(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)

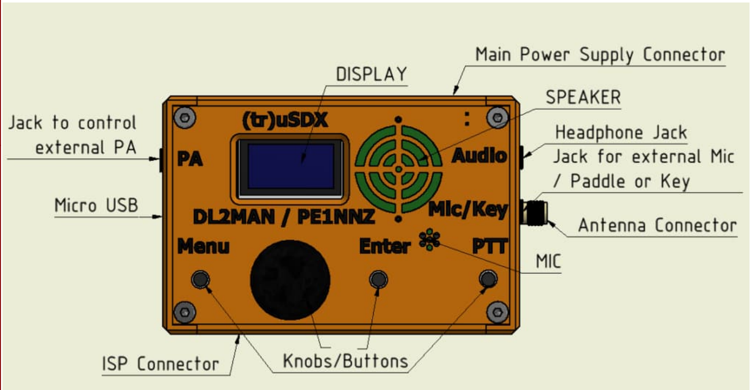
It is supplied with an OLED Display, onboard Mic, (tiny) onboard speaker and for improved QSO onboard PTT Key can be used as emergency CW Key.

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.

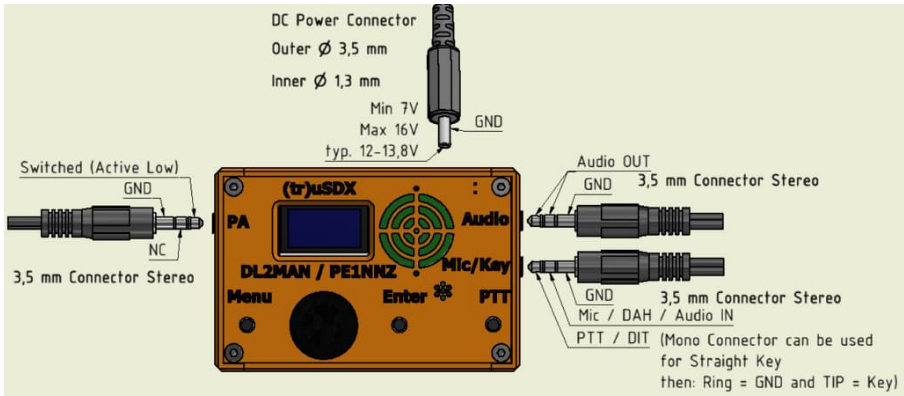
Typically it draws 80mA on RX (with MS5351 – less with Si5351) and 500mA on TX @13,8V and typical 85% PA Efficiency.

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

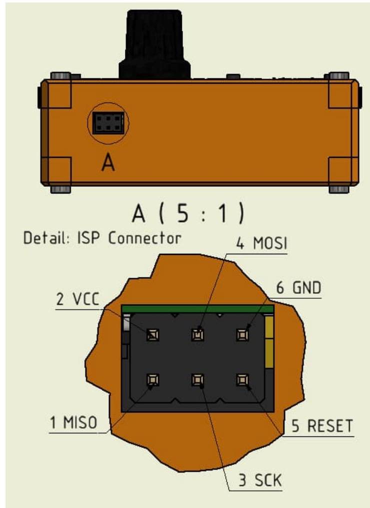
General Overview



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:

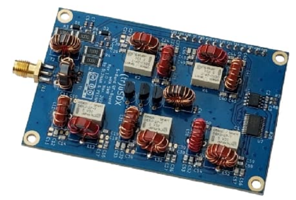
Firmware Page: https://dl2man.de/3b–trusdx–firmware/

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 form a complete set of schematics and other supporting documentation. A type of table of contents.



This third–party schematic provided to improve clarity and aid in troubleshooting by:

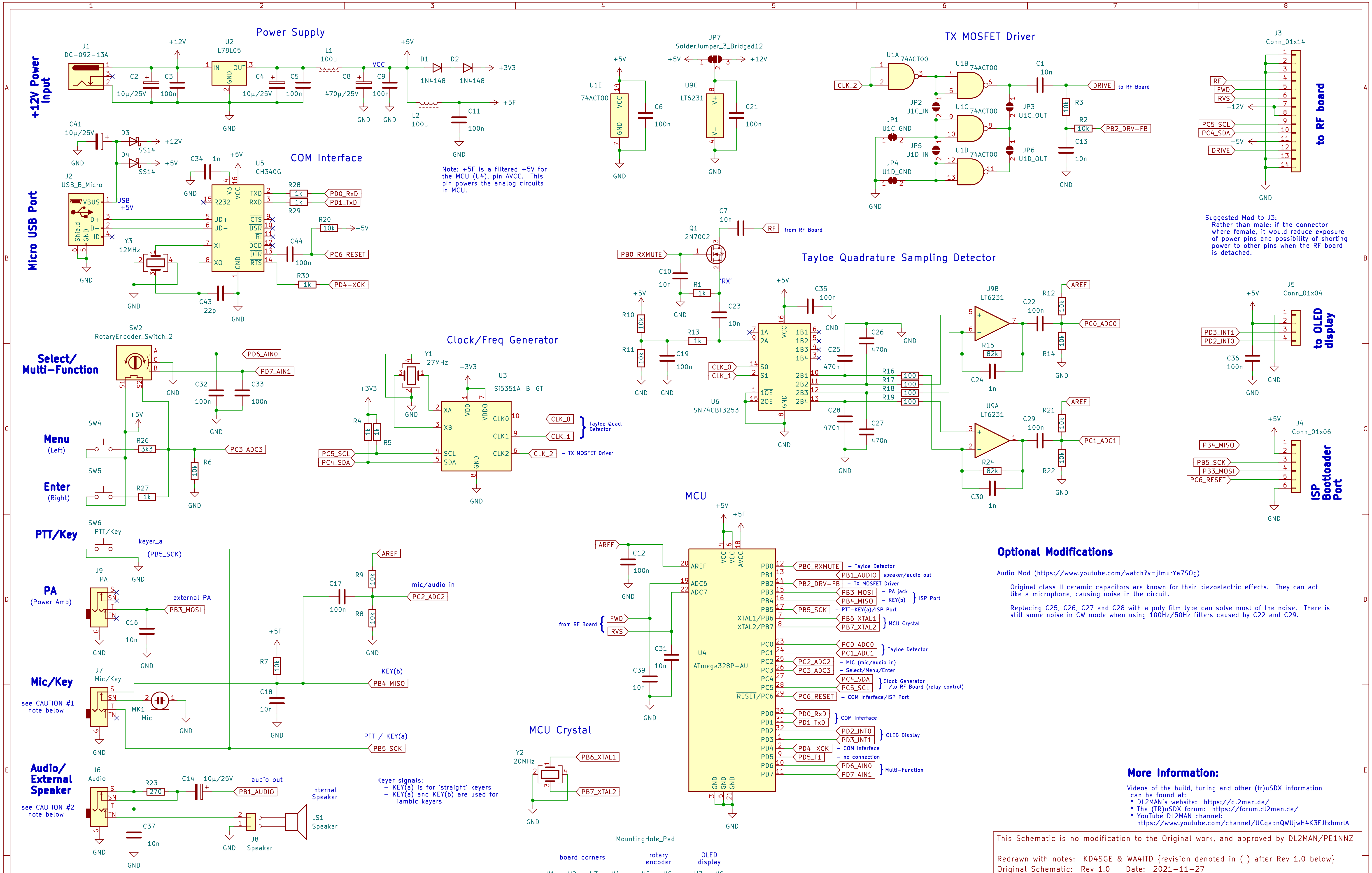
* Combining parts into functional groups reducing the number of global labels used. A few label names were also modified for clarity of function and design
* The ATmega328P symbol was modified to show the three hidden power pins. This can be relevant as the ATmega328PB (note the 'PB'), version changes 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.

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: 2022–10–15 | **Rev: 1.0(n)**
KiCad E.D.A. kicad (6.0.5) | Id: 1/10



Note: +5F is a filtered +5V for the MCU (U4), pin AVCC. This pin powers the analog circuits in MCU.

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.

see CAUTION #1 note below

see CAUTION #2 note below

Keyer signals:
- KEY(a) is for 'straight' keyers
- KEY(a) and KEY(b) are used for iambic keyers

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.

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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) Also, the ring is the Mic input and is pulled up to +5F (+5V) by R7 (10k). On the ring or tip: DO NOT exceed +5V or less than 0V as damage to the MCU (U4) can result.

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.

