IK1ZYW Keypad

for FT-817(ND)

User's Manual

(public firmware)

An IK1ZYW creation.
All rights reserved.

Table of Contents

What is it?

The IK1ZYW Keypad for FT-817 is a wired partial remote control for the little Yaesu transceiver. It was conceived during a 6-hour field session at 2700 m.a.s.l. for a VHF contest in August 2008. Three functions were accessed very often, always hunting for them through the menu: power level, meter mode and VOX toggle. Some easily accessible presets would have helped quick QSYs to special band spots too.

A search on Internet returned few keypads for the little 817, but none that would “export” my three most needed functions. So this project was born.

First a microcontroller had to be selected. Atmel line was chosen because their chips can be programmed with high level languages (C and even BASIC!) and are cheap. Then I built the simple development hardware and started to get acquantained with the µC architecture (last I programmed was Zilog's Z80): LED blink, send VFO toggle, send frequency information, interact with the radio.

It took 3 months of after-dinner development to produce a fully functional FT-817 accessory.

What is it NOT? This keypad is not a replacement of any computer-based control software. This keypad is not designed to work with all Yaesu radioes, altought basic functions are portable to FT-857 and FT-897: direct dial, VFO toggle, on-board presets and mode change. This keypad is not designed for use in any environment or use case that involves direct or indirect emergency traffic handling and/or life support activities.

Special thanks

This project has been made possible thanks to, in chronological order:

- my Parents that bought me an experimenter's book when I was 10 and supported me in my studies, hobbies and choices
- my high school electronics Teachers Bruno De Stefano and Elisabetta Cuniberti, whose passion for the subject has furthermore marked my life
- KA7OEI that published an extensive guide to Yaesu's CAT protocol
- my supporting Wife and curious Daughter that let me dedicate some night time to this idea, and patiently tolerated the kitchen table invasion

Disclaimer

Important notice, read twice. Although the keypad firmware is not sending dangerous data to the radio, the communication protocol does not use any form of checksum. Therefore a mis-interpretation by the radio can cause unexpected results, from a CPU crash (needing a power off-on cycle) to a complete wipe of all EEPROM data, including configuration, software calibration/alignment[1] and memories. You are **strongly encouraged to record at least** all 76 “soft calibration” settings, plus any other information stored in your radio **before using this keypad**[2].

The 13.8Vcc line on the ACC port of FT-817 is connected to the power supply through a 10 ohm 1/16W resistor. **It is not fused**. Damage to the radio will occur if this line gets shorted. Moreover the voltage on ACC port is **always present**, including when internal batteries are installed and the radio powered off: don't forget to switch off your keypad, or unplug it when not in use! If you feel uncomfortable in using this line please use a separate 9V battery to power the keypad. Otherwise use heatshrink pipes for each pin on homemade plugs.

FT-817 stores every setting in a EEPROM. EEPROM cells have a finite number of write cycles, in the order of 10'000 or more. While front panel buttons probably wear out before EEPROM cells exhaust, using an external control interface such as this keypad (as well as any other computer software!) will increase the stress on radio internals.

No responsibility is taken for data loss or any damage to your equipment.

All trademarks belong to respective owners (Yaesu, Atmel, Icom, Microchip,...).

[1] Software calibration settings are unique to every single device. If their values get lost you need to send your radio back to Yaesu for re-alignment. These settings are accessed by pressing keys A+B+C simultaneously and then powering up the radio. Copy them all to paper and store it in a safe place. Feel free to make several copies of your backup.

[2] This safery procedure should be undertaken even when using a CAT computer cable and a computer control software. The danger is not in the keypad but in the potential misinterpretation of data by the FT817.

Quick start

While it is worth reading this document to the end, I understand you might want to start using your keypad as soon as possible. Follow the following steps in order to get started.

Steps 1 to 4 can be done before your keypad is built or in your possession.

