

The chipKIT UNO32 and Friends

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In the Summer 2013 issue of the *QRP Quarterly*, Thomas Witherspoon, K4SWL, reviewed the newest QRP product offering from TEN-TEC in his article “Introducing the TEN-TEC Model 506 Rebel” [1, 2, 3]. The Rebel is an Open Source, Arduino compatible, 20 or 40 meter QRP transceiver based on the chipKIT UNO32 microcontroller board from Digilent, Inc. [4]. In this article, you will get some more information on the board powering the Rebel, variants on the board, and its ecosystem. Perhaps it will inspire you to add some capabilities to your Rebel, which is exactly what TEN-TEC intended for this open source transceiver. There is a lot of community support through various e-mail forums to help you along.

chipKIT UNO32

The chipKIT UNO32 (Figure 1) is an Arduino form factor (credit card sized) microcontroller board designed around the Microchip PIC32MX320F128 32bit processor chip. Sporting 128 kB of Flash memory, 32 kB of RAM and clocking along at 80 MHz, the UNO32 is an Arduino processor on steroids. Digilent states, “...Pin-out compatibility with many existing Arduino Shields that can operate at 3.3v with a lower price-point at four times the performance than existing solutions.” [Arduino “shields” are printed circuit accessory boards which plug into the main Arduino board to provide accessory capability. —Ed.] It is important to note the 3.3 V operating voltage. All of the UNO32’s pins are 5 V tolerant so you don’t have to worry about damaging the part in a mixed supply situation, but not all 5 V based Arduino shields are going to work properly. However, I have been able to drive the 5 V Sparkfun Serial LED and Serial 16x2 LCD displays without a problem. Follow the links on the Digilent site to download the reference manual.

The Arduino abstraction translates the familiar byte-wide PortA, PortB, PortC, ... microcontroller I/O terminology into a series of individual pins, Pin0 → PinX with X determined by the pin count of the microcontroller being used. The Port-to-Pin mapping seems kind of random and you won’t find a lot of consecutive port bits mapping to consecutive pin numbers. This can make for messy code if you need to talk to byte-wide devices. This abstraction lends itself more to individual bit or Serial/SPI/I2C interfaces to off-board hardware. The Arduino Pins are brought out to two rows of female headers. These headers allow for stacking daughter cards (shields). Don’t assume that any random selection of shields will stack properly. Check for pin conflicts between the shields. The chipKIT UNO32 has double wide headers to allow access to its higher I/O pin count.

The UNO32 and the PIC32 family of processors support many built-in peripherals spread across its 42 I/O pins, such as: USB, UARTs, I2C, SPI, Timers, PWM, Analog Comparators, and Analog and Digital I/O. These hardware functions are backed up by software libraries that make the complex (almost) easy. Many examples of peripheral and library usage are included in the development tool download package. PIC32s are not digital signal processors (DSPs) nor do they include a DSP peripheral. However, Microchip has a DSP software library. It is unknown at



Figure 1—chipKIT UNO32.

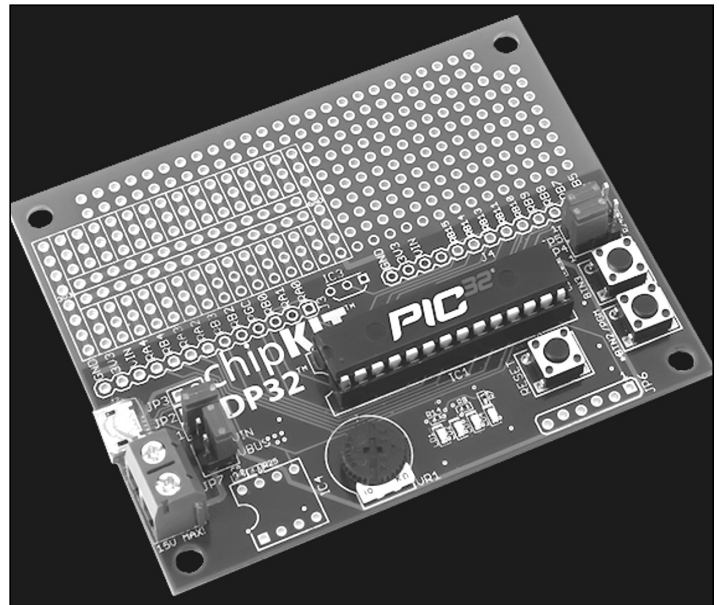


Figure 2—chipKIT DP32.

this time if this C library is compatible with the chipKIT C++ based environment. The TEN-TEC Rebel 506 does not implement any digital filtering algorithms.

