

A Radio Relay System for Remote Sensors in the Antarctic (or anywhere!)

Final Seminar

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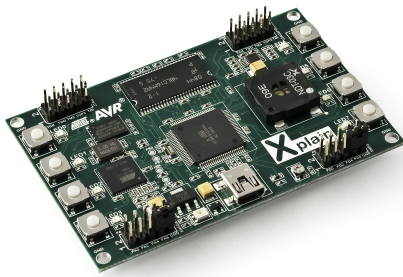
Project Aim

- ▶ Design and build a low power HF data transmitter for use in remote sensor systems.
- ▶ Originally intended for use in the Antarctic.
- ▶ Can be used anywhere!

Hardware & Software Overview

- ▶ Atmel XMega Micro-controller
- ▶ Analog Devices AD9835 Signal Generator IC
- ▶ Class E Power Amplifier

CPU - Atmel ATXmega128A1

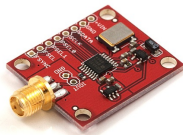


Atmel XPlain Development Board

- ▶ Atmel ATXmega128A1 Micro-Controller, clocked at 32MHz
- ▶ 8MB SDRAM
- ▶ 8MB NAND Flash Memory
- ▶ Low Power Consumption - 18mA @ 32MHz, 1.4mA @ 2MHz, 1.16 μ A Power-Save

Signal Generator - Analog Devices AD9835

- ▶ Original intention was to use an AD9834
- ▶ AD9835 Board ended up having the same power requirements!



Analog Devices AD9835

- ▶ Can generate Sine-waves between 1Hz - 25MHz.
- ▶ 2 programmable (via SPI) frequency registers.
- ▶ Dedicated pins for switching between registers.
- ▶ Using 16MHz SPI clock, can reprogram at 7500Hz.

Power Amplifier

- ▶ Op-Amp based pre-amplifier
- ▶ Class E MOSFET Power Amplifier

Software Overview

- ▶ Coded entirely in C.
- ▶ Morse, RTTY (FSK) and DominoEX modulation implemented.
- ▶ Data acquisition from onboard ADCs, UARTs, or I²C Devices.

Morse Code & QRSS

- ▶ Morse Code at very slow speeds can be received over very long distances.
- ▶ Signals are pulled out of the noise floor with DSP techniques.
- ▶ Very low signal bandwidth.
- ▶ Not very useful for transmitting lots of data.
- ▶ Great for a beacon!

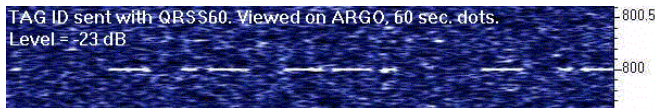


Figure: QRSS Morse Broadcast, signal level -23dB below the noise floor.

RTTY (FSK)

- ▶ FSK Modulation, with start and stop bits.
- ▶ Implemented to operate between 50 and 300 baud (symbols/sec).
- ▶ Carrier Shift programmable from 170 to 425Hz.
- ▶ Plenty of existing software to decode RTTY (i.e. fldigi)

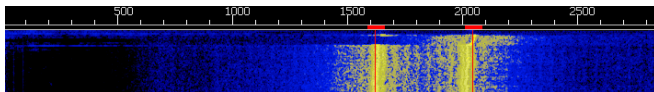


Figure: 300 Baud RTTY, with 425Hz Carrier Shift

DominoEX (MFSK)

- ▶ The first MFSK-based mode implemented - utilises Incremental Frequency Shift Keying.
- ▶ Resistant to multi-path and doppler effects.
- ▶ 6 variations available, each with different symbol rates (3.9 to 29.5Hz) and bandwidths (173 to 524Hz).
- ▶ Data rates varying from 2 to 14 *characters* per second.

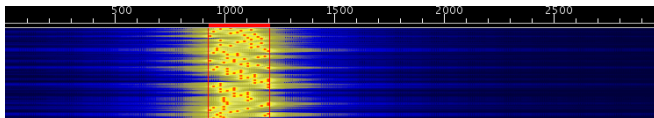


Figure: DominoEX8 - 7.8125 baud, 346Hz Bandwidth