(tr)uSDX – 5–Band / Mulitmode QRP Transceiver

efficient Class E PA and Supports CW/LSB/USB and AM/FM. It covers by default 80/60/40/30/20m (alternative Filter Setups possible)

The (tr)uSDX is a 5–Band / Mulitmode QRP Transceiver in Pocket Format (90x60x30mm – 140g). It features a highly efficient Class E PA and Supports CW/LSB/USB and AM/FM. It covers by default 80/60/40/30/20m (alternative Filter Setups possible)

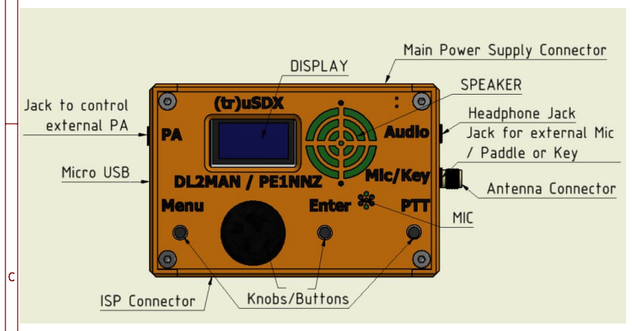
It is supplied with an OLED Display, onboard Mic, (tiny) onboard speaker and for improvised QSO onboard PTT Key can be used as emergency CW Key.

Further on, the (tr)uSDX has a (Micro)USB CAT and Programming Interface, and while it produces typically 5W @ 13,8V Power Supply, it can create 0,5W Output from 5V USB Supply alone.

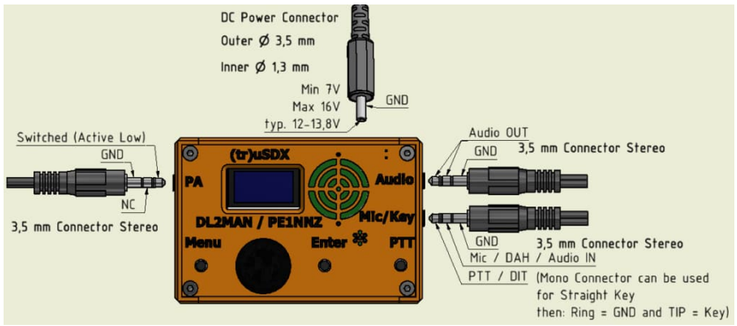
Typically it draws 80mA on RX (with MS5351 – less with Si5351) and 500mA on TX @13,8V and typical 85% PA Efficiency.

It is supplied with OnBoard SWR Bridge and Voltage/Current measurement Hardware, to help in tuning and operation.

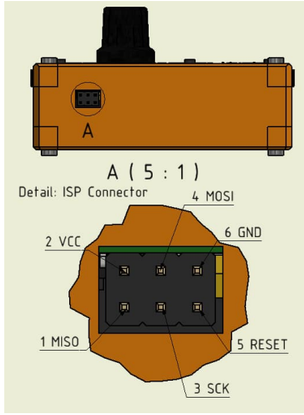
General Overview



External Connections



ISP Connection



Programming

Bootloader

The Bootloader needs to be installed only once, before the Firmware can be installed. Normally, for Group Buy or Kit Buy, the organizer would normally have installed the Bootloader. The Firmware cannot be loaded via the USB port without first installing the Bootloader. Installing the Bootloader requires an ISP programmer. While there are many ISP programmers than can be purchased, an Arduino Uno can be used as an ISP programmer.

More information about loading the Bootloader and using an Arduino Uno can be found here:

https://dl2man.de/3a–trusdx–bootloader/

If the Bootloader has been installed according to the instructions at the link above AND the Firmware has not been installed yet, then every time the (tr)uSDX is powered on, an 18 digit hexadecimal number will appear on the display. This hexadecimal number is the 'serial number' which must be written down and kept – once the Firmware is installed, this number will not be displayed anymore unless the EEPROM is erased when the Bootloader is reinstalled. And this number is required in order to download the Firmware from the (tr)uSDX website.

Firmware

You will need the 18 digit hexadecimal 'serial number' to download the firmware. (see Bootlader instructions). At the time of this writing, the firmware v2.00i and this version will not dispay the serial number. The only method to retrive the serial number, is to reinstall the Bootload and wipe the EEPROM.

Your Callsign is optional. Instructions and more information about loading the Firmware can be found at:

Firmware Page: https://dl2man.de/3b–trusdx–firmware/

Software updates will be announced in the (tr)uSDX Forum, https://forum.dl2man.de/

and provided on the Firmware page for download. An experimental beta, when available, is uploaded here:

Beta Firmware: https://dl2man.de/wp–content/uploads/2022/01/wp.php/beta.html

Below are additional sheets that are form the complete set of schematics, a type of table of contents. It is also KiCAD hieratchical links to the other sheets.

(tr)uSDX Main Board v1.0

Page 2: Main board schematic

File: (tr)uSDX_Main_Board_v1–0.kicad_sch

(tr)uSDX Main Board Parts Layout A v1.0

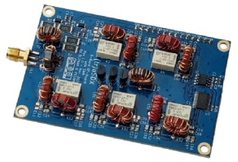
Page 3: Main board parts layout without copper trace pattern

File: (tr)uSDX_Main_Board_Parts_Layout_A_v1–0.kicad_sch

(tr)uSDX Parts Main Board Parts Layout B v1.0

Page 4: Main board parts layout with copper trace pattern

File: (tr)uSDX_Main_Board_Parts_Layout_B_v1–0.kicad_sch



(tr)uSDX RF Board v1.0

Page 5: RF board schematic with 'Lo' band configuration

File: (tr)uSDX_RF_Board_v1–0.kicad_sch

(tr)uSDX RF Board – Alternate Bands v1.0

Page 6: Alternative 'Classic ' band with FDT86256 MOSFET configuration and additional RF filter information

File: (tr)uSDX_RF_Board–Alt_Bands_v1–0.kicad_sch

RF Board Parts Layout A v1.0

Page 7: RF board parts layout without copper trace pattern

File: (tr)uSDX_RF_Board_Parts_Layout_A_v1–0.kicad_sch

RF Board Parts Layout B v1.0

Page 8: RF board parts layout with copper trace pattern

File: (tr)uSDX_RF_Board_Parts_Layout_B_v1–0.kicad_sch

More Information:

Videos of the build, tuning and other (tr)uSDX information can be found at:
* DL2MAN's website: https://dl2man.de/
* The (TR)uSDX forum: https://forum.dl2man.de/
* YouTube DL2MAN channel: https://www.youtube.com/channel/UCqabnQWUjwH4K3FJtxbmrlA

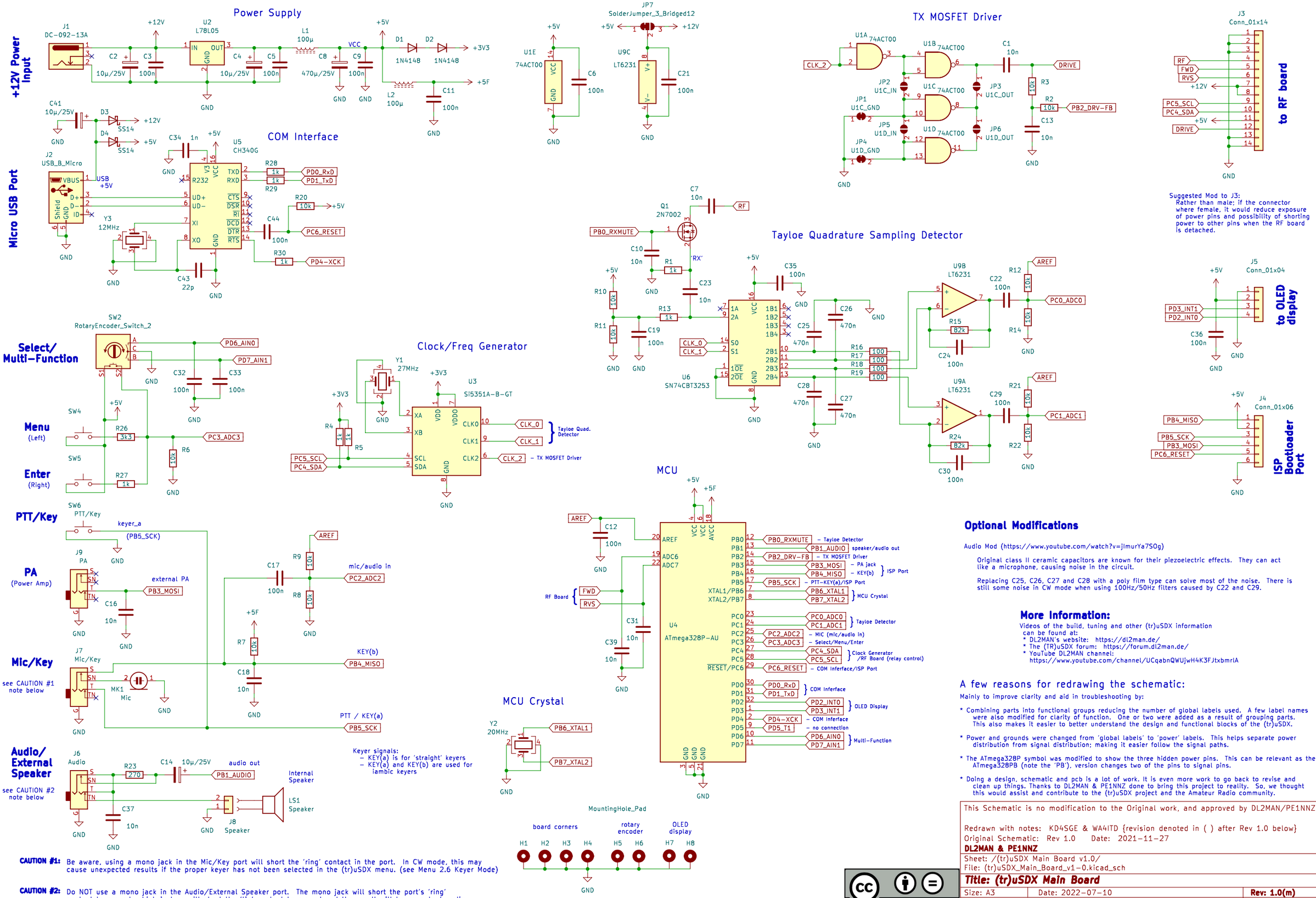
This Schematic is no modification to the Original work, and approved by DL2MAN/PE1NNZ

