were used.

Each output pin of the PIC can handle a maximum current of 25mA and the total for all output pins is limited to 200mA.



With a 4-way lighting system, lots of LEDs will be illuminated at the same time and this can be a problem, particularly if want to use high current lamps for larger scales.

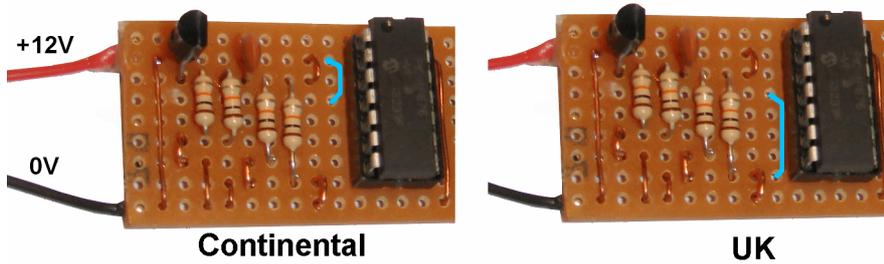
So, the circuits use a ULN2003 chip, known as a 'Darlington array'. It has seven separate amplifier circuits, although we only use six for this project.

Its job is boost the current handling levels of the

PIC. For example, pin 13 of the PIC connects to pin 2 of the ULN2003. When the PIC's pin 13 switches high, it switches pin 2 of the ULN2003 chip and this lowers the voltage on its pin 15.

The ULN2003 can handle 500mA from each output.

The UK light sequence is Red - Red & Amber – Green – Amber – Red.  
A common sequence found outside the UK is Red – Green – Amber – Red.  
This kit can produce either sequence by wiring a link between pin 3 of the chip and either the +5V line or the 0v line.



As the images show, wiring pin3 to a +5v track produces the continental sequence, while taking the link to a 0v track produces the UK sequence.

If you are a MERG member, this is available as a kit - PMP9 Part No: 809.

# Pocket Money Projects

## Part 10

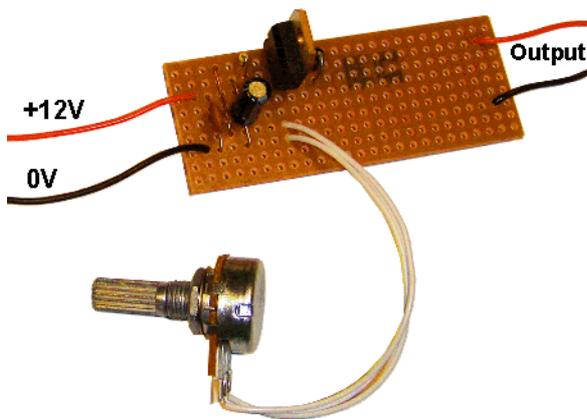
A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

## A speed controller

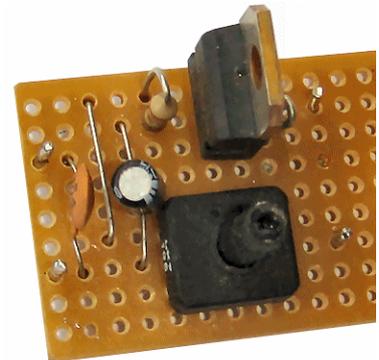
This easy to build project has two uses:

- To provide a basic motor speed controller. (e.g. for a loco, cooling fan, etc.).
- To provide a basic variable voltage power supply for use on your workbench.



The image shows a variable resistor fitted. This allows easy control over the output voltage, using a knob.

For use with the unattended shuttle module (PMP4), the potentiometer can be replaced by a 4k7 preset. The preset is



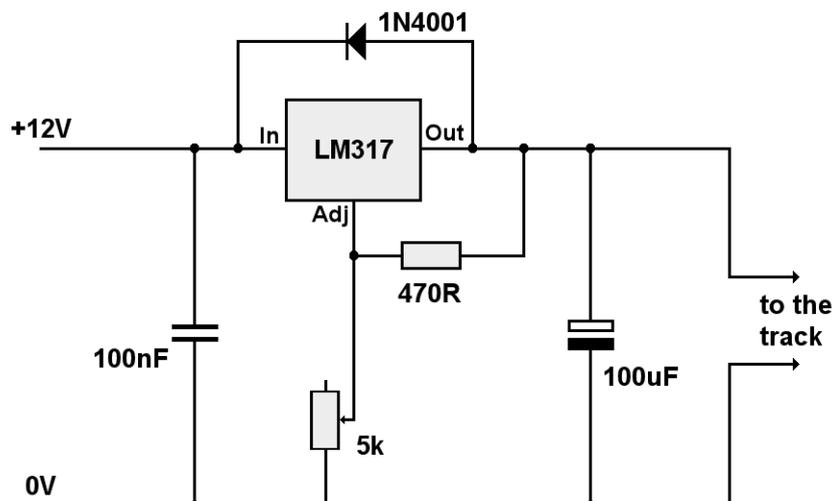
adjusted to match the speed requirements of the loco being used and the loco is then left to run by itself.

This setup can also be used if you require a fixed voltage for any other layout feature (e.g. setting the speed for a windmill or watermill).

## How it works

Here is the circuit diagram for the controller.

It uses just six components.



The LM317 is a 3-pin device that can have its output set to provide output voltages from 1.2V upwards (it does not go down to 0V). The output depends on the input fed into it and the combination of the resistor and potentiometer values that provide a voltage feedback to the chip's adjustment pin.

The chip needs to maintain a 1.25V difference between its output pin and feedback pin, which explains why a 12V input produces an output range of around 1.2V to 10.7V.

The 100uF capacitor acts as a reservoir to smooth out any small changes caused by current variations.

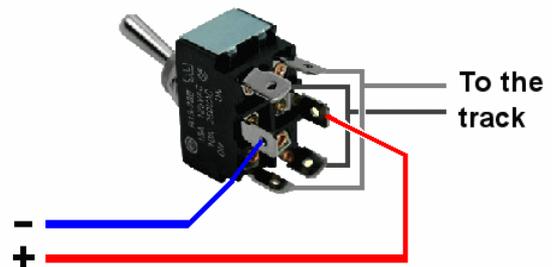
The diode is used to prevent possible damage to the chip that would be caused by a fully charged 100uF capacitor trying to push current back through the LM317 in the event that its input became shorted (unlikely but, for the sake of a few extra pence, worth the trouble).

This module controls a DC motor – as long as it is going in the one direction.

That is fine for a fan, windmill, etc., but if using with a railway loco, some means of reversing the direction is required.

This achieved by adding a changeover switch at the output.

This requires a double pole double throw switch to reverse the polarity and its wiring is shown in this illustration.



The LM317 is capable of handling currents up to 1.5A.

When such high currents are being taken, a heatsink should be bolted to the LM317 on its plain metal side. This should not be required when running a small N gauge loco.

Remember, though, that the voltage cannot be reduced to zero; there is always at least 1.2V on the output.

While it does not have the sophisticated features of other loco controllers (acceleration, deceleration, etc.) it is a good starter project that provides basic control at a great price.

Also, if you can't afford an expensive variable voltage supply, this will prove a low-cost alternative.

If you are a MERG member, this is available as a kit - PMP10 Part No: 810.

# Pocket Money Projects

## Part 11

A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

## LED dimmer

Many layouts now incorporate LED lighting inside buildings, in lampposts, yard lights, etc. It is also increasingly being used as a means of illuminating a layout, usually with long LED strips hidden behind pelmets.

LEDs are usually illuminated using a fixed voltage supply and a fixed value of dropper resistor (the dropper resistor prevents excessive current through the LED).

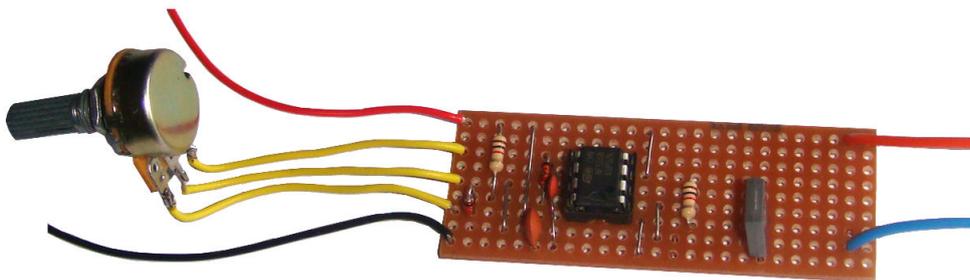
LED strips have built-in dropper resistors and are intended to be run at 12V.

These work fine but always produces the same level of illumination.

Ideally, you want to be able to handle these situations:

- On a bright day, you may want to have maximum brightness.
- Used at night, in a dark, room, you may want to lower the brightness, otherwise the lights become too overwhelming and unrealistic.
- At different public exhibitions, your layout may be situated in areas where the LED light level needs to be adjusted to match the ambient light in the room.
- Illuminating LED strips to different levels to simulate different times of day (morning, dusk, etc.) or different weather conditions (sunny, sunsets, overcast, etc.). This effect is increased if a number of coloured LED strips are used (bright white, warm white, amber, blue).

That's where a LED dimmer is useful, as it opens up ways to bring interesting effects to a layout.



This project can be used to dim a 12V LED strip or dim one or more individual LEDs, using dropper resistors.

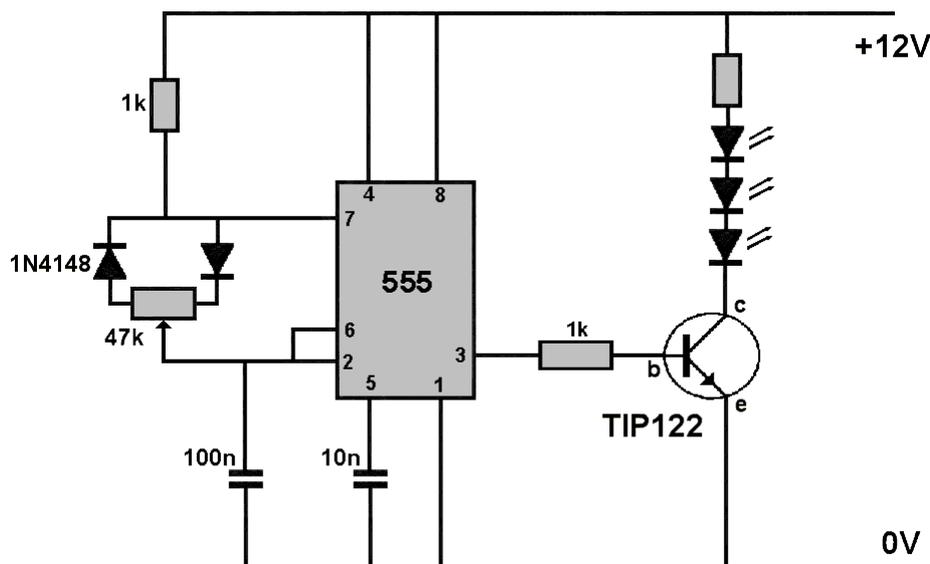
### How it works

A normal incandescent bulb works by supplying sufficient current to heat the filament to the point where it glows brightly. If the voltage to the bulb is reduced the lamp shines less brightly. Increasing the voltage results in a greater current and more light – until it eventually overheats and burns out the filament.

LEDs work differently. If you slowly increase the voltage across a LED, nothing would happen for some time. Eventually the LED will produce light and again will be destroyed if too much current is passed through it. Unlike the incandescent bulb, the range over which it illuminates is small and, once it start to illuminate, current flows at an ever increasing rate for very small voltage increases. This makes altering LED brightnesses very difficult simply by using voltage changes. So, for example, you could not easily dim a LED by placing it in series with a variable resistor.

Some loco controllers use '*pulse width modulation*' as a means of controlling the current through a motor. The same principle can be used to control LED brightness. Firstly, the value of the series resistor is calculated for the required maximum brightness. Then power to a LED, or a string of LEDs in series, is delivered as a succession of on/off pulses. If the pulse period is long, with hardly any off time, the lamp illuminates brightly. Conversely, if the on period is short, with long periods off, the LED will be dim. In other words, altering the pulse width changes the LED brightness. The rate at which the pulses repeat has to be fast enough to prevent the LED simply flashing on and off. So, the voltage never changes; it's the duration of the pulses that determine the average current flowing through the LED.

Here is the circuit diagram for the dimmer.



It uses a 555 timer chip which runs at a fixed frequency of a few hundred Herz (i.e. the number of times its output switches between low voltage and high voltage every second). The output from the 555 chip (pin 3) is a square wave that has a variable 'duty cycle' (the time that the voltage is high compared to the time it is zero). The duty cycle can vary from 0% (never on) to 100% (always on) and is determined by the setting of the 47k potentiometer

The output of the 555 is taken to a TIP122 power transistor. This transistor is able to switch higher currents than the output of the 555, allowing it to control a long string of LEDs if required. The TIP122 is rated for a maximum of 5A. When using high currents, a heatsink is advisable.

If you are a MERG member, this is available as a kit - PMP11 Part No: 811.

# Pocket Money Projects

## Part 12

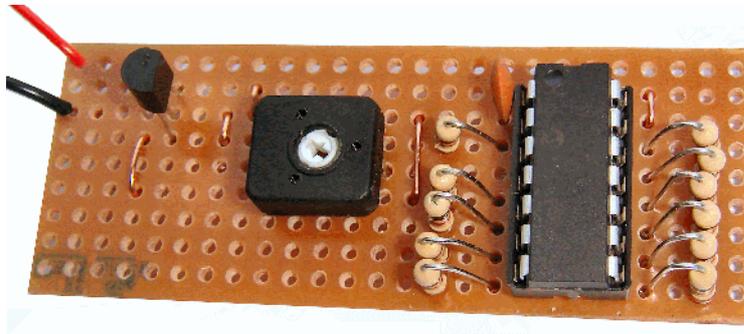
A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

## Random lights

Some railway layouts have no scenic lights whatsoever. Every building is in darkness. Other layouts have lamps inside the buildings. The buildings are constantly lit. While constant lighting is better than no lighting, permanently-lit buildings are not ideal. Of course, you can use switches to manually control building lights, or even have lights that are triggered automatically (e.g. a station light comes on when a train enters the station).

This project provides the ability to have 10 lights that come on and off randomly, as in real life. Imagine a block of flats, a row of houses, a factory, an office or a hotel where the lights work without your intervention.



The module has a preset potentiometer that can be adjusted with a small screwdriver. This sets the speed at which lights may be changed. For instance, you may use the shortest delays to test that all the LEDs work. Short delays are also useful at exhibitions, where kids expect things to happen quickly. At other times, you can adjust the delay to your own needs.

