Picaxe Electronics For Astromechs

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Contents

Note: *These are just the electronic control for these devices, no mechanical connection ideas are included for connecting servos to doors or holoprojectors.*

Introduction to the Picaxe System

What is the Picaxe System?

The Picaxe is a Microcontroller system which is programmed from your computer with simple programming system to tell the board what you want it to do. The programming uses simple commands such as:

Servo 1,150

In this case the command is telling the servo connected to pin 1 to move to position 150. Simple huh?

Why Use Picaxe?

There are a number of reasons for using the Picaxe System some of them include -

* Quite cheap
* Boards already assembled (always a plus)
* Very flexable since YOU program what you want them to do.

Where Can I Get Them?

The Picaxe systems are available online from the following places -

USA - SparkFun:
www.sparkfun.com

UK - Rev-Ed:
www.rev-ed.co.uk/picaxe/

Australia - Microzed:
www.microzed.com.au/

How Much?

The following starter pack I have found most useful for Astromech use -

Picaxe 18X	$24.95 USD (SparkFun)
	£15.10 Inc Vat (Rev Ed)
	$50.70 AUSD (Microzed)

Price includes Board, Picaxe Chip & Programming Software CD. Price for Rev Ed and Microzed also includes programming cable. Programming cable sold separately for SparkFun packs:

Programming Cable - Serial	$6.95
Programming Cable - USB	$25.95

The cheaper serial cable is sufficient and the only reason you would need the USB cable is if your computer does not have a serial port.

A slightly cheaper option is to buy the board and the chip only, as well as the download cable. The software can be downloaded from the Rev-Ed site for free (it is around a 27mb download). If you are buying multiple Picaxe systems, or buying extra Picaxe systems after the starter pack, you are better off buying this way.

One potential problem with the Picaxe 18 board is that it doesn't have any mounting holes, how you get around this is up to you. But a number of ideas include slots to slide the board in your Astromech or putting the board in a plastic container and attaching the container to the frame.

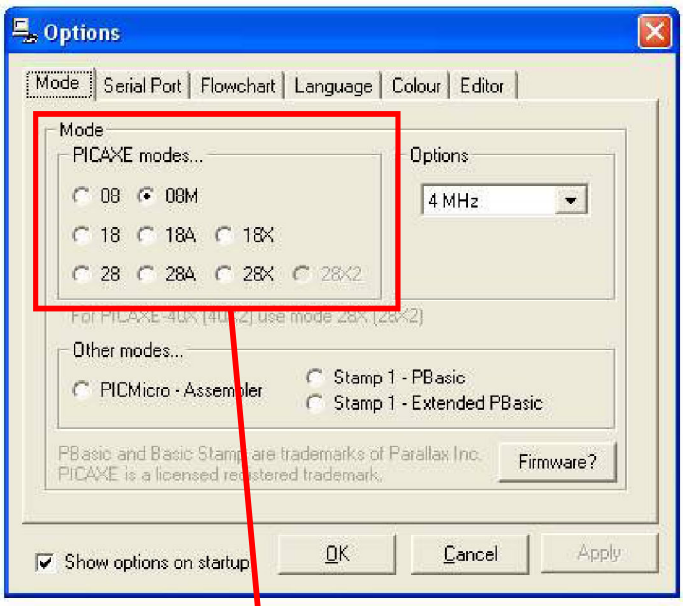
Other Picaxe chips and board combinations are available, such as Picaxe 8M and Picaxe 14M, but they are slightly more limited and they are supplied as a "kit" which you must solder together. I for one would rather have a fully assembled board. Also the price difference with the 14M and the 18X is not much different, so the convenience of an already assembled board makes it a good buy.

NOTE: *A Picaxe 18X "Power" board is available but it is mostly for powering small motors up to 1.5amps so not needed for projects included here.*

Picaxe Programming Editor Basics

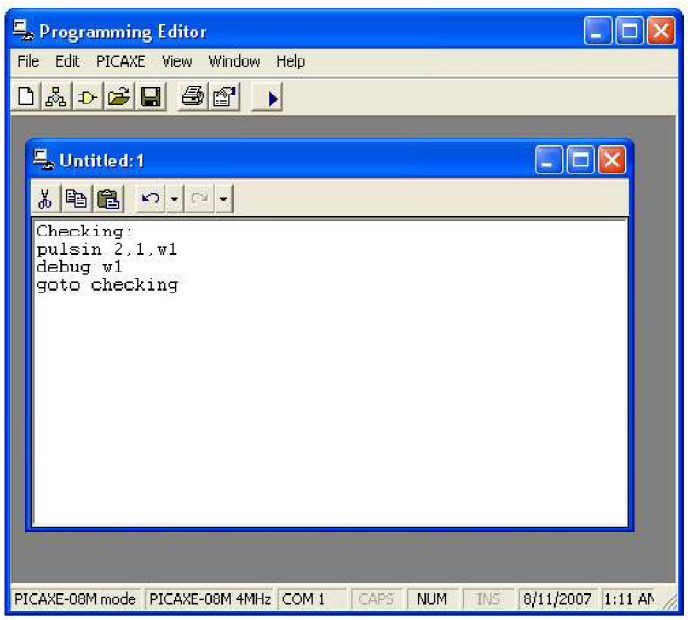
When you first startup the programming editor you will see this startup screen to select your options.

The only critical option you must change is the **"Picaxe Mode"** option to the type of chip you are using. We will be using the 18X.

