SPECIFICATIONS: **M1 DDS CONTROLLER**

Frequency Range:	5kHz–70MHz **(AD9850/51 with a 30MHz Oscillator module and internal x6 Multiplier)**
	5KHz– 175MHz **(AD9951/54 with a 100MHz Oscillator module and internal x4 Multiplier)**
Frequency Resolution	10Hz steps RF and Display Readout, **(10Hz minimum steps using Ham Radio Deluxe)**
Frequency Steps	(Mechanical Encoder Variable or fixed Rate Tuning) Step sizes 10Hz, 100Hz, 1kHz, 10kHz, 100kHz, 1MHz, 10MHz, 100MHz. (Optional Optical 100 to 600PPM Encoder) set tuning rate profiles and user programmable)
Display Offset:	To suit zero IF, or first IF roofing filters up to 145MHz on the 0-30MHz band
Display Divider:	Zero IF, Divide by 2, Divide by 4
VFO:	A and B, including Split, RIT, Repeater
Bands:	160M, 80M, 40M, 30M, 20M, 17M, 15M, 12M, 10M, 6M, FM, AIR, 2M, 70CM, Phantom.
Modes:	AM, FM, AMs, LSB, USB, CW, CWR
Memories:	202 including 2 for Memory scanning, 16 memory groups, Memory Text Labeling
Outputs:	Band Data, Modes, Filter selection, RF Output, Power, AGC, IPO, ATT, NB, Proc, Vox, RX/TX, TX Enable
Inputs:	(Digital), PTT, Optical Encoder, (Analogue), S Meter
Software:	Uses a preprogrammed PIC18F4520 with boot loader and M1_DDS_VER_1_x firmware **Updatable via USB**
Computer Interface:	Optional USB FT232R to serial adaptor
Power Supply:	+12vdc (140mA including LCD Display)

DESCRIPTION: The basic M1 DDS Controller Kit consists of the EME190 Microcontroller board, EME189 encoder board, 4x4 keypad, 16x2 LCD display, and miscellaneous hardware. An optional EME187 logic interface module can be connected to the microcontroller module, to expand the outputs on the microcontroller for the functions required by the M1 modules. The original Mini-Kits HF-DDS software is used to control all the functions required by the M1 Transceiver, and can be used with either the AD9850/51 or AD9951/54 DDS. The AD9951/54 is recommended for high performance receivers as the spur level is very low. The AD9850/51 does produce a few audible high level spurs on spot frequencies that can be annoying.

SOFTWARE: The original HF-DDS software was originally written in 2009 to suit a PIC16F4520 Microcontroller which allows for future expansion, and the option of using either the AD9850/51 or 12 bit AD9954 DDS. The circuit design has changed many times over the years to improve the overall construction and performance.   The HF-DDS software is based on the Yaesu FT817 Transceiver, and has many of the control functions that are not used with the M1 Transceiver. The functions can either be controlled using a rotary encoder and 4x4 numeric keypad, or by using Ham Radio Deluxe with CAT commands through an optional FT232R USB to serial adaptor. Some minor functions which are not used on the M1 are only settable in Ham Radio Deluxe, and are not available on the keypad or in the LCD menu settings. The PIC Micro-controller module can be interfaced to an optional M1 logic interface module for switching of external circuitry normally associated with a Radio Transceiver including RX/TX power switching, band switching, modes, and AGC etc.   The M1 logic module connects to the various 16 pin IDC headers used

on the M1 Transceiver modules. **For the complete Software specifications including all functions and how to use it, refer to the M1-DDS Software documentation on www.minikits.com.au/m1-dds-control**

HARDWARE: Refer to the block diagram for the M1 DDS Controller.   The hardware consists of a number of module Boards and components that are connected together using IDC headers with ribbon cables. This is to avoid wiring mistakes and makes it much easier to interconnect to other circuitry without requiring time consuming crimping of individual header terminals to wires. The A4 and A5 headers on the EME190 are used to connect the logic and data signals to the other hardware for logic control and the LCD display.

MICROCONTROLLER: The PIC 18F4520 Microcontroller is pre programmed with a boot loader to protect the software copyright. The boot loader allows for firmware updates to be programmed through the A6 serial port using a USB to serial adaptor and Microchips quick programmer software (AN851) available from the Mini-Kits website. The same cable that allows remote operation via a computer using Ham Radio Deluxe can be used. **A standard PIC programmer cannot be used on the ICD programming port as it will fully erase the boot loader in the chip.** All information regarding updates of the firmware software can be found on the M1 DDS Controller webpage.

