Using the SDR Control Box

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Rev 0.4.1 Corrections to USB Host connector pinout

What follows are the details of the implementation. This should be used along with the schematic when planning uses for the Control Box. Also included are suggested pin assignments for use with both the DD4WH Convolution SDR and the DSP-10.

I2C Control Interface – This is a standard hardware interface that gives up some flexibility for only needing 2 wires and ground. Multiple devices can share the interface as long as there built-in addresses do not collide. See [Wikipedia I2C]. The control box makes available a single I2C with the Teensy as a master and all devices are slaves, using

```
Teensy Pin 18  I2C SDA   Data
Teensy Pin 19  I2C SCL   Clock
```

These lines operate directly with the Teensy using 3.3 Volt logic, and must never be operated with 5 Volt logic. The damage from doing so would be with the Teensy.

These two lines are available in the 25-pin D connector as

```
D-Pin  4  I2C SDA
D-Pin 16  I2C SCL
```

Note that the selection of 3.3 Volt/5 Volt output for the 25-pin D connector, using jumpers E35, E36 and E37, does not change the I2C in any way. It is always 3.3 Volt logic.

The exact same I2C wires are available for general use on the 4-pin header, P15. The pins are:

```
P15-1   Ground
P15-2   I2C SDA
P15-3   I2C SCL
P15-4   +3.3 VDC
```

Teensy Audio Adapter SGTL5000 Codec in the SDR Control Box uses the I2C bus for control. It is at address 0x0A (default) or 0x2A (rewire jumper).

The I2C buss must have a pair of pull-up resistors to 3.3VDC. This is suppled by the Teensy Audio Adaptor (2.2K) and no other resistors are needed.

SPI Control Interfaces – Flexible "SPI" serial interfaces are available, all using the Teensy as Master. Each SPI device needs a private "Chip Select" line, but otherwise, the buss lines are sharable, as

```
   Teensy Pin  7  SPI MOSI  Data, Master Out Slave In
   Teensy Pin 12  SPI MISO  Data, Master In Slave Out
   Teensy Pin 14  SPI SCK   Clock out from master
```

The chip selects are any general purpose digital I/O lines:

```
   Teensy Pin 12 SPI CS to D-Pin 11
   Teensy Pin 12 SPI CS to Aud Adaptor memory (alternative)
   Teensy Pin 16 SPI CS to D-Pin 8
   Teensy Pin 20 SPI CS for the 320x240 touch display
   Teensy Pin 28 SPI CS to on-board Audio amp and 595 shift reg
```

In addition, there are two complete SPI ports, for general use, brought to headers. These continue to share the MOSI, MISO and SCK but have there Chip Selects provided by the 595 shift register, which is itself a SPI port. These two ports are not buffered and are direct Teensy digital outputs, with 3.3-Volt logic. The pinouts:

```
SPI Port #2
   P5-1   +3.3VDC
   P5-2   Ground
   P5-3   SPI SCK
   P5-4   SPI MISO
   P5-5   SPI MOSI
   P5-6   Chip Select, Shift Reg Pin U5-D
 SPI Port #3
   P4-1   +3.3VDC
   P4-2   Ground
   P4-3   SPI SCK
   P4-4   SPI MISO
   P4-5   SPI MOSI
   P4-6   Chip Select, Shift Reg Pin U5-E
```

Serial UART Interfaces – In order to fully support the older DSP-10 design, this Control Box has 3 independent RS-232 serial interfaces. These are supported by hardware UARTs, There are differences in the three that again relate to the DSP-10 hardware design. Obviously, these need not be implemented if the DSP-10 support is not required. The MAX 3232 buffers allow RS-232 voltages to be met while running off 3.3 Volts.

```
RS-232 #1 for antenna dish mover control, 9 pin D, M
   P9-1   Not used, available by E23
   P9-2   RX Data in to Box
   P9-3   TX Data out of Box
   P9-4   Not used, available by E21
   P9-5   Ground
```

```
RS-232 #1 for antenna dish mover control, 9 pin D, M
   P9-1   Not used, available by E23
   P9-2   RX Data in to Box
   P9-3   TX Data out of Box
   P9-4   Not used, available by E21
   P9-5   Ground
```


```
RS-232 #1 for antenna dish mover control, 9 pin D, M
   P9-1   Not used, available by E23
   P9-2   RX Data in to Box
   P9-3   TX Data out of Box
   P9-4   Not used, available by E21
   P9-5   Ground
```


Serial USB Device – The Teensy board includes a Micro Type B socket to allow programming and serial communications with a USB Host PC. I left a 0.5-inch hole to allow a cable to pass through the back panel, just above the 25-pin D connector. This cable needs to be made accessible.

In addition, for many SDR it is possible to borrow power from the 5-Volt 500 mA USB supply.

