Analogue-to-Digital Converter
for 400 bps P3 PSK Data Demodulator

Introduction

This ADC is a user fitted upgrade for the G3RUH MKII 400 bps P3 PSK Data Demodulator. Its input is the bit detector's integrate-and-dump signal at TP3 and its output is a 9600 baud TTL RS-232 stream at 400 bytes/s for connection to a MAX232, or similar, line driver. In this way detected PSK bits are available to a user's computer not only as binary decisions (0/1), but also with an additional 7 bits of detection quality information. See fig.1. The 400 byte/s stream of symbols is now processed in the user's computer to:

- Decode the standard AMSAT P3 telemetry block format; in effect, user software replaces sheet 3 of the P3 PSK Data Demodulator schematic.
- Decode other formats, notably Forward Error Correction (FEC) transmissions from the AMSAT Oscar-40 and future 400 bps PSK Phase III satellites.

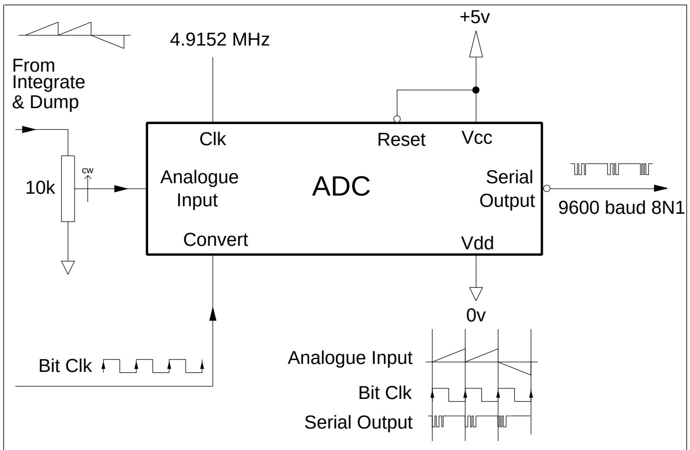

Fig. 1 Block Diagram

Parts Required

- ADC integrated circuit, part 0031-042
- 16-pin DIL IC socket
- 6.2V zener diode, 500 mW (small)
- 1k resistor
- 10k multi-turn trimpot, e.g. *Bourns* 3296X, *Spectrol* 64X etc, 20-25 turns
- blob of epoxy adhesive
- very fine 'hook-up' wire; 30 AWG wire-wrap grade is best.

> ***Caution:*** *you are about to perform surgery on an electronic PCB. If you constructed the board, the task should be well within your abilities. But if you are unskilled at this kind of work, please find somebody to do it for you.*

Installation

1. [ ] *Before starting, please read all of this section. Tick the* [ ] *boxes when done.*
2. [ ] Access to both sides of the PCB is required, and it must NOT be powered!
3. [ ] Parallel R12 with 1k resistor; see fig.3 overleaf. You may remove R12 if you wish.
4. [ ] Parallel R31 with 6.2V zener diode; see fig.3 overleaf. The 'band' must be towards U37. You may remove R31 if you wish.
5. [ ] Install 16-pin DIL IC socket on the PCB at 'spare' location adjacent to TP2 & TP6. Hold in place by soldering the two corner pins 8 & 16.
6. [ ] Cut the underside trace between U23 pin 11 (MAX232) and U24 pin 13 (4013).
7. [ ] Glue down the trimpot in the area between U41 and the regulator REG1 in such a way that you can make top or side adjustment as required.
8. [ ] Connect the trimpot pins 1 & 3 to TP0 and TP3. Connect trimpot wiper pin 2 to the DIL socket pin 1 on the PCB underside as per fig.2.
9. [ ] Do the underside point-to point wiring from DIL socket pins 4,5,6,12 & 14 to PCB points as per fig.2.

