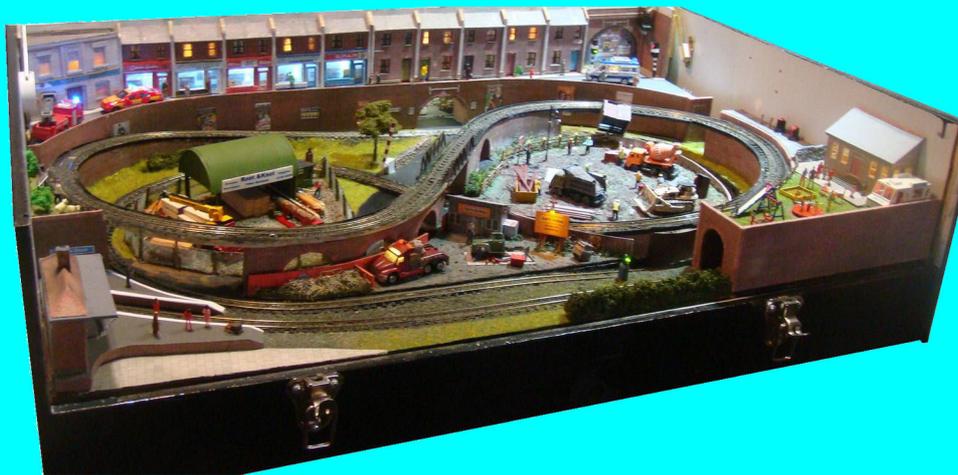


Electronics for Model Railways



Chapter 15

Animations

By Davy Dick

Electronics for Model Railways

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In memory of Margaret



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Animations

You build your layout. It looks great. It works great. And yet, you may feel that there is still something not quite complete about it. Then you realise that the only things moving on the layout are the trains. If that is the effect you wanted to achieve, then that is fine. However, you may feel that to be authentic it should mirror real life, with sounds, lights and other things moving.

The starting point for all animations is the idea; the means to achieve them flows from the idea. For inspiration, look at the many examples from the incredible Miniatur Wunderland in Hamburg, Germany.

www.miniatur-wunderland.com

Or look at the series of YouTube videos about Saddlesore Gulch.

Also check out:

<http://scenicedandundecided.net/animation.htm>

and

www.youtube.com/watch?v=4gOOKkkV_tw

Other chapters covered lighting and sound, so this chapter covers animations (augmented with sound and light where appropriate).

You can get into animations in three ways;

- Those you can buy
- Those you can build easily
- Those you can build that are more tricky, or need programming skills

The ready-built animations are convenient and work straight out of the box. On the other hand, they are expensive and have a limited range of actions.

Animations ideas

When you start to think about it, you see all sorts of activities every day and mostly all can be emulated on your layout.

Here are just a few examples, in no particular order:

Lineside

- Points
- Crossing gates
- Loading cranes
- Traverser (transfer table)
- Uncoupler
- Hopper wagons (loading/tipping)
- Wig Wag crossing signal (US)
- Semaphore signal arms
- Barrier gates
- Water cranes
- Turntable
- Sector plate
- Working platform clock
- Coaling station

Industrial

- Bulldozer
- Forklift
- Road roller
- Tipper truck
- Pile driver
- Conveyor belt
- Garage lift
- Warehouse hoist
- Reversing truck
- Sawmill carriage
- Windmill
- Water wheel
- Beam engine
- Oil field pump
- Barge
- Man with stop-go sign
- Sliding door
- Rising door
- Up-and-over door
- Mine shaft

Other scenic

- Canal lock
- Radar aerial
- School yard
- Fire engine ladders
- Barber shop rotating pole
- Large gun emplacement
- Automatic road systems
- Lifting bridge
- Swing bridge
- Wind turbine
- Carnival rides
- Helicopter
- Hotel lift
- Dogs and animals

People

- Policeman directing traffic
- Man chopping wood
- Man drinking beer/tea
- Rabbit popping out of hole
- Station master
- Street cleaning
- Builders on site
- Man digging road

The above lists only scratch the surface. Look around you and you will find many other examples of both human and machine activities.

To these lists we can add the movement of cars, buses, trucks, etc. around the layout. The most popular commercial systems are by Faller (shown here), Tomytec and Magnorail which even includes pedal cycles in its catalogue.



Animation methods

If we discount manual methods (pulling wires, etc.) the main mechanisms are:

- Open relay
- DC motor
- Servo
- Stepper motor

Relay

For this we need an open relay – one that is not permanently encased.

The type shown has a clear plastic cover to protect it and this is easily removed.

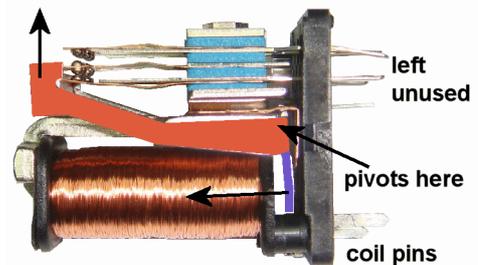
It has an L-shaped moving part that pivots where shown. When power is applied to its coil, a magnetic field is created.

The metal shown in purple is attracted to the coil and that pivots the far end of the section marked in red upwards.

So, with nothing more complex than powering a relay, we have mechanical movement.

A length of wire can be soldered or epoxied where the arrow is shown.

The other end of the wire can make a man pop his head out of a signal box, a station master raise his flag, a rabbit pop out of its burrow (an old favourite) and much more.



Pneumatic drill

This technique is used here to improve on the commercial product that was sold by Viemann (a retailer of a wide range of animated figures).



The image on the left shows the model sold by Viemann. Note the ugly grey disc on which he stands. If you watch this video clip:

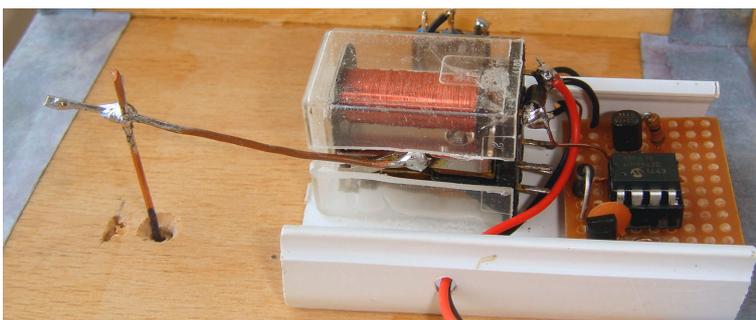
www.youtube.com/watch?v=yEIVvf8kXsc

you will see that he rotates unrealistically back and forth instead of moving vertically.

