Mini-Kits® AD9850/51 DDS Experimenters Kit EME85F VERSION2.

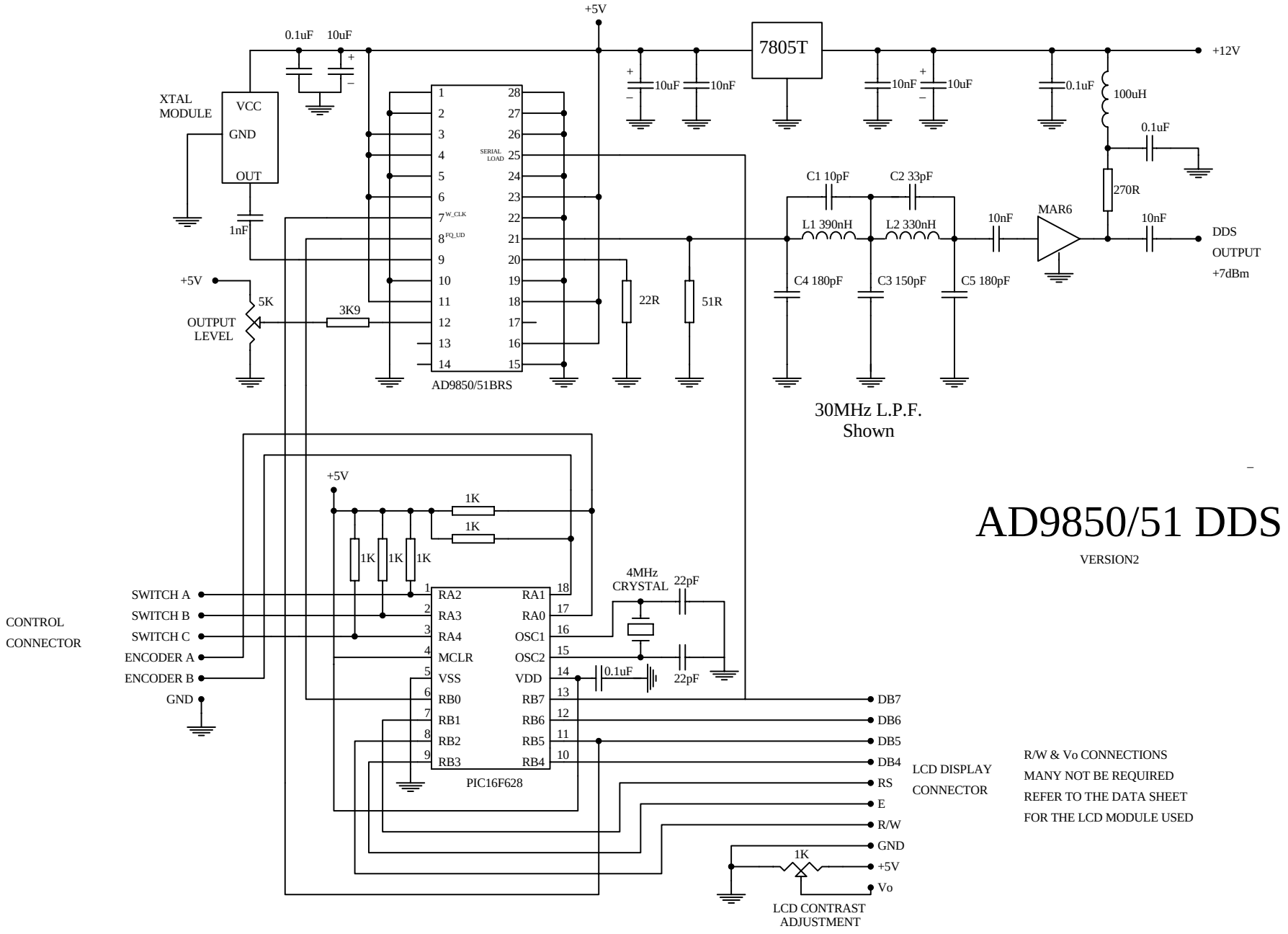
SPECIFICATIONS:	Frequency Range	0Hz – 60MHz **(AD9851)**
	Frequency Resolution	1Hz steps RF & Display Readout
	Frequency Steps	1Hz Low Rate (Variable Rate Tuning)
	Software	dd_synth_ver2.1 (Email Mini-Kits for Software)
	Output Low pass Filter	0 to 30MHz or 0 to 70MHz Elliptic
	RF Output	+7dBm, (5mW minimum), typically +9dBm
	Power	+12 to 13.8 volts (140mA excluding LCD Display)

DESCRIPTION: If you are building any of the DDS VFO Kits or SWEEP Kit then please refer to the additional notes for these Kits before reading this document. This document refers to the basic EME85 DDS Kit that uses the older version dd_synth_ver2.1 software & Basic Version 1 control circuit.