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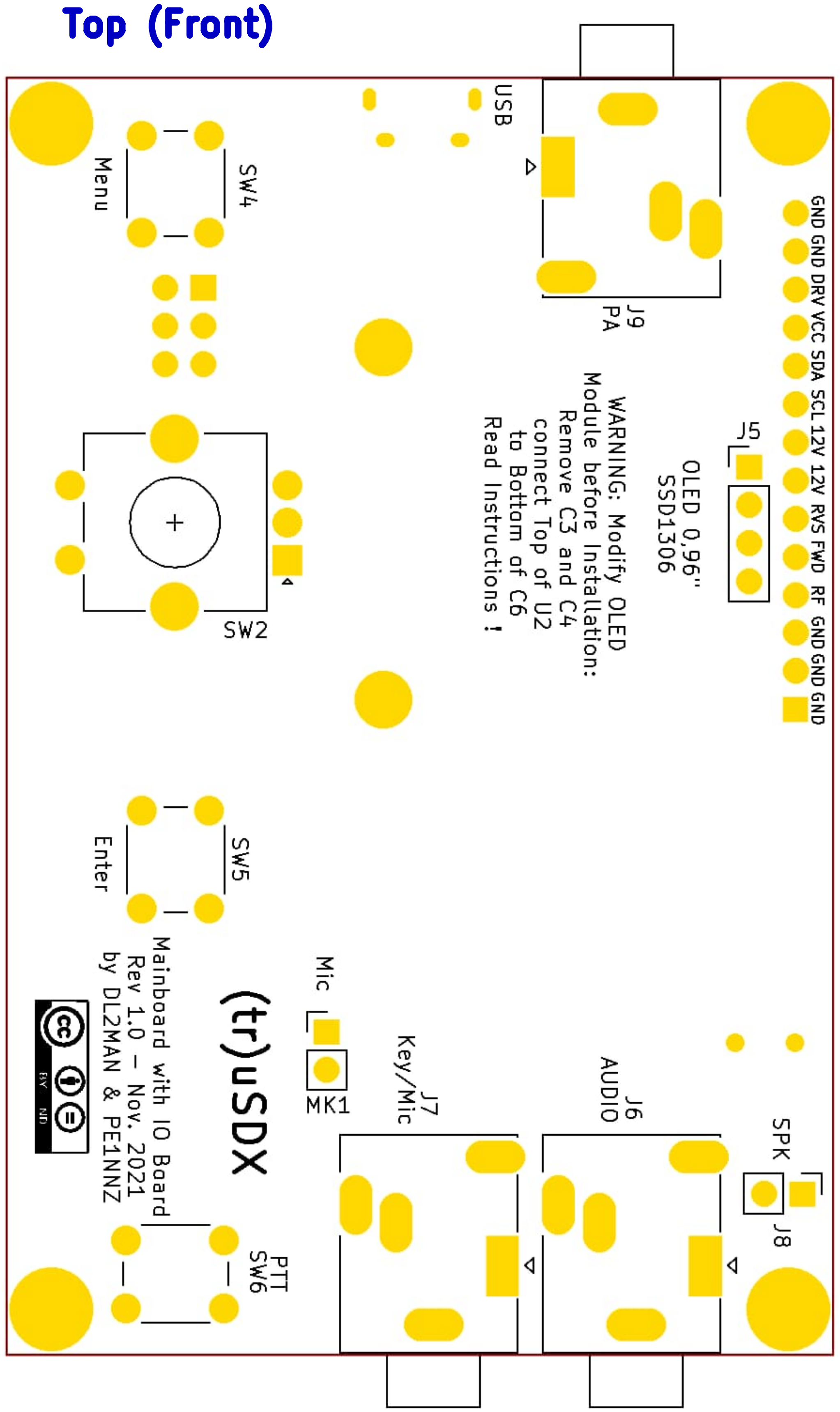
Redrawn with notes: KD4SGE & WA4ITD {revision denoted in ( ) after Rev 1.0 below}
Original Schematic: Rev 1.0 Date: 2021-11-27
DL2MAN & PE1NNZ

Sheet: /(tr)uSDX Main Board v1.0/
File: (tr)uSDX_Main_Board_v1-0.kicad_sch

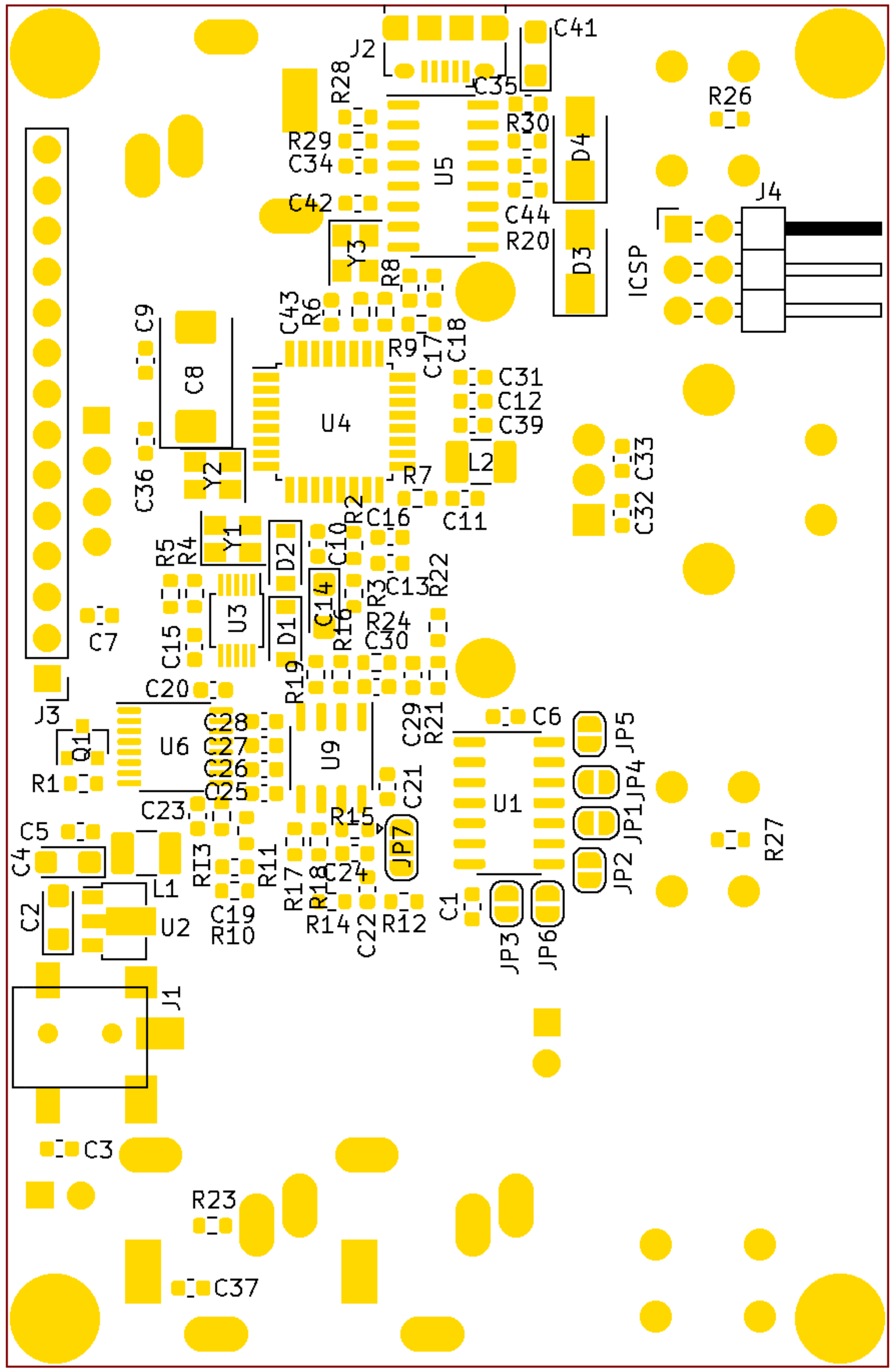
Title: (tr)uSDX Main Board

Size: A3	Date: 2022-10-15	**Rev: 1.0(n)**
KiCad E.D.A. kicad (6.0.5)		Id: 2/10

Top (Front)



Bottom (Back)



Assembly Note:
Part Placement

Parts are placed on the side of the board with the part outline.

For example:

J4 is placed on the bottom of --> the board.

<-- J9 is placed on the TOP of the board.

<-- J5 is placed on the TOP of the board.

<-- SW2 is placed on the TOP of the board.

J3 is placed on the bottom of --> the board.

J1 is placed on the bottom of --> the board.

<-- Speaker wires, SPK, solder to the TOP of the board.

Main Board Parts Layout without 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.