This video clip shows the result of connecting a figure of a man with a pneumatic drill to the end of the relay wire:

www.youtube.com/watch?v=YDYfizInnU0

The relay is switched on and off rapidly, making the drill jump up and down.



The movement is more realistic, there is no ugly base, and it is cheaper.

So, how do we manage to make the relay chatter?



Here we can see the choices of complexity.

- To make the relay chatter, all we need to do is energise the relay from an astable multi-vibrator (see how in the chapter on '*Semiconductors and ICs*'). This will work but the relay would be chattering constantly.
- We could control the bursts of activity by switching the power on and off. Ideally, though, we would like the animation to run without human intervention.
- To avoid switches, we could use another chip to act as a timer. For example, this could make the animation happen for only ten seconds every few minutes. The timer chip would trigger the multi-vibrator that controls the relay.
- That is better but the driller tends to drill in bursts, with a longer pause in between. To achieve that effect, we could add a sequencer board (it is a MERG kit) to switch the driller on for a series of short bursts every so often.
- Even better, if you have the skills, is to replace all of these individual modules with a single programmed chip as shown in the image. The example uses a programmed PIC chip but it could also be controlled by an Arduino.
- Along with the action, you could use a sound chip to provide the sound of the drill.

Motors

Although DC motors simply rotate, we can use them in different ways:

- Direct drive
- Operating a piston
- Operating cams
- Turning a belt drive

Direct drive

The obvious uses for a DC motor are watermills, windmills, wind turbines, play park roundabouts, fairground rides and so on.

The issues here are speed and noise.

DC motors rotate at speeds that are far too fast and so the motor needs a gearbox to reduce the speed.



Many cheaper motors have noisy gearboxes but there are many quite motors to be had.

The one shown here is a 12V motor and can be purchased with a gearbox that provides either 6rpm, 12rpm or 27rpm. You just buy the motor with the required speed and mount it.

These types consume about 70mA.



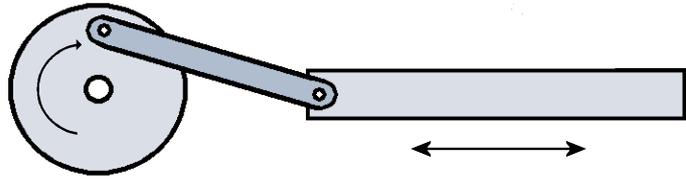
Operating a piston

There are times when we could use a continual back and forth motion, known as '*reciprocation*'.

We can achieve this with the use of a crank, as shown.

Uses include a reciprocating steam engine or pump, a man walking back and forward, a sawmill carriage, etc.

If mounted vertically, it will produce an up-and-down motion.



Operating cams

Another approach is to use cams.

The use of different cam profiles provides different types of movement.

The illustration on the left shows an eccentric profile.

It produces a smooth up and down motion.

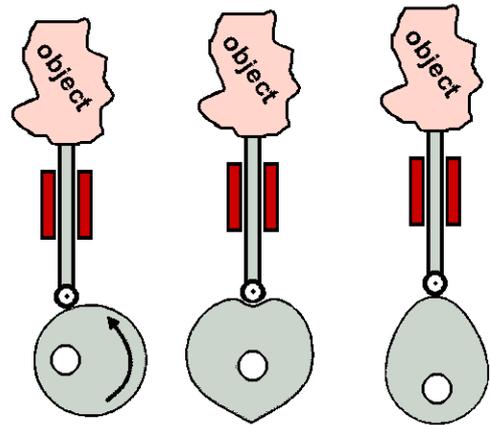
Watch its operation here:

www.youtube.com/watch?v=jcofAou8oK0

The middle illustration has a heart shaped profile.

Watch its operation here:

www.youtube.com/watch?v=MOgXiw6ZEso

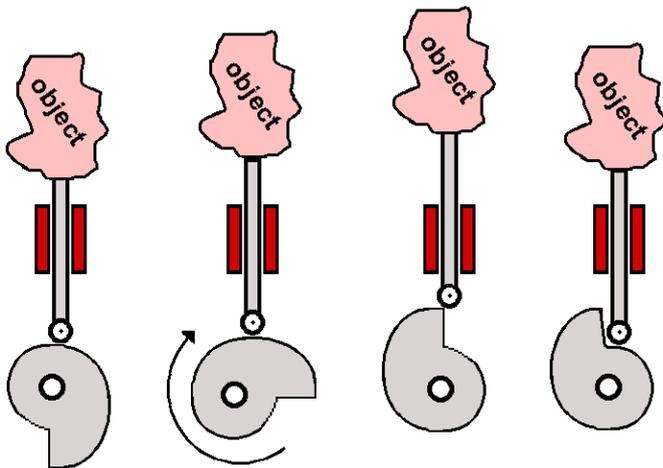


The illustration on the right has a pear shaped profile.

Half the time nothing happens, then the object is moved up and down.

Watch its operation here:

www.youtube.com/watch?v=bW8p3Q2mjl8



This illustration shows the operation of a drop cam.

As the cam rotates, the object is slowly raised before dropping suddenly.

Possible uses include:

- A man chopping wood (the axe comes down quicker than raising it up).
- A pile driver.
- A rabbit slowly emerges from its burrow, before rapidly going back down.

Watch its operation here:

www.youtube.com/watch?v=EzD0HsdR4O4

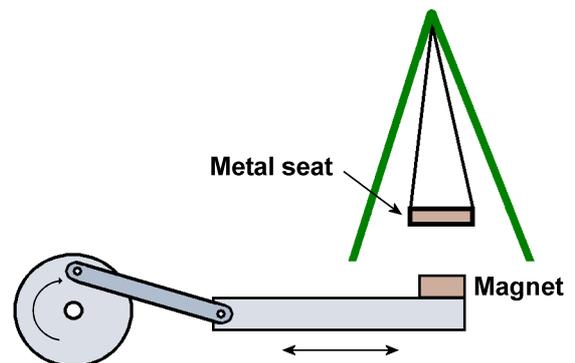
Example of use

This image is a of a corner cameo on the *'Uppen Doon'* demonstration layout.



It uses three motors, each with a different method of achieving movement.

