VK5RMG

Channel 6 Repeater

The Bluff

November 2017

**Passwords**

December 2017 =

…………………………………

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**Why a Mk4 controller**

The Mk1 repeater controller has been in use at hundreds of sites for many years. It does have some limitations such as voice callsign or messaging is difficult to add and it doesn’t support off-air recording. When used in conjunction with an audio bridge to support two links it is a pain to setup audio levels, it doesn’t provide for on-site adjustment of parameters and lastly the CTCSS detection is not very good.

The Mk4 controller adds 5 line level audio inputs, the ability to change the password, better interface provision using opto couplers, an ability to control each port with CTCSS, supply voltage in morse, low or high battery voltage warnings, a tune up tone, and menu control of the CTCSS frequency. This project uses surface mount components for a smaller footprint and to overcome supply issues.

You might ask what happened to Mk2 and Mk3. They exist as software projects on my computer and did not reach the hardware stage.

**Introduction**

Primarily designed to work with the TAIT remote station modules this controller provides complete management of one duplex repeater and two associated radio links. It is anticipated that the completed repeater station would sit between two other sites receiving and supplying audio of a fixed level (-10dBm) from/to both linking units thus simplifying the setup processes. The common point of the audio mixer is available on connector CN6 to facilitate either a CRO or other level monitoring. The unit will replace a VK5DJ Repeater Controller Mk1 (with only one linking port) and its associated audio circuit. The audio stages are designed to mix the various signals without affecting load impedances. The intention is that -10dBm input on any of the 5 inputs to the audio stages will result in -10dBm output on all the outputs of the audio stage. Load impedance = 600 ohms. This design uses top cut filters on the PIC pins to present beeps/callsigns/messages as sine waves. There are level controls for the CW output, the 1kHz test tone and the CTCSS and DTMF decoders.

The absence of other level controls is intentional, the TAIT receivers and exciters have line level controls so the audio section provides mixing only. The audio bridge portion is designed to work with audio in and out of -10dBm.

The controller manages the PTT of the main repeaterand associated radio links. Each transmitter can be enabled or disabled, and control of TX functions can also include CTCSS control. Timeouts are fully flexible on main timeout (mins), callsign (mins), length of tail, presence of courtesy tones. Three callsign modes are supported.

The setup can be managed by DTMF and/or locally using a keypad and LCD. The latter being fed from a 16 bit expander chip (MCP23017) driven by the I2C bus from the PIC18F2480. A useful addition is the capability to change the password from the keypad.

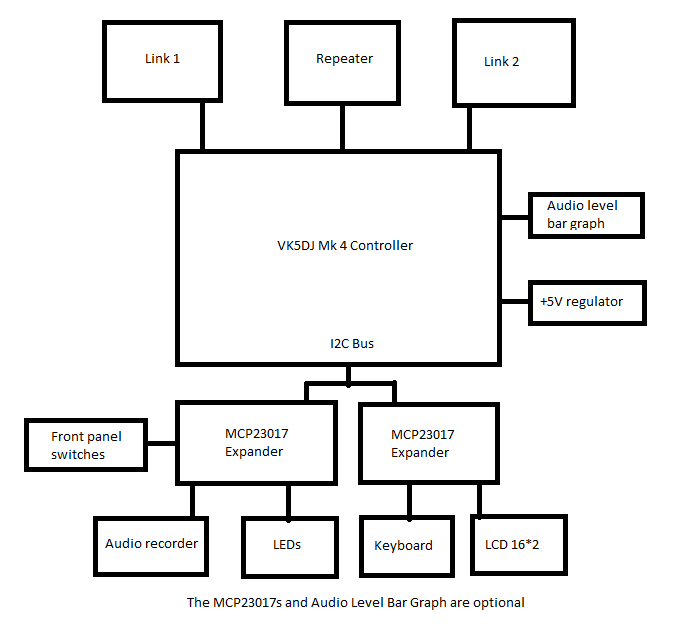
A complete list of functions is shown later in this document, see Table 2.

To ensure correct sequencing for simplex links the controller, on receipt of a COS, provides outputs (active low) to disable the inactive receivers. E.g. an input on the Repeater receiver disables the two link receivers, then activates the two link transmitters (assuming they are enabled in settings). On loss of the repeater receiver COS the transmitters are first shut down then the receivers are activated. There is no de-activation of the repeater main receiver as it is a duplex system and local input always has precedence over the links.

The Watchdog timer operates in the controller and protects against lockups. It is set for **one minute**. If for some reason the system crashes or if you are in the remote control mode for longer than one minute the watch dog timer will reset the controller.

**Features**

* Repeater port plus two links (or as gateways with tails enabled)
* Setup controlled by either keypad and LCD while local, or DTMF from remote.
* Adjustable timeout which may be inhibited by remote control or CTCSS.
* Adjustable callsign timing including no callsign, preset time and the 15/3sec mode. All callsigns occur at the end of an over.
* Normally CW callsign but supports voice call announcement with add on recorder.
* Voice is recorded ‘over the air’ by remote DTMF control
* Message feature in voice. Plays back a recorded off air message 100 minutes after last COS operation of repeater port. Used for advising of club meetings etc.
* CTCSS on board with FX365. CTCSS frequency locally settable from keyboard or by DTMF. This facilitates a change in CTCSS frequency policy.
* CTCSS may be used to enable any of the ports or access a timer cancel feature for broadcasts (port enabling or timer cancelling are alternatives and are mutually exclusive).
* Complete control (excluding record function) of features from local keyboard including DTMF password.
* Factory reset supported (excludes call and password) if you lose track of settings.
* Inhibit links and repeater PTT
* Two add on boards controlled using I2C. One manages keyboard and LCD while the other controls front panel LEDs, manual switching and message/callsign functions. The manual switches (active low) activate (1) PTT of Link 2, (2) PTT of link 1 (3) PTT repeater (4) inhibits software control of all PTT so that inadvertent operation of a transmitter can be avoided during servicing of the repeater. Useful for on-site activities.  
  The controller works without these additional boards but they add useful features and operating ease when on site. The 8 LEDs indicate the condition of each COS, PTT, presence of CTCSS or DTMF. The LEDs are in the following order Rptr COS, rptr PTT, Link1 COS, Link1 PTT, Link2 COS, Link2 PTT, CTCSS, DTMF.
* Future expansion possible using available I2C.
* Access to programming pins of the 18F2480 to enable update of the program.
* Anti-flutter available to minimize chopping on mobile signals.
* Each COS may be set for a delay before opening. Useful to dodge noise blips.
* Supports three callsign modes. 0=Normal which provides a callsign at the end of overs when the callsign timer rolls over, 1= 15 second silence mode which will not ident unless there has been at least 15 seconds of no triggering and then 3 seconds of continuous carrier. This latter method prevents callsigns when button pushers are active. Thirdly, 2= callsigns prevented entirely.
* Voice is supported –Jaycar Multi-message recorder (voice ID and one message) and inexpensive single message ISD1820 boards are supported. The latter supports one message and software settings determine if it is used for ID or as a message. Other message boards will probably work depending on their control sequence.
* Measurement of supply voltage supported. Value appears in CW on tail replacing beep when remote controlled on. Accurate to 0.1 volt after calibration.
* Set low and high battery voltage limits. Above *High Volts* normal operation, between *Low Volts* and *High Volts* a descending three tones on tail, below *Low Volts* the transmitters are inactive to protect backup battery.
* Controller will send 1kHz tone for 30 secs at -10dBm for level adjustments.

Without the I2C peripherals, the controller is fully functional and is controllable by DTMF and CTCSS

## How to operate the menu on the keypad/LCD

|  |  |
| --- | --- |
| **Keypad Cmds** | **Function** |
| “\*” | Causes the device to enter menu mode |
| “#” | Causes the device to exit menu mode and update variables/flags |
| “A” | Moves the menu up one item (note it does not save data) |
| “B” | Moves the menu back one item (the menu is circular) |
| “C” | Cancels the entered data on line 2 of the LCD |
| “D” | Saves the entered data to EEDATA for long life memory |

Table 1

In the LCD menu a 1 may be entered just as a single digit whereas in the DTMF command set the commands and data must **always** be entered in pairs. The exception in the LCD menu is callsign entry where pairs of numbers must be entered in accordance with Table 3. The two numbers appear on Line 2 of the display and the ASCII letter appears in the next position. For example, to identify as VK5DJ enter 32 21 05 14 20 and press “D”.

# How to control using DTMF

This is a radio controlled method and allows most of the features of the controller to be modified.