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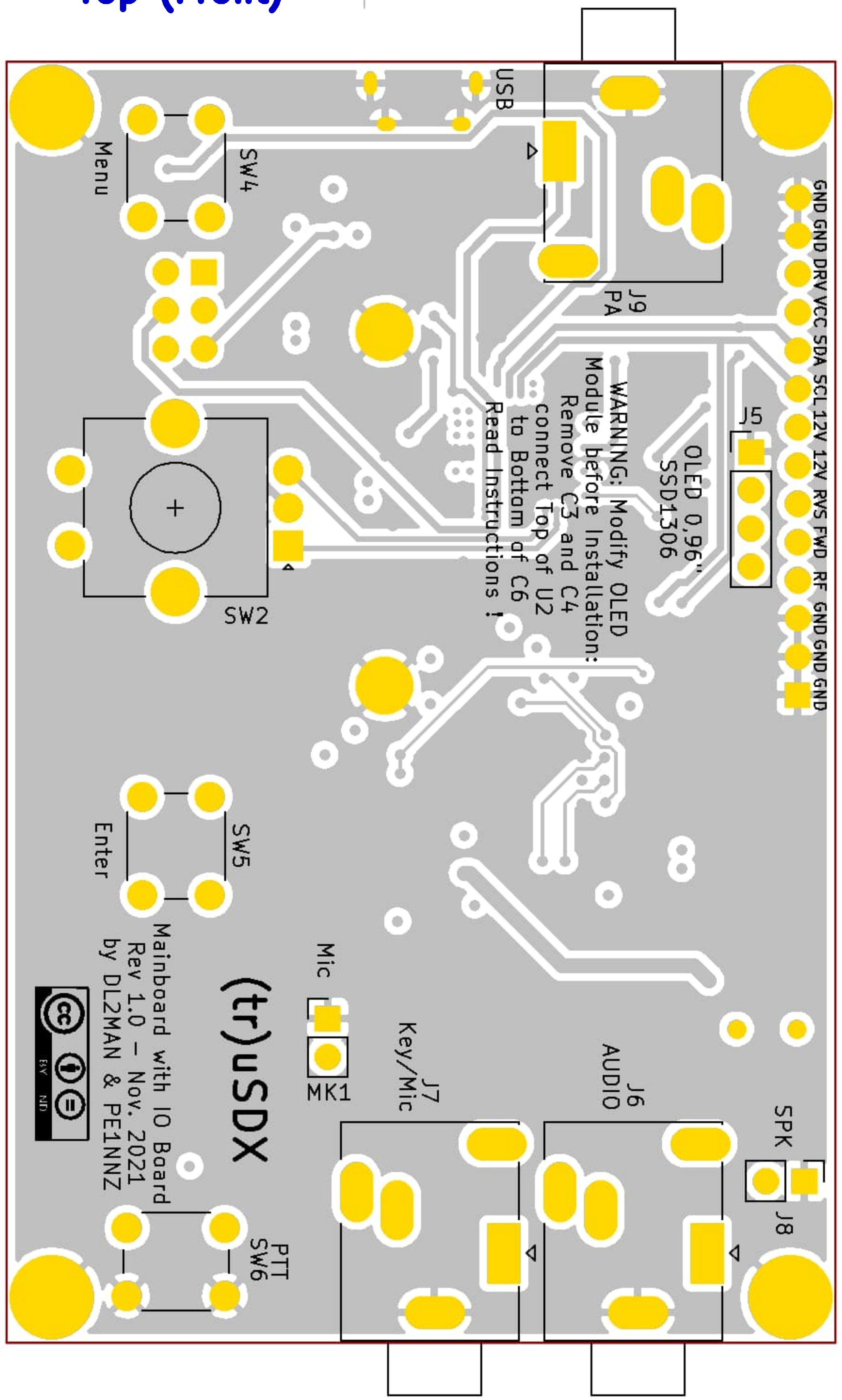
Redrawn with notes: KD4SGE & WA4ITD {revision denoted in ( ) after Rev 1.0 below}
Original Schematic: Rev 1.0 Date: 2021-11-27
DL2MAN & PE1NNZ
Sheet: /(tr)uSDX Main Board v1.0 – Parts Layout/
File: (tr)uSDX_Main_Board_v1-0_Parts_Layout_wo-Trace.kicad_sch
Title: (tr)uSDX Main Board v1.0 – Parts Layout without Trace Pattern

Size: A3	Date: 2022-10-15	Rev: 1.0(n)
KiCad E.D.A. kicad (6.0.5)		Id: 3/10

Top (Front)



Assembly Note:
Part Placement

Parts are placed on the side of the board with that part's outline.

For example:

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<-- J9 is placed on the TOP of the board.

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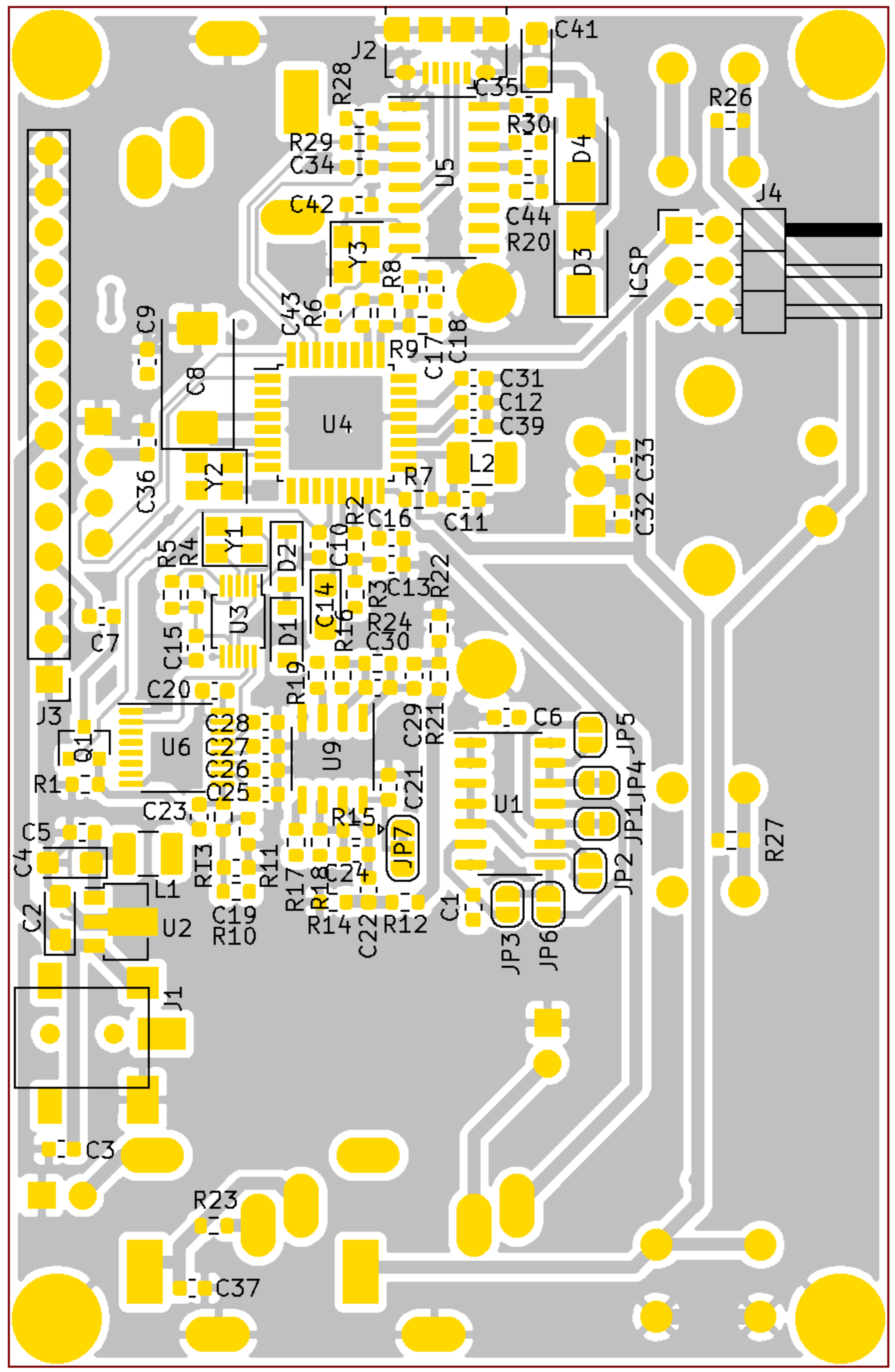
<-- SW2 is placed on the TOP of the board.

J3 is placed on the bottom of the board. -->

J1 is placed on the bottom of the board. -->

<-- Speaker wires, SPK, solder to the TOP of the board.

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 v1.0 - Parts Layout with Trace Pattern/	
File: (tr)uSDX_Main_Board_v1-0_Parts_Layout_w-Trace.kicad_sch	
Title: (tr)uSDX Main Board v1.0 - Parts Layout with Trace Pattern	
Size: A3 Date: 2022-10-15	**Rev: 1.0(n)**
KiCad E.D.A. kicad (6.0.5)	Id: 4/10

Band Slots – LPF Filters for 'Lo' bands (20/30/40/60/80m) using three BS170 MOSFET Output Drivers

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.

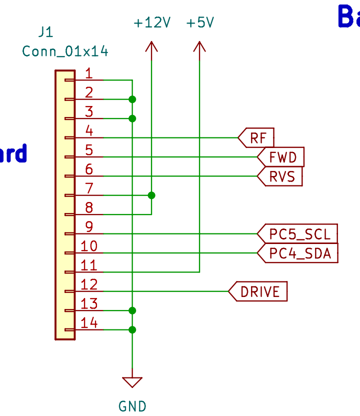
Toroids in LPF are all T37-2, red.

WARNING:
The low amount of toroid windings makes tuning of the filters more important than ever! Especially second harmonic notch needs to be carefully tuned with NanoVNA !!!

