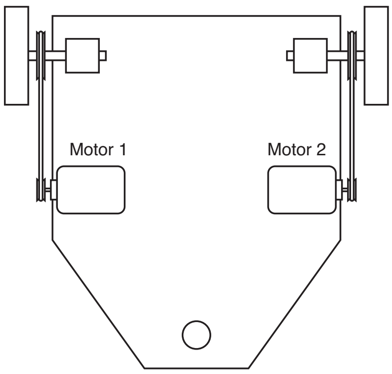
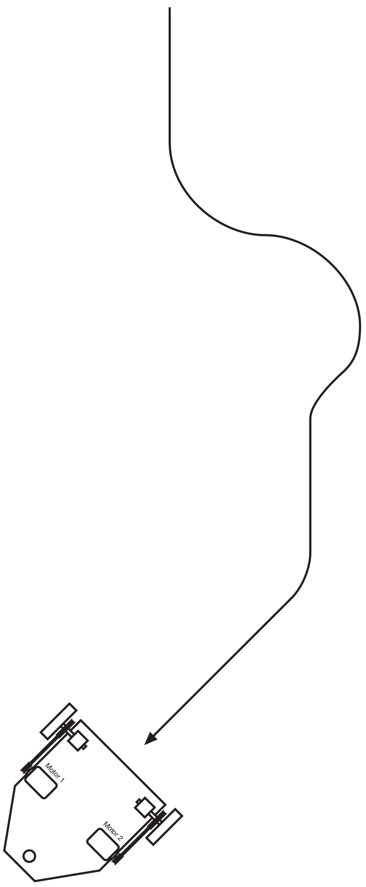
POSSIBLE APPLICATIONS OF THE BIT BY BIT CONTROLLER

Potential applications of the TEP controller are almost unlimited. Several examples are given here - including stepper motor *emulation* using any small DC motor.

1. Event counter/timer. One or more outputs can be programmed to signal expiry of a timed interval. This application requires calibration of the board against an accurate clock.

2. Buggy control. Two outputs can be used to drive two electric motors in a standard buggy configuration. Steering is achieved by stopping one of the motors for a short duration. A sample program is show - together with an approximate path diagram.