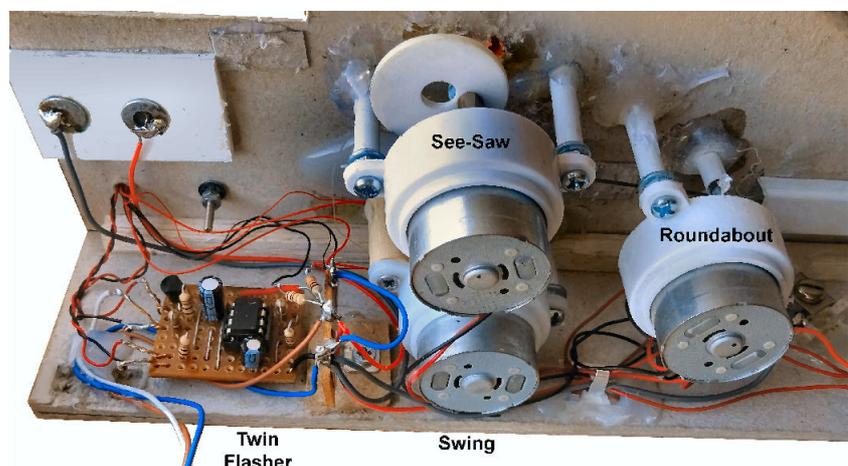
- The roundabout is directly coupled to a slow speed motor.
- The see-saw uses a motor with cams that rock it back and forth.
- The swing uses a motorised piston that has a magnet attached to its rod. The swing is made of metal and is rocked back and forth under the influence of the magnet.



Just out of sight, at the side of the school, is an ice cream van.

At random times, there will be either:

- The sound of the school bell ringing.
- The sound of children laughing and playing.
- The sound of the ice cream van chimes, complete with flashing coloured lights inside the van.



Lead screw drive

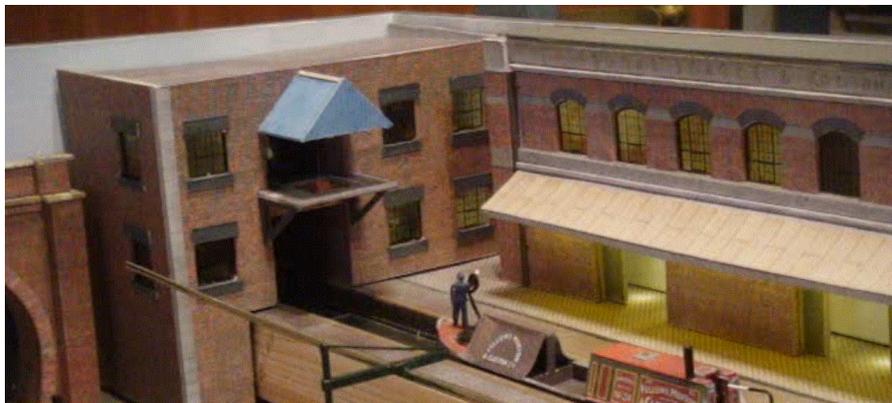
These are used extensively in 3D printers, CNC machines and anywhere you want precise movements. In these cases, they are normally attached to stepper motors (see later). However, if we attach a long threaded rod to the end of a DC motor we can achieve long distance movements. A nut is on the rod and when the motor spins the rod, the nut can be made to run up and down the screw of the rod. Slow, smooth movements are easily achieved with this method. It can be mounted vertically (lifts) or horizontally (gantry crane, sliding doors).



Examples of use

Canal

This canal barge glides back and forth on a canal at the rear of the 'Backen Forth' demonstration layout.



It pauses at each end of the canal and in the middle.

The nut has a sled attached and this operates microswitches at the three stopping points.

A programmed PIC acts on these switch inputs, knows where the barge is and acts accordingly.

When the barge stops in the middle of the canal stretch, a lorry reverses out of a warehouse to meet it.

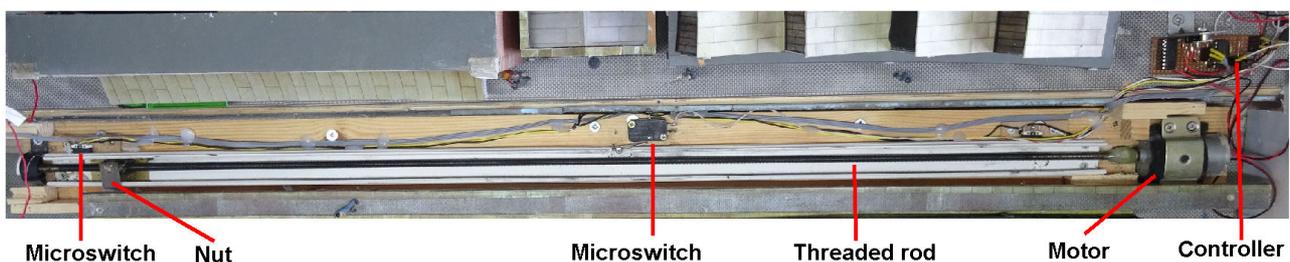
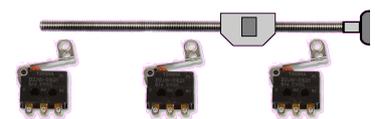
When the barge enters the warehouse on the left, three things happen:

- The light on the hoist comes on
- A man comes out to operate the hoist.
- A load is lowered into the barge.

These activities are controlled by the same programmed PIC module.

Here is the canal with the cover removed.

You can see the long threaded rod, the motor, the microswitches and the sled with the nut.



Road roller

This feature uses the same technique in a more simplified form.

You can see the slot where a rod attached to the nut moves the road roller along. The rod is hidden behind a fence and is not visible from the front of the layout.

There is a microswitch at each end of the threaded rod and their state is monitored by a PIC chip.

The PC chip controls the motor, making it go back and forward from time to time.



Belts

Gears are used to match fast-running DC motors to the loco's wheels.

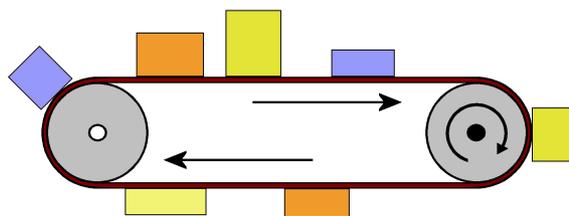
There are a few exceptions.

Some old Lionel HO locos used belts for the main drive and Nigel Lawton still uses belts for the main drive in his tiny 009 locos. At one time, the Hornby Class 31 had a drive belt to operate an internal cooling fan.

Gears are also used in DC motor gearboxes to produce low revving motors for animations. Some gears can be noisy and some need occasional maintenance.

For moving objects along distances, a common approach is to use belts and pulleys. One pulley rotates and drags the belt round using friction or meshed teeth.

Imagine looking through a factory window and seeing objects slowly moving along a production line. A belt is held in tension between a motorised pulley (on the right) and a free pulley. As the motor rotates slowly, the objects glide along the top of the belt, while the rest of the mechanism is hidden from view. Alternatively, it could be people moving along a walkway, or conveyor belts in mines or quarries.