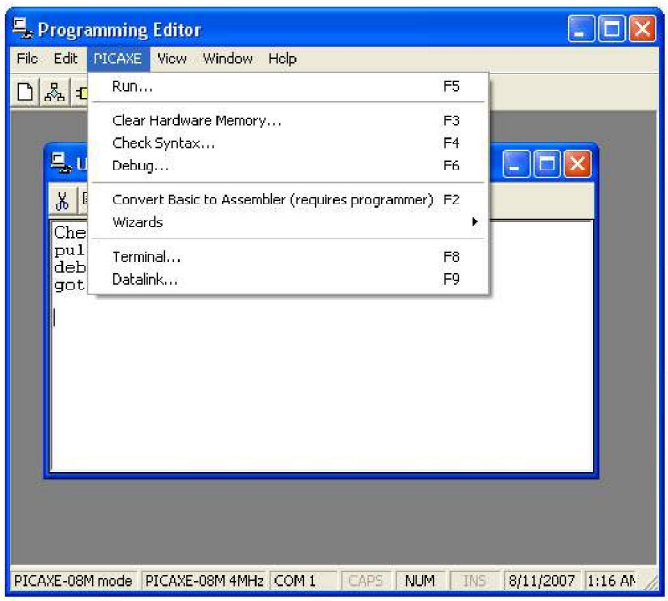


Change Mode to the type of Picaxe chip you have

After you click on the OK button you get to the programming editor. Type in your program, such as below:



When you are happy with your program and wish to run it on the Picaxe system simply plug in the programming cable, and make sure the Picaxe has power. In the menu select **PICAXE > RUN** and your program will be downloaded to your Picaxe.



There are over fifty commands in Picaxe Basic so the PDF Datasheets on the Rev-Ed site should be printed out and studied if you want to get the most out of your Picaxe system. The most important are:

Picaxe Manual 2 - Basic Commands
Picaxe Manual 3 - Electronic Interfacing Circuits

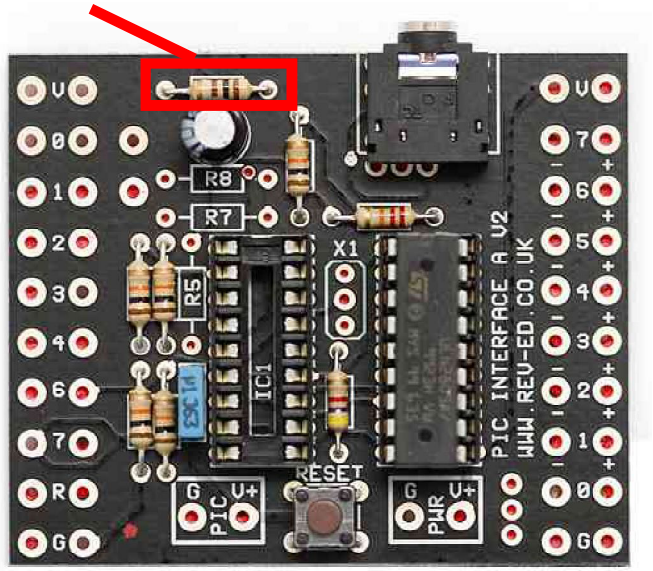
Other PDF Datasheets are also important, such as the datasheets for the individual boards etc.

8 Channel Front or Rear Logic Display

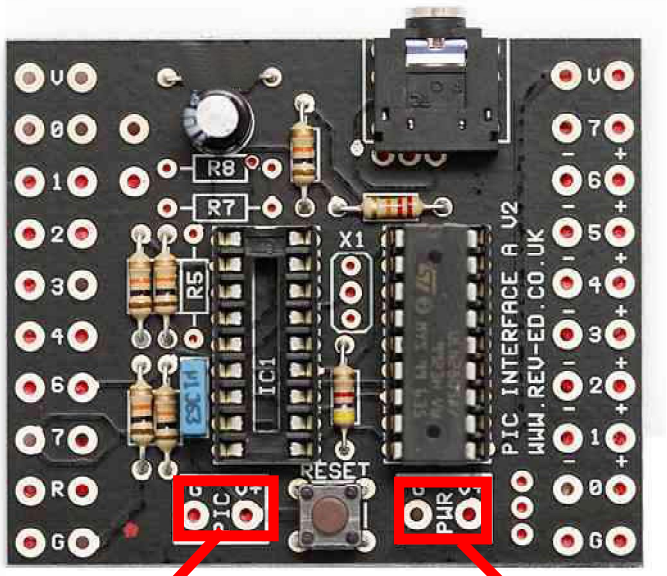
Modifications to the Picaxe 18 Board

To use the Picaxe-18 board for LED Logic displays the following resistor has to be removed:

Cut off this resistor



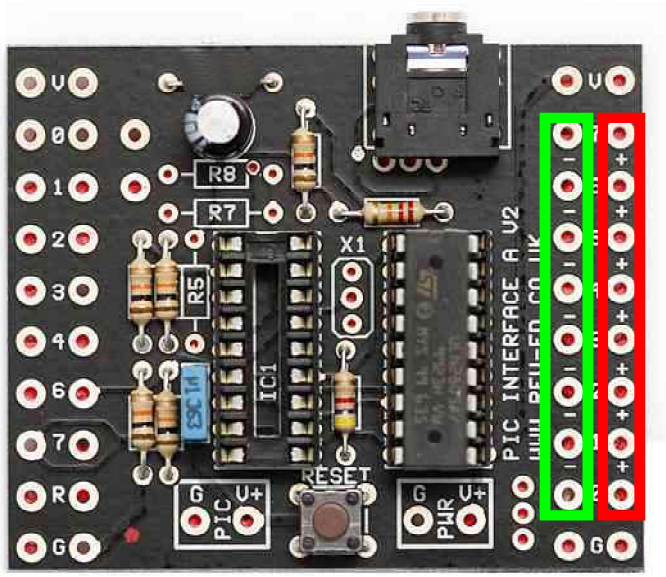
This will now seperate the power supplies so that for the Logic display it will allow a larger voltage to be used.



