

# Microcode

## Morse Code Reader

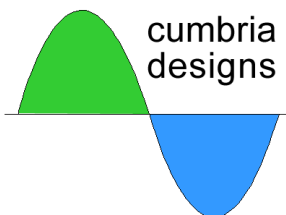
### User Manual

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[www.cumbriadesigns.co.uk](http://www.cumbriadesigns.co.uk)

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# 1 Introduction

Thank you for purchasing the Cumbria Designs Microcode kit. We hope that you enjoy constructing and using your new Microcode Morse Reader. This manual describes the assembly and operation of the Microcode kit, even if you are a seasoned constructor, please read this manual and familiarise yourself with the instructions and kit contents before commencing soldering. If assembled carefully, this unit will provide many years of reliable service.

*The Cumbria Designs Team*

## 2 Preparation

### 2.1 Tools

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

25W fine tipped soldering

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 careful component handling, careful 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 assembly notes carry 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 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

Before applying solder check **carefully that the component you have placed is in the right position!** This is a through plated double sided board. Whilst some of the pads are very small, the area presented by the through plating is more than adequate to allow good solder flow to form mechanically strong good electrical joints. However, these can be difficult to undo, so please double check placement!

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 as 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 Microcode is a micro-controller based Morse Code reader that accepts audio or key inputs. There are two audio inputs; an internal electret microphone for acoustic coupling to a loudspeaker and a line input for accepting a direct electrical connection. Both of the audio inputs are processed by a PLL tone decoder to produce a logic level keyed input to the processor. The key input is directly connected to one of the processor inputs. The input source and display format are selected through the setup menu, this controls the input signal flow to the processor and tells the processor how to present information on the LCD.

### 3.2 Theory of Operation

Audio from the electret Microphone is filter and amplified by IC1 and then passed to the PLL tone detector IC2 for conversion to logic level keyed states. The simple input filter provides some rejection of unwanted ambient noise picked up by the microphone. The filter centre frequency is tuned by VR2. An audio tone falling within the capture range of the PLL causes the PLL output to go low. The detection frequency of the PLL is set by VR1. This is adjusted to the mid range of the preferred audio frequency of the incoming Morse Code. The bandwidth of the PLL is very narrow, offering

good unwanted signal rejection and a degree of resilience against noise. The logic output levels of the decoded Morse Code are passed to the processor where digital filtering is applied to greatly enhance immunity to noise. The processor measures the duration of the detected Morse Code elements and by comparing each element duration against a running reference, determines whether the signal represents a dot or a dash. Each character is built up from a series of dot and dash signals to form a binary address which, when an end of character state is detected, is used to address a table holding corresponding ASCII characters. The ASCII text is passed to the LCD for display. The Key input allows a Morse key to be connected to the Microcode for training purposes. In Key mode the Audio stages are disabled. The Key should be a “volts free” device, i.e. a direct contact such as a high speed

relay, an NPN transistor open collector or N channel FET drain. A 10K pull up resistor holds the key input to the processor high at 5v whilst the key is in the open state. When the key is operated, the input is pulled low to ground representing a “key down” state.

The speed of the incoming Morse is calculated from the running reference value. This provides the speed in Words per Minute (WPM) based upon a standard 50 element word (PARIS) and the average element duration. The speed reflects the equivalent speed that the element duration would yield. Be aware that badly sent Morse or Farnsworth style sending with long durations between characters will produce a WPM display not representative of the actual character speed.

## 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.

**NOTE: The switches, LED and LCD are mounted on the underside of the board.**

### 4.1 *Fixed Resistors (Broad tolerance band shown in capitals)*

15R	R1	Brown, Green, Black, (GOLD)
100R	R2	Brown, Black, Black, Black, (BROWN)
470R	R10, R20	Yellow, Mauve, Black, Black, (BROWN)
1K	R5	Brown, Black, Black, Brown, (BROWN)
2K2	R11	Red, Red, Black, Brown, (BROWN)
4K7	R6	Yellow, Mauve, Black, Brown (BROWN)
10K	R3, R4, R7, R12, R14, R17, R18, R19	Brown, Black, Black, Red, (BROWN) (RED)
47K	R13	Yellow, Mauve, Black, Red, (BROWN)
100K	R8, R9, R15	Brown, Black, Black, Orange, (BROWN)
220K	R16	Red, Red, Black, Orange, (BROWN)

### 4.2 *Diodes*



Fit the two 1N4148 level clipping diodes D1 and D2 noting orientation.

### 4.3 IC Sockets



Ensure correct orientation! Match index cut out on socket to board printing. Tip; solder one pin only then check positioning before continuing. Heat solder and reposition if necessary.