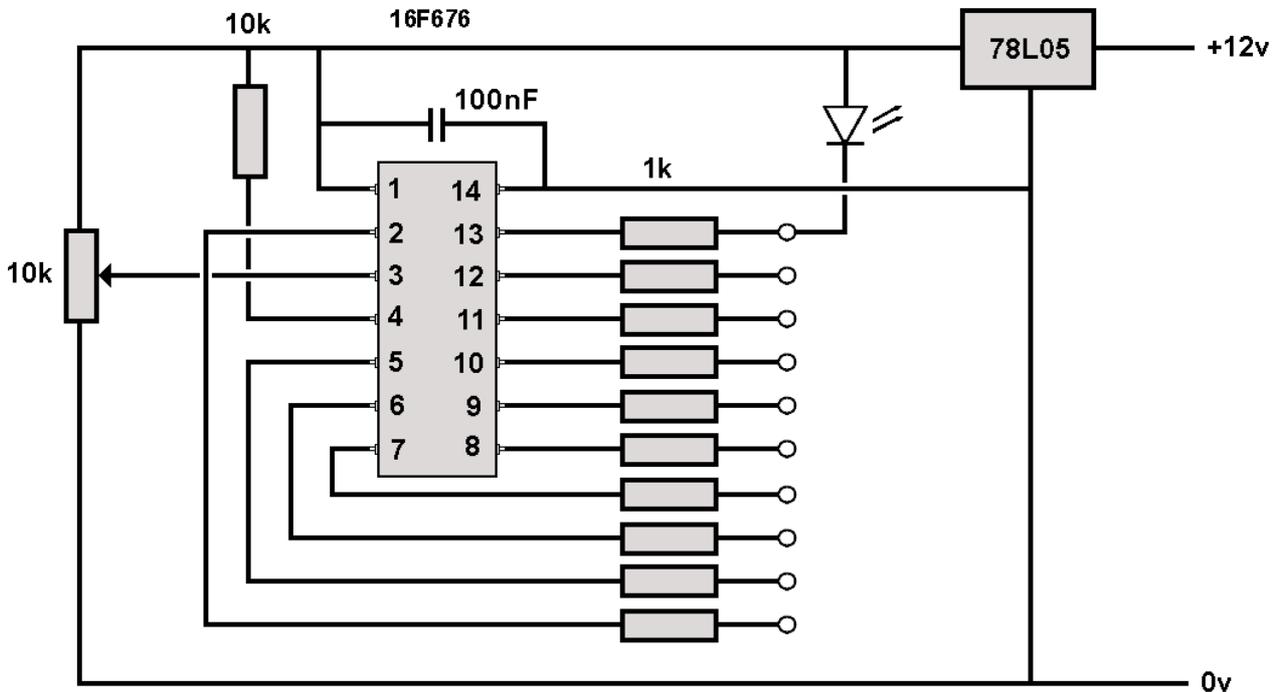
### How it works

The circuit diagram is on the next page. It is based on a pre-programmed PIC chip that contains all the decision-making and controls.

The sequence continually repeats itself and is as follows:

- The 10k preset potentiometer sets the delay time. Rotating the screwdriver alters the voltage fed into pin 3 of the PIC. The PIC reads this voltage and uses it to set the delay time.
- After the delay is over, the PIC chip makes a random choice between 1 and 10. This decides which light may be altered.
- The PIC chip then randomly decides whether that LED should be lit or unlit. It then makes the output to the chosen LED high or low.

This provides a double random system. You don't know which light will be next. You don't even know whether it will change the light, since the chip might decide to light a LED that is already lit (or vice versa). In that situation, nothing happens and the delay before any possible change is doubled.



Each output of the PIC is taken to a 1k resistor and the outputs can be fed directly to a LED. The output on pin 13 is shown wired to a LED, as an example. Each output can handle a maximum current of 25mA, with the chip capable of a total of 200mA. So, 250mA must be the combined total of all LEDs used, as there may be times when all LEDs are lit and drawing current. This should not pose a problem as modern LEDs are very bright at low currents. The 1k resistors limit the current to around 5mA per LED but these can be replaced with lower values if brighter LEDs are required.

If you don't want to use all 10 outputs, you can decide which pins you want to use – giving an even more random effect.

## Modifications

If you want a room in a building to be extra bright, you can look for a suitable LED (with a max current of 25mA) and calculate the value of the resistor from this web site;

<http://led.linear1.org/1led.wiz>

To use even higher current LEDs, you have to use transistors or a ULN2003 chip to handle the extra current. But, that's for another day.

If you are a MERG member, this is available as a kit - PMP12 Part No: 812.

## A lighthouse simulator

In fact, this project has two uses:

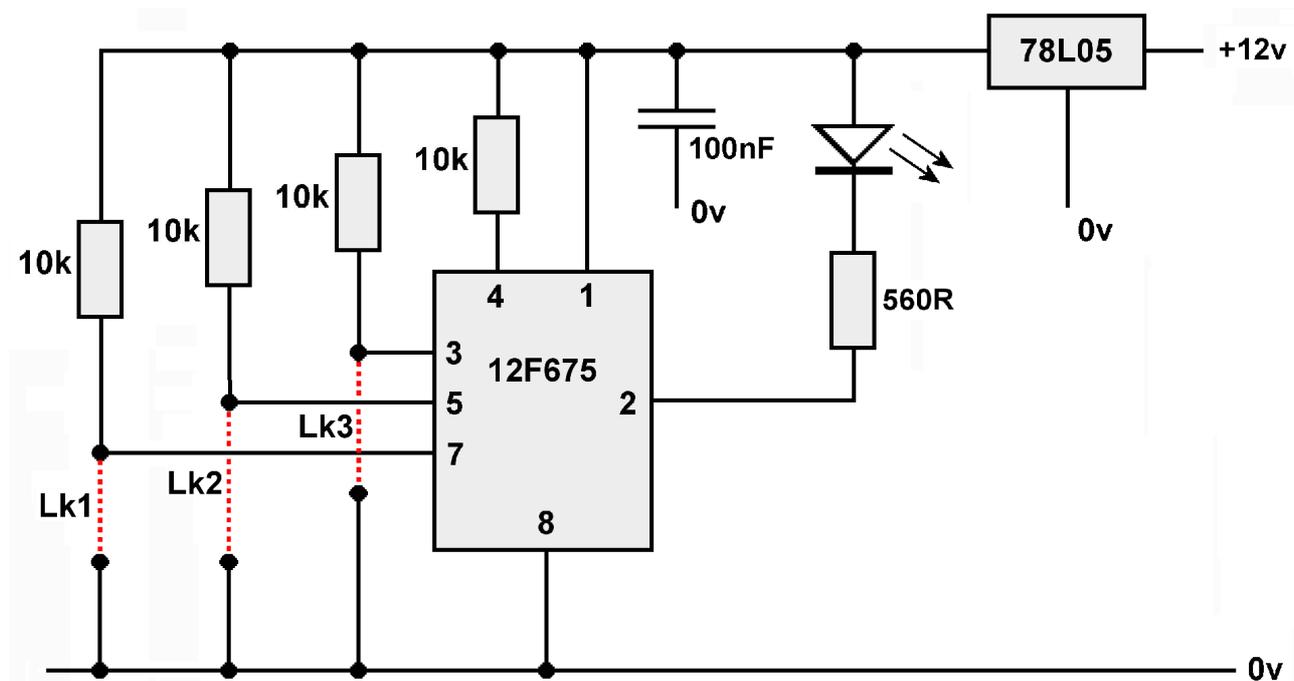
- To simulate a variety of UK lighthouses. Seven different flashing patterns are provided, covering a total of 32 UK lighthouses.
- To simulate the aircraft warning lights that are fitted on tall structures (buildings, TV masts, power pylons, bridges, etc.)

Three links are used to select which mode of operation is displayed.

### How it works

Here is the circuit diagram for the simulator.

Despite the variety of output patterns, it uses just nine components.



All the timing, decision making, etc. take place within a pre-programmed 12F675 PIC chip. Pins 6 is unused in this circuit.

The 78L05 is a voltage regulator. It reduces the 12V supply to the 5V used by the PIC and the LED.

Pins 3, 5 and 7 are normally held to a high voltage as they are taken to +5V via the 10k resistors. If a link is inserted, it brings that particular pin down to 0V. Since there are three possible links, there are 8 possible permutations (see the chart later). The chip senses which links are inserted and pulses the LED on and off in the pattern chosen by the user's selection.

The available patterns are:

<b>Link1</b>	<b>Link2</b>	<b>Link3</b>	<b>Pattern</b>	<b>Lighthouses</b>
N	N	N	4 flashes every 5 secs	Flamborough, Lynmouth Foreland, Pendeen, Strumble Head
N	N	Y	2 flashes every 30 secs	Alderney, Casquets, Nab Tower
N	Y	N	2 flashes every 20 secs	Beachy Head, St Bees, Holy Isle
N	Y	Y	1 flash every 20 secs	Longstone, Mull of Galloway, Peninnis, Royal Sovereign
Y	N	N	1 flash every 15 secs	Lowestoft, Lundy North, Sark, Turnberry, Wolf Rock
Y	N	Y	1 flash every 10 secs	Anvil Point, Crammag Head, Dungeness, Point Lynas, Southwold
Y	Y	N	1 flash every 5 secs	Cromer, Little Ross, Lundy South, Monkstone, Orfordness, South Bishop, St. Catherines, Trwyn Du
Y	Y	Y	1 flash every sec	Aircraft warning lights

The lighthouse simulations should use a white LED, while a red LED is commonly used for aircraft warning lights.

If you are a MERG member, this is available as a kit - PMP13 Part No: 813.

# Pocket Money Projects

## Part 14

A series of small, cheap, easy to build projects using stripboard

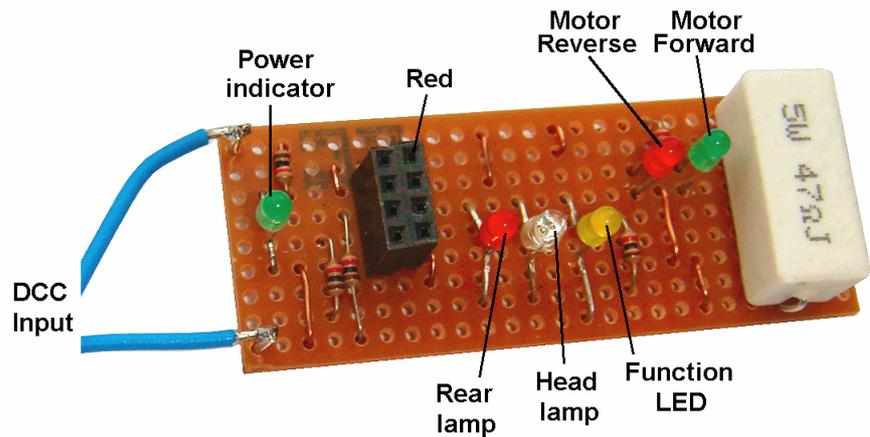
by Davy Dick M1853

## A DCC Test Rig

This project is intended for use with DCC decoders that have 8-pin plugs at the end of their connecting leads.

The module has two uses:

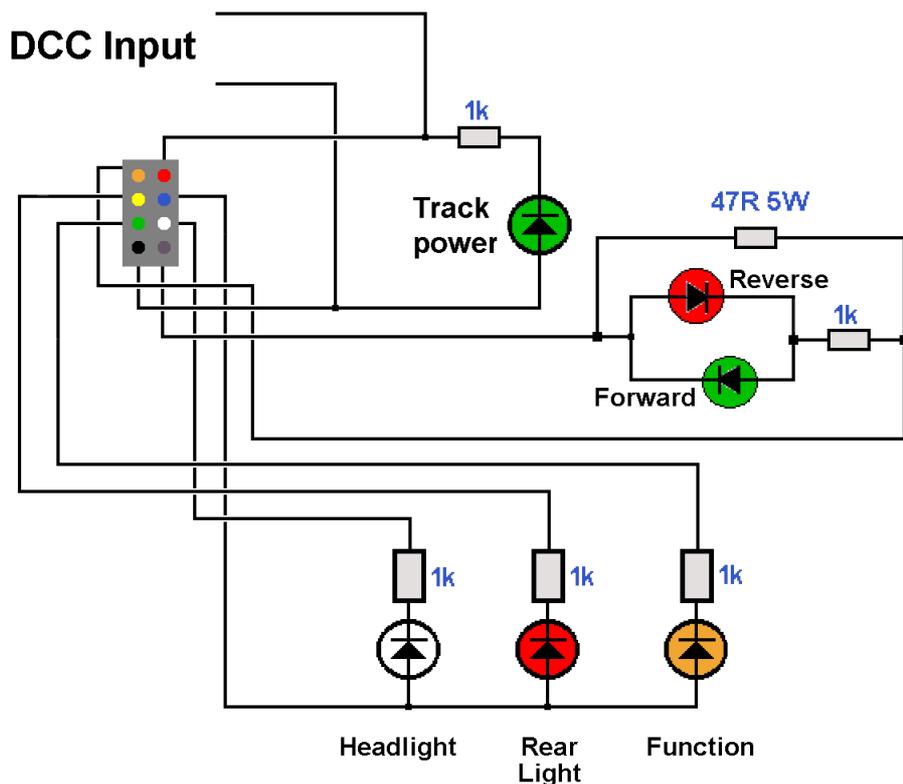
- To test a newly-purchased decoder prior to fitting to a loco.
- To set up a decoder's CVs.



Commercial test rigs are available but are expensive. This is a useful, and much cheaper, alternative.

### How it works

Here is the circuit diagram for the test rig.



The DCC decoder is plugged into the module's 8-pin socket.

The module is wired to a command station's output, connecting via the socket to the red and black wires on the decoder.

When the command station is switched on, it sends out a continual waveform and that is used to illuminate the *'track power'* LED (the LED and its resistor are connected directly across the incoming DCC signal).

The command station needs to sense a load on its output to fully function. This would normally be a loco's motor. This is replaced on the module by a high-wattage resistor. If you have an unused motor, this could be used in place of the resistor (see later).

The orange and grey connections on the decoder normally connect to the loco's motor. In the module they connect across the 47R power resistor.

Across the 47R resistor are two LEDs. These are connected in reverse of each other, then connected across the 47R resistor, with a 1k resistor in series. The output of the orange and grey wires is the PWM output to the motor, so increasing and decreasing the loco speed control on the command station results in one of the LEDs being made brighter and dimmer. In the forward direction, the green LED illuminates, while the red LED illuminates when the controller is being used in the reverse direction.

## How to use it

The decoder is plugged into the 8-pin socket and must be inserted with the plug's red lead at the top right-hand corner of the socket.

### Testing

- The project's two leads are taken to a DCC command station's normal output connection. The leads can be connected either way round.
- The command station can then be switched on.
- The project's power indicator LED should illuminate.
- A newly-purchased decoder is factory set to operate at address 3, so the command station would be set to address 3.
- Increasing the speed in the forward direction should make the *'Motor Forward'* LED light with increasing brightness.
- Increasing the speed in the reverse direction should make the *'Motor Reverse'* LED light with increasing brightness.
- The three lamp and function LEDs should be switched on and off using the functions keys on the command station. This will depend on the capabilities of the decoder being tested (read the decoder's manual).

In this way, all the main functions of the decoder can be testing prior to it being brought into use.

If the decoder being checked is not brand-new, it will probably be set to a different address than the default of 3.

If you know its address, just change the command station's address to match the decoder's. If you don't know the address, you can try different addresses on the command station until the direction lights illuminate.

### Note

The 47R resistor is large because it has to handle the full voltage that would normally be applied to a loco's motor.

Instead of creating movement, as with a loco motor, the power is dissipated in the resistor in the form of heat. This results in a fair amount of heat if the speed control is set to max. Now you know why a high wattage resistor is used. So, handle with care!

### **Setting up**

The module is also useful for setting up a DCC decoder's performance, by adjusting the decoder's CV values to set up loco address, acceleration, deceleration, and much more. A decoder's manual provides details on what CVs are supported on the decoder (the basic ones are all identical but the more sophisticated settings are usually only available on the more expensive models – check the manual).

- The project's two leads are taken to a DCC command station. This may be the command station's programming output connections or the standard output connections if the controller and the decoder support POM (programming on the main).
- Alternatively, connect the leads to the output of a SPROG.

Thereafter, use the hardware and/or software (e.g. Decoder Pro) that you normally use to configure decoders.

This article is not intended as a tutorial on configuring decoders; there are plenty of articles available on the Internet, or in user manuals, that describe the process.

### **Modifications**

If you have a spare loco motor, you can replace the forward and reverse LEDs with their 1k resistor and the large 47R resistor with the motor.