1. **Do NOT connect the keypad to the radio, YET**
2. Turn on your FT-817, long press the [F] button, navigate to “14 CAT RATE” using the [SEL] rotary switch and set it to 4800 baud. Long press [F] again to store this setting.
3. Turn off the transceiver
4. (Optional but strongly recommended) Record the soft calibration settings that are exclusive for your piece of equipment. Keep [A] [B] and [C] buttons pressed while turning on the FT-817. Browse through all setting using [SEL] rotary switch and record on paper their value. Make copies of the paper and put them in the safe. Turn off the FT-817 as usual.
5. Remove ALL power sources including the internal battery, if your keypad does not carry an on/off switch
6. Connect the keypad to the rear ACC socket. Be gentle and patient, do not force it
7. Looking at the keypad LED (if installed) apply power to the radio and keypad (ie switch on the power supply and the on/off switch if installed): the LED should blink. Also the green status LED should light up (if installed).
8. Switch on your FT-817 and go to VFO A
9. Press the “A” button on keypad and observe the change in VFO (if your firmware carries this function)
10. Enjoy

Tested on...

This keypad has been developed on a FT817ND/I (Italian version) with serial number 5H00xxxx. The keypad firmware uses both CAT commands from the User's Manual and Internet pages detailing the extended command set for FT817 serial number 1D21.

Given the combination above there are good chances that this keypad will work on all FT817(ND) worldwide. Reports of working keypad on your flavour of FT817 are welcome.

How it works

This keypad is operated through the 4x4 matrix keyboard. Several functions are programmed in the microcontroller and are accessible via one or more key press, as detailed further down.

The keypad waits for a key press, that initiates a command input sequence; the green LED is lit (if installed). Each key press is confirmed by a short blink of the red LED (if installed) and the green LED goes off when the keypad is waiting for further input before sending data to the radio. Once the sequence is complete the keypad microprocessor sends the appropriate command to the radio, which should react accordingly[3] and the green LED lights up.

Each key press is subject to 50 milliseconds of debounce and 200 milliseconds of repeat delay. Keeping a key pressed longer than 250 milliseconds is equivalent to a second press. These values have been found to be a reasonable compromise between dial speed and dial accuracy.

In order to minimize RFI and data corruption, it is suggested to operate the keypad when the radio is in receive mode and idle (not operating it through its front panel buttons/switches).

Please note that because of memory constraints of the chip used, not all functions can be programmed in, therefore some operations described below will not apply to your version. Refer to the shipping notes that accompanied your chip (or firmware) to know what your keypad is able to do.

Radio setup

The keypad firmware communicates with the FT817 at 4800 baud, the lowest possible data rate in order to minimize communication errors. On the radio press “F” button for about one second, navigate to menu #14 “CAT rate”, set display to show 4800, long-press “F” again to store the value[4]. You're ready to go.

For easier compatibility with other devices you might connect to your FT817, a different speed (9600 or 38400 baud, as supported by the radio) can be programmed. Please specify it when ordering your chip or firmwre.

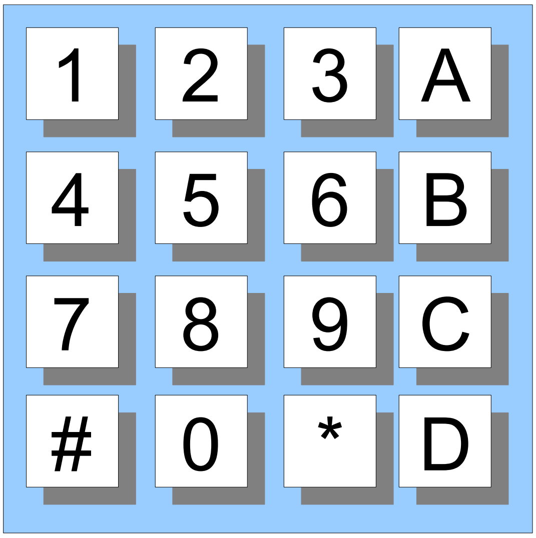
Main Menu

At power up and after a command sequence has been submitted to the radio, the keypad sits in the Main Menu. As soon as the keypad is powered it blinks the red LED and lights up the green LED (if installed).

