FD-01 Display Module

User Manual

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1 Introduction

Thank you for purchasing the Cumbria Designs FD-01 Display Module. We hope that you enjoy constructing this kit and find many uses for this feature rich design. This manual describes the assembly and operation of the FD-01, even if you are a seasoned constructor we respectfully ask that you read this manual and familiarise yourself with the instructions and kit contents before commencing construction. If assembled carefully, this unit will provide many years of reliable service.

Thank you

The Cumbria Designs Team

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2 Preparation

2.1 Tools

We recommend that the following tools are used during assembly and testing;

25W soldering iron with fine or pointed tip

60/40 Rosin cored solder

5" or smaller diagonal side cutters

Small pointed nosed pliers

Solder sucker (just in case!)

Multimeter

2.2 Conventions

The following symbols are used within the assembly instructions to draw attention to critical steps such as component orientation and anti-static precautions. The associated narrative describes the action required.

! Critical Step

Static Sensitive

2.3 Assembly

The production of a successful finished working kit is dependent upon care during component handling, placement and good soldering! Don't be tempted to rush the construction, even though this is a relatively simple kit, a wrongly placed component can provide hours of frustrating fault finding. Also, as this kit uses a double sided Printed Circuit Board (PCB) with through plating, removal of a wrongly soldered part can be difficult. Follow the assembly instructions carefully to avoid mistakes.

2.4 Component Identification

All parts carry a coded identity to describe their values. It is important to be able to recognise these during assembly. Capacitors have their value printed numerically, e.g. 104 = 100nF, 103 = 10nF etc. Resistors have their values represented by coloured bands – this is a frequent source of confusion!

To simplify component identification, the parts list carries the identities of each component as it appears on the device. For resistors the colour coding is given. This should be referred to during assembly to ensure the right parts are placed in their respective positions on the PCB.

2.5 Component Leads

Many of the passive components will require their leads to be formed to align with the holes on the PCB. This mainly applies to the axial parts such as resistors and diodes. Forming component leads is easily done with a pair of pointed nose pliers and using the hole spacing on the PCB as a measure. Alternatively, small formers made from scrap off cuts of Vero board etc make ideal templates that produce consistent results. Some parts, such as the variable resistors, have preformed leads designed for machine assembly. These will require straightening to align with the board layout. Again, a pair of pointed nose pliers should be used to carefully flatten the factory performing to produce straight leads.

2.6 Soldering

The majority of problems are likely to be caused by soldering faults. These can sometimes be difficult to find. Here are some basic golden rules that will help you to avoid poor solder joints;

- **Clean Iron**

Make sure your soldering iron tip is in good condition and tinned. A small moistened pad for cleaning tips, regularly used to wipe off excess solder and flux, will ensure that your iron performs well. Remember to tin the iron immediately after each wipe.

- **Clean Leads and Pads**

All of the component leads and PCB pads in this kit are pre-tinned and should not need cleaning before soldering. Please ensure that parts are handled so as to avoid contamination with grease or fingerprints.

- **Soldering**

This is the bit that can trip up even experienced constructors. For the solder to fuse with the surfaces to be joined it is necessary for them to be hot – but not so hot as to damage the parts! It's a simple as ***1-2-3***;

1. *Place the tip of the iron against the joint, hold it there briefly to bring the metal surfaces up to temperature.*
2. *Apply the solder allowing it to flow smoothly onto the surfaces.*
3. *Remove the iron and inspect the new joint.*

The finished joint should have a smooth shiny coating of solder. If the joint is dull grey or has formed a spherical "blob", apply the iron to the joint, remove the old solder with a solder sucker and re-solder.

3 Circuit Description

3.1 General

The FD-01 is designed to be easily configurable for use as a piece of test equipment or a transceiver display. In transceiver applications, all of the key operating information is presented on a compact Liquid Crystal Display (LCD). This offers many advantages over conventional analogue instrumentation, improving accuracy and simplifying the mechanical design of the host transceiver. There are three types of inputs to the FD-01; RF, for frequency measurement, Analogue for graphical display of voltages (AGC etc) and User Controls to instruct the FD-01 to perform specific operations. The heart of the FD-01 is a 16F877A PIC microcontroller. This is a pre-programmed device which performs all of the control and arithmetic actions needed to carry out measurements and communicate with the LCD.

3.2 Frequency Measurement

The signal to be measured is applied to the two pin *RF input* connector (input/ground). A J-FET buffer Q1 provides a high impedance interface for frequencies up to about 30MHz. This allows direct connection to circuitry with minimum loading. Beyond 30MHz the input capacitance of the J-FET progressively reduces the input impedance. At these frequencies, depending upon the application care may be needed to select a measurement point capable of driving an impedance of several hundred Ohms.

A bipolar transistor, Q2, provides the gain needed to drive IC2A and IC2B the gate shaping circuit. IC2D is the counter gate. This is opened and closed by the 16F877A. IC2C is used to clock out any residual stored count in IC5, the pre-counter.

IC5 is a dual 4 bit binary counter configured as a 6 bit counter. This is a high speed CMOS device capable of operating at much higher frequencies than the internal prescaler of the 16F877 which has rated upper frequency limit of 32MHz. The combination of the input amplifier and the use of high speed CMOS in the gating and pre-counter circuits provide an upper operating capability in excess of 100MHz. The 16F877 internal prescaler is programmed to act as a divide by 2. When combined with the divide by 6 action of IC5 this provides a divide by 8 action, the 8 bit count jointly held in the pre-counter and prescaler represent the binary Least Significant value of the measured frequency.