Simply omit fitting these components and wire the motor across the top and bottom tracks of the stripboard on the right-hand side (the side opposite the leads to the controller).

Finally, this project was designed for 8-pin decoders. If you use 6-pin decoders, you could redesign the layout to accommodate them instead.

If you are a MERG member, this is available as a kit - PMP14 Part No: 814.

# Pocket Money Projects

Part 15

A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

## Train auto stop

A simple module that stops a train at any chosen point, controlled by the output of one or more train detectors. It is suitable for both DC and DCC, and best with slow moving trains as it does not have acceleration or deceleration.

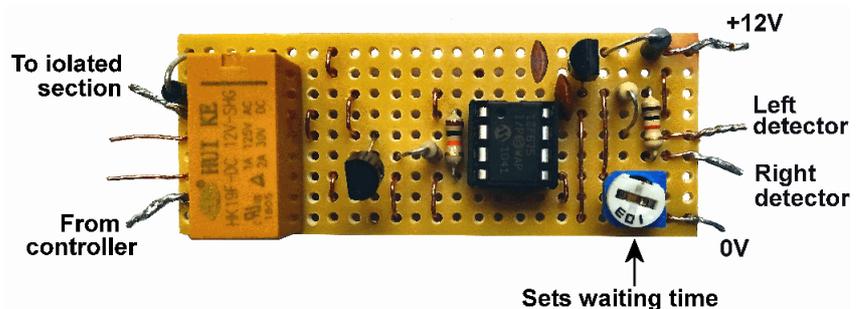
So, first there was the Simple Shuttle kit (PMP4).

It was recently augmented by the Automatic Points Changer kit PMP4a. This allowed two or more trains to traverse the single track.

It was then suggested that the train should be able to stop at a station on its journey back and forth. Of course, the ATC kits 45 and 46 provide this with the benefit of acceleration and deceleration.

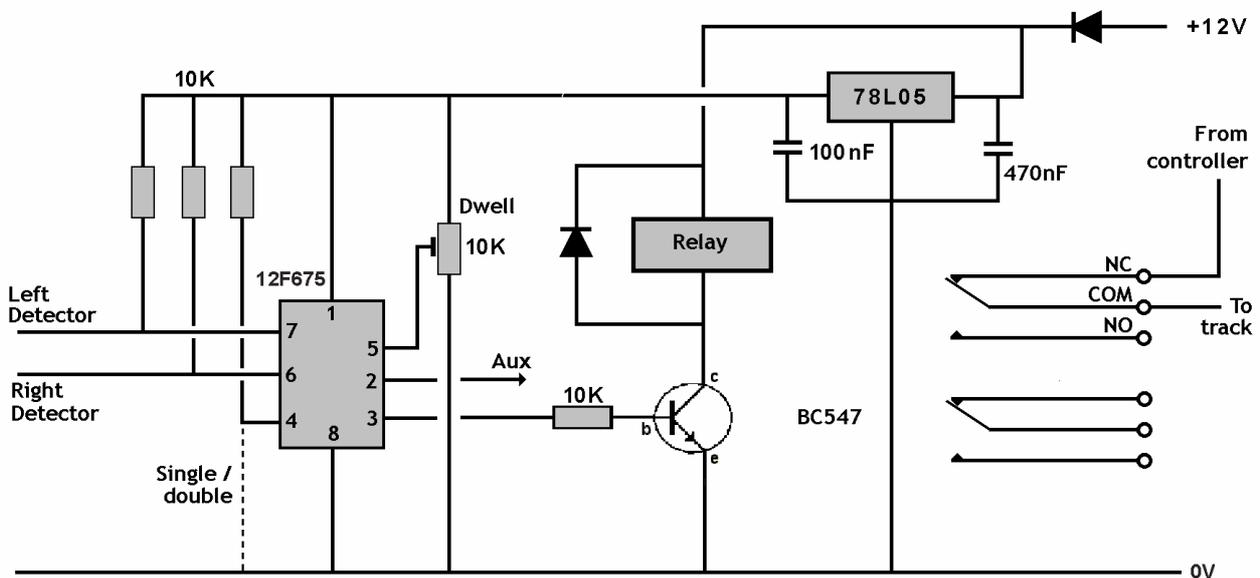
This module could be used as a low-cost add-on to the Simple Shuttle kit.

However, it can be used to stop a train anywhere on your layout.



## How it works

The section of track where the train will stop has to be isolated from the rest of the track, getting its power only through the relay contacts. The relay has two sets of contacts so you can choose to isolate one rail or both rails. The schematic shows a single rail being isolated.



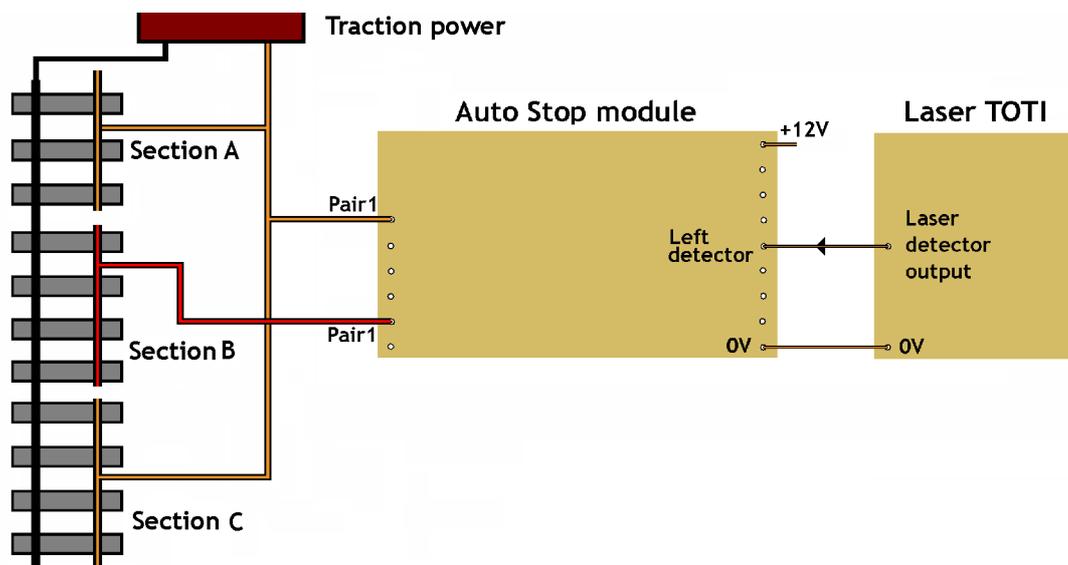
In normal operation, the relay is not activated and the track power is fed to the isolated section.

### Stopping anywhere

A single train detector (e.g. a laser detector, a Hector, a reed switch) is located at or across the isolated track section. When the train triggers the detector, its output goes low and triggers the Auto Stop's left detector. This results in the relay operating and cutting off the power to the isolated section for a period determined by the position of the trimmer (up to 25 secs). The auxiliary pin 2 also goes low for possible triggering of other modules. After the delay expires, the relay drops out and power is restored to the isolated section. Since the power is cut off and restored abruptly, this will be very noticeable with fast moving trains. With slow moving trains, the effect is much less noticeable.

### Laser TOTI example

One of the outputs of the speed controller is connected to the unbroken length of rail. The other rail is cut in two places to create a track section where the train is to stop (Section B). The other controller output connects to the rail section A and C, either side of the isolated Section B.



When the controller applies power to the track, sections A and C are continuously powered. Section B is powered via the relay contacts in the module.

The laser emitter and detector are placed across the track at an appropriate point on Section B.

When the train breaks the laser beam, the output of the laser module goes low.

Its output connects to the Auto Stop's left detector and this results in the relay operating and cutting off the power to Section B. The train stops in the section for a delay period (the 'dwell') that you set using the trimmer resistor.

After the delay expires, the relay drops out and its contacts restore power to the rail on Section B.

Note that the laser TOTI and the AutoStop module share the same 0V line.

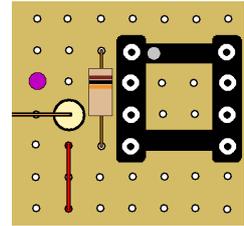
## With the Simple Shuttle

There is an extra consideration when using with a shuttle. Consider stopping at a station platform. A single detector is not suitable as the train would stop at a different position when moving leftwards compared to rightwards,

For a shuttle, therefore, we need to use two detectors, one at each end of the platform.

That is why the module allows for both a left and a right detector.

To activate shuttle mode, add a link wire as shown here in red.



## Modifications

The module has an additional output, shown in purple on the image.

This output is normally high but goes low during the period the train is stopped.

This can be used to trigger other modules (e.g. station lights come on, or factory conveyor belt starts up, or water crane rotates round, etc.).

If you are a MERG member, this is available as a kit - PMP15 Part No: 815.

# Pocket Money Projects

## Part 17

A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

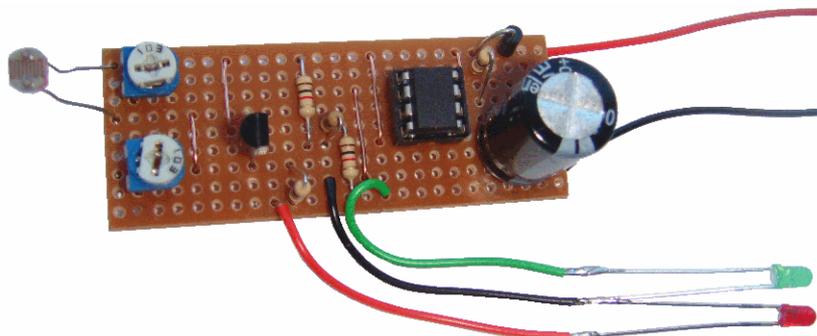
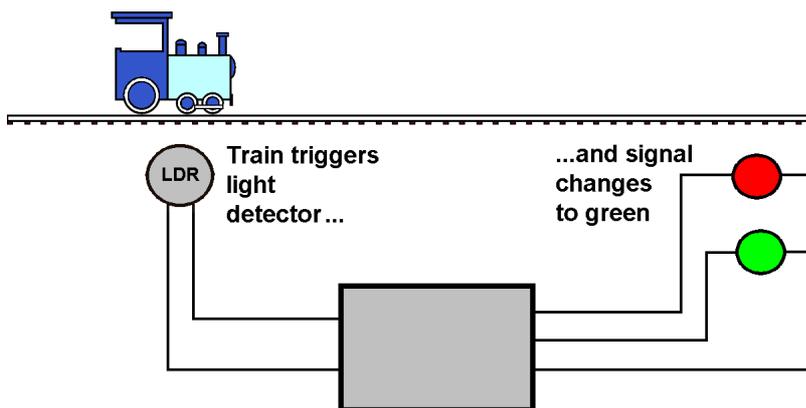
## Automatic signals

This project was prompted by model railway club that has an up line and a down line. Each line has signal lights that are currently operated by switches. Unfortunately, the operators usually forget to throw the switches, resulting in trains running through red lights.

This module detects the approaching train and automatically turn the lights to green for a period until the train passed. The delay in switching back to red should be adjustable. We already have a train detector – the PMP2. This uses an LDR as a general purpose light detector. It is used to detect trains in hidden sidings, automatically switch on station lights when a train is on a platform, etc.

This circuit uses the same detector circuit but blocking the light to the light-dependent resistor (LDR) triggers a timer that is added to the board. This results in a module with a single function but one that is useful and not readily available or at a reasonable price.

This illustration shows the setup.



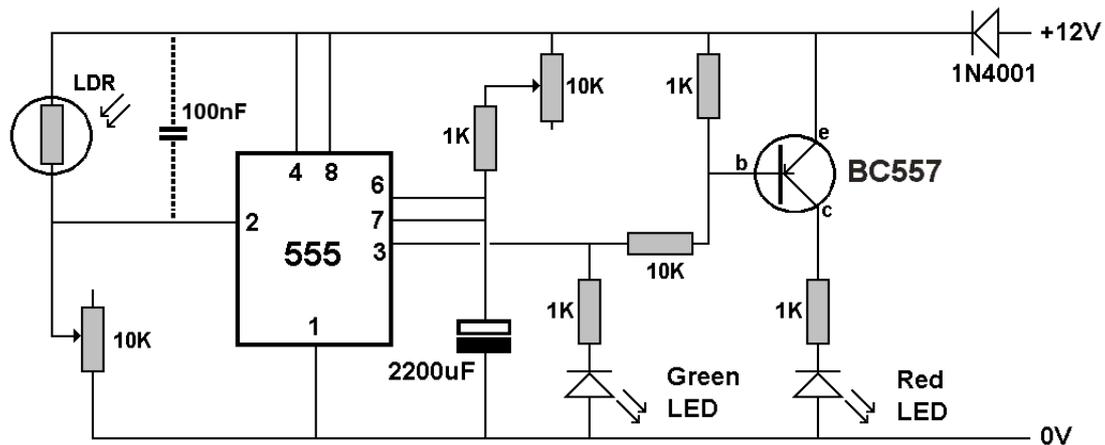
### How it works

The module is composed of three separate parts as follows:

#### The detector

The LDR and a 10k preset potentiometer (a small variable resistor) are in series across the 12v supply. The voltage at the junction where the LDR and the trimmer join will vary depending on the resistance of the LDR (which, in turn, varies with the amount of light shining on it).

When exposed to light, the LDR has a low resistance and the voltage at this junction will be high.



When the loco passes over the LDR, it blocks the light reaching the LDR. In darkness, the LDR has a very high resistance and this lowers the voltage at the junction.

The 10k trimmer is used to adjust the sensitivity of the detector.

### The timer

A low voltage on pin 2 of the 555 chip triggers the timer into operation.

The 555 timer chip is used in 'monostable' mode which means that it has a normal stable state, with its output (pin 3) at 0V.

The output pin stays low until there is a negative-going pulse on pin2. This results in the output pin going high for a fixed period, before returning to 0V again.

How long the output stays high is determined by the values of the resistors and capacitors connected to pins 6 and 7. This can be calculated with the formula

$$t = 1.1 \times R \times C$$

where t is time, R is total resistance in Ohms and C is Farads.

The other 10K trimmer adjusts the value of the total resistance and in this circuit produces delays between 3 seconds and 26 seconds.

### The outputs

The output of the 555 is used to drive two LEDs, one directly and one via a transistor.

The second transistor is used as an 'inverter' which means that a high voltage on its base results in a low voltage on its collector – and vice versa.

When pin 3 goes high, the green LED illuminates during the time of that pulse.

The high voltage on the transistor's base drives its collector low and the red LED extinguishes.

The 1n4001 diode ensures that incorrect connection of the 12V power will not damage the circuit. The power has to be connected the correct way round for the circuit to function.

The 555 chip can operate on a voltage range of around 4.5V to 14V and the time delays are independent of the voltage used.

If you are a MERG member, this is available as a kit - PMP17 Part No: 817.

# Pocket Money Projects

## Part 18

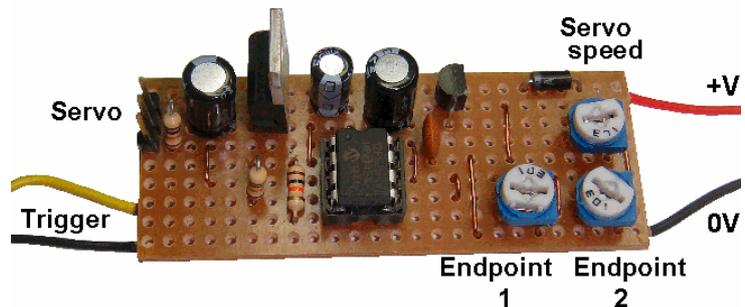
A series of small, cheap, easy to build projects using stripboard

by Davy Dick M1853

## EzyPoints

This servo module controls your points and is set up using only a small screwdriver. It is suitable for use on DC, DCC, and CBUS systems and does not require a computer to set it up.

