Getting Started in Digital Communications - Part 3 - RTTY

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Getting Started in Digital Communications

Part 3—It's relaxing, informal and friendly. Its signals are music to the ears of those who've grown to love it. What are we talking about? RTTY, of course!

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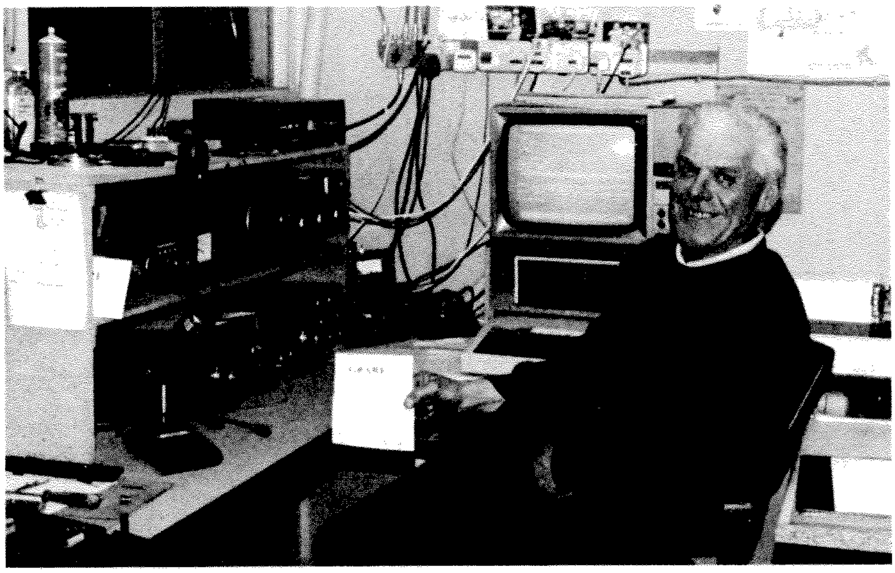

Why is GØARF smiling? He just completed another successful ARRL RTTY Roundup despite gale-force winds and two power outages.

The beginnings of radioteletype (RTTY) date back to World War II when the military began connecting mechanical teletype machines to HF radios. At first they attempted to use simple on/off keying as a means of sending text, but the results were poor. After some further experimentation, the designers soon switched to *frequency shift keying* (*FSK*). This scheme did the trick and RTTY was born!

RTTY is one of the most popular digital-communication modes on the amateur HF bands. Its error-correcting cousin, AMTOR, is steadily gaining ground, but RTTY has a special advantage: almost *any* SSB transceiver—no matter how old—can be used for RTTY. With a data terminal or computer and an RTTY modem or multimode communications processor (MCP),[1] you'll be up and running in no time. RTTY QSOs are loose and friendly, not the "weather here is..." variety. Opportunities for DX abound, too!

A Bit of *Shifty* Theory

The basics of RTTY reception are relatively simple. To decode the information, it's only necessary to detect the pulse state of the incoming signal. In RTTY jargon, we say *mark* for the *on* pulse and *space* for the *off* pulse. The difference between the mark and space frequencies is the *shift* of the FSK modulation. The shift almost all RTTY enthusiasts use today is 170 Hz.[2]

To decode RTTY signals, the tones must be converted back into logic levels—a "1" pulse for mark and a "0" pulse for space. This is accomplished by setting the receiver to the correct sideband (usually lower sideband) and tuning slowly until the tones correspond to the center frequencies of two audio filters in the RTTY demodulator. The output from each filter is then detected and amplified to produce the required mark and space pulses.

By tuning the receiver, we can produce practically any audio frequency for mark or space. However, the frequency difference between the mark and space tones *always* matches the shift used by the transmitting station. As you might guess, the exact center frequencies of your demodulator filters are not critical as long as their *difference* matches whatever shift is in use at the time.

When it comes to transmitting RTTY, most modern transceivers don't shift their carrier frequencies as a direct response to digital teletype signals. Instead, the teletype data signal shifts the frequency of an audio oscillator (the RTTY modulator). This is known as AFSK—for *audio* FSK. The oscillator generates one tone for mark and another for space.

Can you guess what happens when we apply these tones to an SSB transceiver operating on LSB? The 2125-Hz mark tone produces a signal that is 2125 Hz below the suppressed carrier frequency. The 2295-Hz space tone creates a signal that is 2295 Hz below the suppressed carrier frequency. Both signals differ by 170 Hz—our RTTY shift! Although it's generated differently than true FSK, AFSK is basically the same. I prefer to call it "indirect FSK."

Fig 1 shows a comparison of "direct" FSK and "indirect" FSK techniques. These diagrams have been simplified for clarity. The carrier oscillator, balanced modulator, and LSB filter are usually at 455 kHz and then mixed with a VFO (and fixed oscillators) to the desired output frequency.

Many modern transceivers include FSK capability. However, a careful study of their schematics sometimes reveals that the so-called FSK mode includes an internal AFSK generator that's applied to the balanced modulator while the transmitter is operated on LSB!

Get Out Your Cables

RTTY theory takes you only so far. The real challenge is getting on the air and

[1]Notes appear on page 47.