Two further 8 bit counters, internal to the 16F877, provide a binary 24 bit frequency count for each gate sample. This is processed by the 16F877 to factor in any offset or multiplier values, converted to Binary Coded Decimal (BCD) and passed to the LCD for display.

3.3 Analogue Measurement

Three analogue voltage measurement channels are presented on PL2. Two are used for AGC measurement, their values drive the S-Meter display, the third is provided for a plain bar graph representation of voltages such as DC supply or Transmit Output level taken from a diode sampler. IC2A and IC2B are used to sample the AGC voltage and the AGC reference voltage. The reference voltage is the standing DC bias of the AGC line, this can be taken from within the AGC circuit or created by a voltage divider within the transceiver. 100K trimpots on the inputs of IC2A and IC2B allow adjustment of input voltage level. The 16F877 sequentially measures the AGC value and the Reference value, calculates the difference, and displays the result over a range of just over 2.4 volts, as zero to S9+50.

IC2D has a fixed level 100K input. It is presumed that level adjustment for this input is provided at the sample point inside the transceiver. The output from IC2D is represented as a linear bar graph with a Full Scale Deflection (FSD) of 1.4 volts.

All three analogue inputs to the 16F877 are protected by 4.7v zener diodes to prevent damage should the outputs of IC2 rise above 5 volts.

3.4 Control Inputs

12 diode protected control inputs are presented on PL3. These allow the user to select the various functions of the FD-01. The inputs are normally held high by pull up resistors, grounding an input activates the associated function.

The function of each pin is given in Table 1 below;

PL3 Pin	Function	High or Open	Low (Ground)
1	Mode Display		
2	Mode Display	See Table 2	
3	Mode Display		
4	Tx/Rx Annunciator	Hide	Show
5	Tx/Rx Annunciator	Rx Display+S-Meter or Bar	Tx Display + Bar
6	Meter Format	S-Meter	Linear Bar
7	Delta Mode	Normal Measurement	Show difference
8	Offset Frequency	Direct Frequency Display	Apply Offset Frequency
9	Offset Sum/Diff	Add Offset	Subtract Offset (difference)
10	Offset Select	Use Offset A	Use Offset B
11	Multiplier Mode	No Multiplier	Apply Multiplier
12	Multiplier Factor	Use Mult A	Use Mult B

Table 1 PL3 Control input functions

PL3 Pin			Displayed Message
1	2	3	
High	High	High	Blank
High	High	Low	CW
High	Low	High	LSB
High	Low	Low	AM
Low	High	High	USB
Low	High	Low	FM
Low	Low	High	DSB
Low	Low	Low	PSK

Table 2 Mode Display

The most commonly used modes, CW, USB and LSB are selected by grounding a single pin. Other modes or combinations are selected by grounding multiple pins. Selection of the full range of annunciators from a single pole rotary switch, is easily achieved with a simple external diode matrix.

The three push button switches connected to the control inputs, allow user programming of IF Offset frequencies and Multiplier values.

4 Assembly

The following assembly sequence is recommended. This allows most of the smaller parts to be held in place with the board turned over whilst soldering the underside. All components are mounted on the top (silk screen) side of the board.

4.1 Resistors

All resistors (except R1) are 1% tolerance, this is indicated by a broad Brown band at one end. R1 has a gold tolerance band.

a)	R1	15R	Brown, Green, Black
b)	R2, R4	1K	Brown, Black, Black, Brown
c)	R3	10K	Brown ,Black ,Black, Red
d)	R5	1K	Brown, Black, Black, Brown
e)	R6	100K	Brown, Black, Black, Orange
f)	R10	2M2	Red, Red, Black, Yellow
g)	R11	220R	Red, Red, Black, Black
h)	R8	100K	Brown, Black, Black, Orange

i)	R12	10R	Brown, Black, Black
j)	R9	470R	Yellow, Mauve, Black, Black
k)	R7	470R	Yellow, Mauve, Black, Black

4.2 Crystal

Fit Q1, the 20MHz crystal. This is heat sensitive and is easily damaged if overheated. It is recommended that a gap of about 2mm is left between the crystal and the PCB. This will provide a little extra thermal isolation during soldering.

4.3 IC Sockets

! Ensure correct orientation – **note that IC4 and IC5 are in opposite directions!** Match index cut out on socket to board printing.

a) Fit the 40 pin microcontroller socket for IC3
b) Fit 14 pin sockets for IC2, IC4 and IC5

4.4 Resistor Networks

! Resistor networks have a 'common' pin marked by a 'spot' at one end. For correct operation of the controls the common pin must be aligned to pin 1 on the board print.

a)	Fit RN1	8x10K
b)	Fit RN2	4x10K

4.5 Diodes

The 1N4148 signal diodes and the BZX55 4V7 Zener diodes are very similar in appearance. Because of the small body size, the component legends are difficult to read. Tip: *The body of the BZX55 is slightly larger then the 1N4148.*

! Polarity conscious components. Make sure that orientation is correct.

a) Fit the 12 Control Input blocking diodes D5..D16 1N4148

The diodes are mounted **vertically**, body next to the SIL resistor networks, black polarity band to the top. Fold the top wire over to fit.

b) Fit Zener Protection Diodes D2, D3 and D4 BZX55 4V7

Note, these parts are mounted within the IC3 socket on the top side of the board (see picture in 4.7).