And Friends

Based on Open Source concepts, the chipKIT family is expanding rapidly. Digilent offers (a) the MAX32, based on the Arduino Mega form factor (a larger pcb with additional female headers) with 83 I/O pins, Ethernet, and CAN interfaces and (b) the DP32 (Figure 2) that offers a 28 pin SPDIP PIC32 and a small prototyping area. Microchip [5, 6] offers the stick-of-gum sized

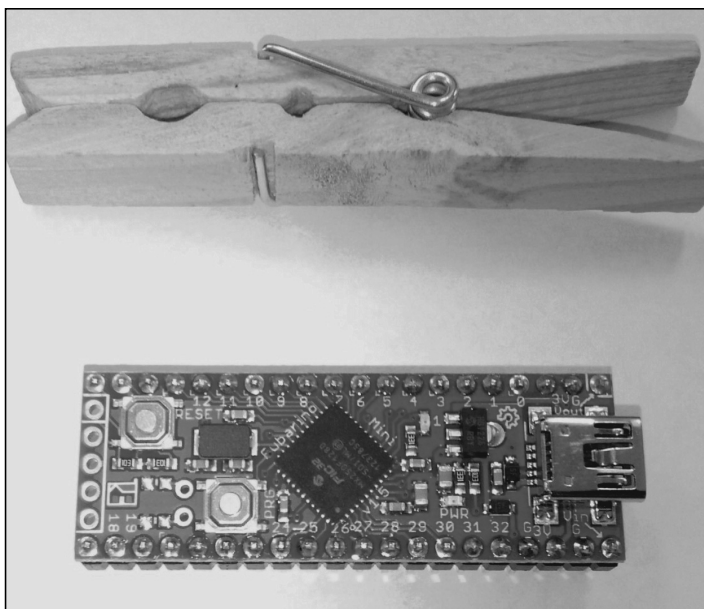


Figure 3—Fubarino-Mini.

Fubarino Mini (Figure 3), designed by Fubar Labs and Schmalz Haus LLC, that uses the 44 pin PIC32. And, several blog/wiki posts [7, 10] show how to implement a minimal breadboard (Figure 4) version with the 28 pin SPDIP. The DP32, Fubarino Mini, and breadboard implementations are not in the Arduino form factor and therefore don't support stackable shields. But, they are an excellent value if you don't need the shield capability. Not all of the pins are 5 V tolerant on these boards, so be sure to consult the pin-out documentation before applying 5 V to any of the I/O pins.

The DP32, Fubarino Mini and the breadboard implementations have many peripherals and limited pins to connect these

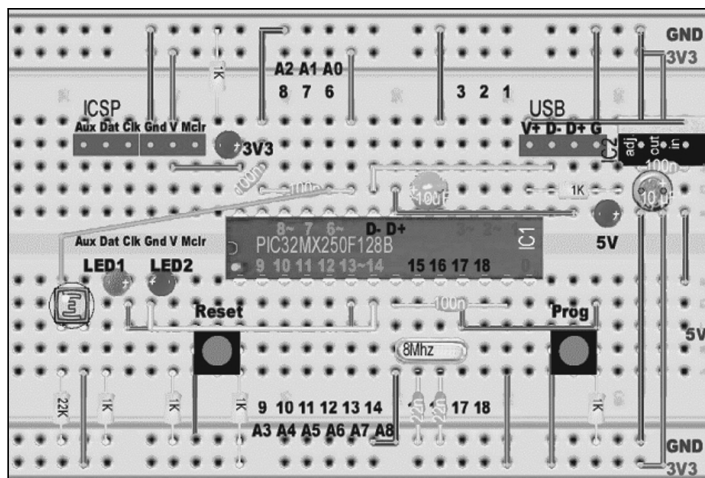


Figure 4—chipKIT BB32.

functions to the outside world. To help with this issue, Microchip has included a limited matrix/crossbar switch on the chip that allows many of the logical peripheral pins to be remapped to different physical pins. Peripheral Pin Select (PPS) allows an input or output pin to be remapped to up to eight physical pins. Any more details would require a separate article for this chip.