Assuming that your keypad looks like this:

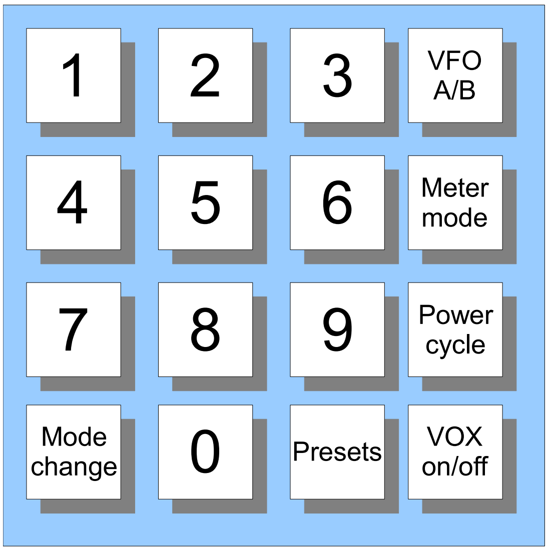
[3] Not all setting changes might have a corresponding display symbol on the radio, or might not be displayed in the current radio state (i.e. Enabling VOX in CW mode, changing the TX meter function, ...).

[4] The longest command sequence requires the exchange of 12 bytes. At 38400 baud the data transmission would take 0,4ms while at 4800 baud it takes an incredibly slow 3ms: better safe than sorry!



1	2	3	A
4	5	6	B
7	8	9	C
#	0	*	D

Default Main Menu assignments are as follows:



1	2	3	VFO A/B
4	5	6	Meter mode
7	8	9	Power cycle
Mode change	0	Presets	VOX on/off

Controls corresponding to keys A-B-C-D are effective with a single press. Mode change and presets (if available on your keypad version) expect a second/third key press that specifies your choice (green LED is off, if installed). Numeric keys require up to six presses to complete the direct frequency dial sequence.

Direct frequency dial

Frequencies have to be inserted specifying all leading zeroes (hundreds of MHz, tens of MHz and MHz). Direct frequency dial always begins with a digit key press. Starting with numbers 0, 1 and 4 will probably result in valid frequencies, but there is no control over it: an invalid frequency will be sent to the radio, that will simply ignore it. Frequencies outside the specified radio receive coverage are invalid (see your FT817 datasheet/user manual), thus ignored.

Direct frequency dial can be prematurely ended by pressing a non-digit key. The microprocessor will add trailing zeroes for you and send the command to the FT817.

While the frequency sequence is being completed, the green LED stays off. As soon as 6 keys are pressed, or a non-digit key is hit, the green LED switches on and the keypad returns in the main menu,

Some dial examples:

Type	QSYs to
007000	7.000 MHz
007* or 007A or 007C or ...	7.000 MHz
014200	14.200 MHz
0142# or ...	14.200 MHz
145500	145.500 MHz
1455B or ..	145.500 MHz
4322# or ...	432.200 MHz
221000	Ignored (221.0 MHz)
070100	Ignored (70.1 MHz)

Onboard memories

Up to 15 onboard frequency/mode memories can be programmed in the keypad hardware. The frequency/mode information is read from the currently selected VFO (or whatever is currently in use, i.e. what is shown on the display) and stored in a permanent memory area of the keypad. Presets will survive keypad power off and long term storage since they are stored in EEPROM cells.

In order to program an onboard memory you have to press **"#"** followed by **"*"** and then the **key** corresponding to the desired memory location. Once the memory location is written the keypad turns on the red LED with a longer flash (twice as a key press).

Onboard memories are accessed with two key strokes: **"#" + key**. , where "key" is the one chosen during the programming process. Since the "*" key is used for programming, you cannot assign it a value (actually you can, but you'll not be able to retrieve it).

Note that after pressing **"#"** the green LED goes off (if installed) until a memory is written or sent to the radio.

Keypad memories are written to the currently selected VFO. First the frequency is sent, then mode is set and frequency sent again. This process should avoid setting an invalid mode in the broadcast band (WFM only), that would hang the FT817 requiring removal of power.

CAUTION! When programming your own chips, be aware that EEPROM area is not initialized, therefore do not recall onboard memories unless you have programmed them!

Chips sent by the author have their 15 onboard memories set to 14060 kHz CW.

An excercise:write a preset in location “A”

Tune to 29600 kHz FM mode. Use either front panel controls or the keypad itself.