Redrawn with notes: KD4SGE & WA4ITD {revision denoted in ( ) after Rev 1.0 below}
Original Schematic: Rev 1.0 Date: 2021–11–27
DL2MAN & PE1NNZ

Sheet: /
File: (tr)uSDX_Main–RF_Schematics_v1.0.kicad_sch

Title: (tr)uSDX Overview and Subsheets

Size: A3	Date: 2022–07–10	**Rev: 1.0(m)**
KiCad E.D.A. kicad (6.0.5)		Id: 1/8


Power Supply
+12V Power Input
J1
DC-092-13A
U2
L7805
L1
100µ
D1
1N4148
D2
1N4148
C2
10µ/25V
C3
100n
C4
10µ/25V
C5
100n
C8
470µ/25V
C9
100n
C11
100n
L2
100µ
C41
10µ/25V
D3
SS14
D4
SS14
U1E
74ACT00
C6
100n
JP7
SolderJumper_3_Bridged12
U9C
LT6231
C21
100n
TX MOSFET Driver
U1A
74ACT00
U1B
74ACT00
U1C
74ACT00
U1D
74ACT00
C1
10n
DRIVE
R3
10k
R2
10k
PB2_DRV-FB
C13
10n
JP1
U1C_GND
JP2
U1C_IN
JP3
U1C_OUT
JP4
U1D_GND
JP5
U1D_IN
JP6
U1D_OUT
CLK_2
J3
Conn_01x14
to RF board
RF
FWD
RVS
PC5_SCL
PC4_SDA
DRIVE
Suggested Mod to J3:
Rather than male: if the connector where female, it would reduce exposure of power pins and possibility of shorting power to other pins when the RF board is detached.
Micro USB Port
J2
USB_B_Micro
C34
1n
U5
CH340G
R28
1k
R29
1k
PD0_RxD
PD1_TxD
R20
10k
C44
100n
PC6_RESET
R30
1k
PD4-XCK
Y3
12MHz
C43
22p
COM Interface
Tayloe Quadrature Sampling Detector
Q1
2N7002
C7
10n
RF
PB0_RXMUTE
C10
10n
R1
1k
'RX'
R10
10k
R11
10k
C23
10n
R13
1k
C19
100n
U6
SN74CBT3253
C35
100n
C26
470n
C25
470n
C28
470n
C27
470n
R16
100
R17
100
R18
100
R19
100
CLK_0
CLK_1
U9B
LT6231
U9A
LT6231
R15
82k
C24
100n
R24
82k
C30
100n
C22
100n
C29
100n
R12
10k
R14
10k
R21
10k
R22
10k
AREF
PC0_ADC0
PC1_ADC1
J5
Conn_01x04
to OLED display
PD3_INT1
PD2_INT0
C36
100n
J4
Conn_01x06
ISP Bootloader Port
PB4_MISO
PB5_SCK
PB3_MOSI
PC6_RESET
Select/ Multi-Function
SW2
RotaryEncoder_Switch_2
PD6_AIN0
PD7_AIN1
C32
100n
C33
100n
Menu
(Left)
SW4
R26
3k3
PC3_ADC3
R6
10k
Enter
(Right)
SW5
R27
1k
SW6
Clock/Freq Generator
Y1
27MHz
U3
Si5351A-B-GT
R4
1k
R5
1k
PC5_SCL
PC4_SDA
CLK_0
CLK_1
CLK_2
Tayloe Quad. Detector
TX MOSFET Driver
MCU
U4
ATmega328P-AU
AREF
C12
100n
RF Board
FWD
RVS
C31
10n
C39
10n
XTAL1/PB6
XTAL2/PB7
MCU Crystal
Y2
20MHz
PB6_XTAL1
PB7_XTAL2
PB0_RXMUTE
PB1_AUDIO
PB2_DRV-FB
PB3_MOSI
PB4_MISO
PB5_SCK
PC0_ADC0
PC1_ADC1
PC2_ADC2
PC3_ADC3
PC4_SDA
PC5_SCL
PC6_RESET
PD0_RxD
PD1_TxD
PD2_INT0
PD3_INT1
PD4-XCK
PD5_T1
PD6_AIN0
PD7_AIN1
PTT/Key
PTT/Key
keyer_a
(PB5_SCK)
J9
PA
PA
(Power Amp)
external PA
C16
10n
C17
100n
R9
10k
R8
10k
mic/audio in
PC2_ADC2
R7
10k
C18
10n
KEY(b)
PB4_MISO
Mic/Key
J7
Mic/Key
see CAUTION #1 note below
MK1
Mic
PTT / KEY(a)
PB5_SCK
Keyer signals:
– KEY(a) is for 'straight' keyers
– KEY(a) and KEY(b) are used for iambic keyers
Audio/ External Speaker
J6
Audio
see CAUTION #2 note below
R23
270
C14
10µ/25V
audio out
PB1_AUDIO
C37
10n
