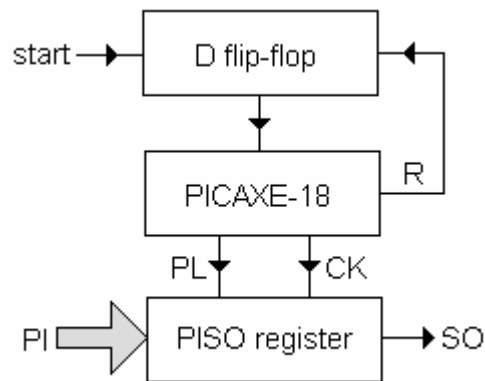
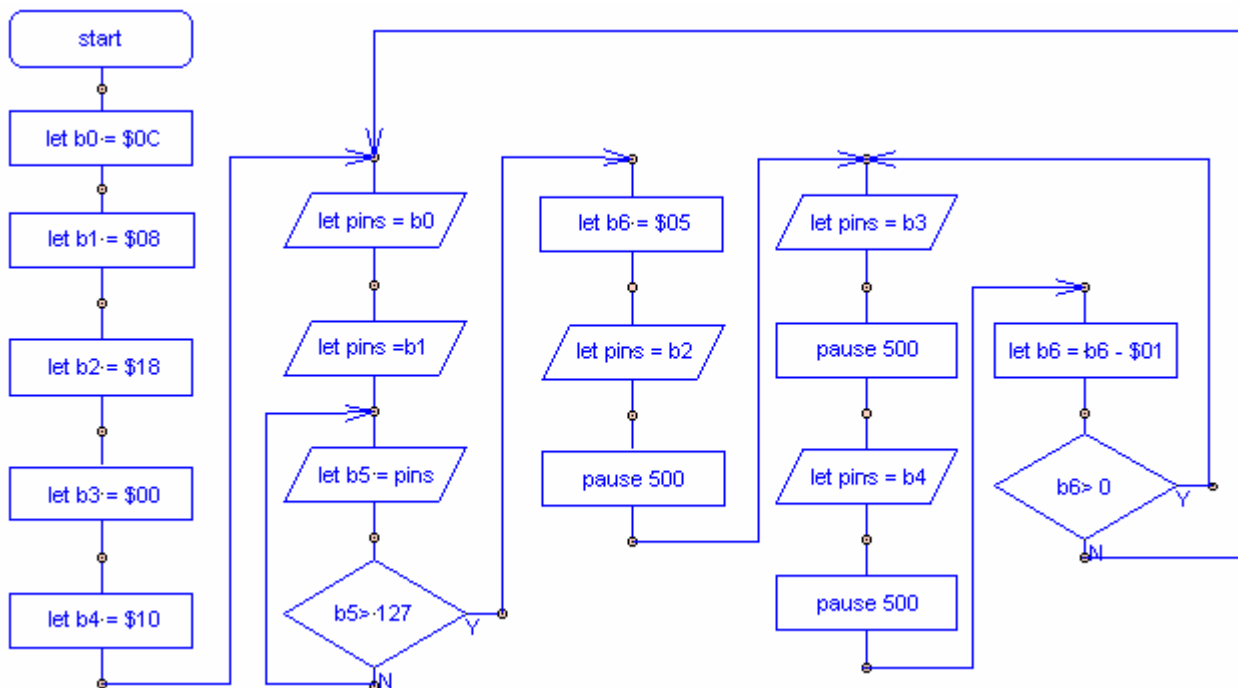


