SS-40 Digital Transceiver

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The SS-40 Digital is a modular transceiver that was designed as an extension to the original SS-40 receiver from 2011. The design elements that made that receiver so exceptional remain, but enhancements were made that include microprocessor control, an efficient class-E transmitter, and Rx/Tx PIN diode switching.

The design and all its components are being offered to the Ham community in hopes that it spurs building, learning and innovation in the future. The information is released under GNU General Public License v3.0, completely without support or warranty. Complete schematics, BOM, Gerber files, documentation and software are all stored on GitHub at https://github.com/ku4qo/SS-40-Digital-Transceiver. We want to encourage that future enhancements be shared freely with everyone.

There are 6 different boards needed to complete the transceiver, and the functions have been separated to encourage experimenting and allow flexibility of use. The builder has the flexibility to only build the sections they need. Each will be described separately below.

-Receiver

-Control

-Encoder/switch

-Transmitter

-Attenuator

-Front Panel

Receiver:

The receiver board architecture is very similar to the original SS-40. The front-end is comprised of a combination band pass-low pass filter set, followed by a RF Amplifier/Attenuator, with additional band pass filtering on the output of this stage. This is followed by a Minicircuits ADE-1 first mixer, a low-noise op-amp based (LT1253), two-stage IF amplifier, followed by an NE602 product detector (with audio AGC), and finally, a LM386 audio amplifier, which can provide room filling audio. Improvements include a 6-crystal QER IF filter and a very low loss reverse polarity protection MOSFET. The signals in and out of the board are brought to 0.1" header pins which allow the use of the common Female-Female Dupont connector assemblies. The connectors are described below.

Use caution when connecting the boards together. The Dupont connectors are not polarized. For most of these two-pin signal connections there is a signal pin and a ground pin. Although the connector location is clearly marked on the PCB, the polarity of the pins is not.

J1 - VFO	Input - Signal from the external VFO to feed the first mixer
J2 - Rx_Antenna	Input - RF signal input to the receiver
J3 - Tx_Power	Output - Power out to Tx board
J4 - Power_In	Input - Main power into reverse polarity protection circuit
J5 - Audio_output	Output - To speaker or headphones
J6 - Rx_Mute	Input - Mute control of receiver
J7 - Controller_power	Output - Power out to digital controller board
J8 - Attenuator_power	Output - Power out to Attenuator board

Controller:

The Controller board uses an Arduino Nano and a generic (or Adafruit) Si5351 I2C module to control the transceiver. It connects to the tuning encoder and the input switches for software control, and the 4-line I2C LCD screen for display. It provides the VFO for the receiver, the TX signal for the transmitter, along with orchestrating the Tx/Rx switching. The software provides a simple speed-adjustable keyer, sideband agility and voltage monitoring, along with calibration routines for initial setup.

J1 - Controller_power	Input - Reverse polarity protected power from Rx board
J2 - Encoder	Input - From the tuning encoder
J3 - Switches	Input - From the front panel switches
J4 - Rx_Mute	Output - To mute control of Receiver
J5 - Paddle	Input - From paddle jack for paddle or straight key connection; center pin is ground
6 - Rx_PIN	Output - To Tx board for receiver PIN diode control
J7 - Tx_PIN	Output - To Tx board for transmit PIN diode control
J8 - I2C_Buss	Output - To LCD display - Verify the LCD pin out, there is no standard; pins from top to bottom: SCL, SDA, Ground, +5VDC

J9 - Unused_ports	Input/Output - unused control lines from Arduino Nano for future expansion
J10 - Spare_power	Output - Power lines for future expansion
J11 - Tx_Enable	Output - To Tx board to enable transmit section power and envelope control
J12 - Tx_Freq	Output - Transmit signal to Tx board
J13 - BFO	Output - Not used
J14 - VFO	Output - VFO to Rx board first mixer

Encoder/switch:

This simple board mounts the encoder used for tuning and adjusting along with the three input switches used by the controller to interface with the software.

The four-pin connector under the "Up" switch is for the switches. The four pin connector under the "Down" switch is for the encoder. These go directly to the Controller board with straight-through 4 wire cables. Match the ground pins and the others will be connected correctly.

Transmitter:

The transmit board uses a trio of BS170 MOSFETs, envelope shaping and a low-pass filter to provide an efficient 5 watts of RF power to the antenna. It also has a PIN Rx/Tx switching circuitry based on the common 1N4007 rectifier diodes. It provides fast switching and reduces the intermodulation products possible with back-to-back diode designs.

J1 - Tx_Power	Input - Power from Rx board. Requires >500mA so size wire and connectors accordingly
J2 - Tx_Enable	Input - Turns on power to the final MOSFETs
J3 - Antenna	Output - To transmit antenna
J4 - Tx_Freq	Input - RF transmit signal from control board
J5 - Tx_PIN	Input - Transmit PIN diode control
J6 – Rx_Antenna	Output - To receiver antenna port (or Attenuator Board if used)
J7 - Rx_PIN	Input - Receive PIN diode control

Attenuator:

The Attenuator board provides a manual switched 10db, 20db or 30db attenuation to the receiver's incoming signal. This can be useful for taming very strong signals which can cause some artifacts with the receiver's AGC. It uses a pair of relays to switch in the attenuators, which can be controlled directly by an SPST switch, or optionally, you can employ the MOSFET drivers and drive them from a low level digital source.

J1 - Input	From the Tx board J6
J2 - Output	To the Rx board J2
J3 - Attenuator_power	From Rx board J8
J4 - 10db	10db attenuator control
J5 - 20db	20db attenuator control

Front Panel:

This board is not an electrical component. It is simply a mounting location for the attenuator switches and the volume control.