DX Connection QSK 2500 High-Power External QSK Switch

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A few years ago, an ARRL website poll indicated that approximately 30% of amateurs have an amplifier. One often-overlooked issue is transceiver/amplifier timing, especially for those who operate CW. The typical amplifier without full break-in (QSK) capability uses a transmit-receive (TR) relay that typically takes 12 – 20 milliseconds to switch and settle. Most transceivers have a default RF-delay-after-amp-key time that is less than this, although many modern transceivers offer an adjustable delay through the menu system.

Whether or not you operate full break-in, hot-switching of the transceiver output, the amplifier output, or both, can occur if the transceiver RF output occurs before the amplifier's TR relay has completed switching. Hot switching can be hard on the transceiver or amplifier finals as the equipment can see a momentary high SWR during a hot-switch event. It can also be a source of key clicks on CW with QSK-capable amplifiers if the transceiver has premature unkey/RF timing. Figure 4 shows how the sequence of timing events should occur.

Some examples of transceiver switching times: Yaesu transceivers have a default amp-key-to-RF-output delay of 5 ms, the Elecraft K3 default delay is 8 ms, and Kenwood radios have a default delay of 10 ms. Yaesu and Elecraft have variable delay menu settings that can accommodate virtually any TR delay requirement. Recent Kenwood transceivers have fixed 10 ms and 25 ms settings, and recent TEN-TEC transceivers have a single 15 ms fixed delay. Some Icom radios such as the IC-7300 and IC-7700 have adjustable delay from 10 to 30 ms, but other Icom radios have no delay adjustment at all. I measured an IC-706KIIG delay at 12 ms and an IC-7000 delay at 8 ms, virtually ensuring hot-switching with most non-QSK amplifiers.

Further, many hams operate full break-in (QSK) CW during contests and DX chasing. While most current HF transceivers will operate full break-in, only higher-end amplifiers have the switching components capable of the speed and switching reliability necessary for full break-in operation. And to complicate this further, some transceivers unkey the amplifier before RF has completely decayed, which can cause hot-switching on un-key.[4]

External QSK Switching

Currently there are two types of QSK switching methods: PIN diode switching, and relay switching. PIN diodes provide microsecond switching speed, silent operation, and essentially limitless life. However, a PIN diode switch has measurable

Bottom Line

The DX Connection QSK 2500 offers owners of any RF power amplifier full break-in (QSK) operation, as well as freedom from first-dit hot-switching without equipment modification.

How Long Will the Relays Last?

The relays are wrapped in double-sided tape and are attached to the PC board with pendant wires. So while the relays can be replaced, it is not a trivial process. What kind of life can you expect? The QSK 2500's relay life is specified at 30 million operations minimum at 72,000 operations/hour (1200 operations/minute). The relay life increases as the operations-per-hour decreases. To determine a realistic operational relay lifetime, let's evaluate this using the standard PARIS text.

PARIS has 10 dits and 4 dahs, resulting in 14 relay operations/minute at 1 WPM. Assuming an average of 25 WPM code speed, you would have 360 relay operations per minute. So the 30 million relay specification would result in about 1400 hours of relay life. Since you probably transmit 50% of the time and receive 50% of the time during a QSO, the relay operational life doubles to about 2800 hours. There are 8760 hours/year, which means you could operate 116 days at 25 WPM before the relays exceeded their lifetime spec — *if* you always operate full break-in and are in QSOs 24 hours a day! But when you operate, you probably listen about 75% of the time and are in a QSO 25% of the time. This would quadruple your relay operational life to 464 days if you operate 24 hours a day. Let's assume you operate 2 hours a day, 7 days a week. This will extend the relay life to about 15 years — even neglecting time spent operating semi break-in and relay lifetime improvement due to relay operations much less than the 72,000 operations/hour relay specification! The bottom line — don't worry about wearing out the relays any time soon.