**Serial Transmitter**

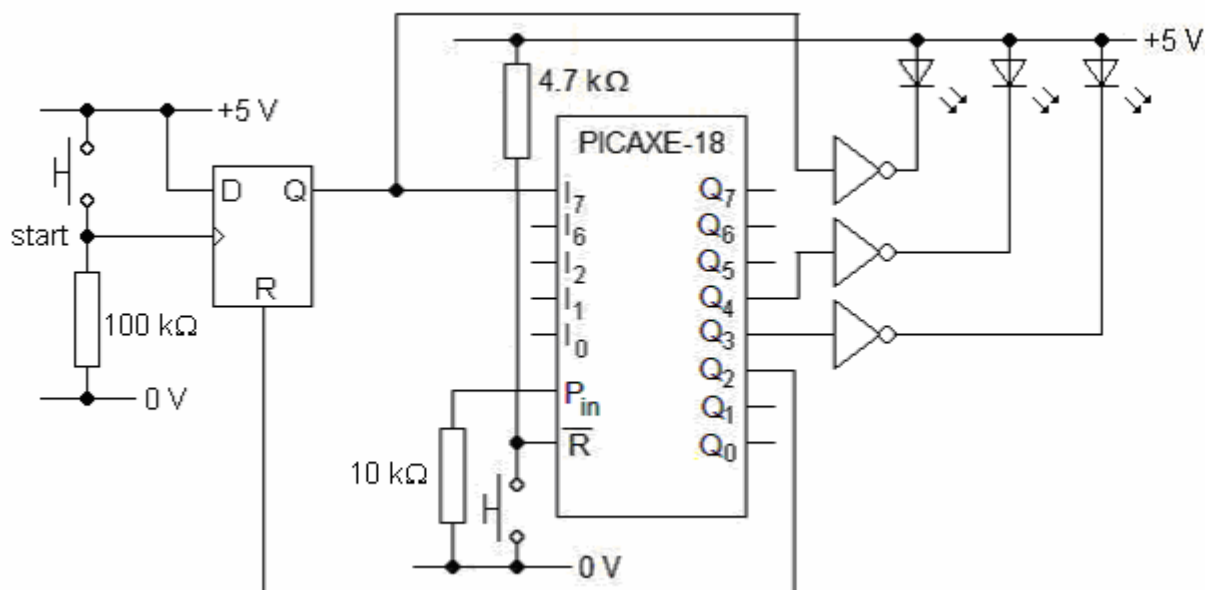
You are going to assemble a serial transmitter of four-bit words. The block diagram is shown opposite. The microcontroller will provide the timing signals for the PISO register and D flip-flop.



- 1 Start by entering the flowchart below into a PICAXE-18 i.c.



- 2 Assemble the circuit shown below. The NOT gates act as drivers for the LEDs.

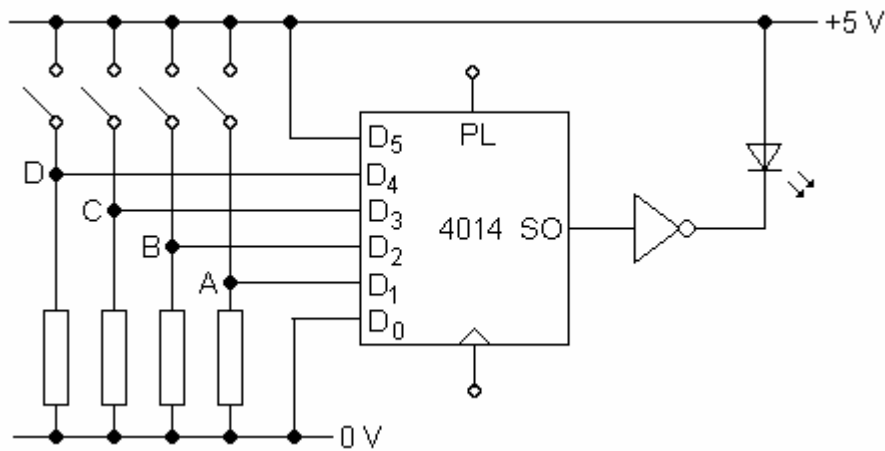


3 Reset the PIC. If all is well, only one of the LEDs should glow.  
 Now press the switch to pull **start** high. If all is well, the LEDs should run through a sequence lasting about 5 s before returning to their initial state.