c) Fit Power Diode D1 1N4004

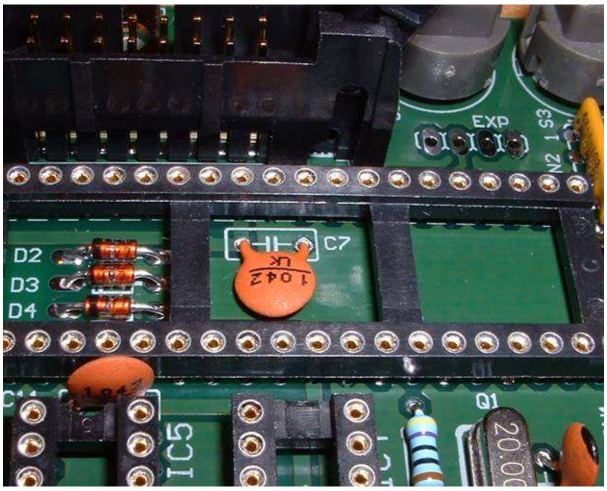
4.6 Variable Resistors

Values printed underneath or on side. Remember to straighten the preformed leads!

a) Fit 100K Analogue Input Level Cermets VR1 and VR2 (104)

b) Fit the 10K LCD Contrast Cermet VR3 (103)

4.7 Capacitors



Suggested Installation order;

C2	100nF (104)	
C3	"	
C13	"	

Note C7 is mounted flat underneath IC3 on the top side of the board. (See picture)

C7	"	
C14	"	
C12	"	
C11	"	
C9	"	
C16	"	
C6	10nF (103)	
C8	"	
C5	"	
C15	"	
C17	"	
C10	22pF	22p
TC1	22pF Trimmer Capacitor TC1	

! C1 and C4 are polarised Capacitors, the short lead marked '–', goes to ground

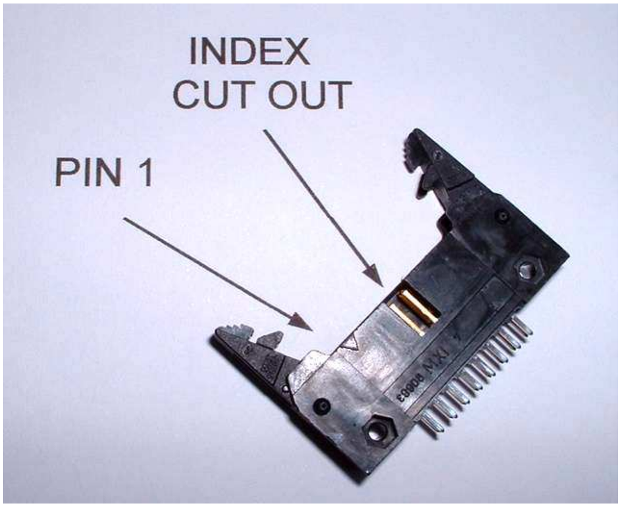
C1	100uF
C4	10uF

4.8 Switches

! Install Push Switches with the *flat faces* outwards.

Fit push button switches S1, S2 and S3

4.9 Connectors



! Alignment of PL1 the LCD connector is critical. Ensure that pin 1 on connector (marked by a triangle) matches pin1 on board print. Indexing slot will face towards VR3. Recommended Pin Header Connector orientation is with rear locking tab facing into the centre of the board.

a) Fit the 8x2 way PL1, see note above!
b) Fit 2 pin headers +12V (Power) and RF (RF input)
c) Fit 4 pin PL2 (Analogue inputs)

d) Fit 12 pin PL3 (Control inputs)

The EXP (Expansion) connector alongside S1 is unused in this design. There are no components to fit in this position.

4.10 Semiconductors

Static sensitive parts. Discharge yourself to ground before handling. Avoid wearing static generating clothing (e.g. wool, man made fibres etc) during assembly.

Orientation is critical. Observe correct alignment of pins and leads. IC leads may need to be gently formed for correct alignment before insertion into sockets. IC leads can be pushed inwards by placing the device on its' side on a firm surface, and gently pressing the body down against the pins. When inserting parts take care check alignment, particularly for the processor which requires a relatively high insertion force.

a)	Fit J-FET T1	J310
b)	Fit Bipolar transistor T2	MPSH-10
c)	Fit Voltage Regulator IC1	LM7805
d)	Fit Quad Op Amp IC2	LM324
e)	Fit IC5	74AC00
f)	Fit IC4	74VHC393
g)	Fit IC3	PIC 16F877A

4.11 LCD

Finally connect the LCD to the 16 way connector on the board using the ribbon cable supplied.

The LCD is static sensitive, handle with care. Depending upon the pattern of LCD supplied, an "LCD-A" adapter unit may be included to convert from the linear 16 way Hitachi style pin out, to a 8x2 format for a ribbon connector. See the LCD-A instructions for assembly and use.

Note that the ribbon cable and multiway connectors are indexed to ensure correct orientation. Do not force.

4.12 Connector Assemblies

Connector shells and pins are supplied to allow connection of power, signal and controls to the FD-01. The use of good quality, colour coded, heat resistant, multi stranded wire is recommended. To avoid accidents, a colour code convention should be chosen to represent function, e.g. Red +ve supply, Black ground, striped colours controls etc. The connector assemblies comprise of two components; the shell and the pins. To terminate a conductor first strip back about 2mm of insulation and tin the exposed wire. Place the tinned end of the wire into a pin such that the tinned wire sits inside the inner pair of tabs and the insulation sits within the outer tabs. With small pointed nose pliers carefully compress the outer tabs onto the insulation to hold the wire. Repeat this with the inner tabs to grip the exposed conductor. Very carefully solder the exposed conductor in place taking care not to allow solder to flow onto the locking tab. Finally, insert the pin into the shell with the small locking tab orientated to the face of the shell with the small cut outs. Push home until the locking tab snaps into the cut out. Should you need to remove a pin, gently press the locking tab in with a small screwdriver or the end of some pointed nose pliers. The pin will be released and can be pulled out of the shell.