USER INTERFACE: The M1 DDS uses the EME189 control board as a wiring interface between the PIC Controller board and a EC12E rotary encoder, 4x4 Numeric keypad, and 16x2 LCD display module. The rotary encoder and 4x4 keypad allow the user to input changes to the functions, and the LCD

display module allows for a visual indication of the settings including frequency, band, mode, etc. There are 3 menus that can be displayed and changed allowing for initial hardware settings through to commonly used functions like AGC, ATT, Preamp etc. The Calibration, (Cal) Menus are where the settings for the DDS hardware, frequency bands and offsets are stored. To enter the Cal Menu the power needs to be disconnected from the EME190, and while holding the # button, reapply the power and the display will show CAL MENU 1. The Function Menus are used to change commonly used functions like AGC, IPO, Speech Processor, and VOX, To enter the Function Menus simply momentarily press the # key and the display will show FUNCTION MENU 1. The Setup Menu is used to store not commonly used settings for optional I/F filters, a sweep function, and for the optional (Input / Output) I/O Expander board. To enter the Setup Menus, press the # button holding it in until the display shows SETUP MENU 1. The rotary encoder is used to change the Menu numbers, and the # key is used as an enter key to change and step through the settings. Frequencies can be directly entered using the Keypad by pressing the 0 button, and then entering the frequency. E.g. for a frequency of 123.45678MHz press 0 123*456*78 # . **For more detailed information, please refer to the M1-DDS Software documentation on www.minikits.com.au/m1-dds-control**

HF DDS SOFTWARE: The software has been written to emulate some of the software peculiarities of the Yaesu FT817 Transceiver, but also has to be able to be used with the M1 user control interface. The Ham bands are selectable with the 1 or 4 keys on the keypad, and are able to user programmed for the lower and upper band edge frequencies, the DDS frequency range, and frequency display offset. When you tune outside a Ham band, the software switches to the Phantom band just like in the FT817. The phantom band memorizes its settings just like the other bands but has a wide band limit of 100kHz to 33MHz. This is ideal for general coverage receive, and the software disables the PTT function and enables the TX Inhibit output high to avoid transmitting out of band. You can get to the Phantom band by directly entering a frequency e.g. 3MHz that is outside of the programmed Ham bands set in the software. As you tune up or down from 3MHz eventually you will reach the edge of a programmed Ham Band and it will switch from the phantom band to one of the Ham bands. The tuning rates and modes can be changed for each band, and are memorized when changing bands. This can cause some confusion when tuning out of a Ham band to the phantom band, that may have a different tuning rate or mode set. **It is best to initially set the same tuning rate and mode for all bands including the phantom band, to avoid confusion.**

CONSTRUCTION:

1. This Kit is for constructors that have some experience with using SMD components.

2. Do not fit any IDC headers or wire any boards etc together, until later on in the construction notes. Many mistakes are made here which can cause much lost time and can damage circuitry if the hardware is wired incorrectly.

3. Construct the relevant Kits that are used to construct the M1-DDS Controller as per the instructions supplied with the Kit. **Do not solder in any of the PCB headers to the board.**

4. Construct the EME189 Control board Kit as per the supplied Kit instructions. **Do not solder in any of the PCB header plugs or ribbon cables to the board.** The EC12E Encoder is mounted on the front of the board (writing side) and the diodes are mounted on the rear of the board.

5. Construct the EME188/189 adaptor board for the LCD observing the polarity of the IDC headers keyway cut out.

6. Construct the optional EME187 Logic Control Kit as per the instructions supplied with the Kit.

7. If you have bought one of the compatible AD9850/51 or AD9954 DDS Kits, then construct it as per the instructions supplied with the Kit.

CONNECTIONS:

1. Refer to the M1 DDS Control Block diagram for the polarity of the PCB header plugs and ribbon cable that connects all the hardware together. When fitting the PCB Headers it is best to think before you mount them as they are polarized. Most Headers are marked on the block diagram showing Pin1 to e.g. Pin 16. Where one board is connected to another, Pin1 is used to identify the polarity of the red wire on the ribbon cable

2. Complete Kits that are used to make up the M1 DDS Controller Kit are supplied with IDC Header connectors, and quality ribbon cable to connect all the hardware together which makes it easy to connect or disconnect boards. There are still a few 2.54mm inline headers that will require crimping of pins to ribbon cable. You can solder the crimp pins onto the wires, but the connections can be very unreliable with the wires prone to breaking if the cables are moved about.