Serial USB Host – CORRECTION – This supports the Teensy operating as a Host for USB. This needs to go to a panel Type A USB socket. Currently there are no users for this, but it has much potential, and the Teensyduino library is filling out with device types. Note that Rev 0.4 of the schematic had the wrong pin functions. These were corrected on Rev 0.4.1 and are (the PCB is unchanged):

```
   J4-1   +5 Out
   J4-2   DM
   J4-3   DP
   J4-4   GND
   J4-5   GND
```

Button Interfaces – The box front panel should include 8 push buttons. Two or three of these can be built into the rotary encoders. These all pull a line to ground through 4.7K resistors. The 9 pin header is

```
   U9-1   Ground
   U9-2   Button 1
   U9-3   Button 2
   U9-4   Button 3
   U9-5   Button 4
   U9-6   Button 5
   U9-7   Button 6
   U9-8   Button 7
   U9-9   Button 8
```

Rotary Encoder Interfaces – The box front panel should include 3 rotary encoders. They can be either mechanical or optical, but need to be in-phase/quadrature type (I-Q) that is very standard. The I-Q lines are pulled to ground with 4.7K pull up resistors to 3.3 VDC on the PCB. Power is supplied for optical type encoders; note this is 5-Volts. The three headers are

```
P11, Rotary Encoder #1 (usually 'Tune" with a large knob)
   P11-1   Ground
   P11-2   I
   P11-3   Q
   P11-4   +5 VDC

P12, Rotary Encoder #2
   P12-1   Ground
   P12-2   I
   P12-3   Q
   P12-4   +5 VDC

P13, Rotary Encoder #3
   P13-1   Ground
   P13-2   I
   P13-3   Q
   P13-4   +5 VDC
```

DC Voltage Monitor – Teensy pin 21 is used as analog input to measure a summation of all power supply voltages. This does not tell where a problem is, but it does a simple test of whether there is a problem. There is a 1000 Ohm resistor to ground, so the sum of the currents into the resistor should be roughly 1.5 mA with the sum node at 1.5 Volts. A 4700 Ohm resistor to the 3.3 Volt buss provides 0.38 mA. A 10K resistor to 5V provides another 0.35 mA. This leaves about 0.85 mA that can come from the SDR through D-Pin 7. As an example, if this was connected to a 10.0 Volt supply, it would need (10-1.5)/0.85 = 10K Ohms. The value in the SDR is reduced by the R13 protection resistor in the Control Box (1000 Ohms) so that 9K is needed.

If no external resistor is used, a voltage of 0.65 Volts will be measured, just checking the two supplies in the Control Box.

Red/Green LED – A bidirectional LED connected to the 2-pin header P3 will indicate status. This is controlled by the shift register U5-A and U5-B on the internal SPI buss.

Audio Interfaces - First, a jumper is required inside the control box to connect the Audio Adaptor In/Out to the main PCB P1. For the Audio Adaptor, see https://www.pjrc.com/store/teensy3_audio.html especially the back side markings of the PCB.

Audio inputs/outputs for the Control Box are on 4 two-pin headers:

```
P2 – Audio in left
P3 – Audio in right
J1 – Audio out left
J2 – Audio out right
```

This connects the inputs through U1, the programmable LTC6912-2 audio amplifier. If this is not desired, the P2 and P3 connections should go directly to the Teensy Audio Adaptor.

DC Power Selection –

Important: Unless you are going to always power everything through the Teensy USB connector, you must cut the 5 Volt jumper on the Teensy 3.6 board. See https://www.pjrc.com/teensy/schematic.html and https://www.pjrc.com/teensy/pinout.html (the right end of the backside).

The only voltage used as an input for the Control Box is 5 Volts that is must go to E39 (see schematic sheet 2). This can come from the external SDR via D-Pin 19, which in turn is accessed by a connection between E38 and E39. Alternatively, the 5 Volts at E39 can come from off the board, either via the USB connector on the Teensy, or from an off board regulator in the control box. Note that there is a 3.3 Volt regulator on the PCB, but its input is **always** 5 Volts.

Traditionally 12 was general level of voltage used as a starting point for radios. If this is desired, it can be provided through the external SDR (but regulated down to 5-Volts for D-Pin19). Alternatively, a 12 to 5 Volt regulator can be placed in the Control Box.

If this seems like too many options, this figure (TBD) shows an off-board 3-position switch that selects

```
1  Power from SDR via D-Pin19
2  Power from the Teensy USB
3  Power from a 12 to 5 Volt regulator in the Control Box
```

I have placed such a switch on the back panel of my Control Box.