- press (and release) “#”, red LED blinks as key is accepted, green LED goes off
- press (and release) “*”, red LED blinks as key is accepted
- press (and release) “A”. red LED blinks as key is accepted
- red LED blinks twice as long to show the sequence has ended and data has been stored, green LED turns on again

Now tune away and change mode.

Recall the stored onboard memory:

- press (and release) “#”, LED blinks as key is accepted
- press (and release) “A”, LED blinks as key is accepted
- radio changes back to 29600 kHz FM

Frequency presets

Effective 16 September 2010: “frequency presets” on free firmware have been changed into the “onboard memories” function. The following text is left in the document for backward reference purposes only.

*Up to 16 frequency presets can be factory programmed in the keypad firmware. They are accessed with two key strokes: **“#” + another key**. The following table maps the default QRP presets vs key distribution:*

1843 CW	3560 CW	7030 CW	10116 CW
14060 CW	18096 CW	21060 CW	28060 CW
14285 USB	50090 CW	21285 USB	28500 USB
144300 USB	50150 USB	432200 USB	29600 FM

So, “#” + “4” goes to 20m QRP CW calling frequency; “#” + “7” to 20m QRP SSB calling frequency, “#” + “#” to 70cm SSB DX, etc...

USB frequencies have been pre-programmed for those bands where, according to the author, QRP voice activity is likely to be more successfull.

Presets are written to the currently selected VFO. First the mode is changed then the new frequency is sent to the radio.

While the preset sequence is being completed, the green LED stays off. As soon as both keys are pressed the green LED switches on and the keypad returns in the main menu,

Mode change

This function is available with dedicated buttons on the FT817, therefore it is the preferred candidate to be left out of the microcontroller program memory in order to fit more useful and less accessible functions for custom firmwares.

If your keypad firmware has the mode change function, you will access it with a press on the **"*"** symbol. The second press will change the operating mode as follows:

Sequence	Changes mode to
*4	AM
*5	FM
*6	CWR
*7	USB
*8	LSB
* + any other key	CW

Please note that this function mimics front panel buttons, so a change from/to CW/CWR will result in automatic frequency adjustment of an amount equal to your sidetone setting.

While the mode sequence is being completed, the green LED stays off. As soon as both keys are pressed the green LED switches on and the keypad returns in the main menu.

VFO toggle

This is a single press operation on the **"A"** key. The radio toggles between VFO A and VFO B.

This simple control is a good way to check whether your keypad-radio setup is working properly.

VOX toggle

This is a single press operation on the **"D"** key. The VOX setting is toggled between on and off. This function is active independently of your current operating mode, but the new VOX status will be available (and shown on the display) only when using "voice" modes.

Please note that this command requires an interactive communication between the keypad and the radio. In order to minimize communication errors, the microcontroller has been programmed to introduce up to 200ms of combined delays. Once the red LED blinks, meaning that the key press has been read, wait 200ms before expecting a change on the radio. If nothing happens for one second, try the command again. If nothing ever happens please contact the Support.

NB: the CAT command sequence laying beside this control applies to FT817's only.

Meter functions

The FT817 can measure output power, SWR, ALC level and modulation level. A single press on the **“B”** key will cycle between these 4 settings, as if the function was accessed on the front panel menu. The meter operating mode will be shown only when the radio is set to transmit.

Please note that this command requires an interactive communication between the keypad and the radio. In order to minimize communication errors, the microcontroller has been programmed to introduce up to 200ms of combined delays. Once the red LED blinks, meaning that the key press has been read, wait 200ms before expecting a change on the radio. If nothing happens for one second, try the command again. If nothing ever happens please contact the Support.

NB: the CAT command sequence laying beside this control applies to FT817's only.

Power level

The FT817 has 4 power levels. A single press on the **“C”** key will cycle downwards between these 4 settings, as if the function was accessed on the front panel menu. The change is visible on the radio display.

Please note that this command requires an interactive communication between the keypad and the radio. In order to minimize communication errors, the microcontroller has been programmed to introduce up to 200ms of combined delays. Once the red LED blinks, meaning that the key press has been read, wait 200ms before expecting a change on the radio. If nothing happens for one second, try the command again. If nothing ever happens please contact the Support.

NB: the CAT command sequence laying beside this control applies to FT817's only.