DTMF via a transmitter operating on any of the radio channels (repeater, link1 or link2) is acted upon although when accessed via a link only the repeater responds with an “OK” in morse (exception if links are set as gateways). All command sequences are prefaced using the “\*” character followed by the password. The sequence is : \* pwd/command/value. All DTMF commands and values are sent using two decimal digits. For example \*973 **01 01**. Each command therefore takes 8 digits except callsign entry (function 16) which operates differently. **A single digit number must always be entered as two digits e.g. 03.**

The **Mk4 controller uses decimal numbers for all entries**. Some key pads may not be labelled with the letters A,B,C,D in the fourth column. My Yaesu FT50 has quite different labels than what is expected but the fourth column works in the way described with ‘A’ in the top right hand corner, then B,C,D below it in sequence. For control you must have a 16 digit DTMF keyboard to enable full movement around the menus.

Because the Mk4 controller uses **decimal notation** for all entries, the password sequence is limited to a star plus three numerals.

## Summary of the commands for the Mk4 Repeater Controller

Commands may be sent by remote DTMF or locally from a keypad and LCD. The item numbers are identical for both methods but only the keyboard may change the password and the type of voice recorder while only the DTMF system may begin a recording session.

DTMF assumes that a password is sent first with a star prefix. Example \*987. In the command/function list square brackets indicate the function which is then followed by the data.

All DTMF commands and data use two digits e.g. 01,02,03,....99

|  |  |  |
| --- | --- | --- |
| **Function** | **Keypad** | **DTMF** |
| Timeout in minutes – maximum of 99 | 1-99 | [01] 01-99 |
| Inhibit timeout (0=off, 1 = on,2 = CTCSS ) | 0,1,2 | [02] 00,01,02 |
| Tail in 0.1s of a sec (e.g. 8=800msec) | 0-99 | [03] 00-99 |
| Anti-flutter in 0.1s of a sec (e.g. 2=0.2 secs) | 0-99 | [04] 00-99 |
| COS rptr delay, before open in 0.1s increments (e.g. 3=0.3s) | 1-99 | [05] 00-99 |
| COS link1 delay, before open in 0.1s increments (e.g. 3=0.3s) | 1-99 | [06] 00-99 |
| COS link2 delay, before open in 0.1s increments (e.g. 3=0.3s) | 1-99 | [07] 00-99 |
| Auxiliary Output 1 on for minutes | 1-99 | [08] 00-99 |
| Auxiliary output 0=off, 1=on | 0,1 | [09] 00,01 |
| Volt (0=off, 1=send voltage telemetry) | 0,1 | [10] 00,01 |
| Courtesy beep (0=off, 1=on) | 0,1 | [11] 00,01 |
| **DTMFrptr is heard on repeater (0=off, 1=on)** | **0,1** | **[12] 00,01** |
| DTMFlk1 is heard on link1 (0=off, 1=on) | 0,1 | [13] 00,01 |
| DTMFlk2 is heard on link2 (0=off, 1=on) | 0,1 | [14] 00,01 |
| **CTCSSrptr – repeater PTT needs COS and CTCSS (0=off,1=on)** | **0,1** | **[15] 00,01** |
| CTCSSlk1 – link1 PTT needs COS and CTCSS (0=off,1=on) | 0,1 | [16] 00,01 |
| CTCSSlk2 – link2 PTT needs COS and CTCSS (0=off,1=on) | 0,1 | [17] 00,01 |
| CTCSSdelay adjusts flutter avoidance on CTCSS (100ms intervals) | 0-99 | [18] 00-99 |
| CTCSSFreq is frequency sent to FX365 decoder chip | Table 5 | [19] see note |
| Rptr – enable repeater (0 = off, 1 = enable) | 0,1 | [20] 00,01 |
| Link1 – enable Link1 (0 = off, 1 = enable) | 0,1 | [21] 00,01 |
| Link2 – enable Link2 (0 = off, 1 = enable) | 0,1 | [22] 00,01 |
| Version shows in LCD menu but in DTMF sends version when COS drops | Shown | [23] 01 |
| Send test tone 1kHz at -10dBm for 30 secs then resets itself (unsaved) | 1 | [24] 01 |
| Link or Gateway. 0=both links, 2=L1 gate,4=L2 Gate, 6=both gateways | 0,2,4,6 | [25] 01,02,04,06 |
| Battery cutout on=1, off=0. Monitors Line voltage to detect flat battery | 0,1 | [26] 00,01 |
| High Battery SET Volts. First trigger point for tone slide on tail (Table 4) | 0-51 | [27] 00-51 |
| Low battery SET volts. Below this the TXs are inhibited (Table 3) | 0-51 | [28] 00-51 |
| Over voltage alarm. Above this there is a voltage problem & send alarm | 0-51 | [29] 00-51 |
| Change password (keyboard only) – enter 3 digit number e.g. 973 | 100-999 | [30] NA |
| Callsign timer in minutes – maximum of 99 | 1-99 | [31] 01-99 |
| Change call by DTMF, use table 3 | Table 3 | [32] Table 3 |
| Call mode (0=when timer expires, 1= 15/3 sec, 2=no callsigns | 0,1 | [33] 00,01,02 |
| ID method where 0=CW, 1=voice, 2=voice every second ID, 3,4,5 etc | 0,1 | [34] 00-20 |
| Change default voice recorder 1=ISD1820, 2=HK828 multi message | 0,1 | [35] NA |
| Record Audio to message 1 (callsign) or message 2 (club message) | NA | [36] 01,02 |
| Club voice message 0=prevent, 1 = allow rptr, 2= rptr + links | 0,1,2 | [37] 00,01,02 |
| Factory reset – value not stored, does it immediately on a 1 | 1 | [38] 01 |

Table 2

## Assumptions for inputs/outputs

That COS is active low and PTT is active low. Link receivers are inhibited with a low. If nothing is connected to a COS input then the voltage will settle high at about 12V minus the drop across the LED in the optocouplers. Both COS, PTT and receiver inhibit use optocouplers and neither require a voltage when inactive. The PTT will not require special treatment providing the exciter requires a ground to activate. If your radios use active high it will be necessary to add inverting transistors.

## Function Descriptions

**Function number for remote access is shown in brackets). DTMF function and commands are ALWAYS two digit. A “\*” character is ALWAYS sent as the first character of the password and unless otherwise commanded as passthrough shuts down the transmitters to prevent eavesdropping.**

**Timeout functions**

* **Timeout in minutes [1]:** Determines the timeout of the controller. There is only one setting for all receivers. A 3 minute timeout (default) will cause a Timeout (“TO” sent in CW) after 3 minutes and the system will not be available until all receivers close their mutes.
* *Sample DTMF command : <pwd> 01 03*
* **Inhibit timeout [2]**: 0=normal timeout, 1=timer cancelled completely, 2=timeout cancelled by sending 3 seconds of CTCSS tone. The CTCSS extension of timeout is designed for broadcasts. *Command 10 02 cannot be used with other CTCSS functions*. CTCSS timeout is for 99 minutes. Not resettable until 10 minutes remains.  
  *Sample DTMF command : <pwd> 02 02*

**Tail functions**

* **Tail [3]** in 1/10 of second multiples with a maximum of 9.9 seconds (0-99). This sets the period after COS drops and before a beep or callsign.  
  *Sample DTMF command : <pwd> 03 15 (1.5sec tail)*
* **Antiflutter timer [4]**: in 1/10s of a second with a maximum of 9.9 seconds (at setting of 99). Recommended values of 0,1,2 or 3. This timer helps prevent flutter causing drop outs. Most will find this unnecessary as the receiver mutes may do this satisfactorily. It works *only on the repeater port* as it’s assumed the links have no need due to the ‘other’ repeater(s) managing flutter. It’s there if you need it.  
  *Sample DTMF command : <pwd> 04 01*

**Delay opening of transmitters**

* **COS Repeater delay before TX [5]** in 1/10s of a second (0-99). Maximum of 9.9 seconds (setting of 99). This function may be used to prevent noise bursts from activating the repeater controller functions. Experimentation needed depending on your noise sources. Suggested values from 0-10. Different values permitted for Repeater, Link1 and Link2.  
  *Sample DTMF command : <pwd> 05 04*
* **COS Link 1 delay before TX opens [6]** in 1/10s of a second (0-99). Maximum of 9.9 seconds (setting of 99). This function may be used to prevent noise bursts from activating the link1 controller functions. Experimentation needed depending on your noise sources. Suggested values from 0-10. Different values permitted for Repeater, Link1 and Link2.*Sample DTMF command : <pwd> 06 04*
* **COS Link 2 delay before TX opens [7]** in 1/10s of a second (0-99). Maximum of 9.9 seconds (setting of 99). This function may be used to prevent noise bursts from activating the link2 controller functions. Experimentation needed depending on your noise sources. Suggested values from 0-10. Different values permitted for Repeater, Link1 and Link2.*Sample DTMF command : <pwd> 07 01*