The Kit uses a preprogrammed PIC16F628 Micro controller to control a AD9850/51 DDS & a standard Hitachi 2 Line x 16 character LCD display module. The Software can be easily changed to allow the DDS to be used for many applications. The Kit is supplied with the AD9851 as it is only a few dollars more compared to the AD9850, which are both are pin compatible. The EME85F PC board is now the 6th generation that allows experimentation with the AD9850/51 DDS chips. The previous update EME85E has extra plated through holes & filtering capacitors to reduce DDS noise on the 5 volt power supply rail. The EME85F has the addition of a solder mask, & a 2 pin socket for the power connection. The Pre-programmed software in the PIC allows the AD9851 DDS to tune from 1Hz to 60MHz which could be used as an accurate signal generator, or as a local oscillator for a receiver or transmitter. This Kit is essentially for experimenters that are prepared to experiment with the design & software to make a DDS for their own application.

MICROCONTROLLER: The dd_synth_ver2.1 software allows the 16F628 to output data on pins 6, 11, & 13 to control the AD9850/51 IC, along with driving a standard 16x2 LCD display, monitoring inputs from function buttons, & the rotary encoder. A combination of Switch inputs A to C are pulled low via external diodes to control Step size, RIT, Calibrate, Repeater mode, & RX to TX switching. Some errors can occur if two buttons are pressed at the same time. Encoder A & B inputs are for a standard mechanical rotary encoder like the ALPs EC12E for tuning & Step size. Outputs on pins 7 to 13 are used to drive a standard Hitachi 2 line x 16 character LCD display module. Many different brands of 16x2 displays should work ok with this software. The software even allows displays without a R/W (Read/Write) connection to be used. An external 4MHz Crystal is used for the timing functions of the 16F628 Micro controller. All options & settings can now be made in a Calibration menu setup screen, so no reprogramming of the PIC16F628 is required to change anything. When in Calibration mode, the LCD Display is used as a Menu settings screen to change the user settings. Settings like frequency min & max, display multiplier, offset frequencies, & DDS clock frequency etc, can be made in this Menu. **An explanation on the operation of the DDS functions is explained in the readme file that can be downloaded from the http://www.minikits.com.au/eme85.htm webpage. The file does not include the HEX & ASM PIC software which is only available by email.**

AD9850/51 DDS IC: The chip incorporates many features that are not used in this design. Refer to the manufacturers Data Sheet & Technical Notes for further information. The chip can be loaded with serial or parallel data, serial is used in this Kit design. RF output from the DDS on pin 21 is essentially very low level, so an MAR-6 amplifier is used after an Elliptical Low Pass Filter to bring the level up to around +7dBm (5mW). A MAR-6 has been used due to its low frequency gain >20dB, & normally produces around +2dBm output with a bias of 16mA. The MAR6 has been biased at 30mA for more output & is well under the 50mA maximum rating producing up to +9dBm output. Pin12 on the DDS is normally 0 volts, & increasing the


+5V
0.1uF
10uF
7805T
+12V
XTAL MODULE
VCC
GND
OUT
1nF
10uF
10nF
10nF
10uF
0.1uF
100uH
0.1uF
270R
10nF
DDS OUTPUT +7dBm
C1 10pF
C2 33pF
L1 390nH
L2 330nH
MAR6
C4 180pF
C3 150pF
C5 180pF
+5V
5K
OUTPUT LEVEL
3K9
22R
51R
SERIAL LOAD
W_CLK
FQ_UD
AD9850/51BRS
30MHz L.P.F.
Shown
AD9850/51 DDS
VERSION2
+5V
1K
1K
1K
1K
1K
SWITCH A
SWITCH B
SWITCH C
ENCODER A
ENCODER B
GND
CONTROL CONNECTOR
RA2
RA3
RA4
MCLR
VSS
RB0
RB1
RB2
RB3
RA1
RA0
OSC1
OSC2
VDD
RB7
RB6
RB5
RB4
PIC16F628
4MHz CRYSTAL
22pF
22pF
0.1uF
DB7
DB6
DB5
DB4
RS
E
R/W
GND
+5V
Vo
LCD DISPLAY CONNECTOR
1K
LCD CONTRAST ADJUSTMENT
R/W & Vo CONNECTIONS
MANY NOT BE REQUIRED
REFER TO THE DATA SHEET
FOR THE LCD MODULE USED

voltage on this pin via a trimpot connected to the +5v rail can be used to decrease the RF output level. Either an external high stability frequency reference, or an onboard TTL crystal oscillator module can be used for the DDS frequency reference. The preprogrammed PIC supplied is set for a frequency reference of 180MHz using the internal x6 multiplier with a 30MHz TTL crystal oscillator module. The software can be changed to use other reference clock frequencies, & either x1 or a x6 internal multiplier by changing it in the Calibration setup menu.