There are three types of belts that we can use.

A good starting point might be to look here:

<https://hobby.uk.com/>
www.robotshop.com

V belts

The pulleys are in a V shape and can be metal or plastic.

When the belt is wound round the pulley and held under tension, it is gripped by the sloping sides of the pulley. This provides the friction to move the belt.

If you over tension the belt, the motor friction becomes too great with the risk of excessive wear or motor stalling.

Check out the set produced by Tamiya.



Linked chains and sprockets

The chain sits in the sprocket's teeth. As the sprocket rotates, it pulls the chain along with it.

This needs less tension to work. It is similar to how a bicycle chain works, except that the chain and sprocket are smaller and more delicate.

This set is available from technobotonline.com.

However, some modellers have been known to use cycle chains to animate objects.



Toothed pulleys and belts

This method is commonly used for the X and Y drives on a 3D printer.

The rubber belts can be purchased as loops of various fixed lengths, or can be purchased as a single length that you cut to your own requirements. You can buy the parts individually or you can buy a set of parts as in this image.



The synthetic rubber belt has teeth spaced along it and its pitch has to match of those the teeth on the driving pulley.



The popular GT2 has 2mm spacing and the GT3 has 3mm spacing.

Although these could be used for conveyor belts, etc., they can be adapted for use as a road vehicle system. It would not be as feature rich as Faller but it has the advantage of tighter turns, forward and reverse movement and eliminates the need to charge vehicle batteries.

The belt would run under the baseboard and could move vehicles in one of two ways:

- One, or probably more, magnets are glued to the belt and pull round vehicles above the baseboard. This is similar to the Magnorail system that uses magnets on a plastic chain that is pulled round plastic trunking.
- One, or probably more, pins are inserted into the belt and protrude through the baseboard to pull round vehicles.

Servos

How servos work is covered in another chapter.

Suffice to say, it rotates a lever, known as a 'horn' between two angles that you can set.

At its simplest, a user can throw a switch and the horn will move (e.g. to move a semaphore arm).

This image shows the horn being rotated to pull down the wire connected to the semaphore arm.



Servo-based animations can easily be automated.



In this image, a water crane is rotated when a loco approaches. A light detector module reacts when the loco blocks its light. Since this module is connected to the servo controller, the crane is rotated. When the train moves away, the water crane rotates back.

In this example, a train detector spots a loco at the platform and moves the station master out to greet it. You can just see the arc cut in the platform. A wire through this arc connects the figure to the servo horn.



This timber yard uses three servos.

- One rotates the crane on the lorry.
- One moves the sawmill carriage in and out.
- One has a man chopping a log.

The sequence is controlled by a timer.

This same layout has a dog that comes out to bark at the train as it passes. It is controlled by a train detector that triggers two activities:

- The dog rocks back and forth.
- A sound module plays the clip of a barking dog.

This sequence does not run every time the train passes (to preserve everyone's sanity).

Using two servos

This image shows a commercial servo mount that holds two servos.

The bottom servo rotates the top servo and the top servo provides an up and down movement.

This combination is used for robot arms and is commonly used to mount cameras to remotely capture pictures and videos of birds and wild life.



This is too large for most model railway layouts but you can make your own.

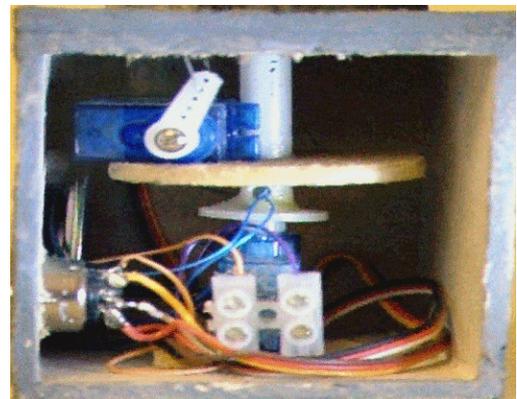


This image shows an animated gun that was for use in a *'Tobruk'* layout.

The design is simplified and it uses the bottom servo to rotate the gun while the upper servo raises/lowers the gun.

Once the gun is in position, a LED in the barrel flashes and an audio module produces the gun sound.

This mechanism could be miniaturised further by using very small servos such as the HobbyKing Ultra-Micro HK-5320.



Other examples

The excavator



This model also uses two servos. One, as before, rotates the model.

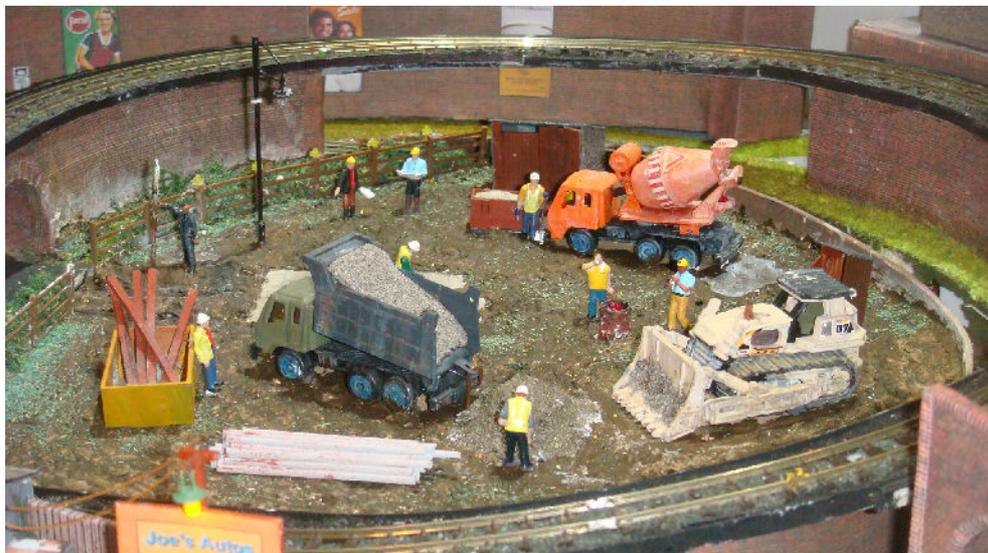
The other uses a length of strong thread (could also be fishing line) to raise and lower the jib.

This model could be manually controlled but it uses a number of electronic modules to create an automated sequence.

- A timer module ensures that the sequence occurs periodically.
- A sequencer module ensures the cab rotations and jib movements take place in a set order.
- Servo modules control the servo movements.
- An audio module plays an audio track during an operating session.

The bulldozer

The bulldozer is part of a building site scene.