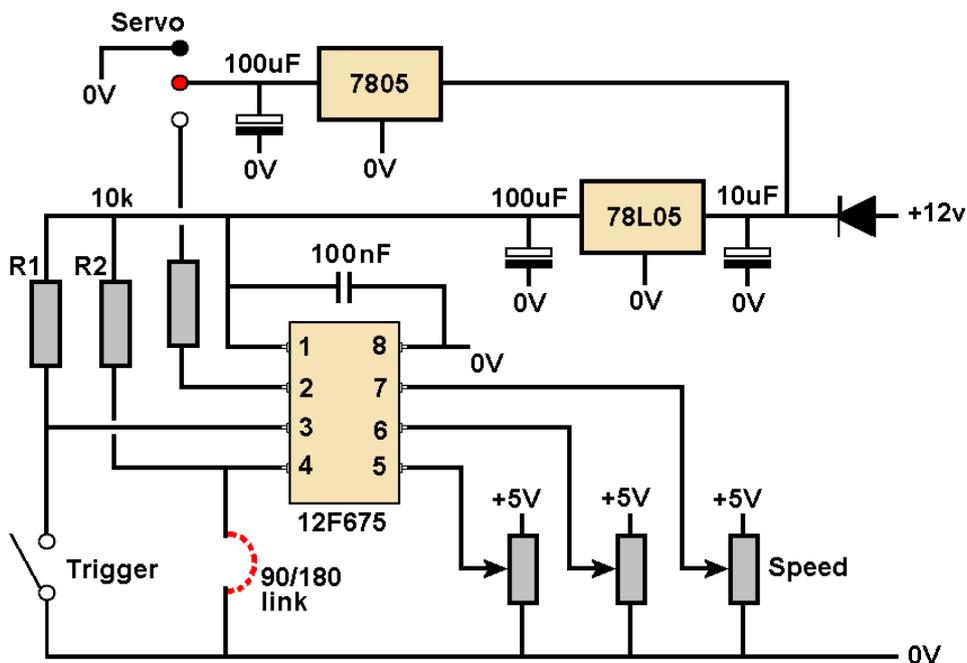
This project controls a single servo, requiring only connections to a 12V DC supply, the servo and a simple on/off switch to operate the point.



## How it works

The circuit uses a pre-programmed PIC chip that contains all the decision-making and controls.

The 78L05 is a voltage regulator. It reduces the 12V supply to the +5V used by the PIC. Another 5V regulator, the 7805, provides a separate +5V line to the servo.



There are three trimmers that are adjusted using a small screwdriver. One sets how far the servo rotates when the switch is closed; another sets the servo position when the switch is opened – and the third sets the speed at which the servo arm turns.

When the trigger switch is closed, it takes one of the PIC's pins (pin 3) down to 0V. The chip

then reads the voltage from the '*Endpoint 1*' trimmer into pin 6. This voltage decides the composition of the control signal that is sent to the servo. When the switch is released, the chip reads the voltage from the '*Endpoint 2*' trimmer into pin 5 and this results in a different signal being sent to the servo.

The voltage read into pin 7 controls the speed of the servo arm's rotation.

V2 provides an option to choose between having a maximum rotation of just over 90° and just over 180°. Leaving out the link provides the 90° option.

## Installing the servo

Before fitting the servo to your point, adjust the trimmers so that the servo arm is in mid-position when the switch is both open and closed. If necessary, remove the servo horn (the moving arm) and refit for best position. You can then install the servo knowing that it has movement available in both directions.

## Modifications

Although the module is called EzyPoints, it can also be used to operate semaphore signals, crossing gates and animated trackside features. Its your choice.

It is also capable of being operated by other MERG modules.

The circuit diagram shows a switch being thrown/released to operate the module.

All the switch does is bring the chip's input pin 3 down from +5V to 0V.

So, other modules whose output switches between +5V and 0V could be used to operate EzyPoints. Just make sure that they share the same 0V connection, as all voltages are with respect to this common ground connection.

This allows, for example, the *remote* operation of points/features by connecting the outputs of a DCC Steady State decoder (Kit53) or a CBUS CANACC8 (Kit 88) to the input of the EzyPoints module. Points/features can then be controlled from your control panel or DCC command station.

Also, it allows *local* operation of the module by connecting the outputs of the DTC8 8-channel block detector (Kit 56), the DCC Train Detector (PMP Kit 807) or the LDR Train Detector (PMP Kit 802) to the input of the EzyPoints module. Example uses are detecting when a train is in a particular track section and station/yard lights coming on, doors opening, cranes moving, sounds being played, etc.

If you are a MERG member, this is available as a kit - PMP18 Part No: 818.

# Pocket Money Projects

## Part 19

A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

## Automatic coach lighting

This is an automatic lighting system where the coach lights only come on when the train is moving. When movement is detected, the LED lights come on and stay on during the train's journey. If the train stops at a station or at a signal, a built-in delay keeps the lights on for a couple of minutes. However, if the coach is left parked, its lights will go out after those couple of minutes. This process is automatic, the only control being a small power 'switch' that is set at the start of a session.

This little 18mm x 16mm module is suitable for both DC and DCC users, as it uses a small battery (DCC users see the end of the article on suggestions for adapting for DCC use).

A group of individual white LEDs is powered from a 3V coin cell battery CR2032. The example shows both cool white and warm white LEDs, although you would decide which looks best for your stock of coaches.

The battery is external allowing for easy changing. There is no need to open the coach to change the battery (or to flick an on/off switch).

The photograph above tends to exaggerate the brightness. The lights are not as bright as commercial offerings but I think that makes them more realistic.

If you want very bright lights, you probably want to use a 12V LED strip and a 12V supply (using either a 12V battery or taking power from the DCC supply).

### How it works

The project uses only a handful of components, based around a infra-red detection component and a pre-programmed PIC chip.

The image shows a TCRT5000 reflective optical sensor. This is mounted under the coach, pointing downwards towards the track.



It has four leads. Two are used to power an infrared LED which emits infra-red light down towards the track. The other two leads connect to a phototransistor which reacts to the amount that is reflected back upwards.

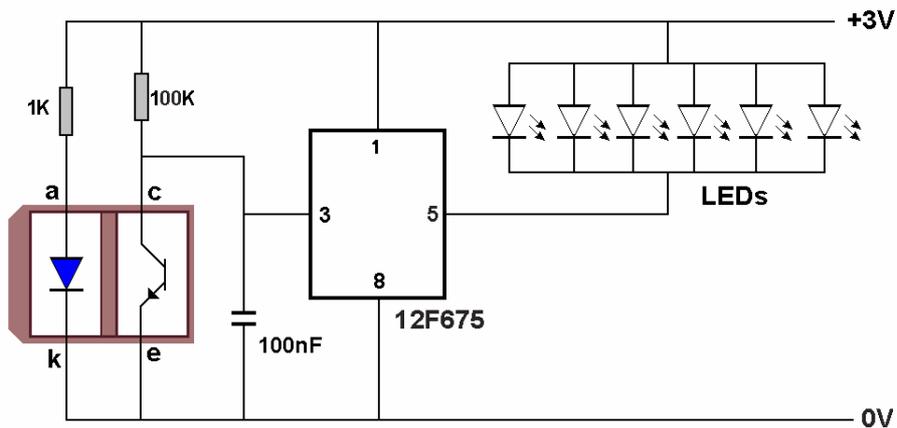
If the train is stationary, the light that is reflected will remain fairly constant, regardless of whether the TCRT5000 is sitting over a sleeper or over the ballast (or even in between).

When the train starts to move, there will be noticeable changes in the intensity of the reflected infra-red. This is detected by the PIC chip which switches on the LEDs.

When the train stops, the level of reflection will return to being fairly constant. If there is no further light changes after a few minutes, the chip switches the LEDs off.

The circuit below shows that the TCRT5000 is actually two separate components in the one casing. The infra-red emitter (the blue one) is fed from the 3V supply via a 1K resistor.

The level of reflected light results in a voltage being developed across the 100K resistor and this is fed into the PIC's pin 3.



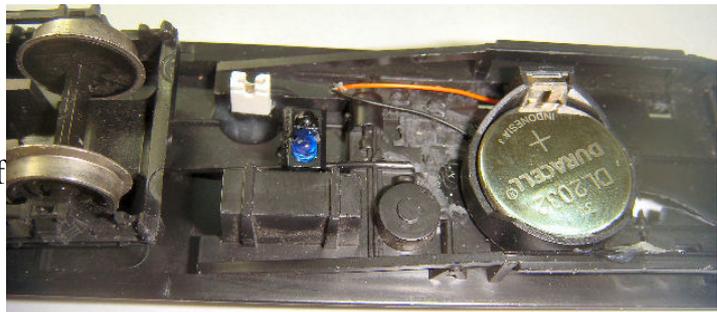
The 12F675 chip's pin 5 is used switch the LEDs on and off.

The code inside the PIC chip is self-adjusting for different sleeper and ballast colours. It 'learns' the difference between your sleep and ballast reflections, regardless of their levels of lightness/darkness. As a result, there is no need for any external sensitivity controls.

### Fitting to coach

The board is fitted inside the coach, in as inconspicuous place as possible (in the toilet or standing on its end?). The other parts are fitted under the coach largely out of site from most viewing points,

Before fitting, check where you want to fit the sensor, the on/off switch and the battery holder. To make battery changing easy (save dismantling the roof etc.) and to prevent any components being seen inside the coach, I placed the battery holder and switch under the coach.



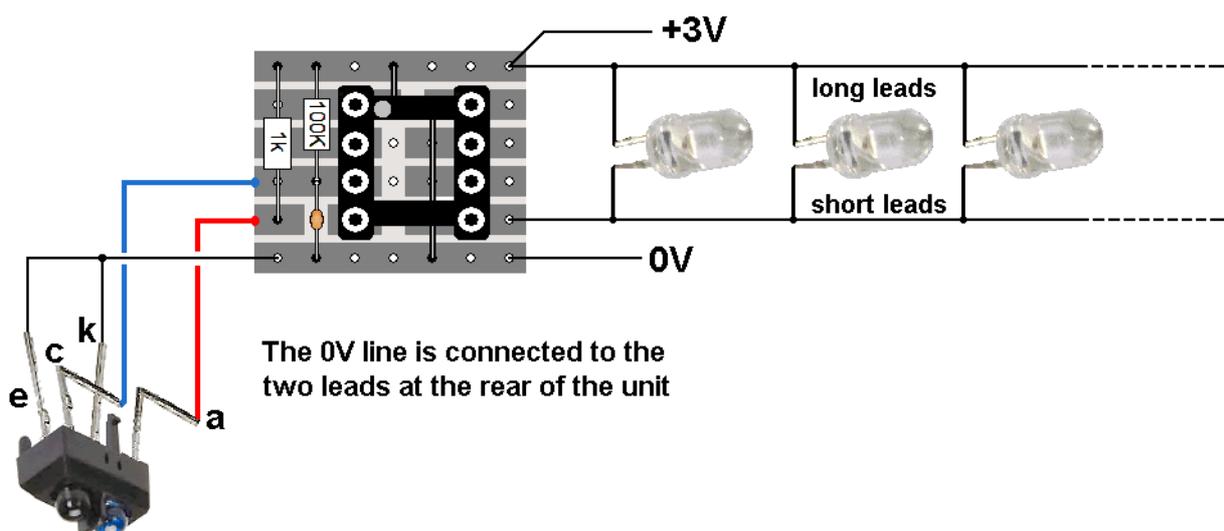
The steps for assembling the coach lighting kit are:

1. Solder two wires to the tags on the battery holder. For clarity, the image shows red and black wires being routed from the battery into the coach through a small hole drilled in the undercarriage. In practice, use black wire (preferable Kynar wire) to make the wires inconspicuous. Secure the battery holder in place with epoxy.
2. To reduce size, I replaced a standard on/off switch with a 2-pin male connector, with a jumper being inserted to switch on the battery. The connector has two wires soldered to it and these are routed into the coach through a small hole drilled in the undercarriage. The connector is then epoxied to the undercarriage. For clarity, the image shows a white jumper being used. In practice, a black jumper is used.
3. Drill four small holes in the coach's undercarriage and push the TCRT5000's leads through these holes (see image). Position the tip of the sensor about 12mm above the level of the sleepers and bend the wires inside the coach.

4. Solder the two sensor leads together as shown in the illustration below; these are the two leads that connect to 0V. Solder these to the end of the bottom copper strip as shown in the illustrations. Soldering direct to the strip saves allocating space for a column of holes.
5. Solder the other two TRCT5000 leads to the ends of the appropriate copper strips, as shown in the illustration.
6. Make up a lighting assembly consisting of two bare wires that will run along each side of the inner roof. Connect LEDs across these bare wires at appropriate spacing to illuminate where required in the coach. Use either cool white or warm white low current LEDs, depending on your needs. Ensure that all the LEDs' longest leads are connected to the same wire. The PIC chip's maximum current is 25mA, so ensure that the total consumption of all your lamps does not exceed this value.
7. As a final test, connect the battery directly to the two wires supporting the LEDs. If the LEDs all illuminate and the total current is no more than 25mA (use your multimeter), unsolder the battery wires and attach the LEDs' supporting wires to under the coach roof (I use a glue gun).
8. Solder wires from the light assembly to the ends of the appropriate copper strips (longest LED leads to the +3V strip and the shortest LED leads to the track second from the bottom (i.e. pin 5 of the chip)).
9. Solder the wires from the battery to the top and bottom copper strips, with the positive lead connecting to the top track (see the illustration).
10. Insert the CR2032 3V coin cell into the battery holder.

The assembly is complete and the coach can be tested. I found no need to alter the sensor height above the track sleepers but you can experiment for optimum height before securing the sensor in place.

I found no problems with unwanted light affecting the module's performance and therefore did not fit any type of hood around the sensor.



## Modifications

As described, this module is most suitable for use with 00 or larger scales.

However, with a bit of ingenuity it can be adapted to take up less space inside the coach.

### Miniaturise further

- You can reduce the module's depth if you solder the PIC directly to the stripboard without using the IC holder. Of course, you have to be careful that you insert it the correct way round and all track cuts and links are definitely correct. Once soldered, it will be difficult to make good any mistakes. If you can afford the space, using the IC holder is the safest way.
- The TCRT5000 is, in fact, two components in the one case. The case can be removed to reduce the required volume. Note, however, that there is a plastic divider between the emitter and the phototransistor. This prevents the infrared being received directly from the emitter instead of from the reflections. This wall is part of the case's plastic moulding. If removing the case, fit your own replacement divider.
- You can further reduce the size of the stripboard if you fit the resistors and the capacitor on the coach's undercarriage.

### Rear light

You may want this circuit to also illuminate a red light at the rear of the coach.

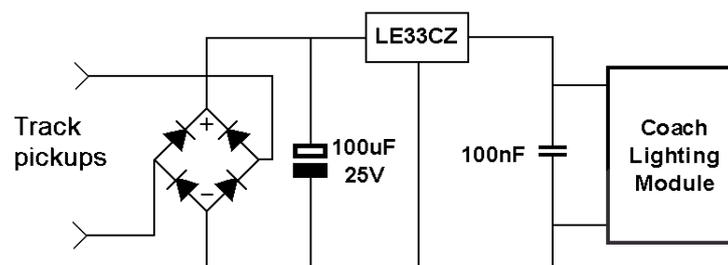
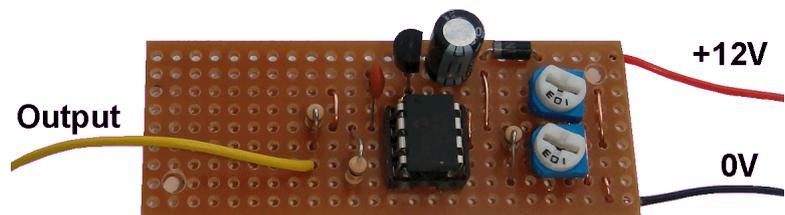
Beware that a red LED illuminates at a lower voltage than white LEDs, so a dropper (say 1k) should be placed in series with the LED and then wires across the two copper wires of the light assembly. Again, ensure that this addition does not take the total current consumption of all your LEDs to above 25mA.

