# Tone-Keyed Radio-to-Soundcard Interface

This is an improved version of the audio interface commonly used to connect a computer soundcard to a transceiver's receive and transmit audio circuits. This kind of interface is used by computer programs that send and receive SSTV, RTTY, CW, PSK31 and various other digital modes entirely in software.

Soundcard interfaces are not data controllers, TNCs, decoders or signal processors. They merely couple audio from the radio receiver to the computer sound input, couple computer-generated audio from the soundcard output to the radio transmitter, and provide some way for the computer to key the transmitter.

The usual version of this type of interface (including the commercial "RigBlaster") requires a computer serial port to provide PTT (push-to-talk) control for the radio's transmitter. This type of control uses only the RS-232 RTS and DTR handshaking lines; the actual TXD and RXD data lines themselves are not even used!

This version includes an audio tone detector that keys the transmitter whenever transmit audio is generated by the application running on the PC. No serial port connection is required; a major advantage since PCs in ham shacks seem to never have enough serial ports. This problem becomes particularly acute in APRS setups where packet TNCs, GPS receivers, and modems for Internet access are all competing for a limited number of serial ports and IRQs. (Furthermore, many newer computers don't have any serial ports at all; traditional serial and parallel ports have been replaced with USB connectors.)

The audio coupling is normally done with audio transformers to avoid a common ground connection between the computer and radio. This prevents ground loops which can cause hum and feedback on transmit.

NOTE: A common mistake in soundcard-interface construction is to use an 8-ohm-to-10K transformer for the receiver-to-soundcard-line-input connection. The incorrect assumption is that the 8-ohm speaker impedance needs to be "matched" to the sound card Hi-Z input. You are trying to couple voltage, not maximize power transfer (the condition where impedance matching is required). All that happens is that the roughly 30:1 turns ratio (turns ratio is the square root of the impedance ratio) of such a transformer causes a 30:1 voltage stepup, delivering FAR more signal level (several volts of audio) at the computer than is required. The soundcard input stage will overload, and make the onscreen level control almost impossible to adjust (the optimum level will wind up somewhere between zero and the first step on the Windows control panel slider!). The audio levels at a radio's speaker terminal or the rear panel "packet", "data", or Kenwood 13-pin ACC jacks are already at the right level (about .1 to .5 volts ); all that is required is isolation. The classic 1:1 ratio 600-ohm-to-600-ohm audio "line" transformer is exactly what you want. If you have to use a mic input (many laptop computers don't have a line-level input), you will probably have to provide a 10:1 or 20:1 voltage divider network to reduce the receive audio level.

If transmit audio is being inserted into the transceiver via the mic jack, an attenuator network is required. This network reduces the 300-500 millivolt audio level normally output by the sound card to the 5-10 millivolt level required by most radio mic inputs.

On SSTV, voice transmission alternates with sound-card-generated data. In this design, the second set of poles on the double-pole double-throw PTT relay disconnect the mic and connect the soundcard output, whenever a computer-generated tone is detected.

Many current transceivers have an 8-pin Mic jack with fixed low-level receive audio on one of its pins, and 8 volts DC (intended to power illuminated touch-tone mics) on another. Some of the models with this type of connection include the Kenwood TS-450, TS-690, TM-221, TM-421, TM-731 (when the modular-to-8-pin adapter is used) and the Yaesu FT-100 and FT-1500, etc. I have added the receive audio connection to radios that didn't originally have it such as the TS-50, TM-211, TM-411, TS-711 and 811 VHF/UHF allmodes, etc. (On these radios, the mic jack pin that carries RX audio on newer models was unused). Normally, I pick up the hot end of the receiver volume control pot and connect it to this pin [ Fortunately, even on the latest radios, Kenwood seems to continue to use classic analog volume control pots instead of a digitally controlled attenuator ] to provide a fixed-level output that is typically 50-100mV. This level is a perfect match for the usual sound-card line-level input.

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**The following pages show three versions of this interface.**

**Diagram 1** below is a modification of the design using discrete transistors shown in the help system of K0HEO's WinPix32 soundcard SSTV software. Changes include substituting an NPN transistor for the original PNP (so it can work on a positive power supply), and having the power-MOSFET keying line activate a DPDT relay (instead of keying the radio directly).

This version was designed specifically to be connected to, and powered by, Kenwood transceivers by a single cable connected to the Mic jack. No separate DC connection or wall wart is required. Obviously, the tone keyer circuit could be used with a separate power source on non-Kenwood radios. I have used this interface on my Yaesu FT-100 after making a RJ-11-to-8-pin adapter for the mic jack, and after connecting the one unused pin in the mic jack to fixed receive audio as described above. The adapter consists of a surface-mount RJ-11 telephone jack with a standard 8-pin ham mic jack mounted in a 5/8-inch hole punched into the jack's cover. The two extra pins used by Kenwood 8-pin mics ("UP" and "DOWN" buttons) are not connected.