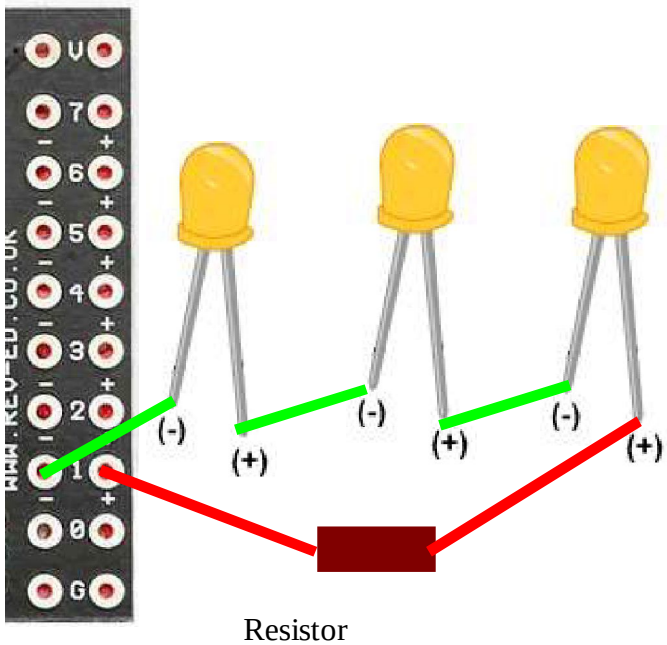
Picaxe Power 5V

Power for LED's

Wiring Your LED's



To give you a better idea the above shows **GREEN** for LED out from the Picaxe connection (-) & **RED** for the other side of the LED string (+).



Resistor

This is how each string of Led's is attached to the board. Their is no room on the board for the resistor so it must be attached to the LED's off the board. Their are eight outputs you can use numbered 0 to 7, the above string of LED's is attached to output 1. Just do the same for the other outputs.

You will have to work out which resistor you will need for each string of LED's. Their are many online LED calculators to help you. One I have used is LED Wizard

http://led.linear1.org/led.wiz

You will need to know Source Voltage, LED Voltage, LED current, and number of LED's in each string.

When you have everything wired up it is time to download a program to the picaxe and try it out -

```
main:
random w0          'get random number
let pins = b0      'make outputs high or low
pause 1000         'wait 1 second
goto main          'go back to start
```

The program simply picks a random number and using that number turns on the string of LED's randomly. The entire program is only 5 lines, but if you want to expand on the program the Picaxe 18x can have up to 600 lines of code, so lots of range for experimentation.

If you don't want the LED's to appear randomly but want a particular pattern, then other commands can be used.

For example the command:

high 1

would turn on output 1, and

low 1

would turn it off.

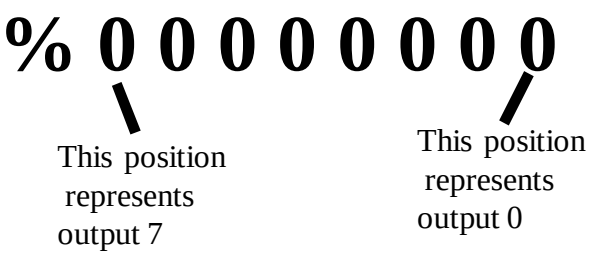
If you wish to turn on outputs at the same time you need the Let Pins command.

The command below would turn on all outputs -

let pins = %11111111

And to turn all outputs off -

let pins = %00000000



Simply put a "1" in the position of the output you want to go on, and a"0" for any you want to be off.

Combine this with a pause command and in no time at all you will have the Logic Display the way you want it. Any time you want the display to look different, just change the program.

With the pause command

```
pause 500      = half a second
pause 1000     = 1 second
pause 2000     = 2 seconds
```

Use whatever amount looks good to you.

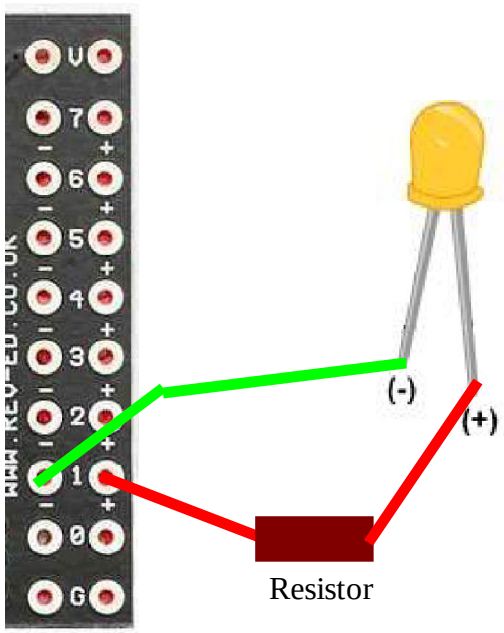
An example of a non random program -

```
main:
let pins = %10100110
pause 500
let pins = %01011001
pause 300
let pins = %11100100
pause 600
let pins = %00101001
pause 500
goto main
```

Remember you can have up to 600 lines of code so there is plenty of room for experimentation.