Software Development

Programs for chipKITs are called “Sketches” and are written in a C++ dialect. Again from Digilent, “chipKITs can be programmed using an environment based on the original Arduino™ IDE, modified to support PIC32, that also still supports the original Arduino™ line”. MPIDE—the Multi-Platform Integrated Development Environment is used to create, edit, compile, download, debug, and provide terminal emulation for sketch development (Figure 5). It is critical to note that at the present time the chipKIT MPIDE is not yet fully compatible with Arduino 1.5.x. However, porting of the 1.5.x libraries is being actively worked on.

Each chipKIT board comes with a pre-installed bootloader that runs when the board is reset to allow downloading of a new sketch. In addition, these boards can also be programmed outside the Arduino environment using Microchip's MPLAB or MPLAB X IDEs and a hardware programmer like the PICKit 3. Stable release and development versions of MPIDE can be downloaded from Digilent[4] or the project archive[8]. MPIDE also supports ATMEL-based Arduino implementations and more recently the Raspberry Pi.

Example Sketch

The Blink example in Table 1 illustrates the basic structure of a sketch: A setup() function that runs once at startup and a loop() function that runs indefinitely. In addition, interrupt handling functions can be defined and attached to any of the inter-

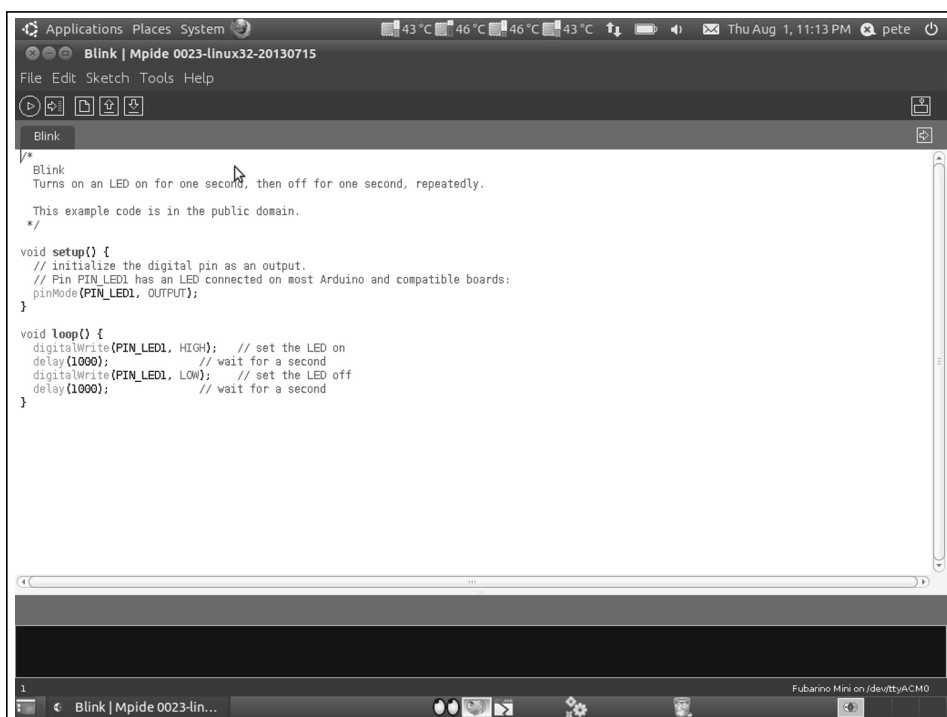


Figure 5—MPIDE screen shot.

nal and external interrupt sources. Pin Change Interrupts allow almost any pin to trigger an interrupt. The USB port can be used to connect your sketch to the MPIDE Terminal Emulation Window or code running on your PC.