[ Side-note on keying the FT-100: In order to combine the the mic remote functions that Kenwood uses 8 mic pins to implement, into only 6 conductors of a standard RJ-11 telephone jack, Yaesu uses multiple voltage levels on the PTT line -- not just HI or ground. Various buttons on the mic pull the same line to ground through different value resistors. Directly grounding the PTT line will cause the radio to start scanning instead of transmitting. You must connect the PTT line to ground through a 27K resistor to actually transmit. ]

In the interest of maximum isolation and RF immunity, I chose to use a DPDT relay (instead of solid state switches or opto isolators) to switch transmit audio and provide a positive zero-voltage-drop PTT. The maximum current available from the mic jack 8 VDC line is very limited (about 50mA) so a very high sensitivity 5 VDC relay is required. Normal 5 VDC DPDT DIP- package relays have a coil resistance of about 50 ohms. The relay on the diagram has a coil resistance of over 300 ohms, and will operate from the limited current available.
The SPST toggle switch disables the relay, preventing the interface from keying the transmitter. The TX led still lights up when a tone is present, allowing the sound card output to be adjusted (using the Windows mixer level controls) for positive keying without putting a signal on the air.
I connected a surplus piezo audio transducer across the TX audio input to the interface to provide a low-level monitor of the transmitted audio (Normally, plugging a cable into the laptop line-out cuts off the internal speakers so the transmit tones can't be heard.) It produces a perfect low-level side tone for the transmitted data and doesn't load the audio line at all. (And if you want to mute it completely, stick a piece of tape over the transducer's hole.)

**Diagram 2** below shows the result of an effort to use an absolute minimum number of components, and to improve the performance (sensitivity and keying speed) This greatly simplified design uses an inexpensive ( approx $ .50 USD) LM158/258/358 series dual op-amp integrated circuit to replace a lot of discrete parts including the two transistors. This particular op-amp IC works well on a single-voltage power supply. The input voltage range can swing all the way to the negative supply value (i.e. ground). With the LM158 device, less than 100mV of sound card audio will reliably key the transmitter. [ With most common op-amps, the input voltage swing can not get closer than about 1V to either power supply value. The soundcard would then be required to provide in excess of 1 volt of audio to trigger PTT. ]

The miniature Aromat DPDT dip-package relays shown on the schematic are sensitive enough, and draw a low enough current through their coils, to be activated directly by the op-amp output stage **without external transistor drivers**. They are also, amazingly, very cheap. The 12-volt 1000-ohm coil version is about USD $2.50 from Digi-Key; the 5-volt 350-ohm-coil version is about $5.00

This design also keys and unkeys the transmitter much faster (an important issue if you are using packet modes generated by the AGW Packet Engine or MixW software). Using a dual-trace triggered scope, I have measured the RX-toTX delay (time between start of tone and PTT relay contact closure) at less than 2 milliseconds. The TX-to-RX delay (time between the end of the tone and the PTT relay opening) is less than 3.5mS! Clearly an insignificant addition to packet TXD overhead.

**Diagram 3** below shows a modification to use the common 6-pin dip-package 4Nxx-series opto-isolators to replace the relay. The key and unkey times are even faster (less than 2 mS), but you lose the second set of contacts to automatically transfer TX audio between mic and sound card. This is not an issue if you are connecting the interface via a radio rear-panel non-mic “data” or “packet” jack.

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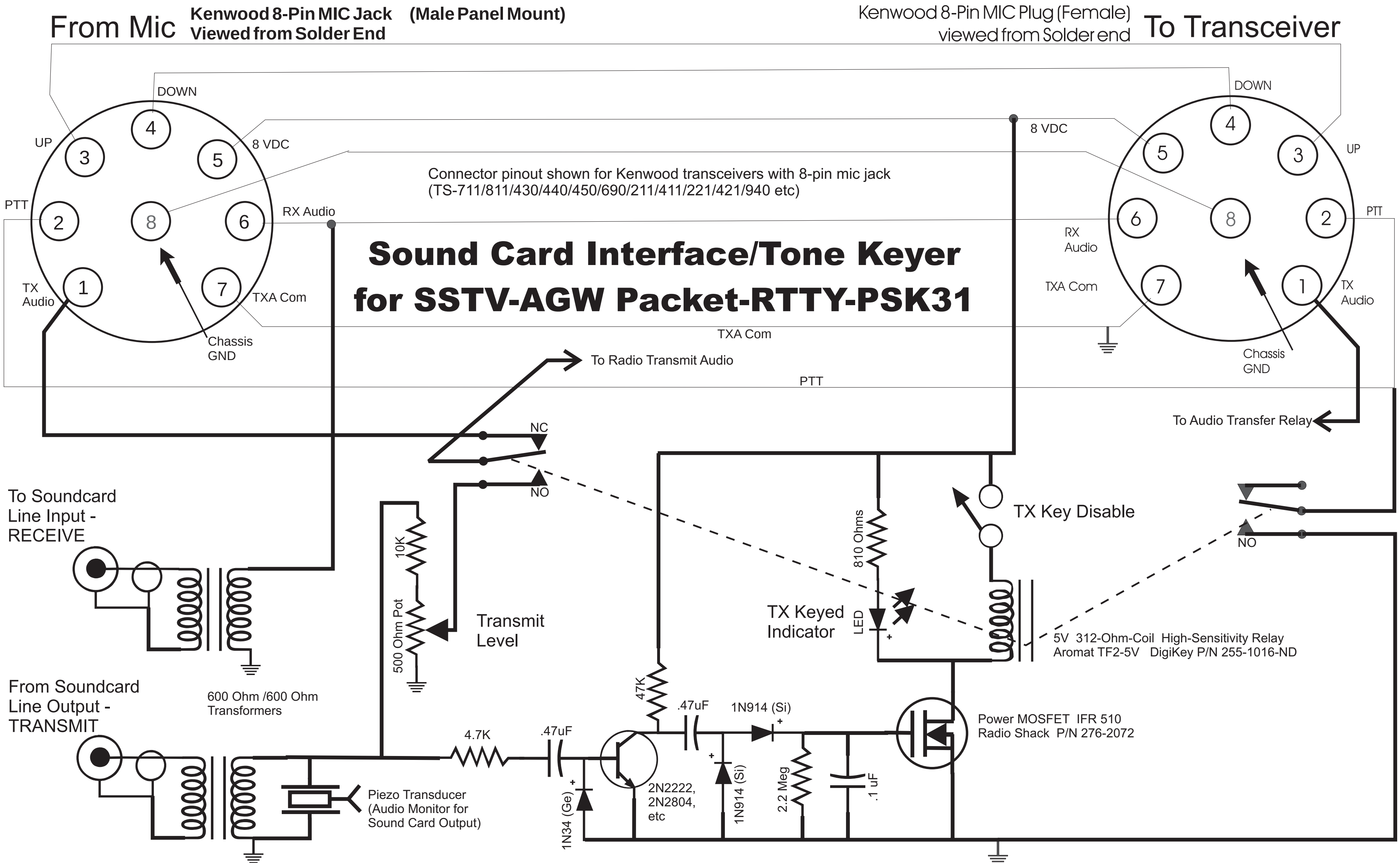
**Diagram 4** below shows a alternative approach, based on the KH6TY self-powered design. As shown, it is intended for connecting the 3.5mm 4-conductor combined stereo playback-out/mic-in jack on iPads & iPhones to the 6-pin mini-DIN "data port" present on many transceivers. The same 4-conductor "TRRS" (**T**ip-Ring-**R**ing-**S**leeve) jack is present on some other devices such as Acer netbooks & various tablets. (The all-in-one audio jack was originally intended for use with boom-mic headsets for Skype, etc.)