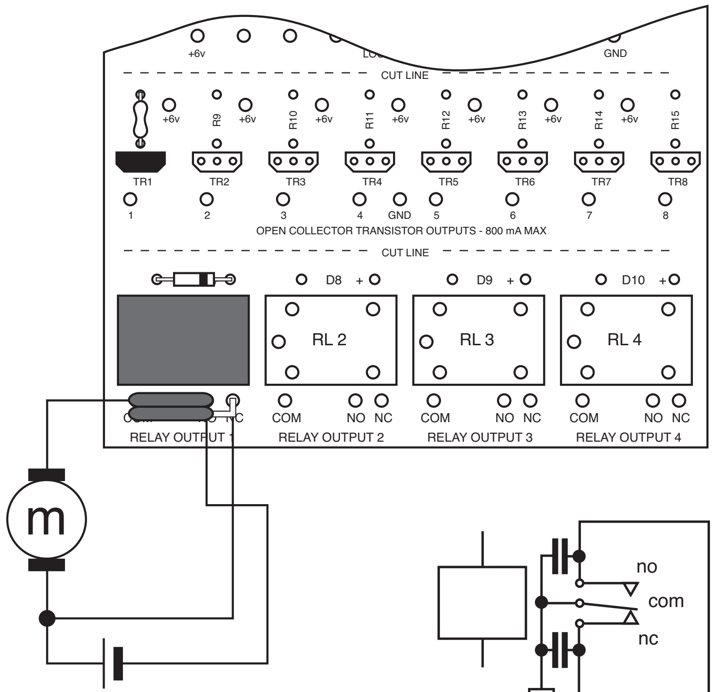


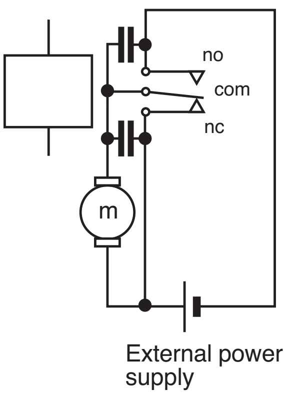


1	on	on						
2	on	on						
3	on	on						
4	on	off						
5	on	off						
6	off	on						
7	off	on						
8	off	on						
9	on	off						
10	on	on						
11	on	on						
12	on	on						
13	off	on						
14	on	on						
15	on	on						
16	on	on						

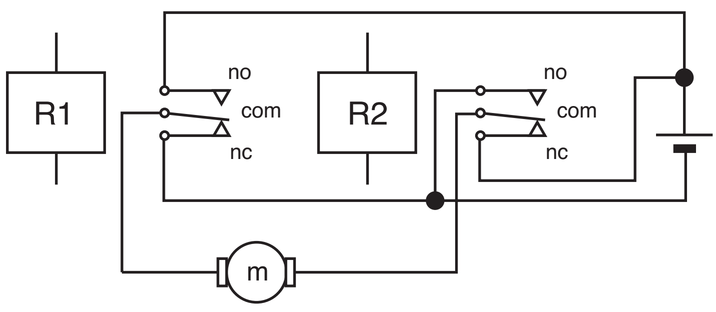
m1 m2

A motor can be connected to a relay to achieve *shunt braking.* Normally when a motor is switched off, the inertia of the spinning armature keeps it running for a short period. If, immediately it is switched off, it is short circuited or shunted, it tries to behave as both generator and motor and stops spinning almost instantly. This is achieved by wiring the motor to the relay as shown. (See 3 below). Note that a suppression capacitor also has to be connected between 'com' and 'nc' in this application.



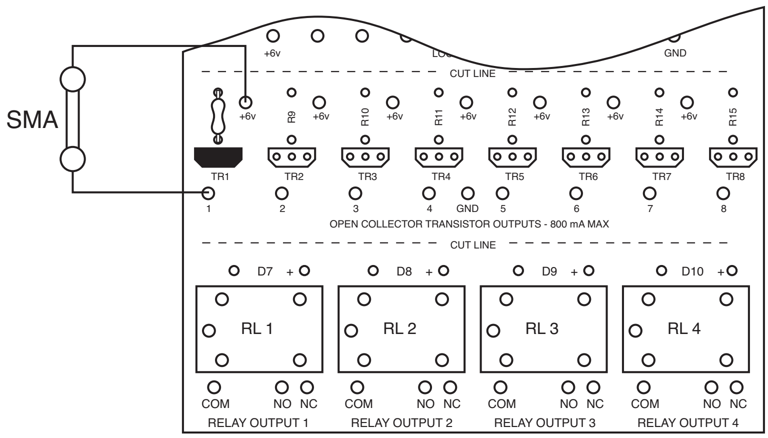


Please also note that outputs to two relays programmed to operate in unison can be used to reverse the direction of a motor.