One servo makes the bulldozer move forward and backwards, while the other raises and lowers the blade.

Another servo operates the stop-go sign held by the site worker and yet another is used to tip the truck's load.

The cement mixer constantly rotates using a slow speed DC motor.

All the servos are controlled in a sequence by a programmed PIC chip.

Extending servo movement

There are occasions when you want greater movement than that offered by the size of the servo horn.

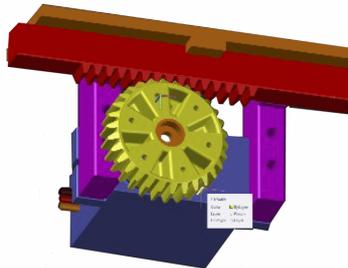
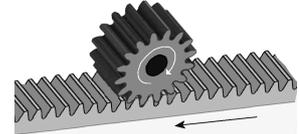
Sometimes you want a greater sweep of the servo arm and that can be achieved by 3D printing a servo horn with added length or by adding an extension piece to the existing horn.



Other times, you want a longer linear length.

For a servo, that is best met with a rack and pinion type of mount.

As the image shows, rotation of the pinion makes it slide in the linear plane.



Here is an AutoCAD design of a 3D printed long reach mount with a rack with a travel of up to 30mm.

This is a rack and pinion set available from Technobots.



Rack-and-pinion movements are ideal for lifts, car lifts, fire ladders, sliding doors, rising doors, etc.

Example

This a goods shed animation sequence that starts 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 (rotational servo).
- C The shed's sliding door opens (linear servo) and the interior light comes on.
- D The cranes rotates over the wagons (servo rotating again).
- E A lorry moves round from behind the shed (rotating servo with extended arm).



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).

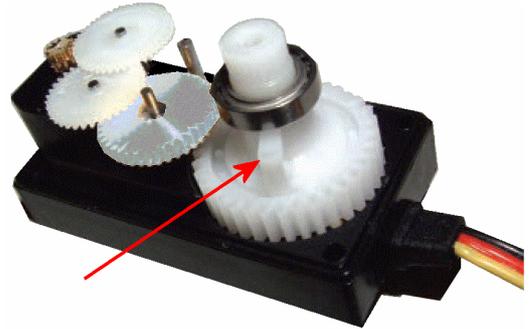
There are delays between each activity, with the sequencer module handling two LEDs and four servos.

Continuous Rotation Servos

A servo has a DC motor with a gearbox.
It can be converted into a useful continuous rotation motor.

It is also a useful way to re-purpose a servo that has a burnt out control board.

As long as the motor and the gearbox are OK, the servo can be converted.



To make a simple motor, open the case and cut off the plastic tab that restricts the motor's rotation.

Remove the control board and connect 5V power wires directly to the motor, or use 12V with a suitable dropper resistor (say 220 ohms).

Reverse the power leads to make the motor rotate in the opposite direction.

With this method you now have a working motor – but with a fixed speed.

Another type of servo is available commercially.

It does not restrict its movement to between two points on an arc. It also provides continuous rotation.

They are commonly used in fighting robots (e.g. Robot Wars).

They look like an ordinary servo but they use a different electronic board inside.

They still receive the standard servo pulses but treat them differently.

In a standard servo, the different incoming pulse widths are translated into motor rotation to fixed points in the 90° or 180° arc.

In continuous rotation servos, the pulse widths are translated into motor speeds and direction.

- With a 1.5mS pulse, the motor is stationary.
- Pulses longer than 1.5mS makes the motor rotate counter-clockwise .
- The longer the pulse widths the faster the motor speed.
- Pulses shorter than 1.5mS makes the motor rotate clockwise, with speed increasing as the pulse narrows.

In some servos, the process is reversed – narrow pulses result in clockwise rotation.

These servos rotate at relatively slow speeds, with models varying from maximums of 43rpm to 108rpm.

For example, the SpringRC SM-S4303R has a maximum speed of 54rpm. As you can see, it looks like a standard servo, although it is larger and more robust (handy for fighting robots).



You can convert your servo to this type and achieve both speed and direction from the servo's existing controller.

Full instructions can be found here:

www.youtube.com/watch?v=zZGkkzMBL28

Stepper Motors

Unlike standard servos, stepper motors provide continual rotation.

If they act like motors, what extra benefits can be expected from stepper motors?

First, consider some of the problems with DC motors:

Rotational position

A servo knows what point in the arc it sits at (its internal potentiometer tells it).

A motor, once you remove the power could finish anywhere in its rotation (unless it is fitted with complex brakes and clutches).

Total movement

How do you know how many revolutions the motor has completed (without fitting sensors, encoders, etc.).

Torque

Motors provide poor torque at slow speeds.

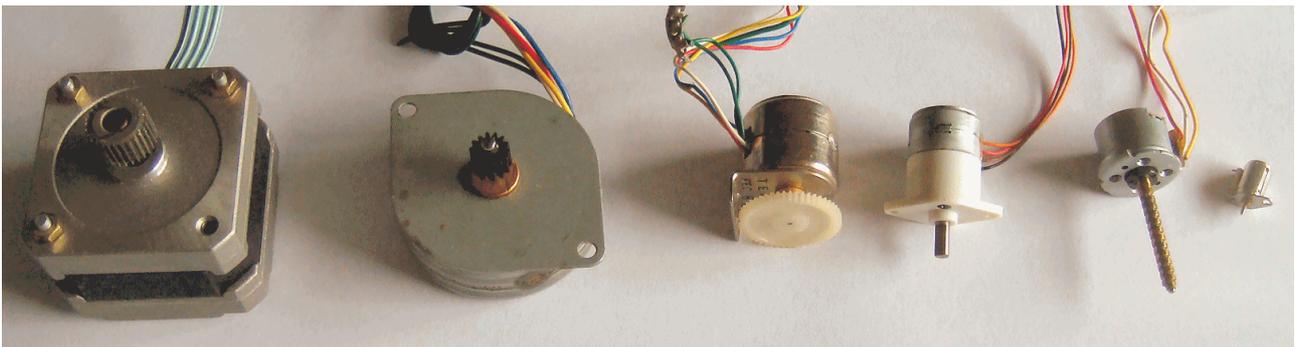
Stalling

Stalling can result in motor burnout.

A stepper, on the other hand, works by rotating its shaft in defined steps.

For instance, a stepper may require 400 pulses before it completes one revolution (each step being 0.9°).

This shows a random selection of stepper motors of varying size.