Usually such a 4-conductor all-in-one jack is marked with a modified version of the standard headphones icon that shows a boom mic in addition to the usual earpieces.

Modified Headset Icon Near Jack

The self-powered VOX transmit keyer is far slower than my powered design. (Packet/APRS operation requires a minimum of 150-200 milliseconds TXD compared to 5 ms for my active design) but has the advantage that no additional power source is required. This a real advantage when using the mini-DIN data port instead of a mic jack. (Unlike many mic jacks, the mini-DIN data port does not provide any kind of DC power to the device attached.) The minimum audio level required out of the computer sound system to successfully key the transmitter is far higher; around .7 volts compare to just a few millivolts for the active design. Normally one will set the computer volume controls to maximum, and adjust the transmit level (modulation) with the variable resistor in the interface.

The self-powering VOX keyer scheme uses the common 600-600 ohm line transformer, but one with a center-tapped winding is required. On playback (i.e. "Transmit"), using half of the primary winding with the full secondary winding yields a 2:1 voltage gain before the full-wave voltage-doubler rectifier doubles it again. For maximum keying sensitivity, use germanium diodes such as 1N34 types rather than silicon ones like 1N914s. (Germanium diodes have about .3 volts drop in the forward conducting direction, compared to .6 to .7 volts drop for silicon devices. This makes a major difference when the audio source voltage is barely 1.5 V peak-to-peak.)