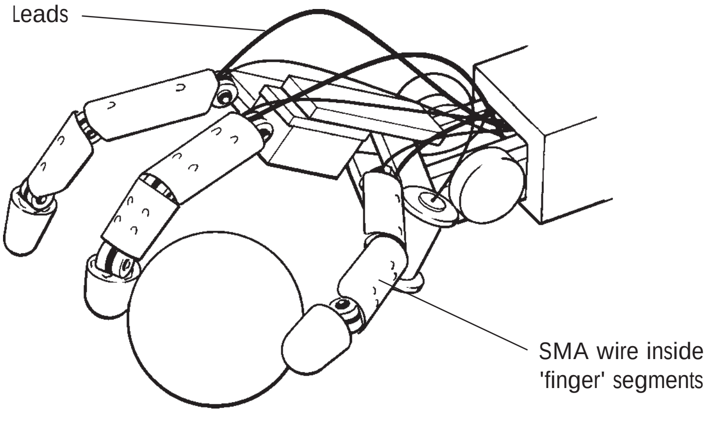


3. Robotic control. The principle of shunt braking (described in 2 above) can also be applied to emulate the action of a stepper motor which rotates in a series of discrete steps. An output channel is programmed to switch the motor on and off at an appropriate speed. This is a useful facility for simple robotic devices that use one or more inexpensive miniature DC motors to effect positional movements. (Warning: switching a motor on and off rapidly uses extra supply current because the motor draws a very high current momentarily before the armature begins to spin.)

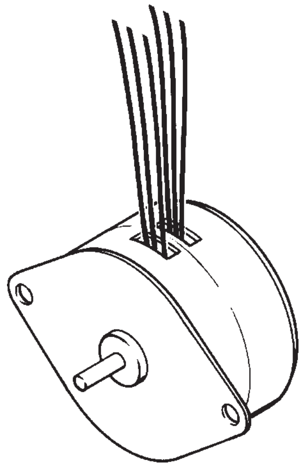
An alternative method of effecting mechanical movements for robots involves the use of shape memory alloy SMA in wire form (supplied through TEP as 'Smart Wire'.)



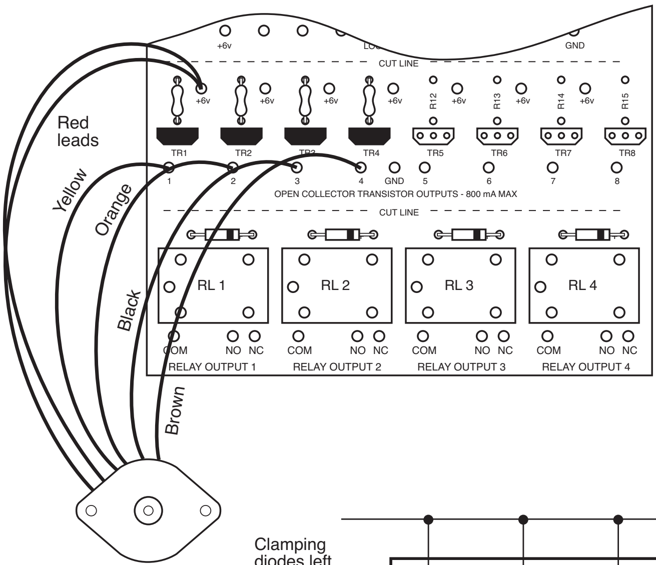
This alloy contracts to a shorter length when it is heated to a temperature of approximately 70°C, and does so with a useful pulling force. The 100 micron wire SMA wire has a high electrical resistance and can be heated to its transition temperature by passing through it a small current. A 200mm length of 100 micron 'smart wire' can be connected safely to a transistor output or alternatively it can be connected to an external power supply via a relay output. (Study file 3. See also: 'Smart Wire and its Applications' ISBN 1 898126 70 4 - available from Middlesex University's Teaching Resources or direct from The Engineering Council.)

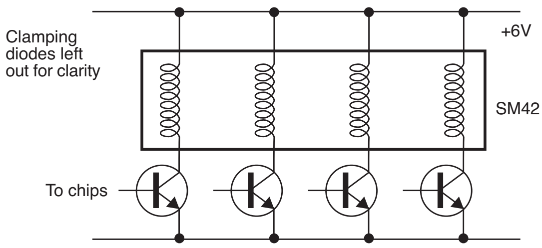


4. Stepper motor control. The controller board can be programmed to control up to two conventional 4 pole stepper motors such as TEP's model SM42. A four pole stepper motor has four coils arranged around a permanent magnet rotor. When these coils are switched on and off in the correct combination the rotor moves in increments or steps. The four TEP controller outputs are programmed to energise the coils in the correct sequence given by the manufacturer. If only one stepper motor is used, it is convenient to connect it to the four left hand transistor outputs. This is because the clamping diodes, one for each coil of the motor, can be easily soldered into place as if they were being used with relay coils.