CONSTRUCTION:

1. If you are building any of the DDS VFO Kits or Sweep Kit then please refer to the additional notes for these Kits before construction of this Kit. The PCB supplied is a professional plated through hole board with solder mask, which makes construction much easier. Most components are mounted on the top ground plane side of the board, & only the 7805T regulator is mounted on the bottom side.

2. Follow the PC Board overlay diagram and circuit carefully, by checking the components and placing them onto the board. Mount all the SMD components first, followed by the larger components. To solder in the chip capacitors & resistors, a pair of tweezers are used to hold them in place, soldering one side first then the other side. When soldering in the MAR-6 amplifier, the device is simply soldered to the striplines. Grounding is provided through the plated holes underneath the MAR-6 earth leads. If you are not using the optional 30 or 70MHz low pass filter, then simply bridge out the PC board tracks with wire. When mounting the 7805T regulator, its leads are bent to enable the body to sit against the bottom of the board. It is suggested that the metal tag is then soldered to the ground plane on the bottom of the board for heat dissipation. **Be careful when mounting the 7805T & make sure that you mount it under the board the correct way around. A mistake here could damage the chips including the AD9850/51.**

CONNECTIONS: Unless you are building the basic EME85 DDS Kit, then you should refer to the DDS VFO notes, or the Sweep Kit notes before you start to solder in any header plugs or do any wiring. The connection notes below refer only for the Basic EME85 DDS Kit. The EME85F Kit includes the EME85 Conn Kit & consists of 2, 6 & 10 way Header plugs & sockets to suit the LCD & control connections on the EME85F board. Connections to the LCD display & rotary encoder can be made using standard ribbon cable to the connections on the board. If you have bought a LCD display module, then the data sheet would have been supplied with it. Most LCD modules may have extra connections, R/W or Vo that are not required to make the display work. The Data sheets for the LCD module & Alps EC12E Rotary Encoder can be downloaded from www.minikits.com.au/data.html There are three pins on the EC12E, the center one is the ground connection, the other two are A & B output. It is easy enough to experiment here with the A & B connections until you get it to change frequency in the right direction. For the RF output connection either use 50 ohm cable directly wired to the board, or a small SMA09 PCB mount RF connector.

CONTROL BOARD: The DDS V2.10 software is programmed to recognize two types of control boards when connected to the EME85 board. There is a basic control circuit Version 1 that has the basic functions, & a more advanced control circuit Version 2 that has an extra memory function & a spare switch for future expansion. Both circuits are available for download on the DDS WEB page www.minikits.com.au/eme85.htm The simple control board circuit Version 1 can be constructed by soldering diodes to momentary pushbutton switches mounted on a panel or box. **The Optional Advanced EME129 Control board Kit Version 2 is no longer available August 2009 as an option, refer to the Mini-Kits WEB site.** The advanced control board Version 2 is too difficult to construct on Vero board without making mistakes, so it is recommended that you purchase the newer hardware & software PIC using the Version 3 control board EME159 Kit, 4x4 Keypad, & dd_synth _ver2.2 software.

TESTING: Before applying any power to the DDS board, make sure that you have inserted the 7805T regulator in the PCB the correct way around. Always use a current regulated power supply when initially applying power to the board.

1. Turn the 1k ohm LCD Contrast Trimpot fully clockwise, & apply power to the board. Check that the LCD display

lights up & shows the software version number & then the frequency. Some LCD modules don't require this as they have onboard bias resistors. If you still get no display then check your wiring to the LCD display. **Any wiring faults to the control board will cause the LCD to show erratic numbers or possibly not work.**

2. To check for RF output from the DDS, tune a HF Receiver to 10.5MHz & set the DDS frequency to 10.5MHz & check for a carrier from the DDS. **The 5kohm SMD trimpot will have to be adjusted to get an output from the DDS. 0 Volts on the center wiper of the trimpot will produce maximum RF output. Be careful when measuring any voltages with a Multimeter around the DDS chip, as one slip could destroy the chip.**

ADDITIONAL NOTES:

1. The DDS software is only available from Mini-Kits by email. Also visit www.minikits.com.au/kithelp.html for any Kit changes or modifications.