- a) Fit the 18 pin microcontroller socket for IC3
- b) Fit 8 pin sockets for IC2, IC4

### 4.4 SIL Resistor RN1



The orientation of the 10K SIL resistor is critical. Install with the text side of the SIL package facing Q2/Q3. The spot marking pin 1 will be adjacent to C7.

### 4.5 Crystal

Fit X1, the 20MHz crystal. This is temperature sensitive and may easily be 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.

### 4.6 Ceramic Dipped Capacitors

Three 10% tolerance 10nF ceramic dipped capacitors are provided for use in the audio filter and the PLL oscillator. For correct operation of the analogue stages it is important to use these, not standard ceramics, in the positions shown. The dipped ceramic capacitors are easily identified; they have a small rectangular body, have a shiny yellow coating (similar to the SIL resistor) and are marked with their value "103K" =10nF, "104K" =100nF, in very small text.

10nF	C15, C19	103K
100nF	C4	104K

### 4.7 Ceramic Disk Capacitors

Standard brown body disk ceramics are used for general circuit decoupling. Suggested Installation order;

22pF	C10, C11	22J
10nF	C21	103Z
100nF	C1, C2, C3, C7, C13, C14, C16, C17, C20, C22	104

### 4.8 Transistors



Polarity conscious components, ensure that orientation is correct. The 2N7000 is a Static sensitive part. Discharge yourself to ground before handling. Avoid wearing static generating clothing (e.g. wool, man made fibres etc) during assembly.



- a.) Fit Bipolar transistor Q1      2N3906
- b.) Fit FET Q2                      2N7000
- c.) Fit FET Q3                      2N7000

### 4.9 Regulator



Polarity conscious component, ensure that orientation is correct. Carefully bend leads through 90 degrees to allow regulator to lie flat on the board aligned to the mounting which is provided to mount an optional heat sink should the Microcode be used at voltages above 14V.

Fit 5V regulator IC1      MC7805CT

#### 4.10 Variable Cermet Resistors

The pre-formed leads will require to be straightened to fit. Remove the corrugations by gently compressing each lead with a pair of small pliers.

- |    |                                  |     |     |
|----|----------------------------------|-----|-----|
| a) | Fit the 10K PLL tuning Cermet    | VR1 | 103 |
| b) | Fit the 10K LCD Contrast Cermet  | VR2 | 103 |
| c) | Fit the 10K Filter tuning Cermet | VR3 | 103 |
| d) | Fit the 10K Line Input Cermet    | VR4 | 103 |

#### 4.11 Electrolytic Capacitors



Polarised Capacitors, observe the polarity shown by the silk screen.

100uF    C6, C8, C9, C18

#### 4.12 Polystyrene Capacitors

Rectangular body, no polarity.

- |    |         |        |
|----|---------|--------|
| a) | Fit C5  | 0.47uF |
| b) | Fit C12 | 1.0uF  |

#### 4.13 Connectors

Recommended Pin Header Connector orientation is with rear locking tab facing into the centre of the board.

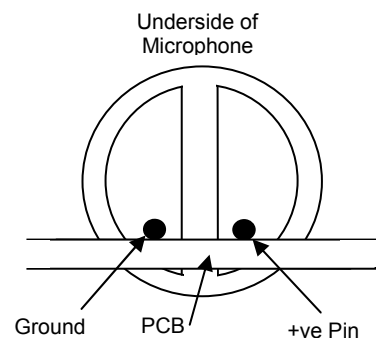
Fit the three two pin headers; +12V, LINE, KEY

#### 4.14 Microphone - Underside Component!



Polarity conscious part!

Solder the electret microphone pins flat onto the two large pads on the underside of the PCB. The microphone is at 90 degrees to the PCB and is butted up against the PCB edge with it's +ve pin soldered to the pad nearest to the centre line of the PCB, adjacent to VR3.



#### 4.15 Switches – Underside Components!

Mount the two menu control switches on the underside of the PCB. Orientation is set by the switch pin and PCB hole spacings. The switch top body retaining clips will face across the PCB.

#### 4.16 Switch Buttons

Press the two black buttons onto the switch shafts.

#### 4.17 LED – Underside Component!

The red tuning LED is mounted on the underside of the PCB between the two switches. The LED is inserted with the longer anode lead towards the outer edge of the PCB, through the pad with the track leading to R11. Adjust the height of the LED to position it so that it is similar to the switch buttons. This will allow it to mate up to an enclosure panel.