Stepper motor





The SM42 motor can be made to run continuously by a short 4-line program which the controller will just repeat over and over - at a predetermined speed. Alternatively, if a motor used - say - for micro-positioning, the full 64 lines of programming might be used to make it stop, start and run to give small angular movements. A stepper motor can be programmed to run in either direction.

Motor coils

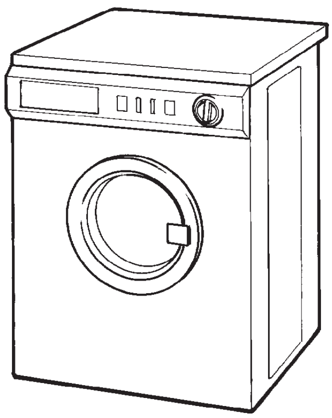
	1	2	3	4				
1	on	off	off	on				
2	on	off	on	off				
3	off	on	on	off				
4	off	on	off	on				

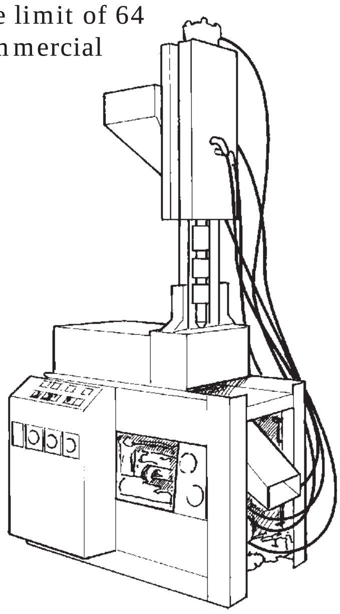
Motor coils (reverse direction)

	1	2	3	4				
1	off	on	on	off				
2	on	off	on	off				
3	on	off	off	on				
4	off	on	off	on				

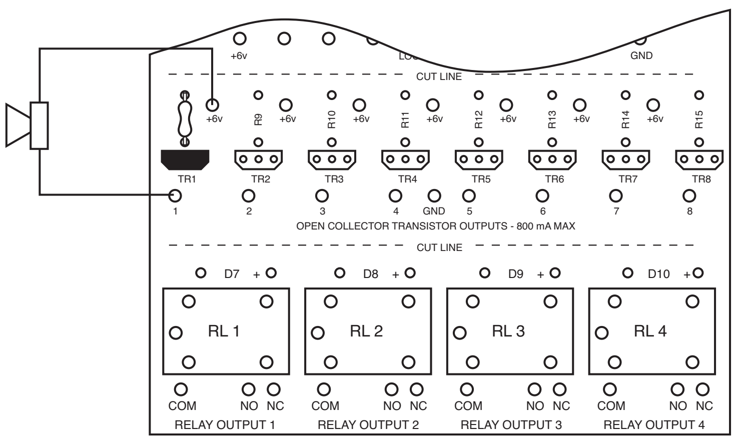
Remember, too, that external switches and circuits can be connected either to 'PAUSE INPUT' and 'RESET INPUT' to stop and start a motor which is otherwise running continuously. If this facility is used, the speed of running must be kept relatively low, otherwise the motor will tend to overun when it is stopped and stall when it is turned on. The TEP controller plus SM42 provides a unique combination capable of running a stepper motor at just 6 volts.

5. Process control. The TEP controller board is capable in principle of many sequential control operations - for example, the kind of process control involved in running an injection moulding machine or washing machine. The outputs can control solenoid air valves to actuate pneumatic rams (injection moulding machine) or solenoid water valves (washing machine). The only practical limiting factor is the limit of 64 programming lines and the cost of commercial actuators such as pneumatic rams.