Extra functions

The following functions have been developed and tested. **They are not included in the publicly available firmware** but can be loaded on request as a replacement of existing functions (see “Customizing” below). Each function occupies a different amount of program memory, therefore it may not be a “direct replacement” of another function in terms of used bytes:

- Quick (timed) tune
- Manual tune
- Break-in on/off
- Scan up/down/stop
- Repeater offset direction
- Menu Page Quick Jump
- VFO A=B
- 25 onboard memories (instead of 15)
- KeYeR on/off
- Split on/off
- Lock on/off
- RIT on/off
- AGC on/off
- PBT on/off
- FaST on/off

Customizing

Since every FT817 owner probably has her/his own habits, it is possible to request some customization of the keypad firmware, up to the extent of available program memory[5]. Given a basic set of features, like direct frequency dial and onboard memories, all other key assignments can be set to suit your needs.

Please be aware that some settings are both VFO and band specific and **cannot be handled by this keypad**, like IPO, ATT, NAR, tuning step.

On the other hand the following menu functions can be developed and loaded (leaving something else out): **DCS/CTCSS, Lock, RIT on/off and amount, NB, AGC, DW, PRI, Scan, BK, KYR, VLT, DSP, CHG, CW keyer speed, PBT, Fast tuning, Quick tune (for ATUs).**

When thinking of a custom firmware, keep in mind that out of 16 keys, 13 of them can be used for special controls. They can act as direct access to a function or as a way into a submenu. Each submenu then has up to 16 assignments available, as long as there is available program memory (but there is not that much memory space anyway).

A good way to request a custom firmware is to compose a priority ordered list, from most to least needed functions. Study the table with functions few pages below and feel free to add any of those listed as “possible”. I will try to fit as many as possible according to your ordered list, and I will contact you with a proposed configuration.

An example. See what one gentleman asked for and actually got after some interaction:

#	Function	Implemented
1	Scan up/down	Yes
2	Direct dial	Yes
3	Meter function	Yes
4	Power level	Yes
5	BK (break-in)	Yes
6	CW delay	Not enough memory
7	Sidetone volume	Not enough memory
8	RPT -/+/simplex	Yes
9	Onboard memories	Yes
10	VFO A/B	Yes
11	VOX	Not enough memory
12	Mode change	Not enough memory
13	Band up/down	Not possible

[5] “A-B-C-D” key functions, mode change, onboard presets and direct dial, as described in this document, fill 95% of the available program memory. This means about three more presets could be added, but not a FT817 function that eats about 8% of program memory.

Send me a detailed description of your needs or request at

ik1zyw@yahoo.com

(mention “keypad” in the subject line)

Support

This keypad contains a microprocessor that runs software. Even if all efforts have been made to produce a stable software, it can still contain bugs. Fortunately the microprocessor chip can be reprogrammed some thousand times with a simple hardware that connects to a computer parallel port. Updates to public firmware versions might be released in the future and announced on the keypad home page (URL http://spazioinwind.libero.it/ik1zyw/hardware/keypad/index.html).

If you encounter an unexpected or undocumented behavior in your keypad, please contact me at:

ik1zyw@yahoo.com

(mention “keypad” in the subject line)

If you are not equipped to program your own chip I can send a preprogrammed item at live costs (offer subject to hardware and time availability). Feel free to add any amount of gratification for the research&development work done. Contact information as shown above.

Please also consider joining the keypad reflector/mailing list at Yahoo! Groups:

http://groups.yahoo.com/group/817keypad/

Technical specifications

Core microprocessor	Atmel ATtiny2313-20PU
Clock frequency	11.0592 MHz
Power supply	8 to 30 V DC (internally converted to 5V)
Current	14mA in stand-by 30mA @LED ON (red) mA during data exchange to be measured
Communication protocol	Serial at 0V/5V levels, Yaesu CAT
Communication speed	4800 baud 8N2

What you would get if...

This table summarizes what other keypads for FT-817(ND) are advertised for, and how this keypad compares to them. Since this is not a perfect world, each one is a winner and a loser somewhere. If you know of other products I will be glad to include them in the comparison chart (see contact info few pages back). Bold cells are unique amongst all products.