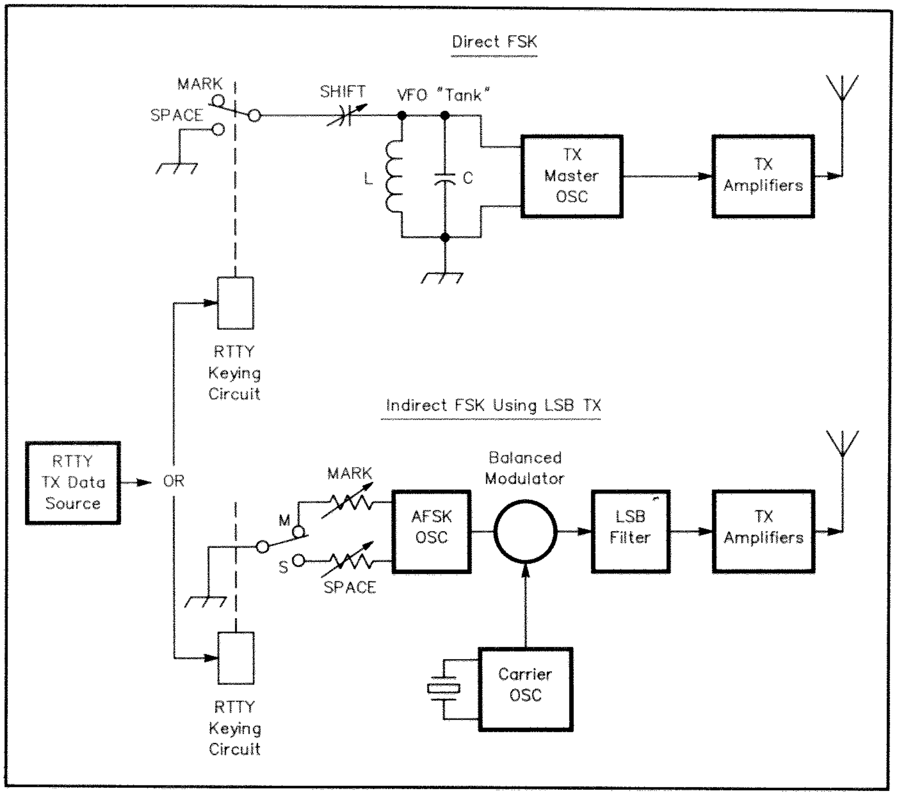

Fig 1—An illustration of *direct* versus *indirect* FSK.

no more than six feet in length. Inexpensive audio cables will work just fine. However, their shielding leaves much to be desired. A piece of RG-58 with phono connectors has superior shielding. If you have an RFI problem, try improving the grounds and cable shielding first. Contrary to audio grounding techniques, ground the cable shields at *both ends*.

Setting Up for LSB Operation

Using an SSB transceiver in the LSB mode is the easiest way to get on RTTY. In most cases, all you have to do is make a few simple connections, adjust the transmitter and you're on the air (see Fig 2). Even if your transceiver features an FSK mode (which many RTTY devotees prefer), it's a good idea to get your feet wet using AFSK first—then switch to FSK as you become more experienced.

To operate in the AFSK mode, follow these steps:

- Set your transceiver to LSB.
- Connect the **TX Audio** leads from your RTTY modem or multimode communications processor to the phone patch or microphone input of your transceiver.
- Connect the modem/MCP push-to-talk (PTT) leads to the transmitter PTT terminals.
- Connect the modem/MCP **RX Audio** leads to the phone patch *output* or external speaker jack. Try to find a rear-panel connection that is *not* disabled when you plug in the headphones. (I often insert a "blank" plug in the headphone jack to quiet the *deedle-deedle* noise.) If your receiver has a 600-ohm line output, by all means use it.

working someone! Before you can do that, you have to assemble your station equipment.

As you begin installing your RTTY components, remember to establish good RF ground connections between each piece of equipment. RFI can be a major headache with solid-state RTTY devices. Computer "birdies" (unwanted signals), for example, can make reception miserable. By the same token, your transmitter can wreak havoc with your computer. I've used ½-inch braid for my ground connections with good results. Many RFI experts now advocate using ½-inch wide copper straps. Regardless of the material you choose, make the ground connection your *first* priority and you'll never regret it!

Keep all cables as short as possible. A 20-foot audio cable makes a marvelous antenna for RFI. Try to locate all equipment close together and limit all cables to

A Handy Attenuator

The commercial standard for audio-frequency signals is a 0-dBm level (about 0.77 volts RMS) and 600 ohms impedance.