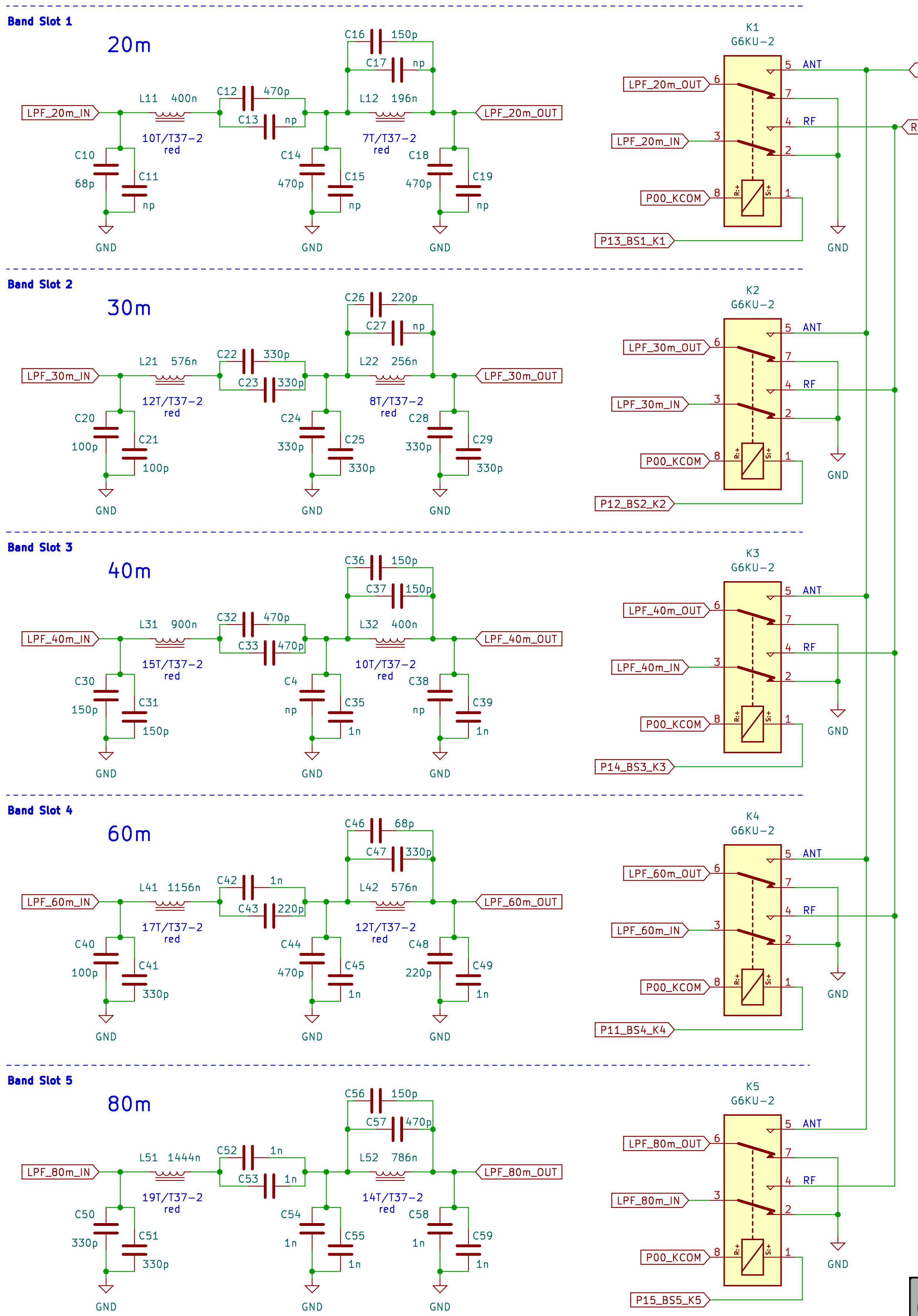
Example: On 10m the difference between 4 turns distributed equally and 4 turns compressed is more than 5MHz difference in notch position!!!

With FDT 86256 on higher bands it was not possible to achieve 80% Efficiency at all times. Expect 70-75%. But FDT86256 is way more tolerant for bad SWR.

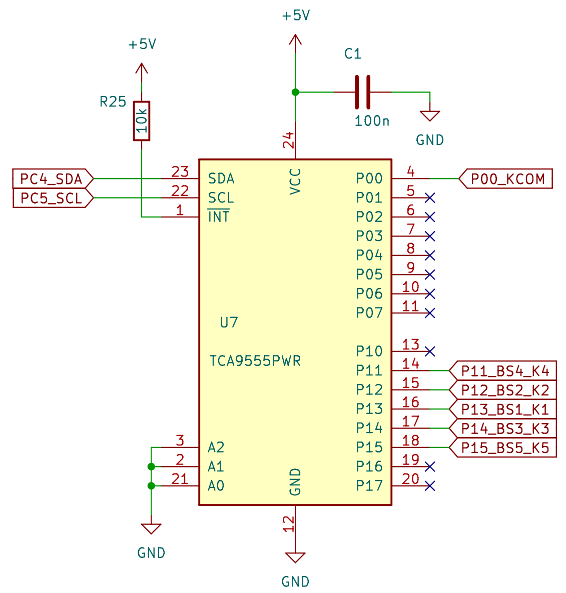
to Main Board



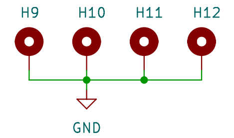
Suggested Mod for J1:
Rather than female; the connector should be male since there is not power on these pins when the RF board is not attached to the main board.



Latching Relay Control (Band Select)



MountingHole_Pad
pcb four corners



Latching Relay Notice:

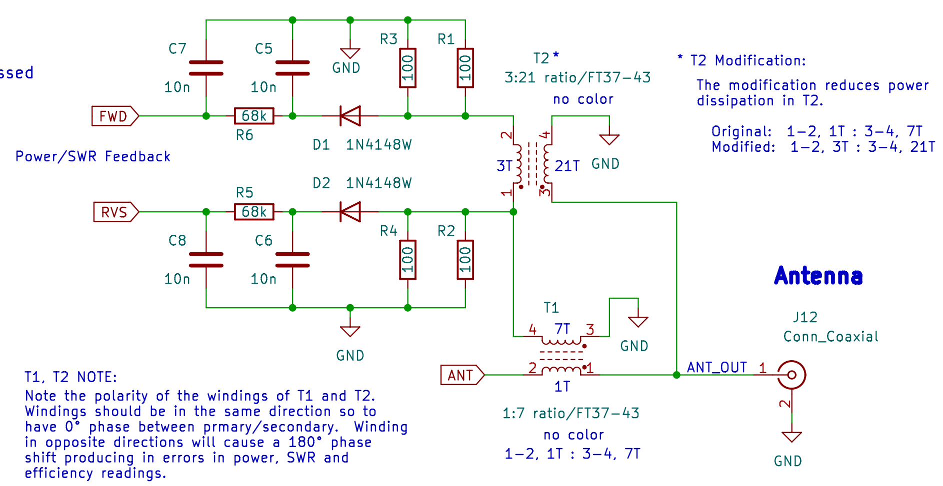
The relays are latching types, the coil is only energized to toggle the relay. Which way the relay toggles depends on the direction of the current thru the coil.

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.

Torroid Notes:

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

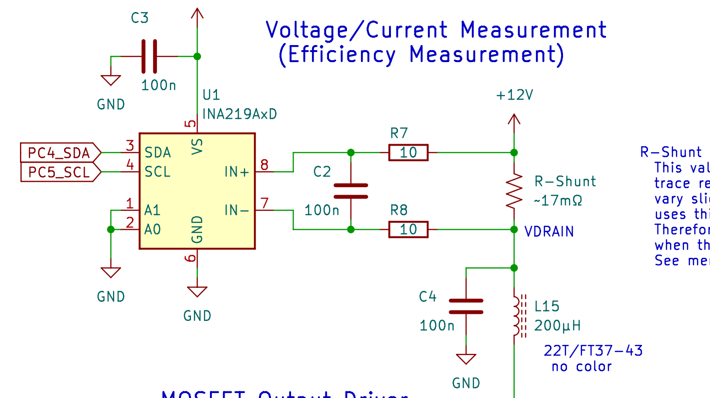
Power/SWR Bridge



* T2 Modification:
The modification reduces power dissipation in T2.
Original: 1-2, 1T : 3-4, 7T
Modified: 1-2, 3T : 3-4, 21T

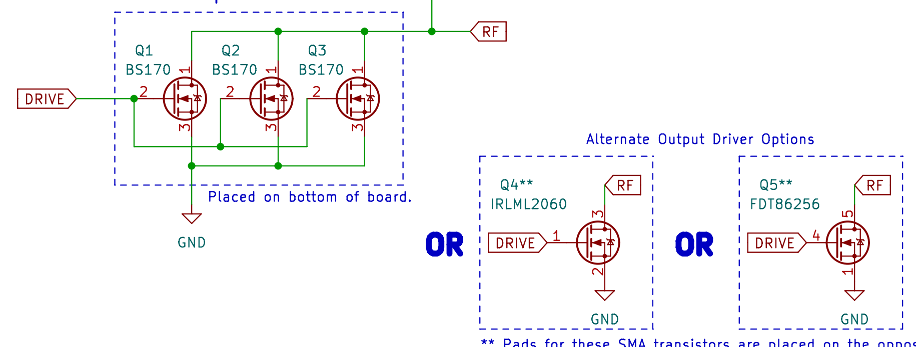
T1, T2 NOTE:
Note the polarity of the windings of T1 and T2. Windings should be in the same direction so to have 0° phase between primary/secondary. Winding in opposite directions will cause a 180° phase shift producing in errors in power, SWR and efficiency readings.

Voltage/Current Measurement (Efficiency Measurement)



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. Therefore, the reported efficiency will change when this value is changed.
See menu '8.6 R Shunt'.