Process State Indicators

The LED's are connected exactly the same as the Logic Displays except only one LED is uses for each output:




```
main:
high 0
low 1
high 2
low 3
pause 1000
low 0
high 1
low 2
high 3
pause 500
goto main
```

You can still use unused pins 4 - 7 for something else if you wish.

Calculate the resistor value as before using an online LED calculator.

The program is similar to the example given for the Logic Displays except you would only need to use 4 of the outputs (Front - Red/Blue & Rear - Green/Yellow).

In this example program -

Front Red - Output 0

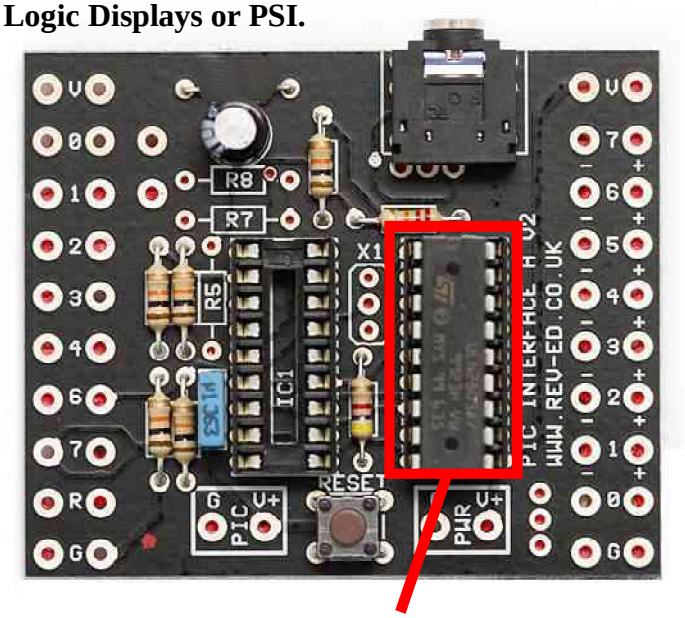
Blue - Output 1

Rear Yellow - Output 2

Green - Output 3

Random Holoprojector Movement

For Servo use a small change to the board is needed. The resistor described in the Logic Display section needs to be removed as normal to split the power supplies. Another change is needed for servo use. The ULN2803A chip needs to be removed and a 16 Pin, 8 x 330k resistor DIL pack is put in its place. **Do not make this change if you are using the board for Logic Displays or PSI.**

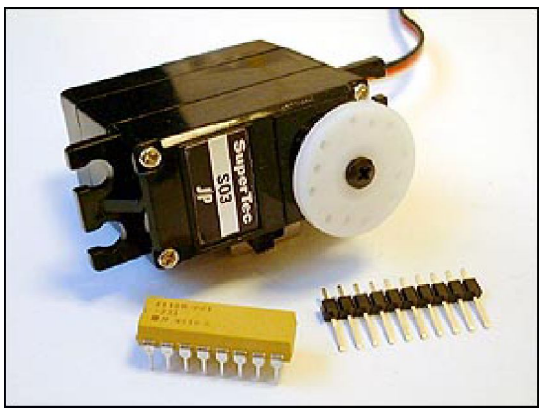


ULN2803A Chip pictured
Replace with -
16 Pin, 8 x 330k resistor DIL pack

The ULN2803A is an 18 pin Chip, the replacement Resistor pack is 16 pin, this is correct, just leave the bottom row of pins of the socket empty.

You can buy a servo upgrade pack includes one servo, DIL resistor pack and 10 pin header strip.

Price -
Rev-Ed: Order Code - AXE030 - £13.00
Microzed: Order Code - AXE030 - $45.00
SparkFun: Not available



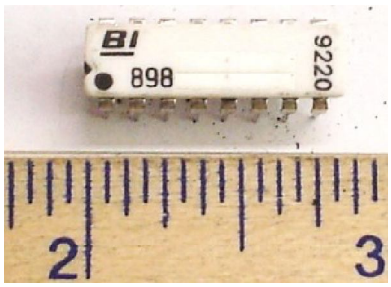
The Resistor DIL pack can be bought seperately if you already have enough servos. A quick Google brought up a few places to buy -

www.electronicplus.com

Search by Part Number: **898-3-R330**

Description:
330k ohm 16 pin dip (dual inline package) resistor network-consists of 8 individual resistors each isolated from each other (individual resistors are connected to pins 1 & 16, pins 2 & 15, 3 & 14, etc

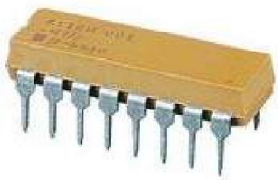
Price: $1.75



Note: The search will produce two results. The first with 330 OHM in description is the one you want. NOT the 330K.