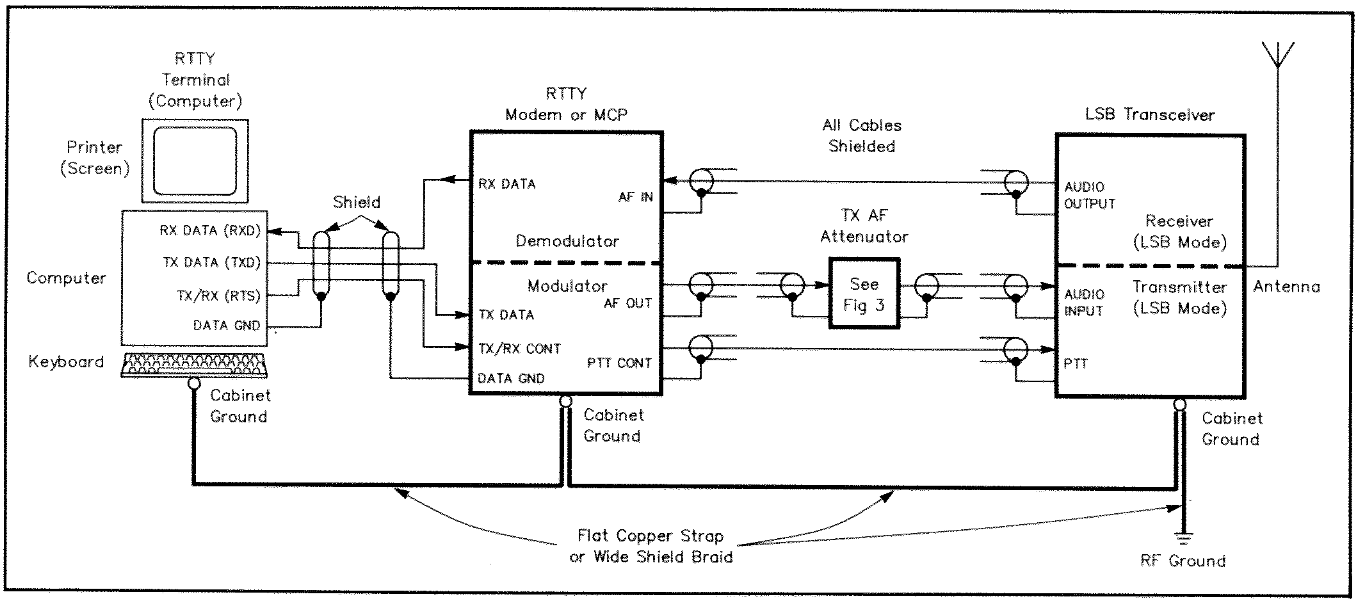

Fig 2—Computer, modem/MCP and transceiver configuration for AFSK RTTY on lower sideband.

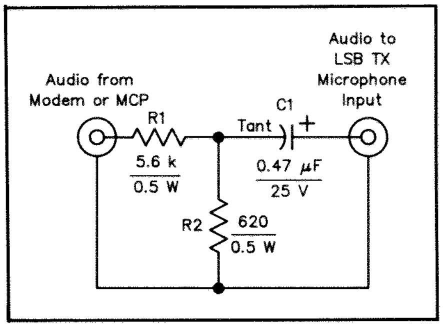

Fig 3—An audio attenuator for AFSK RTTY operating.

RTTY Standards

Here's a quick summary of the basic operating standards that most RTTY enthusiasts follow. You can usually implement these standards through your terminal software.

Tone frequencies: mark = 2125 Hz; space = 2295 Hz; shift = 170 Hz.

Polarity: Normal (mark = 2125 Hz; using AFSK or FSK mode).

Code and Speed: Baudot, 45 baud (60 WPM).

End-Of-Line (EOL) Designator: CR LF LTRS (CR LF for MARS).

Line Length: 72 Characters (69 for MARS).

Transmit Delay: 1-2 seconds (if available).

Terminal Mode: "ASR" (split-screen)

Other parameters can be set as well. In most cases, the default settings of your RTTY modem or multimode communications processor should be adequate.

Although most amateur equipment is designed primarily for voice transmissions, we rarely get 600-ohm, 0-dBm audio input (or receiver output) for RTTY.

Microphone inputs usually require 30 to 70 mV RMS (−20 to −30 dBm) for full RF output. This is 20 to 30 dB below the 0-dBm level. If you look at Fig 2, you'll notice an optional TX AF attenuator between the RTTY modem/MCP and the transceiver. The actual schematic is shown in Fig 3. The attenuator provides a 20-dB signal reduction between the RTTY modem or MCP output and the microphone input. If you experience difficulty matching your RTTY modem or MCP to your rig, this attenuator may provide the cure.

Make sure the attenuator is well-shielded (an aluminum minibox is ideal). Also, run shielded cables to and from the box. Place the attenuator close to the transmitter. Set the modem or MCP output level about ⅓ below its maximum setting and perform transmitter power adjustments using the rig's mike-gain control. If you experience RFI, try adding 0.001 µF disc-ceramic capacitors between the center pins of the attenuator connectors and ground.

C1 in the attenuator may not be required with some equipment. An increasing number of transmitters place dc on the audio input terminal for powering an electret-capacitor microphone, microphone preamplifier or other active devices. C1 blocks dc, but passes the audio signal.

Setting up for FSK Operation

As mentioned earlier, many modern transceivers provide an FSK mode. Most radios with variable selectivity and/or narrow filters (intended primarily for CW) let you use these features in the FSK mode. In contrast, many rigs with such features—but without FSK—*don't* provide these capabilities in SSB modes.

Some amateurs assume that using the FSK mode creates a *purer* RTTY transmission. This is doubtful. Yes, you can overdrive the transmitter in AFSK and produce an assortment of unwanted signals. When used properly, however, there is *no fundamental difference* between the RF output of either mode.

It's easy to set up for FSK operation (see Fig 4):

- Switch your rig to the FSK mode.
- Connect the your RTTY modem or MCP **TX Data** leads to the **FSK IN** or **RTTY IN** terminals. Use a rear panel connection if one is available.
- Connect the modem/MCP **PTT** output to your transceiver's PTT terminals. Once again, a rear-panel connection is highly desirable.
- Connect the modem/MCP **RX Audio** leads to the rig's phone-patch output or speaker terminals. Again, try to use a rear-panel connection that is *not* interrupted when you plug in the headphones.