MOSFET Output Driver



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

MOSFET Driver Notes

The board is designed to allow one of three MOSFET output drivers. Each driver configuration is a different transistor. DO NOT combine different transistors. Use either the three BS170 or one IRLML2080 or one FDT86256 for the output driver.
NOTE: The turns/inductors and capacitors used in the LPF filters of the bands may need to be modified for the transistors being used due to transistor source-drain capacitance.

More Information:

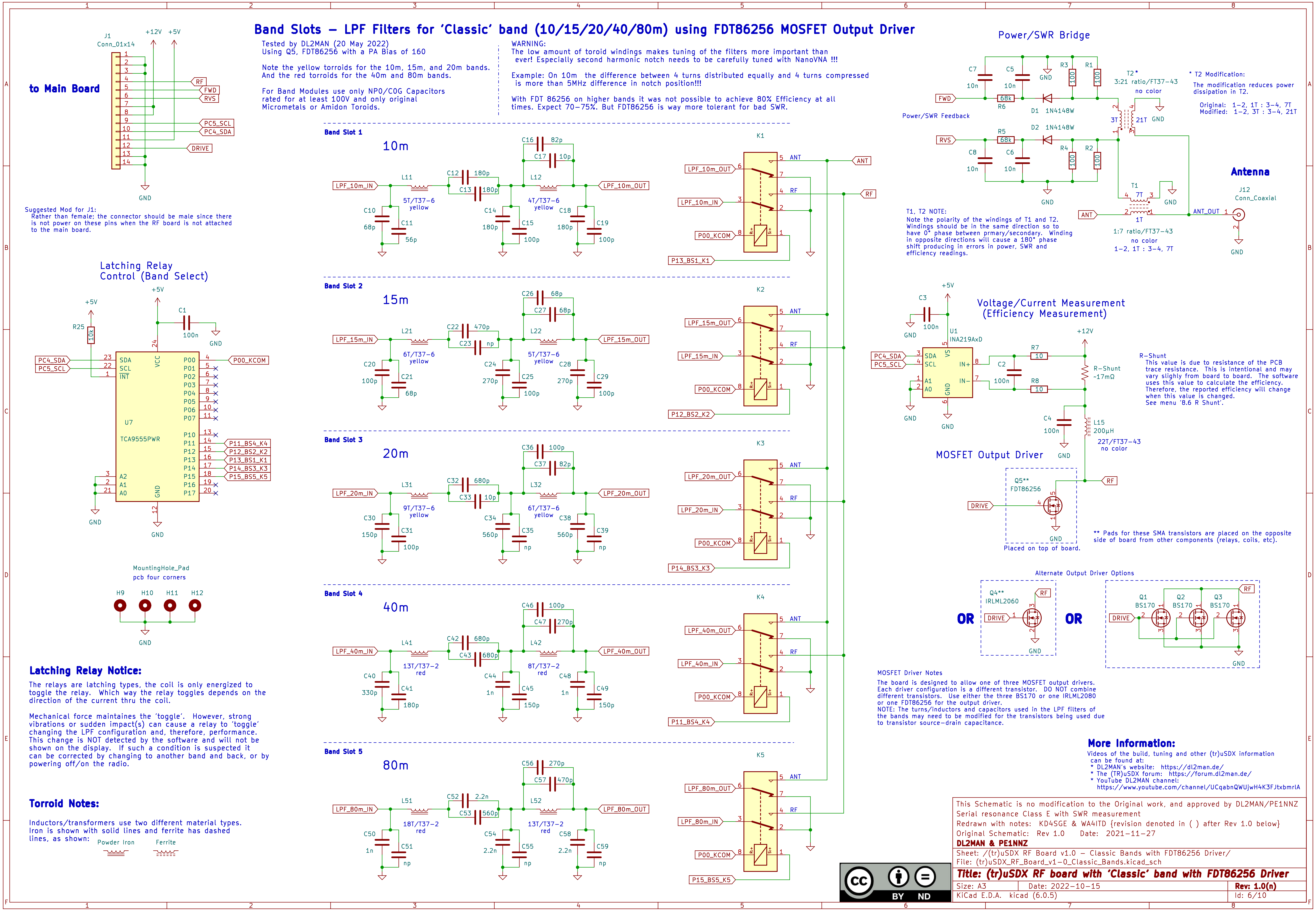
Videos of the build, tuning and other (tr)uSDX information can be found at:
* DL2MAN's website: https://dl2man.de/
* The (TR)uSDX forum: https://forum.dl2man.de/
* YouTube DL2MAN channel: https://www.youtube.com/channel/UCqabnQWUjwH4K3FJtxbmrlA

This Schematic is no modification to the Original work, and approved by DL2MAN/PE1NNZ
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 - Lo Bands with BS170 Drivers/
File: (tr)uSDX_RF_Board_v1-0_Lo_Bands.kicad_sch