www.rapidonline.com

Search Order Code - **63-0635**

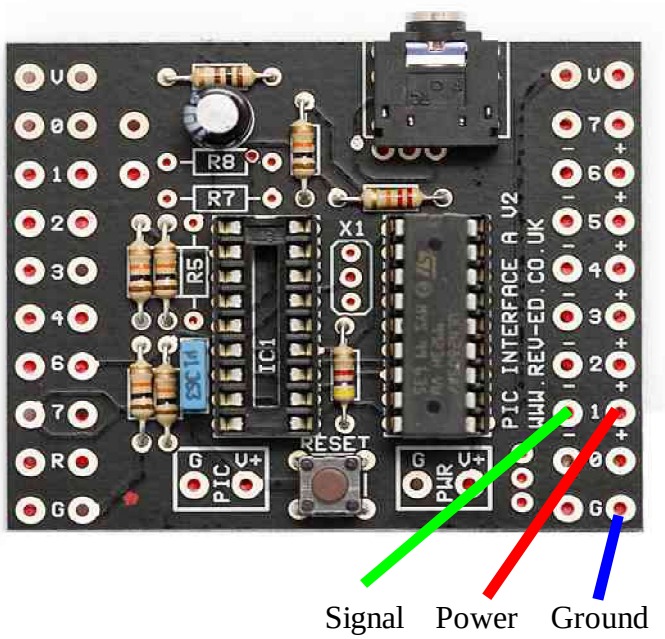


www.techsupplies.co.uk

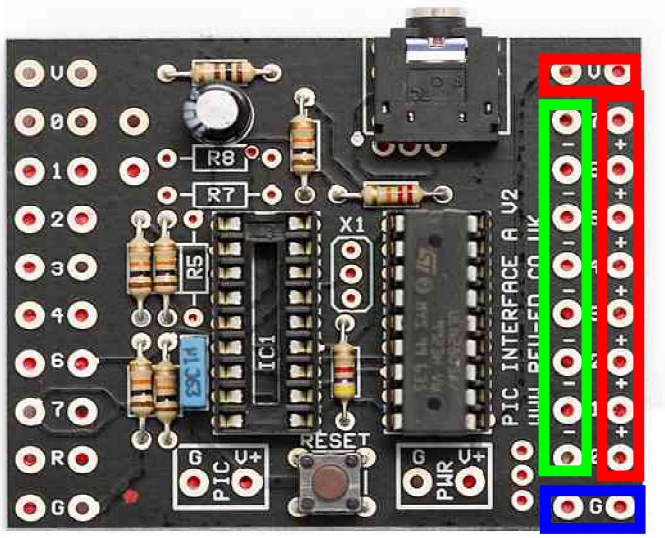
Search Order code - **RES034**

This is by no means the only places to buy this resistor pack, but it is not a common item. Just remember you need - **16 pin, 8 x 330k ohm Resistor DIL pack.**

Wiring Your Servos



The above example shows the connection wires go to on the servo. The ground wire will have to be shared between servos.



To give you a better idea the above shows **GREEN** for the connection for the Servos signal wire, **RED** for the Power wire, and **Blue** for the Ground connection wire.

On my Futaba Servos they are wired -

Red - Power
Black - Earth
White - Signal

But this can vary between manufacturers.

Example Programs

The servo command is simply Servo, Output Pin Number, Servo Position. The position is a number between 75 and 225. The servos command can go outside this but if you use a number outside your servos capability it could damage it, so the numbers here are conservative.

Servo Position 75 = Fully Left
Servo Position 150 = Middle
Servo Position 225 = Fully Right

Example program to move a single servo connected to output 1 -

```
main:
servo 1,75        'move servo to one end
pause 2000        'wait 2 seconds
servo 1,150       'move servo to centre
pause 2000        'wait 2 seconds
servo 1,225       'move servo to other end
pause 2000        'wait 2 seconds
goto main         'loop back to start
```

If you want random movement the random number generator has to be used -

```
main:
random w0                'get a random number
w1 = w0 // 225 + 75      'range convert 75 - 225
servo 1,w1               'move servo
pause 3000               'pause 3 seconds
goto main                'go back to the start
```

To move two servos -

```
main:
random w0                'get a random number
random w2                'get a random number
w1 = w0 // 225 + 75      'range convert 75 - 225
w3 = w2 // 225 + 75      'range convert 75 - 225
servo 1,w1               'move servo 1
servo 2,w3               'move servo 2
pause 3000               'pause 3 seconds
goto main                'go back to the start
```

It is very easy to experiment until you get your holoprojectors moving the way you want.

Using A Servo To Open A Door

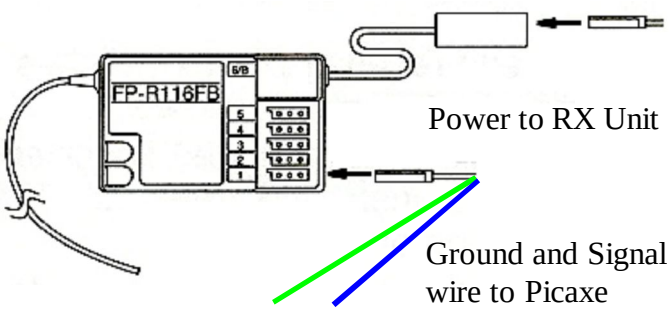
Just the same as the Random Holoprojector movement you need to remove the resistor and replace the ULN2803A chip with the DIL resistor pack and the servos are wired exactly the same.