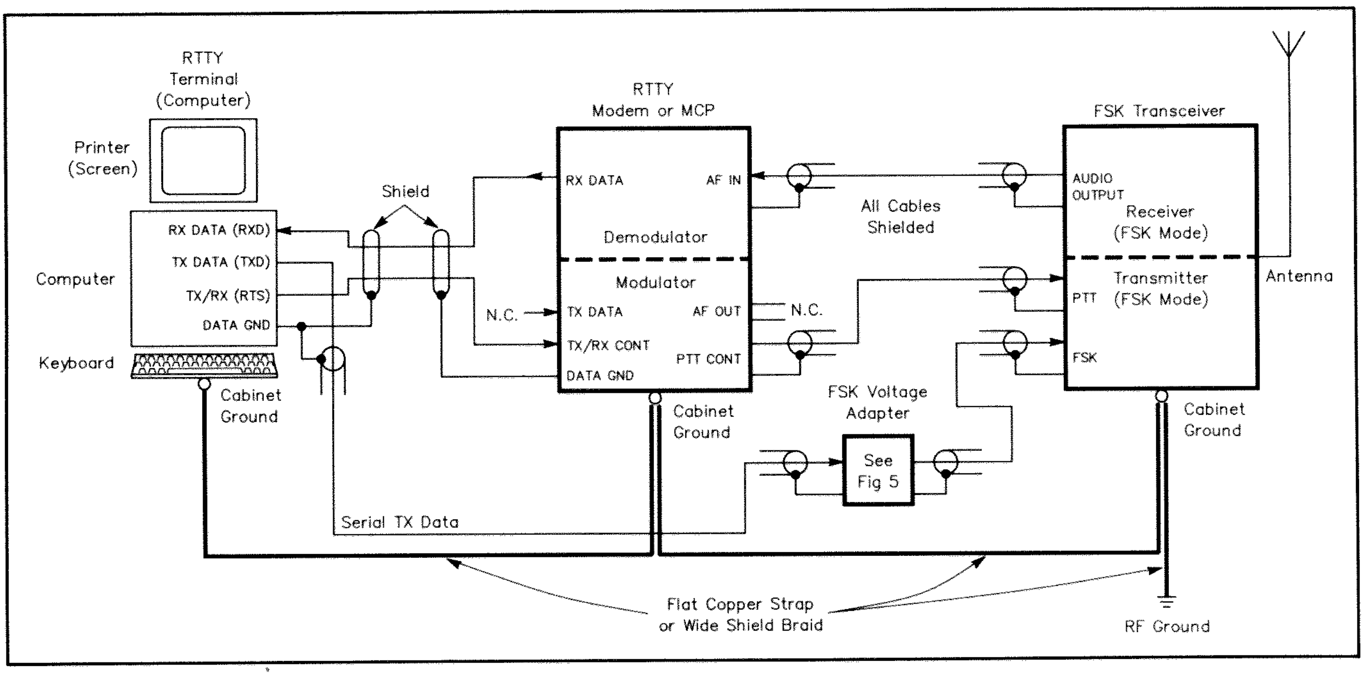

Fig 4—A typical RTTY set up for FSK operation.

The FSK Voltage/Polarity Problem

If wires and cables were all we had to worry about, FSK operating would be a snap! It may surprise you to know, however, that transceiver manufacturers have *not* established standards for FSK input polarities and voltage levels. Each rig has its own requirements, and it can be difficult to get your RTTY modem or MCP to produce the necessary signals.

All is not lost, though. Take a look at the FSK voltage adapters shown in Fig 5. Like our attenuator, these are optional. With any luck, you may not need them—especially if you own a Ten-Tec Corsair, Paragon, or Omni-V; a Kenwood TS-440S or any other rig that is fully EIA-232-D (also known as RS-232-C) compatible.

Adapter A is suitable for rigs that demand reverse-polarity RS-232-C and TTL levels. Adapter B is used with transceivers that require standard RS-232-C polarity and TTL (0 or +5 V) voltage levels.

I must caution that Fig 4 illustrates typical connections between a computer, RTTY modem and transceiver for FSK operation. This diagram assumes that you are using a standard RTTY demodulator (HAL ST-6, ST-5000, ST-6000, etc) and *not* a multimode communications processor (MCP). Many of the multimode devices include their own TTL or RS-232-C data outputs that may be somewhat more flexible when used to drive your transceiver's FSK input. Read your MCP manual carefully before trying your hand at FSK.

If you're using a HAL PCI-3000 RTTY/AMTOR modem, a separate FSK output is included and circuit board jumpers are provided to set the voltage polarity and level. See Tables APC.1 and APC.2 (page A-14) in the *PCI-3000 Reference Manual.*

Frequency Displays Never Lie—Do They?

The amateur standard for specifying a RTTY frequency is to specify the frequency of the mark signal. While this is a logical approach, the mark frequency can be *different* from what your rig's fancy multi-digit display tells you it is![3]

If you're using your transceiver in the LSB mode, your digital display indicates the *suppressed carrier frequency*. In most cases you can subtract 2125 kHz to determine your mark frequency. On the other hand, if you're in the FSK mode, you'll discover that calculating the exact frequency is *not* a matter of simple subtraction! It all depends on what rig you're using.