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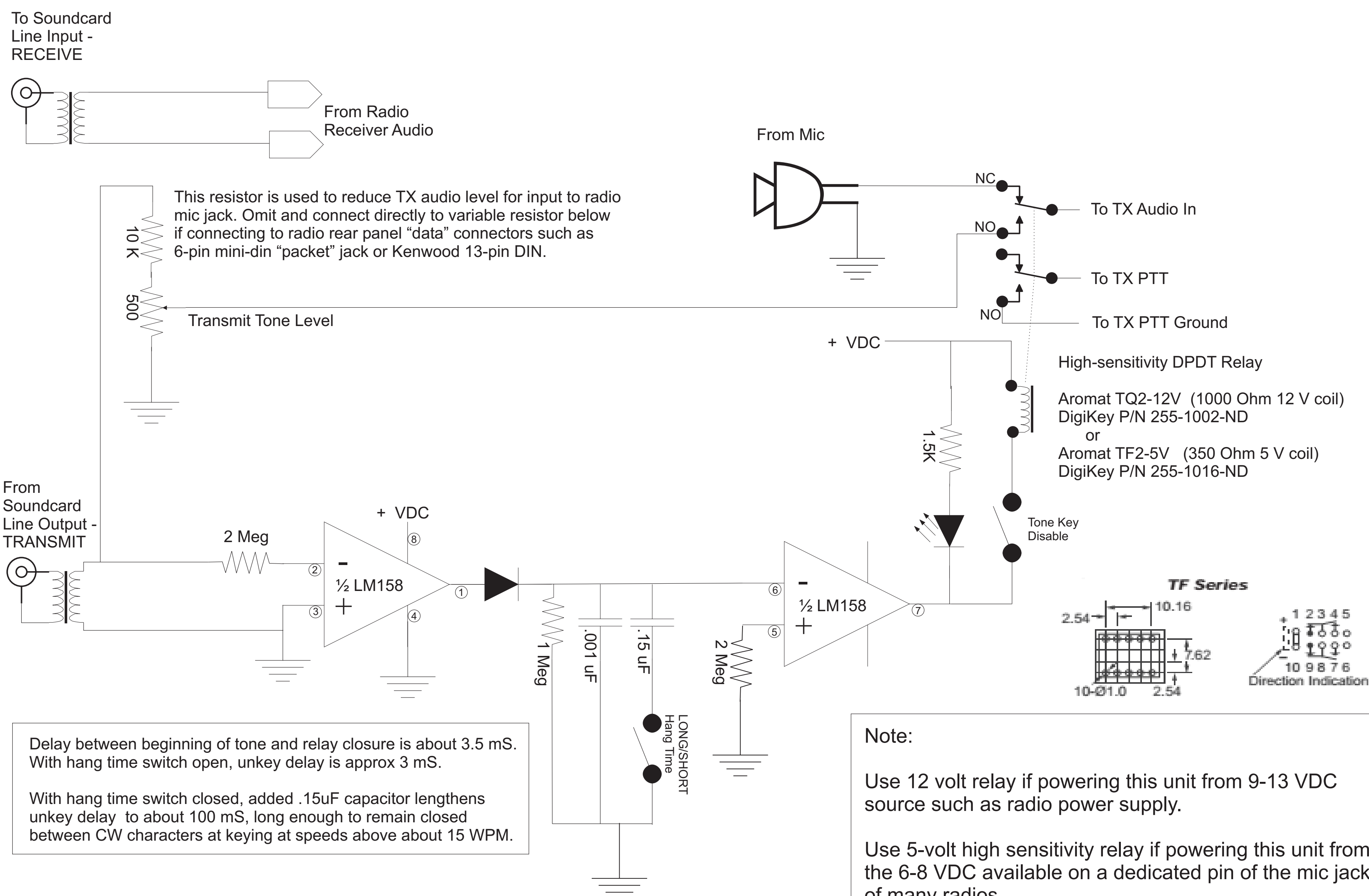
# 2nd Generation Tone-Keyed Sound Card Interface




Delay between beginning of tone and relay closure is about 3.5 mS. With hang time switch open, unkey delay is approx 3 mS.

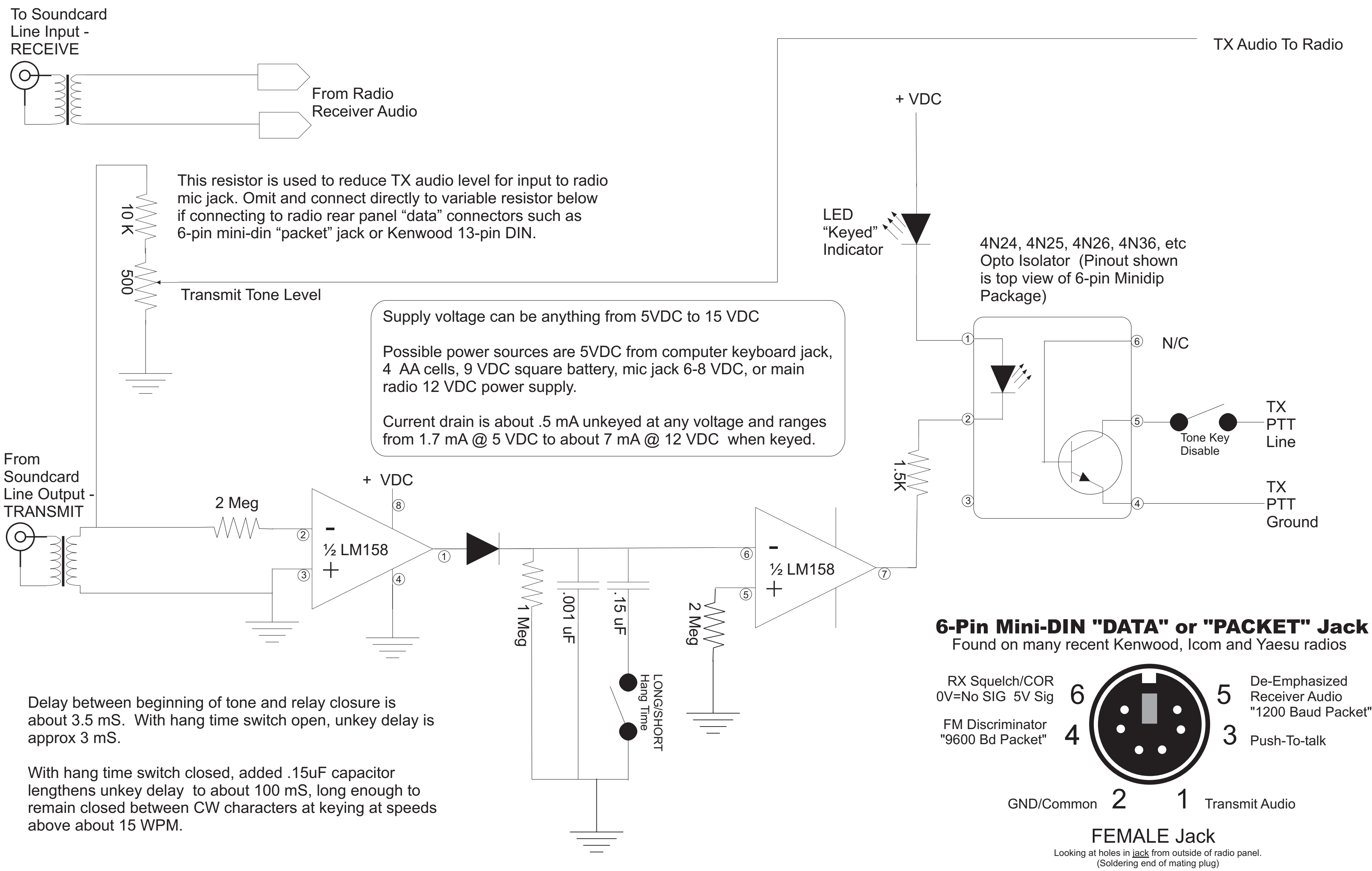
With hang time switch closed, added .15uF capacitor lengthens unkey delay to about 100 mS, long enough to remain closed between CW characters at keying at speeds above about 15 WPM.