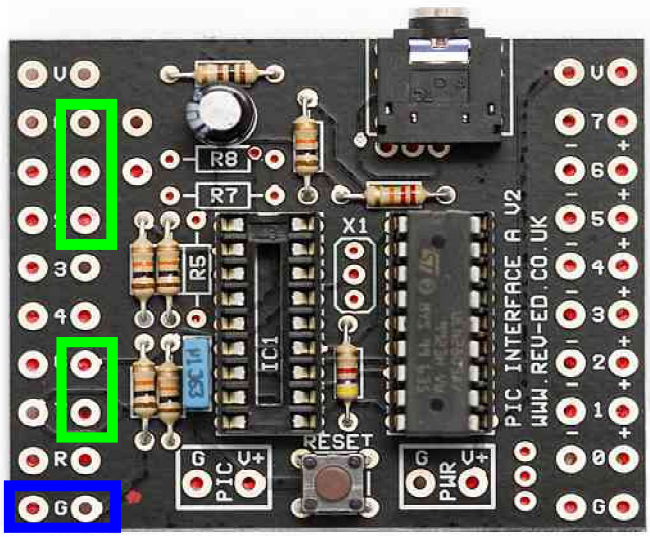
An example program -

```
main:
servo 1,75        'move servo to one end
pause 2000        'wait 2 seconds
servo 1,225       'move servo to other end
pause 2000        'wait 2 seconds
goto main         'loop back to start
```

But this would just make the door continuously open and close so you need some way to tell the servo when to open or close. For that you need to receive your RC Radios RX Signal or use a separate 12 Channel Remote. The 12 Channel Remote is described later, I will focus on using the RC system.

Your Radio Control Receiver should look similar to below.





This time the board shows **GREEN** for the connection for the RC signal wire (Input) and **BLUE** for the Ground connection wire (Earth), the power wire doesn't need to be connected to receive the signal.

A Quirk of the Picaxe 18 system is that there is no pin 5 input and although pins 3 and 4 are shown they cannot be used. So only 5 inputs - 0,1,2,6,7.

Plug in your Download cable from your computer to the Picaxe system and try the following program to see if everything is hooked up correctly –

Note: You must leave the download cable plugged in so that the debug command can send info back to the computer -

```
main:
Pulsin 1,1,b0
Debug b0
Goto main
```

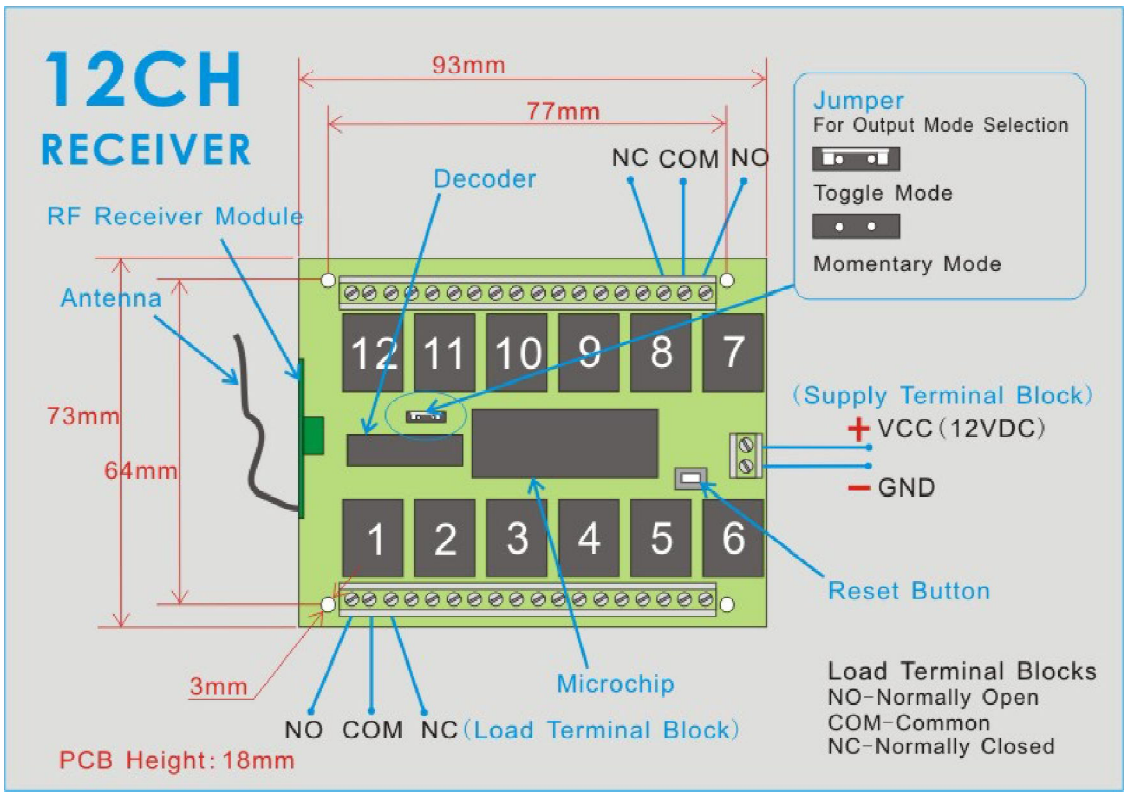
Simply move the stick connected to the channel you have connected to the Picaxe and watch the numbers change when the stick is moved.