Some radios (ICOM and Ten-Tec units, for example) show the mark frequency. Others indicate the space frequency (TS-930S and TS-940S in particular). Others show the *suppressed carrier frequency* (just like LSB operation). And still others show f_0—the imaginary center frequency between mark and space. (MARS stations specify f_0.) If in doubt, read your manuals.

It's also important to note that digital frequency displays are *not* frequency meters! Usually, three or four oscillator stages, in addition to the VFO, determine the rig's output frequency. If a frequency error occurs anywhere other than the VFO, it may *not* be evident in the display. Your display reading can easily be several hundred or even a few thousand hertz off! Buying the "high stability option" (if available) will improve the frequency stability of your transceiver, but it usually won't correct your display calibration. (WWV has been "off-frequency" on my radio for years!) If you really want to know your exact RTTY frequency, buy a frequency counter, attach a short wire antenna and measure your mark signal frequency while sending continuous mark pulses. This technique works on *all* radios.

It's important to know your operating frequency for two reasons:

- To maintain your signal within the legal band limits according to your license class.
- To set your transceiver to the correct frequency for bulletin boards or autostart operation.

Receiving RTTY

Before you even touch your power switch, read your modem/MCP and terminal software manuals thoroughly. Make sure you understand the control keys that govern transmission, reception and special program features. Some programs offer a huge variety of features that can easily overwhelm a beginner. A little light reading pays off in the long run!

When you're ready, turn on your computer and load your terminal software. Switch your transceiver to LSB or FSK—whichever mode you've decided to use. Set the modem or MCP data polarity to **NORMAL** and the shift to 170 Hz at 45 baud. Most RTTY modems and MCPs default to the receive mode when you turn them on. If not, switch to **RECEIVE** now.

Tune slowly through the RTTY subbands and search for signals. As soon as you find one, stop and eavesdrop for a while. It's always a thrill to listen to the pulsating tones and watch them become *words* on your monitor screen! Tuning and listening will give you valuable practice in proper RTTY receiving techniques. I suggest trying 14.080 to 14.100 MHz. You'll also want to check 3.60-3.65, 7.05-7.10, 21.075-21.100 and 28.075-28.125 MHz.

Be patient when using your modem or MCP tuning indicator. Keep practicing until you understand what it's trying to tell you. Every tuning indicator is a bit different, but it all boils down to knowing when you have the mark and space tones perfectly centered. Take some time to experiment with various filters and passband settings, if possible. A 500-Hz filter is ideal, but it's not essential for normal RTTY reception. I prefer to hunt for contacts using the wider SSB filter and then switch to a 500-Hz filter if I encounter interference.

It Sounds Like RTTY, But...

As you're searching for RTTY signals, you may discover a few oddballs. Your tuning indicator will tell you that everything is as it should be, but you're seeing gibberish on your screen—or nothing at all.

As I've said before, 45 baud/170 Hz shift is the most common amateur RTTY mode, but that doesn't mean everyone uses it. If you can't print the signal, try changing the shift or speed setting. Also check to see if the signal is *inverted* (mark and space fre-

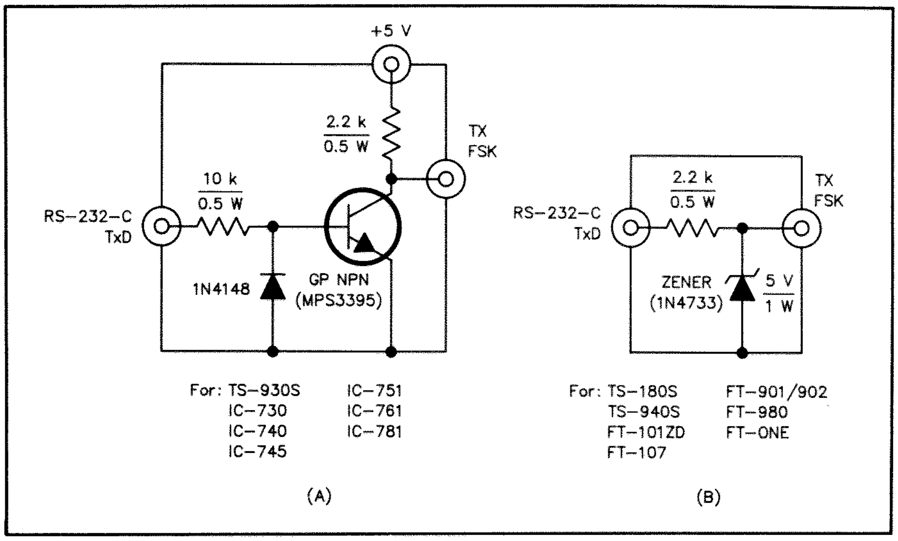

Fig 5—Voltage and polarity adapters for FSK RTTY operation. Adapter (A) is designed for rigs requiring reverse polarity RS-232-C and TTL levels. Adapter (B) provides standard RS-232-C polarity and TTL levels. Recommended transceiver models are shown below each adapter diagram.

quencies reversed).

There's also the possibility that you've picked up an AMTOR Mode B FEC signal. You probably thought AMTOR signals only made that funny *chirp-chirp* sound, didn't you? Well, they do—most of the time. When an AMTOR station is calling CQ, however, the transmission is sent in Mode B so that any AMTOR station can copy the text. Mode B signals sound like very rapid RTTY and often confuse first-time operators. If your RTTY modem or MCP has AMTOR capability, switch to the *listen* mode and you should be able to copy the CQ message.