3. Refer to section 1 above again, before fitting any IDC headers to the board or to the ribbon cable. If you are

going to use a single length of 16 way IDC cable to interconnect the EME188 to EME189 **B1**, EME190 **A5** and EME187 **J6** then some careful thought is required to the positioning to where the IDC headers will be crimped along the cable. It would be best to mount the hardware first before and cabling is done to avoid mistakes.

4. Referring to the M1 DDS Controller Block for the EME190 board, observe the polarity of the IDC header keyway cut outs and fit them to the top of the board**.** If you require the use of the TX_EN and S Meter connections on the board, then a Inline header can be fitted to PORT A on the board. Fitting headers to the other Port connections on the board are not required with the current M1 application.

5. All connections to the EME189 board are on the rear **(bottom side)** of the board. IDC headers are used on all these connections to make it easier to interconnect the board. Fit the three IDC Headers for B1, B2 and B3 on the rear of the board noting the polarity of the keyway cut out.

6. Refer to the data sheet for the 4x4 Keypad for the position of pin 1. Next solder some 8 way ribbon cable directly to the 4x4 Keypad. Cut the cable to the length required and crimp a 8 way female IDC Header to the cable observing the correct polarity to the B3 header on the EME189 board.
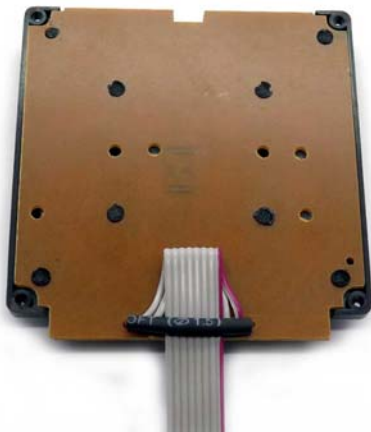
Picture shows the correct way to solder the ribbon cable to the keypad and protect it from damage.

7. Cut a suitable length of 10 way ribbon cable to go from EME189 B2 to EME190 A4. Observing the polarity crimp a 10 way female IDC header on each end of the cable.

8. Next solder a length of 6 way ribbon cable directly to the row of 6 holes B5, on the EME159 board. Cut the cable to the length required and attach a 6 way Header Socket to the cable observing the correct polarity to the A6 header on the EME150 board.

9. The 16x2 LCD module is connected via an adaptor board and 16 way ribbon cable to the EME190 board. Refer to the M1-DDS-Control-Block.pdf for how the module is wired. Two adaptor boards have been designed to make it easier to connect the ribbon cable to the LCD modules pin outs. Standard pin out 16x2 LCD modules including the QC1602A or Hantronix HDM16216I-5 LCD modules use the EME188 board, and the non standard pin out EastRising ERM1602-1 uses the EME198 board. To light up the LCD modules backlight LED's, a 22ohm 1/4 watt resistor is used on the EME188/198 board which sets the correct current for a +5vdc supply. **Carefully check that the wiring between the LCD module and the EME190 board is correct using a multimeter before turning on the DC power, as damage could occur to the LCD module or PIC controller.** Refer to the data sheets for the LCD modules on the Mini-Kits website. http://www.minikits.com.au/data-sheets.

OPTIONS:

1/ Optional Optical Encoder. Software versions after 1.L allow an optical encoder to be used with the M1. The software can be used with many optical encoders from 100 to 600PPR. Encoders with an open collector output can be safely used with the microcontroller inputs on the EME190 board. The encoder is connected to the RE1 and RE2 inputs on the EME190 board. 4k7 1206 Pull up resistors need to be fitted to the RE1 RE2 positions on the bottom of the EME190 board. The encoder needs to be powered and if it is a 12vdc type then it can be connected to the spare A2 connector on the EME190 board.
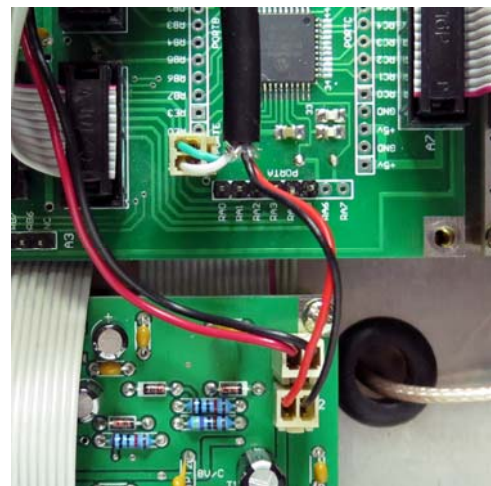
Picture shows the connections for the optional Optical Encoder