Assembly complete, well done! Now carefully check your work for dry joints and bridges before moving on to testing.

5 TESTING

Before connecting the FD-01 to your power supply for the first time, carry out these simple checks – just to be safe!

5.1 Basic Electrical Tests

5.1.1 +12 Volt Rail

With a multimeter set to resistance, place the Red meter lead onto +12v and the Black to Ground and check for a high resistance. Note that due to C1 charging the reading will show change, providing there is not a short circuit then all is well.

Carry out the same test on the other side of D1 at the connection with the Regulator (IC1) input. Again a changing reading is caused by C1.

5.1.2 +5 Volt Rail

Carry out the same test on the regulator (IC1) output to check the integrity of the +5 volt rail. Due to the circuitry of the counter a much lower resistance will be measured, typically around 250 Ohms.

5.1.3 Inputs and Controls

With the multimeter still set to resistance, put the Black lead on ground and use the Red lead to check for shorts on the analogue inputs, the RF input and the control inputs.

This concludes the basic electrical checks, you are now ready to power up for the first time!

5.2 Powering Up

Set the LCD Contrast pot VR3 to mid range. This sets the appearance of the display. If on power up the display is blank, re-adjust this to set contrast.

5.2.1 Power

Connect a +12 volt supply to the +12v and Ground pins of PL1. Double check the polarity, take a deep breath and switch on. After a brief pause the start up message will appear displaying model number, software version and the Cumbria Designs copyright legend.

5.2.2 Initialisation and Message Checks

After a couple of seconds the unit becomes active and the start up message will be replaced with the normal display format. It should now be possible to change Tx/Rx and Mode Messages by grounding the pins given earlier in Tables 1 and 2.

If the IF Offset enable pin, PL3 pin 8, is grounded the display will show an IF offset of 9MHz – the factory default.

No Display? Try adjusting the contrast pot VR3. If there is still no display check for a 20MHz clock on a Receiver – See Trouble shooting section.

5.2.3 RF Checks

Connect a signal source between the RF input pin and ground, a grid dip oscillator loosely coupled to the input with a 2 or three turn loop of wire is ideal. (Note the comments in Section 3 regarding input impedance). The display will now show the frequency of the source.

Apply the default IF offset by grounding the IF offset pin PL3 pin 9, this will be added to the displayed frequency. If the IF Add/Sub pin is grounded the difference between the source frequency and the default IF offset will be displayed.

5.2.4 Analogue Checks

Set the AGC and Reference pots VR1 and VR2 to mid range. Apply a dc voltage of up to +12 v to the S1 and S2 inputs. Adjusting VR1 clockwise to increase the S1 input level will cause an increasing S-Meter bar graph to be displayed. Adjusting VR2 clockwise will cause the S-Meter bar graph to reduce. For the S-Meter to be displayed, the S1 voltage must always be greater than S2; S1>S2.

Grounding the Meter Mode pin, PL3 pin 5, will select the bar graph input (BAR) and change the bar graph format to a normal bar graph. Applying a voltage of 1.4V or greater to the BAR input will cause full scale reading.

This concludes the unit testing.

6 USER SET UP

6.1 Frequency Calibration

Before calibrating the frequency display, allow the temperature of the FD-01 to stabilise to that of the environment it will be used in.

Apply a signal of a few hundred millivolts, at known accurate frequency to the RF input. The display should now register a frequency close to the source frequency. With a non metallic trimming tool, adjust TC1 to bring the display frequency to the same value as the calibration source. The frequency calibration is now complete.

6.2 Set Up Mode

In Set Up mode, the default IF Offset and unity multiplier value can be overwritten by values to meet the needs of an end user application. **The set up buttons use control inputs 1, 11 and 12. For correct operation in set up mode, it is essential that these pins are not grounded by external switches. Either remove PL3 connector or set user controls such that these pins are all high (open).** To enter set up mode follow these simple steps;

- Ensure unit is powered off
- Power unit on
- When Version Message appears, press “Select”

The “USER SET UP” message will be displayed for a couple of seconds after which the unit goes into Offset Program Mode.

6.3 Offset Program Mode

There are two programmable offsets, A and B, selectable from the control connector. In program mode, “OFFSET A PROGRAM” is presented first and after being saved, “OFFSET B PROGRAM” is presented.

In Offset Program mode a steady cursor indicates that digit selection is active, a blinking cursor the digit change is active. This will become clear when setting a new offset value. Offset Program mode is entered with digit selection active and the cursor on the 10Hz value. The Up/Down buttons step the cursor sideways through the decades. Once the cursor has been placed upon a decade to be changed, briefly pressing the Select button enables digit change, indicated by a blinking cursor. The Up/Down button now increment or decrement the decade. In this way the new offset value is set up on the display.

To save the new offset value press and hold the Select button for 2 seconds. Once both offsets have been programmed the set up menu will now change to Multiplier set up.