A**uxiliary Output**

* **Timer for Auxiliary device [8]** if fitted. Using the free pin at 21 on the PIC this may be used to control an external device such as an antenna relay or a fan. Values from 0 to 99 in minutes. Active high which can be used to drive a transistor. Zero value here equates to always on. Works in conjunction with the next function.  
  *Sample DTMF command : <pwd> 08 30*
* **Enable Auxiliary device [9]**: A value of 0 de-activates this pin (pin grounded by software). A value of 1 enables the device and period is determined by previous function. Not saved.  
  *Sample DTMF command : <pwd> 09 01*

**Voltage telemetry – monitor battery volts**

* **Volts indication [10]**: 0= off, 1= on. This function when activated replaces the beep with a CW message describing the voltage on the 12V input. This will be of value for those using solar panels and enable a check of battery condition. A calibration pot on the main board will be adjusted on a known input voltage. The CW message has no decimal point so 123 should be read as 12.3V. For obvious reasons this function will normally be turned off.   
  *Sample DTMF command : <pwd> 10 01*

**Courtesy beep on repeater**

* **Beeps On/Off [11]**: 0=off, 1=on. Determines if beeps are to appear on the repeater transmissions. Note that a high beep indicates the repeater receiver was active, a medium beep indicates Link 1 was active, while a low beep indicates link 2 was active.  
  *Sample DTMF command : <pwd> 11 01*

**DTMF relayed through**

* **Pass DTMF tones through repeater [12]**: 0=off, 1=on. This function determines if the repeater transmitter is active when DTMF remote functions are in use (pass through).  
  *Sample DTMF command : <pwd> 12 01*
* **Pass DTMF tones through link1 [13]**: **]**: 0=off, 1=on. This function determines if the link1 transmitter is active when DTMF remote functions are in use (pass through).   
  *Sample DTMF command : <pwd> 13 00*
* **Pass DTMF tones through link 2 [14]**: **]**: 0=off, 1=on. This function determines if the link2 transmitter is active when DTMF remote functions are in use (pass through).  
  *Sample DTMF command : <pwd> 14 00*

**CTCSS commands**

* **Enable CTCSS operation for repeater [15]**: 0=off, 1=on. This command determines if the repeater receiver requires CTCSS to operate.   
  *Sample DTMF command : <pwd> 15 01*
* **Enable CTCSS operation for link1 [16]**: 0=off, 1=on. This command determines if the link1 receiver requires CTCSS to operate.   
  *Sample DTMF command : <pwd> 16 01*
* **Enable CTCSS operation for Link2 [17]**: 0=off, 1=on. This command determines if the link2 receiver requires CTCSS to operate.   
  *Sample DTMF command : <pwd> 17 01*
* **CTCSS hold [18]**: in 1/10s of a second. If the CTCSS drops out during a transmission this timer enables a hang time to prevent signal chop. A value of less than 5 is suggested. It’s another anti-flutter feature.  
  *Sample DTMF command : <pwd> 18 00*
* **Set CTCSS response frequency [19]:** See table 5 to set the frequency at which the CTCSS chip (FX365 responds). Default is 91.5 Hz.  
  *Sample DTMF command : <pwd> 19 16*

**Enable transmitters**

* **Enable repeater TX [20]**: 00= none, 01=TX available.  
  *Sample DTMF command : <pwd> 20 01*
* **Enable link1 TX [21]**: 00= none, 01=TX available.  
  *Sample DTMF command : <pwd> 21 00*
* **Enable link 2 TX [22]**: 00= none, 01=TX available.  
  *Sample DTMF command : <pwd> 22 00*

S**how version**

* **Show version [23]**: 00=none, 01= send version number in morse when COS drops when DTMF commanded. Using keyboard the version is shown on the LCD.  
  *Sample DTMF command : <pwd> 23 01*

**Send test tone**

* **Send calibrate tone [24]:** A tone of 1kHz is put on the audio bus for 30 secs at -10dBm. If initiated by remote, the sequence is activated when the COS closes. Next, approved transmitters are then activated for 30 secs with the tone applied to the audio bus. The repeater is not available to users during the 30 seconds. If initiated from the keypad the transmitters and the tone are activated when the # is pressed. Deviation of transmitters can be checked or adjusted or receivers at other sites can be set.  
  *Sample DTMF command : <pwd> 24 01*

**LCD operate within remote operation**

* **Links or Gateways [25]:** Sets secondary ports as links or Gateways. The difference is that links shutdown immediately the active COS shuts down. That is, no Tail or Callsign is sent. In Gateway mode the port remains open during callsign and tail. This is required if the port is connected into another band so that users of e.g. a HF link hear the beep/or callsign. Values: 0=both secondary ports are links, 2=L1port is a gateway, 4=L2port is a gateway and 6=L1port and L2port are gateways.   
  *Sample DTMF command : <pwd> 25 02 (L1port is a gateway, L2 is a link)*

**Battery voltage functions**

* **Set battery cutouts [26]:** Set = 1, Cleared = 0. If set, the controller monitors the 13.8 Volt supply line before the regulator. If voltage goes below the voltage set in **[27]** then a ramped tone appears on the tail or if it drops below the voltage set in **[28]** then the controller will not enable the transmitters. If it is above the voltage set by Over voltage alarm there is a warning series of three rising tone.This function operates after the next tail.  
  *Sample DTMF command : <pwd> 26 01*
* **Set high battery cutout [27]:** See table 4 for numbers to be entered. Default is 12.0V. Above this value the repeater operates normally, below this value and above the low battery cutout there are ramped tones.   
  *Sample DTMF command : <pwd> 27 30*
* **Set low battery cutout [28]:** See table 4 for numbers to be entered. Default is 10.5V. Above this value and less than the high battery setting there is a ramped tone on the tail indicating that the battery is reducing. When battery voltage is below this setting the transmitters are inhibited to prevent battery damage. Low battery ramp is also put on links to warn all users.  
  *Sample DTMF command : <pwd> 28 15*
* **Over voltage alarm[29]:** See table 4 for numbers to enter. Default is 14.0V. Above this value the controller sends a rising tone in the tail to advise there is a power supply problem with over volts.  
  *Sample DTMF command : <pwd> 29 50 (14.0 volts)*
* **Monitoring of the battery voltage:** See function 10

**Password**

* **Keyboard only, Change password** **[30]:** enter three numerals, press “D” to save

**Callsign functions**

* **Callsign timer in minutes [31]:** Determines the time before another callsign is due when in ‘normal’ mode. The controller will identify when the last mute (COS) closes if the callsign timer has expired. The timer resets when the callsign finishes. This timer has no effect if mode 01 or mode 02 of command 32 is set.   
  *Sample DTMF command : <pwd> 31 10*  *(Callsign ID every 10 minutes)*
* **Change callsign [32]**: See table 3 for achieving this via DTMF or the keypad. When using DTMF 99 must be sent to finish the sequence. When using the keypad just click ‘D’ to save.  
  *Sample DTMF command : <pwd> 32* 32 21 05 14 20 99 (sets call to VK5DJ)
* **Callmode [33]**: 00=normal timer with period set by Function [30], 01=15 sec mode (15 seconds of no COS then at least 3 secs of COS), 02=no call.   
  Calls are only sent after a COS drop and if rules are met. Mode 01 is useful because it minimizes callsigns and reduces the likelihood of a callsign being sent by button pushers.  
  Mode 2 prevents all callsigns.  
  *Sample DTMF command : <pwd> 33 01*  *(set 15 sec mode)*
* **Call in CW or voice [34]**: 00=CW callsigns, 01=Voice callsigns, 02=voice every 2nd ID to max of 20.  
  *Sample DTMF command : <pwd> 34 05 (4 CW calls then a voice call)*

**Voice module**

* **Keyboard only, change default Voice recorder/player [35]**:   
  01= ISD1820 single message, 02= HK828 Multi-message
* **Record audio DTMF only** **[36]:** Send 01 to record call. Send 02 to record message. Recording stops when COS drops. During record the transmitters are turned off for privacy. When the mute drops there is a short pause, the repeater transmitter comes on and the recording is played back.   
  My recording device uses a HK828 chip in a project by Silicon chip Magazine and kitted by JAYCAR. The board requires 9-14VDC. The MCP23017 for the LEDs has 8 spare positions and three of these are used for control of the project. Sending <pwd>2101 sets record callsign until carrier drops or 20 seconds elapses. Sending <pwd>2102 sets record club message until the repeater carrier drops or 20 seconds elapses.  
  The voice callsign announcement will occur in accordance with the setting of the callsign mode (see function 32). The message is sent every 99 minutes being the maximum delay available and depends on the setting of command 36 where 00 inhibits message and 01 sends message 99 minutes after the last COS activation.   
  *Sample DTMF command : <pwd> 36 01*
* **Permission for voice message [37]**: A 00 inhibits messages. If set with 01 then message plays once after 60 minutes of inactivity on rptr only, set to 02 plays on rptr and links.  
  *Sample DTMF command : <pwd> 37 01* (play the voice message on local repeater only after 60 mins of inactivity)

**Factory reset**

* **Factory default [38]**: 01 returns everything except callsign and password to factory defaults.  
  *Sample DTMF command : <pwd> 38 01*

## How to change the callsign

**Example of Changing the callsign using (DTMF):** \*+password + 32 + multiple 2 digit data + 99

The callsign may be set during the programming process by altering the data in EEDATA before burning but it may also be done on air via DTMF or via the keypad. On completion of the sequence and hearing the “OK” set the callsign delay for 1 minute to facilitate checking. This will generate callsigns (after a mute activation) every minute. Return the delay to 10 (or whatever you choose) after successful programming.