2. To go into Calibration Menu mode, hold the CAL switch down & apply power, +12 volts to the DDS board. The display should show (ENABLE RPT NO). Stop pressing the CAL button & press it again & again it will cycle through the options. The DDS x1 or x6 multiplier along with DDS reference frequency 180MHz can be set. For a 30MHz Xtal Module the DDS reference should be 180MHz, (30MHz x6). All options can be changed by pressing the Cal button & turning the rotary encoder. When you have set all the settings, another press of the Cal button will save the settings to the eeprom in the PIC & return the display to normal. You will probably have to change the default 1Hz frequency step size to a higher tuning rate by pressing the step button, & turning the rotary encoder before changing the settings.

3. The current Software Version 2.10 & later only supports the PIC16F628 chip only. There was not enough memory available to use a PIC16F84 chip for the extra functions, & memories.

4. It is suggested that the DDS board be mounted inside a metal box as it radiates quite a lot of spurious RF possibly from the Xtal module. Recently an interference problem on TV channel 9 VHF was tracked down to RF radiating from the DDS board. All leads in & out of the box should be kept as short as possible, & use ferrites over the leads if possible.

5. The maximum recommended DDS output frequency for a 100MHz crystal oscillator, is 30MHz, which is a 3rd. Because of this the DDS will not be very clean above 30MHz, it will be a compromise. To use up to 60MHz the highest possible frequency output recommended for the AD9851, use a 30MHz crystal oscillator & the internal x6 Oscillator Multiplier. To produce an even cleaner output for local oscillators, it is suggested that the DDS output be filtered through a bandpass filter, or used with a 1:1 phase locked loop. The frequency display can be offset in the software to accommodate this. Optional 30 & 70MHz Low Pass Filter Kits are available to clean up the output of the DDS.

6. Confirmation on whether the DDS board is working ok, can be made by disconnecting the LCD & control board connections & then reapplying power to the DDS board. The PIC supplied with the Kit is pre-programmed for a default output frequency of 10.5MHz from the DDS chip that can be checked on a suitable HF receiver. **This is only the case when using a 30MHz module & the menu settings have not be changed.**

7. The DDS RF output can be seen on an oscilloscope as a very clean sine wave. It can also be seen on a Spectrum Analyzer or heard by tuning into the signal on a suitable HF receiver. When operating the DDS from 0 to approx 32 MHz with the 30MHz filter fitted, the second harmonic is only around 20dB down. This is due to the MAR6 acting as a multiplier. The drive to the MAR6 if reduced by adjusting the SMD trimpot will stop the multiplier action with reduced output level at the fundamental frequency. This was not see as an issue as the DDS was designed as a simple signal generator only. If the DDS is to be used on a receiver or transmitter then the MAR6 can be replaced with a high dynamic range amplifier stage, & narrow band local oscillator filtering for better performance.

8. When using the DDS as a local oscillator for a receiver or transmitter, a simple 50ohm bandpass filter should be used on the output of the DDS that covers the frequency range required to stop unwanted frequencies getting to the receiver or transmitters mixer. Without a filter the DDS used on a receiver, may produce an approximate 1Khz audio tone to be heard from the receivers speaker. This is due to the DDS output being rather complex with the frequencies that are produced. A simple 1MHz high pass filter on the output of the DDS board may fix the audio tone problem when using the DDS on a receiver, (Not Tested). Alternatively a PLL, (phase locked loop) circuit with VCO, (voltage controlled oscillator) could be used. Most modern Transceivers use a DDS as a reference oscillator on a PLL.

PARTS LIST:

RESISTORS

1 x 22R	1206 SMD Resistor
1 x 51R	1206 SMD Resistor
1 x 270R	1/4 Watt Resistor
5 x 1k	1/4 Watt Resistor
1 x 3k9	1206 SMD Resistor

TRIMPOTS

1 x 1k	TPV 5mm Trimpot Resistor
1 x 5k	SMD Trimpot Resistor

CAPACITORS

2 x 22pF	Ceramic Capacitor
1 x 1nF	Ceramic Capacitor
1 x 1nF	0805 Chip Capacitor
3 x 10nF	0805 Chip Capacitor
2 x 10nF	Monolithic Capacitor
4 x 0.1uF	Monolithic Capacitor
3 x 10uF	EXR Electrolytic Capacitor 25v