Transmitting RTTY

If you're comfortable receiving RTTY signals, it's time to adjust your transceiver in preparation for your first RTTY QSO. Connect your transceiver to a dummy antenna and set your output power to minimum. Type several lines of text and then place the RTTY modem or MCP in the transmit mode.

While watching your RF power meter, slowly increase output until it is *half* of your maximum CW or phone output. If you're using FSK, increase your output to the maximum level recommended in your manual for FSK operation. Note this setting as your *maximum* RTTY power setting.

As you're transmitting, use a second receiver (without an antenna) to monitor your signal. Tune above and below your RTTY frequency by at least 20 kHz, listening for "extra" (spurious) signals and distorted modulation. It often helps to have another nearby station listen to your signal, too. If you hear spurious signals or distortion, all is not well! Try decreasing transmitter power to alleviate the problem. If you're using AFSK, check the input signal to make sure you're not overdriving the transmitter. A hum or buzz on your transmitted signal is almost always caused by poor shielding and/or grounding.

A Word about Power

A few comments are in order concerning RTTY output power. I have suggested that you adjust your transmitter for an output power level that is *half* of what you might normally use. This is admittedly conservative. On most modern transceivers, it means that your "normal" RTTY output will be about 50 watts—when you could get 100 watts or more if you ran "full bore."

It's important to remember that RTTY is a 100%-duty-cycle mode—meaning that the transmitter is keyed *continuously* during each transmission. In contrast, CW typically has a 50% duty cycle; SSB is even less. In other words, 50 watts during a RTTY transmission produces at least as much heat as 100 watts of phone or CW. You know what prolonged, excessive heat does to electronic components. Since transmitter parts are expensive, why risk them?[4]

Keep output power in perspective: 50 watts is only 3 dB less than 100 watts. That's *half* an S-unit on the other guy's receiver. Bear in mind that transmitters generally exhibit more distortion at full power, too. On voice, the result is splatter. On AFSK RTTY, the result can be spurious signals that could earn you a citation from the FCC! By running higher power you also increase the risk of interference to your digital equipment. If you're having computer problems at 50 watts, imagine what might happen at 100 watts!

If you believe that you need more than 50 watts to communicate, it's best to consider using a linear amplifier and running it well below full output. In RTTY service, the amplifier rule of thumb is: "The bigger and heavier, the better!"

RTTY on the Air

After all of the reading, wiring and adjustments, we've finally reached the moment of truth. It's time for your first RTTY QSO!

The easiest approach is to tune around and find another station calling CQ. Make note of his call as soon as you copy it. When he signs K, it's your chance to answer. Keep the call short. Assuming that I (K9GWT) am answering W6IWO, I prefer this format:

[switch your modem or MCP to transmit]
[send a blank line]
W6IWO W6IWO W6IWO DE K9GWT
K9GWT K9GWT W6IWO DE K9GWT
K9GWT K9GWT IN URBANA, IL K
[send another blank line]
[switch back to receive]

Note the blank lines above. The first blank line assures that the other station's equipment prints your response on a new line on the screen or printer. The second blank line gives you the same advantage when you receive his response.

If the station doesn't answer, try again two or three times. It's *much* better to make several short calls than to make one long call. If you want to call CQ yourself, try this format:

[switch your modem or MCP to transmit]
[send a blank line]
CQ CQ CQ DE K9GWT K9GWT K9GWT
CQ CQ CQ DE K9GWT K9GWT K9GWT
CQ CQ CQ DE K9GWT K9GWT K9GWT,
BILL IN URBANA IL K
[send a blank line]
[switch back to receive]

Whatever you do, avoid the temptation to start your CQ with "RYRYRY..." or, worse, "THE QUICK BROWN FOX..." messages. Such preambles were helpful to operators 30 or 40 years ago, but they are frowned upon today. Yes, you'll see other operators sending RYs without end, but imitating their bad habits won't win you any friends. Also, your RTTY modem or MCP probably has the ability to send date/time messages automatically along with your text. These date/time groups may be required for MARS and other traffic handling operations, but there's no point in sending them on initial calls.

To improve your chances of getting an answer to your CQs, stick to a quick, clean transmission. Don't resort to fancy or cute CQs. They may look neat on your screen, but most of us lose patience with fancy formats and keep tuning for someone who'll keep calls short and to the point. The most important part of any RTTY transmission is *your call sign*. Send enough CQs so that it's clear what you're after, then send your call several times. After all, no one can answer you if they don't know who you are.

Assuming that you've established communications with another RTTY ham, the rest is quite simple. RTTY is by nature a *simplex* or *half-duplex* mode. That is, you and the other station take turns transmitting. For those of us who are not good typists (me in particular), this gives us a chance to get a running start on our next transmission while the other fellow is sending.

How can we do this? Through the magic of software! Virtually all modern terminal programs include a split-screen transmit and receiver buffer (storage) option—frequently called "ASR mode" in honor of tape systems we used on the old Model 19 and 28 Teletype machines. (See the sidebar, "An *RTTY-Speak* Glossary.")

When you've finished your first transmission and the other station starts sending to you, disable the transmit buffer output and start typing your reply. Begin by inserting a blank line and call sign exchange (W6IWO DE K9GWT). Use **ENTER** or **RETURN** to start another new line and begin typing your comments or answers as you read the other station's text. Also, look at the screen and fix those annoying typos that always seem to appear.