The PIC program reads a coded value of each letter of the callsign then uses a lookup table to construct the morse code.

Both DTMF control and keypad use the same codes as described in table 2 on this page.

Here is an example of how you would put a callsign into the PIC’s memory using DTMF.

Using my callsign (VK5DJ) as an example. On the DTMF pad press: \*987 (the password in this example) 32 (the command) 32 21 05 14 20 99 (the 99 tells the device that the call is complete). There is space for an 11 character/numeral callsign not counting the 99 which inserts an end of message character. Numerals, letters and the forward slash are supported.

I’ve shown spaces to make it easier to read but the numbers are sent:\*98732322105142099

The code MUST receive a 99 to abandon the remote control loop as it has no other way of knowing the sequence is finished. If no action is taken for 1 minute the watchdog timer will reset the PIC18F2480 to avoid lockup and abandon the entry.

**Changing the callsign with the keypad**

Press “\*” to bring the controller into display/edit mode. Use the “A” (up) or “B” (down) buttons to find item 32. When the callsign entry is found press the appropriate numbers to enter each letter. These must be entered in pairs, so “1” must be entered as “01” etc. When each pair is entered the callsign letter or digit is displayed. If a mistake is made press “C” to cancel. When finished press the “D” key to save. The callsign will be displayed. Press “#” to abandon edit.

Here are the numeral/letter codes for entry in LCD menu “Change Call” or DTMF command 32

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| No entered | No/Letter | No Entered | Letter | No entered | Letter |
| 00 | 0 | 13 | C | 26 | P |
| 01 | 1 | 14 | D | 27 | Q |
| 02 | 2 | 15 | E | 28 | R |
| 03 | 3 | 16 | F | 29 | S |
| 04 | 4 | 17 | G | 30 | T |
| 05 | 5 | 18 | H | 31 | U |
| 06 | 6 | 19 | I | 32 | V |
| 07 | 7 | 20 | J | 33 | W |
| 08 | 8 | 21 | K | 34 | X |
| 09 | 9 | 22 | L | 35 | Y |
| 10 | / | 23 | M | 36 | Z |
| 11 | A | 24 | N |  |  |
| 12 | B | 25 | O |  |  |

**Table 3** (For callsign entry where “No entered” is the actual DTMF or keyboard entry)

e.g. VK5DJ is entered as 3221051420 in one long string then ‘D’ to save. The program looks for pairs i.e. 32 21 05 14 20. Note that when changing callsign by DTMF the finishing code is 99.

**Table to be used for voltage settings**

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Enter No | Voltage | Enter No | Voltage | Enter no | Voltage | Enter no | Voltage |
| 00 | 9.0 | 13 | 10.3 | 26 | 11.6 | 39 | 12.9 |
| 01 | 9.1 | 14 | 10.4 | 27 | 11.7 | 40 | 13.0 |
| 02 | 9.2 | 15 | 10.5 | 28 | 11.8 | 41 | 13.1 |
| 03 | 9.3 | 16 | 10.6 | 29 | 11.9 | 42 | 13.2 |
| 04 | 9.4 | 17 | 10.7 | 30 | 12.0 | 43 | 13.3 |
| 05 | 9.5 | 18 | 10.8 | 31 | 12.1 | 44 | 13.4 |
| 06 | 9.6 | 19 | 10.9 | 32 | 12.2 | 45 | 13.5 |
| 07 | 9.7 | 20 | 11.0 | 33 | 12.3 | 46 | 13.6 |
| 08 | 9.8 | 21 | 11.1 | 34 | 12.4 | 47 | 13.7 |
| 09 | 9.9 | 22 | 11.2 | 35 | 12.5 | 48 | 13.8 |
| 10 | 10.0 | 23 | 11.3 | 36 | 12.6 | 49 | 13.9 |
| 11 | 10.1 | 24 | 11.4 | 37 | 12.7 | 50 | 14.0 |
| 12 | 10.2 | 25 | 11.5 | 38 | 12.8 | 51 | 14.1 |

**Table 4** (Low and High Battery voltage detect)

**Factory defaults**

DurationTimeout = 3 ‘in minutes for all three ports  
DurationCall = 10 ‘minutes when in normal callsign mode  
DurationTail = 8 ‘in 100msec units length of tail before beep  
DurationFlutter = 0 ‘anti-flutter timer in 100msecs units  
COSrDelayTimer = 0 ‘delay before COS is actioned. Anti-noise pulse 100ms units  
COSLk1DelayTimer = 0 ‘for first link  
COSLk2DelayTimer = 0 ‘for second link  
AUXOnForMins =1 ‘1 minute, note 0 gives continuous operation if AUXon = 1  
AUX on = 0 ‘flag to initiate an AUX operation  
InhibTO = 0 ‘inhibit timeout flag with CTCSS  
VoltOn = 0 ‘measure voltage on non-regulated voltage in  
BeepsON = 1 ‘flag for beeps  
DTMFpass = 0 ‘no DTMF pass through for any port, no CTCSS timeout enabled  
CTCSSenable = 0 ‘no ports require CTCSS   
CTCSSdelay = 5 ‘in 100ms units time CTCSS remains active after signal loss to stop chatter.  
CTCSSfrequency = 8 ’91.5Hz  
TXenable = 7 'all ports enabled (4+2+1) = binary %00000111  
Password = 973 ‘3 numeral password (highly recommended that you change this)  
 Callmode = 0 ‘0 = standard callsign, 1= 15 second style or 2 = no callsign

MorseVoice = 0 ‘morse ident = 0, Voice ident = 1, values 2-20 ratio of morse:voice  
MsgPermission = 0 ‘allow messages if repeater quiet for 100 minutes 0=off 1=on Rptr,2=on all  
Gateway=0 ‘sets links so no callsigns or beeps are retransmitted.   
Batt Cutout=0 ‘disallows voltage monitoring and TX shutdown. 1=active  
HighBatt =12.0 ‘if volts above this value then normal operation of TXs  
LowBatt =10.5 ‘volts< LowBatt then no TXs, Lowbatt<volts<Highbatt then tone slide.

OKtoPlay=2 ‘1=ISD1820 voice recorder, 2=HK828 voice recorder (multi message)

**CTCSS frequencies for FX365:**

|  |  |  |  |
| --- | --- | --- | --- |
| **Keyboard/DTMF** | **Result** | **Keyboard/DTMF** | **Result** |
| 0 | 67.0 | 9 | 94.8 |
| 1 | 71.9 | 10 | 97.4 |
| 2 | 74.4 | 11 | 100.0 |
| 3 | 77.0 | 12 | 103.5 |
| 4 | 79.7 | 13 | 107.2 |
| 5 | 82.5 | 14 | 110.9 |
| 6 | 85.4 | 15 | 114.8 |
| 7 | 88.5 | 16 | 118.8 |
| 8 | 91.5 (default) | 17 | 123.0 |

**Table 5**

The FX365 chip may be tone programmed using the keyboard or DTMF. e.g. for DTMF you might send \*987 25 06 to set the FX365 to respond to 85.4Hz whereas you might send 6 (and “D” for save) from the keyboard to access the same frequency.

## Sound recorder

Connections between the LED MCP23017 and the JAYCAR kit. **Table 6**

|  |  |
| --- | --- |
| Pin of MCP23017 | Pin on Jaycar board and function |
| 21 (low is active) | Play-record pin 1 |
| 22 (low is active) | Select message 1 on pin 3 (callsign) |
| 23 (low is active) | Select message 2 on pin 4 |
| 24 (low while active) | Msg 8 of the Jaycar board (LED of DS1820 board) |

**Record sequence**: Play-record goes low, and wanted message number held low. Recording sequence stops when message line goes high.