INDUCTORS, RF CHOKES

1 x 100uH	Axial RF Choke

30MHz LPF OPTION

1 x 10pF	0805 Chip Capacitor **(C1)**
1 x 33pF	0805 Chip Capacitor **(C2)**
1 x 150pF	0805 Chip Capacitor **(C3)**
2 x 180pF	0805 Chip Capacitor **(C4 & 5)**
1 x 330nH	SMD Coil **(L2)**
1 x 390nH	SMD Coil **(L1)**

70MHz LPF OPTION

1 x 4p7	0805 Chip Capacitor **(C1)**
1 x 10pF	0805 Chip Capacitor **(C2)**
1 x 33pF	0805 Chip Capacitor **(C5)**
1 x 39pF	0805 Chip Capacitor **(C4)**
1 x 68pF	Ceramic Capacitor **(C3)**
1 x 150nH	SMD Coil **(L2)**
1 x 180nH	SMD Coil **(L1)**

SEMICONDUCTORS

1 x 7805T	Regulator
1 x AD9851	DDS IC (Soldered To PCB)
1 x PIC16F628	Microprocessor (Pre-programmed)
1 x MAR-6	Mini-Circuits Amplifier (Bevel lead is the input)

MISCELLANEOUS

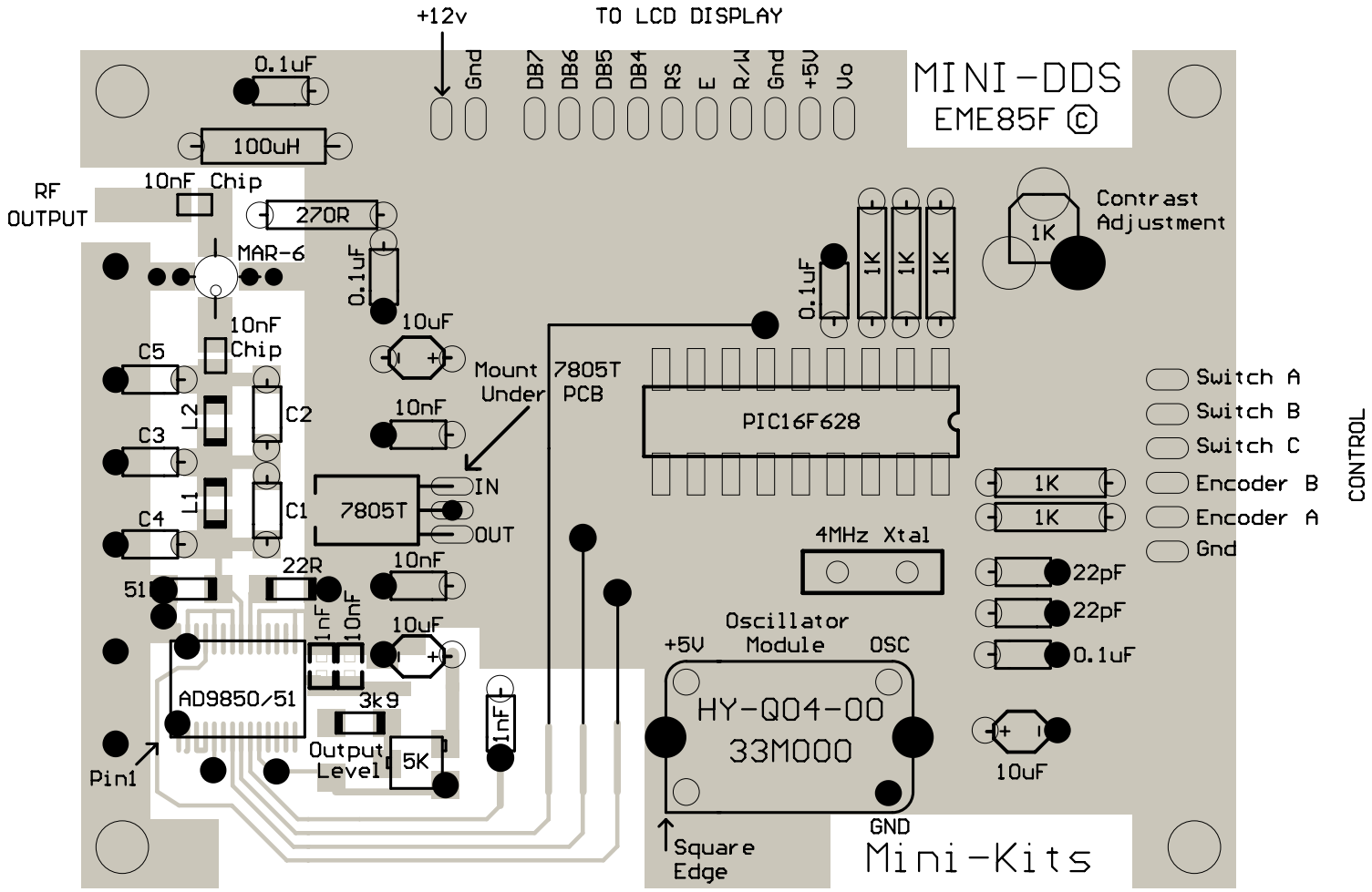
1 x PC Board	EME85E
1 x Instructions	EME85E
1 x 4MHz	Microprocessor Crystal
1 x 18 Pin	IC Socket
1 x HDS2P	2 Pin Socket
1 x HDS6P	6 Pin Socket
1 x HDS10P	10 Pin Socket
1 x HDP2P	6 Pin PCB Mount Header
1 x HDP6P	6 Pin PCB Mount Header
1 x HDP10P	10 Pin PCB Mount Header