#### 4.18 LCD Module – Underside Component!

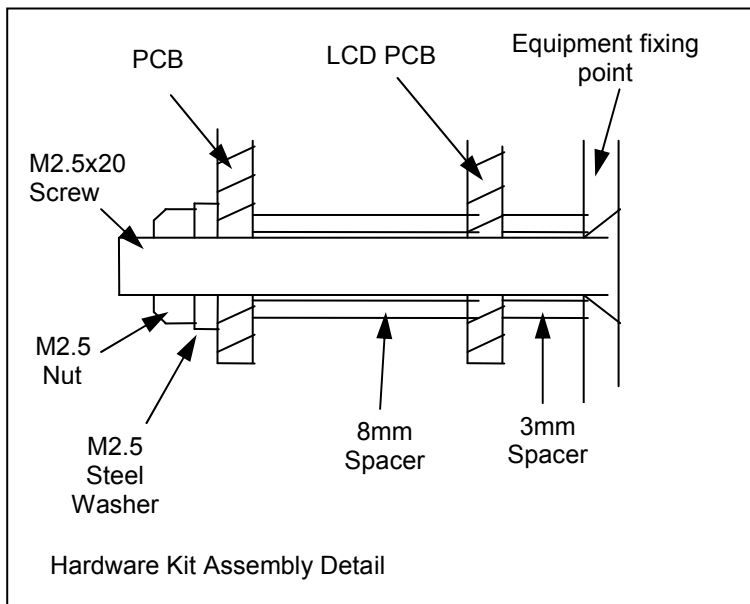


Static sensitive parts. Discharge yourself to ground before handling. Avoid wearing static generating clothing (e.g. wool, man made fibres etc) during assembly.



The LCD is connected to the board by the 16 way SIL connector. To ensure correct alignment the following procedure is recommended;

- a) Place LCD face down on a flat surface, insert the broad pins of the SIL pin strip into the 16 Way LCD terminal. **Do not solder at this stage.**
- b) Plug the 16 way SIL socket fully home onto the exposed narrow pins of the SIL pin strip.
- c) Locate the assembled Microcode PCB onto the pins of the 16 way SIL socket.
- d) Fit the four 8mm spacers between the two PCB's at each corner.
- e) Place a 3mm spacer onto each M2.5 screw and pass through each mounting hole and 8mm spacer from the front of the LCD. Secure on the top side of the main PCB by first fitting an M2.5 steel washer and an M2.5 nut. (See final assembly picture for detail)
- f) Once the LCD and main PCB are correctly adjusted for alignment, carefully solder the SIL connectors on the LCD and main PCB.



The countersunk head of the mounting screws are presented at the front of the LCD to support the mounting of the complete assembly to countersunk mounting holes within the chosen enclosure. The short nylon spacers provide clearance between the top side tracks of the LCD module and the rear of the mounting surface. The LCD header pins should be checked for clearance and if necessary trimmed to prevent contact with the

underside of the enclosure surface.

#### 4.19 Integrated Circuits



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 IC pins which will need to be gently formed for correct alignment before insertion into sockets. IC pins 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 to check pin alignment.

Fit	IC4	NE5532	Dual Op Amp
Fit	IC2	LM567	PLL Tone decoder
Fit	IC3	PIC16F628	Processor (18 pin DIL)

#### **4.20 Connector Assemblies**

Connector shells and pins are supplied to allow connection of power and signal lines to the Microcode. 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 a pair of pointed nose pliers. The pin will be released and can be pulled out of the shell.

**Assembly complete, well done! Now carefully check your assembly and soldering work before moving on to testing.**

## **5 TESTING**

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

### **5.1 Electrical Tests**

#### **5.1.1 +12 Volt Input**

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 may show change, providing there is not a short circuit then all is well.

#### **5.1.2 +5 Volt Rail**

Carry out the resistance test on the output side of the regulator (IC1) to check the the +5 volt rail ensuring that it is clear of shorts to ground.