6.4 Multiplier Set Up

This is an interesting feature allowing users to multiply the display frequency by an integer value. A typical application would be a VHF oscillator multiplier chain with an output frequency beyond the upper frequency limit of the unit. By measuring the source frequency and applying the multiplication factor we can display a frequency equivalent to the output frequency of the multiplier chain.

e.g. in a VHF transceiver;

Rx Oscillator 51.9MHz

Multiplier x3

Sub IF MHz10.7

Displayed Frequency 145MHz

This feature can also be used to correct the displayed frequency when the FD-01 is used with a fixed division prescaler.

There are two multiplier factors, A and B. These are selected by the Multiplier controls on PL3 pins 11 and 12.

6.4.1 Mult Factor Set Up

The message “MULT FACTOR” will be displayed on line 1 with the default value of x1 shown below. The Up/Down buttons allow the value to be stepped to any integer value between 1 and 99.

6.5 Hang Time Set Up

The Tx/Rx control line changes the format of the display. In Rx state, the display shows “Rx” and allows selection of S-Meter or plain Bar Graph meters. In Tx state, “Tx” is displayed and only the plain Bar Graph meter is available. The Tx/Rx control can be wired to other function such as Offset and/or Multiplier controls to correct the display value when used with transceivers having different Tx/Rx IF’s. For use in CW “break-in” applications, where the Tx/Rx transitions are very fast, a small delay is built in to hold the Tx configuration briefly during Tx to Rx transitions. This in turn holds the format of frequency display in the Tx state during short transitions to Rx, avoiding display disturbances. The delay is called “Hang Time” and can be user defined in steps of approximately 100mSec from 100 to 1500mSec.

To adjust Hang Time, step through the Set Up screens until the “Tx>Rx HANG TIME” screen is reached. The delay can be increased or decreased using the Up/Down buttons

Once the desired value has been set, holding the Select button down for 2 seconds saves the new user set up values to EEPROM. The “SAVED” message is displayed and after a couple of seconds the FD-01 restarts, loading in the new values.

7 Use

7.1 Installation

The FD-01 is designed to be a multi purpose instrument. It can be mounted inside a transceiver or used as a versatile stand alone frequency counter. If it is decided to install the FD-01 in its own case for stand alone use, the control buttons can be extended to the front panel from PL3. No modification of the circuit board is necessary. Refer to the circuit diagram for wiring details.

Four 2.54 mm mounting holes, with tinned surfaces, are provided on the FD-01 to allow easy installation into an enclosure or host equipment. The tinned area around each hole is isolated from ground. A grounded, through plated pad is provided alongside each mounting hole to allow the user to selectively apply grounding to each mounting screw. The FD-01 ground may be extended to the host equipment ground by using metallic mounting screws with small solder tags wired to the ground pads. This approach provides the user with full control of the grounding system to overcome earth loops or noise problems.

Note that the mounting holes on LCD Display Module are generally not isolated. To preserve the integrity of the chosen FD-01 grounding approach, it may be necessary to mount the display using insulated stand offs or nylon screws.

7.2 RF Input

As described earlier, the RF input presents a high impedance (~ 2M2) at low and MF frequencies. This will allow direct, low capacitance cable connection, to a signal source with minimal loading. At these frequencies an RMS drive level of a few tens of millivolts should be adequate to allow reliable frequency measurement.

At higher frequencies, the input capacitance of the JFET causes the input impedance to fall to typically several hundred Ohms at 100MHz. To avoid undesirable loading on the source, this reduced impedance must be accounted for with a buffer stage or impedance matching. At the upper VHF measurement range a drive level of about 1volt RMS will be necessary to support reliable operation.

7.3 Analogue Inputs

Three analogue inputs and a ground connection are available on PL2. Two inputs are used for the S-Meter display, the third for a linear bar graph for applications such as TX power output etc.

Whilst the S-Meter input level pots are capable of carrying higher voltages it is strongly recommended that the S-Meter inputs are not operated at more than +12 volts. All analogue inputs must not be taken negative with respect to the FD-01 ground.

The linear bar graph input is the easiest to apply. An external voltage is applied to the input and the level is adjusted by an external pot or voltage divider, to a offer a range of 0 - 1.4 volts. This will result in full scale deflection. **The linear bar graph input voltage must not exceed 12 volts.**

To understand how to use the S-Meter inputs we must first consider how a typical AGC voltage behaves.

7.3.1 AGC Voltage

A receiver's AGC voltage has two fundamental properties; we will call them the *threshold voltage* and the *dynamic voltage*.

The threshold voltage is the 'no signal' voltage of the AGC line. This is usually set within the receiver, to a level just before the onset of AGC action. Depending upon the design of the IF stage, this may be at level of several volts.

The dynamic AGC voltage is the range of voltage over which the gain of IF stage will change. Once again, depending upon design this can span a range of several volts. Note also that with some IF amplifiers an increasing (more positive) AGC voltage reduces gain whilst in others a negative going (below the threshold) voltage reduces gain.

To provide a reading starting at zero, an S-Meter circuit must be able to remove any threshold level from the AGC voltage such that only the dynamic AGC voltage is displayed. A typical S-Meter circuit that does this is shown in fig. 1.

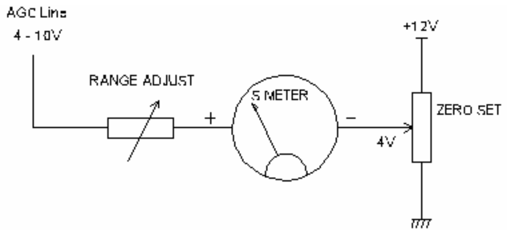


Fig.1 Typical +ve going AGC S-Meter

This shows an S-Meter configured for a positive going AGC voltage with a threshold voltage of 4 volts and a dynamic AGC voltage range of 4 to 10 volts. The zero set pot needs to be adjusted to give 4 volts on the –ve side of the meter for it to read zero with an AGC voltage of 4 volts on the +ve side of the meter.