### DCC version

With DCC you have the advantage of having a permanent power source available at all times. This dispenses with the need to use batteries for coach lighting.

There are a few requirements:

- You must be able to get the DCC from the track to this module. You can use pickups in each coach or use wired connections between locos and coaches (this is discussed in another chapter).
- You need to convert the DCC signal to suitable voltage to drive the lighting module. This circuit shows a 3.3V voltage regulator circuit that could be used.



- This converter will take up additional space inside the coach. Of course, you can also use surface mount components (e.g. an AMS1117-3.3V voltage regulator) to create a smaller unit. With DCC you have the advantage of having a permanent power source available at all times. This dispenses with the need to use batteries for coach lighting.

### **Footnote**

This project is unlike many of the previous Pocket Money Kits. In addition to building the module, you are required to make alterations and additions to your coaches.

The prototype for this project was taken to exhibitions and run on a variety of layouts with different track constructions (different ballast colours and shades, cork underlay, bare MDF, etc.). It performed equally in all the tests but I would recommend you make and test one on your own layout before committing to converting a quantity of coaches.

A number of factors could potentially affect the project's sensitivity:

- The height above the sleepers (alterable by you)
- The voltage voltage to the emitter (alter the value of the 1K resistor)
- The switching threshold inside the chip (involves reprogramming the PIC chip)
- Possible ambient light disturbance (fit a hood round the TRCT5000).

If you are a MERG member, this is available as a kit - PMP19 Part No: 819.

# Pocket Money Projects

## Part 20

A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

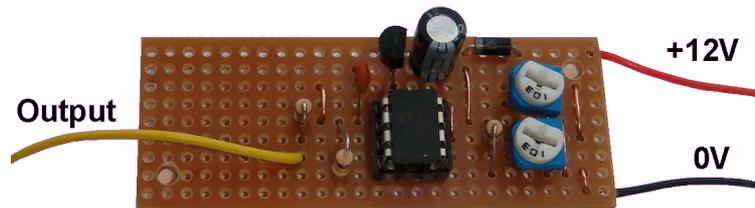
## Versatile timer

More layouts are incorporating additional features such as animations, lights or sounds. However, many animations and sounds can quickly become annoying if operated constantly, so it is best that these only operate from time to time.

This module provides control over the delay between these lineside activities and also how long the activity lasts.

As an additional feature, it offers the ability to produce random times between activities.

Two trimmers control the on and off times and these are adjusted with a screwdriver. The module has a single output and it can be switched high (to +5V) or low (to 0V). One trimmer sets how long the output



remains high while the other sets the time the output remains low.

Wire links determine whether these timings are in seconds or in minutes. The timings work independently of each other so, for example, you can have an activity that lasts seconds occurring many minutes apart.

It uses only a handful of components because most operations are handled by the pre-programmed chip. The available options are:

- With no links fitted, the high and low times can be set up to around 25 seconds each. This would be useful for flashing or pulsing LEDs.
- With both of the timing links fitted, the high and low times can be up to around 9 minutes.
- With just one timing link fitted, you can have a long delay between short bursts of activity, or vice versa.
- With the random link fitted, the high time's delay will last a random time up to 25 seconds or 9 minutes (depending on whether the 'high' link is fitted). The low time will still be determined by that trimmer's setting and whether the 'low' link' is fitted.

## How it works

All the difficult stuff (voltage sampling, decision making, timing, etc.) takes place within the pre-programmed 12F675 PIC chip.

The 78L05 is a voltage regulator. It reduces the 12V supply to the +5V used by the PIC.

There are two trimmers that are adjusted using a small screwdriver. One sets how long the output stays at 0V while the other sets how long the output stays at +5V.

The 10K resistors hold pins 2, 4 and 5 at a high voltage. Fitting links between these pins and 0V brings the pins down to 0V. The PIC chips looks at the voltage on these pins and decides on whether the trimmers are setting delays in seconds or minutes, or whether to produce a random delay.

## Examples of connections

The use of this module depends on your needs and your imagination. Here are some possible examples of use.

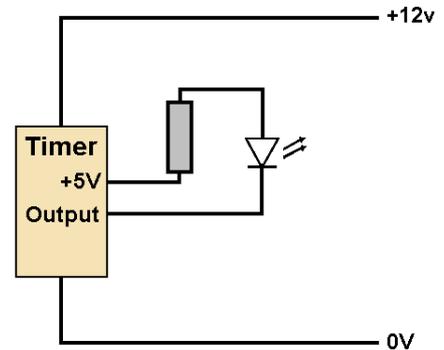
### LEDs

The module can be used to simulate emergency vehicle lighting, with flashing or strobing effects. For this, do not fit any of the three optional links.

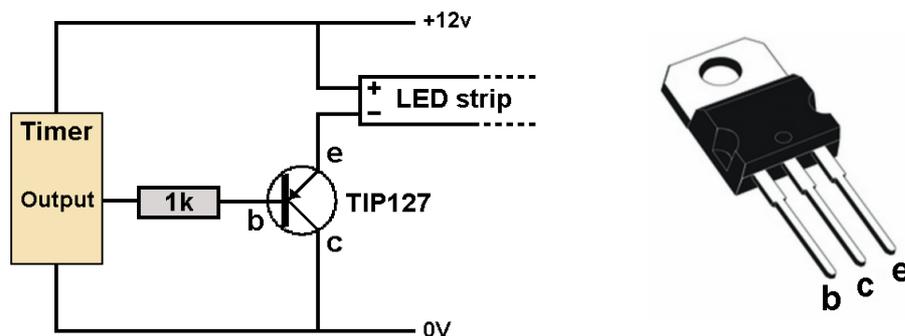
You can connect a LED directly to the module's output as shown in this diagram. The resistor's value can be anything from 330 ohms to 1k (1,000 ohms), depending on the LED used and the amount of illumination required. The current drawn from the LED's output must not exceed the maximum limit of 25mA.

The LED and its resistor are fitted between the module's output and the module's +5V supply (see the +5V out connection on the earlier illustration).

If required, several low-current LEDs and their resistors can be fitted in parallel with each other between the module's output and the +5V supply, as long as the combined maximum current does not exceed the 25mA limit.



While it can handle low-power LEDs, the PIC cannot supply enough power to directly drive a 12V LED strip. So a power transistor is used to boost the current handling capacity. This diagram shows a TIP127 power transistor connected to the module's output.

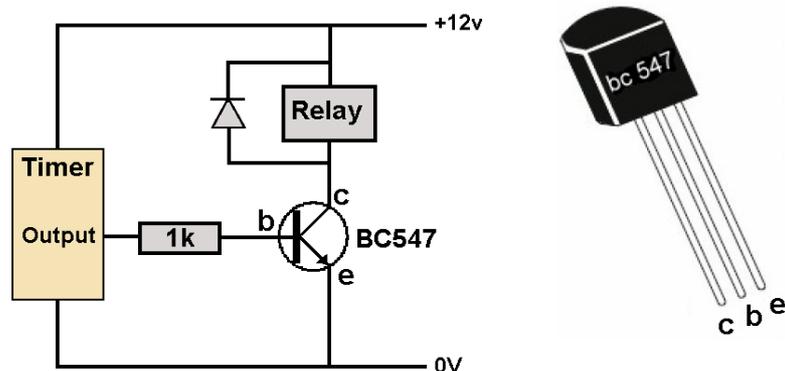


In this case, the LED strip is connected between the transistor and the +12V supply.

### Relays

If you want the module to be able to control high power devices such as motors, you can use a relay to do the switching.

This diagram shows the timer's output driving a transistor that switches a relay. The relay contacts are wired to the device being used.

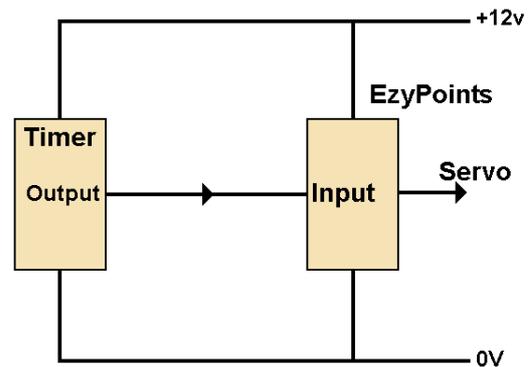


## EzyPoints

This timer module is very useful if you want to animate something on your layout from time to time. You can make a door open, the station master pop out of the station building, a workman rotate a stop/go sign, a lorry tip its load, a rabbit pop its head out of its burrow – and many many more little touches.

No modifications are required to either module.

The output of the timer board is directly wired to the trigger input of the EzyPoints board as shown in this diagram.



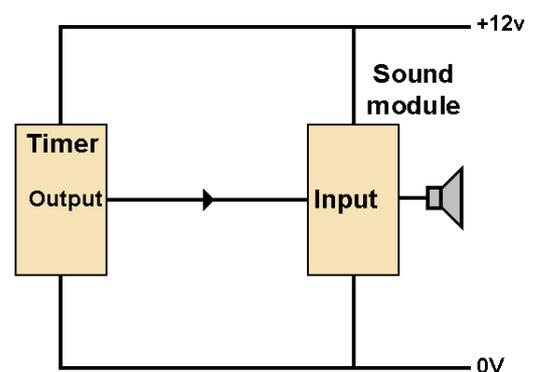
## Sound modules

When not overdone, the occasional use of sound can add life to a layout. Your country scene could have cows mooing and dogs barking from time to time. Your industrial scene could have machinery being run periodically. Your town scene could have car horns and police sirens interrupting the peace occasionally. The limits are your imagination.

The use of DIY sound modules is covered in another chapter.

Most sound modules have their sounds activated by taking their inputs down to 0V.

So, for example, the inputs of the WTV020 and WT588 modules can be directly connected to the timer's output.



If you are a MERG member, this is available as a kit - PMP20 Part No: 820.

# Pocket Money Projects

## Part 21

A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

## Twin Flasher

This little project flashes two LEDs alternately.

It has many uses including:

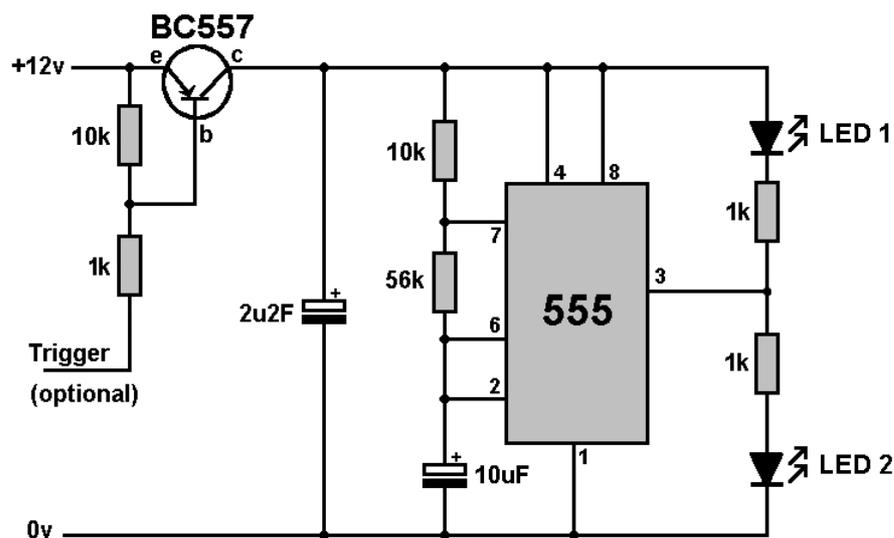
- Pick-up trucks, emergency vehicles.
- Crossing gate warning lights.

It operates from a 12V supply and has a fixed flashing rate.



### How it works

The 555 chip is configured as an oscillator with its output (pin 3) swinging between high and low voltages.



When pin 3's voltage is high, LED 2 illuminates while LED 1 remains unlit. When pin 3's voltage drops to 0V, LED 1 is illuminated and LED 2 is extinguished.

This continually repeats, at a rate set by 10uF capacitor and the 10k and 56k resistors.

You can change the flash rate by altering these values. There is a handy calculator at:

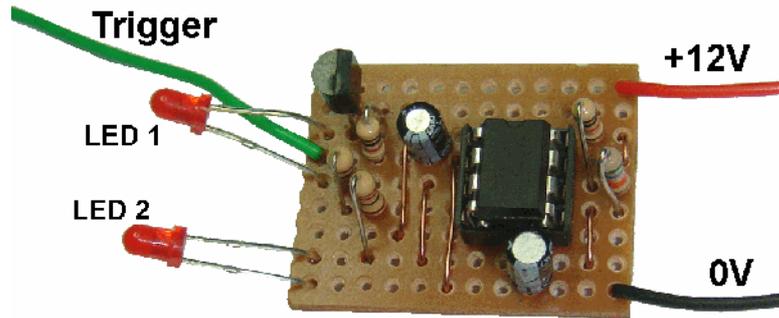
[www.ohmslawcalculator.com/555-astable-calculator](http://www.ohmslawcalculator.com/555-astable-calculator)

### Simple flasher

You omit the BC557 transistor and its 10k and 1k resistors and just connect the +12V straight through to the other components.

That way, the circuit is always powered and the LEDs will continually flash.

This mode is useful for pickup trucks, pedestrian crossings, etc.

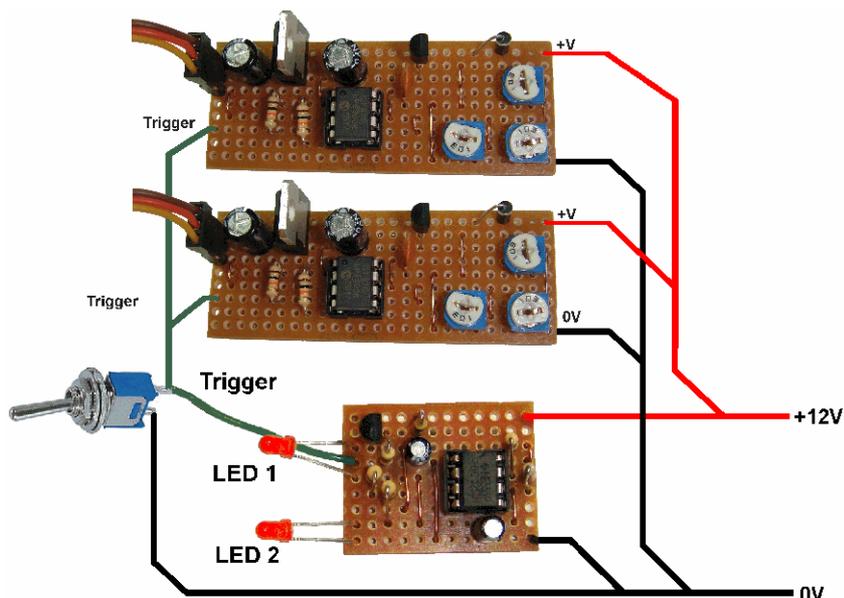


## Wiring for a crossing

When used with a barrier crossing, you need the flashing to be switchable, only working when the gates are lowered. The BC557 transistor, when fitted, acts as a switch. When the transistor's base connection is brought down to 0V, the transistor is switched on, providing the voltage to operate the 555 oscillator chip.