#### **5.1.3 Powering Up**

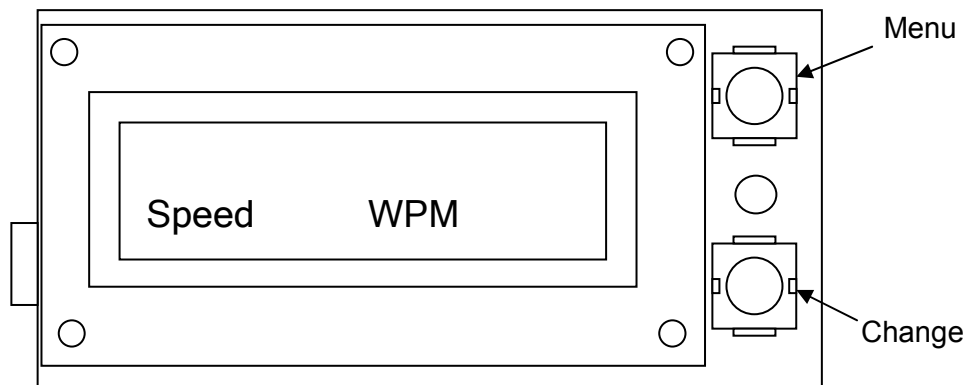
Turn VR2 (LCD Contrast) fully anticlockwise. With no controls set, connect a +12 volt supply to the Microcode. Double check the polarity, take a deep breath and switch on. After a brief delay whilst the processor and LCD initialise, the LCD will display the Cumbria Designs copyright message for about two seconds and then change to show a single line text format with speed in WPM on the second line.



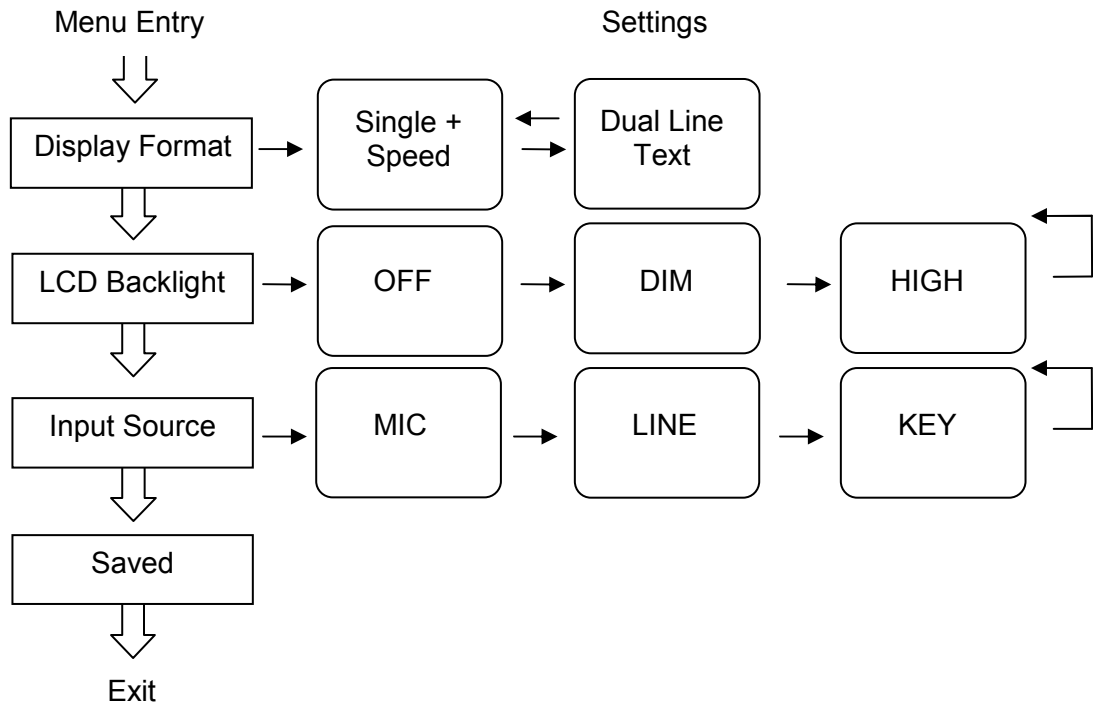
## 6 SET UP AND OPERATION

### 6.1 Configuration

The Microcode is easily configured at any time during normal operation using the two front panel push buttons; "Menu" and "Change". With the unit powered up and showing the normal receive display state, press and release the MENU button. The first menu option will be displayed. With each subsequent push and release of the MENU button, the display will step through each menu option until "Saved" is reached at which point all settings are applied and stored in EEPROM for the next time the Microcode is used. To change a displayed setting, press and release the CHANGE button.



With each operation of the CHANGE button the settings under a menu option will be displayed. Once the required setting is displayed pressing the MENU button will record the setting and move onto the next menu option. The available menu options and their settings are illustrated below.



*Configuration Menu and Settings*

## 6.2 Configuration Settings

### 6.2.1 Display Format

- a.) **Single + Speed** Received text is displayed on Line 1 with the equivalent speed in words per minute (WPM) shown on line 2.
- b.) **Dual Line Text** Received text is written to Line 1 and wraps round onto Line 2. There is no speed display with this format.