If everything is working correctly, wire in a servo as previously shown in the random Holoprojector movement and leave the RX unit connected. When you have done all that, try the following program -

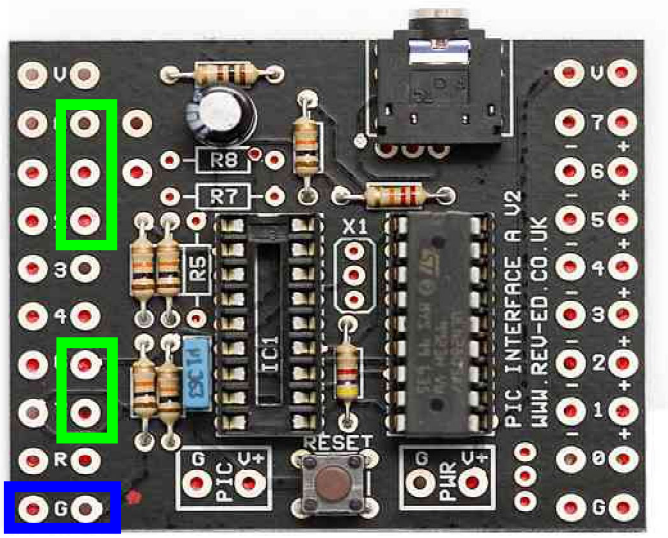
```
b1 = 0
main:
pulsin 1,1,b0
if b0 > 100 then goto main
b1 = b1 + 1
if b1 = 1 then goto open
if b1 = 2 then goto close
open:
servo 2,225
pause 1000
goto main
close:
servo 2,75
pause 1000
b1 = 0
goto main
```

12 Channel RF Relay Board Connection

Your 12 Channel Relay Board should look similar to below -



Just wire the NO connection to one of the Picaxe input pins circled in Green, and the COM connection to the Ground on the Picaxe board circled in Blue. Don't forget the power for the Picaxe and the 12CH Receiver board. Also remove the jumper on the 12CH receiver board to turn on momentary mode. Don't forget to put in the Resistor DIL pack for Servo use as described in the random servo example.

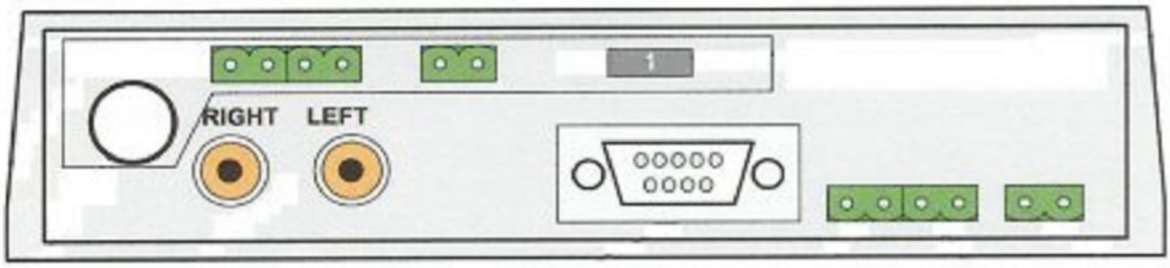


In this example Picaxe Program I will assume that only Relay 1 is wired up to input 2 on the Picaxe board and that you have a servo wired to output 3.

```
b1 = 0
main:
if pin 2 = 1 then goto door
goto main
door:
b1 = b1 + 1
if b1 = 1 then goto open
if b1 = 2 then goto close
open:
servo 3,225
pause 1000
goto main
close:
servo 3,75
pause 1000
b1 = 0
goto main
```

If everything is working correctly, every press of button 1 on the remote will trigger the relay to move between two positions. Handy for doors on your Astromech.

CF Sound II & III Control



For the following you need a CF-III Sound System, or for those that have the older CF-II, I will show how to hook that up also.

The CF III Sound System – available from:

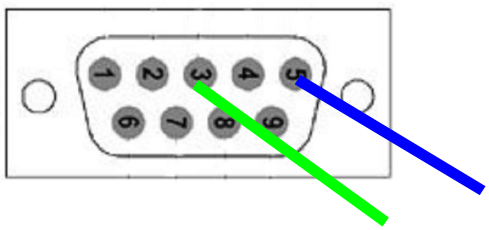
www.cfsound.com/index_CFSound.asp

You also need a Compact Flash Card – Not LEXAR brand, they are not compatible. Formatted to Fat 16. Also needed is a Speaker – 4-8 ohms, 15 watt max and a 9 Pin Female Serial Connector shown below.

NOTE: The extra contact sense boards are not needed for this setup.

Make sure that the Picaxe board is set up the same as for the servo connection with the resister DIL package and no more than 5v to the picaxe.

Below is a view from the **rear** of the 9 pin Serial Connector, connect the Ground wire to pin 5 and serial in to pin 3 as shown This is then plugged into the CF Sound II or III.



Connect the other ends of the above wires as shown, Ground to Ground BLUE Wire connection and the other wire to an output pin GREEN wire.

You will then need some R2 Sounds. They need to be converted to the following formats -

CF II - WAV, Mono 8 bit 22 KHZ – PCM format.

CF III - WAV, Mono or Stereo 16 bit 44.1 KHZ – PCM format.

Sounds can be converted with the sound recorder program that comes with windows.

Copy these sounds to your Compact Flash card, making sure they are renamed to a number plus a ”C” after the number so the sound will play when the contact is closed. i.e. – 01C.wav, 02C.wav up to 99C.wav if you have that many sounds.