2/ Optional USB Interface: An optional RS232 to mini USB interface module can be used for software updates, and to remotely control the M1 Transceiver using the Ham Radio Deluxe software. The recommended module is the USB-AD02 as it has been tested and compatible and can be plugged into the A6 connector on the EME190 board.

WIRING: There will be a number of 16 way ribbon cables required to wire the EME187 Logic board to the various M1 module boards. It is suggested that careful thought be made to how the various module boards are laid out on a chassis and how the 16 way headers are aligned. The prototype M1 that can be seen on the M1 Transceiver webpage, uses long lengths of 16 way ribbon cable with multiple crimped 16 way IDC headers to connect modules. The layout was not ideal as the ribbon cable had to sometimes be bent 90 degrees to turn corners or manipulated to reverse the red tracer wire to align with the modules headers. It is expected that many constructors will use up to 40 IDC16 connectors and a few metres of 16 way ribbon cable with around 50% being written off due to mistakes. **If mistakes are made or if a cable needs to be extended**, then an optional EME186 joiner Kit is available that allows easy joining of two 16 way IDC cables.
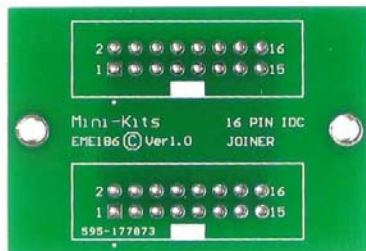
TESTING:

1. Testing of the EME190 board should be done first before plugging in any other hardware. Do not apply any power to the EME190 board without either using a current limited power supply, or inline fuse. Set the power supply to +12 volts, and the current limiting to around 350mA. If you are happy that the EME190 board is working ok then you can power it off and then plug in all the other hardware. **Refer to the Testing section of the notes supplied with the individual Kits.**

2. If all was ok above, then apply power and **adjust the LCD Contrast trim pot** on the EME190 board so that you can see the LCD display. You should now be able to tune the rotary encoder or press the keypad and see the display changing.

3. Set up the software menu settings in the next section.

INITIAL SOFTWARE SETUP:

Most of the setting required for the M1 have already been set when the PIC microcontroller has been programmed.

1/ To Enter the Calibration Menu: With no power connected hold the # key down and apply power. The rotary encoder changes the menu number and the # button is enter.

CAL MENU 2: Enter Cal menu 2 (DDS CALIBRATION), and setup the software to suit the AD9951/54 DDS. If you have the EME167 DDS board plugged into the EME190 board, then the AD9951/54 chip should be automatically recognized by the software. Do Not use over clocking (This has not been Tested), unless you are willing to accept any damage that could happen to the DDS chip due to high clock speeds. For the AD9951/54 DDS Set the following in the CAL Menu2.

> DDS O/P Divider to None
> DDS Ref to 100.000MHz
> DDS Ref Multiplier to x4

The DDS system clock is used to trim the DDS output frequency if the 100MHz crystal clock module is slightly off frequency. The 400.000MHz +/- can be set for a 10MHz output on a frequency counter, or zero beat on a receiver. **Make sure that the DDS is set to AM mode before setting the 10MHz output, as USB and LSB have 1.5kHz offsets**. Using a 400MHz, (100 x 4) clock, the maximum DDS output can be set to 175MHz or lower.

CAL MENU 3: Enter Cal menu3 (BAND FREQUENCY LIMITS) and set all the bands upper and lower frequencies to suit your country. This will allow the PIC controller to recognize when you are out of Band, which then disables the PTT and TX_ENABLE. The Band Frequency Limits do not stop the DDS tuning outside of the bands as it changes to the Phantom band for general coverage receive operation.