Consider now an AGC system that employs a negative going AGC voltage to reduce IF gain. This might typically be found in MOSFET or bipolar IF designs. The diagram is very similar to the +ve going S-Meter, except that the polarities are reversed.

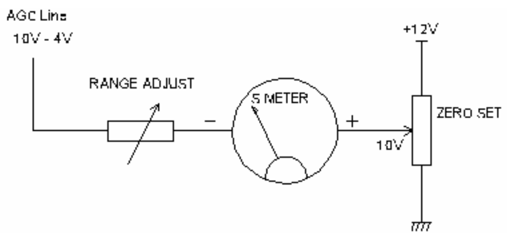


Fig.2 Negative going S-Meter circuit

In this version maximum IF gain (least AGC attenuation) occurs at +10v, therefore the zero set pot must be set to give +10v at the +ve side of the meter to balance out the AGC voltage. As the AGC voltage reduces, in turn reducing IF gain, the voltage across the S-Meter increases causing the meter needle to move.

The FD-01 can replace the meter in both of the circuits shown. The value of the dynamic AGC value is achieved by sampling the AGC level and the threshold voltage and mathematically calculating the difference. The difference is displayed as an 'S-Unit' bar graph and assumes that the AGC law of the receiver is log-linear. For the S-Meter to function correctly, the S1 voltage must always be greater than the S2 voltage. The displayed value is directly proportional to the difference between the S1 and S2 voltages. Each S-Unit corresponds to 6 steps of the 16F877 Analogue to Digital Converter (ADC) allowing calibration of 6dB per S-Unit, S9+50dB = S1-S2 = 2.4V minmum.

7.3.2 AGC Connections (Positive going AGC)

The AGC Reference input S2, is either connected to a point in the AGC circuit where the threshold voltage is defined (this could conveniently be the S-Meter circuit) or to an external potential divider that can be adjusted to the same level as the threshold voltage.

The AGC Input line S1, is connected to the receivers' AGC line. Adjusting VR1 and VR2 sets the range of the Reference and Input voltage. These two pots allow the user to zero the S-Meter display under 'no signal' conditions and set the Full Scale Defection against a known input signal level.

7.3.3 AGC Connections (Negative going AGC)

For negative going AGC schemes the AGC Reference and AGC Input connections are reversed. S1 becomes the reference input and S2 the AGC line input.

7.3.4 LCD Backlight

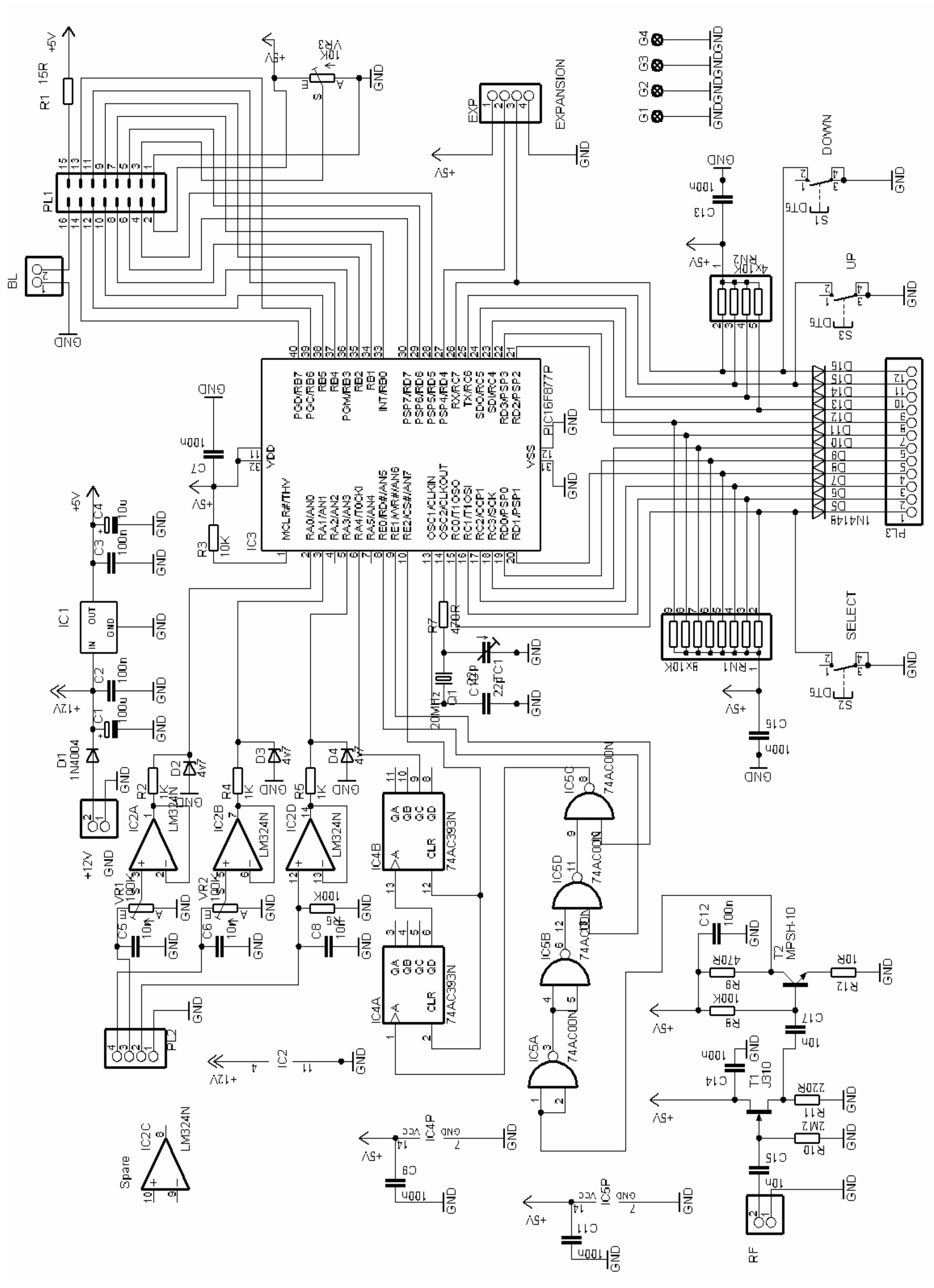
The "BL" pads are provided to give users the option to either permanently enable the back light (by soldering a wire link between the two pads) or to extend control to a front panel switch to save power in battery operated equipment. By linking the two "BL" pads on the main PCB, the circuit is completed illuminating the LCD.