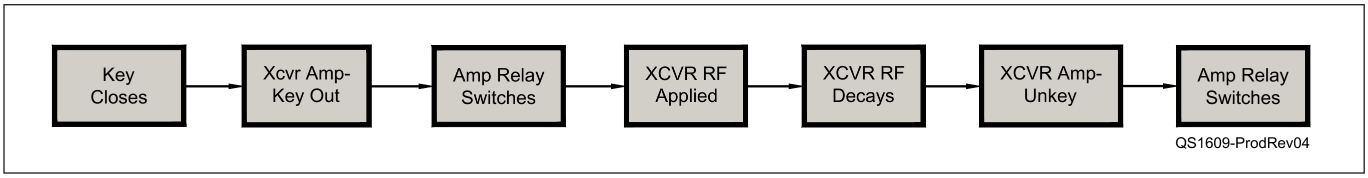

Figure 4 — Transceiver/amplifier timing sequence.

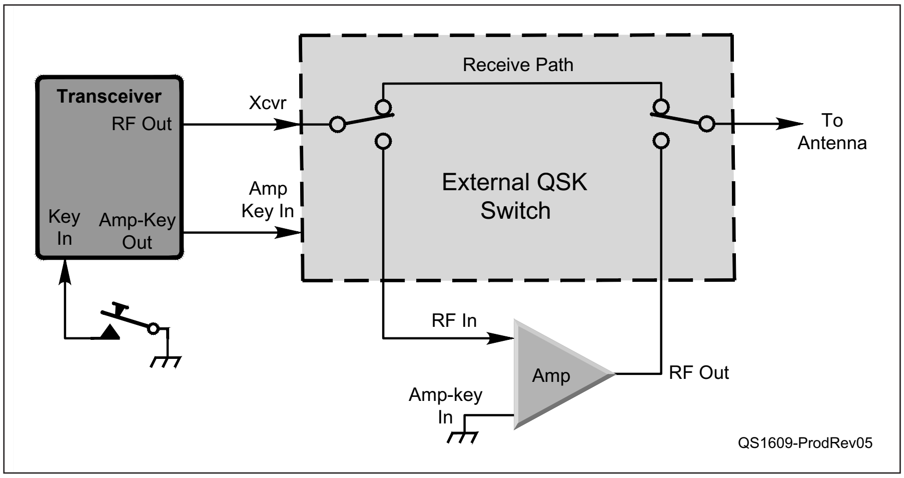

Figure 5 — External QSK switching of a non-QSK amplifier.

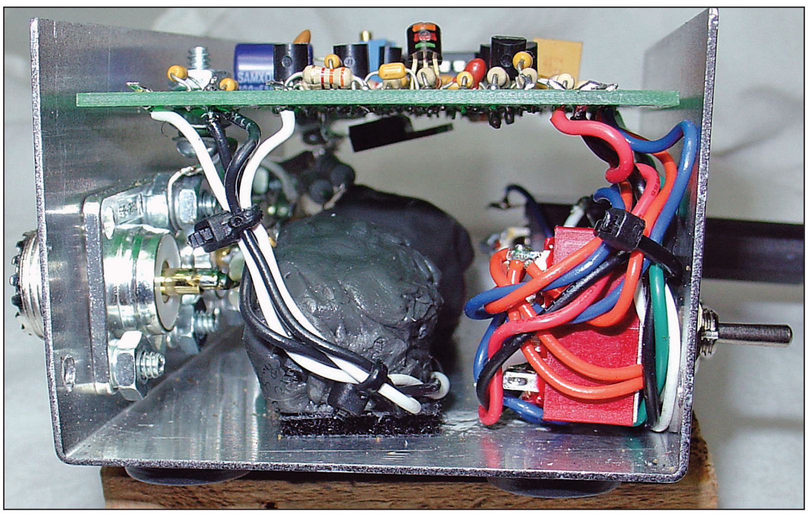

Figure 6 — The QSK 2500 relays are wrapped in double-sided foam tape and then attached to the case with hook-and-loop fastener strips to reduce relay switching noise.

insertion loss (typically 0.5 dB), requires a high voltage power supply for biasing, and can be damaged by high SWR and/or hot switching. A relay-based QSK switch has a more limited lifetime (see the sidebar, "How Long Will the Relays Last?") and is slower than a PIN diode switch, though still fast enough for QSK operation. Compared to a PIN diode switch, a relay-based QSK switch is less sensitive to high SWR and hot switching, is much simpler electrically, and is virtually lossless.