4 Complete the timing diagram for the signals at I<sub>7</sub>, Q<sub>4</sub> and Q<sub>3</sub>.



5 Add a 4014 PISO shift register as shown below.  
 You have to decide which of the PIC signals to use for CK and PL.



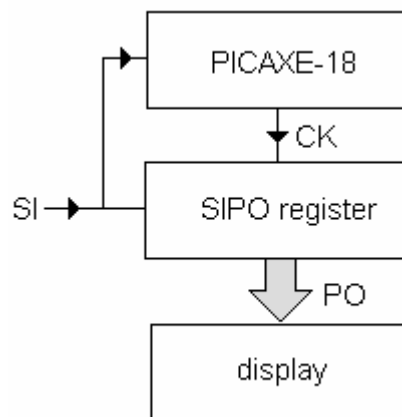
6 Use the DIL switch to set up the four-bit word DCBA = 0101 at the parallel inputs of the PISO register. Press the switch to pull **start** high. If all is well, the LED connected to SO should turn off and on three times before returning high.

7 Add a signal for SO to the timing diagram above for DCBA = 0101.

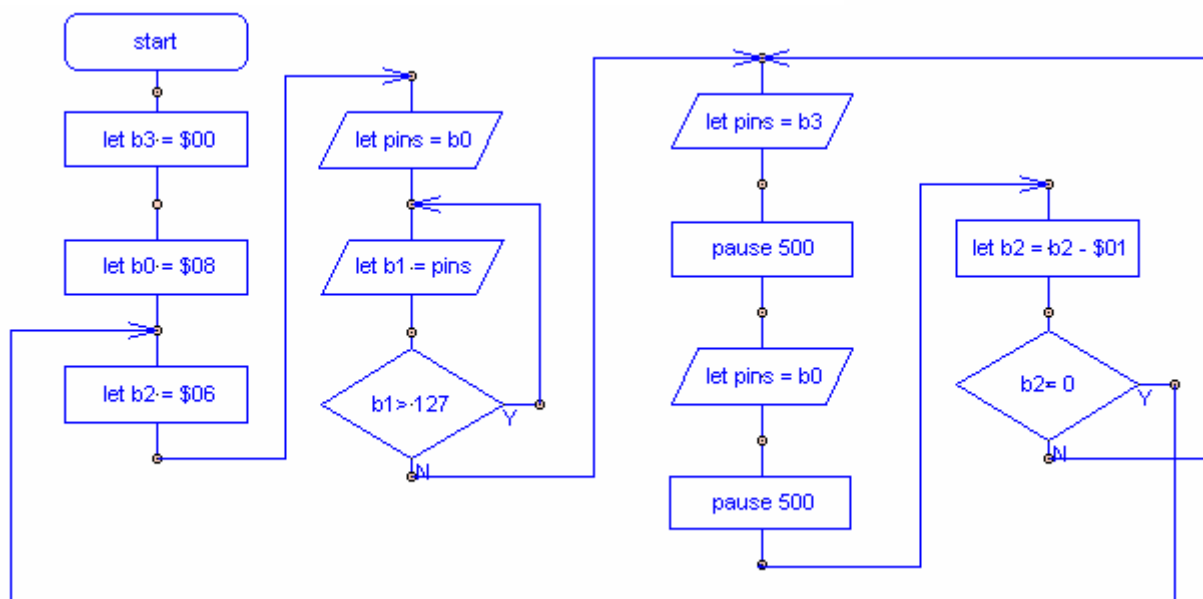
8 **Don't dismantle your working circuit.** You will need it for the next practical!