OPTIONAL NOT INCLUDED IN KIT

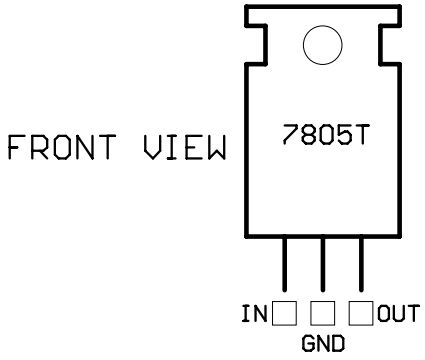
1 x Oscillator Module (30MHz standard)
1 x Rotary Encoder (EC16B ALPs)
1 x 16 x 2 LCD Display Module
1 x Software (ddsv2.10, email sales@minikits.com.au for software)

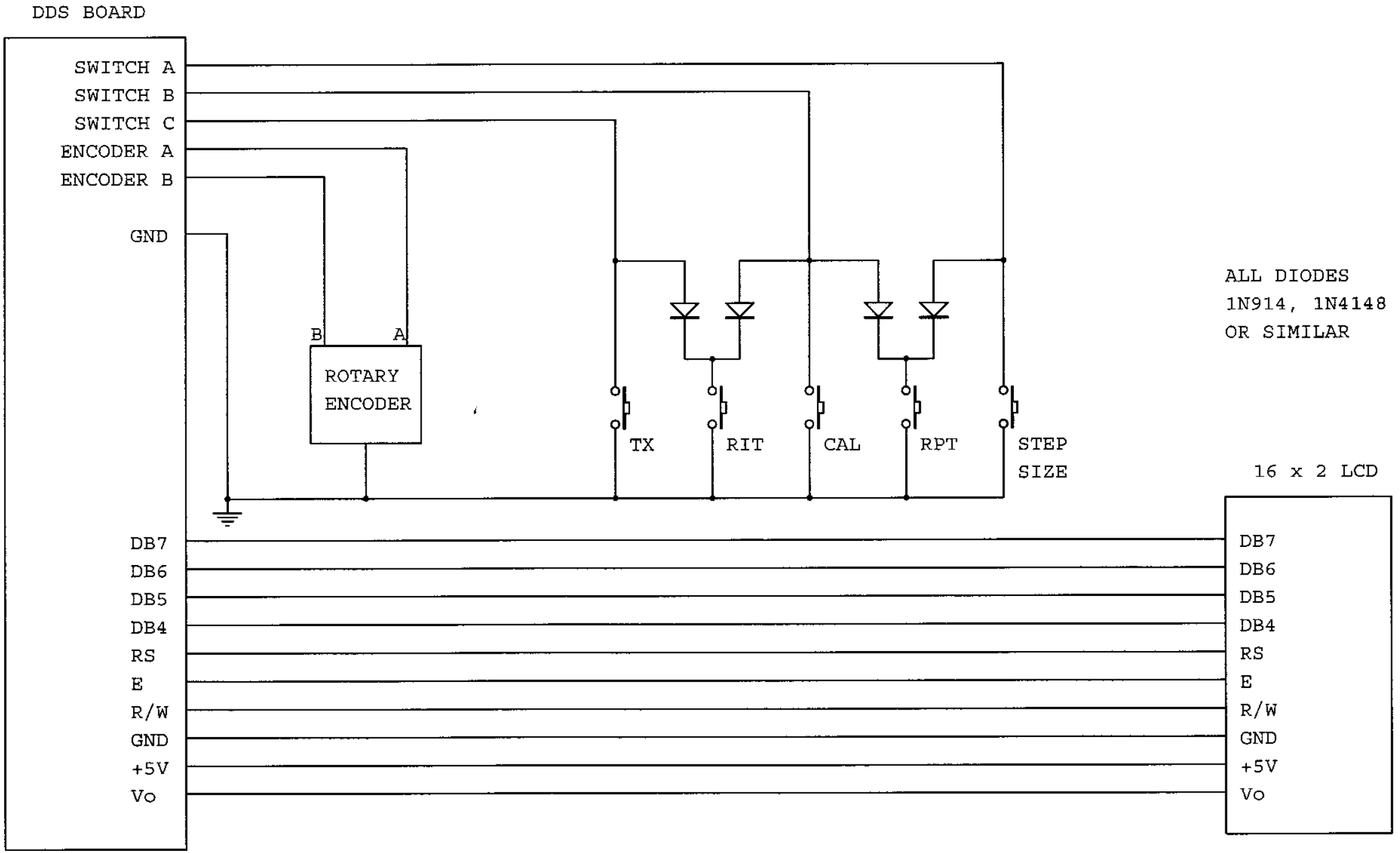
For any reported faults & modifications, please refer to www.minikits.com.au/kithelp.html Refer to the EME85 DDS Kit links on this page for Help.