Let's begin by examining how an external QSK switch works. Very simply, the amplifier is keyed continuously and the external QSK device switches the amplifier in and out of line at full break-in speed. High-speed relays or PIN diodes in the external QSK device do the switching. Figure 5 shows a simplified block diagram. The transceiver's amplifier keying output controls the QSK switch, not the amplifier. The amplifier's keying input is grounded constantly in order to keep the amplifier relays in the transmit direction, and amplifier bias properly set for linear operation. Leaving the amplifier keyed constantly may cause a heat problem, especially in those amplifiers that do not employ dynamic bias control.[5]

Enter the QSK 2500

Bill Rodgers, K3HZP, the owner of DX Connection, developed the QSK 2500 to handle amplifier switching for both QSK and non-QSK operation. All switching is accomplished with sequenced high-speed, high reliability sealed relays and relay speed-up circuitry. The QSK 2500 relays switch and settle in less than 8 ms and release in less than 3 ms, and they have an operational life specification of 30 million operations — 15 times greater than the typical vacuum relay. The relays are wrapped in double-sided foam tape to minimize relay noise, and then attached to the case with hook-and-loop fastener strips. This does an excellent job of keeping relay switching noise low. I found it comparable to the switching noise of typical relay-switched transceivers operating full break-in. Figure 6 shows the transceiver and amplifier relays mounted within the QSK 2500.

The QSK 2500 specifications and measured performance are given in Table 7. The QSK 2500 addresses three issues. The first is the amp-enable-to-RF-out delay discussed earlier. A second issue is control of the amplifier's bias. And finally, the QSK 2500 addresses any potential transceiver RF output occurring after the transceiver has unkeyed the amplifier.

The amp enable/RF delay and bias control issues are tightly integrated. Besides transferring the RF path through the amplifier when an amplifier is keyed, an internal amplifier relay also enables the amplifier's operating bias current to ensure linear operation. An amplifier can be keyed continuously while an external QSK product switches the RF path from transmit to receive, but this can result in constant higher operating power dissipation. The QSK 2500 handles the delay and bias control by routing CW key inputs through the QSK 2500, and then to the transceiver. The QSK 2500 immediately keys the amplifier, but delays the key inputs to the transceiver by a nominal 10 ms. This adds the 10 ms delay to the transceiver's key-input-to-RF-output delay. The transceiver no longer keys the amplifier — the QSK 2500 does. This gives the time necessary for the amplifier relays to switch and settle, after which the QSK 2500 switches the amplifier in and out of line at full break-in speeds. Then, after a pause of about 3 seconds, the amplifier is unkeyed which drops the amplifier bias back to its standby/resting state. Finally, the QSK 2500 has an internal RF detector that keeps the QSK 2500 relays keyed if more than ¼ W of RF is present. This solves the problem of premature amplifier unkeying in the presence of RF. A functional block diagram of the QSK 2500 is shown in Figure 7.

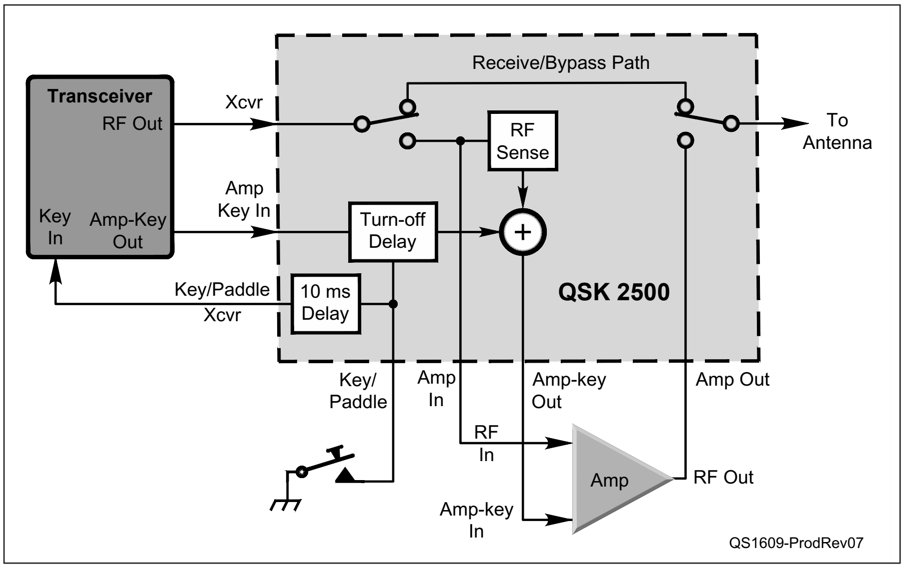

Figure 7 — QSK 2500 block diagram

It is important to note that if your transceiver's internal memory keyer is used, no delay is added to the keying input. But if your transceiver has an adjustable amp-key-to-RF-output delay, the QSK 2500's 10 ms key delay is unnecessary. In this case, keying inputs can connect directly to the transceiver and do not have to be routed through the QSK 2500.