A value of 15 Ohms was chosen for R1 to provide sufficient brightness for reading the display in dim or dark conditions without drawing excessive current. This keeps the regulator at a comfortable temperature and conserves power – useful for for battery operation.

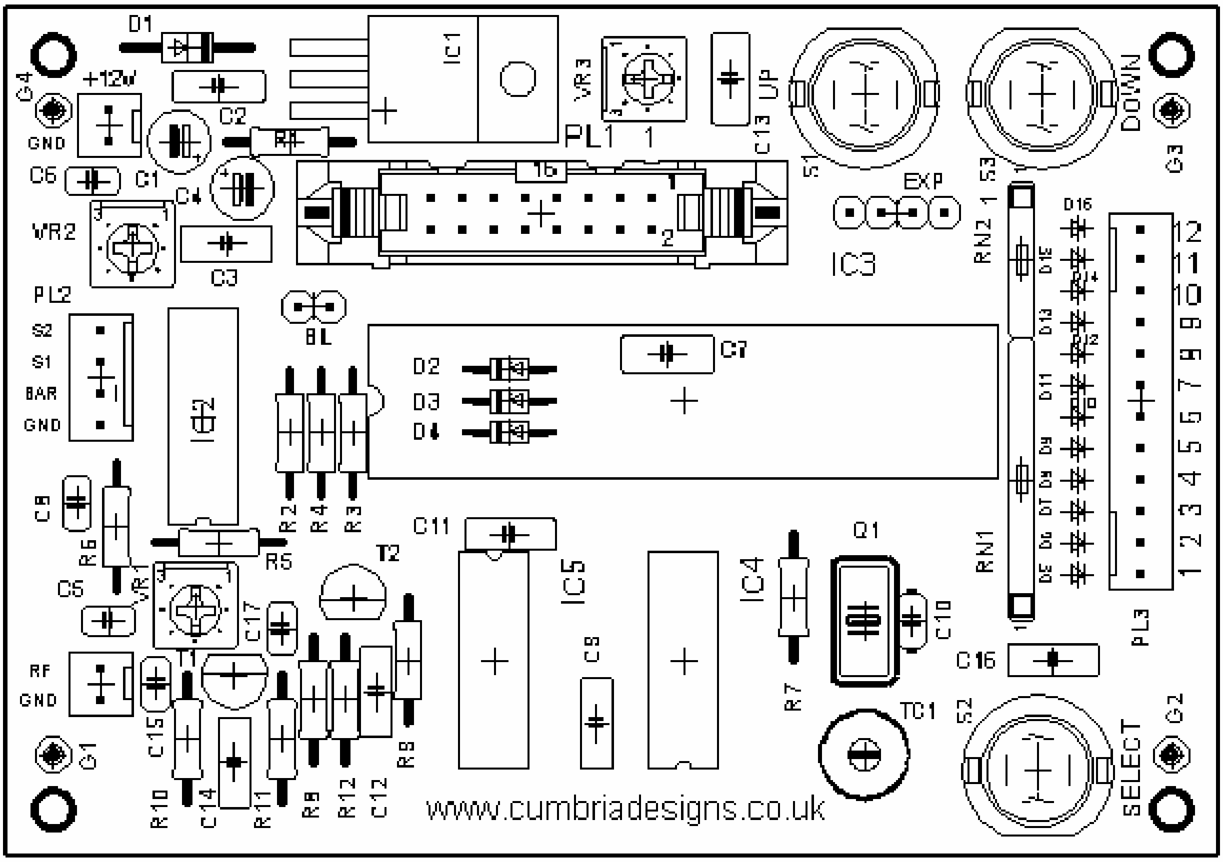
The backlight is capable of being run at a much higher current to produce more light by reducing the value of R1. However, we recommend a lower limit for R1 of 10 Ohms. At this value, some form of heatsink should be fitted to the regulator to keep the operating temperature to an acceptable level.