The same wire from the switch can be used to operate the servos.

This diagram shows wiring two PMP18 EzyPoints kits.



## Other inputs for crossing barriers

The dual flasher is also capable of being operated by other MERG modules.

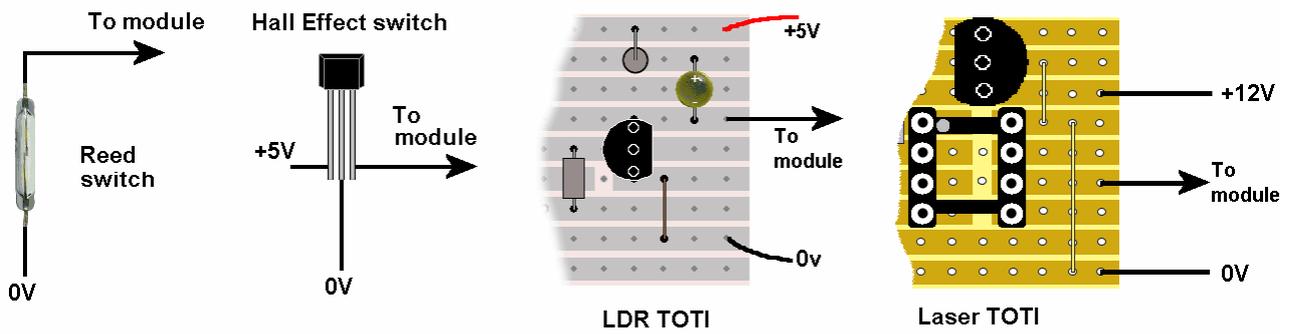
The circuit diagram above shows a switch being thrown/released to operate the modules.

All the switch does is bring the flasher's transistor input down to 0V. So, other modules whose output switches down to 0V could be used to operate the crossing.

Just make sure that they share the same 0V connection, as all voltages are with respect to this common ground connection.

This allows, for example, the *remote* operation of the barriers by connecting the outputs of a DCC Steady State decoder (Kit53) or a CBUS CANACC8 (Kit 88) or an EzyBus Output Module to the input of the flasher and points module. The barrier crossing can then be controlled from your control panel or DCC command station.

Also, it allows *automatic* operation of the modules by connecting the outputs of the DTC8



8-channel block detector (Kit 56), the DCC Train Detector (PMP Kit 807) or pin3 of the Automatic Signals kit (PMP Kit 817) to the input of the above circuits.

If you are a MERG member, this is available as a kit - PMP21 Part No: 821.

# Pocket Money Projects

## Part 22

A series of small, cheap,  
easy to build projects  
using stripboard

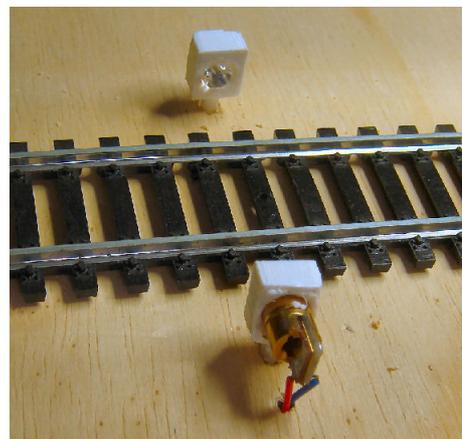
by Davy Dick M1853

## A laser detector

Yet another TOTI (train on track indicator)?? What is different about this one that is worth looking at?

This laser-based circuit attempts to provide a module that meets various needs, while avoiding the limitations of some other modules. While the laser beam is interrupted, one of the module's outputs goes from +5V to 0V while another output goes from 0V to +5V.

If you fit an optional link, the outputs are held in these altered states for 10 seconds after the beam is restored. After 10 seconds, the outputs revert back to their normal states. This provides various options for the module's use.



## What is already on offer

MERG already has five kits for train detection, each with its own strengths, weaknesses and limitations.

- Two kits (the DTC8 and the PMP 7 DCC TOTI ) are designed for DCC only. DCC detectors are ideal for detecting locos on long stretches, including bends. However, if you want spot detection (i.e. detecting a loco at precise spot rather than anywhere in a track section) you have to either provide an additional very short isolated section or install an additional spot detector such as the Hector or LDR TOTI.
- The Hector is a very useful spot detector (albeit with limited range) but cannot detect over an entire track section. It has the advantage that it can operate in the dark (e.g. tunnels) although it benefits from being shielded from ambient light in normal situations.
- The LDR TOTI is simple to set up and use but needs to be adjusted for ambient light conditions. Like the Hector, it is a spot detector. In a tunnel, or ill-lit situation, it would require an extra light source.
- The TOTI-4 works with both DC and DCC but needs a split supply.

## The laser version

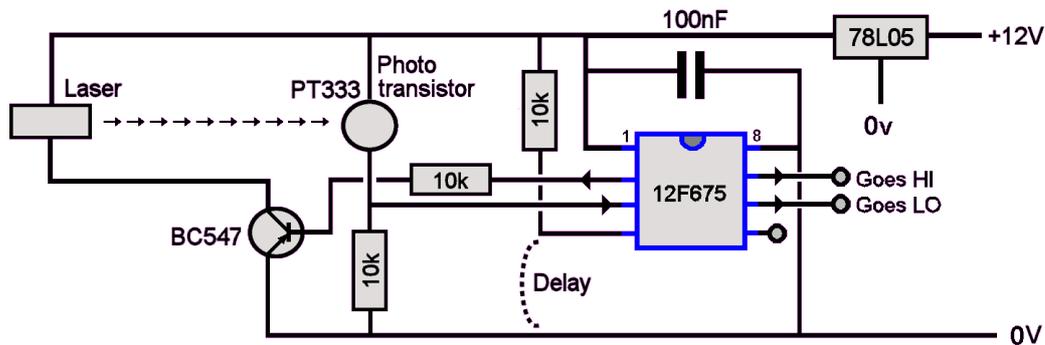
The above picture shows a test setup for the module.

A laser diode head is shown at the near side of the image, with a detector at the other side of the track.

The laser head is readily available on eBay as a replacement for laser pointers.

## How it works

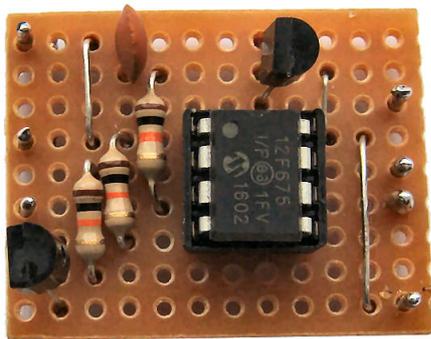
The laser head is switched on in short bursts – about four short bursts per second. The PT333 photo-transistor reads the light level while the laser is switched off and this is detected as the ambient light level.



The laser is then switched on and another light reading is taken. If there is nothing obstructing the path between the laser head and the photo-transistor, this higher reading is detected. However, if anything is obstructing the light path (e.g. a loco) the light level detected by the PT333 drops.

The PIC chip can differentiate between 'normal' ambient light changes such as house lights being on or off, people casting shadows, etc. and the changes caused by the laser beam being obstructed. If the light level changes beyond this allowable threshold, pin 6 of the chip goes low and pin 7 goes high.

These changes will remain as long as the beam is interrupted. When the interruption ceases, the pins revert to their previous state (i.e. pin 6 goes back to +5V and pin 7 goes back to 0V). That is, unless you have fitted the 'delay' link, in which case there will be a 10 second delay before the pins return to their normal states.



The outputs can be used to illuminate LEDs or can be used activate other devices (relays, servos, inputs to CANACE8C, EzyBus etc.).

## Safety

The laser head used in this project is a 'Class 3R', the type used in many laser pointers and DIY laser spirit levels. It has a maximum power of 5mW and has a red colour (wavelength is 650nm). It can project a narrow beam over a long distance, more than we would need on a model railway.

Public Health England states that these heads “*can potentially cause eye injuries, although the risk of injury is still low.*”

This circuit is even safer, as each laser burst is only on for around 0.01 seconds.

Although it can only cause discomfort, the beam should not shine directly into anyone's eyes. Clearly, it would nevertheless be sensible to position the laser head so that it cannot be viewed directly by a viewer or operator.

Therefore, you build this module at your own risk.



## Fitting

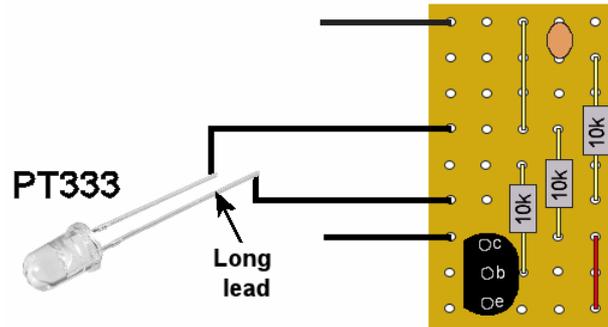
As the illustration shows, the short lead of the PT333 phototransistor is wired to the fourth row from the top (i.e. direct to the +5V supply). This is the opposite to the way most devices such as LEDs are wired.

The laser head is mounted so that its beam directly hits the front of the PT333.

Aligning the laser head and the photo-

transistor are not specially critical over short distances. With longer distances, extra care is required for alignment.

Placing a piece of white paper in front of the PT333 helps. Particularly in a darkened room, the spot of the beam is clearly seen and the laser head can be moved for perfect alignment.



## Used as a spot detector

The illustration shows the beam set at a diagonal across the track.

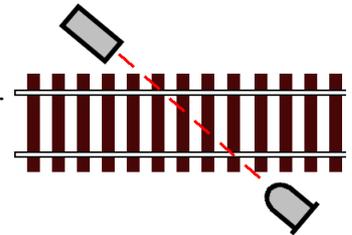
This ensures that gaps between items of rolling stock are not detected,

with the outputs only being reset after the last item passes. The module's output is only changed when a train breaks the beam.

The output reverts to its original state when the train leaves the detectable area (perhaps after an optional delay).

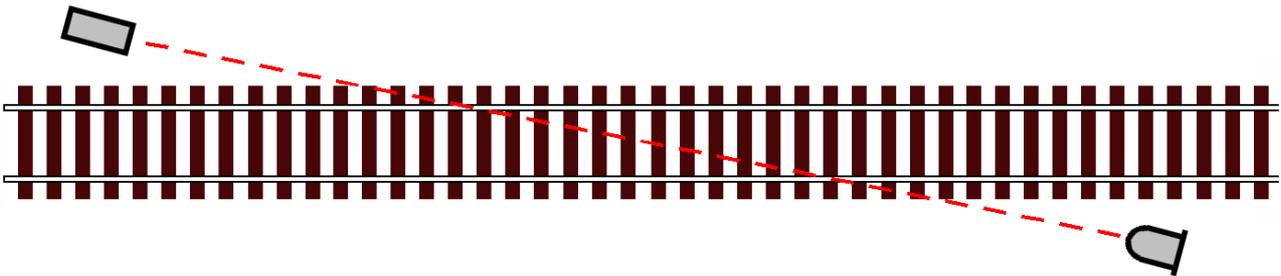
If the train passes the detector and stops further along the track,

the section is occupied but there is no feedback. This method is useful for triggering events such as sounds or CBUS notifications.



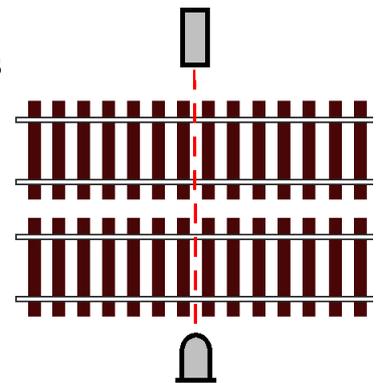
## Used as a section detector

This TOTI can also be used to detect trains along a long straight section of track, if the laser head and phototransistor are situated at a narrow angle as shown.



## Testing multiple tracks

Since the module has a long range, it can be used to detect across multiple tracks. The illustration shows how we used it in our latest demonstration layout. When the loco enters either siding, it is detected. It would work equally well across many more parallel tracks.



Finally, the module does not have to be positioned across a track.

The laser head could be mounted above a track (e.g. in a tunnel or inside a shed) with the phototransistor embedded between the sleepers.

In this case, the train would be interrupting a vertical beam.

## Modifications

The 5mW laser head can be replaced by a 1mW head. These are completely safe to use but are much more expensive (57-5872 from Rapid) .

The PT333 photo-transistor can be replaced with an Everlight PT15-21C IR Photo-transistor (63-1364 from Rapid). This is a tiny surface mount device and is much easier to hide on a baseboard (if you are happy with soldering surface mount components).

## Comparison of different occupancy detectors

The restrictions, or possible restrictions, are marked in grey.

	<b>ToTi-4</b> (part 62)	<b>Hector</b> (part 72A)	<b>DTC8</b> (part 56)	<b>LDR TOTI</b> (part 802)	<b>DCC TOTI</b> (part 807)	<b>Laser</b>
Number of channels	4	2	8	1	1	1
Works on DC?	Yes	Yes	No	Yes	No	Yes
Works on DCC?	Yes	Yes	Yes	Yes	Yes	Yes
Works on 12V?	No <sup>1</sup>	Yes	Yes	Yes	Note 2	Yes
Spot detection?	No <sup>3</sup>	Yes	No <sup>3</sup>	Yes	No <sup>3</sup>	Yes
Section detection?	Yes	No	Yes	No	Yes	Yes
Long distance?	Yes	No	Yes	No	Yes	Yes
Works in the dark?	Yes	Yes	Yes	No	Yes	Yes
Free from ambient light?	Yes	No	Yes	No	Yes	Yes
Can read multiple tracks?	No	No	No	No	No	Yes

### Notes

- 1 - Requires a split supply
- 2 - Module gets its power from the DCC signal
- 3 - Only if you make a very short track section

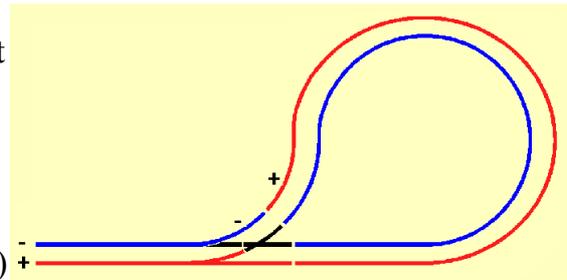
If you are a MERG member, this is available as a kit - PMP22 Part No: 822.

## DCC reverse loop controller

Also known as '*reversing loops*' and '*balloon loops*', return loops allow trains to reverse direction without shunting or turntables.

As the diagram shows, trains enter a loop head first and then exit head first.

The problem arises with the wiring to the track. Without taking any steps, there would be a short circuit as the outer rail (shown as positive in the example) became the inner rail (shown as negative) at the other end of the loop.



The common way to solve this is to isolate the main part of the loop at both ends, on both rails, as shown. Although the loco's decoder does not care about track polarity ('forward means forward'), the polarity of the isolated section still needs to be switched at appropriate moments to avoid shorts.

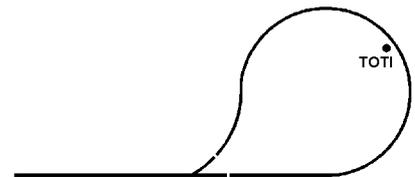
This module uses TOTIs (train detectors) to provide fully automatic control of both train, tracks and point movement.

### Options

The controller offers three different levels of complexity, with added functionality as you add extra detectors. You decide how far you want to go with this module.