**Serial Receiver**

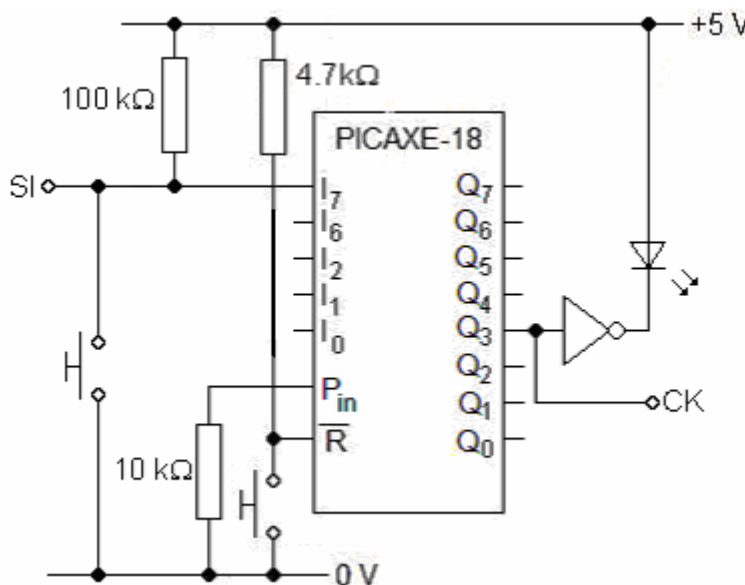
You are going to assemble a serial receiver of four-bit words. The block diagram is shown opposite. The microcontroller provides the timing signals for the PISO register.



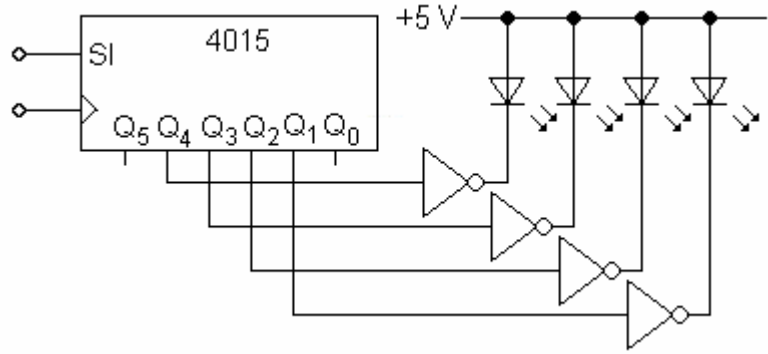
- 1 Start by entering the flowchart below into a PICAXE-18 i.c.



- 2 Assemble the circuit shown opposite.
- 3 Press the switch to pull SI low for a moment. If all is well, the LED should go off six times before staying on again.
- 4 Work out how to assemble a six-bit SIPO register from the pair of four-bit SIPO registers in a 4015 i.c.

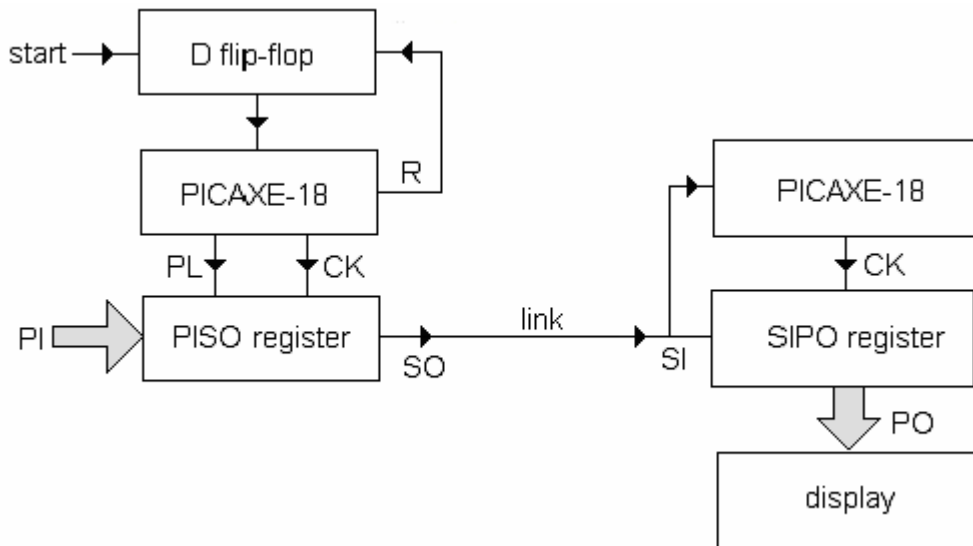


5 Add a six-bit SIPO register and display, as shown opposite. Note how the LEDs display the word being received without the stop and start bits at either end.