**Playback:** Play-record held high, wanted message line pulsed low for 400msec. Message end determined on pin 24 of MCP23017.



**Using sound recorder/player**

Recording must be initiated from the repeater primary channel as the repeater COS is used to sense the end of recording.

The outputs on the MCP23017 are set as follows for the HK828.

Control assumptions:

1. Hold record button low then hold message select button low (active low to record. Release message select when finished record, then release record button.
2. To play, hold low the appropriate message until it auto completes.

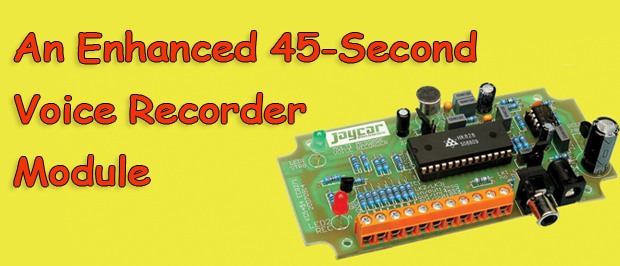
<http://www.nskelectronics.com/audio_ply_bk_brd.html>

You will have to attach wires under the board as it does not have sockets for microprocessor control. It seems to be a very close relative of the Silicon Chip Magazine article. Unfortunately Kiran does not currently export.

I use a project described in Silicon Chip Magazine and once sold as a kit by Jaycar Electronics. Unfortunately only small numbers of the kit are available in some stores. A part of the article can be read here: <http://www.siliconchip.com.au/Issue/2007/December/An+Enhanced+45-Second+Voice+Recorder+Module>

To allow the controller to detect when end of message is reached a small modification is required on the Jaycar board. Pin 10 is the busy (active low) signal output of the HK828. To improve the connections I ran a wire from Pin 10 to the underside of the Msg 8 external connection and cut the trace coming from pin 9 and the pullup resistor. The Msg 8 connector became the EOM wire. This connector must be connected to pin 24 of the MCP23017 (pin 1 of the connector – see circuit diagram). There is no +12V available on connector TB so this will require an external connection if using the Jaycar board. I removed the microphone and added a pin on the side nearest the links for audio in. It accepts -10dBm quite well.

The ISD1820 board has the busy pin available and is labelled “LED”. Again I removed the microphone and added a pin nearest the speaker connections. It also accepts -10dBM in.



Recording the callsign

Record: Send DTMF <pwd>36 01. Pin 21 of the MCP23017 goes low initiating record mode, and a short moment later the message select pin 22. Recording begins after a short pause (uses tail timer as a short time).

When you have finished dictating the callsign stop transmitting and the recording completes. The recording also stops if the record time limit is reached. To check the recording, the message is immediately played back for checking purposes.

Recording the message

Record/playback chips/boards that support multiple messages may be set to multiple message modes. The software supports this. To record the message for occasional play, use the command <pwd>36 02 and follow the instructions above.

Cheap alternative

The ISD1820 is a very inexpensive single channel device. It is available for about AUS$6 from AliExpress including shipping.

If you use one, you need to choose between voice identification or a 10 second message in the menus. Use the appropriate commands to select (commands 33 and 35). If you accidentally activate both in the menu you will hear the same message as a callsign and as a message. The simple recorder does have a high level of background hiss but it is definitely usable. Some top cut may help.

Although the output can drive a speaker it produces line level (-10dBm) into the controller’s 600ohm input. You shouldn’t need a level control.

**Menu change needed if using a multi-message module or ISD1820 module**

The choice of ISD1820 (single record module) or a HK828 (multi-message module) may be made in the Keypad menu. The last item in the menu, a “1 “ activates the code for an ISD1820 single message module and a “2” represents a HK828 multi-message module. After changing the kind of module in the menu, and saving the result with “D”, you must reboot the controller so that the program may correctly initialize the MCP23017 when it reboots. This reboot is needed because the modules use different polarities to record and play. To avoid possible conflicts it may be better to plug in the audio module after you have chosen the module in the menu and shut down the power. (Author’s note: during the debugging of the software I didn’t always do this and I got away with it but you may not). Following this, the type of module is stored in the long term memory.

Have fun,

John Drew 10/9/17

VK5DJ (www. vk5dj.com)

**Acknowledgements:**

Barry Williams (VK5BW) for turning my sketches into accurate schematics, fixing hardware errors, adding features, designing and building the board and much testing and feedback.

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Brian VK5VI John VK5DJ Barry VK5BW

## Appendix 1:

**Pin layout of PIC18F2480 – Table 7**

|  |  |
| --- | --- |
| **Pin of 18F3480** | **Function** |
| 1 | MCLR held high but High Voltage programming pin (Pins 1,27,28 for programming) |
| 2 | A/D voltage conversion for morse output of power supply +V (accurate to 0.1V) |
| 3 | Repeater COS active low |
| 4 | Link 1 COS active low |
| 5 | Link 2 COS active low |
| 6 | Link 1 Receiver inhibit (active low) |
| 7 | Link 2 Receiver inhibit (active low) |
| 8 | Earth Vss |
| 9 | DTMF detect Q1 from MT8870 active high |
| 10 | DTMF detect Q2 |
| 11 | DTMF detect Q3 |
| 12 | DTMF detect Q4 |
| 13 | DTMF detect Tone present – active high – tone present |
| 14 | SCL of I2C |
| 15 | SDA of I2C |
| 16 | Repeater PTT (high active at this point but after Optocoupler active low) |
| 17 | Link 1 PTT (high active at this point but after Optocoupler active low) |
| 18 | Link 2 PTT (high active at this point but after Optocoupler active low) |
| 19 | Vss (second earth point and for chip located bypass cap) |
| 20 | Vdd (+5V) |
| 21 | Spare (shown as aux and available as a timed output by remote) |
| 22 | Morse and beeps audio sinewave |
| 23 | CTCSS tone detect pin |
| 24 | FX365 programming D2 serial clock |
| 25 | FX365 programming D3 serial data |
| 26 | FX365 programming Load/latch |
| 27 | Programming PGC |
| 28 | Programming PGD or Calibrate tone out depending on jumper and remote functions |

**Pin layout for recorder ISD1820 module to MCP23017 – Table 8**

|  |  |  |
| --- | --- | --- |
| **MCP23017 pin** | **ISD1820 pin** | **Function** |
| 21 | Rec | Active high puts module into Record mode |
| 22 | PlayE | Short active high to initiate Playback |
| 23 | NC |  |
| 24 | LED | Brief 0V informs controller that message is complete |

**Pin layout for recorder HK828 Jaycar module – Table 9**

|  |  |  |
| --- | --- | --- |
| **MCP23017 pin** | **HK828 module pin** | **Function** |
| 21 | RE invert | 0 V to initiate and hold to record or +V puts into play mode |
| 22 | Msg 1 (callsign) | 0V to select playback mode. High stops record or play of msg1. |
| 23 | Msg 2 | 0V to select playback mode. High stops record or play of msg2 |
| 24 | Msg 8 (modified) | 0V while playing then high when message is complete |

## Appendix 2: Wiring the keypad

Keypads vary in their connections.

My keypad:

With the board face down and the connections facing you then pins numbered from left to right 1,2,3,4 (columns), 4,5,6,7 (rows).

Column one being the ABCD column, column 2 being the 3,5,9,# column, column 3 being 2,5,8,0, and column 4 being 1,4,7,\*.

Row 1 on pin 5 of the keypad is the bottom row \*,0,#,D

Row 2 on pin 6 is second row up i.e. 7,8,9,C

Row 3 on pin 7 is third row up i.e. 4,5,6,B and

Row 4 on pin 8 is top row and 1,2,3,A.

It just happened to be a convenient way to wire the MCP 23017 to the keypad to have pin 1 of the keypad to pin 1 of the MCP23017 etc all the way to pin 8 of the keypad to pin 8 of the MCP23017.

Accordingly the software for the PIC18F2480 is prepared with this assumption.

If your keypad is connected differently you’ll have to do some research. Simple logic to work out the change.

Here are the connections for a 16 keypad from Jaycar: Table 10

MCP23017 pin number Keypad number when sitting as above

|  |  |
| --- | --- |
| 1 | Column 1 |
| 2 | Column 2 |
| 3 | Column 3 |
| 4 | Column 4 |
| 5 | Row 1 |
| 6 | Row 2 |
| 7 | Row 3 |
| 8 | Row 4 |

## Front panel switches via the MCP23017 (LEDs and switches) – Table 11

|  |  |
| --- | --- |
| Pin of MCP23017 | Switch function SPST (active when grounded) |
| 25 | Inhibit controller prevents accidental TX when on site |
| 26 | Activate repeater TX |
| 27 | Activate link 1 TX |
| 28 | Activate link 2 TX |

## Audio level monitoring

Brian VK5VI has developed a bar graph LED which takes its input from the audio common point CN5 to allow setting of input levels to the controller.