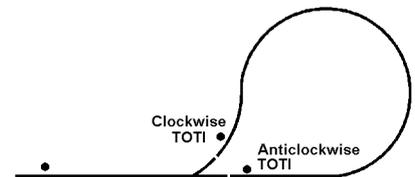
#### Single detector

This is the easiest to implement, with the TOTI positioned mid-way round the isolated section. This limits the train length to half the length of the isolated section. Since you don't know how long a train is, you have to set a timer to control the switching of the point and isolated section.



#### Two detectors

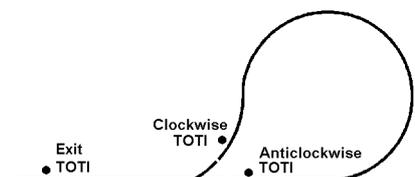
This method places a detector at each end of the isolated section, allowing the train to be the length of the isolated track section. You still need to set a timer.



#### Three detectors

This method places a detector at each end of the isolated section, plus another detector on the main track, also allowing the train to be the length of the isolated track section.

Since the 'Exit' detector indicates when the train has fully left the loop, there is no need for a timer.



## The module

The module uses few components, with a pre-programmed PIC chip carrying out the decision making. Users connect their own detector(s) to the module.

The module assumes that the outputs of detectors go low when activated.

Although there is provision for four detector inputs; users connect a single detector, two detectors or three detectors depending on which option is chosen.

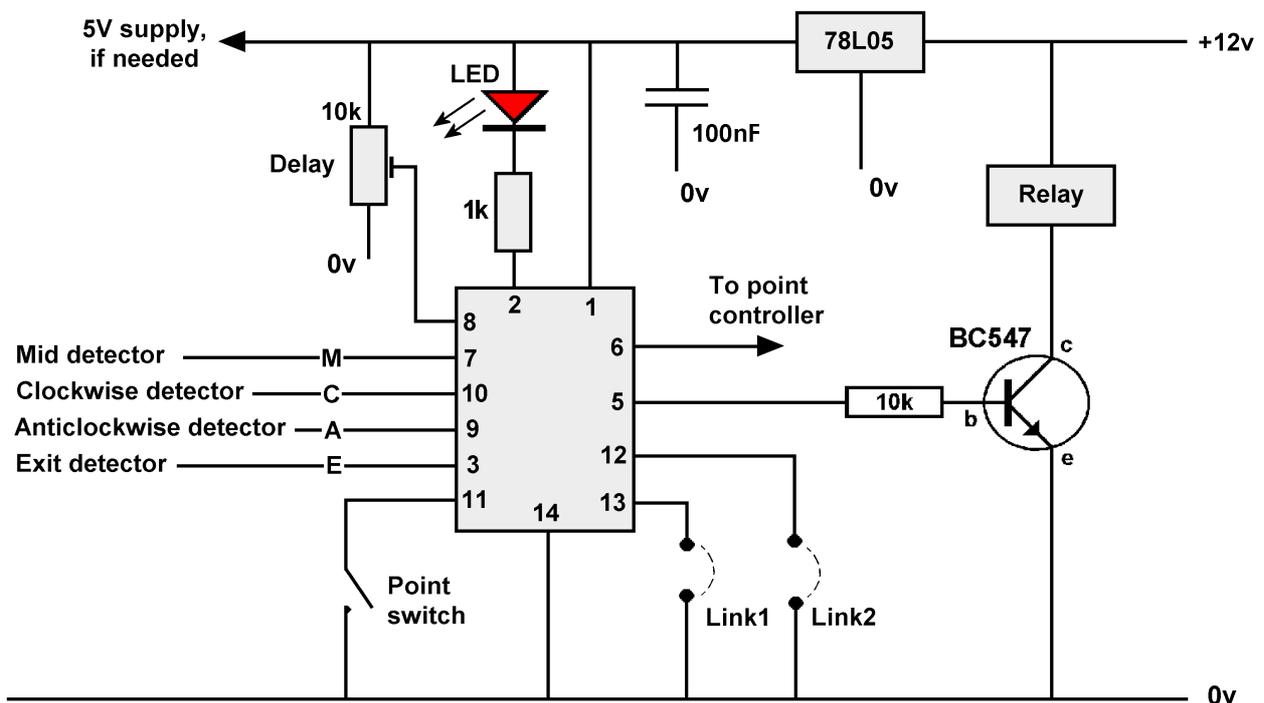
Options are chosen using wire links:

No links – single detector mode

Link1 fitted – two detector mode

Link2 fitted – three detector mode

Here is the circuit diagram:



## The inputs

The single pole point switch that normally connects to a point controller (e.g. Servo4, EzyPoints, etc.) is instead routed through the module and back out to the point controller.

The user can operate the point as normal, up until a loop detector is triggered, when the module will take charge of point operations until the train exits the loop and point.

This allows both operator control and automatic control of the point movement.

Pins 3, 7, 9 and 10 are used for connecting your detectors. You connect one, two, or three detectors, depending on which mode you want to use.

### Single detector

Connect the mid-detector to pin 7 (marked as 'M' on the illustration)

### Two detectors

Connect the clockwise detector to pin 10 ('C' in the illustration) and the anticlockwise detector to pin 9 ('A' in the illustration)

### Three detectors

Connect to pins 9 and 10 as above, plus connect the exit detector to pin 3 ('E' in the illustration).

The pin inputs must not exceed +5V.

Here are the connections for a selection of different detector options:

Please note that the LDR TOTI should be connected to a 5V supply instead of the usual 12V.

The 5V supply for the Hall Effect switch and the LDR TOTI can be taken from the reverse loop controller's 5V supply. The laser TOTI can be fed from a 12V supply as normal, as its output already only swings between 5V and 0V.

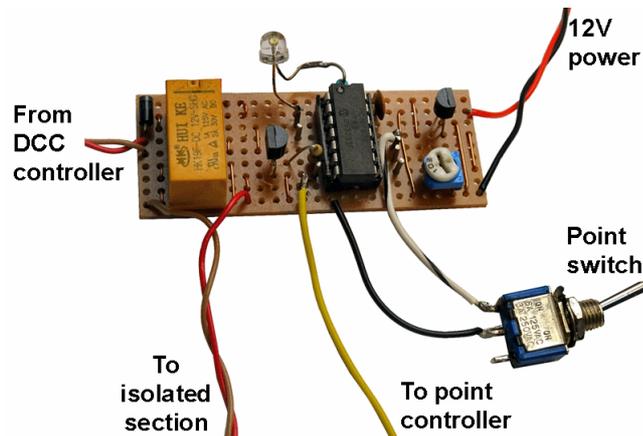
The final input to the module is from a 10k trimmer and is used to set the delay time for modes 1 and 2; its setting is ignored in mode 3.

## The outputs

There are only three outputs – to the relay that switches the polarity of the isolated section, to the external point controller, and to the optional LED.

The LED is illuminated while the train is in the isolated section. It should also be connected to the module's 5v supply via a 1K resistor.

The photograph shows the module set up for single detector working, with a LED fitted.



## How it works

### Single detector

A detector is fitted at the mid point of the isolated section, triggering at the same point whether the train is running clockwise or anti-clockwise.

Consider the case of the point set to 'branch', with the train running in a clockwise direction.

- When the train triggers the detector, the LED illuminates.
- The module switches the point to 'straight' and reverses the power to the isolated section.
- The train passes through the section and the point without any human intervention.
- After the pre-determined delay (set by the operator), the point returns to 'branch' and the LED extinguishes.

A similar process takes place if the train is moved through the loop in the counter-clockwise direction.

The module waits until the train has cleared the detector before switching, allowing the train to stop in the loop (e.g. at a station).

### Two detectors

This functions similarly to the single detector version, except that the operation of the points and relay are triggered by the second detector (by the anticlockwise detector when travelling clockwise – and vice versa).

### Three detectors

This functions similarly to the two detector version, except it does not use the timer. Instead, the third detector tells the module when the train has fully left the loop and cleared the point.

If you are a MERG member, this is available as a kit - PMP23 Part No: 823.

# Pocket Money Projects

## Part 25

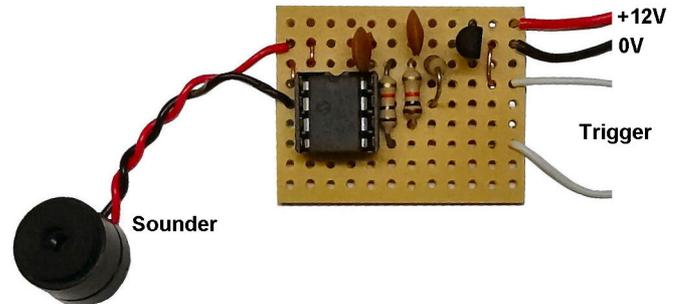
A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

## Steam sound emulator

This module provides a cheap way to reproduce the sound of a steam loco's steam outlet, with a choice of usage.

If your layout has a stationary loco with a flickering LED in its firebox, why not add the occasional sound of the steam release.



The options are:

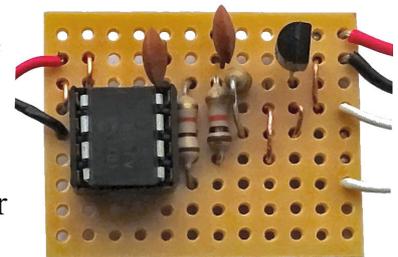
- Play the steam sound at random intervals.
- Play when a switch, or other trigger, is operated.
- Play after a five second delay when a switch, or other trigger, is operated.

The first option is useful for unattended operation.

The third option is for use with a train detector. When a loco stops in a section of track, the steam release is heard after a short delay.

Options are set with additional links:

- With no links fitted, play at random intervals (see picture above)
- With the shorter optional link fitted, only play when the trigger pin is brought down to 0V.
- With both optional links fitted, wait for five seconds after the trigger pin is brought to 0V, before playing (see picture).



Drill a hole between the sleepers, at the spot in the track over which the loco will sit.

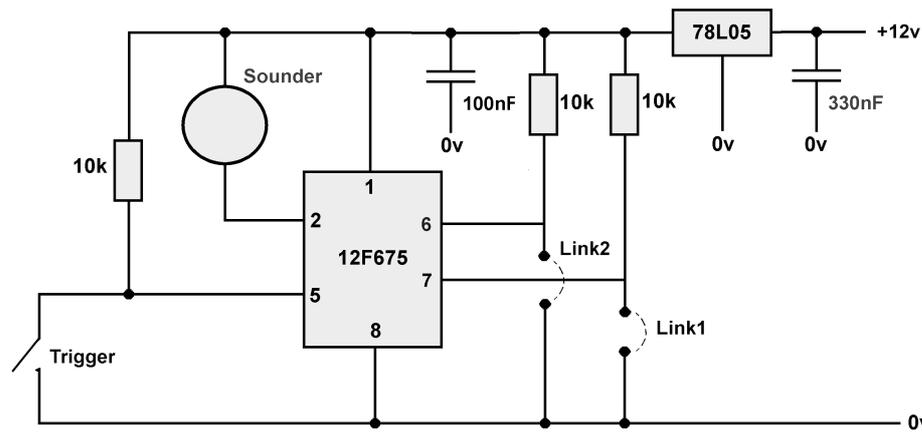
Mount the sounder under the baseboard, with a tube connecting the sounder to the area with the hole.

Fitting a tube to the sounder enhances the volume as well as directing the sound upwards.

Of course, you could decide on another way to mount the sound source.

## How it works

All the difficult stuff (detecting voltage changes on input pins, decision making, timing, etc.) takes place within the 12F675 PIC chip. The chip is programmed to produce 'white noise', audio that combines sounds of all different frequencies. The resulting 'shhh' sound is similar to that of steam release.



The 78L05 is a voltage regulator. It reduces the 12V supply to the +5V used by the PIC. The 10K resistors hold pins 6 and 7 at a high voltage. Fitting links between these pins and 0V brings the pins down to 0V. The PIC chips looks at the voltage on these pins and knows which option you have chosen.

The 'trigger' can be anything that brings pin 5 down to 0V. If you want manual control, it can be a simple switch or pushbutton.

For automatic operation, the module can be triggered by a TOTI (train on track indicator). The output of the TOTI can be connected to pin 5 of the PIC chip, with both modules sharing the same 0V line.

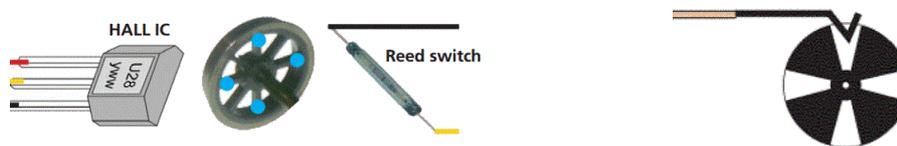
## Modifications

The module's white noise output is an approximation to the steam release sound; it is not a digital recording. Filtering and wave shaping of the audio output would increase its realism. However, extra circuitry would be required.

### Poor man's chuffer

The module was intended for use on the baseboard but it could also be adapted for use in a loco (perhaps with a SMD version?). For those who can't afford to fit DCC sound decoders, or for DC users, it could be a cheap and cheerful alternative.

In fact, some LockSound the SoundTrax DCC sound decoders use mechanical (cams) or electronic (Hall Effect ICs or reed switches) to detect the amount of wheel rotation and covert it into synchronised chuffing. A similar approach could be adopted.



An alternative approach might be to fit the steam emulator in the loco's tender or leading wagon/coach and use the TCRT5000 sensor as used in PMP 19 (automatic coach lighting) to trigger the sound module.

If you are a MERG member, this is available as a kit - PMP25 Part No: 825.

# Pocket Money Projects

## Part 26

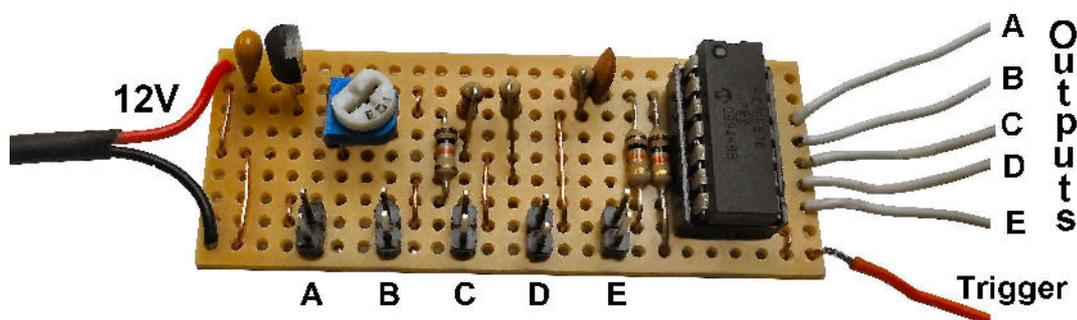
A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

## Event sequencer

### Animated sequences without programming

Now you can enhance your layout with sequenced activities such as lights coming on and off, animations, and sound effects – all with time delays between each activity set by you – and without the need for any programming skills.



The sequencer module has one trigger input and five available outputs.

Each output can be set for a delay between 1 second and 10 seconds before it switches on or off.

Connecting the trigger input to 0V starts the output sequence. The trigger could be a switch on your control panel, a TOTI (train on track indicator), an output from a CBUS or EzyBus module, a microswitch, etc.

The outputs, with suitable interfaces, could control LEDs, servo controllers (Servo4, EzyPoints, etc.), relays, motors, etc. The combinations depend on your imagination.

### Example sequence

This layout runs a good shed animation sequence when the train enters the siding. A train detector detects the presence of the train and initiates the following sequence:

- A The lamp above the shed door comes on
- B The store man comes out (servo-driven)
- C The shed's sliding door opens and the interior light comes on (servo+LED)
- D The cranes rotates over the wagons (servo again)
- E A lorry moves round from behind the shed (another servo)



When the train leaves, the trigger is no longer held at 0V and the sequence runs in reverse (i.e. lorry moves round behind shed .... light goes out over shed door).