J8
Speaker
Internal Speaker
LS1
Speaker
CAUTION #1: Be aware, using a mono jack in the Mic/Key port will short the 'ring' contact in the port. In CW mode, this may cause unexpected results if the proper keyer has not been selected in the (tr)uSDX menu. (see Menu 2.6 Keyer Mode)
CAUTION #2: Do NOT use a mono jack in the Audio/External Speaker port. The mono jack will short the port's 'ring' contact to ground, which in turn will short the 'tip' contact to ground and the result will be no output audio.
MountingHole_Pad
board corners
rotary encoder
OLED display
H1
H2
H3
H4
H5
H6
H7
H8
Optional Modifications
Audio Mod (https://www.youtube.com/watch?v=JlmurYa7SOg)
Original class II ceramic capacitors are known for their piezoelectric effects. They can act like a microphone, causing noise in the circuit.
Replacing C25, C26, C27 and C28 with a poly film type can solve most of the noise. There is still some noise in CW mode when using 100Hz/50Hz filters caused by C22 and C29.
More Information:
Videos of the build, tuning and other (tr)uSDX information can be found at:
* DL2MAN's website: https://dl2man.de/
* The (TR)uSDX forum: https://forum.dl2man.de/
* YouTube DL2MAN channel: https://www.youtube.com/channel/UCqabnQWUjwH4K3FJtxbmrlA
A few reasons for redrawing the schematic:
Mainly to improve clarity and aid in troubleshooting by:
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* Power and grounds were changed from 'global labels' to 'power' labels. This helps separate power distribution from signal distribution; making it easier follow the signal paths.
* The ATmega328P symbol was modified to show the three hidden power pins. This can be relevant as the ATmega328PB (note the 'PB'), version changes two of the pins to signal pins.
* Doing a design, schematic and pcb is a lot of work. It is even more work to go back to revise and clean up things. Thanks to DL2MAN & PE1NNZ done to bring this project to reality. So, we thought this would assist and contribute to the (tr)uSDX project and the Amateur Radio community.
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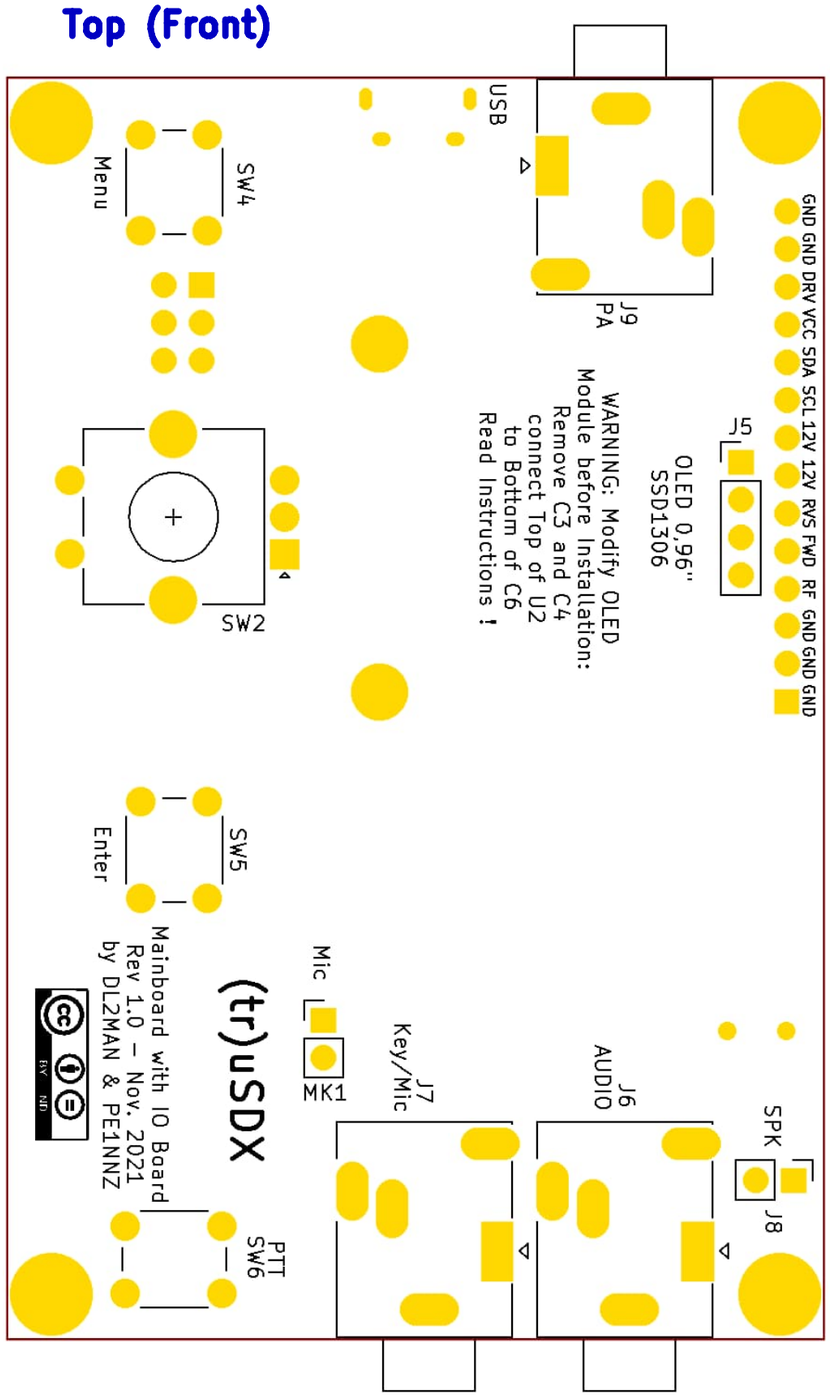
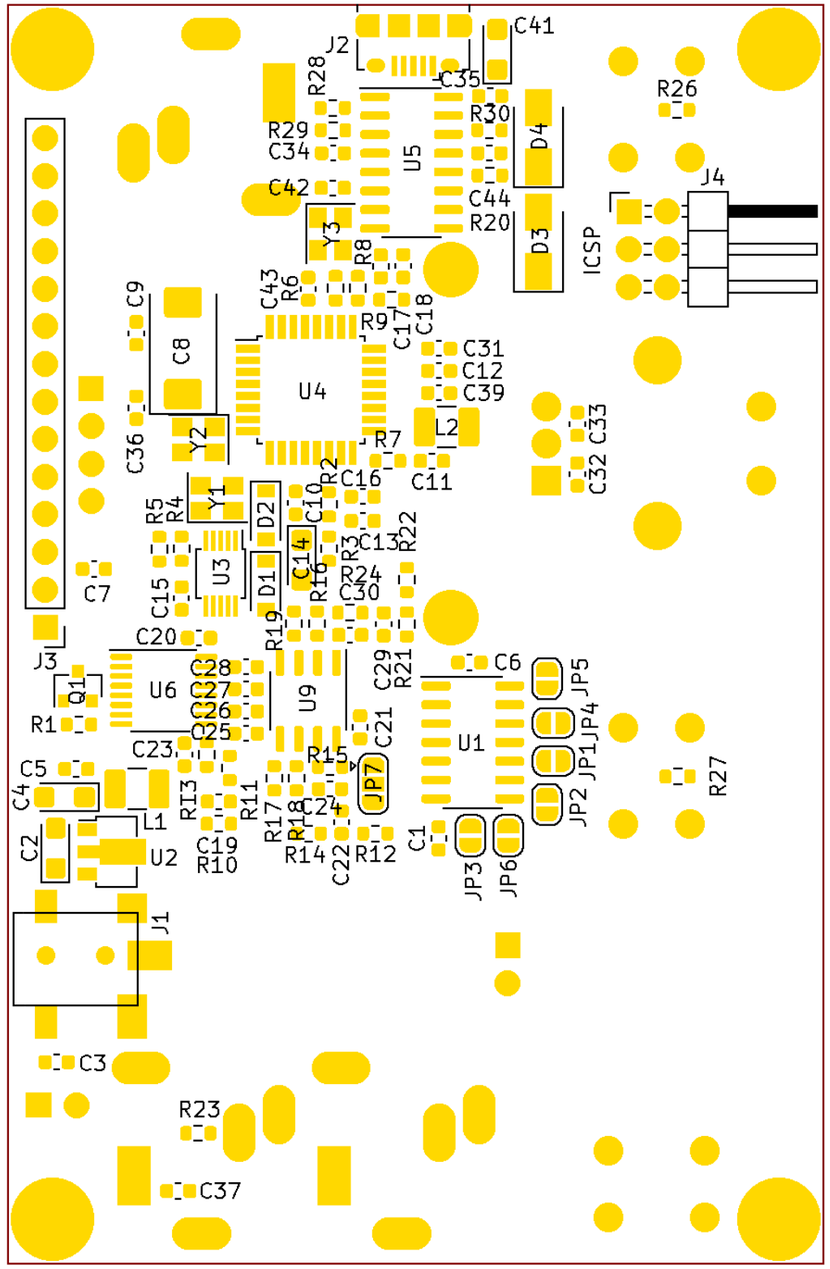
Redrawn with notes: KD4SGE & WA4ITD {revision denoted in ( ) after Rev 1.0 below}
Original Schematic: Rev 1.0 Date: 2021-11-27
DL2MAN & PE1NNZ
Sheet: /(tr)uSDX Main Board v1.0/
File: (tr)uSDX_Main_Board_v1-0.kicad_sch
Title: (tr)uSDX Main Board
Size: A3
Date: 2022-07-10
Rev: 1.0(m)
KiCad E.D.A. kicad (6.0.5)
Id: 2/8
BY ND

Top (Front)



Bottom (Back)



Main Board Parts Layout without copper trace pattern

This Schematic is no modification to the Original work, and approved by DL2MAN/PE1NNZ