		IK1ZYW	M.Q.	R.M.	IT9XXS	DH1PAX
General	**Core**	Atmel AVR	Unknown	Unknown	Microchip PIC	Atmel AVR
	Free Firmware	Yes	No	No	Yes	No
	Public Diagram	Yes	No	No	Yes	Yes
	Upgradable, live project	**Yes**	No	No	No	No
	Rugged, commercial product	No	Yes	Yes	No	No
	Customizable	**Yes**	No	No	No	No
	Supports other Yaesu RX/RTX	Probably	FT857 FT897 FT100	FT857 FT897	n.d.	No
	Supports other brands	No	Icom	No	No	No
	Self-powered	Yes	Yes	Yes	Yes	Yes
	Estimated cost	25€	55€ kit / 75€	110€	20€	20€
		IK1ZYW	**M.Q.**	**R.M.**	**IT9XXS**	**DH1PAX**
Common Yaesu Functions	**VFO A/B**	Available	No	Yes	Yes	No
	VFO A=B	Possible	No	Yes	No	No
	Direct dial	Available	Yes, smart	Yes, smart	Yes	Yes
	Mode change	Available	Yes	Yes	Yes	No
	Auto mode change	No	No	No	**Yes**	No
	Split on/off	Possible	No	Yes	Yes	No
	Repeater offset (+/-)	Available	Yes	No	Yes	Yes
	Quick tune	Available	No	Yes	No	No
	Manual tune	Available	No	Yes	No	No
	Timed tune	Available	No	No	No	No
	Lazy PTT	Available	No	No	No	No
	RIT on/off	Possible	No	No	No	No
	Freq/mode readout	No	**Yes**	No	No	No
	Fixed presets	Available	No	No	No	No
	Onboard memories	Available	No	Yes	No	No
		IK1ZYW	**M.Q.**	**R.M.**	**IT9XXS**	**DH1PAX**
FT-817(ND) Extensions	**VOX on/off**	**Available**	No	No	No	No
	Meter mode	**Available**	No	No	No	No
	Power level	**Available**	No	No	No	No
	Set DCS/CTCSS	**Possible**	No	No	No	No
	Lock on/off	**Possible**	No	No	No	No
	Set RIT amount	**Possible**	No	No	No	No
	NB on/off	**Possible**	No	No	No	No
	AGC mode	**Possible**	No	No	No	No
	DW on/off	**Possible**	No	No	No	No
	PRI on/off	**Possible**	No	No	No	No
	Scan up/down	**Available**	No	No	No	No
	BK on/off	**Available**	No	No	No	No
	KYR on/off	**Possible**	No	No	No	No
	VLT on/off	**Possible**	No	No	No	No
	DSP on/off	**Possible**	No	No	No	No
	CHG on/off	**Possible**	No	No	No	No
	CW speed	**Possible**	No	No	No	No
	Quick Menu Jump	**Available**	No	No	No	No
	PBT on/off	**Possible**	No	No	No	No
	Fast tuning on/off	**Possible**	No	No	No	No

Troubleshooting

Problem	Possible solution
LED blinks but radio does not react.	Test it with VFO A/B (key A). ● check the connecting cable ● power the 817 with an external supply, switch everything off ● look at the LED and switch the supply ON: it should blink ● check the voltage between pin 20 and pin 10 on the microcontroller (should be 5V) *It has been observed that the keypad does not work if the Voltage shown on FT817 display is less than 8V (dead int'l/ext'l batteries).*
The keypad does not react when transmitting	The keypad is not designed to be RFI proof. The radiofrequency generated when transmitting close to it may interfere with keypad readings, and block the keypad operation. Ferrite beads and a shielded box may reduce interference. *It has been observed that full 5W into a dummy load on the bench 30cm from the keypad do interfere.*
The keypad has drained the internal battery	Whenever a DC source is connected to the FT817 (including the internal battery pack) there will be voltage present on the ACC port, therefore the keypad will draw current if left plugged. Do not store away the FT817 with the keypad attached if you have internal batteries installed, unless your keypad has an on/off switch.
Keypad is switched off but LED appears to be on	This effect is caused by some current flowing from the FT817 ACC data lines (mainly TXD) into the microprocessor. A circuit correction is being studied (as of 2009-01-21). Either do not switch off the keypad or use a 2-way switch to interrupt both Vcc and data lines. Alternatively unplug the keypad. However no damage has been reported, neither to the FT817 nor to the keypad.