Community Support

Open Source almost always means community support. ChipKIT community support is available via the chipKIT Forum [9], the chipKIT Wiki [10], the Fubarino Home Page [11], the Arduino Home Page [12], the Rebel Yahoo Group [13] and various blogs and repositories [7, 14]. Search the web before reinventing the wheel. There is a ton of code out there. Join the Rebel Yahoo Group to download the Rebel code, schematics, user contributed documentation files, many photos, and to read the community posts.

Conclusion

The chipKIT UNO32 and the chipKIT Family is a very capable platform with a range of performance to support any amateur project that you can imagine. Design your own add-on hardware or look for an extant shield that supports your design requirements.

What features will you add to your Ten-Tec Rebel 506?

- Band switching?
- Frequency display?
- Audio filters?
- PC remote control?
- General coverage receive?
- Wi-Fi interface?
- Add-on hardware shields?
- Upgrade to the chipKIT MAX32 for its greater memory or Ethernet capability?
- Add a second chipKIT processor via I²C?
- What can you imagine?

For less than \$30, plus tax, tag, options & dealer prep, you can begin learning the chipKIT UNO32 while you are waiting for your Rebel to arrive.

References

1. www.tentec.com — TEN-TEC Rebel 506 Open Source Transceiver.
2. www.arrl.org/news/dayton-hamvention-friday-roundup — TEN-TEC Rebel 506 announcement at the Dayton Hamvention.
3. www.qrper.com/2013/05/ten-tec-introduces-the-model-506-rebel-an-open-source-qrp-transceiver — Original blog post by Tom Witherspoon, K4SWL, also revised and published in the Summer, 2013 *QRP Quarterly*.
4. www.digilentinc.com — chipKIT UNO32, PIC32MX320F128, 128/32/80: \$26.95
chipKIT MAX32, PIC32MX795F512, 512/128/80: \$49.50

```
/*
  Blink .pde
  Turns a LED on for one second, then off for one second, repeatedly.
  This example code is in the public domain.
*/
void setup() {
  // initialize the digital pin as an output.
  // Pin PIN_LED1 has an LED connected on most Arduino and compatible boards:
  pinMode(PIN_LED1, OUTPUT);
}
void loop() {
  digitalWrite(PIN_LED1, HIGH);    // set the LED on
  delay(1000);                    // wait for a second
  digitalWrite(PIN_LED1, LOW);    // set the LED off
  delay(1000);                    // wait for a second
}
```

Table 1— Code example for a Blink function.

chipKIT DP32, PIC32MX250F128B, 128/32/40: 23.99
Plus Data Sheets, Schematics, Reference Manuals, etc.

5. www.microchipdirect.com — TCHIP011 (Fubarino Mini), PIC32MX250F128D, 128/32/48: \$19.99
TCHIP-USB-MX250F128B, 28pin DIP w/pre-programmed boot-loader: \$3.80

6. www.microchip.com — Home for the MPLAB and MPLAB X development environments. Source for PIC32 datasheets, application notes, etc.

7. <http://caroper.blogspot.sg/> — chipKIT BB32, a breadboard chipKIT implementation.

8. chipkit.s3.amazonaws.com/index.html — chipKIT MPIDE development environment download page. Support for Windows, Mac, & Linux. Stable and development releases are available.

9. www.chipkit.org/forum — chipKIT users' forum, an active support group. ChipKIT board designers and MPIDE porters are frequently answering questions on this site.

10. www.chipkit.net — chipKIT Wiki.

11. www.fubarino.org/mini/index.html — Home page for the Fubarino Mini board. Reference Manual, code examples and pcb schematic.

12. www.arduino.cc — Home of the Arduino project. Language reference, sample code, etc.

13. groups.yahoo.com/group/TenTec506Rebel — Ten-Tec Rebel 506 Forum. Code, photos, documentation files, schematic, posts, etc. *Note:* To get a readable sized print of the schematic, take the PDF file to your local office supply store. I got a D size print for \$3.29 at Staples.

14. [www.github.com/jmlynescjr/chipKIT-Arduino-Examples](https://github.com/jmlynescjr/chipKIT-Arduino-Examples) — Code examples.

Credits: Figure 4 is courtesy of Chris Roper (<http://caroper.blogspot.sg/>). Figure 2 is courtesy of Digilent, Inc. (www.digilentinc.com).