A level of -10dBm is adjusted for flicker between green and red LEDs.

Appendix 3 : Sending DTMF commands: Programmer’s notes

The DTMF tone pads do not create the normal accepted notation and have to be translated in the PIC. The following table shows the conversion process. It is of interest to programmers only. Users should disregard this table. It forms part of **my record only**. Note the star key is translated as a character decimal 14 or ‘E’ in Hex, while the cross hatch key is translated as a character decimal 15 or ‘F’ in Hex. This **Mk4 controller has all entries in decimal numbers**. Some key pads may not be labelled in the letters A,B,C,D but usually these occupy the fourth column. My Yaesu FT50 has quite different labels than what is expected but the fourth column works in the way described with ‘A’ in the top right hand corner, then B,C,D below it in sequence.

|  |  |  |
| --- | --- | --- |
| LABEL ON DTMF PAD | NUMBER SENT | NUMBER after translation |
| 0 | Binary 1010 = Hex 10 | Hex 0 Decimal 0 |
| 1 | Binary 0001 = Hex 1 | Hex 1 Decimal 1 |
| 2 | Binary 0010 = Hex 2 | Hex 2 Decimal 2 |
| 3 | Binary 0011 = Hex 3 | Hex 3 Decimal 3 |
| 4 | Binary 0100 = Hex 4 | Hex 4 Decimal 4 |
| 5 | Binary 0101 = Hex 5 | Hex 5 Decimal 5 |
| 6 | Binary 0110 = Hex 6 | Hex 6 Decimal 6 |
| 7 | Binary 0111 = Hex 7 | Hex 7 Decimal 7 |
| 8 | Binary 1000 = Hex 8 | Hex 8 Decimal 8 |
| 9 | Binary 1001 = Hex 9 | Hex 9 Decimal 9 |
| A | Binary 1101 = Hex D | Hex A Decimal 10 |
| B | Binary 1110 = Hex E | Hex B Decimal 11 |
| C | Binary 1111 = Hex F | Hex C Decimal 12 |
| D | Binary 0000 = Hex 0 | Hex D Decimal 13 |
| \* | Binary 1011 = Hex B | Hex E Decimal 14 |
| # | Binary 1100 = Hex C | Hex F Decimal 15 |

Table 12

For control you must have a 16 digit DTMF keyboard to enable full movement around the menu. The Mk4 controller uses **decimal notation** for all entries. The password sequence is therefore limited to a star plus three numerals.

A standard DTMF control consists of \*973 (example only) + the function number (2 digits) +parameter (2 digits). Each command therefore takes 8 digits except callsign entry (function 16) which operates differently. **A single digit number must always be entered as two digits e.g. 03.**

## Appendix 4 : programmer’s notes

**Commands stored in CDATA and functions associated variables – programmer info only**

**Menu item stored in CDATA Address for reading Variable used**

**CData** "Timeout (mins) " TimeoutAddr byte DurationTimeout word

**CData** "Callsign (mins) " CallTimeoutAddr byte DurationCall word

**CData** "Tail (100ms) " PrebeepAddr word DurationTail word

**CData** "Flutter (100ms) " FlutterAddr byte DurationFlutter byte

**CData** "COSRdelay 100ms " COSRdelayAddr byte COSrDelayTimer byte

**CData** "COSL1delay 100ms" COSL1delayAddr byte COSLk1DelayTimer byte

**CData** "COSL2delay 100ms" COSL2delayAddr byte COSLk2DelayTimer byte

**CData** "AUX1 on for mins" AUX1onForAddr byte AUX1onformins word

**CData** "AUX1 1=on,2=off " AUXon byte AUXon

**CData** "Inhib T/O 0,1,2 " InhibitTOaddr as byte InhibTO as byte

**CData** "Volt 1=on,0=0ff " VoltONaddr as byte VoltONFlag as byte

**CData** "Beeps 1=on,0=off" BeepsONaddr as byte BeepsOn as byte

**CData** "DTMFrptr 1=on " DTMFaddr as byte bit 0 DTMFpass as bit0

**CData** "DTMFlk1 1=on " bit 1 DTMFpass L1 as bit

**CData** "DTMFlk2 1=on " bit 2 DTMFpass L2 as bit

**CData** "CTCSSrptr 1=on " bit 0 ctcssaddr CTCSSenable as byte

**CData** "CTCSSlk1 1=on " bit 1 bit 1

**CData** "CTCSSlk2 1=on " bit 2 bit 2

CData “CTCSSdel 100ms “ CTCSSdelayAddr byte CTCSSdelay as byte

**CData** "CTCSS frequency " wCTCSSfreq CTCSS freq as word

**CData** "CW=0,Voice=1 " MorseVoice byte MorseVoice

**CData** "Change call " Start\_call string of 10 not needed

**CData** "Change PWD -kbd " PasswordAddr word N/A

**CData** "Rptr 1=on 2=off " TXenableAddr byte bit 0 TXEnable byte bit0

**CData** "Link1 1=on 2=off" bit 1 bit 1

**CData** "Link2 1=on 2=off" bit 2 bit 2

CDATA “Callmode (0,1,2)” CallModeAddr as byte Callmode as byte

CDATA “ID CW=0,Voice=1 “ MorseVoiceAddr MorseVoice as byte

CDATA “Version “ VersionNo as byte address only used

**CData** "Factory 1=reset " byte not stored but does the reset.

CData “Message 1=on “ PlayBackMsgAddr MsgPermission as bit

CData “Show DTMF 1=ON “ RemotePrintAddr RemotePrint as byte

CDATA "Batt Cutout ON=1" BattCutoutAddr BattCutout as byte

CDATA "HighBatt SetVolt" BattHighCutAddr HighBatt as byte

CDATA "Low Batt SetVolt" BattLowCuttAddr LowBatt as byte

CDATA "1820=1,Multi=2 " VoiceTypeAddr OKtoPlay as byte

# Appendix 5: builder’s notes

**The jumpers.**

JB1 is an isolating link in the line to the repeater transmitter. It should be jumpered in normal use.

JB2 provides access to the auxiliary pin. The active pin is nearest the FX365. The other pin is just there for support and is not connected (the current circuit diagram is incorrect)

JB3 normally connects the PGD pin (28) to the audio system where it is used to generate the 1kHz calibration tone. The jumper should be in for normal operation. If difficulty is experienced in programming the PIC then it might help to temporarily remove this jumper as it could be loading the PGD pin during programming. Remember to replace it once there is a successful program.

**Programming with PICkit3**

I usually power the circuit using the PICkit3, however it is possible that the current load is too great. If trouble is experienced I have found that it is OK to both power the system through the PICkit and also through the normal power supply for the controller. I haven’t blown up my PICkit3 yet!

# Appendix 6: Construction details for controller

**Alignment and Calibration of the Mk4 Repeater Control Card**

When the new card has been completed and ready for the addition of the operating software and alignment, the following procedure is to be followed.

**Items of test equipment required :-**

* A variable power supply that can be varied between 10 and 15 volts, preferably with an adjustable current limit – (200mA is sufficient).
* A digital multimeter and probes.
* A PIC programmer and software that has the capability to use the programming connector on the PCB - CN7. A Pickit3 unit is preferred and MPLAB software or equivalent.
* The current version of the Repeater HEX software and documentation.
* A remote control and LCD display unit with adaptor cable connected to the I2C connector CN6.
* The LED display unit and cable to plug into the second I2C connector CN5.
* A dummy control box to simulate the repeater or link unit, with a suitable cable and connector to plug into CN1, CN2 or CN3. See Appendix xx
* An oscillator unit with 600Ω output impedance, frequency from 90Hz to at least 1Khz, and an adjustable output from -30dBm to 0dBm.
* A level meter calibrated in dB at 600Ω impedance and capable of Hi Z and terminated measurements.
* An audio monitoring unit with 600Ω input impedance or a terminating resistor on its input.
* An oscilloscope with suitable probes.
* An accurate frequency counter that can measure down to 90 Hz and up to at least 10Mhz.
* A source of programmable DTMF tones (a laptop running Audacity is OK).
* Sundry 600Ω terminations, dummy terminated headers for link ports if dummy control boxes are not available for Links 1 & 2, miscellaneous clip leads etc.

**Procedure :-**

* Connect up the controller card to the test configuration shown in Fig 2. with the dummy test box to CN1 (repeater connector).
* IMPORTANT ! – set RV1 fully anticlockwise before applying DC volts to the test box or the PCB – this will prevent possible damage to the micro port.
* Set the power supply to 12.5v and current limit (if any) to 200mA.
* After checking the setup, apply power. The current drawn should be in the range of 50-70mA, any larger deviation than this will mean that there is a fault on the PCB or other attached unit.