Microcontroller programming

This keypad has been developed and programmed using a simple parallel programmer and avreal32 programming software.

With a brand new ATtiny2313 chip, fuses need to be changed in order to work with the provided firmware. Using avreal32 definitions, fuses have to be set as follows (1 = off):

```
OSCCALs        = 68  6A
CKDIV          = 1
CKOUT          = 1
SUT            = 2
CKSEL          = F
DWEN           = 1
EESAVE         = 1
WDTON          = 1
BODLEVEL       = 7
RSTDISBL       = 1
SELFPRGEN      = 1
```

If you are unsure about their meaning, just change fuses in bold. Basically you need to set external clock above 8 MHz without internal divider. Refer to ATtiny2313 Datasheet for further information.

Please note that I am not able to help with the programming process or debugging.

Assembling

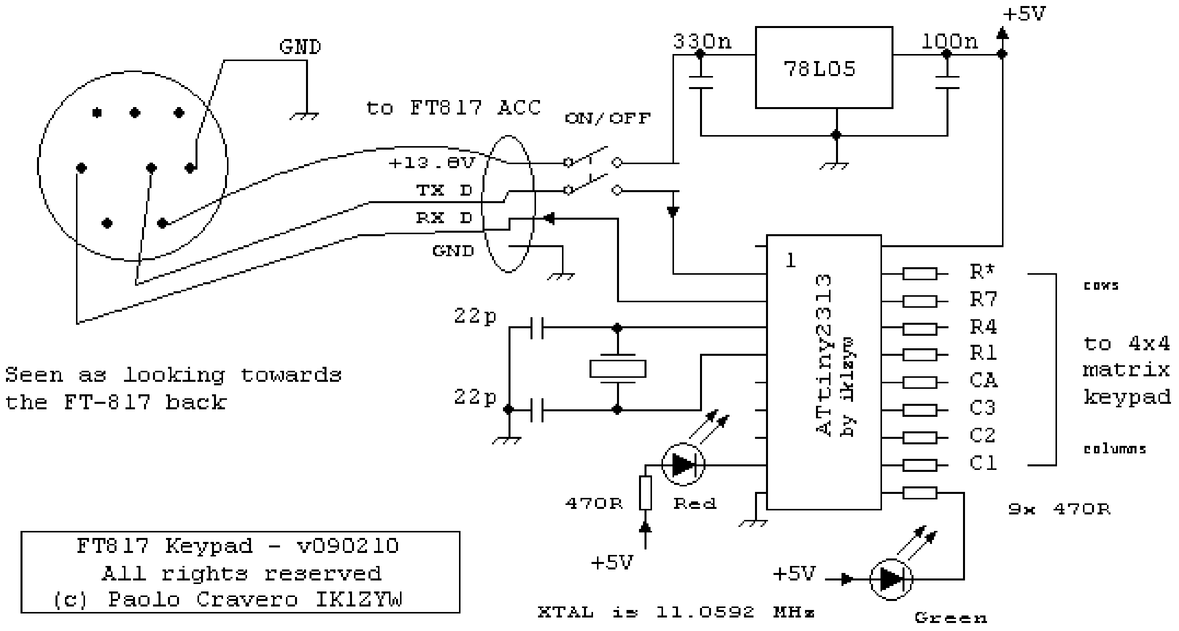


Illustration 1: schematic diagram and wiring to ACC port.

Currently there is no physical PCB available for this keypad. PCB artwork in Eagle format has been drawn and is available on explicit request. Anyway the circuit is so simple that it can be assembled on veroboard/perfboard. There are also no strict ground requirements.

With respect to previous circuit version, these are the changes:

- The reset button has been removed. If an on/off switch is installed their effect would have been the same since the microprocessor is ready in few microseconds in both cases.
- A green LED has been added to show the keypad is both powered and idle, waiting for a key press to start a command input sequence. This LED is optional.

Do use a socket for the microcontroller IC so that you can re-program it one day. Or easily replace it in case of unexpected destructive conditions.