Connecting the QSK 2500

Refer to Figure 7, the title photo. and Figure 8. The QSK 2500 KEY/PADDLE input, a ¼-inch stereo phone jack, accepts a straight key or bug, an external keyer, a paddle, or computer generated CW. The QSK 2500 KEY/PADDLE TRANSCEIVER output, a 3.5 mm stereo jack, then connects to your transceiver's key input. Amplifier keying connections are phono jacks, and the RF interconnects are all UHF connectors. An optional cable set includes two 6-foot cables with phono plugs on each end, one 6-foot cable with 3.5 mm stereo phone plugs on each end, and one female 3.5 mm stereo to ¼ inch male stereo adapter.

An important interface is the AMP KEY OUT. This is specified at ±200 V at 150 mA, which supports most amplifier keying inputs. However, you should verify that your amplifier's keying requirements fall within this range. As an example, some older Henry amplifiers require sinking 240 mA for keying. And some old amplifiers present 120 V ac open-circuit voltage for keying, which will only work if the ac from the amplifier is isolated from ground. Contact DX Connection if you have any questions on your amplifier's keying interface.

Table 7
DX Connection QSK 2500

Manufacturer's Specifications	Measured Performance
Frequency coverage: 1.8 – 54 MHz.	As specified.
Modes of operation: CW, SSB, data modes.	As specified.
Continuous RF power: 2.5 kW @ 1.5:1 SWR, 1.5 kW < 2.5:1 SWR; 1.25 kW < 3:1 SWR.	Tested at 1200 W.*
Insertion loss: Not specified.	<0.05 dB from 1.8 – 50 MHz.
Residual SWR: Not specified.	<1.1:1 from 1.8 – 50 MHz.
Keying input: 5 V dc open circuit, 1 mA closure to ground.	As specified.
Key/paddle input delay: 3 – 16 ms, default 10 ms.	As specified.
Amplifier un-key delay: 2 – 10 s, default 3 s; SSB mode, 31 s	As specified.
Disable RF level inhibit: Not specified	250 mW.**
Amplifier keying voltage: up to ±200 V at 150 mA.	
Power requirements: 17 – 25 V dc @ 200 mA max (120/240 V ac-to-18 V dc power adapter included).	
Size (height, width, depth): 2 × 5.25 × 3 inches (excluding SO-239 connectors); weight, <1 lb.	
Price: QSK 2500 $379; cable set, $19.	

*The amplifier relay dielectric strength is specified at 1000 V RMS between contacts, and 5000 V RMS between contacts and coil. The legal limit (1500 W) worst-case voltage between contact-to-contact and contact-to-coil at a 2.5:1 SWR is 433 V RMS.

**This is the RF level above which the QSK 2500 relays will *not* switch to receive. This protects against hot-switching on unkey for transceivers with premature unkey/RF timing.

Note: There is a factory option to use the Kenwood transceiver +12 V dc amp-key output. This +12 V dc output on transmit in Kenwood radios may be used instead of the normal relay amplifier key output. This may be desired for older Kenwood radios to eliminate transceiver relay switching. Newer Kenwood radios have a menu selection that permits setting this output to the standard ground on transmit.

Figure 8 — QSK 2500 RF connections for transceiver, amplifier, and antenna.

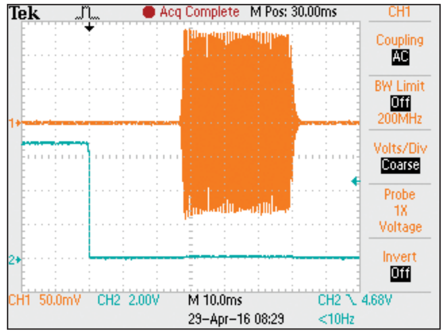

Figure 11 — Keying/RF output through the QSK 2500.