TOP PCB OVERLAY

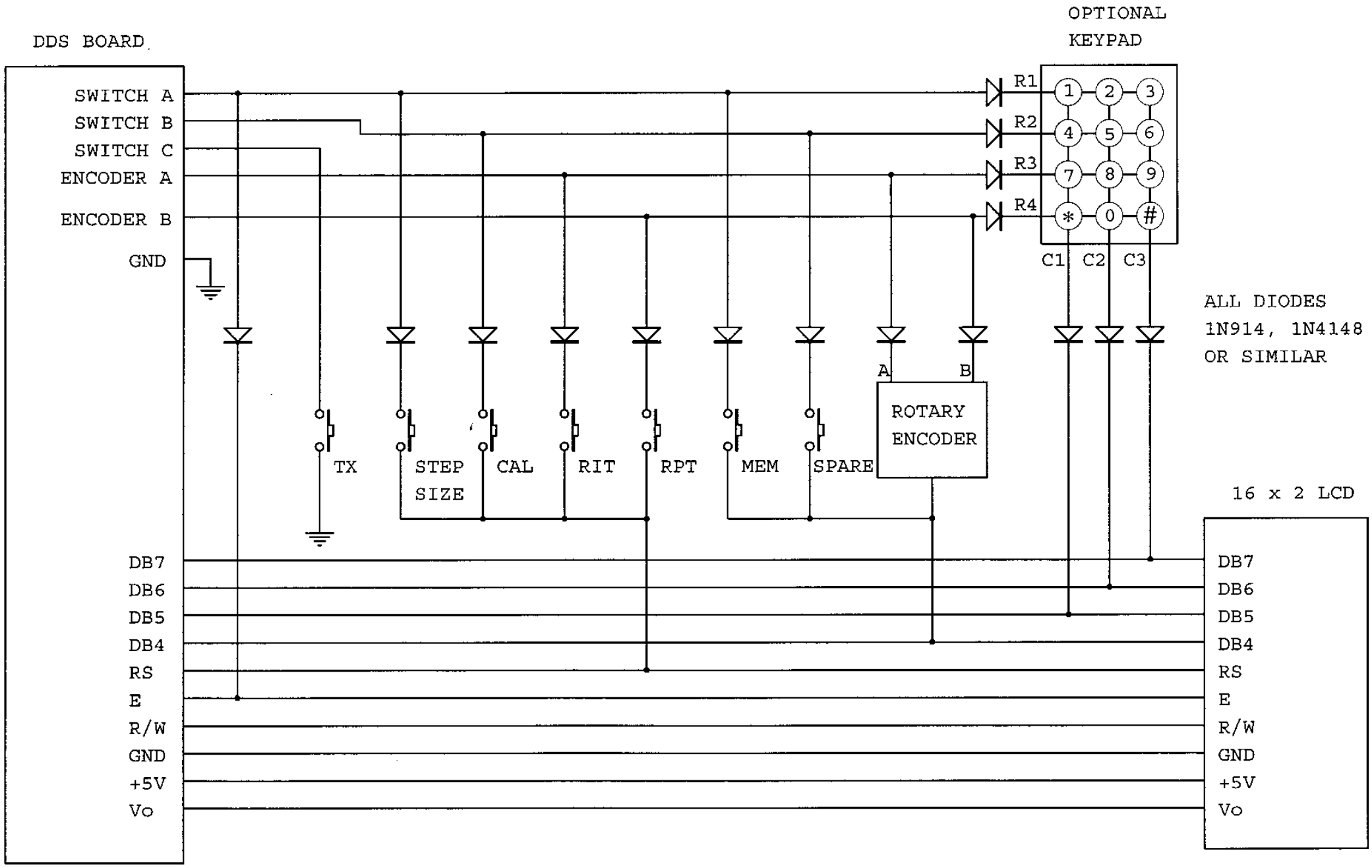


● EARTH THROUGH HOLE CONNECTIONS





DD_Synth Ver 1.xx