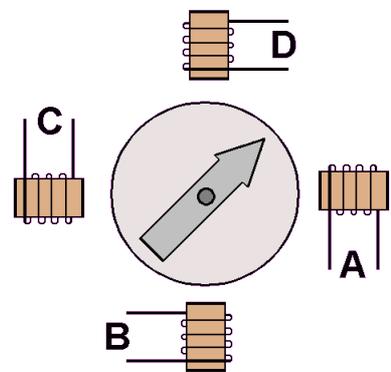


You will notice that some have a different number of wires than others (more about that later).

They also vary in weight, supply voltage, and current requirements.

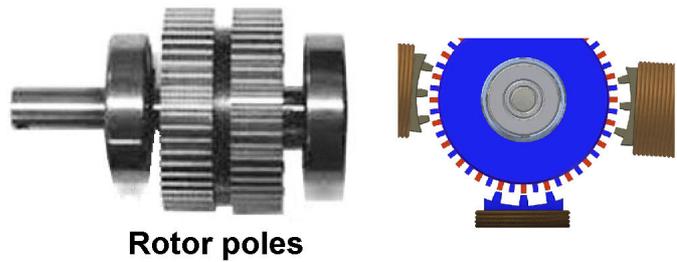
This very simplified illustration demonstrates how a stepper motor works.

- When power is applied to coil A, the magnetic core is attracted to it.
- When power is then switched to coil B, the rotor continues rotating to get to B.
- Then coil C is powered, producing further rotation.
- When coil D is powered, the rotor rotates to complete a single revolution.



Of course, a real stepper motor would not have four steps per revolution. The most basic model may use 64 steps (each step moving 5.625°) while better specified models may use 400 steps (each step moving 0.9°).

In practice, the rotor is not a single pole as shown above. It looks like this image. It has two rotor poles, so there are multiple poles facing the coils.



If you look closely, you will see that the two sets of poles are slightly staggered. The illustration on the right shows the poles being attracted to the bottom coil.

The poles are not aligned with the left hand coil. When the left coils is energised, the rotor has to move to align the magnets. That results in the rotor's poles not aligning with the right hand coil and so the rotation continues in small steps.

As each coil is energised in turn, the rotor moves a single small step.

Because of their precise and repeatable positioning with excellent speed control, stepper motors can be found in 3D printers, CNC machines, scanners, printers, cameras, telescopes, satellite positioning systems, head positioners in disc drives. small camera dollies, small scale robotics, and more.

Stepper motor benefits

- Rotation proportional to the number of input pulses.
- No position feedback required.
- Excellent acceleration/deceleration.
- Excellent low speed without gears.
- Full torque at slow speed.
- Good holding torque when kept energized.
- Bi-directional.
- No brushes - longer trouble free life and no interference caused by arcing.
- Lifetime only limited by bearings.

Potential downsides

- They cannot run freely by themselves: they need electronic controls.
- Not easy to operate at extremely high speeds (not a big issue for model railways).
- Needs current to hold position.
- If overloaded might skip a step (not likely on model railway projects).
- Needs a known starting point to count steps from.

Two stepper types

The two stepper motor types both rotate in small steps but they have different designs and use different electronics to control them.

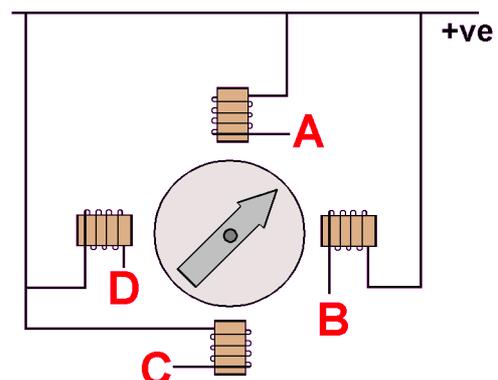
Unipolar

This is the type described above, with a single coil being energised at a time to achieve a single step.

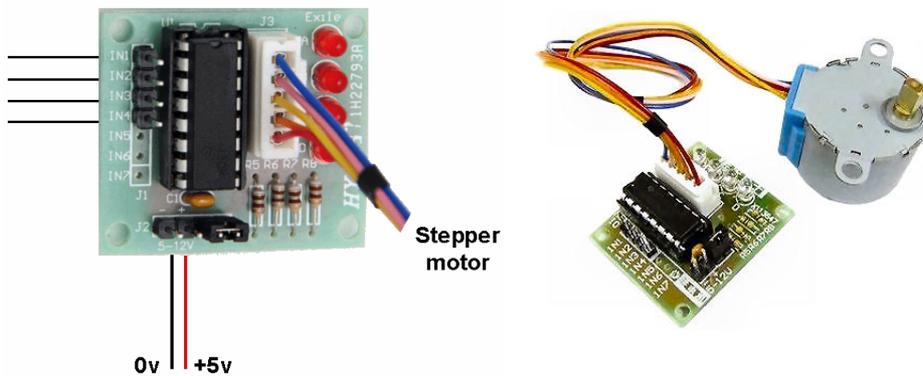
Each coil connects to the positive supply.

To energise each coil in turn all we have to do is bring the other end of each coil down to 0V in turn.

First A, then B, then C, then D, then back to A, and so on.

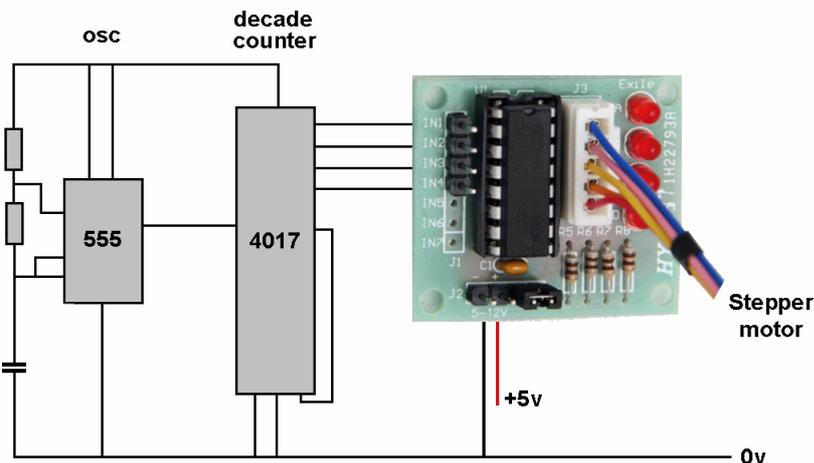


We now need some sort of electronics module that will drive each of the coils in turn. We could use the ULN2003 chip, as described in the chapter on *'Semiconductors and ICs'*.



