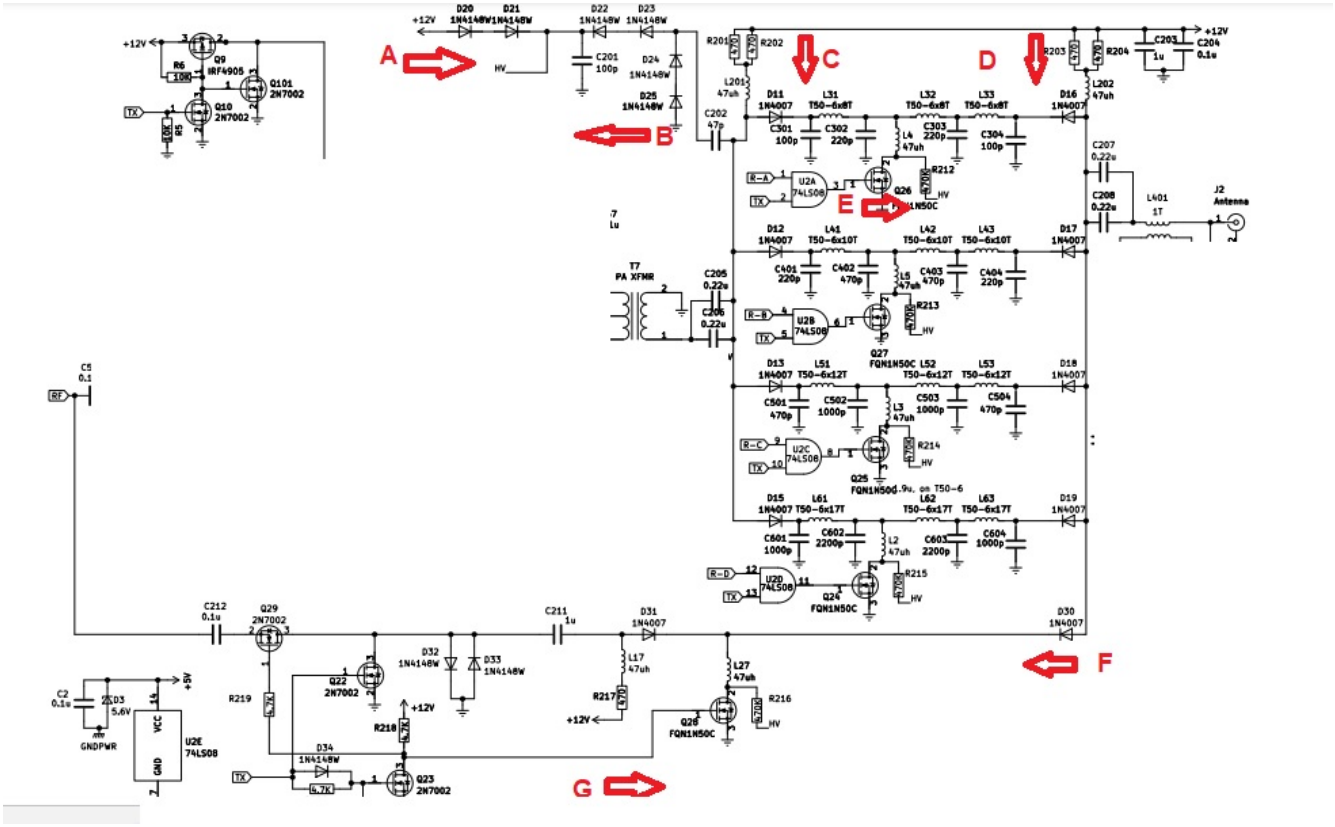
Troubleshooting TR Switching

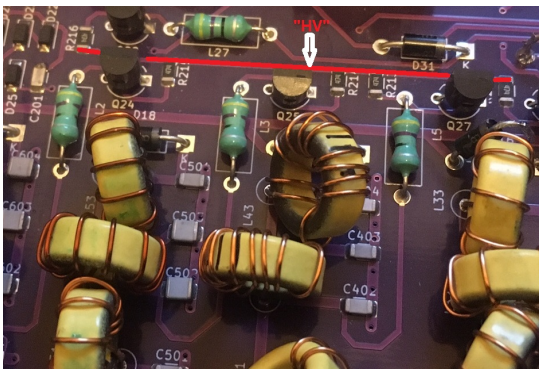
Gordon KX4Z Nov 13 2023



The sBitx T/R switching is a high performance, complicated, diode-switched logic system. The accompanying schematic attempts to capture the major inputs

Expected Voltages

Circuit Point	Voltage in Transmit	Voltage in Receive	Comment
C201 ("HV")	Twice the peak transmitted RF voltage	Power supply input voltage minus 1.2 V (two diode drops)	This is a key control voltage for all of the Transmit/Receive and low pass filter circuitry ---------- This voltage can be measured at C201, or at any of the mutually connected sides of 474K resistors R212, R213, R214, R215, R216. It can be measured using the simples digital voltmeter even from

			Harbor Freight (although the reading may not be as accurate. Avoid adding any capacitance to this junction; it may be wise to put a resistance of 470-2K in series with your voltmeter to make the measurement. Remember this can easily exceed 100VDC in full output transmit. 
Junction of right hand side of C201 and all of the anodes of the INPUT side of the low pass filters	Approximately 0.6V	Approximately supply voltage (eg 12vdc)	If this voltage is very negative in transmit, then L201 is likely OPEN. If L201 is OPEN, this voltage will decay from a negative voltage toward zero in receive.
Junction of L202 and the anodes of the OUTPUT side of the low pass filters	Should be approximately 0.6 volts due to conduction of the proper diode on the selected LPF.	Should be approximately 0.6Volts due to conduction of of D30	If L202 opens, this voltage may trend toward zero in receive, and toward a large negative voltage in transmit.
Junction of D30 and D31	Should be a quite high positive DC voltage during Transmit (e.g 60, 90 120 VDC)	Should be a low voltage, like fractions of a volt during receive.	