CAL MENU 4: Enter Cal Menu 4 (DDS RANGE LIMITS) and set what DDS range limits and display offset frequency that you require for all bands. The display offset allows the DDS output frequency to be offset from the displayed frequency on the LCD module by a set amount. **To set the display offset for a 9MHz I/F for the M1 Transceiver**, go into Cal Menu 4 and set the DDS OFFSET for both the 0.1 to 33MHz HF, and 33 to 76MHz bands to 9.000.000MHz. The DDS will now produce an output of 9.1MHz to 63MHz with the display reading 0.100 to 54MHz.

If you want continuous frequency coverage above 30MHz, then you would need to set the band limits of the HF and 6M bands to suit. This is not something that you would do if you are using the DDS only for the M1, as this would allow out of band operation. To make the DDS work from 30 to 50MHz you would need to change the Menu 3 Band Frequency Limits to 33.001MHz min to 76MHz max. If you try and enter a frequency that is outside of any of the DDS RANGE LIMITS, then the DDS will jump to the closest Band.

CAL MENU 5: Enter Cal Menu 5 (S METER). This menu can only be set if your Receiver design has a form of AGC and can derive a DC voltage suitable to feed into the S Meter

input RA5. Please refer to the M1-DDS software notes on how to program the S-meter settings.

2/ SETUP MENUS: To Enter the Setup Menu: With power already on, hold the # key down until it says SETUP MENU 1. The rotary encoder changes the menu number and the # button is enter.

SETUP Menu 2: MOD MODE OFFSETS that allows the LCD display to be offset to suit the centre frequency of the crystal filters that are used with each mode. This function was added as most homebrew crystal filters centre frequencies are rarely close to 9MHz. Modes like LSB, USB, and AM can be set by adjusting the offset on received signals that are of a known frequency accuracy. E.g. on the 40M band the LSB offset can be adjusted to correctly tune the signal for best resolved audio clarity. **This should only be done after the EME205 BFO oscillator has been aligned for LSB and USB.**

SETUP Menu 3: HIDE MOD MODES so that you can hide any modes that you don't want to be selectable or displayed on the LCD display. The AMs, FM and PKT can be set to hidden as they are not currently used with the M1.

SETUP Menu 4: HIDE BANDS so that you can hide any bands that you don't want to be selectable or displayed on the LCD display. The 30M, FM, AIR, 2m, and 70cm bands can be set to hidden as they are not currently used with the M1.

SETUP Menu 5: M1 I/O EXPANSION This was added after version 1.L software to add a number of new functions including logic outputs for the EME211 Attenuator / Trap, and the EME213 Noise Blanker modules. You can set enable to both settings to activate them.

SETUP Menu 6: I/O BOARD SETUP This sets the outputs for the EME187 Logic board. This screen allows you to select what is output on the 32 pins of the I/O board. **The settings in Table 1 shows the settings that are required to suit the M1 functions.** First select which O/P pin you want to edit, then you select the function you want to assign to that pin. See steps 2 to 5 below. (There is no timeout on this screen)

1/ First press the A button to allow you to select which O/P pin to edit. The cursor is placed under the O/P pin number to indicate you are in the select pin mode. You can use the rotary encoder to select one of the 96 O/P pins. Or key in the two digit pin number using the keypad.

2/ Next press the B button to allow you to select which O/P function you want assigned to the pin. The cursor is placed under the O/P function number to indicate you are in the select function mode. You can use the rotary encoder to select one of the 256 O/P functions. Or key in the three digit function

number using the keypad. Not all 256 functions are currently used, see the function table for the M1.

3/ Next briefly press the MENU button (#) to enter your selection, you will be returned to step (1) with the cursor placed under the O/P pin number, ready to select the next pin to edit.

4/ Finally press the MENU button (#) for 2 seconds to save all the changes to EEPROM. You will be prompted to confirm that you want to save the changes. If you select YES using the rotary encoder, all the changes made in the I/O BOARD SETUP screens will be saved to the 24LC256 EEPROM. If you select NO the changes will not be saved. You will then be returned to the setup menu.

SETUP Menu 7: MECH ROTARY ENC This can be set for a default legacy setting or user tunable rates. Refer to the complete M1-DDS-Software-Notes.pdf downloadable from the M1 DDS Controller webpage.