Title: (tr)uSDX RF board with 'Lo' band with BS170 Drivers

Size: A3	Date: 2022-10-15	Rev: 1.0(n)
KiCad E.D.A. kicad (6.0.5)		Id: 5/10


Band Slots – LPF Filters for 'Classic' band (10/15/20/40/80m) using FDT86256 MOSFET Output Driver
Tested by DL2MAN (20 May 2022)
Using Q5, FDT86256 with a PA Bias of 160
Note the yellow torroids for the 10m, 15m, and 20m bands.
And the red torroids for the 40m and 80m bands.
For Band Modules use only NP0/C0G Capacitors rated for at least 100V and only original Micrometals or Amidon Toroids.
WARNING:
The low amount of toroid windings makes tuning of the filters more important than ever! Especially second harmonic notch needs to be carefully tuned with NanoVNA !!!
Example: On 10m the difference between 4 turns distributed equally and 4 turns compressed is more than 5MHz difference in notch position!!!
With FDT 86256 on higher bands it was not possible to achieve 80% Efficiency at all times. Expect 70-75%. But FDT86256 is way more tolerant for bad SWR.
to Main Board
J1
Conn_01x14
+12V
+5V
RF
FWD
RVS
PC5_SCL
PC4_SDA
DRIVE
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)
U7
TCA9555PWR
R25 10k
C1 100n
P00_KCOM
P11_BS4_K4
P12_BS2_K2
P13_BS1_K1
P14_BS3_K3
P15_BS5_K5
MountingHole_Pad
pcb four corners
H9
H10
H11
H12
Band Slot 1
10m
LPF_10m_IN
LPF_10m_OUT
L11 5T/T37-6 yellow
L12 4T/T37-6 yellow
C10 68p
C11 56p
C12 180p
C13 180p
C14 180p
C15 100p
C16 82p
C17 10p
C18 180p
C19 100p
K1
P13_BS1_K1
Band Slot 2
15m
LPF_15m_IN
LPF_15m_OUT
L21 6T/T37-6 yellow
L22 5T/T37-6 yellow
C20 100p
C21 68p
C22 470p
C23 np
C24 270p
C25 100p
C26 68p
C27 68p
C28 270p
C29 100p
K2
P12_BS2_K2
Band Slot 3
20m
LPF_20m_IN
LPF_20m_OUT
L31 9T/T37-6 yellow
L32 6T/T37-6 yellow
C30 150p
C31 100p
C32 680p
C33 10p
C34 560p
C35 np
C36 100p
C37 82p
C38 560p
C39 np
K3
P14_BS3_K3
Band Slot 4
40m
LPF_40m_IN
LPF_40m_OUT
L41 13T/T37-2 red
L42 8T/T37-2 red
C40 330p
C41 180p
C42 680p
C43 680p
C44 1n
C45 150p
C46 100p
C47 270p
C48 1n
C49 150p
K4
P11_BS4_K4
Band Slot 5
80m
LPF_80m_IN
LPF_80m_OUT
L51 18T/T37-2 red
L52 13T/T37-2 red
C50 1n
C51 np
C52 2.2n
C53 560p
C54 2.2n
C55 np
C56 270p
C57 470p
C58 2.2n
C59 np
K5
P15_BS5_K5
ANT
RF
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.
Torroid Notes:
Inductors/transformers use two different material types. Iron is shown with solid lines and ferrite has dashed lines, as shown:
Powder Iron
Ferrite
Power/SWR Bridge
C7 10n
C5 10n
C8 10n
C6 10n
R3 100
R1 100
R4 100
R2 100
R6 68k
R5 68k
D1 1N4148W
D2 1N4148W
Power/SWR Feedback
T2*
3:21 ratio/FT37-43
no color
* T2 Modification:
The modification reduces power dissipation in T2.
Original: 1-2, 1T : 3-4, 7T
Modified: 1-2, 3T : 3-4, 21T
T1
1:7 ratio/FT37-43
no color
1-2, 1T : 3-4, 7T
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, SWR and efficiency readings.
Antenna
J12
Conn_Coaxial
ANT_OUT
Voltage/Current Measurement
(Efficiency Measurement)
U1
INA219AxD
C3 100n
C2 100n
R7 10
R8 10
R-Shunt -17mΩ
C4 100n
L15 200µH
22T/FT37-43
no color
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. Therefore, the reported efficiency will change when this value is changed.
See menu '8.6 R Shunt'.
MOSFET Output Driver
Q5**
FDT86256
Placed on top of board.
** Pads for these SMA transistors are placed on the opposite side of board from other components (relays, coils, etc).
Alternate Output Driver Options
Q4**
IRLML2060
OR
Q1 BS170
Q2 BS170
Q3 BS170
MOSFET Driver Notes
The board is designed to allow one of three MOSFET output drivers. Each driver configuration is a different transistor. DO NOT combine different transistors. Use either the three BS170 or one IRLML2080 or one FDT86256 for the output driver.
NOTE: The turns/inductors and capacitors used in the LPF filters of the bands may need to be modified for the transistors being used due to transistor source-drain capacitance.
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Serial resonance Class E with SWR measurement
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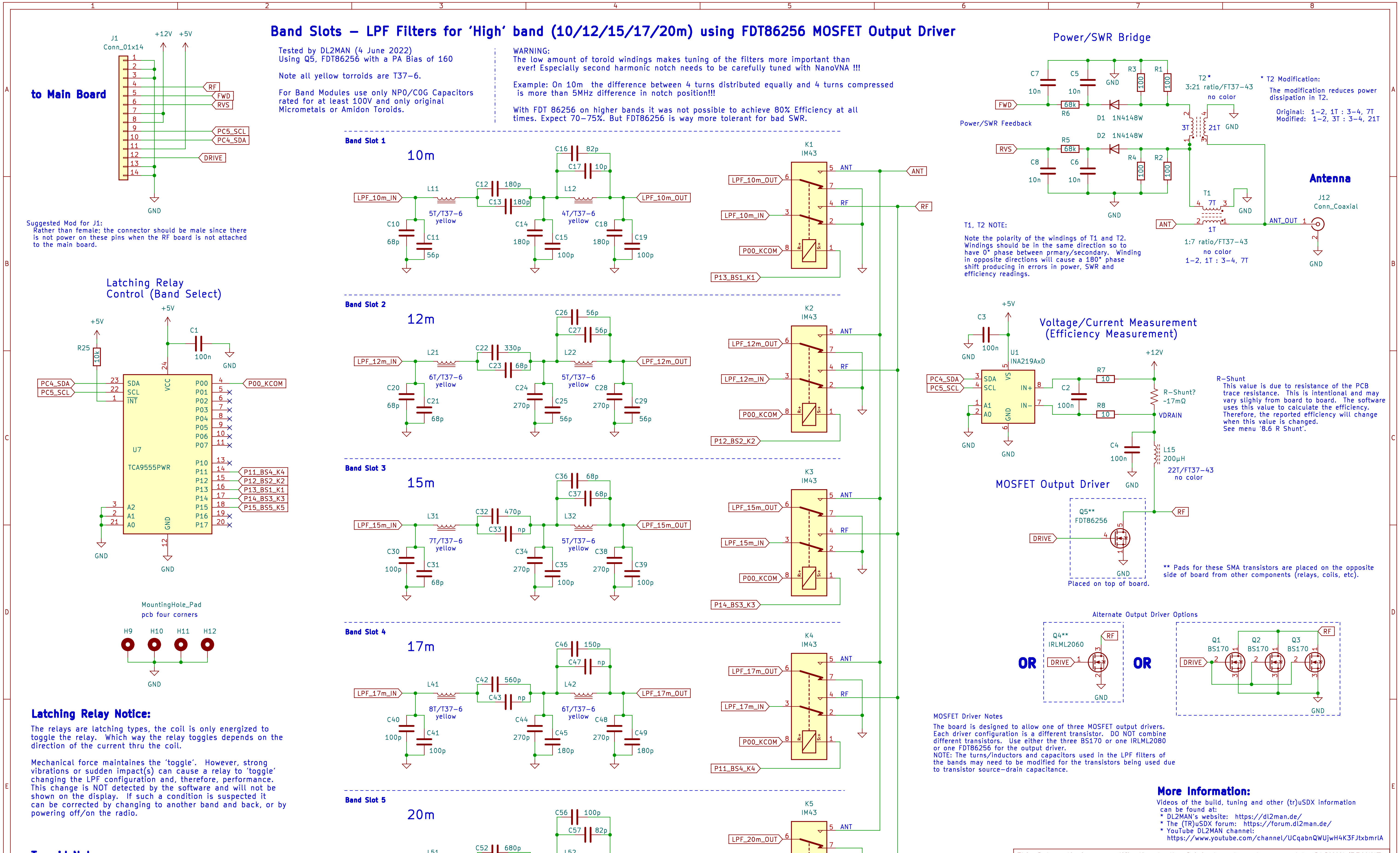
Original Schematic: Rev 1.0 Date: 2021-11-27
DL2MAN & PE1NNZ
Sheet: /(tr)uSDX RF Board v1.0 – Classic Bands with FDT86256 Driver/
File: (tr)uSDX_RF_Board_v1-0_Classic_Bands.kicad_sch
Title: (tr)uSDX RF board with 'Classic' band with FDT86256 Driver
Size: A3 Date: 2022-10-15 Rev: 1.0(n)
KiCad E.D.A. kicad (6.0.5) Id: 6/10
BY ND



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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 v1.0 – High Bands with FDT86256 Driver/
File: (tr)uSDX_RF_Board_v1-0_High_Bands.kicad_sch
Title: (tr)uSDX RF board with 'High' band with FDT86256 Driver
Size: A3 | Date: 2022-10-15 | **Rev: 1.0(n)**
KiCad E.D.A. kicad (6.0.5) | Id: 7/10

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.

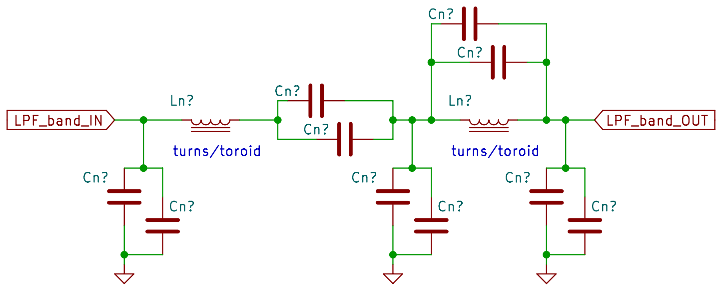
Relays are an exception
as there is only one relay per LPF. So a relay, K, is simply 'Kn'.

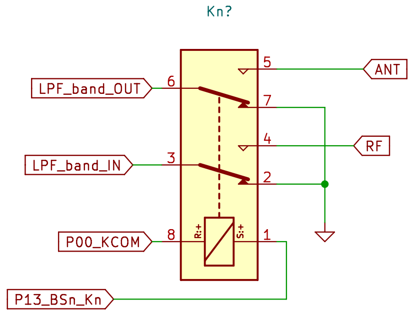
There are several online and offline tools to calculate the turns/toroids for a band. Search for one you like best. Below are examples of two offline calculators that can be used.

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.

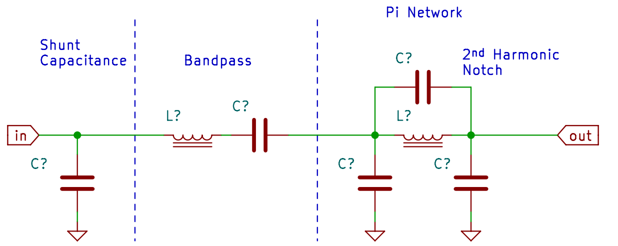
Recommending readings:

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 WAØITP 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.



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/COG 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.

Band Configuration Options

Overview:

The (tr)uSDX provides for three bands configurations: Lo, Hi and Classic. The 'Lo' band is the common configuration. These band groupings are defined in the firmware and are not changable by the user.

The 'Lo' band covers 20m, 30m, 40m, 60m and 80m amateur radio bands.
The 'Hi' band covers 10m, 12m, 15m, 17m and 20m amateur radio bands.
The 'Classic' band covers 10m, 15m, 20m, 40m and 80m amateur radio bands.

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

Band Configuration and Transition Frequenies

Each configuration expects a specific LPF band filter to to be in a given band slot. For example, the 'Lo' band configuration expects the 20m LPF to be in band slot 1,
the 30m LPF to be in band slot 2, the 40m LPF to be in band slot 3, and so on. Another way of thinking about it; the highest LPF band goes in slot 1, the second highest LPF band goes in slot 2, the third highest LPF band goes in slot 3, and so on.

Also worth noting: In each of the three configurations, the firmware has to switch from
one LPF band slot to the next as the frequency is tuned. The switching, or transition, occurs at a frequency that is dependent on the which band configuration is selected in the menu. This transition occurs on a predefined frequency in the firmware. The table below shows each band configuration and the frequency the relays transition from LPF band slot to the next.

For example: In the 'Lo' band configuration, when going from 20m to 30m, the firmware will transition from band slot 1 to slot 2 at 13 MHz. The same transition at 13 MHz when going from 30m to 20m. And going from 30m to 40m (or 40m to 30m), the transition from slot 2 to 3 (or slot 3 to 2), occurs at 9 MHz. The 40m - 60m transition occurs at 6 MHz. And 60m - 80m transition occurs at 5 MHz.

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.

Changing Bands in a Configuration

It is currently not possible/practical to select a personal combination of five radio bands - this is because the firmware would not know the frequency to transition to the next LPF.