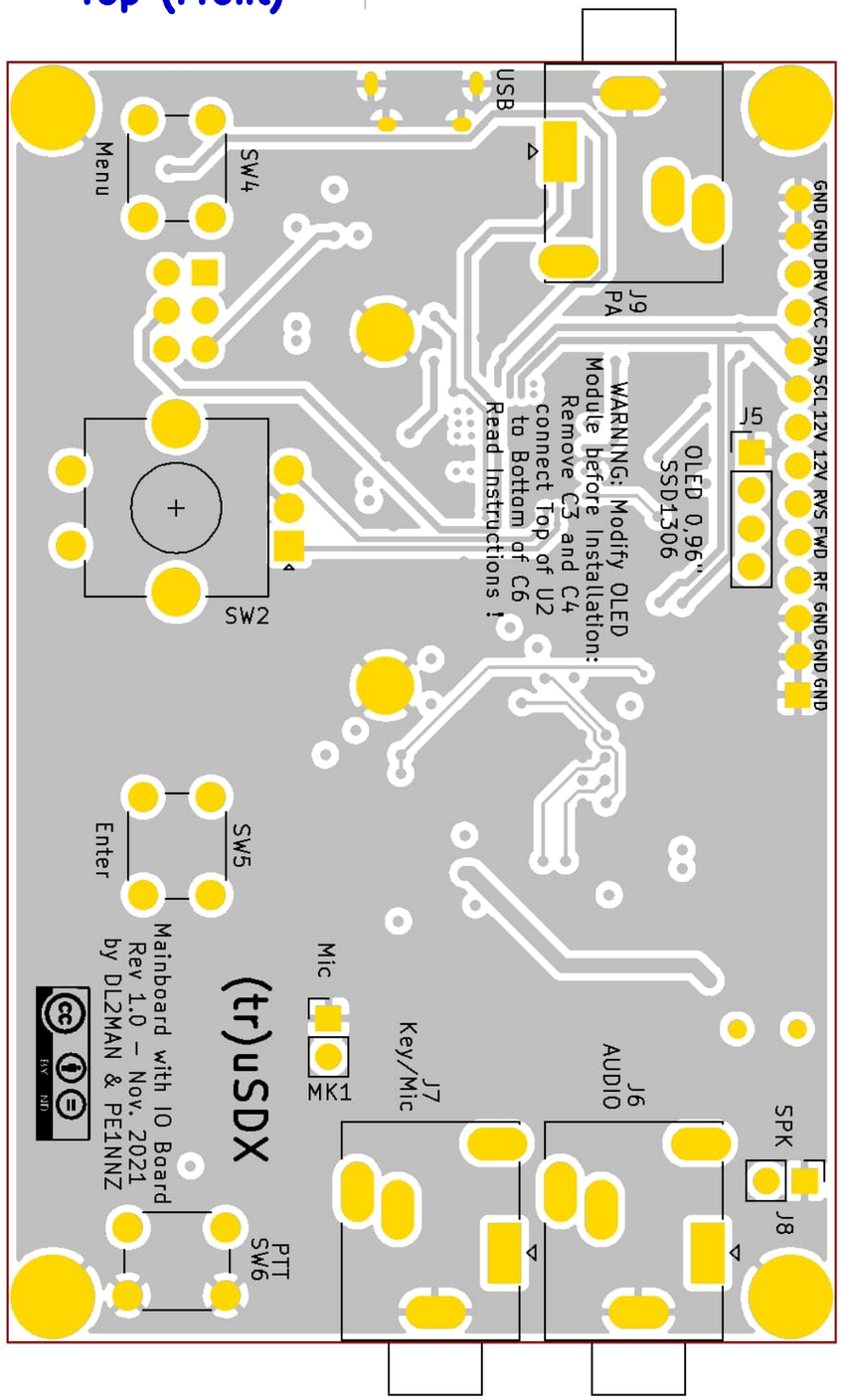
Redrawn with notes: KD4SGE & WA4ITD {revision denoted in ( ) after Rev 1.0 below}
Original Schematic: Rev 1.0 Date: 2021-11-27
DL2MAN & PE1NNZ

Sheet: /(tr)uSDX Main Board Parts Layout A v1.0/
File: (tr)uSDX_Main_Board_Parts_Layout_A_v1-0.kicad_sch

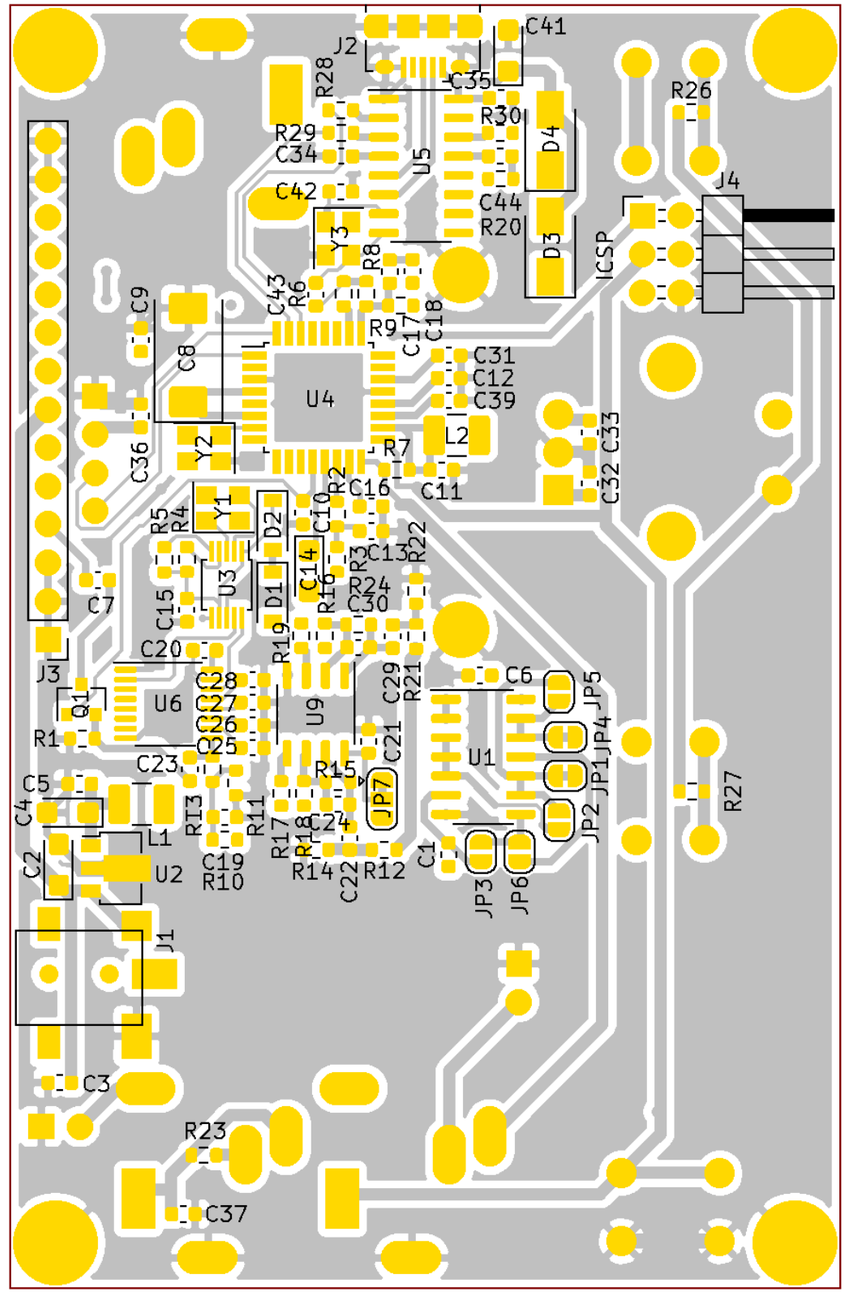
Title: Main Board Parts Layout A

Size: A3	Date: 2022-07-10	**Rev: 1.0(m)**
KiCad E.D.A. kicad (6.0.5)		Id: 3/8

Top (Front)



Bottom (Back)



Main Board Parts Layout with copper trace pattern

Note: This is a four layer board. The two internal layers are mainly power and ground planes. But there may also be a few internal traces which would not be visible. So, if a trace looks like it goes nowhere, it may continue on an internal layer.

This Schematic is no modification to the Original work, and approved by DL2MAN/PE1NNZ

Redrawn with notes: KD4SGE & WA4ITD {revision denoted in ( ) after Rev 1.0 below}
Original Schematic: Rev 1.0 Date: 2021-11-27
DL2MAN & PE1NNZ

Sheet: /(tr)uSDX Parts Main Board Parts Layout B v1.0/
File: (tr)uSDX_Main_Board_Parts_Layout_B_v1-0.kicad_sch

Title: Main Board Parts Layout B

Size: A3	Date: 2022-07-10	**Rev: 1.0(m)**
KiCad E.D.A. kicad (6.0.5)		Id: 4/8

Band Slots – LPF Filters for 'Lo' bands (20/30/40/60/80m)

Values given are when using three BS170s (Q1, Q2 and Q3)
If using Q4 or Q5 or a different MOSFET then values may be different.

*Capacitors not placed/installed are shown with a value of 'np'.
*Toroids wound using 0.4mm(18mil)[26ga] wire.

See sheet 6 and https://dl2man.de for more information.

Inductors/transformers use two different material types.
Iron is shown with solid lines and ferrite has dashed lines, as shown:

Powder Iron Ferrite

to Main Board

J1 Conn_01x14

+12V +5V

1 RF
2 FWD
3 RVS
4
5
6
7
8
9 PC5_SCL
10 PC4_SDA
11
12 DRIVE
13
14

GND

Suggested Mod for J1:
Rather than female; the connector should be male since there is not power on these pins when the RF board is not attached to the main board.