### 6.2.2 LCD Backlight

- a.) **OFF** The LCD Backlight is switched off. In this mode the supply current is reduced considerably, a useful feature for battery operation.
- b.) **DIM** The LCD Backlight operates at half brightness. Suitable for most ambient lighting conditions.
- c.) **FULL** The LCD Backlight is running at full brightness.

### 6.2.3 Input Source

- a.) **MIC** The internal microphone, filter and preamplifier are enabled. In this mode the Microcode will detect and decode audio Morse signals from a receiver loudspeaker or practise oscillator.
- b.) **LINE** The internal microphone filter and preamplifier are switched off. The Microcode will detect and decode audio Morse signals on it's LINE input socket from a compatible source such as a receiver's speaker terminals or headphone or line output socket. The Line input level can be adjusted using VR4.
- c.) **KEY** All audio stages are switched off and the Microcode input is taken from the KEY socket. In this mode a voltage free keying source such as a Morse Key, relay or open collector NPN transistor or open drain N channel FET can be used to drive the Microcode. A 10K pull up resistor provides the bias for this input.

### 6.2.4 Saved

On completion of any configurations changes, the "Saved" message will be displayed briefly before the Microcode undergoes a warm restart and applies the new settings. The new settings are saved to EEPROM and will be recalled each time the Microcode is switched on until further changes are made.

## 6.3 Filter and PLL Tuning

To allow the Microcode to be able to detect and decode audio Morse signals the Phase Locked Loop (PLL) and Active Filter must be carefully tuned to the preferred audio frequency. An easy technique is use an HF receiver in SSB/CW mode tuned to a strong AM station to produce a loud heterodyne;

- a.) Adjust the receiver tuning until the note of the heterodyne is at your preferred frequency for receiving Morse, this will be normally be around 800Hz.
- b.) With the Microcode configured for MIC operation, place it near the receiver's loudspeaker and carefully adjust VR1 until the LED illuminates indicating that the PLL has locked to the incoming tone.

- c.) Reduce the receiver's volume or move the Microcode away from the loudspeaker until the LED *just* goes out. Adjust VR3 to peak the input filter so that the LED illuminates again. Tune around the detection point and set VR3 mid range of the illuminated zone. Repeat step (c) until the position of VR3 is optimised.

## **6.4 Operation**

### **6.4.1 Microphone Input**

Select MIC as the input source. Place the Microcode in a convenient position near to the receiver's loudspeaker. Carefully tune the receiver onto a Morse signal observing the Microcode's signal LED which will illuminate when the frequency of the audio Morse tone falls within the PLL capture range. Adjust the receiver tuning to obtain a bright LED that flashes in sympathy with the incoming Morse. After a character or two the Microcode software will synchronise with the Morse and begin displaying text.

### **6.4.2 Line Input**

Select LINE as the input source. With the Microcode connected to the receiver's line, headphones or speaker output, tune the receiver as described above to obtain a clean bright LED pattern. If using a headphone or speaker output, the receiver's AF gain control will set the level of the signal input to the Microcode, additionally the Microcode's Line Input pot will also provide control over the audio signal input level. Adjust the receiver for normal operating volume and then adjust the Microcode's Input level pot for reliable operation.

### **6.4.3 Key Input**

Select KEY as the input source. With the contacts of a Morse key connected across the KEY input, the signal LED will illuminate when the key is down (contacts closed) and extinguish when the key is up (contacts open). The audio stages will be switched off preventing interference from any ambient noise.

## **6.5 Operating Tips**

The following points will help you to get the best performance from your Microcode;

### **Audio Input Modes**

- Ensure that a stable SSB/CW receiver is used to prevent the frequency of the Morse from drifting outside the PLL detection range.
- Adjust the receiver's audio output to avoid false triggering of the Microcode's LED by no signal noise.
- In MIC mode, avoid noisy locations where background noise may cause false triggering. For example if operating portable outdoors, wind noise across the microphone may cause false detection, better to use the LINE input.

### **Key Input**

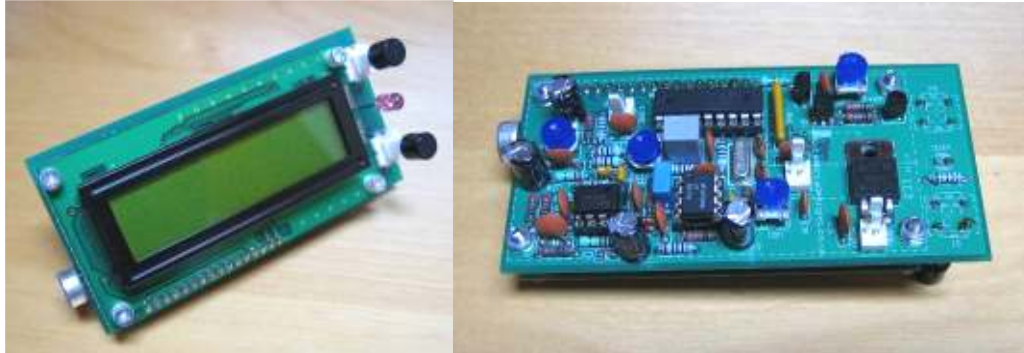
- Ensure that the Key contacts present a low resistance when closed and that the connections between the key and the Microcode are good.