THE FOLLOWING IS NOT RECOMMENDED BY THE DESIGNERS NOR THE AUTHORS! Doing any of the following is at your own risk.

It is possible to change some of the end bands for each configuration but you have to be aware of the transition frequencies. For example, if the 'Lo' configuration is selected - the the 20m LPF could be changed to any band above 20m. This is because band slot 1 is selected for all frequencies above 13 MHz.

Another example: If the 'Hi' band configuration is selected, then band slot 3 can have any band that exists between thre transition frequencies 9 to 18 MHz. This means in the "Hi" configuration, the 20m LPF can be changed to 17m, 20m or 30m LPF.

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.

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

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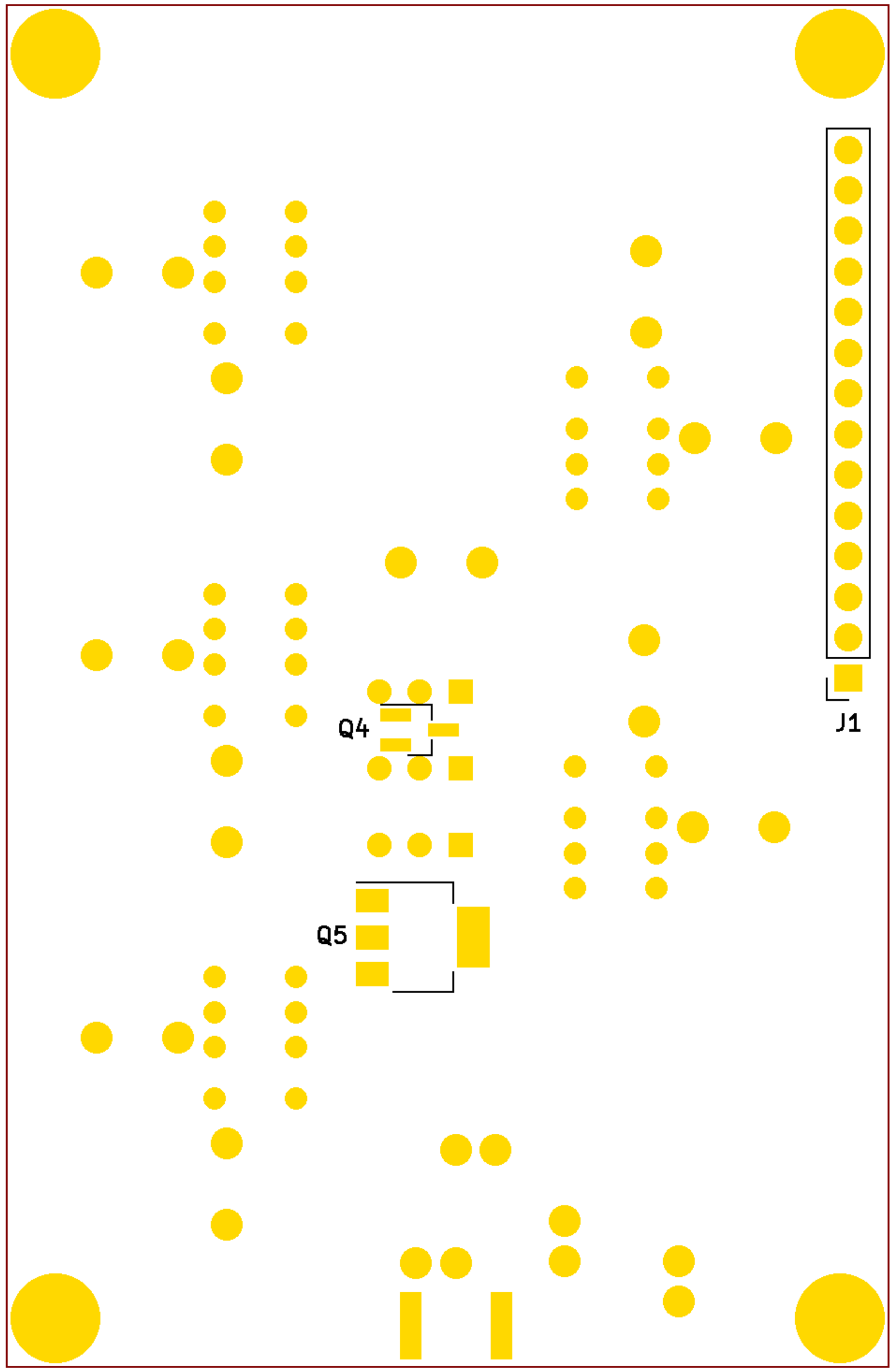
Original Schematic: Rev 1.0 Date: 2021-11-27
DL2MAN & PE1NNZ
Sheet: /(tr)uSDX RF Board v1.0 - LPF Filter Notes/
File: (tr)uSDX_RF_Board_v1-0_LPF_Filter_Notes.kicad_sch

Title: (tr)uSDX RF Board - LPF Filter Notes

Size: A3	Date: 2022-10-15	**Rev: 1.0(n)**
KiCad E.D.A. kicad (6.0.5)		Id: 8/10

Top (Front)



Assembly Note:
Part Placement

Parts are placed on the side of the board with the part outline.

Band Slot 4

Lo – 60m
Hi – 17m
Cl – 40m

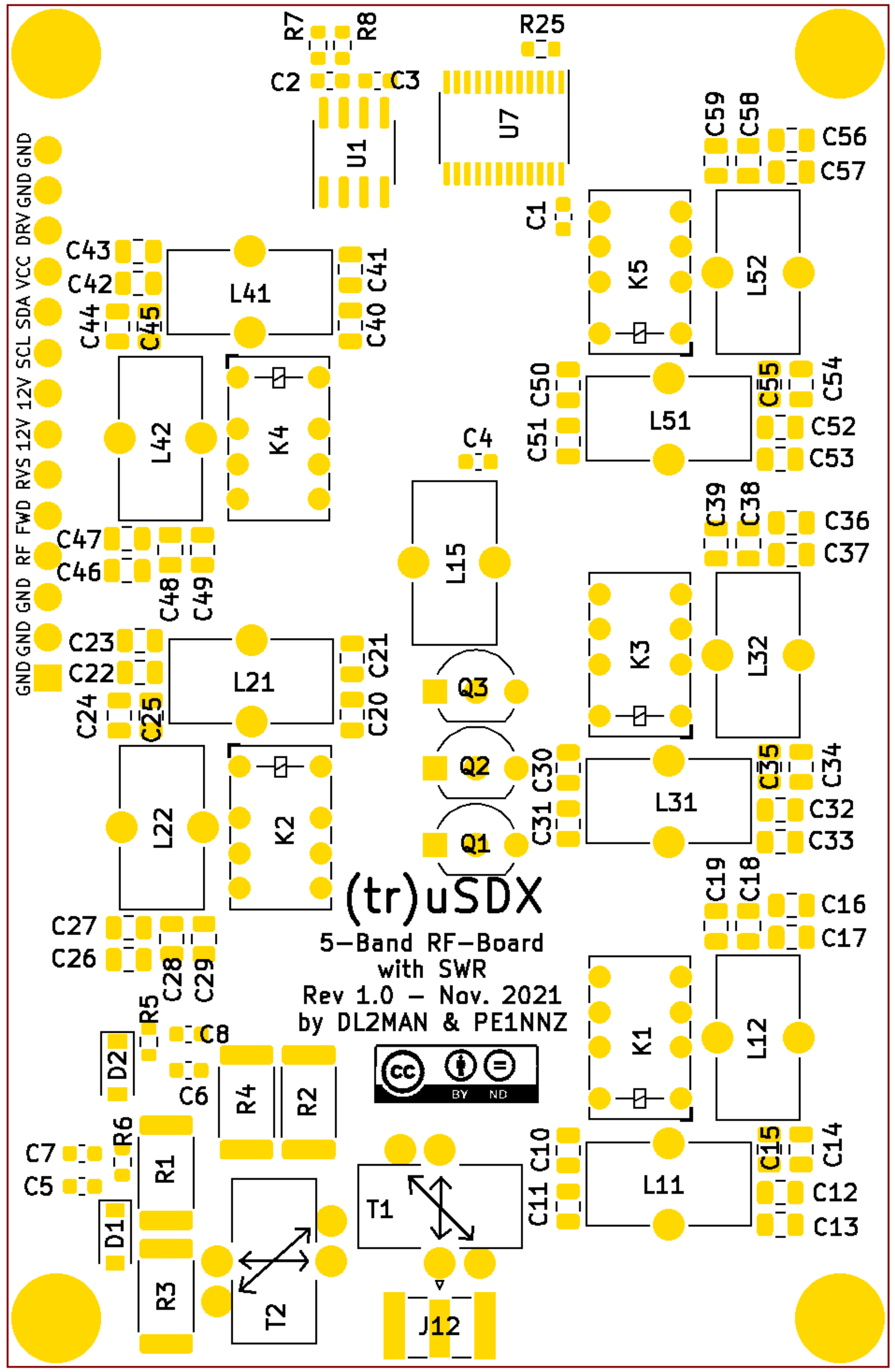
Band Slot 2

Lo – 30m
Hi – 12m
Cl – 15m

Filter Bands

Lo = Low
Hi = High
Cl = Classic

Bottom (Back)



Band Slot 5

Lo – 80m
Hi – 20m
Cl – 80m

Band Slot 3

Lo – 40m
Hi – 15m
Cl – 20m

Band Slot 1

Lo – 20m
Hi – 10m
Cl – 10m

RF Board Parts Layout without 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.