When the other station finishes his transmission, switch your station to transmit and your computer will start sending the text you've already typed. Until the buffer empties its contents and catches up to your *real-time* typing, all text is transmitted at full "machine speed." As far as the other station is concerned, your transmission looks like the fast, smooth output of a newsroom wire service or a W1AW bulletin! With practice, you'll soon reach the point where your entire response is pretyped. Your transmission will look great on the other guy's screen and you'll waste little time sending the information. That's the relaxing part of RTTY. Just sit back and watch your computer send your reply for you!

Identification

The FCC rules say we must identify our stations at least once every 10 minutes during a QSO. I prefer to ID more often and

An *RTTY-Speak* Glossary

AFSK: Audio frequency-shift keying. The modulation method used for VHF RTTY operation on AM and FM radios. Also used to refer to the practice of applying audio tones to the input of an HF SSB transmitter to produce an FSK RTTY signal (see *Indirect FSK*).

ALC: Automatic level control (or automatic load control). A feed-back voltage in the transmitter's output amplifier used to prevent amplifier overload.

AMTOR: Amateur teleprinting over radio. An error-correcting form of RTTY.

ASCII: American national standard code for information interchange. The standard 8-bit code used for computer-to-computer communications. Also used for HF RTTY.

ASR: Automatic send-receive. An RTTY terminal mode that allows the operator to compose a response while receiving text from the other station. ASR was originally used by the Teletype Corporation to denote mechanical machines in which paper tape could be punched while receiving. Modern usage applies to split-screen CRT terminals and computer terminal software with separate transmit and receive character buffers.

Asynchronous: A data format that includes start and stop bits, permitting the receiving printer or terminal to maintain synchronization with each character received.

Baud: A measure of the data rate (or speed) of a RTTY signal.

Baudot: The standard 5-bit teletype code used for HF RTTY.

Bit: The shortest data pulse used to make a RTTY character. The Baudot code uses 5 data bits. ASCII code uses 8 bits (7 data plus one parity bit).

Code: Baudot is the standard HF RTTY code. ASCII may also be used.

CR: Carriage return. The control character that places the print carriage or screen cursor at the beginning of a line.

Demodulator: The portion of a modem or MCP that converts received RTTY tones into mark or space data pulses.

EOL: End-of-line control-character sequence. For Baudot code, the amateur standard is to send CR, LF, and LTRS in sequence at the end of each transmitted text line (MARS uses CR LF, no LTRS). The ASCII EOL is CR LF for HF use and CR only for computer-to-computer communications.

FIGS: A Baudot control character that signals the printer to shift to the FIGureS case.

FSK: Frequency-shift keying. Modulating the transmitter by using the RTTY data signal to shift the carrier frequency.

HDX: Half-duplex. A communications system in which stations take turns transmitting and receiving.

Indirect FSK: The practice of using audio tones to drive the input of an HF SSB transmitter to produce an FSK RTTY signal output (sometimes referred to as AFSK).

KSR: Keyboard send-receive. A RTTY terminal mode in which the operator may either type characters to be sent or receive characters from another station. KSR was originally used by Teletype Corporation to distinguish between simple teletype machines and those including Automatic Send-Receive paper tape equipment (see ASR).

LF: Line feed. The control character that advances the paper or screen cursor position to the next text line.

LSB: Lower sideband. The mode used for most amateur RTTY transmissions.

LTRS: A Baudot control character that signals printer to shift to the letters case.

Mark: The ON or "resting" pulse state of a RTTY data signal. Also the "1" digital logic state.

Mark frequency: The RF or audio frequency corresponding to the mark data signal. 2125 Hz is the standard audio RTTY mark frequency.

MCP: Multimode communications processor. A modem device that includes digital processing to decode and process RTTY and other data modes. Also known as a multimode data controller.

Modem: A *MO*dulator-*DEM*odulator device that translates digital RTTY data pulses to and from audio tone frequencies.

Modulator: That portion of a MODEM that converts RTTY data pulses into mark or space audio tone frequencies for transmission.

PTT: Push-to-talk. The transmit/receive control line of a transceiver or separate transmitter and receiver system.

Polarity: The order of RTTY data pulses and tones. The RTTY standard is mark = 2125 Hz, space = 2295 Hz; RS-232-C data mark = −V, space = +V.

RATT: A nickname for radio teletype

RS-232-C: A data voltage and load protocol used by most computer devices for data pulses. An RS-232-C mark pulse has a negative voltage between −3 and −25 volts. A space pulse is positive between +3 and +25 volts.

RTTY: Radio teletype. Often pronounced "ritty."

RTTY delay: The delay between the moment a transmitter is keyed and the actual transmission of RTTY data. Also, the delay between the end of a RTTY transmission and the return to a receive-ready state. An adequate time delay prevents data loss that might occur if transmit/receive switching is slow. Recommended delay times for HF radios are 1 to 2 seconds.

RX data: Received RTTY data pulses from the demodulator.

Shift: The frequency difference between the mark and space pulses. The standard RTTY shift is 170 Hz.

Space: The off or "open-loop" pulse state of a RTTY data signal. Also known as the "0" digital logic state.

Space frequency: The RF or audio tone frequency corresponding to the space data signal. 2295 Hz is the standard audio RTTY space frequency.