Latching Relay Control (Band Select)

+5V +5V C1 100n GND

R25 10k

PC4_SDA 23 SDA
PC5_SCL 22 SCL
1 INT
VCC 24

U7 TCA9555PWR

P00 4 P00_KCOM
P01 5
P02 6
P03 7
P04 8
P05 9
P06 10
P07 11
P10 13
P11 14 P11_BS4_K4
P12 15 P12_BS2_K2
P13 16 P13_BS1_K1
P14 17 P14_BS3_K3
P15 18 P15_BS5_K5
P16 19
P17 20

3 A2
2 A1
21 A0
GND 12

GND GND

MountingHole_Pad
pcb four corners

H9 H10 H11 H12

GND

Latching Relay Notice:

The relays are latching types, the coil is only energized to toggle the relay. Which way the relay toggles depends on the direction of the current thru the coil.

Mechanical force maintaines the 'toggle'. However, strong vibrations or sudden impact(s) can cause a relay to 'toggle' changing the LPF configuration and, therefore, performance. This change is NOT detected by the software and will not be shown on the display. If such a condition is suspected it can be corrected by changing to another band and back, or by powering off/on the radio.

Band Slot 1

20m

LPF_20m_IN — L11 400n 10T/T37-2 — C12 470p, C13 np — L12 196n 7T/T37-2 — LPF_20m_OUT

C10 68p, C11 np — C14 470p, C15 np — C18 470p, C19 np — GND

K1 G6KU-2

LPF_20m_OUT 6 — 5 ANT — ANT
LPF_20m_IN 3 — 4 RF — RF
P00_KCOM 8 — 2
Re+ Se+
P13_BS1_K1 — 1 — GND

Band Slot 2

30m

LPF_30m_IN — L21 576n 12T/T37-2 — C22 330p, C23 330p — L22 256n 8T/T37-2 — LPF_30m_OUT

C26 220p, C27 np

C20 100p, C21 100p — C24 330p, C25 330p — C28 330p, C29 330p — GND

K2 G6KU-2

LPF_30m_OUT 6 — 5 ANT
LPF_30m_IN 3 — 4 RF
P00_KCOM 8 — 2
Re+ Se+
P12_BS2_K2 — 1 — GND

Band Slot 3

40m

LPF_40m_IN — L31 900n 15T/T37-2 — C32 470p, C33 470p — L32 400n 10T/T37-2 — LPF_40m_OUT

C36 150p, C37 150p

C30 150p, C31 150p — C4 np, C35 1n — C38 np, C39 1n — GND

K3 G6KU-2

LPF_40m_OUT 6 — 5 ANT
LPF_40m_IN 3 — 4 RF
P00_KCOM 8 — 2
Re+ Se+
P14_BS3_K3 — 1 — GND

Band Slot 4

60m

LPF_60m_IN — L41 1156n 17T/T37-2 — C42 1n, C43 220p — L42 576n 12T/T37-2 — LPF_60m_OUT

C46 68p, C47 330p

C40 100p, C41 330p — C44 470p, C45 1n — C48 220p, C49 1n — GND

K4 G6KU-2

LPF_60m_OUT 6 — 5 ANT
LPF_60m_IN 3 — 4 RF
P00_KCOM 8 — 2
Re+ Se+
P11_BS4_K4 — 1 — GND

Band Slot 5

80m

LPF_80m_IN — L51 1444n 19T/T37-2 — C52 1n, C53 1n — L52 786n 14T/T37-2 — LPF_80m_OUT

C56 150p, C57 470p

C50 330p, C51 330p — C54 1n, C55 1n — C58 1n, C59 1n — GND

K5 G6KU-2

LPF_80m_OUT 6 — 5 ANT
LPF_80m_IN 3 — 4 RF
P00_KCOM 8 — 2
Re+ Se+
P15_BS5_K5 — 1 — GND

Power/SWR Bridge

C7 10n, C5 10n, GND, R3 100, R1 100

FWD — R6 68k — D1 1N4148W — T2* 1:7 ratio/FT37-43 — GND

Power/SWR Feedback

RVS — R5 68k — D2 1N4148W — R4 100, R2 100

C8 10n, C6 10n — GND

T1 1:7 ratio/FT37-43
1–2, 1T : 3–4, 7T

GND — ANT — ANT_OUT 1

* T2 Modification:
Reduces power dissipation in T2.
Original: 1–2, 1T : 3–4, 7T
Modified: 1–2, 3T : 3–4, 21T

T1, T2 NOTE:
Note the polarity of the windings of T1 and T2. Windings should be in the same direction so to have 0° phase between prmary/secondary. Winding in opposite directions will cause a 180° phase shift producing in errors in power and SWR readings.

Antenna

J12 Conn_Coaxial

ANT_OUT 1 — 2 — GND

Voltage/Current Measurement (Efficiency Measurement)

+5V — C3 100n — GND

U1 INA219AxD

PC4_SDA 3 SDA
PC5_SCL 4 SCL
VS 5
1 A1
2 A0
GND 6
IN+ 8
IN− 7

C2 100n

R7 10 — R-Shunt ~17mΩ — VDRAIN
R8 10

+12V — C4 100n — L15 200µH 22T/FT37-43 — GND

R-Shunt
This value is due to resistance of the PCB trace resistance. This is intentional and may vary slighly from board to board. The software uses this value to calculate the efficiency. See menu '8.6 R Shunt'.

MOSFET Output Drivers

DRIVE — Q1 BS170, Q2 BS170, Q3 BS170 — RF

GND

Alternate Output Driver Options

OR

Q4 IRLML2060 — DRIVE 1 — RF — GND

OR

Q5 FDT86256 — DRIVE 4 — RF — GND

Pads for these SMA transistors are placed on the opposite side of board from other components (relays, coils, etc).

More Information:

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* The ATmega328P symbol was modified to show the three hidden power pins. This can be relevant as the ATmega328PB (note the 'PB'), version changes two of the pins to signal pins.

* Doing a design, schematic and pcb is a lot of work. It is even more work to go back to revise and clean up things. Thanks to DL2MAN & PE1NNZ done to bring this project to reality. So, we thought this would assist and contribute to the (tr)uSDX project and the Amateur Radio community.

This Schematic is no modification to the Original work, and approved by DL2MAN/PE1NNZ
Serial resonance Class E with SWR measurement
Redrawn with notes: KD4SGE & WA4ITD {revision denoted in ( ) after Rev 1.0 below}
Original Schematic: Rev 1.0 Date: 2021-11-27
DL2MAN & PE1NNZ

Sheet: /(tr)uSDX RF Board v1.0/
File: (tr)uSDX_RF_Board_v1-0.kicad_sch

Title: (tr)uSDX RF Board

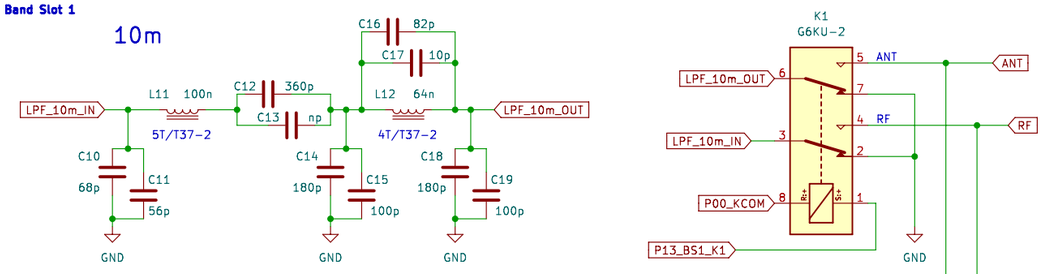
Size: A3	Date: 2022-07-10	**Rev: 1.0(m)**
KiCad E.D.A. kicad (6.0.5)		Id: 5/8

Band Slots – LPF Filters for 'Classic' band (10/15/20/40/80m)

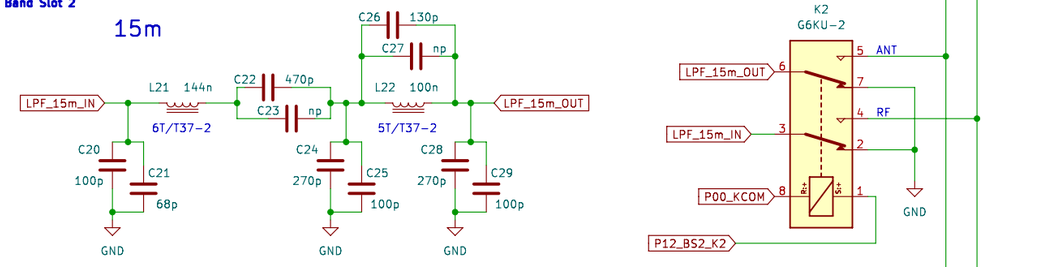
Tested by DL2MAN (20 May 2022)
Using Q5, FDT86256 with a PA Bias of 160