NOTES

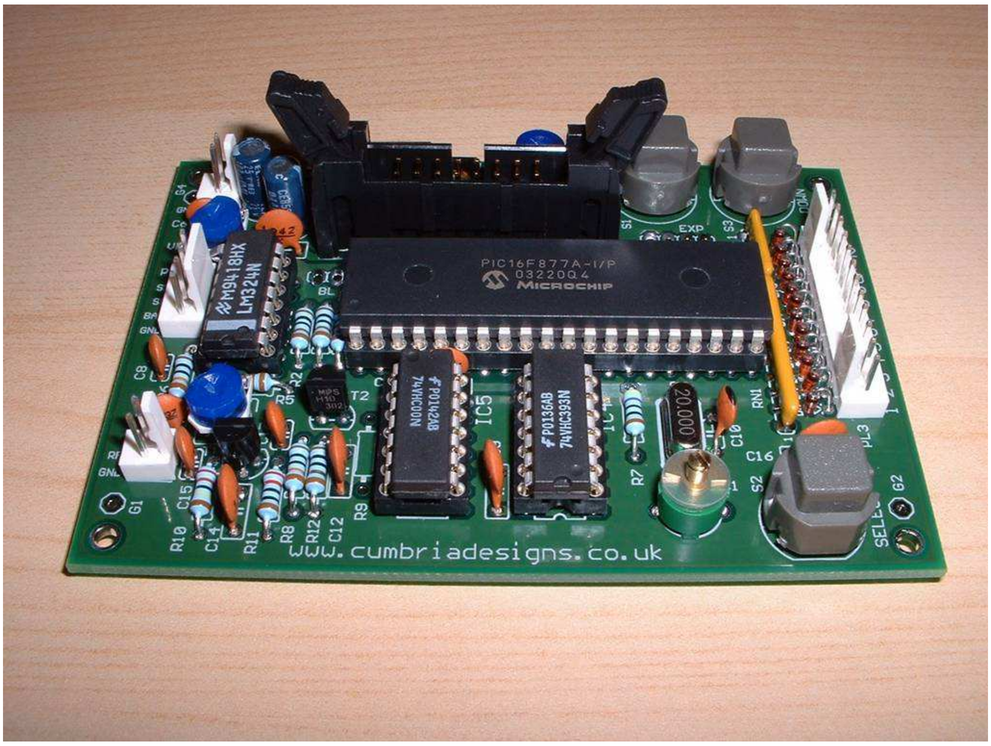
FD-01 Schematic



FD-01 Component Overlay



The Assembled Main Board



FD-01 PARTS LIST

Qty Value Parts

Connectors and Switches

1	16 Way Connector		PL1
2	Pin Header 1x2		Power, RF
2	1x2 Shells		Power, RF
1	Pin Header 1x4		PL2
1	1x4 Shell		PL2
1	Pin Header 1x12		PL3
1	1x12 Shell		PL3
20	Connector Pins		
1	40 Way DIP IC Socket		IC3
3	14 Way DIP IC Socket		IC2,IC4,IC5
3	DT6 Push Switch		S1, S2, S3

Resistors

1	15R	Metal Film 0.4W	R1
3	1K	Metal Film 0.25W	R2, R4, R5
1	10K	Metal Film 0.25W	R3
2	100K	Metal Film 0.25W	R6, R8
2	470R	Metal Film 0.25W	R7, R9
1	2M2	Metal Film 0.25W	R10
1	220R	Metal Film 0.25W	R11
1	10R	Metal Film 0.25W	R12
1	8x10K	SIL Network	RN1
1	4x10K	SIL Network	RN2
2	100K	Trimpot	VR1, VR2
1	10K	Trimpot	VR3

Capacitors

1	100uF	Electrolytic	C1
1	10uF	Electrolytic	C4
9	100nF	Ceramic	C2,C3,C7,C9,C11,C12,C13,C14,C16
5	10nF	Ceramic	C5,C6,C8,C15,C17
1	22pF	Ceramic	C10
1	22pF	Trimmer	TC1

Crystal

1	20MHz	HC18U-V	Q1

Semiconductors

1	1N4004		D1
3	BZX55 4v7		D2,D3,D4
12	1N4148		D5,D6,D7,D8,D9,D10,D11,D12,D13, D14,D15,D16
1	J310		T1
1	MPSH-10		T2
1	LM7805		IC1
1	LM324N		IC2
1	PIC16F877P		IC3
1	74AC393N		IC4
1	74AC00N		IC5
1	16x2 BL LCD Module		LCD

Appendix A

Troubleshooting

The following checks may help in identifying the cause of operational problems.

Area	Symptoms	Actions
Power	Power applied but unit doesn't work. Little or no current drawn.	Supply checks Check Power Supply polarity. Check +12V on Regulator. Check Regulator Ground continuity Check D1 continuity Check +5v on all logic devices, LCD and input circuit. Regulator functioning?
LCD	LCD Blank	Turn contrast pot VR3 fully clockwise. No Change, check LCD Power and ground connections. Single line of Blocks appears - LCD self initialising. Check continuity of all data and control lines between processor pins and LCD pins. Check processor clock is running by listening for 20MHz signal on a general coverage receiver. Check clock circuit continuity. Double row of blocks appears – LCD communicating to processor and initialising under processor control. Processor waiting for gate circuit signal. Check pin to pin continuity of processor controls to IC4 and IC5, check continuity of IC4 output to processor.
No Count	Display OK and annunciators working but with an in range input signal frequency is zero.	Input circuit fault. Check T1 and T2 bias voltages. Use an oscilloscope to check continuity of signal path to IC5. Look for dry joints.
Erratic Operation	Annunciators and operating mode are erratic.	Check that +5v appears across all pins on resistor networks RN1 and RN2. Check for correct orientation of RN1 and RN2. With meter set to Diode Check, test pin to pin continuity from processor inputs to PL3.