Speed: 45 bauds is standard RTTY data rate (speed = 60 WPM). 50 bauds (66 WPM), 57 bauds (75 WPM), and 75 bauds (100 WPM) may also be used with Baudot code. 110 baud is the common data rate for HF ASCII RTTY.

Split-frequency: Using a different frequency for transmitting and receiving.

Start bit: The first bit sent in an asynchronous data transmission. The START bit is always a space with a time duration equal to one data bit. HF Baudot RTTY always uses one start bit.

Stop bit: The last data bit sent in an asynchronous data transmission. The stop bit is always a mark pulse. In Baudot, the stop bit may be 1.41, 1.5, or 2 times the length of a data bit. In HF ASCII, the stop bit is two times the length of a data bit. At ASCII data rates greater than 110 baud, the stop bit is generally the same length as the data bit.

Synchronous: A data format that does *not* include start and stop bits. Receiving devices are synchronized by special sequences of data bits at the beginning of each transmission. HF RTTY does not use synchronous data, but AMTOR and packet do.

TX data: Transmit RTTY data pulses from the RTTY terminal or computer (TxD).

identify *both* stations when I do. My preference is to identify at the start and end of each transmission. For example:

W6IWO DE K9GWT

A "one-by-one" ID is sufficient. Once again, turn off your automatic date/time generator. Most RTTY operators don't care what time your computer may think it is! If you make a 1- or 2-line short-break transmission, one ID at the start or end is enough. RTTY operators are a close-knit, fun group. There are often a lot of us listening in. If we see a familiar call sign, or a topic about which we want to comment, we will often break in and turn the QSO into a 3-way, 4-way and so on.

Speaking of break-in, it works very well in modern RTTY. For this reason, "drag your feet" a few seconds after the other station's transmitter stops transmitting to see if you have any breakers. It becomes an automatic reflex after a while.

Contest Techniques

RTTY contests are loads of fun. That's when all the RTTY DX stations come out of the woodwork! On a good contest weekend, you can earn your RTTY DXCC if you stay at it. During a contest, you'll hear many short CQs as you tune up and down the band. A DX station usually stays near the same frequency, quickly making one contact after another. If you don't copy his call sign the first time, *don't* get on the air and send "QRZ DE K9GWT." Instead, *listen*—the station will eventually send CQ again, or will identify itself as it answers another call.

When you do call a DX station, *keep your call short*. As I mentioned earlier, a one-line call is enough. In fact, you may want to modify that approach to two repeats of his call and *four* of yours. He knows his own call, but he *doesn't* know yours!

A DX station is often called by many RTTY stations—a true RTTY pileup! Under these conditions it can take a long time for the DX station to tune through the signals and find one he can copy. Be patient! If it's a country you need for DXCC or a new multiplier—and you don't snag him after three or four calls—note his frequency and tune around. You can often work several more stations on other frequencies and return to him later.

RTTY demodulators *cannot* sort out multiple signals when they are all sending on the same frequency. In extreme cases, only the strongest first and last stations calling have a chance to be recognized—and this is the first or last strong station *at the DX QTH*. He is no doubt hearing a completely different set of signals than you are!

An SSB contest practice finally being adopted by RTTY enthusiasts is split-frequency operation. In this case, a DX station will often call CQ, including a note saying "LISTENING UP 5-10" or just "U 5-10." This means that he is listening for replies at frequencies 5 to 10 kHz higher than his transmit frequency. Obey his instructions. If you attempt to call him on his transmitting frequency, you'll only make yourself highly unpopular. Rather, you need to place your transceiver in the split-frequency mode so that your transmit frequency is, in this case, 5 to 10 kHz higher than your receive frequency.

When you finally get that cherished call from the DX station you've been hunting, be considerate and avoid starting a long-winded QSO. After all, this is a contest! Since speed is essential, it's hardly the time to send lengthy descriptions of your station equipment, or a long print-out of a RTTY QSL card!

Next Month

AMTOR is a relative newcomer to Amateur Radio, but the proliferation of inexpensive personal computers has made it one of the fastest growing HF digital-communications modes. In Part 4 of this series we'll explore the mysteries of AMTOR.

Notes

[1]Multimode communications processors, or MCPs, are also commonly known as multimode data controllers.

[2]Some multimode devices use a 200 Hz shift for RTTY operation (mark = 2110 Hz, space = 2310 Hz). These tones are used for HF packet radio as well. To some extent they are compatible with standard 170-Hz shift tones (2125/2295 Hz) since the center frequency (2210 Hz) is the same. However, in weak signal conditions, using a 200-Hz shift places you at a disadvantage. Both you and the other station (possibly using 170-Hz shift) must resort to *straddle tuning* to achieve true transceive operation. This is tricky at best and often results in less than optimum performance. Operators who are truly serious about obtaining optimum RTTY performance retune their MCP receive filters and transmitter tones to match the 2125/2295 Hz standard. While this technique offers a noticeable improvement, you should *not* attempt the adjustment unless you are thoroughly familiar with your MCP and possess all the necessary test equipment. A botched realignment will probably void your MCP warranty.

[3]D. Newkirk, "What Your Frequency Display Really Tells You," *QST*, Aug 1991, pp 28-32 (Part 1) and Sep 1991, pp 26-31 (Part 2).

[4]If you are using a transmitter with tubes in the final amplifier stages, *never* exceed half of your rig's maximum power. Replacement tubes are sometimes hard to find. At the very least, consider installing a fan to cool the tubes.

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