Note:

Use 12 volt relay if powering this unit from 9-13 VDC source such as radio power supply.

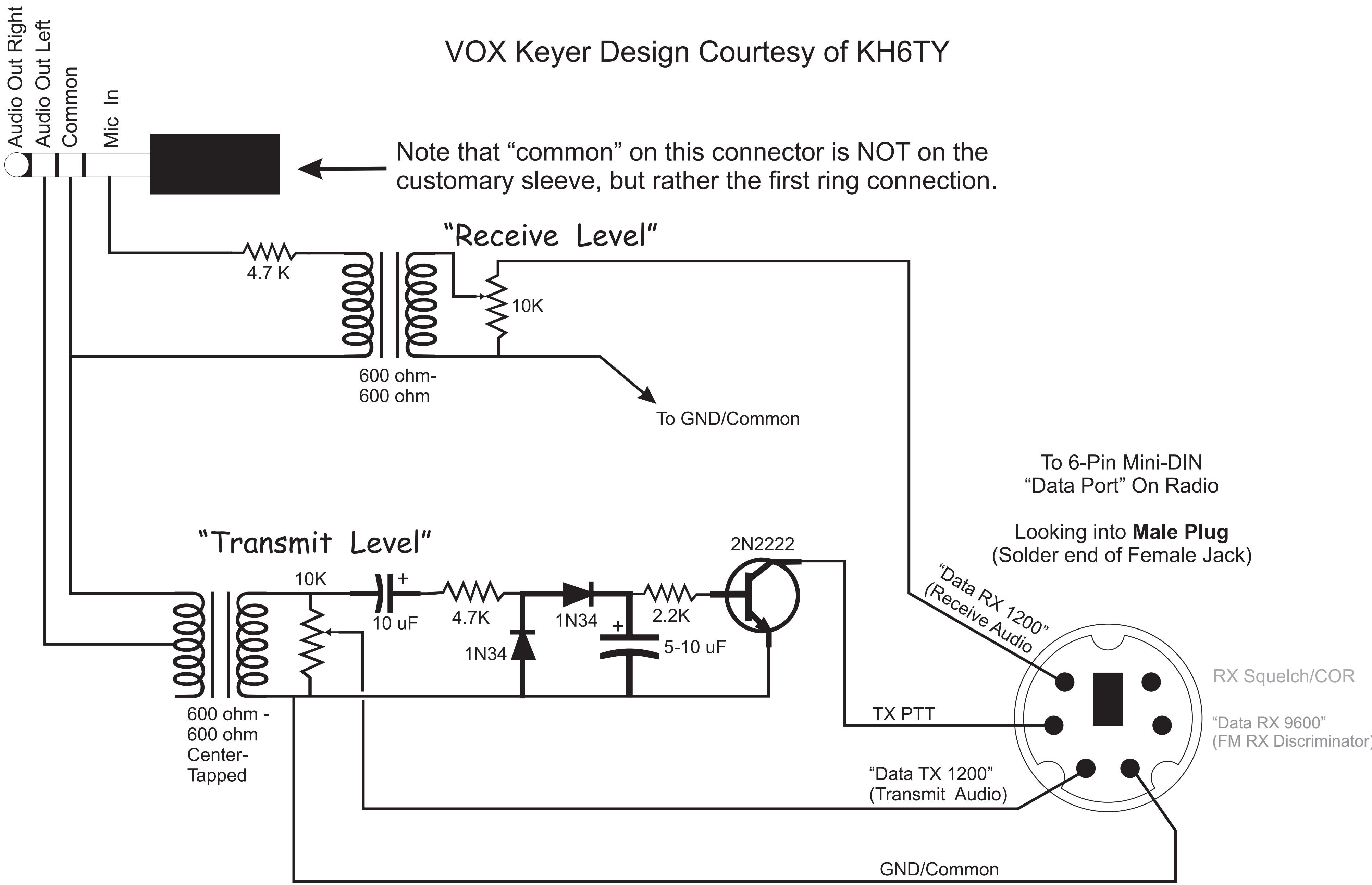
Use 5-volt high sensitivity relay if powering this unit from the 6-8 VDC available on a dedicated pin of the mic jack of many radios.