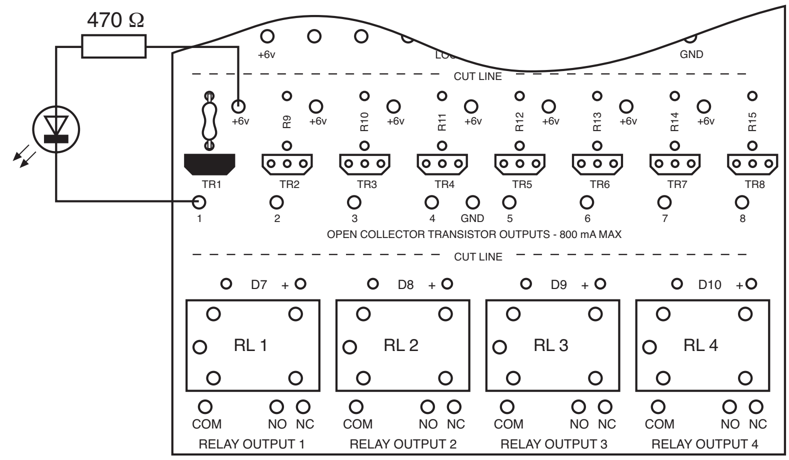




6. Sound generation. Miniature speakers (e.g. 64 ohm) connected to transistor outputs will produce loud rhythmic sounds that can be pre-programmed. The loudspeaker is connected as shown.

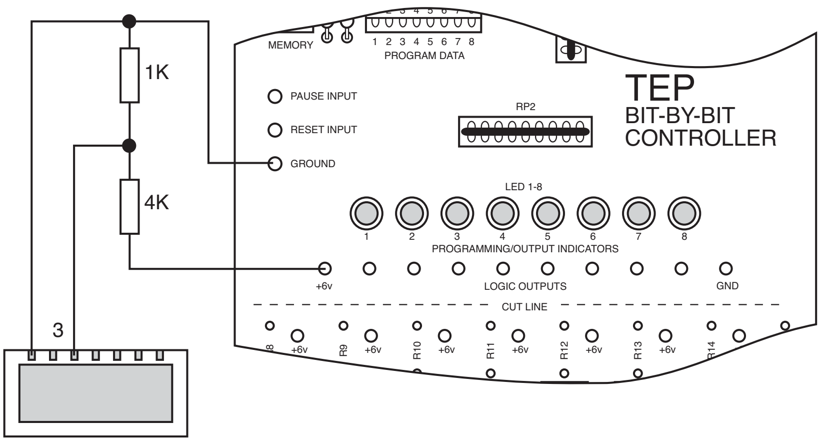


7. Stroboscope. A high intensity LED connected to a transistor output can be used for stroboscopic measurements if the program run speed can be calibrated accurately - e.g. checking the speed of a record player turntable with equal spaced marking around its edge. Alternatively, the controller itself can be calibrated with reference to a record player turntable of known accuracy or an alternative reference source. *For very accurate speed adjustment, the 10k pre-set resistor on the controller board can be removed and replaced with a 10k ten-turn potentiometer - connected via flying leads. Also, the clock capacitor (C2) can be replaced to give a higher strobe speed.*



8. Event counter TEP's LCD-display counter* can be added to any of the logic outputs to display an event count - e.g. the number of steps moved by a stepper motor (this particular example provides the possibility of measuring linear movement if - say - the motor is connected to a lead screw).

The counter module is powered by its own 1.5v battery and requires a voltage of between 1 to 1.5 volts at pin 3 to increment the count. The counter is therefore connected to a logic output via a potential divider as shown to provide pulses in the order of 1.5 volts. Because the module has its own battery, the -ve side of this (pin 1) should also be connected to GND on the controller.



Counter module

*Teaching Resources stock number ET5 004.