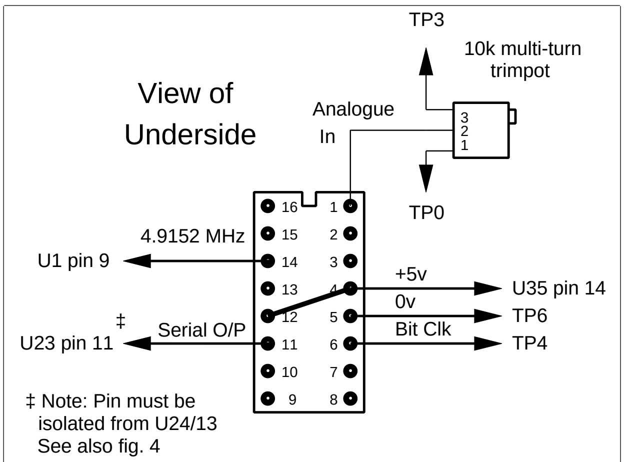

Fig. 2 DIL Socket Wiring

10. [ ] Wire DIL socket pin 11 as indicated in fig.2 unless you want a switch to be able to return to standard operation; then wire as in fig. 4. The switch is optional.
11. [ ] Snip off pins 9 & 10 of the ADC integrated circuit, turning it into a pseudo "16-pin" IC.
12. [ ] Insert ADC into 16-pin DIL IC socket
13. [ ] Check your work. Did you link DIL socket pins 4 & 12? Did you cut the U23/U24 trace? Is the zener diode fitted correctly?

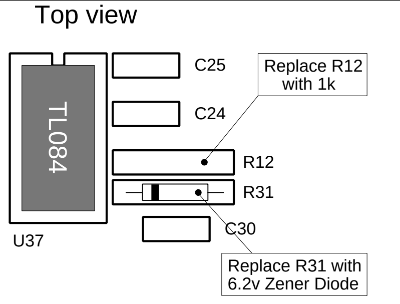

Fig. 3 R12 and R31 changes

Adjustment

The objective is to set the static ADC input voltage to 2.5V so that with no signal the ADC returns the 8-bit value hex 80, which is half-scale. This mid-range voltage is set with the trimpot, and can be measured in several ways. Here are three calibration methods in order of increasing accuracy:

Method 1. There should be *no* audio signal into the main PCB. With a DVM (digital voltmeter), measure the 5 Volt supply at ADC pin 4 (relative to pin 5). Call this Vcc. Now with the DVM at ADC pin 1, adjust the trimpot so that the DVM reads exactly one-half of Vcc. The accuracy required is 10 mV.

Method 2. Perform method 1. Validate your work by attaching a computer to the the demodulator RS232 connector and run a 'dumb terminal' program set to 9600 8N1 format. If the adjustment is correct, the value read should be hex 80. Make a fine adjustment if necessary; the trimpot sensitivity is about 12 units/turn.

Method 3. Perform methods 1 and 2. Input radio noise to the demodulator. Run a calibration utility on your computer which calculates the average value read from the ADC for a period of one minute or more. A good telemetry program will do this for you. The average value should lie within the range 128 ± 0.25 units. If it does not, adjust the trimpot until it does.

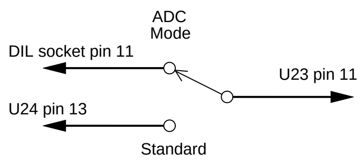

Fig. 4 Option: output switch

Technical Notes

The standard bit detector is a 'slicer', U41 at TP3. It makes a binary decision (0 or 1) depending on whether the output of the integrate and dump at TP3 is higher or lower than V_{ref} (about 6V). However, this binary operation discards the amplitude information which can be used, for example, by a Viterbi convolutional decoder for error correction. The ADC measures this amplitude on the rising edge of the CLK signal at TP4 and returns it to the user with 8-bit resolution. This is called a 'symbol', and there are 400 symbols/s.

In the the standard circuit, V_{ref} is not well enough defined for this ADC system, so the simple R12/R31 voltage divider is replaced by zener stabilisation. This is essential.

Acknowledgements

The ADC is a PIC16C71 microprocessor. Its internal coding was done by Andy Talbot G4JNT for which particular thanks. Source code and related project material can be found at:

`http://www.jrmiller.online/products/figs/adc.zip`

Thanks also to Stacey Mills W4SM for independently testing the ADC in the "real world", and for adopting its use in his AO-40 Telemetry Display suite P3T for *Windows*. `http://www.keplerian.com`

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`http://www.jrmiller.online`