# Tone Keyed  Sound Card Interface
# (Alternative design using opto-isolator output)



# Soundcard Interface for iPad, iPhone, Other Tablets, Netbooks, Smartphones, etc That Use 3.5mm 4-Conductor "TRRS" Combined Headphone and Mic Connector

VOX Keyer Design Courtesy of KH6TY

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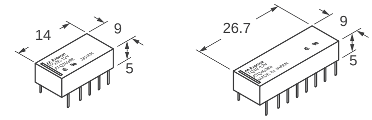
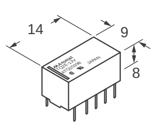
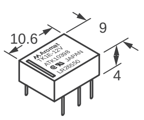
*TQ Series*



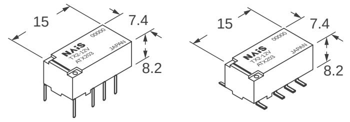
*TF Series*



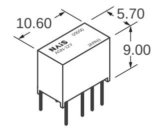
*TK Series*



*TX Series*



*AGN Series*



| Fig. | Cont. Arrange. | Coil Volt | Coil Res. | Coil Curr. (mA) | Contact Ratings (A) 30 VDC | 125 VAC | Pickup/Dropout/ Max. Voltage | Digi-Key Part No. | Price Each 1 | 25 | 50 | 100 | Aromat Part No. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | *TQ Series Telcom Relays* | | | | | | |
| 1 | DPDT | 3VDC | 64.3 | 46.7 | 1 | .5 | 2.25/0.3/4.5 | 255-1225-ND | 2.65 | 2.43 | 2.16 | 1.84 | TQ2-3V |
| | DPDT | 4.5VDC | 144 | 31.1 | 1 | .5 | 3.38/.45/6.7 | 255-1226-ND | 2.65 | 2.43 | 2.16 | 1.84 | TQ2-4.5V |
| | DPDT | 5VDC | 178 | 28.1 | 1 | .5 | 3.75/0.5/7.5 | 255-1001-ND | 2.65 | 2.43 | 2.16 | 1.84 | TQ2-5V |
| | DPDT | 12VDC | 1,028 | 11.7 | 1 | .5 | 9/1.2/18 | 255-1002-ND | 2.65 | 2.43 | 2.16 | 1.84 | TQ2-12V |
| | DPDT | 24VDC | 2,880 | 8.3 | 1 | .5 | 18/2.4/36 | 255-1003-ND | 3.16 | 2.91 | 2.58 | 2.20 | TQ2-24V |
| 2 | 4PDT | 5VDC | 89 | 56.2 | 1 | .5 | 3.75/0.5/7.5 | 255-1013-ND | 17.64 | 16.20 | 14.40 | 12.24 | TQ4-5V |
| | 4PDT | 12VDC | 514 | 23.3 | 1 | .5 | 9/1.2/18 | 255-1014-ND | 17.64 | 16.20 | 14.40 | 12.24 | TQ4-12V |
| | 4PDT | 24VDC | 2,056 | 11.7 | 1 | .5 | 18/2.4/36 | 255-1015-ND | 19.11 | 17.55 | 15.60 | 13.26 | TQ4-24V |
| | | | | | | | *TQ Series Telcom Single Coil Latching Relays* | | | | | | |
| 3 | DPDT | 5VDC | 250 | 20 | 1 | .5 | 3.75/3.75/7.5 | 255-1004-ND | 3.16 | 2.91 | 2.58 | 2.20 | TQ2-L-5V |
| | DPDT | 12VDC | 1,440 | 8.3 | 1 | .5 | 9/9/18 | 255-1005-ND | 3.16 | 2.91 | 2.58 | 2.20 | TQ2-L-12V |
| | DPDT | 24VDC | 3840 | 12.5 | 1 | .5 | 18/18/36 | 255-1006-ND | 3.58 | 3.29 | 2.92 | 2.49 | TQ2-L-24V |
| | | | | | | | *TQ Series Telcom Dual Coil Latching Relays* | | | | | | |
| 4 | DPDT | 5VDC | 125 | 40 | 1 | .5 | 3.75/3.75/7.5 | 255-1007-ND | 3.31 | 3.04 | 2.70 | 2.30 | TQ2-L2-5V |
| | DPDT | 9VDC | 405 | 22.2 | 1 | .5 | 16.75/13.5 | 255-1355-ND | 3.31 | 3.04 | 2.70 | 2.30 | TQ2-L2-9V |
| | DPDT | 12VDC | 720 | 16.7 | 1 | .5 | 9/9/18 | 255-1008-ND | 3.31 | 3.04 | 2.70 | 2.30 | TQ2-L2-12V |
| | DPDT | 24VDC | 1,920 | 12.5 | 1 | .5 | 18/18/28.8 | 255-1009-ND | 3.75 | 3.45 | 3.06 | 2.61 | TQ2-L2-24V |
| | | | | | | | *TQ Series Telcom Relays SMT* | | | | | | |
| 5 | DPDT | 1.5VDC | 16 | 93.8 | 2 | .5 | 1.13/.15/2.2 | 255-1224-ND | 3.01 | 2.77 | 2.46 | 2.10 | TQ2SA-1.5V |
| | DPDT | 3VDC | 64.3 | 46.7 | 2 | .5 | 2.25/.30/4.5 | 255-1228-ND | 3.01 | 2.77 | 2.46 | 2.10 | TQ2SA-3V |
| | DPDT | 4.5VDC | 145 | 31 | 2 | .5 | 3.38/.45/6.7 | 255-1229-ND | 3.01 | 2.77 | 2.46 | 2.10 | TQ2SA-4.5V |
| | DPDT | 5VDC | 178 | 28.1 | 2 | .5 | 3.75/0.5/7.5 | 255-1010-ND | 3.01 | 2.77 | 2.46 | 2.10 | TQ2SA-5V |
| | DPDT | 12VDC | 1,028 | 11.7 | 2 | .5 | 9/1.2/18 | 255-1011-ND | 3.01 | 2.77 | 2.46 | 2.10 | TQ2SA-12V |
| | DPDT | 24VDC | 2,880 | 8.3 | 2 | .5 | 18/2.4/36 | 255-1012-ND | 3.58 | 3.29 | 2.92 | 2.49 | TQ2SA-24V |
| | | | | | | | *TF Series Telcom Relays* | | | | | | |
| 6 | DPDT | 5VDC | 312.5 | 16 | 1 | .5 | 3.75/0.5/7.5 | 255-1016-ND | 5.41 | 4.98 | 4.42 | 3.76 | TF2-5V |
| | DPDT | 12VDC | 1,800 | 6.7 | 1 | .5 | 9/1.2/18 | 255-1017-ND | 5.41 | 4.98 | 4.42 | 3.76 | TF2-12V |