SETUP Menu 8: OPTO ROTARY ENC This is for the optional use of an optical encoder that was added after software version 1.L. This is quite a complex setup and it is best to refer to the complete M1-DDS-Software-Notes.pdf downloadable from the M1 DDS Controller webpage. The mechanical encoder on the EME189 board is still fully operational and can be mounted on the front panel as an additional course tuning control, or the EME189 board can be mounted on the internal chassis if only the optical encoder is required on the front panel.

Please refer to the full software documentation on further menu settings that are available.

FIRMWARE UPDATE:

1/ Never connect a PIC Programmer to the IDC programming port on the EME190 board. If you try and update the firmware this way then you will erase the boot loader software and the complete board will have to be sent back to Mini-Kits for reprogramming. All firmware is loaded into the PIC Micro-controller through the serial connection A6 using an optional FT232R USB to serial adaptor directly from the computers USB port. Refer to the document on Updating the Software on **www.minikits.com.au/m1-dds-control**

HARDWARE: The PIC Controller board and DDS boards should be housed in separate shielded boxes to stop any interference including clock signals from radiating. The PIC controller uses a 10MHz clock that may cause some issues to Radio reception including WWV on 10MHz.

CURRENT ISSUES: Not Resolved

1/ When on AMs mode the EME203 module feeds volts back through a diode to the AM logic enabling the AM demodulator. This will need to be resolved if the Synchronous Demodulator module for AM becomes available.

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         EME187 I/O BOARD default layout M1 Transceiver.
-----------------------------------------------------------------------------------------
  O/P  | FUNCTION
  PIN  | NUMBER

  CONNECTOR J4 ( Pre-selector and Low Pass Filters )

  O/P 01,   007 =  21 MHz,  15m band.                               On = 15m.
  O/P 02,   006 =  18 MHz,  17m band.                               On = 17m.
  O/P 03,   008 =  24 MHz,  12m band.                               On = 12m.
  O/P 04,   005 =  14 MHz,  20m band.                               On = 20m.
  O/P 05,   004 =  10 MHz,  30m band.                               On = 30m.
  O/P 06,   003 = 7.0 MHz,  40m band.                               On = 40m.
  O/P 07,   002 = 3.5 MHz,  80m band.                               On = 80m.
  O/P 08,   001 = 1.8 MHz, 160m band.                               On = 160m.
  O/P 09,   009 =  28 MHz,  10m band.                               On = 10m.
  O/P 10,   010 =  50 MHz,   6m band.                               On = 6m.
  O/P 11,   015 = Phantom, (out of band, 160m-10m)                  On = PHANTOM.

  CONNECTOR J3 ( Mode Selection and Crystal Filters )

  O/P 12,   046 =  FM mode.                                         On = FM.
  O/P 13,   047 = AMs mode ( AM Sync ).                             On = AM Sync.
  O/P 14,   043 =  CW mode.                                         On = CW.
  O/P 15,   041 = LSB mode.                                         On = LSB.
  O/P 16,   042 = USB mode.                                         On = USB.
  O/P 17,   045 =  AM mode.                                         On = AM.
  O/P 18,   022 = RF Preamp                                         On = Preamp On
  O/P 19,   083 = TX                          Off = RX,             On = TX Enable.

  CONNECTOR J5 (Various Functions )

  O/P 20,   018 = ATT  (Attenuator)                                 On = ATT ON.
  O/P 21,   053 = AGC Off                                           On = AGC Off.
  O/P 22,   055 = AGC Fast                                          On = AGC Fast.
  O/P 23,   019 = NB   (Noise blanker)                              On = NB ON.
  O/P 24,   037 = PROC (speech processor)                           On = PROC.
  O/P 25,   038 = VOX                                               On = VOX.
  O/P 26,   082 = ANT2  (Antenna 2, front)    Off = ANT 1 (rear),   On = ANT 2 (front).
  O/P 27,   035 = PWR 0 \ (O/P Power)         Off,Off = LOW 1,      Off, On = LOW 2,
  O/P 28,   036 = PWR 1 /                      On,Off = LOW 3,      On, On = HIGH.
  O/P 29,   252 = ATTEN 0 (6dB Attenuator)    Off, Off = 0dB,       Off, On = 6dB.
  O/P 30,   253 = ATTEN 1 (12dB Attenuator)   On, Off = 12dB,       On, On = 18dB.
  O/P 31,   254 = NB 1 (Noise Blanker 1)                            On = NB1 ON.
  O/P 32,   255 = NB 2 (Noise Blanker 2)                            On = NB2 ON.


  Table1.
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