- If your key causes “contact bounce” this may be interpreted as spurious characters associated with a very high WPM speed. Try placing a small capacitor across the key to clean up the keyed signal.

**Battery Operation**

If battery capacity is limited, operate the Microcode with the Backlight OFF or DIM to reduce the supply current.

**The Assembled Kit**

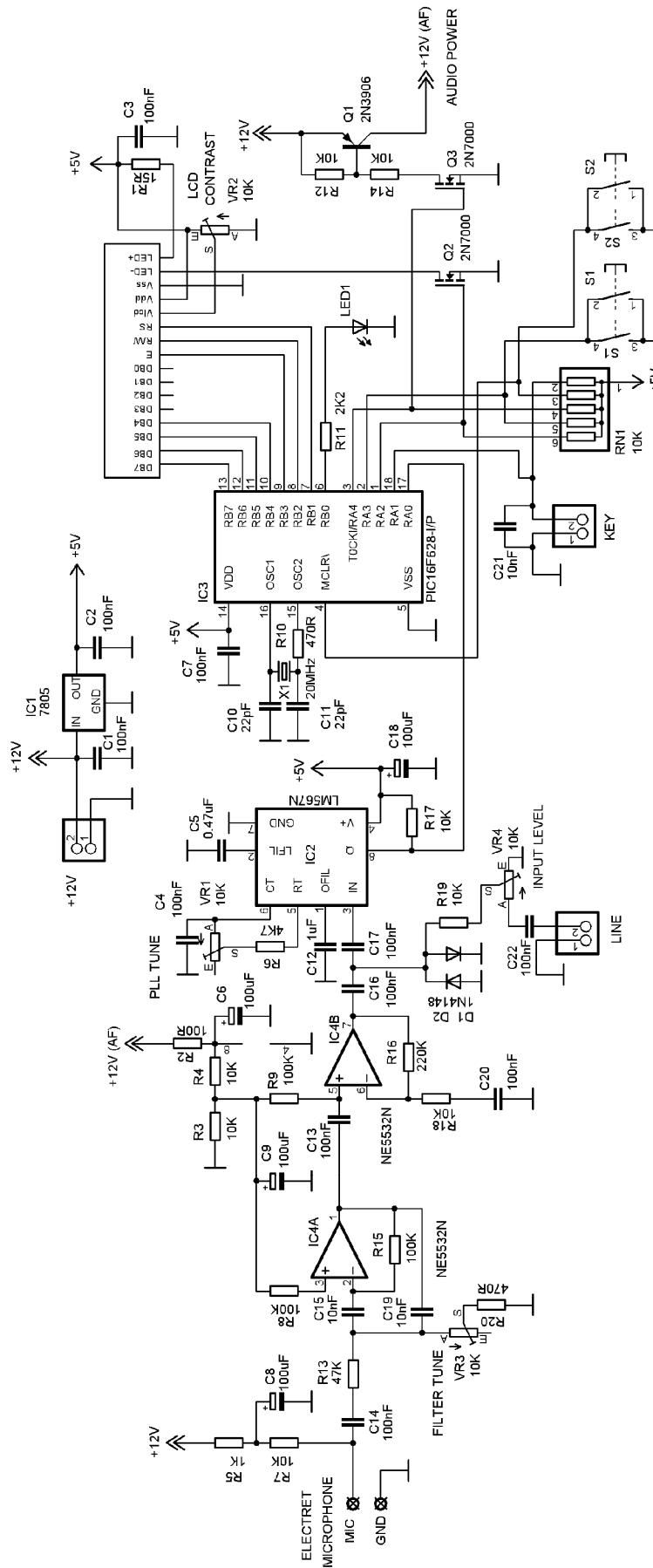


**Supported Code Set**

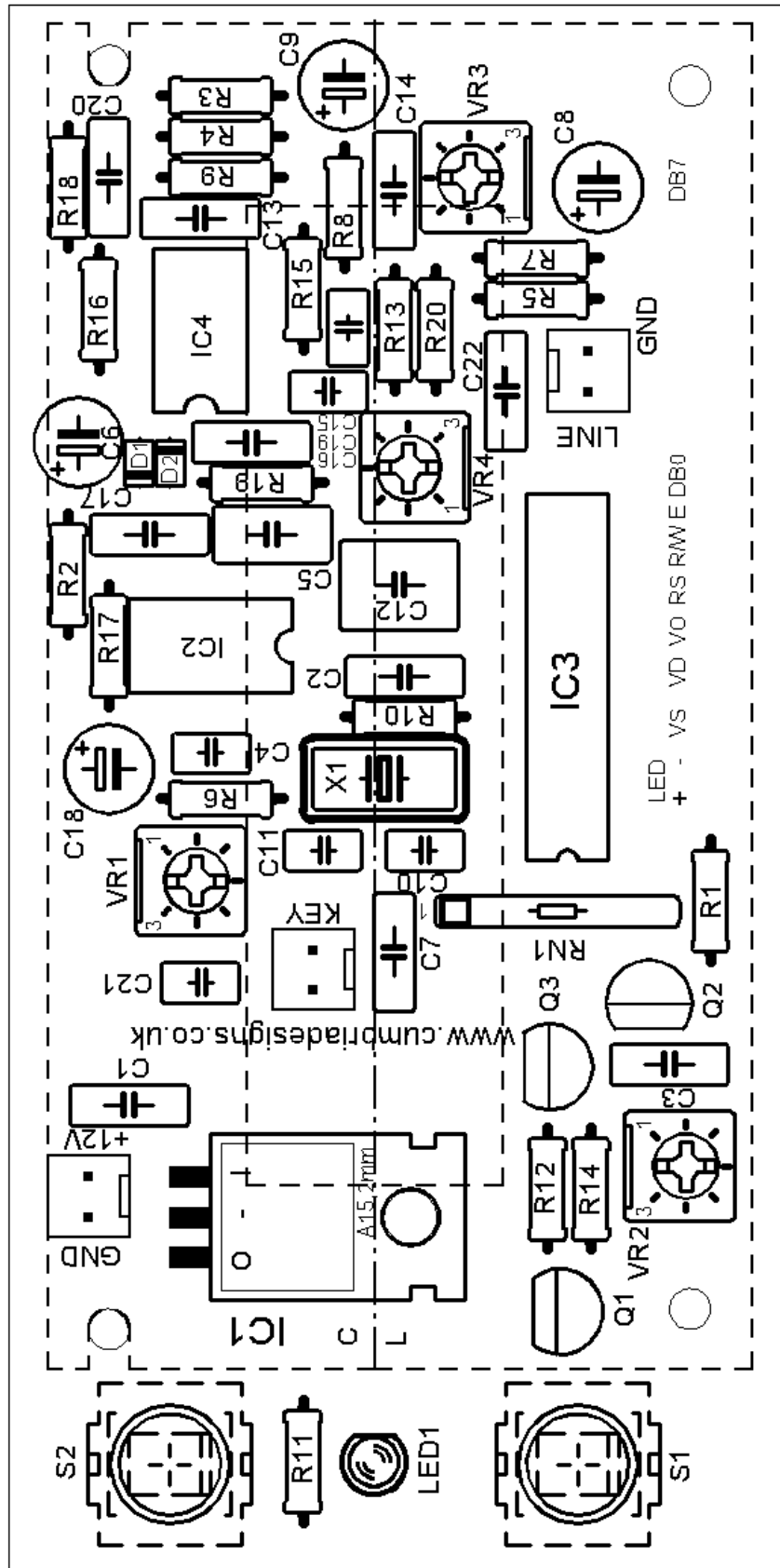
A	•-•	N	-••	0	-----
B	-•••	O	---•	1	•-----
C	-•-•	P	•-••	2	••-----
D	-••	Q	---••	3	•••-----
E	•••	R	•-••	4	••••-
F	••-•	S	•••	5	•••••
G	---•	T	-•••	6	-••••
H	••••	U	••-•	7	---•••
I	••	V	••••-	8	-----•
J	•-••	W	•-••	9	-----•
K	-•-•	X	-•••		
L	••••	Y	---••		
M	--••	Z	---••		
<b>Extensions</b>		<b>Symbols</b>			
ä	••-•	Underscore	••-••	;	-••••
ö	---•	+	••••	!	-•••-
ñ	---••	=	-•••-	)	-•••-
ü	••-••	/	-••••	,	---•••
e (é)	•••••	(	-••••	:	---•••
e (è)	••••-	?	•••••	\$	•••••-
a (à)	••••-	“	•••••	\	•••••
c (ç)	-••••	.	••••-	Blank	••••-
		@	•••••	Blank	-•••-
		-	-••••-	Blank	•••••

A decode outside of these definitions will be shown as an asterisk (\*).