There are delays between each activity, with the sequencer module handling two LEDs and four servos.

## Other possible uses

A layout has a barge that moves along a canal, stopping part way into a warehouse. Its sequence is triggered by a microswitch, switching on a light on the warehouse hoist platform, making an operator appear on the platform, then lowering a load into the barge.

Other examples could include station activities, factory animations, animated water cranes, etc. The module opens up opportunities to have lights, movement, audio all being delivered in your required time sequence.

## Adjusting the delay settings

There are five 2-pin Dupont male connectors and you use a single jumper link to set the timings. Thereafter, the jumper link is not required (unless you want to alter the timings another time).

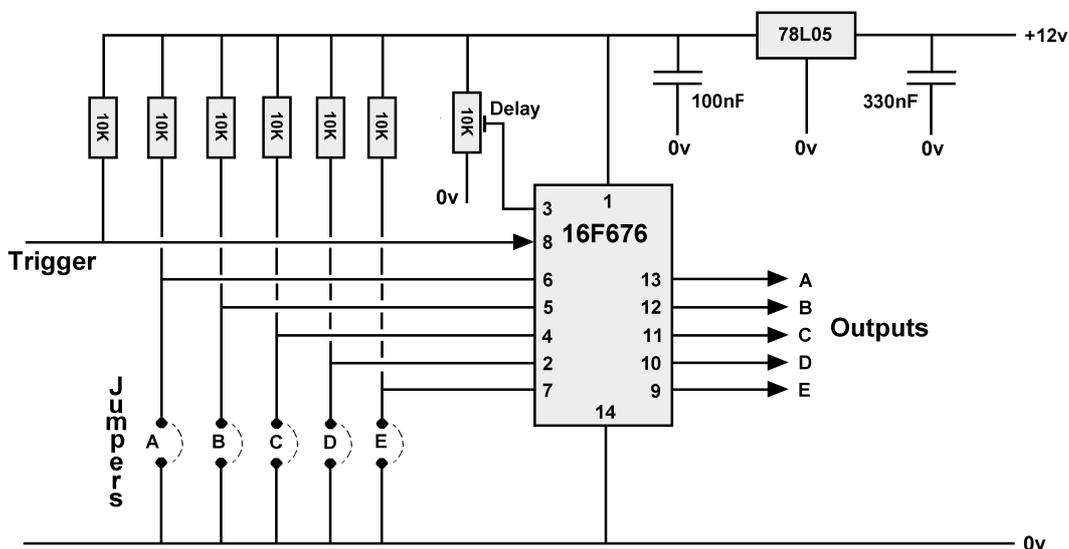
To set the delay for output A, simply place the jumper to bridge the two A pins and use a small screwdriver to adjust the trimmer for the delay required. The delays range between 0 seconds (fully clockwise) to 10 seconds (full anti-clockwise). Then remove the jumper link.

The same for all other outputs. If you need less than five events, just make the unused outputs have a delay of 0 seconds.

The jumper link is only required for setting delays (or altering delays) and should not be left plugged into any set of pins.

## How it works

All the difficult stuff (input sampling, decision making, timing, etc.) takes place within the pre-programmed 16F676 PIC chip.



The 78L05 is a voltage regulator. It reduces the 12V supply to the +5V used by the PIC.

All the delay selection pins (2, 4, 5, 6 and 7) are held at +5V by the 10K resistors.

Inserting the jumper link across one of the sets of pins takes its corresponding PIC chip pin down to 0V. For example, inserting the jumper across the two B pins brings pin 5 down to 0V. The PIC chip detects this and reads the value that you set while adjusting the trimmer. This is stored in the chip's memory even after you remove the jumper.



The wiring to a Servo4 controller is similar.

The Servo4 controls up to four servos and therefore has four trigger inputs.

Any one of these inputs can be directly connected to a sequencer output.

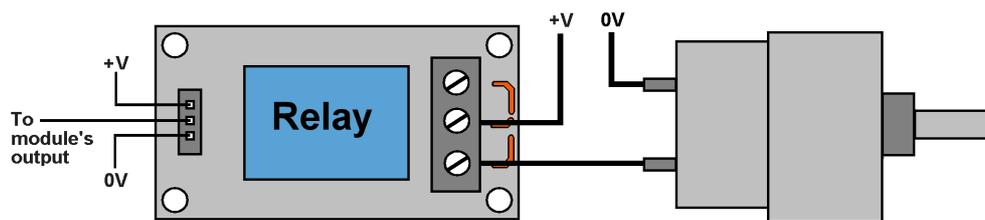
Again, the 0V of the sequencer should share the same 0V connection of the Servo4.

## Connecting relays

The sequencer module's outputs switch between 0V and 5V.

If you buy relay modules that include an '*opto-coupler*', you can use either a 5V or a 12V relay module. Use a relay that is '*active low*' (needs a 0V on its input to switch the relay).

If you only have an 'active high' module, you can use a BC557 transistor to convert a low input into a high output (PMP21 uses a suitable circuit).



This example shows a relay operating a motor (machinery, conveyor belt, etc.).

It could also be used to switch other high current or high voltage devices on and off (12V LED strips, etc.).

## Connecting audio modules

The sequencer can activate any sound module that uses a drop to 0V at its input to start the audio playback.

Suitable examples are the '*talking card*', the WT588, and the DFPlayer,

## Modifications

Some more thoughts ...

### Longer delays

If you want longer delays between events, leave a particular output (or more) unconnected. For example, if we make all delays 10 seconds and only connect devices to outputs A and D then output D will activate 30 seconds after output A.

Alternatively, if you have experience with the JAL language, you can edit a single number in the code to extend the range of delays.

### Extra outputs

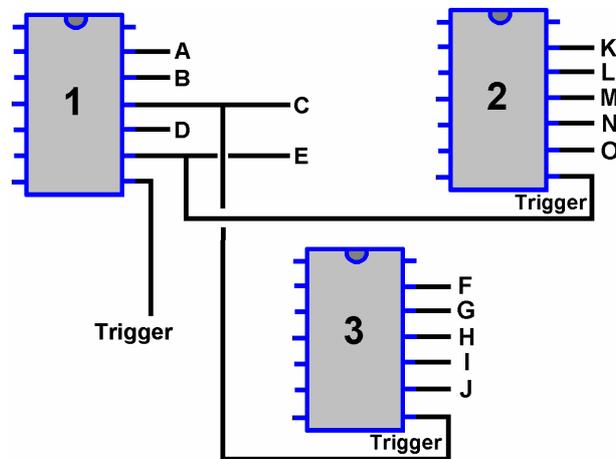
Maybe you would like to have more than five events on a sequence. In that case, you can wire wire modules in series, with the last output of one module triggering the sequence in the next module. Long, complicated sequences can be started from a single switch or train detector.

### Complex sequences

As the name implies, the sequencer works its way through the five outputs in order, or more than five if you add on extra modules.

What if you want a set of activities to start at some point in that sequence and run some activities in parallel?

Consider this example:



- Sequencer 1 is activated by its trigger.
- Events A and B activate in succession, with the preset delays between each.
- Output C activates – but also triggers sequencer 3.
- Events D and E are now activated along with events F and G.
- Event E also activated sequencer 2.
- Now, events H, I and J are activated during the K to 0 sequence.

Multiple sequencers allows many events to overlap in time.

Of course, most of you will be considering a smaller sequence using only a single sequencer – but it shows the potential of the module.

If you are a MERG member, this is available as a kit - PMP26 Part No: 826.

# Pocket Money Projects

Part 27

A series of small, cheap,  
easy to build projects  
using stripboard

by Davy Dick M1853

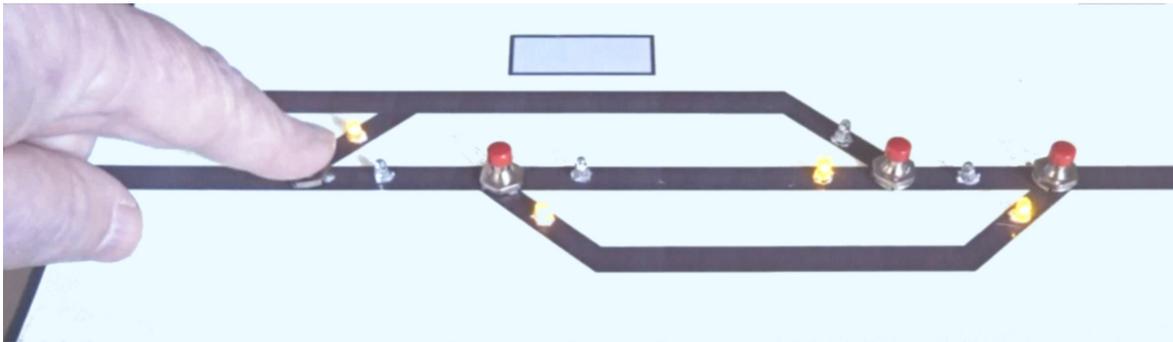
## Button operated servos (or stud-operated)

Many layouts with solenoid-operated points used a 'stud-and-prod' method of operation. With more sophisticated CDUs (Capacitive Discharge Units), control panels use toggle switches to operate the CDUs.

Nowadays, many hobbyists have switched to using servos to operate their points. Servo4 and EzyPoints have inputs that are held either at +5v or 0V and members can still use these toggle switches to produce this change of voltage.

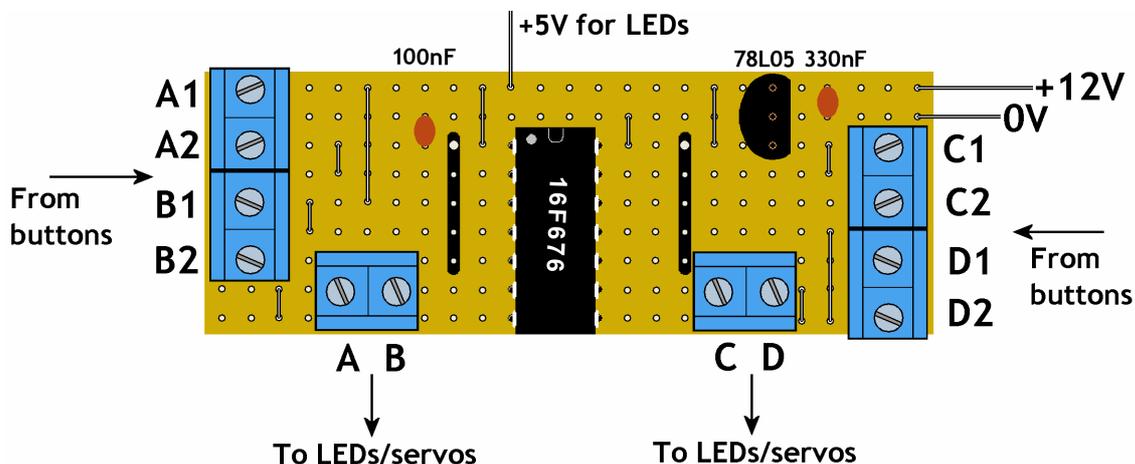
However, you may want to install push-buttons on your control panel, instead of switches. Then again, you may want to change from solenoids to servos but want to keep your stud operated control panel.

This module allows control panels to use stud-and-prods, or push buttons as shown in this image.



The image shows a single-button for each point, with each press changing the point direction. The module also supports two-button mode, with each button switching the point in a different direction.

LEDs on the panel indicate which way a point is set and these settings are remembered when the layout is next switched on.



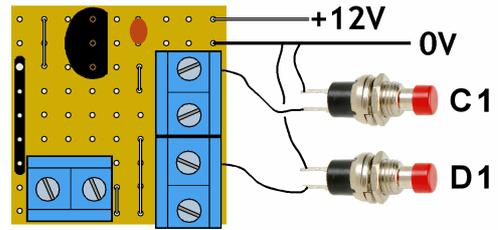
## External wiring

For single button mode, use A1, B1, C1 and D1 inputs to control their respective outputs.

For two-button mode use A1 and A2 to control output A, and so on.

One tag of the push-button connects to the screw terminal. The other tag connects to 0V.

The illustration shows C1 and C2 buttons connected.



## Deciding on one or two-button mode

This module can handle both single button and dual button operations.

To select single-button mode, turn on the power while holding down the A1 button.

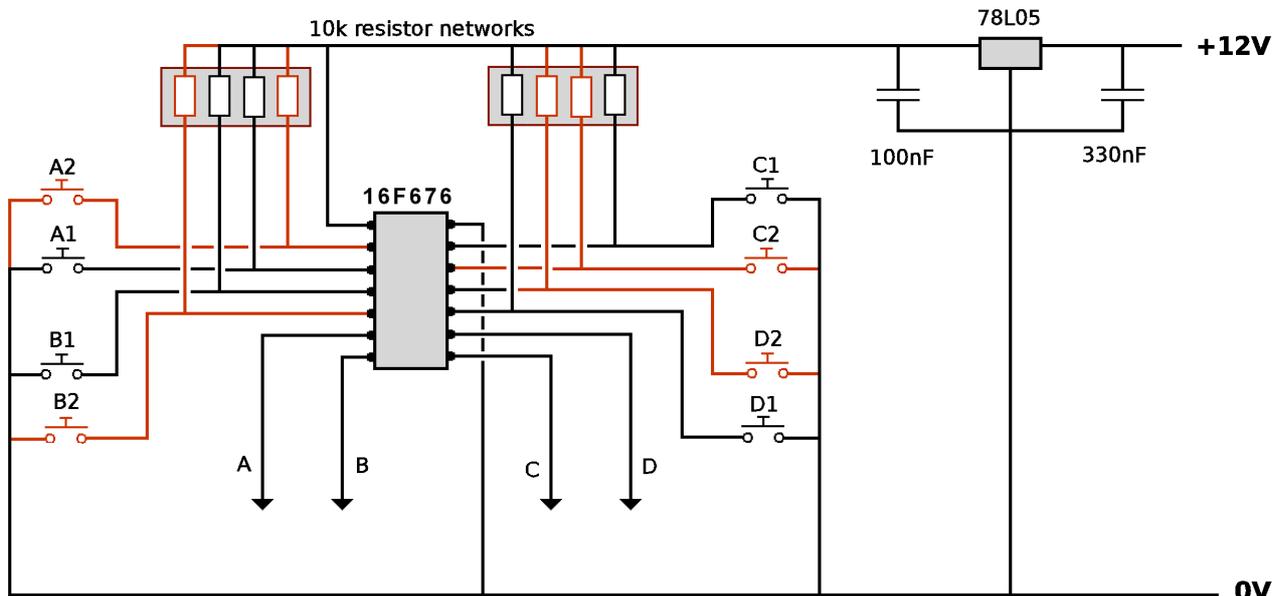
The LEDs attached to output A will flash to indicate the change. Both LEDs on output A will flash, but one LED will be on much longer than the other.

To select two-button mode, turn on the power to the module while holding down the A2 button. The LEDs will flash but this time both LEDs will be on for an equal amount of time.

## How it works

Here is the circuit diagram. It is based on a pre-programmed PIC chip that contains all the decision-making and controls.

The resistors and switches shown in red are only required if using two-button mode.



When you first setup the module's mode (single-button or dual-button) the choice is stored in the chip's memory.

The chip detects when a button is pressed (one of its pins is taken down from +5V to 0V). It knows which button has been pressed and will change its corresponding output depending on the module's mode. When one of the outputs A, B, C and D is switched, its state goes from +5V to 0V (or vice versa). That change will switch one LED on and the other off; it will also operate the servo controller.

The module stores the current setting of each point when the power is switched off.

If you are a MERG member, this is available as a kit - PMP27 Part No: 827.