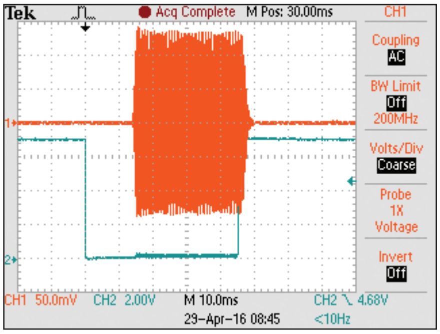

Figure 9 — IC-706MKIIG amp-key timing. The orange trace is the RF envelope and the blue trace is the amplifier key line.

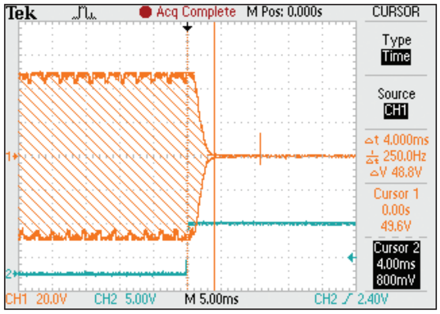

Figure 10 — IC-706MKIIG amp-unkey timing. The orange trace is the RF envelope and the blue trace is the amplifier key line.

I did not attempt to change the enable/dropout timing in the QSK 2500, as this requires soldering jumpers on the PC board, and the default settings should be fine for virtually all applications. My test amplifier is an Ameritron ALS-1306 which has a 12 ms switching time.[6] My back-up transceiver is an IC-706MKIIG, which has about a 12 ms amp-enable-to-RF output fixed delay. This is a perfect combination for testing the QSK 2500 as the IC-706MKIIG and ALS-1306 are either marginally compatible — or marginally incompatible. Further, the IC-706MKIIG continues its RF output about 4 ms *after* the amplifier is unkeyed, which permitted me to evaluate the RF-sensing for switching in the QSK 2500. Figure 9 shows the IC-706MKIIG amp-enable and amp-disable timings. Figure 10 shows more detail on the un-key problem.

The upper orange trace is the actual RF output of the IC-706MKIIG. The lower blue trace is the amp-key (HSEND) output of the IC-706MKIIG.

Next I connected the QSK 2500 in-line. The resultant RF and timing information is shown in Figure 11. The QSK 2500 adds about 10 ms to the actual key input. The amp-key output of the QSK 2500 is used strictly for enabling the amplifier relays, including the bias relay. The QSK 2500 internal relays switch the amplifier in-and-out at full break-in speeds. As the QSK 2500 relay switching occurs prior to RF and about 2 ms after RF (or after the RF power drops below ¼ W), no truncation of the transmitted signal occurs. And I was easily able to hear receive signals between the Morse elements at my keying speed of about 35 WPM.

One last thing worth mentioning is SSB use. Hot switching can occur when using VOX with a non-QSK amplifier (PTT or a footswitch solves this potential problem). As there is no capability to delay audio in the QSK 2500, hot-switching with VOX can still occur on the first syllable. Though not originally designed for SSB, the QSK 2500 does cut down on the number of times that the TR relay in the amplifier switches. SSB operators can insert a ¼-inch plug with the tip shorted to ground in the PADDLE/KEY input all the time. During power-up, the QSK 2500 processor detects the shorted tip and sets the drop-out delay to 31 seconds. More information is available on the DX Connection website.

Summary

The QSK 2500 from DX Connection is an excellent external device that adds full break-in capability to virtually any amplifier. It also resolves other potential hot-switching issues that may occur even when full break-in is not used.

Manufacturer: DX Connection, W. Rodgers, K3HZP, 5727 Buckfield Ct, Fort Wayne, IN 46814; **QSK2500.myfreesites.net**; e-mail **dxconnection@frontier.com**; tel 260-432-8223.

Notes

[4]P. Salas AD5X, "Internal Full Break-In Keying Interface for the ALS-600 Amplifier," *QST* Nov 2011, pp 42 – 44.

[5]T. Rauch W8JI, "Electronic Dynamic Bias System EBS-1 or HF Amplifier Auto-Bias Theory," **w8ji.com/electronic_bias.htm**

[6]P. Salas, AD5X, "Ameritron ALS-1306 HF and 6 Meter Power Amplifier," Product Review, *QST* Jan 2016, pp 55 – 58.