6 Press the switch at SI to trigger the receiver into action. Note the effect of pressing and releasing the switch during the six cycles of CK.

7 Use a wire to link the output of your serial transmitter to the input of your serial receiver as shown below. If the two systems are run off different power supplies, make sure that they have a common 0 V connection.



8 Verify that the system can transmit a four-bit word, with a transmission time of six seconds.

9 Adapt the system so that it behaves as follows:

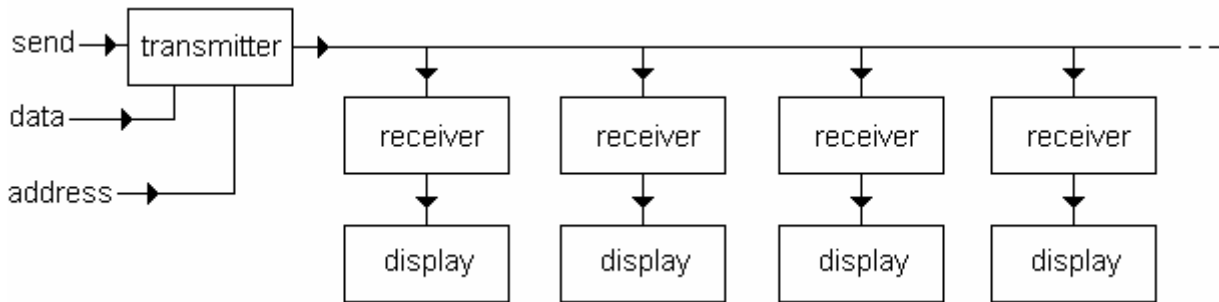
- it transmits six-bit words
- the transmission time is one second

**Sending Packets**

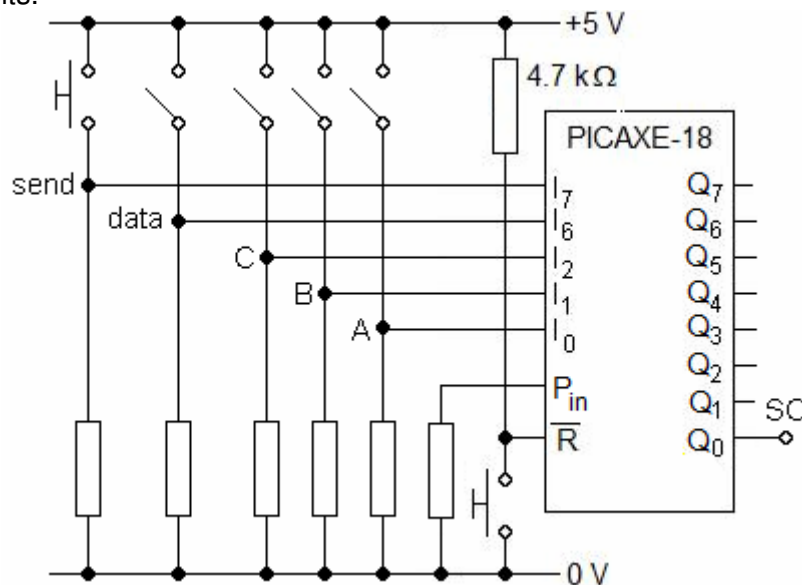
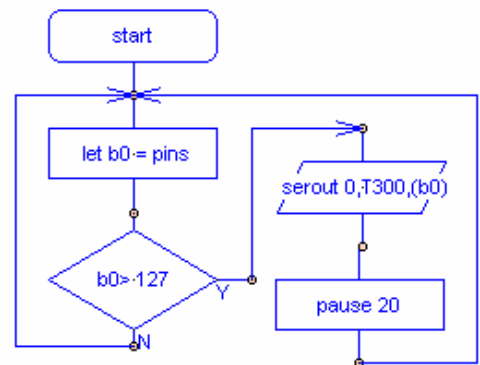
You are going to set up a packet transmission system with the following features:

- a single transmitter controls several receivers
- each packet contains one data bit and three address bits
- each receiver has a different address