| | DPDT | 24VDC | 4,100 | 5.8 | 1 | .5 | 18/2.4/36 | 255-1018-ND | 6.32 | 5.81 | 5.16 | 4.39 | TF2-24V |
| | | | | | | | *TF Series Telcom Dual Coil Latching Relays* | | | | | | |
| 7 | DPDT | 5VDC | 227.3 | 22 | 1 | .5 | 3.75/3.75/7.5 | 255-1019-ND | 7.03 | 6.46 | 5.74 | 4.88 | TF2-L2-5V |
| | DPDT | 12VDC | 1,309 | 9.2 | 1 | .5 | 9/9/18 | 255-1020-ND | 7.03 | 6.46 | 5.74 | 4.88 | TF2-L2-12V |
| | DPDT | 24VDC | 2,880 | 8.3 | 1 | .5 | 18/18/36 | 255-1021-ND | 7.15 | 6.57 | 5.84 | 4.97 | TF2-L2-24V |
| | | | | | | | *TN Series Telcom Relays* | | | | | | |
| 8 | DPDT | 5VDC | 178 | 28.1 | 1 | .5 | 3.75/0.5/7.5 | 255-1022-ND | 3.90 | 3.58 | 3.18 | 2.71 | TN2-5V |
| | DPDT | 12VDC | 1,028 | 11.7 | 1 | .5 | 9/1.2/18 | 255-1023-ND | 3.90 | 3.58 | 3.18 | 2.71 | TN2-12V |
| | DPDT | 24VDC | 2,880 | 8.3 | 1 | .5 | 18/2.4/36 | 255-1024-ND | 4.63 | 4.26 | 3.78 | 3.22 | TN2-24V |
| | | | | | | | *TN Series Telcom Dual Coil Latching Relays* | | | | | | |
| 9 | DPDT | 5VDC | 125 | 40 | 1 | .5 | 3.75/3.75/7.5 | 255-1025-ND | 4.85 | 4.46 | 3.96 | 3.37 | TN2-L2-5V |
| | DPDT | 12VDC | 720 | 16.7 | 1 | .5 | 9/9/18 | 255-1026-ND | 4.85 | 4.46 | 3.96 | 3.37 | TN2-L2-12V |
| | DPDT | 24VDC | 1,920 | 12.5 | 1 | .5 | 18/18/28.8 | 255-1027-ND | 5.49 | 5.04 | 4.48 | 3.81 | TN2-L2-24V |
| | | | | | | | *TK Series Telcom Relays* | | | | | | |
| 10 | SPDT | 5VDC | 178 | 28.1 | 2 | .5 | 3.75/0.5/7.5 | 255-1028-ND | 4.43 | 4.08 | 3.62 | 3.08 | TK1-5V |
| | SPDT | 12VDC | 1,028 | 11.7 | 2 | .5 | 9/1.2/18 | 255-1029-ND | 4.43 | 4.08 | 3.62 | 3.08 | TK1-12V |
| | SPDT | 24VDC | 2,133 | 11.3 | 2 | .5 | 18/2.4/28.8 | 255-1030-ND | 5.10 | 4.68 | 4.16 | 3.54 | TK1-24V |
| | | | | | | | *TX Series Telcom Relays* | | | | | | |
| 11 | DPDT | 5VDC | 178 | 28.1 | 2 | .5 | 3.75/0.5/7.5 | 255-1031-ND | 2.92 | 2.68 | 2.38 | 2.03 | TX2-5V |
| | DPDT | 12VDC | 1,028 | 11.7 | 2 | .5 | 9/1.2/18 | 255-1032-ND | 2.92 | 2.68 | 2.38 | 2.03 | TX2-12V |
| | DPDT | 24VDC | 4,114 | 5.8 | 2 | .5 | 18/2.4/36 | 255-1033-ND | 3.45 | 3.18 | 2.82 | 2.40 | TX2-24V |
| | | | | | | | *TX Series Telcom Relays SMT* | | | | | | |
| 12 | DPDT | 5VDC | 178 | 28.1 | 2 | .5 | 3.75/0.5/7.5 | 255-1034-ND | 3.01 | 2.77 | 2.46 | 2.10 | TX2SA-5V |
| | DPDT | 12VDC | 1,028 | 11.7 | 2 | .5 | 9/1.2/18 | 255-1035-ND | 3.01 | 2.77 | 2.46 | 2.10 | TX2SA-12V |
| | DPDT | 24VDC | 4,114 | 5.8 | 2 | .5 | 18/2.4/36 | 255-1036-ND | 3.55 | 3.27 | 2.90 | 2.47 | TX2SA-24V |
| | | | | | | | *AGN Series Compact Telcom Relays* | | | | | | |
| 13 | DPDT | 4.5VDC | 145 | 31 | 1 | .3 | 3.38/.45/6.75 | 255-1230-ND | 3.38 | 3.11 | 2.76 | 2.35 | AGN2004H |
| | DPDT | 12VDC | 1,028 | 11.7 | 1 | .3 | 9/1.2/18 | 255-1231-ND | 3.38 | 3.11 | 2.76 | 2.35 | AGN20012 |
| | DPDT | 24VDC | 2,504 | 9.6 | 1 | .3 | 18/2.4/28.8 | 255-1232-ND | 3.97 | 3.65 | 3.24 | 2.76 | AGN20024 |
| | | | | | | | *AGN Series Compact Telcom Relays SMT* | | | | | | |
| 14 | DPDT | 4.5VDC | 145 | 31 | 1 | .3 | 3.38/.45/6.75 | 255-1233-ND | 3.50 | 3.22 | 2.86 | 2.44 | AGN200A4H |
| | DPDT | 12VDC | 1,028 | 11.7 | 1 | .3 | 9/1.2/18 | 255-1234-ND | 3.50 | 3.22 | 2.86 | 2.44 | AGN200A12 |
| | DPDT | 24VDC | 2,504 | 9.6 | 1 | .3 | 18/2.4/28.8 | 255-1235-ND | 4.12 | 3.78 | 3.36 | 2.86 | AGN200A24 |
| | | | | | | | *HX Series Compact Telcom Relays* | | | | | | |
| 15 | DPDT | 5VDC | 78.1 | 64 | 1 | .3 | 3.75/.5/5.5 | 255-1236-ND | 3.43 | 3.15 | 2.80 | 2.38 | HX2-5V |
| | DPDT | 12VDC | 450 | 26.7 | 1 | .3 | 9/1.2/13.2 | 255-1237-ND | 3.43 | 3.15 | 2.80 | 2.38 | HX2-12V |
| | DPDT | 24VDC | 1,800 | 13.4 | 1 | .3 | 18/2.4/26.4 | 255-1238-ND | 3.55 | 3.27 | 2.90 | 2.47 | HX2-24V |