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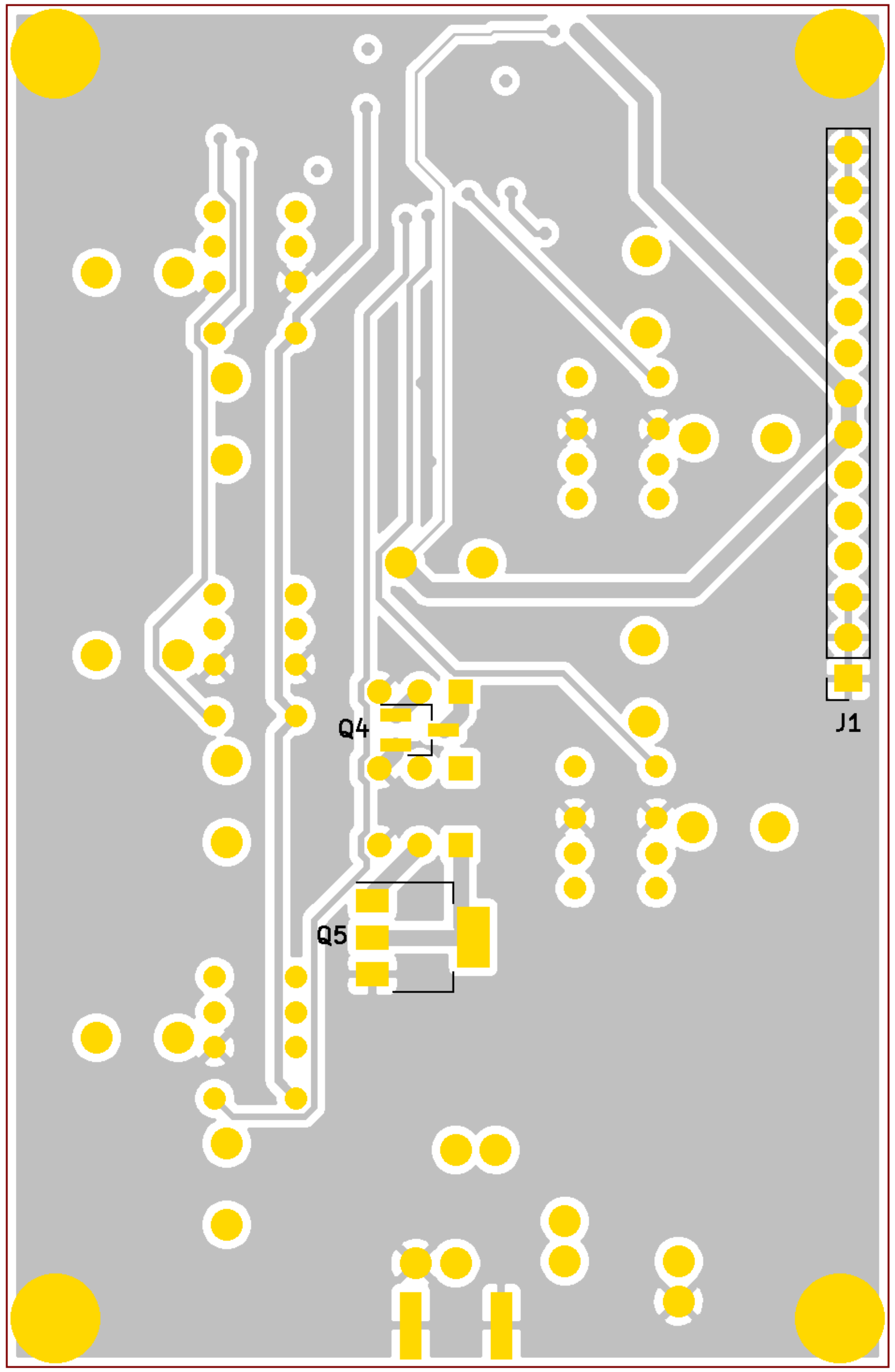
Original Schematic: Rev 1.0 Date: 2021-11-27
DL2MAN & PE1NNZ
Sheet: /RF Board Parts Layout A v1.0 /
File: (tr)uSDX_RF_Board_v1-0_Parts_Layout_wo-Trace.kicad_sch

Title: (tr)uSDX RF Board v1.0 – Parts Layout without Trace Pattern

Size: A3 | Date: 2022-10-15 | **Rev: 1.0(n)**
KiCad E.D.A. kicad (6.0.5) | Id: 9/10

Top (Front)



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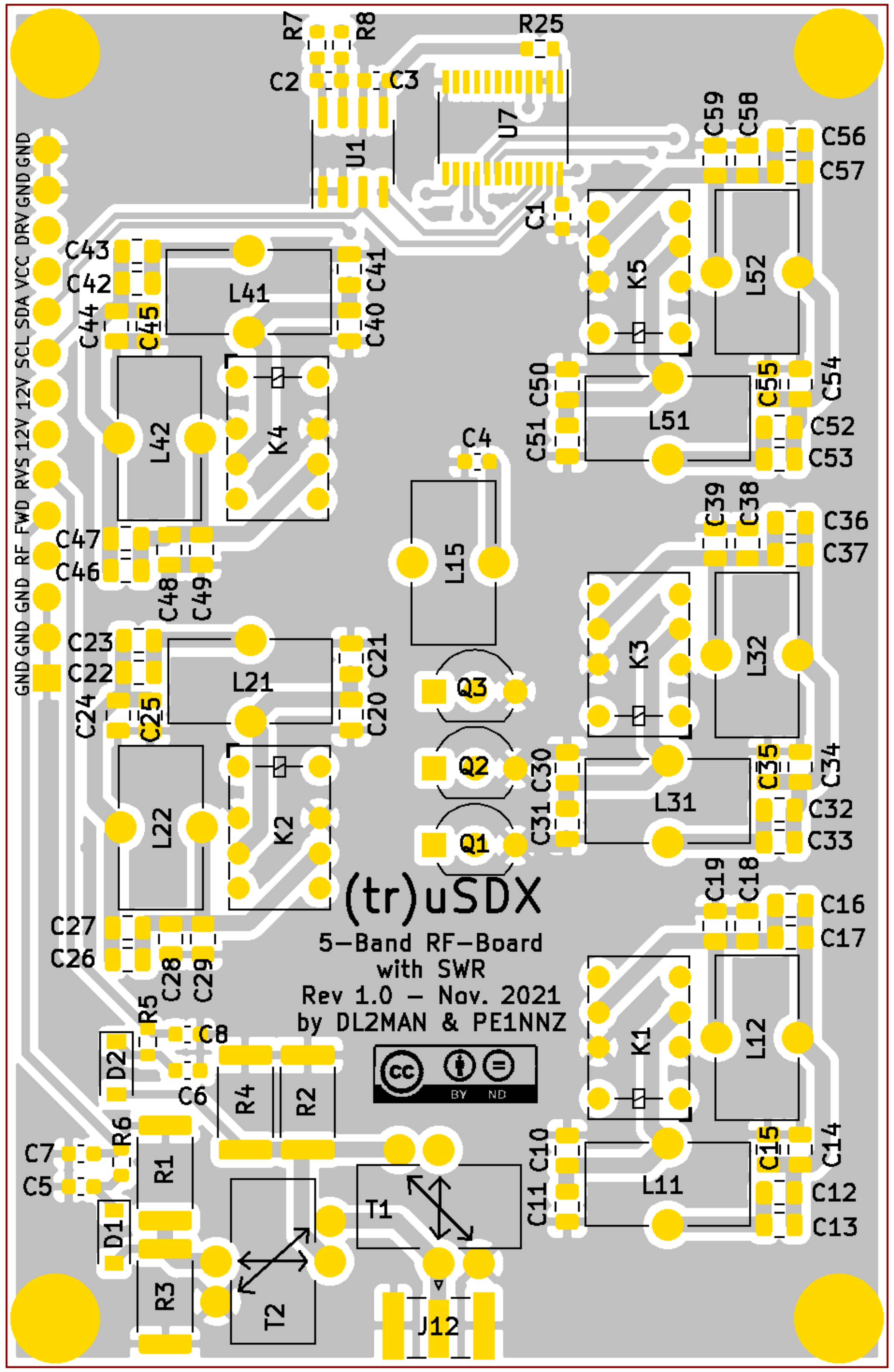

Band Slot 5

Lo – 80m

Hi – 20m

Cl – 80m

Band Slot 3

Lo – 40m

Hi – 15m

Cl – 20m

Band Slot 1

Lo – 20m

Hi – 10m

Cl – 10m

RF Board Parts Layout with copper trace pattern

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Sheet: /RF Board Parts Layout B v1.0/ File: (tr)uSDX_RF_Board_v1-0_Parts_Layout_w-Trace.kicad_sch		
Title: (tr)uSDX RF Board v1.0 – Parts Layout without Trace Pattern		
Size: A3	Date: 2022-10-15	**Rev: 1.0(n)**
KiCad E.D.A. kicad (6.0.5)		Id: 10/10