More info: https://dl2man.de/2-trusdx-assembly/

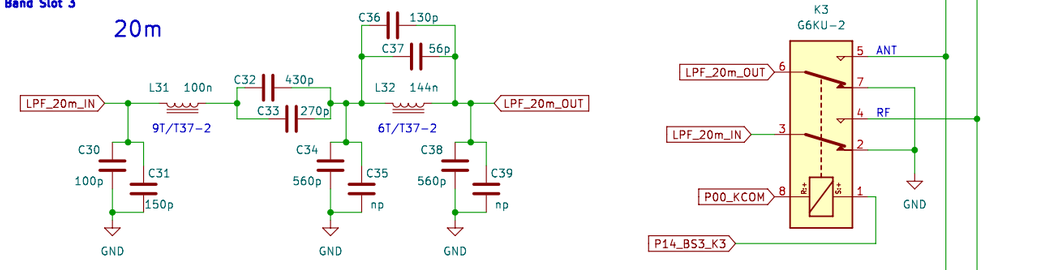
Band Slot 1



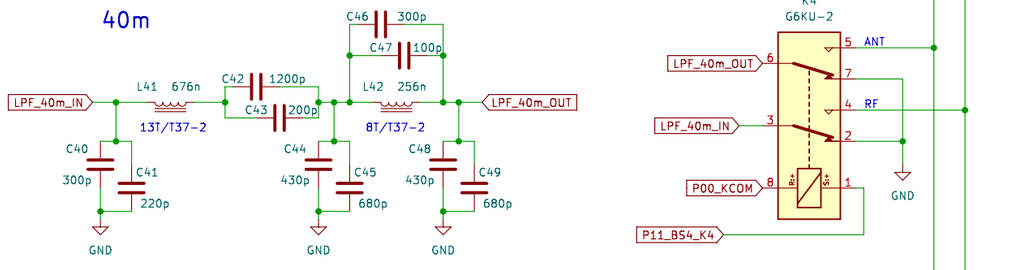
Band Slot 2



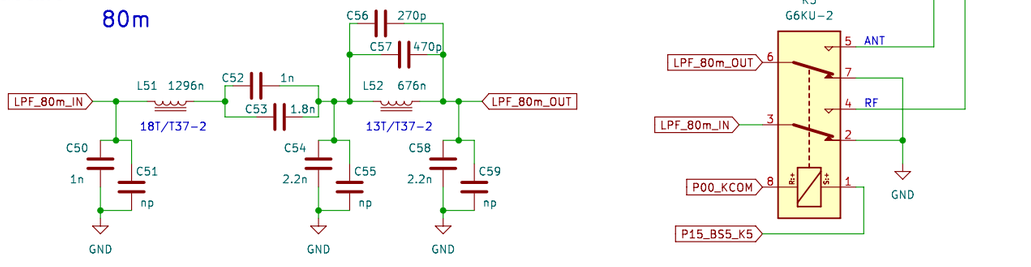
Band Slot 3



Band Slot 4



Band Slot 5



Generic Band LPF Design

LPF – Low Pass Filter

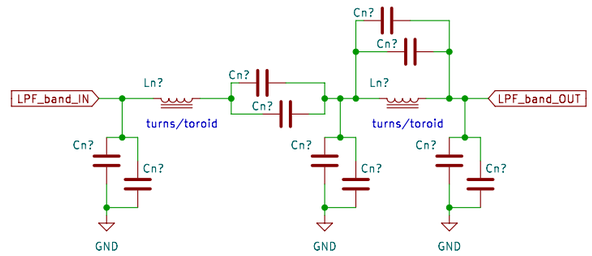
The LPF component reference number has the following pattern:

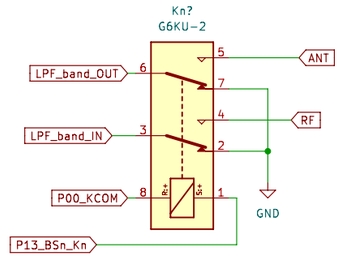
Simply, each component is referenced by a letter and two numbers. The first number is the band slot, 'n' and the second number, 'y' is the specific component.

For example, capacitors would be 'Cny'. There are ten capacitors in each LPF. So, in Band Slot 1 the reference for each capacitor would be C10, C11, C12,...C19. In Band Slot 2 it would be C20, C21, C22,..., C29. And so on for Band Slots 3 to 5.

Inductors, Lny, follow the same scheme.

Relays are an exception as there is only one relay per LPF. So a relay, K, is simply 'Kn'.





There are several online and offline tools to calculate the turns/toroids for a band. Search for one you like best. Below are examples of two offline calculators that can be used.

One tool is:
mini Ringkern-Rechner – https://www.dl0hst.de/mini-ringkern-rechner.htm#en

Another is:
Coil64 (Coil32) – https://coil32.net/

Disclaimer: Downloading and installing any programs from the Internet come with risks and is the responsibility of the end user. The authors of this document are not responsible for any errors or damages in their use. Download responsibly.

Remember: (tr)uSDX Filter Capacitors ALWAYS need to be C0G/NP0 Types, rated for at least 100V !

Simplified Filter Design

Technically, it is not a low pass filter. Rather a combination of a shunt capacitance, bandpass and Pi network. The shunt capacitance (which includes the C_{OSS} of the MOSFET(s)), sets the load, which inturn set the power of the Class E output. The bandpass is also part of the inductive load required for the Class E output. However,the low frequency cutoff of the bandpass is sufficently low as to be concidered ignored.While the Pi network is for impedance transformation and second harmonic notch filtering.

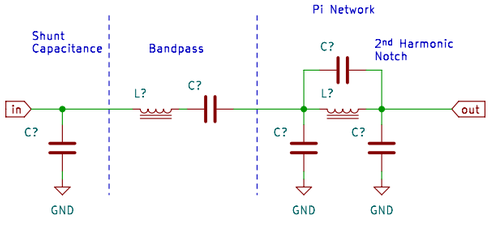
Recommending readings:

Class E Power Amplifiers for QRP by David Cripe NMS, May 14, 2009
http://amfone.net/Amforum/index.php?action=dlattach;topic=35824.0;attach=41753

A calculator for this design can be found on WA0ITP website:
http://www.wa0itp.com/class%20e%20design.html

Also of note is, in the (tr)uSDX, the transmitted signal goes from 'in-to-out' while the recieved signal is reversed, going from 'out-to-in'.

The 2nd harmonic notch is adjusted by changing the winding spacing on L2. Windings closer together increases inductance and spreading apart decreases inductance. The efficiency is adjusted by changing the winding spacing on L1. Note that higher power does not mean higher efficiency.



Band Configurations

The (tr)uSDX provides for three bands configurations: Lo, Hi and Classic. Each configuration expects a specific band filter to to be in a given band slot. So for the 'Lo' bands; the 20m band, in band slot 1, the 30m in band slot 2, and so on.

Each configuration also transitions from one band slot to the next at specific frequencies (relay ƒ transition). So, for the 'Lo' configuration, when tuning, going from 12.99999 MHz to 13.00000 MHz, the relays will toggle from band slot 1 to slot 2; from 30m to 40m the relays toggle at 9 MHz; and so forth.

Failing to place filters in the appropriate band slot AND select the correct band configuration can result in unexpected results and transmission on unintended frequencies.

Band Configuration \ Band Slot	1	2	3	4	5
Lo (current Standard)	20m	30m	40m	60m	80m
Relay ƒ Transistion	13MHz	9MHz	6MHz	5MHz	
Hi (Only HI Bands)	10m	12m	15m	17m	20m
Relay ƒ Transistion	26MHz	24MHz	20MHz	18MHz	
Classic (Classical Bands w/o WARC)	10m	15m	20m	40m	80m
Relay ƒ Transistion	24MHz	18MHz	9MHz	5MHz	

ƒ – frequency

LPF Design Considerations:

The values of the capacitors and inductors can vary for several reasons. Some of those reasons include:

* Tolorance of component values; which can usually vary by 5% or more. This not only includes capacitors but also the toroids.
* The PCB traces add stray capacitance and inductance.
* The C_{OSS} of MOSFETs can vary; either by switching types (BS170 to FDT86256) and/or by count, using multiple BS170s.
* Whether T2 has been modified for 1:7 turns to 3:21 turns.
* And many other random things including metal placed in close proximity to the RF board. This also includes strong magnetic fields.
* Keep in mind the frequencies the relays transition from one band to the next when tuning.

As a result, for a given band, the capacitance and inductor values may vary slightly form board to board and as MOSFETs are changed. So when using values given by other users, the MOSFET and number of, should be specified. But, even then the values would simply be a starting point and tweaking may still be required.

Capacitor/Toroid Notes:

In the LPF circuits, use only:
* NPO/C0G Capacitors rated for at least 100V
* Toroids from Micrometals or Amidon

The wire specified for winding the toroids; 0.4mm(18mil)[26ga]. Smaller diameter wire will decrease the Q of the inductor and a larger wire will increase it.