You can buy one of these chips on a PCB, along with a very rudimentary stepper motor. They can be purchased as a bundle and would make a good starting point to learn about using stepper motors. Just don't expect long life or heavy lifting from the motor.

The next stage is to supply the pulses to the driver module.

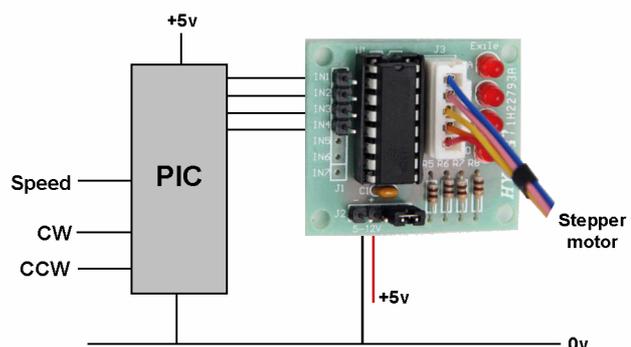


Here is a basic circuit. It uses a 555 timer IC to send out a continual train of pulses. The 4017 chip is a decade counter (it can change the state of ten output pins) that is set to only use four outputs. As the 555 pulses, the four outputs take turns of going high. This makes the outputs of the ULN2003 go low in sequence (the chip's drivers are *'inverters'* – their outputs are the opposite polarity of their inputs). Changing the values of the 555's components will change the speed of rotation.

It is more common to see the driver module being controlled by a PIC chip or Arduino.

This makes it easier to change speed, change direction without any hardware alterations.

It also allows the chip to check for switches, sensors, etc. and control the stepper motor accordingly.



Example

The small stepper motor shown above is suitable for lightly-loaded projects that run for short periods.

This example of a 'crazy clock' was used on a layout for children. The clock hands click round each second, until Thomas enters the building. A train detector informs a PIC chip and it makes the clock hands spin wildly while the LEDs in the light chaser above the entrance sequence. You may have more serious thoughts on their use.



Bi-polar

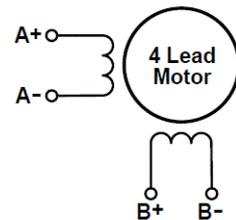
Bi-polar motors are generally more efficient than unipolar versions and have greater torque.

This stepper motor only has two sets of connections and has a more complicated method of driving the coils.

For those who want to delve into this subject more deeply, I suggest a starting point is the Microchip Advice Note AN907 on Stepper Motor Fundamentals

ww1.microchip.com/downloads/en/Appnotes/00907a.pdf

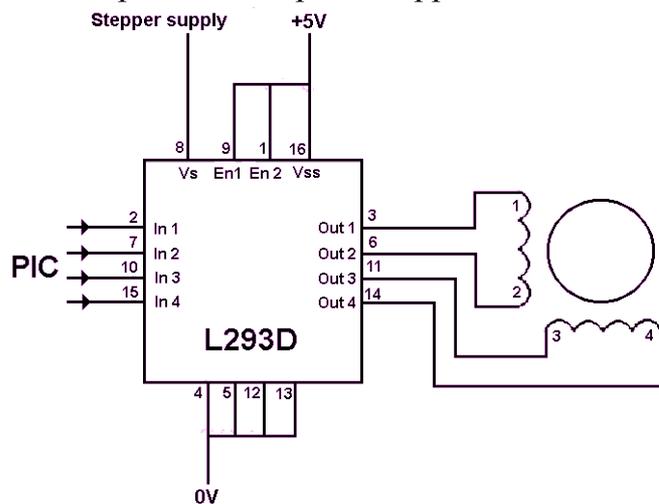
It describes the input sequence need to run both unipolar and bi-polar stepper motors.



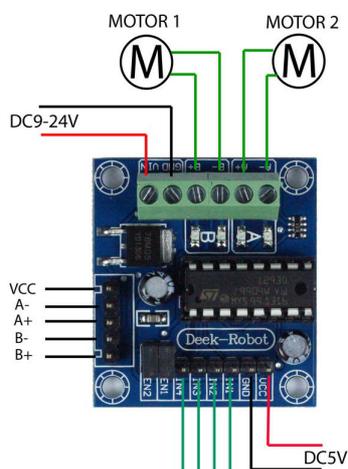
The chapter on 'Semiconductors and ICs' spent some time looking at the L293D bridge driver.

Here is it being used to control a stepper motor.

The 5V supply runs the chip's logic circuits, while the stepper supply used matches the stepper motor voltage requirement.



The L293D expects to be driven by a sequence of changes on its input pins.

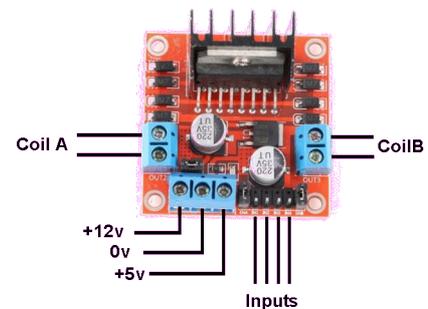


Module boards with this driver chip are easily available.

Here are just two examples.

The L293D needs four inputs, fed in a correct sequence.

That sequence has to be programmed into the PIC or Arduino that will control the stepper motor.



To simplify programming, some driver chips can be controlled by only two inputs.

- One to control the direction of rotation (clockwise or anti-clockwise)
- One to move the stepper's rotor by a specified number of steps

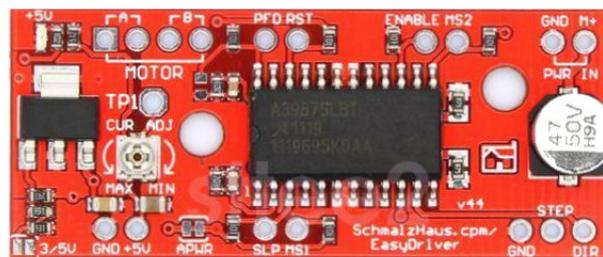
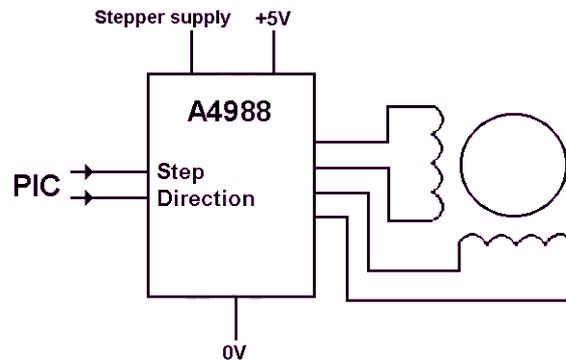
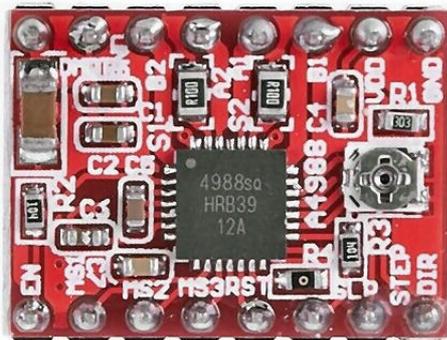
This allows the programmer to use simple commands such as:

rotate(800, 0.5); - to rotate the rotor 800 steps at a slow speed

or

rotate(-400, 1); - to rotate the rotor anti-clockwise 400 steps at a fast speed

Examples of this type of driver are the A4988 and the EasyDriver



Microstepping

A very useful facility is the ability to stop the rotor in between steps. The above chips can set the driver to operate in 1/8th, 1/4, half, and full step modes. The four modes are selected by the logic levels on their MS1 and MS2 input pins.