Use with DD4WH Convolution SDR – To make this Contrl Box general, it was necessary to change some of the pin assignments used with this radio. These are changeable via #define's in the DD4WH software, but at this writing, they are not all collected together. Here are the defines that go with the Control Box:

```
// For I2C "Wire" library, default Teensy 3.6 uses (no #define
needed):
//        SDA   Data    Pin 18
//        SCL   Clock   Pin 19
#define BACKLIGHT_PIN       45   // NOT USED
```

```
#define TFT_DC              10
#define TFT_CS              20
#define TFT_RST             46  // 255 = unused. connect to 3.3V
#define TFT_MOSI             7
#define TFT_SCLK            14
#define TFT_MISO             8
// pins for digital attenuator board PE4306
#define ATT_LE              16
#define ATT_DATA             7
#define ATT_CLOCK           14
// push-buttons
#define   BUTTON_1_PIN      35    // Left
#define   BUTTON_2_PIN      36    // Right
#define   BUTTON_3_PIN      37    // Down
#define   BUTTON_4_PIN      38    // Up
#define   BUTTON_5_PIN      41    // pushbutton pin for tune encoder
(ALT)
#define   BUTTON_6_PIN      26    // the pushbutton pin of the filter
encoder (FCN)
#define   BUTTON_7_PIN      43    // the menu button pin
#define   BUTTON_8_PIN      27    // the pushbutton pin of encoder 3
#define ENCODER_TUNE_I       3
#define ENCODER_TUNE_Q       2
#define ENCODER_FILTER_I     4
#define ENCODER_FILTER_Q     5
#define ENCODER_3_I         47
#define ENCODER_3_Q         48
#define RF_FILTER1          40
#define RF_FILTER2          42
#define RF_FILTER3          51
#define RF_FILTER4          52
#define RF_FILTER5          53
```

In hardware terms, the listing of Teensy pins, 25-Pin D-Pins and Function are

```
T3.6 25-pin
Pin   Conn     Function
---- ------   ----------
0         NU
1         NU
2         Opto Encoder 1 I
3         Opto Encoder 1 Q
4         Opto Encoder 2 I
5         Opto Encoder 2 Q
6         T_CS Disp
7    13   SPI MOSI0 Disp+Share
8    12   SPI MISO Disp +Share
9         I2S BCLK  Codec
10        D/C Disp
11        I2S MCLK   Codec
12   11   NU
```

```
13        I2S RX  Codec
14   10   SPI SCK0 Disp & share
15        Vol Codec DC to uP
16   8    ATT_LE
17        I2S TX Codec
18   4    I2C SDA Codec+Share
19   16   I2C SCL Codec+Share
20        CS Disp
21   7    Power Supply monitor
22   6    NU
23        I2S LCLK Codec
24        T_IRQ  Disp
25   25   NU
26        Button 1
27        Button 2
28        Local SPI SS
29   24   NU
30   23   NU
31        NU
32        NU
33        NU
34        NU
35        Button 3
36        Button 4
37        Button 5
38        Button 6
39   9    AUDIO_AMP_ENABLE
---  20   Ground
---  19   +5 VDC to Ctrl Box
A21  3    NU-Analog
A22  14   NU-Analog
40   21   Filter Band 1 Out
41        Button 7
42   22   Filter Band 2  Out
43        Button 8
44        NU
45        NU
46        NU
47        Opto Encod 3 I
48        Opto Encod 3 Q
49        RTC Battery Voltage ?
50   2    NU
51   18   Filter Band 3
52   5    Filter Band 4
53   17   Filter Band 5
```

Use with DSP-10 (EZ-Kit replacement) -

Software #define's TBD

The hardware connections for the DSP-10 are:

T3.6 25-pin Pin	Conn	DSP-10 Function
0		Serial1 RX (from PC)
1		Serial1 TX (to PC)
2		Opto Encoder 1 I
3		Opto Encoder 1 Q
4		Opto Encoder 2 I
5		Opto Encoder 2 Q
6		T_CS Disp
7	13	SPI Data from uP
8	12	SPI Data to uP
9		I2S Bclk Codec
10		D/C Disp
11		I2S MCLK
12	11	SPI SS #2
13		I2S RX Codec
14	10	SPI Serial Clock #0
15		NU
16	8	SPI SS #1
17	6	NU
18	4	I2C SDA
19	16	I2C SCL
20		CS Disp
21	7	Power Supply monitor
22		I2S TX Codec
23		I2S LCLK Codec
24		T_IRQ Disp
25	25	CW Key to uP
26		Button 1
27		Button 2
28		Local SPI SS
29	24	PLL_LOCK to uP
30	23	PTT to uP & RS-232 RI
31		Serial4 RX (GPS)
32		Serial4 TX (GPS)
33		Serial5 TX (Ant Ctrl)
34		Serial 5 RX (Ant Ctrl)
35		Button 3
36		Button 4
37		Button 5
38		Button 6
39	9	NU
---	20	Ground
---	19	+5 VDC to Ctrl Box
A21	3	NU-Analog
A22	14	NU-Analog

40	21	NU
41		Button 7
42	22	NU
43		Button 8
44		NU
45		NU
46		NU
47		OptoEncod 3 I
48		OptoEncod 3 Q
49		NU
50	2	NU
51	18	NU
52	5	NU
53	17	NU