Keep in mind that several things will affect the inductance of the inductors:
* How loose or snuggly the turns are wrapped on the torroid. A loose turn has lower inductance than a snug turn. But too snug a turn can be hard to adjust the spacing later when adjusting the 2nd harmonic filter.
* The spacing between turns. As turns, even a few turns, get closer together, the inductance will increase. The lowest inductance is obtained with evenly spaced turns around the torroid.

So, when winding the coils:
* A wire pass thru the center of the toroid counts as a turn.
* Try to evenly space the turns around the toroid.
* Avoid overlaping windings.

After the build, the LPF tuning is done by adjusting the toroid winding spacing to notch out the second harmonic frequency, using equipment such as a nanoVNA.

More Information:

Videos of the build, tuning and other (tr)uSDX information can be found at:
* DL2MAN's website: https://dl2man.de/
* The (TR)uSDX forum: https://forum.dl2man.de/
* YouTube DL2MAN channel: https://www.youtube.com/channel/UCqabnQWUjwH4K3FJtxbmrIA

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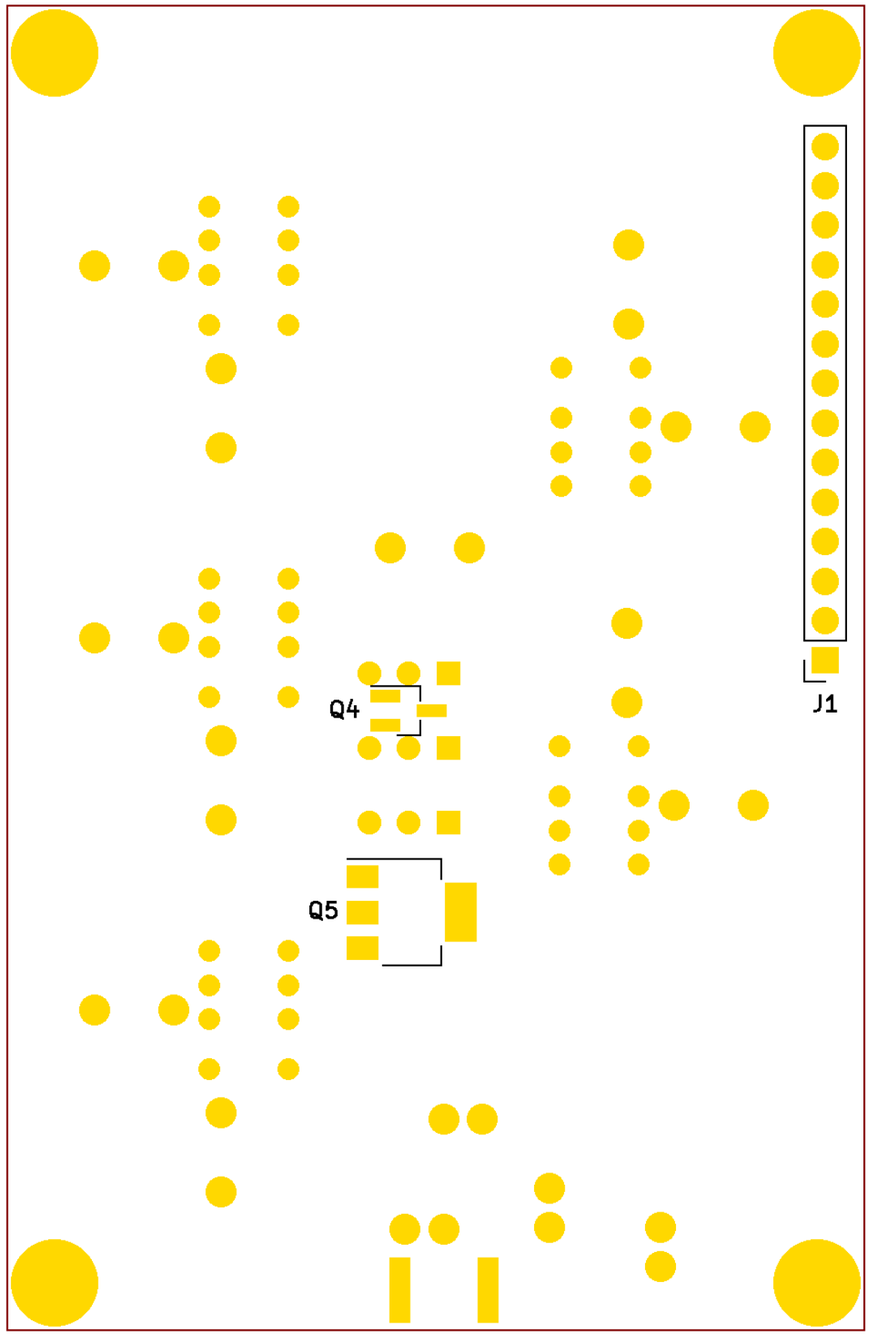
Serial resonance Class E with SWR measurement
Redrawn with notes: KD4SGE & WA4ITD {revision denoted in ( ) after Rev 1.0 below}
Original Schematic: Rev 1.0 Date: 2021-11-27
DL2MAN & PE1NNZ

Sheet: /(tr)uSDX RF Board – Alternate Bands v1.0/
File: (tr)uSDX_RF_Board-Alt_Bands_v1-0.kicad_sch

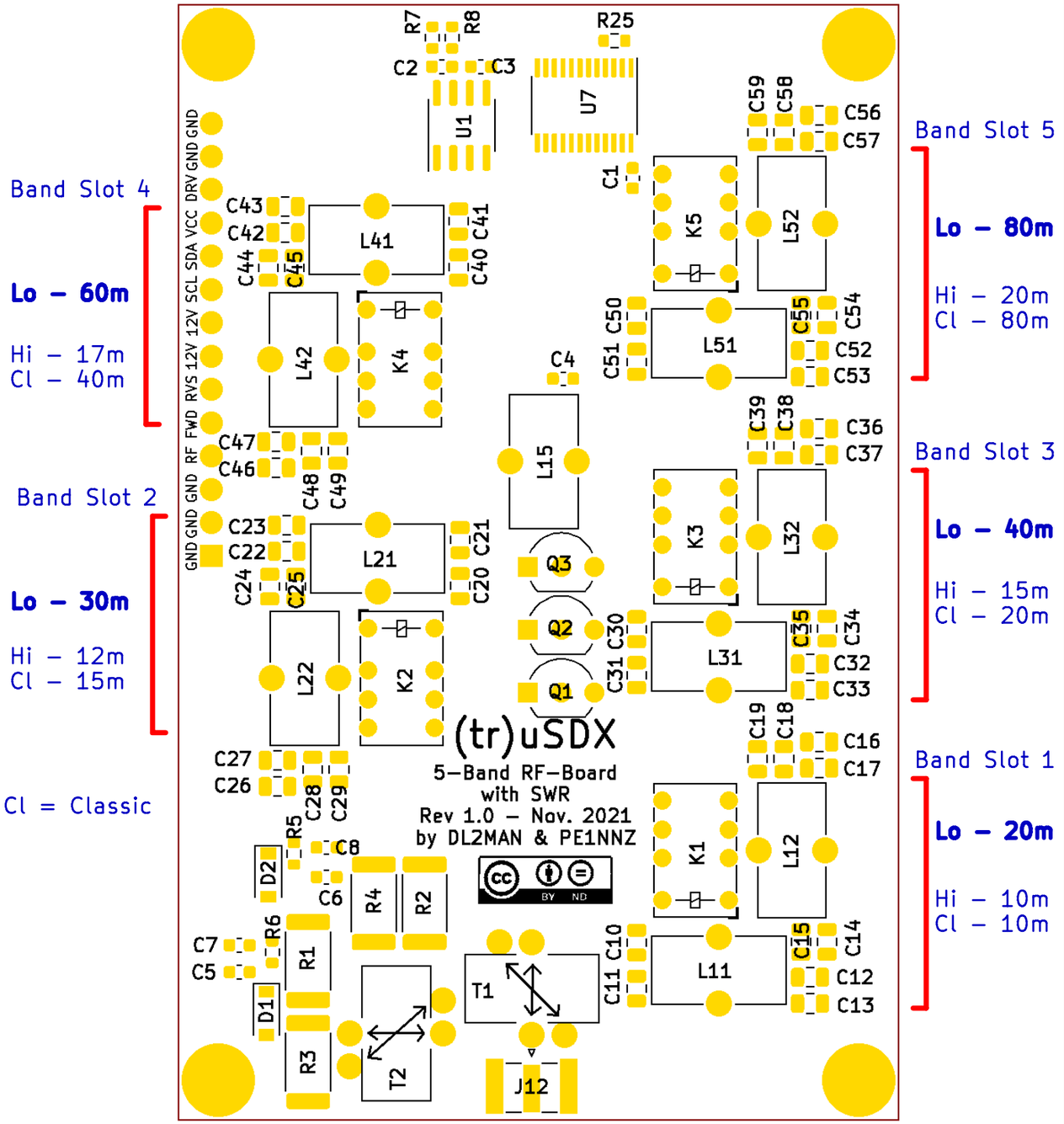
Title: (tr)uSDX RF Board – Alternate Bands and Notes