Letter	System	Operation	Recognition of performance
A	+12VDC input to HV	During receive, and for the first initial instants of transmit, this provide nominal [+12VDC- 1.2V] to the HV system, which makes it possible to a) keep the switching diodes at both ends of each low pass filter (LPF) not conducting heavily. b) keep D30 and D31 in forward conduction so that received antenna signals can proceed leftward in the above schematic to the input of the receiver	If diodes D20/D21 fail OPEN, voltage "HV" will rise from nominal 12V-1.2V, to nominal 1.2-0.6 through conduction in all of the switching diodes on each side of the LPFs. Receiving input signal may be weakened. If diodes D20/D21 fail SHORTED, the RF voltage doubler will be greatly hampered in creating the desired DC positive voltage = 2x peak RF output voltage. As a result, there will be undesired conduction of RF through undesired LPFs and harmonics may be dramatically stronger than they should be. Experimental evidence (n=1) indicates that 20m and 15 meter harmonics will be as much as 20-30 dB stronger than they should be. **This condition is easily detected by finding the HV voltage is NOT rising to 2 x peak RF voltage but instead is more like 1/2 peak RF voltage.**
B	RV Voltage Doubler	Immediately upon the initiation of significant RF output, capacitor C202 will begin to develop a DC charge, left side POSITIVE and right side held to approximately +12nominal VDC Diodes D22, D23, D24, D25 and capacitor C201, in conjunction with capacitor C202 will ramp immediately up to a POSITIVE voltage equal to approximately 2XVpeak of the RF output. This very high voltage (easily 100VDC)	Failure of the HV voltage doubler circuit will cause a) lack of adequate + HV to be developed b) RF energy will bypass the desired LPF through other LPFs c) Much stronger than desired energy may reach the input of the receiver, limited by back to back diodes D32/D33, which may be damaged. Note that due to the arrangement of D22-D25, after determining which

		is used to a) completely back bias switching diodes on the left and right side of undesired LPF into non conduction so that RF energy cannot bypass the desired LPF b) completely back bias diodes D30 and D31 into non conduction as part of the system that disconnects the input to the receiver. The desired LPF is caused to conduct RF energy by a section of U2 sending HIGH to one of the high voltage MOSFETS 1N50, which then conducts heavily, shorting out the 470K small current from the HV supply, and causing the switching diodes of that particular LPF to conduct RF heavily, driven by DC current provided by paralleled 470 ohm resistors through a 47uH choke.	test probe from an ohmmeter develops the positive voltage, these diodes can be check in situ.
C,D	+12V (nominal) to LPF switching diode anodes	Delivered through either 2 or 3 paralleled 470 ohm resistors and a sufficient RF choke, this voltage serves to provide TURN ON the desired LPF diodes during Transmit. The current provided through a diode is approximately 50 or 75 mA each diode (depending on whether 2 or 3 470 ohm resistors are paralleled). This is sufficient to provide RF conduction at the correct power levels.	If the resistors or the min-choke fail, this voltage will be missing and the desired LPF switching diode will be unable to turn on, resulting in: a) Far lower output power on ALL bands b) Very high NEGATIVE DC voltage on the anodes of switching diodes on the input (left) side of the LPF if the failure is on the left sided resistors/choke. One experimenter found that L201 unexpectedly failed with the above symptoms. An unproven theory is that this might result from an undesired series resonance in the miniature choke, leading to excessive current through through the choke and failure. These can be replaced by an FT25-43 or FT33-43

			core with 10 or so turns to make approximately 47uH
E	Conduction of high voltage MOSFET	To force the transmitted RF through the proper LPF, the proper section of U2 is turned ON, resulting in strong conduction of the 1N50 MOSFET. This shorts out the high DC voltage from the voltage doubler (but due to the 470K ohm resistor, does not affect other LPF diodes) and causes forward current from (C,D) above to make input and output switching diodes CONDUCT RF. Note; The current through the 470K resistor is on the order of 0.3mA from the HV DC supply. At the HV MOSFET, this is dwarfed by the approximately 50-75 ma from each side of the switching diodes -- so the total current through the HV MOSFET can be 150 mA.	If the proper MOSFET is not enabled, the proper LPF will not transfer and filter the transmitted RF energy.
F	Receive Pathway	F is the pathway of RF to reach the antenna. Q23 inverts the TX signal; during receive (RX), Q28 is turned ON and draws current down the F pathway, causing D30 and D31 to be forward biased. The current through D31 is nominally 12V/470 ohms; the current through D30 is 2 or 3 times larger due to the paralleled resistors R203/R204 During TX, this current is turned off and those D31 and D30 are reverse biased.	Failure of this pathway to turn ON will result in poor receiver sensitivity. Failure of this pathway to turn OFF may result in damage to D32, D33 and other front end components of the receiver.
G	Inverted TX signal	Q23 inverts the TX (high = transmitting) to give the equivalent of an RX signal (high when receiving). This is set to turn receiving OFF very quickly through diode D34, but to more slowly begin receiving, due to an RC time constant at the gate of Q23.	Open failure of Q23 will leave the system permanently in RECEIVE which could have bad impact on the front end and D32/D33 during actual transmit. Shorted failure of Q23 will leave the

			system unable to provide strong receive signals to the receiver.