**Programming !**

* At this time, the display and control unit should be active but without any readable characters on the LCD screen.
* With your PC or Laptop computer, run the programmer software and load or import the appropriate current HEX file into the software, this will be a file such as ‘Mk4Controller\_XX.hex’ . The ‘XX’ is the version number, so check the Website to see if you have the latest version.
* Connect the Pickit3 programmer to the CN7 connector and configure the software to user the programmer unit you have. Once it has identified that it is connected to the PIC and ready to go, program the chip.
* While this is happening and if you have hooked the audio monitor to the TX Audio port, you will hear the data being squirted into the chip in a series of tones, confirming that programming is taking place.
* On completion, the display and control unit should have information on its screen indicating that it is ‘waiting’. Remove the program cable and cycle the power to the PCB.
* Use the controller unit to set the following parameters – Menu Items (x)
  + (1) – Time out in minutes = 2
  + (2) - Inhibit timeout = 2
  + (11) – Courtesy beep = 1
  + (18) - CTSS Hold = 5
  + (30) - Callsign Timer = 2
  + (32) - Call Mode = 1
* Note : Do not change the default password at this time (973).

**If all is well !**

* Set the audio signal generator to a level of -10dBm and a frequency of 1000Hz to the Rx Audio port of the dummy test box.
* With the CRO and probe, look at the level on TP-2 (Common Reference point), this should read very close to 2.4V P-P, if measured with a Hi-Z level meter, the level will read approximately 0dBm.
* Connect the terminated level meter to the Tx Audio port on the dummy test box and read the level. Adjust RV4 (O/P level Adjustment) to give a reading of -10dBm. This level should now also be found on pin6 of CN2 & CN3 (Link1 & 2 TXA ports with 600Ω terminations).
* Remove the generator tone.
* Use the control unit to go to menu item (24) ‘Calib Test Tone’ and enter ‘1’ then save and enable it (ie press ‘D’ the ‘#’ to enable it), this will send 30 seconds of 1Khz tone.
* Adjust RV6 (Set line up tone up level) for -10dBm at the Tx Audio port.
* By operating the COS switch on the test box, the COS light and the Tx PTT LED’s should light and on switching off, you should hear the ID Callsign being issued and a beep as the TX PTT switches off.
* Connect the CRO to the TP3 (Tx Audio Level) and measure the P-P voltage level of the ID tone or beep and adjust RV5 (ID Tone Level) to a value of 0.5V P-P, this corresponds to approximately -12dBm, 2dB down on line up level.

**Setting up the decoders :-**

* Turn on your frequency counter and allow it **to stabilise**, it is important that its accuracy is good, or the following procedures will be in-effective and decodes will not be accurate.
* With the probe set to the 10x position, measure the frequency of the DTMF oscillator on Pin 7 of the MT8870 Cx1 pad. This should measure 3.579545Mhz or within 1% or less, (this is +/- 35.795Khz - a low of 3.543750Mhz or a high of 3.61534Mhz). If the frequency is high, then a suitable padder capacitor may be added to the Cx1 position, if it is **very** low then another crystal may be required, but **check the decoding accuracy** in all cases before even attempting to replace the crystal.
* Use the probe to measure the frequency of the oscillator of the FX365 chip on the junction of C5/R10. This is a 1 Mhz oscillator, so the limits will be +/- 10Khz. This will likely to be high as it is a ceramic resonator, if you installed the recommended 22pF capacitor to Cx2, then it will be fairly close to frequency, but it may need a little extra capacity (another chip capacitor soldered on top of the existing cap) if it is too high. Practice shows that the frequency accuracy can be got down to better than 0.5%.
* Reconnect the audio generator to the Rx Audio port, 1Khz at -10dBm and connect the CRO to TP1 in AC mode as there is DC on the test point (DTMF sense) and adjust RV2 for 0.4V P-P, this sets the DTMF level at a suitable level that will allow consistent decoding of the tones down to better than -20dBm input.
* Connect the CRO to TP4 (top of C7, CTCSS Level) and adjust RV3 for 0.4V P-P, the decoder will work down to better than -22dBm as well.
* Setup the DTMF generator to send a test sequence of \*9730900 with tones set at 50mS on and 50mS off times. It may be helpful to generate a file with the sequence, as that can be played over and over with just a click of a button.
* Set the level of the DTMF generator to -15dBm (1.4v P-P at TP2 Common point) at the Rx Audio port on the test box, you should now be able to see the Tx PTT LED flash on for a few milliseconds on receipt of the signal when the COR switch is turned on. On turning the COR off, the controller will acknowledge and confirm the receipt of a correctly coded signal, by a Morse ‘OK’ being heard from the monitoring amp.
* Vary the DTMF level downwards to the -20dBm level (0.75V P-P TP2), it should be observed that decoding should still be OK until about -22dBm.
* Set the audio generator to a frequency of 91.5Hz +/- 1Hz and set the generator level to -15dBm into the Rx Audio port. The CTCSS LED will come on to indicate that the signal is present.
* Vary the frequency of the audio generator either side of the nominal 91.5Hz, it should drop out at approximately equal +/- deviation (about 2 – 3 Hz) showing that the CTCSS resonator is at the correct 1Mhz frequency
* Vary the level of the signal downwards to -20dBm, the LED should remain lit until about -22 to -25dBm is reached, it will be observed that there is very little hysteresis. Turn on the COR switch and apply the tone, you should hear 3 beeps after 5 or 6 seconds indicating the TX timer has been turned off.

**Setting the Battery Volt Alarms**

* Using the Controller unit, go to menu (10) and set it to ‘1’ and save the setting, now when the COR switch is cycled you will hear 3 numbers come back in Morse which relates to what the Micro sees coming from the voltage calibrate pot RV1.
* Adjust the power supply to exactly 13Volts and carefully measure what the voltage is on pin 1 of CN1 or on the pad of R1a calibrating resistor soldered to the diode D1, this should be identical.
* Measure the voltage at the potentiometer end of R1, this should read no more than 6v, any deviation outside this limit may indicate the divider string is corrupted and should be examined to correct any fault.
* Measure the volts at the Z0 link from the pot to the micro and adjust RV1 (Volts Cal) to 4.35 volts at the Z0 link from the pot.
* **WARNING:** Under no circumstances must the voltage measured exceed +5v as this may damage the port on the Micro.
* Record the level heard and carefully adjust RV1 either up or down until 1-3-0 is heard on the Morse output, the voltage calibration should now be correct for the remaining battery setups to follow.
* Go to Menu (10) and set it to ‘0’ and save and activate.

**Batteries**

* Table 5 is a reference chart that is used to setup the high and low alarms as follows, you will need this chart to set the limits.
* Repeater backup battery installations tend to use a lead acid based battery, whether it is flooded cell or gel technology, and as such, has limits on what high and low voltages it will tolerate.
* Batteries are usually in the float mode at most sites, with the float voltage set to a maximum of 13.6 – 13.8 volts, any more than this and the electrolyte will effectively be consumed and the battery will be damaged and fail.
* Conversely, batteries do not like being deeply discharged with the terminal voltage falling lower than 11.5 volts, this causes sulphation in the battery and rapidly reduces the capacity of the battery due to the lead sulphate contamination which is irreversible.
* This controller has programmable limits and alarms to warn of potential problems with the backup battery, and will also turn the repeater off to protect the battery until the charge is restored.

**Battery voltage Functions :-**

* Select menu item 27 – ‘set high battery cut out’
  + The default for this item is 12.0 volts and will generally be the normal operational figure for the battery operating between 12v and 13.6v.
  + The number shown in the LCD display is NOT the battery set voltage, referring to Table 5, you will see that for a voltage of 12 volts the value should read 30.
  + Provided the battery stays within the range of 12v to 13.6 volts there will be no alarms given by the system.
  + If the battery should discharge to a value less than 12 volts a downward ramping tone will be issued when the COS releases.
* Select menu item 28 – ‘set low battery cut out’
  + The default value for this item is 10.5 volts or a value of 15, but this is too low as the battery will be damaged it allowed to discharge to this level, set it to 11.8 volts or a value of 28 and save the setting.
  + When the voltage falls to 11.8 volts, the controller will prevent the repeater from keying up on receipt of a signal.
* Select menu item 29 – ‘Overvoltage alarm’
  + The default is set to 14 volts or a value of 50, this is much too high for a floated battery and should be set at 13.8v or a value of 48.