Size: A3	Date: 2022-07-10	**Rev: 1.0(m)**
KiCad E.D.A. kicad (6.0.5)		Id: 6/8

Top (Front)



Bottom (Back)



RF Board Parts Layout without copper trace patterns

This Schematic is no modification to the Original work, and approved by DL2MAN/PE1NNZ

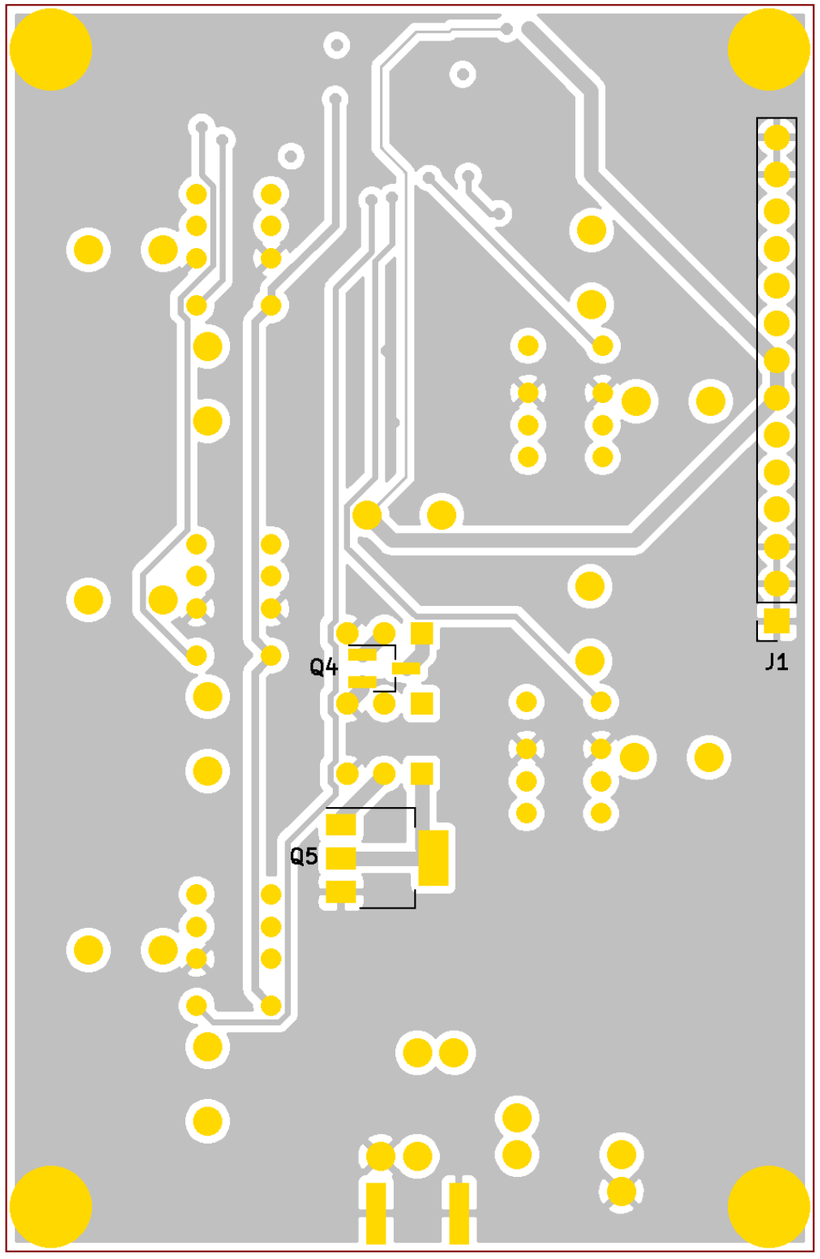
Redrawn with notes: KD4SGE & WA4ITD {revision denoted in ( ) after Rev 1.0 below}
Original Schematic: Rev 1.0 Date: 2021-11-27
DL2MAN & PE1NNZ

Sheet: /RF Board Parts Layout A v1.0 /
File: (tr)uSDX_RF_Board_Parts_Layout_A_v1-0.kicad_sch

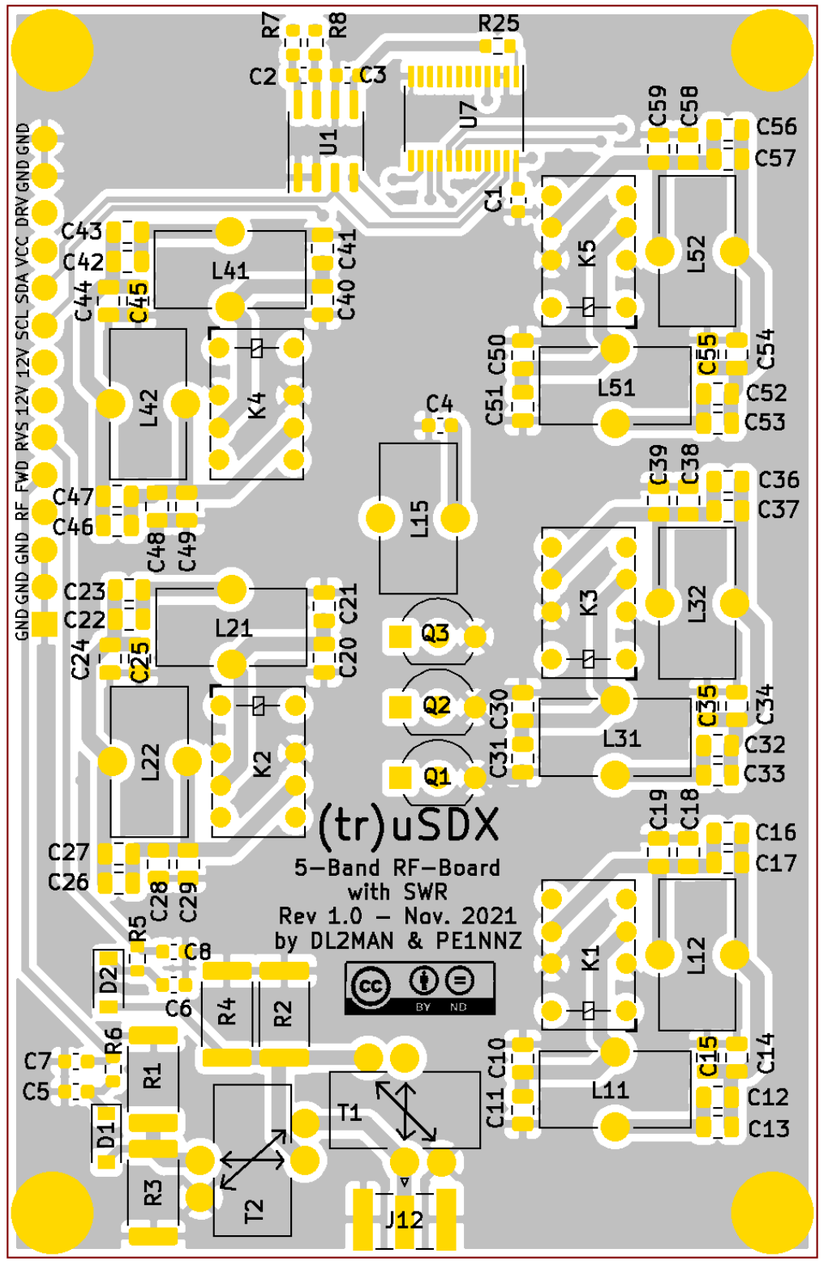
Title: RF Board Parts Layout

Size: A3	Date: 2022-07-10	**Rev: 1.0(m)**
KiCad E.D.A. kicad (6.0.5)		Id: 7/8

Top (Front)



Bottom (Back)



RF Board Parts Layout with copper trace patterns

Note: This is a four layer board. The two internal layers are mainly power and ground planes. But there may also be a few internal traces which would not be visible. So, if a trace looks like it goes nowhere, it may continue on an internal layer.

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Redrawn with notes: KD4SGE & WA4ITD {revision denoted in ( ) after Rev 1.0 below}
Original Schematic: Rev 1.0 Date: 2021-11-27
DL2MAN & PE1NNZ

Sheet: /RF Board Parts Layout B v1.0/
File: (tr)uSDX_RF_Board_Parts_Layout_B_v1-0.kicad_sch

Title:

Size: A3	Date: 2022-07-10	**Rev: 1.0(m)**
KiCad E.D.A. kicad (6.0.5)		Id: 8/8