# Appendix A Microcode Schematic



## Appendix B Microcode Component Overlay



## Appendix C MICROCODE VERSION 3.0 PARTS LIST

### Resistors

15R	R1	
100R	R2	
470R	R10, R20	
1K	R5	
2K2	R11	
4K7	R6	
10K	R3, R4, R7, R12, R14, R17, R18, R19	
47K	R13	
100K	R8, R9, R15	
220K	R16	
10K	SIL RESISTOR RN1	
10K	CERMET TRIMMER	VR1, VR2, VR3, VR4

### Capacitors

22pF	CERAMIC	C10, C11
10nF	CERAMIC	C21
10nF	CERAMIC DIPPED	C15, C19
100nF	CERAMIC DIPPED	C4
100nF	CERAMIC	C1, C2, C3, C7, C13, C14, C16, C17, C20, C22
0.47uF	POLY	C5
1uF	POLY	C12
100uF	ELECTROLYTIC	C6, C8, C9, C18

### Semiconductors

1N4148	D1, D2
LED3MM	LED1
2N3906	Q1
2N7000	Q2, Q3
MDLS16265	LCD
NE5532N	IC4
LM567N	IC2
7805	IC1
PIC16F628-I/P	IC3

### Connectors

Header 2 Way	+12V, KEY, LINE
Connector Shell 2 way	+12V, KEY, LINE
Push Switch	S1, S2
16 Way Socket Strip	
16 Way Pin Strip	

### IC Sockets

DIP 8 Way	IC2, IC4
DIP 18 Way	IC3

### Miscellaneous

20MHz Crystal	X1
Electret Microphone	MIC
PCB V3.0	

### Hardware Pack

M2.5x20 Screws	4
M2.5 Nuts	4
M2.5 Washers	4
Nylon Spacer 8mm	4
Nylon Spacer 3mm	4

## Appendix D Troubleshooting

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

Area	Symptoms	Actions
<b>LCD</b>	No Display	Turn VR2 (contrast) fully anticlockwise
	Display shows a single line of "blocks"	LCD not being initialised by processor. <ul style="list-style-type: none"> <li>• Check continuity of all control and data lines from processor pin to LCD pin.</li> <li>• Check supply voltage and ground connections on processor.</li> <li>• Check processor crystal circuitry, check operation with an oscilloscope or listen for 20MHz clock on a receiver.</li> </ul>
<b>Backlight</b>	Backlight does not operate.	Backlight LED circuit open or high resistance. <ul style="list-style-type: none"> <li>• Check continuity from +5v rail through R1 (15R) to LCD.</li> <li>• With Backlight set to HIGH, check that processor pin 1 and Q2 gate are at +5v. Q2 Drain should show a very low voltage ~ 0.5v or less.</li> </ul>
<b>Power</b>	Power applied but unit doesn't work. Little or no current drawn.	Check Power Supply polarity. Check +12V on inputs to Regulator. Check Regulator Ground continuity.
<b>Menu</b>	Menu operation not functioning correctly.	<ul style="list-style-type: none"> <li>• Check orientation of SIL resistor RN1.</li> <li>• Confirm that +5v is present on RN1 pin 1.</li> <li>• Check that switches are installed correctly and when operated S1 grounds processor pin 4 , S2 grounds processor pin 2.</li> </ul>
<b>LED</b>	Will not illuminate.	Check LED orientation. Check continuity from processor pin 6 via R11 to LED. Check LED ground.
	Responds to KEY input but not MIC or LINE audio inputs.	Audio stages not functioning. <ul style="list-style-type: none"> <li>• Check +5v supply to IC2 pin 4. Confirm ground to IC2.</li> <li>• With configuration set to MIC or LINE check for +12v nominal on IC4 pin 8. Confirm ground connection to IC4.</li> <li>• If no power to IC4 check processor pin 3 is high (+5v) and Q1 has 12v nominal on collector. If not examine placement and soldering of Q1 and Q3.</li> </ul>
	Responds to MIC and Line but not KEY input.	Processor not seeing ground condition during key down. <ul style="list-style-type: none"> <li>• Measure resistance of key contacts to confirm that they present a low resistance circuit on key down.</li> <li>• With key connected and in "up" state confirm that processor pin 18 is at +5v. If not examine RN1 pull up resistor orientation and supply.</li> </ul>

END