Pay attention to LED orientation, whose cathode is always towards the IC. An incorrectly installed LED will work the other way around as described here: rather than blinking “on”, the red LED would blink “off” at key presses.

Use short connections, but don't go crazy with them: a 5x5cm board holds all these parts just right.

Parts list is as follows:

Quantity	Part Name	Quantity	Part Name

1	ATtiny2313-20PU	9	470 ohm ¼W
1	20 pin DIL socket	1	LED (red)
1	11.0592 MHz XTAL	2	22pF
1	78L05	1	330nF
1	Matrix 4x4 keypad	1	100nF
1	1m cable 3 wires + shield	1	MiniDin8 plug

Optional parts make your keypad easier to handle and give it a more professional look:

Quantity	**Part Name**	**Quantity**	**Part Name**
1	DPST switch	1	8-way pin header female
1	8-way pin header male	1	4-way female connector
1	4-way male connector for PCB	10cm	Heatshrink 1mm pipe
1	Box, plastic or metal	1	LED (green)
		1	470 ohm ¼W (for the green LED)

You will also need some wire, at least two different colors, a (max) 25/30W soldering iron and some solder.

Connections

It is strongly advised to connect the keypad to the transceiver when no power is supplied to the radio, including internal batteries, unless you have installed an on/off switch. **Remember that whenever a DC source is connected to the FT817 (including the internal battery pack) there will be voltage present on the ACC port, therefore the keypad will draw current if left connected.**

To Keypad

Eight wires to a 4x4 matrix keypad in the diagram are labeled according to the first matching key in the row/column. **DO** verify with an ohm-meter which lines are connected at each key press. In other words: draw the connection map of your flavour of keypad before connecting it to the chip.

As a starting point, “my” matrix keypad has, from left to right, columns in ascending order then rows in ascending order: C1, C2, C3, CA, R1, R4, R7, R*. These go to pin 12 (C1) to pin 19 (R*). But your hardware keypad might be different.

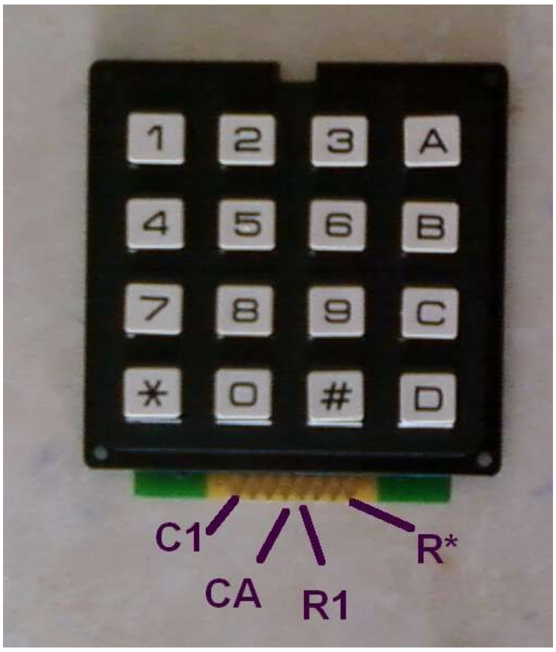


Illustration 1: contact layout on one keypad

I have found that 8-way pin headers produce a clean and sturdy connection between the keypad and the circuit.

To FT-817

Depending on your choice of powering the keypad through the ACC port or an external battery, you need a cable with four or three wires respectively. I suggest using a shielded cable with three or two wires respectively.

Use a 4-way PCB connector to easily remove the connecting cable from the circuit. Alternatively you can mount a 4-way panel socket and use a matching plug on one cable end.

Towards the FT-817 cable end you need a MiniDin8 plug. Soldering into these requires a steady hand, some level of magnification and a thin iron tip. Get hold of some heatshrink pipe to protect your joints afterwards. Check with an ohm-meter for shorts between pins **before** using the cable. Good luck and remember I am not responsible for your faults.

There are commercially available cables with MiniDin8 plugs, namely for an old Apple computer application. Sun SPARC stations keyboards also used them (but some plug modification is required). These cables offer the safety and ruggedness of a molded plug.