*Bottom view shown unless otherwise noted*

**Fig. 1** *TQ Series*

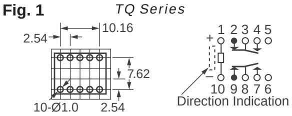


**Fig. 2**

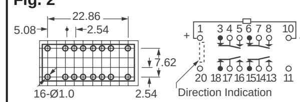


**Fig. 3**

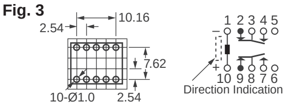


**Fig. 4**

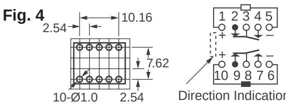


**Fig. 5** *TQ Series SMT*

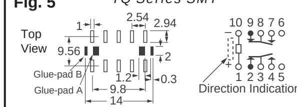


**Fig. 6** *TF Series*

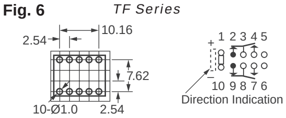


**Fig. 7**

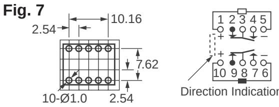


**Fig. 8** *TN Series*

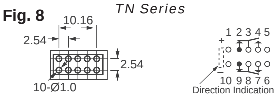


**Fig. 9**

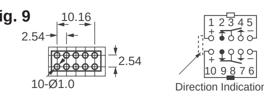


**Fig. 10** *TK Series*

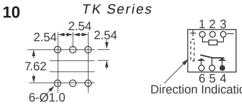


**Fig. 11** *TX Series*

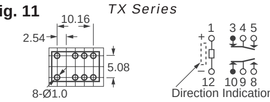


**Fig. 12** *TX Series SMT*

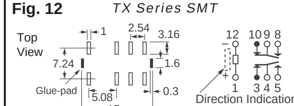


**Fig. 13** *AGN Series*

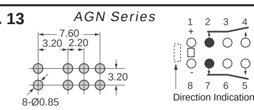


**Fig. 14** *AGN Series SMT*

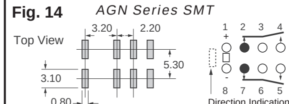
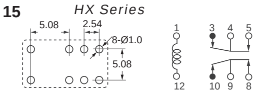


**Fig. 15** *HX Series*



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