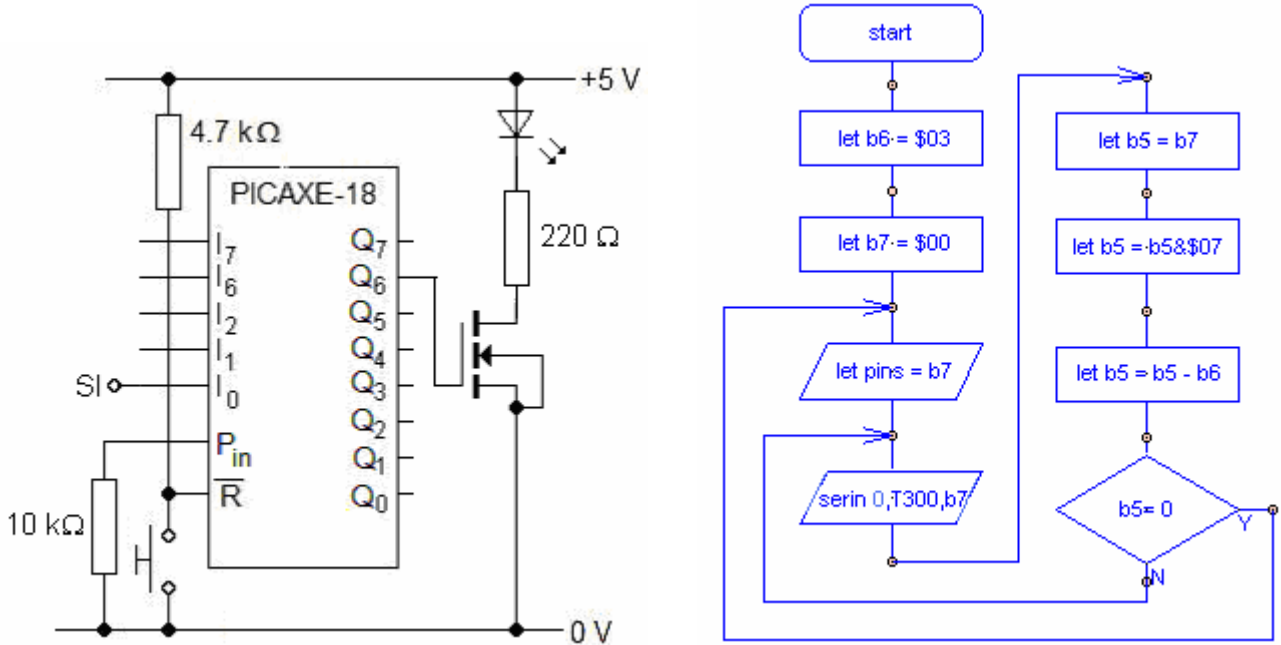
The block diagram is shown below.



- 1 Start by entering the flowchart into a PICAXE-18 i.c. Note the use of the **serout** command to feed out the word in register b0 in serial form through Q<sub>0</sub> at a rate of 300 bits per second.
- 2 Assemble the transmitter sub-system shown below.
- 3 Connect an oscilloscope to SO. Trigger on falling edges. Press the switch to pull **send** high. Verify that SO carries the **address** CBA followed by the **data** and **send** bits.



- 4 Enter the flowchart shown below into another PICAXE-18 i.c. This programs it to act as the receiver whose address is 03 in hexadecimal. Note the use of the **serin** command to read a word in serial form at I<sub>0</sub> and place it in register b7. The **AND** command (&) masks off all but the three lsb of the word in register b5.



- 5 Assemble the receiver sub-system shown above.
- 6 Connect the receiver to the transmitter. Verify that
- when CBA = 011, the state of the LED follows the state of the data switch
  - when CBA ≠ 011, the state of the LED is frozen
- 7 Add other receiver sub-systems. Each should have its own unique address. Verify that the transmitter sends the data bit only to the receiver whose address CBA is set up on the three DIL switches.
- 8 Try having two or more transmitters connected to the link. You will need to use analogue switches to isolate the transmitters from the link when they aren't transmitting.