**Checking the alarm points :-**

* Select menu item 26 – ‘set battery cut outs’ and set this parameter to 1 and save it.
  + With a multimeter set across the power supply, vary the voltage slowly and carefully upward towards the 14 volt mark, making sure that the voltage does not exceed the 15volt limit. Check the alarm point by opening and closing the COS switch on the test box to see what voltage is present when the alarm first occurs and record this voltage on your test sheet.
  + Slowly lower the voltage to 12 volts and observe that you hear the low ramp tones when the COS closes, record this value.
  + Lower the voltage down to the point where the repeater PTT will not operate when the COS is keyed and record this on your test sheet.
  + Observe that when increasing the voltage slightly above that point, restores the Repeater PTT operation again.

# Appendix 7

Notes from the previous VK5RMG repeater regarding the PRF1520

Experiments on audio board and associated controls

The following comments applied with signal generator producing modulated tone into RX on 146.300 and with audio fed into pins 1 and 2 of DB25.

Keying TX with switch between pin 6 and 22 the transmitter is keyed onto 146.9.

On audio board in PRF1520 the SW3 switch set has bit 1 on (others off)

The expansion audio board is out of circuit (see links 1,2,3,4) and removed.

RX audio appears across pins 3 and 4

TX audio across pins 1 and 2

For use with our controller the following pin assignment on DB25 is necessary:

Pin 1= TX audio in

Pin 2= TX audio in (Earthed by JP103)

Pin 3= RX audio out

Pin 4= RX audio out (Earthed by JP102)

Pin 6= PTT (sits high but earth to activate)

Pin 8= MUTE (floating - goes low with received signal)

Pin 7,13,22= Earth as checked with multimeter but not shown as such on circuit.

**Notes:**

When using pin assignment diagrams be careful not to use the PRF1510 diagram in the manual as although the mute connections work they are not interpreted correctly by the control circuitry in the PRF1520. Use the circuit diagram 8544-00-D-02 Issue 2 labelled

# PRF15 SERIES BASE STATION

**PRF1520/20 INTERFACE** (the incorrect diagram has PRF1510 interface)

# WIRING DIAGRAM

Jumpers on the back plane are set :

JP200 – 2&3

JP201 – 1&2

JP202 – 1&2

JP102 – 1&2 (earths pin 4 of DB25)

JP103 – 1&2 (earths pin 2 of DB25)

JP104 – 1&2 (earth’s one side of mute relay)

JP105- 2&3 (puts voltage on the PTT line so it is held high)

JP1 - 1&2 (this is the simplex switch)

I have removed jumper JP104 and connected pin 7 of the DB25 to +12V at controller end.

This means mute behaves as active high. (needs checking)

# Appendix 8

# VK5RMG 2017 notes

The repeater now has three parts:

* The PRF1520
* The two links – one to Naracoorte and the other to Mt Benson
* The new VK5DJ controller taking the place of the NHRC 4 controller and now in the same rack as the links. The audio bridge is no longer required.

**PRF1520**

The transmitter is, at the time of installation, outputting 40W to the duplexer. The receiver mute opens at 0.4 uV. The pre-amp improves this to about 0.15uV.

The audio section of the receiver has been modified to bypass the audio across the FX365 CTCSS decoder to avoid loss of the low frequencies normally filtered out by the FX365. So the audio output of the receiver is de-emphasised but contains the full range to facilitate DTMF and CTCSS in the main VK5DJ controller. C5 and C50 of the audio board piggy backing the receiver are removed. A new 180nF cap is used to bridge the input side of what was C5 to the output side of what was C50. i.e. to R91.

In addition C47 was removed and the Vf output at C21 was linked by wire to TTR audio which forms the receiver audio to the VK5DJ controller.

See appendix 1 for diagrams

The PRF1520 is linked to the controller via one cable that plugs into the top of the controller box.

**The links to Naracoorte and Mt Benson**

**Link 1 to Mt Benson** on 430.475MHz units are located to the left of the chassis. The receiver is placed on the outside. The two units have a combined DB15 socket for the upper of the lower two DB15 on the rear of the controller. 12V is fed through pin 1 to the controller and also to pin 1 of the PRF1520 DB15 as this point is required to provide voltage for the voltage sense in the controller. Originally it was intended to provide +12V to the controller from each of the transmitter/receiver units however this was not done from the repeater. Hence the jumper. The pins 9-15 are connected to earth via a short wire to a ground on the back of the box. A 1.5uF cap is soldered across pin 1 to this earth point to remove some computer radiation.

The antenna switch is a TAIT switch and was needed due to radiation from our home brew experimental antenna switch.

**Link2 to Naracoorte** is also a Tait TX/RX combination on 442.35MHz and is located to the right of the chassis. Because this link runs less power the home brew antenna switch was used. The rest of the wiring is the same as per link1 although there is no link to the repeater’s DB15 for power.

# Modifications to UHF receivers

Inhibit control

1. Remove BN wire from pin 20 (open collector CD)
2. Ensure continuity to DB15 pin 13
3. Connect BN wire to pin 37 for inhibit on TX – active low.

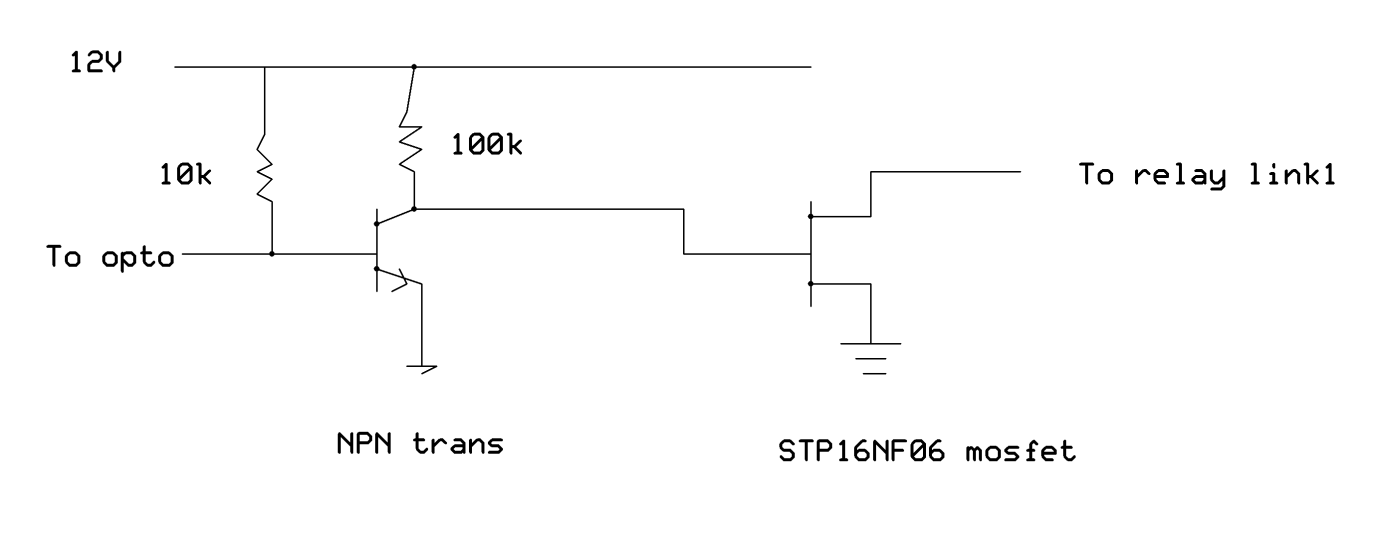
Time delay – inhibit circuit. Active high for carrier detect

1. Lift blue wire pin 27
2. Connect 120 ohm resistor to 27 in rcvr
3. Add wire from DB9 13 to 28 in rcvr

# The relay interface

The opto couplers do not have the capacity to drive antenna relays.

The wiring in the controller/link chassis was cut and an additional Vero board circuit was included. It uses a NPN transistor wired as an inverter and a MOSFET power device. The FET device used was a STP16NF06 60V 16A TO220 bought from Anvil for $2.95 each.



There are two of the above on the board. One for Link1 and one for link 2. The interface also drives the PTT of the link TXs because of where I cut the wires. This is a good thing as the module switches with less than 0.1 of a volt to ground and can successfully switch 160mA tested so there is almost zero voltage drop. When no opto action the voltage on the Drain rises to supply volts.

This board is located centrally under the Link chassis at the rear.

The antenna relays are 24V series with a resistance of 220ohms but work effectively at 12V.

**The relay board driver board**. Note BC548 inverter and STP16NF06 on edge. The wires cross over due to an error creating the board. The input from the optos is on the left and the relays connect to the right. Second photo shows the relay to Link2 (Naracoorte). The receiver antenna is not connected in this photo as the lead from the pre-amp isn’t in place.