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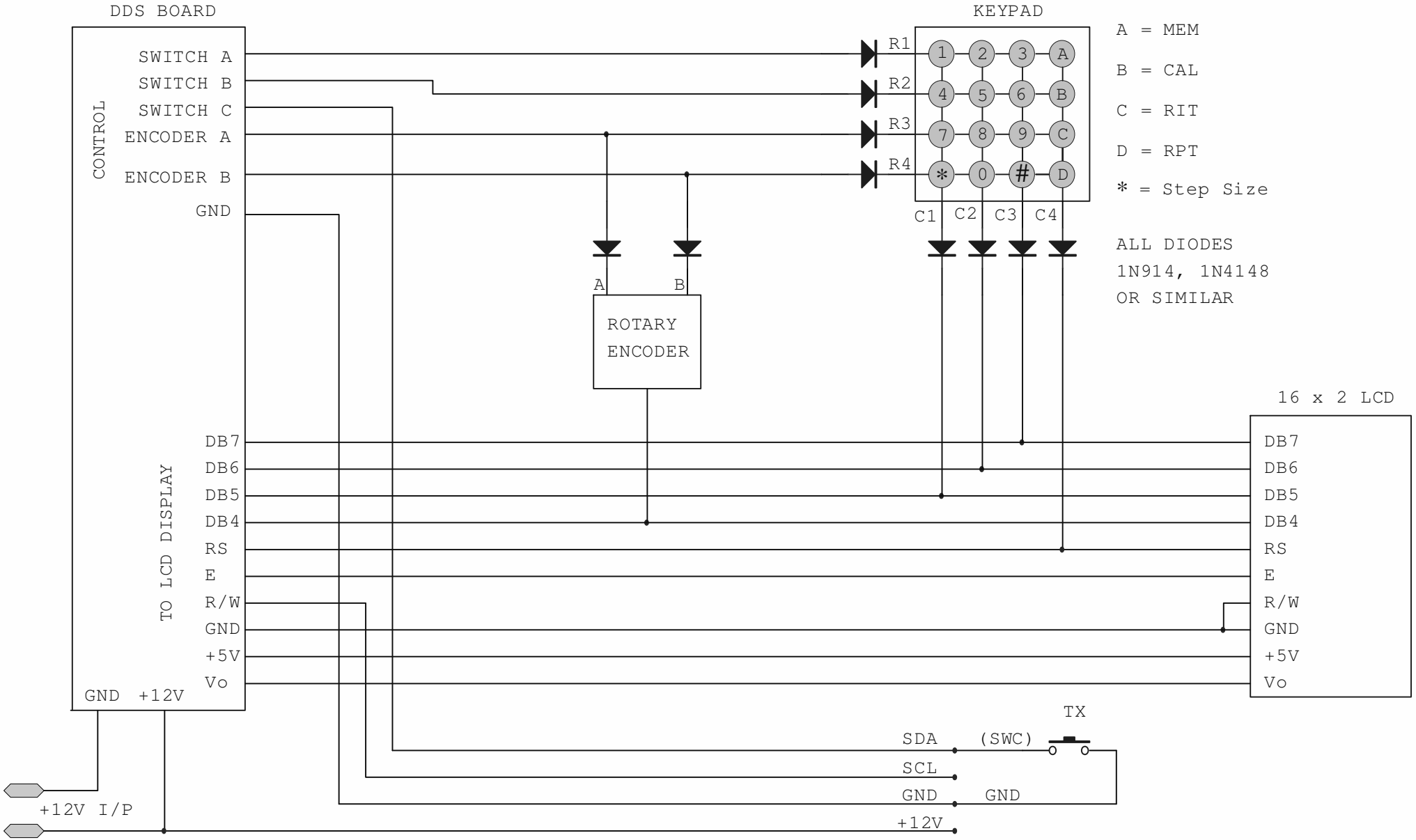

DD_Synth Ver 2.2x