Power both the CF II or III and the Picaxe system making sure you connect the speaker to the CF Sound, then try the following program to see if everything is hooked up correctly. In this example the output pin 1 of the Picaxe is connected to the CF Sound.

```
main:
serout 1,n2400,($01,”P+01”,$03)
wait 4
goto main
```

This program will play sound 01 every four seconds, just substitute the 01in the inverted commas “ ” in the Serout command to play anyone of the 99 sounds.

Using the 12 Channel Remote to connect with the CF Sound and you can play random sounds.

CF Sound + 12 Channel Relay Board Connection

For the following program connect the 12 Channel Relay board Relay outputs 1,2,3,4,5 to input pins 0,1,2,6,7 and the output pin 1 of the Picaxe is connected as shown in the previous CF Sound example.

```
main:
if pin0 = 1 then but1
if pin1 = 1 then but2
if pin2 = 1 then but3
if pin6 = 1 then but4
if pin7 = 1 then but5
goto main

but1:
random b1
b2 = b1 // 20 + 1
SEROUT 1,N2400,($01,"p+",b2,$03)
wait 1
goto main

but2:
random b1
b2 = b1 // 40 + 21
SEROUT 1,N2400,($01,"p+",b2,$03)
wait 1
goto main

but3:
random b1
b2 = b1 // 60 + 41
SEROUT 1,N2400,($01,"p+",b2,$03)
wait 1
goto main

but4:
random b1
b2 = b1 // 80 + 61
SEROUT 1,N2400,($01,"p+",b2,$03)
wait 1
goto main

but5:
random b1
b2 = b1 // 99 + 81
SEROUT 1,N2400,($01,"p+",b2,$03)
wait 1
goto main
```

The previous example program is handy when you have banks of different "mood" sounds. so sounds 1-20 are happy sounds, sounds 21 - 40 are sad sounds, sounds 41 - 60 are chirps and beeps etc.

If instead you want a particular sound to play when a button is pressed - program below plays sound 1 when button 1 is pressed etc.

```
main:
if pin0 = 1 then but1
if pin1 = 1 then but2
if pin2 = 1 then but3
if pin6 = 1 then but4
if pin7 = 1 then but5
goto main

but1:
SEROUT 1,N2400,($01,"p+01",$03)
wait 1
goto main

but2:
SEROUT 1,N2400,($01,"p+02",$03)
wait 1
goto main

but3:
SEROUT 1,N2400,($01,"p+03",$03)
wait 1
goto main

but4:
random b1
SEROUT 1,N2400,($01,"p+04",$03)
wait 1
goto main

but5:
SEROUT 1,N2400,($01,"p+05",$03)
wait 1
goto main
```

Or you can mix the above to have some random and some particular sounds. You could also have a sequence of particular sounds.

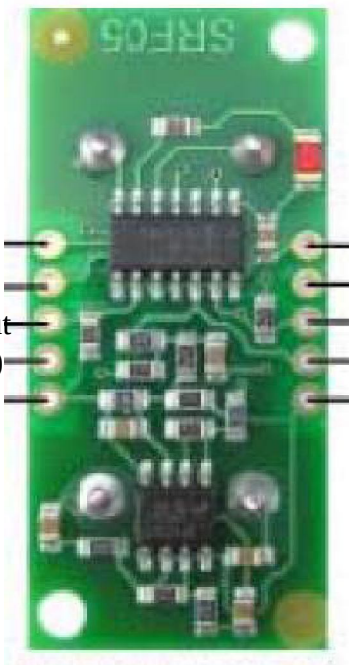
Ultrasonic Rangefinder

Below is the SRF005 Ultrasonic Rangefinder.

Available at:
Rev-Ed: Order Code SRF005 £11.99
Microzed: Order Code SRF005 $42.00

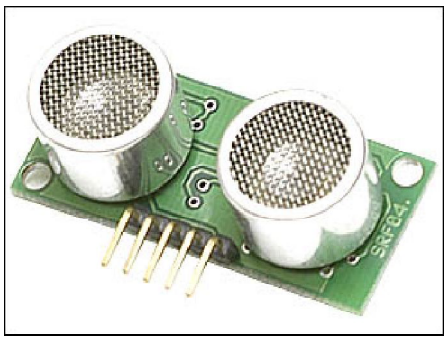
Minimum detection range 3cm, Maximum range 3m.

The rear of the Rangefinder -



5v Supply
To Picaxe Input
To Picaxe Output
(No Connection)
0v Ground

Do not connect to these pins



Ultrasonic Rangefinder

In this program the output pin of the Picaxe is 1 and the input pin is 2. Leave the download cable plugged into the Picaxe system and the debug window on the computer screen will show the variables, in this case W1 will show the distance in centimetres.

```
main:
pulsout 1,2
pulsin 2,1,w1
pause 10
let w1 = w1 * 10 / 58
debug w1
goto main
```

Combine that with the previous CF Sound board example and the Astromech can play a random sound when someone comes within range.

A more complex idea is to use two of these rangefinders and be able to turn the dome to face where someone is standing and the dome to follow them when they move.

In this program outputs 1 and 2 and inputs 1 and 2 are used for the Ultrasonic Rangefinder and a speed controller with motor to dome is connected to the output 3.

```
main:
pulsout 1,2
pulsin 1,1,w0
pause 10
pulsout 2,2
pulsin 2,1,w1
pause 10
let w0 = w0 * 10 / 58
let w1 = w1 * 10 / 58
if w0 < 300 then left
if w1 < 300 then right
servo 3,150
goto main
left:
servo 3,80
goto main
right:
servo 3,180
goto main
```