Here, for example, are the settings available on the EasyDriver chip.

MS1	MS2	Resolution
low	low	Full step
high	low	Half step
low	high	Quarter step
high	high	Eight step

The A4988 chip has three inputs and can also provide 1/16 step mode.

MS1	MS2	MS3	Resolution
low	low	low	Full step
high	low	low	Half step
low	high	low	Quarter step
high	high	low	Eight step
high	high	high	Sixteenth step

Practical issues

The biggest drawback to many is the need to have some programming experience to use stepper motors. This is particularly true in model railways where we want to control the stepper motor but also want to test for inputs, have extra outputs, and so on.

Having said that, for those who are able or are prepared to program, there are a few practical considerations to tackle.

- Reference position – knowing where you are before starting to rotate through steps
- Holding position – keeping the rotor stationary after you reach your wanted position.
- The different wiring arrangement for the same type of stepper motor.

Reference position

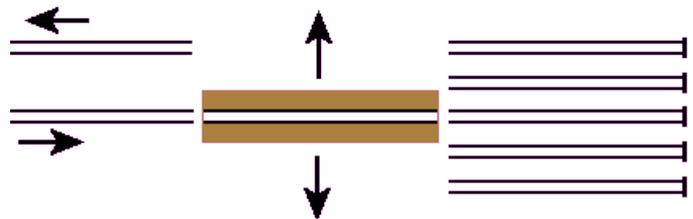
The simplest way to achieve this is to rotate whatever is attached to the rotor until it is detected by a sensor (e.g. microswitch, Hall Effect switch, laser). If this is carried out at start-up then all subsequent steps will be in relation to that reference point.

Holding position

- To hold the rotor at its destination, you have to maintain the power to the stepper motor. This may be fine for small, low-current motors, but can be a problem with high-current stepper motors. Solutions include, indents, locking pins and magnets. If we use a gearbox in conjunction with the stepper motor, its friction is usually sufficient to hold the rotor.

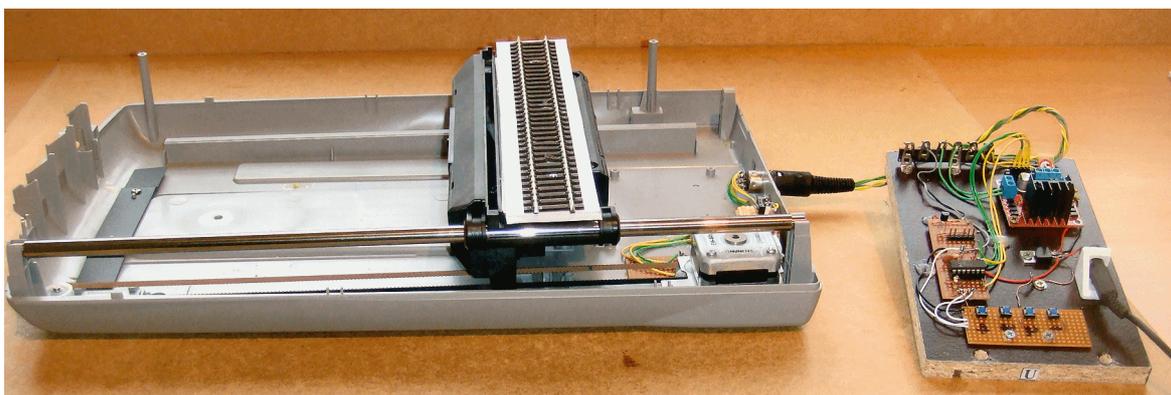
Example

A traverser is very useful on a layout and is space-saving in a fiddle yard. Multiple input track and multiple storage tracks are linked by a single moving track that spans the entire area. This eliminates the massive area that would be required by a collection of points.



A traverser is often operated manually but this image shows a rudimentary traverser being built from a broken scanner.

The electronics were gone but the stepper motor and the drive mechanism were working.



It was an A4 scanner with a scan length of 11.7”.

It used to scan at 1200dpi.

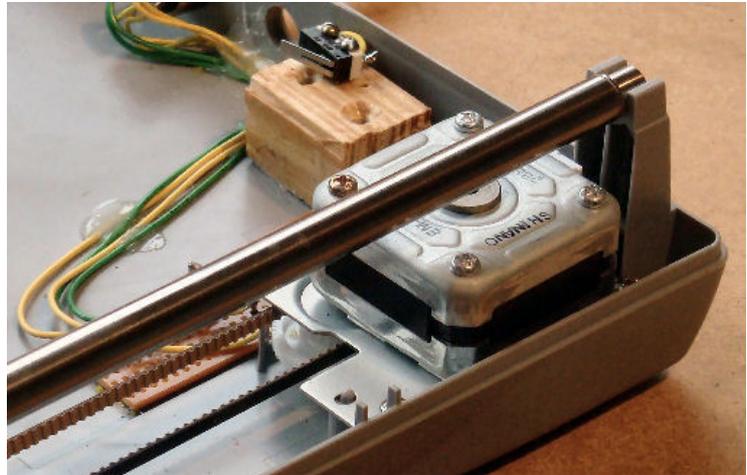
That means that the scanning bar moved 14040 steps to complete the scan.

You won't achieve that degree of resolution on the traverser in practice but it is still pretty accurate.

When the power is switched on, the stepper motor draws the bar towards itself, until the bar operates the microswitch.

At that point the stepper motor power is cut and the electronics now knows the reference point.

So, for example, moving 7020 steps will take the bar to mid position while moving -3510 will bring it back one quarter of the way from the reference point.



The same approach could be used to operate a sector plate, although a threaded rod approach would be better.



Stepper motor wiring options

