

D-STAR Quick-Start Guide

by [Rob Locher W7GH](#)

The goal of this document is to give the reader just enough information to get started operating a D-STAR-capable Icom radio on a local internet-connected D-STAR repeater. After reading this document the reader should read other articles, books, and web pages to learn the finer points.

Welcome

So you just bought a fancy new radio that happens to have D-STAR, and you want to check out this new digital mode. Great! D-STAR is a lot of fun. In my opinion, the best thing about D-STAR is how easily a D-STAR repeater can be linked to other repeaters over the internet. On most D-STAR repeaters an ordinary user can link to another repeater, or to a "reflector" that has many other repeaters linked to it already. No matter how many repeaters are linked, there is no delay to key the other repeaters, no need to key up for a second or two before speaking. Hams on other linked repeaters sound just as good as hams using the local repeater.

D-STAR is taking off around the world, and I find it to be quite a thrill to chat with a ham in São Paulo, Melbourne, Yorkshire, or Stockholm while I'm driving around town. Thanks to the digital nature of D-STAR, the sound quality of a typical signal is excellent, at least until the other ham gets close to the edge of his or her repeater's coverage area, when the signal starts to sound like digital beeps and boops, which are often called "R2-D2" after the noises made by the robot in Star Wars.

First Steps

Before you're allowed on the D-STAR system, your call sign must be registered. The intent of this requirement isn't quite clear, but my guess is that it's meant to keep "riff-raff" out of the system. (If so, this policy is already obsolete; many dealers are happy to register the call sign of any customer who buys a D-STAR radio, no questions asked.) Until you're registered you'll only be able to talk on your local D-STAR repeater; your signal won't be transmitted to any linked repeater. Your local D-STAR repeater might have a web page where you can request to be registered, but generally the best method is to find the person who maintains the local D-STAR repeater, and ask nicely to be registered. You must only be registered by the operator of a single repeater, so don't ask more than one person to register you.

It's possible to set up your radio for D-STAR and program your radio's memory channels using the front panel controls and the microphone, but that procedure is very complicated. I don't recommend that you program your radio manually except in an emergency, and this document won't tell you how. I highly recommend that you program your radio with a computer instead. Icom has released free software for the IC-80AD and ID-880H, which I've used successfully. If you have a different radio model then you'll need to track down software that works with your radio. As far as I know, Icom has released free software for all their D-STAR radio models. [CHIRP](#) by Dan Smith KK7DS works with most or all of the D-STAR capable radios (and also just about any other VHF/UHF radio you can think of), is free, and works on nearly every OS. [RT Systems](#) sells software and cables that are easy to use, but are pricey, and only work on Windows.

In addition to software, you'll also need a USB-to-RS232 converter cable, unless your computer has a serial port. You'll also need the programming cable that came with your radio. You'll want to be sure that your USB adapter has a chip made by FTDI or Prolific. There are inexpensive cables with "clones" of Prolific chips that are difficult to get to work, thanks to driver difficulties. If this sounds like too much hassle and you don't mind spending more money, you can always buy the RT Systems software and cable for your radio, which generally "just works".

D-STAR Nuts and Bolts

Every Icom D-STAR radio also works great as an analog FM radio. I recommend that you learn how to use the radio, and your programming software, with FM repeaters before you mess with D-STAR; that way you won't have to learn everything at once.

To transmit in D-STAR and have other people hear you, you'll need to set four parameters: MYCALL, URCALL, RPT1, and RPT2. Of course you'll also need to set the mode ("DV") and frequency, and if you're trying to talk through a repeater, the offset. At least there are no PL tones to worry about. (If you just want to receive for now, you can ignore MYCALL, URCALL, RPT1 and RPT2.)

- MYCALL is your own call sign, eight characters maximum. You're allowed to add "/" and then other characters; I think the original intent was so that you could sign "/P", "/M", or "/7", but for D-STAR some people get creative, like "/BOB" for someone named Bob, or "/92" for someone using an IC-92AD.
- URCALL can hold routing information or linking commands; to just use the local repeater, URCALL should be set to "CQCQCQ".
- RPT1 should be set to the local repeater and module that you're trying to access. (The setting doesn't matter for simplex.) See below for what I mean by a module.
- RPT2 designates where you want your signal to be routed on your local repeater; normally RPT2 is set to the call sign of the local repeater, followed by "<space>G". (The setting doesn't matter for simplex.)

Don't get too excited about exactly what URCALL, RPT1, and RPT2 are for, because there is a simple web tool you can use that will tell you what to enter: [the D-STAR Calculator](#). Just tell the calculator what you want to do, and it will tell you what to put in MYCALL, URCALL, RPT1 and RPT2. When using the calculator only change one thing at a time, and each time you change something the page will take several seconds to reload; be patient. Hints: always select "Local Repeater with Gateway" rather than "Local Repeater"; have a look at the Calculator's help page.

The "module", "port", or "node" (all three words mean the same thing) of a D-STAR repeater refers to the band. Icom makes modules for 2m (144 MHz), 70cm (440 MHz), and 25cm (1.2 GHz), and a repeater can have nodes for more than one band; some D-STAR repeaters have modules for all three bands. By the way, the "A" port or module is on 1.2 GHz, the "B" port is for 70cm, and the "C" port is for 2m. So if you set RPT1 for "KE7LKX B", that would be the 70cm module / port / node of repeater KE7LKX. (In the RPT2 setting "G" is often used, e.g. "KE7LKX G". In this case "G" doesn't refer to a module, but rather the gateway, which is a computer that connects the repeater to the internet.)

Call Sign Routing

Connecting the local repeater to another repeater or repeaters over the internet is extremely popular with D-STAR users. There are two different ways to do so. In the beginning, there was Call sign routing, and it was good. With call sign routing, you configure URCALL, RPT1, and RPT2 to route your transmissions to another repeater and node. You can either specify the specific repeater and node, or you can route your transmissions to the repeater and node that a specific ham last used.

With call sign routing, there is no permanent link established; your local repeater simply routes your transmissions over the internet to another repeater and node according to your instructions. If a ham using the other repeater node wants to talk back to you, she must set up her radio to route her transmissions to your repeater and node. Some examples follow.

Using the local repeater (no routing)

W7GH just wants to talk to other local hams using his local repeater KE7LKX, which is on 70 cm (node B).

MYCALL: W7GH
URCALL: CQCQCQ
RPT1: KE7LKX B
RPT2: KE7LKX G

Call sign routing to a specific repeater and node

W7GH is using his local repeater KE7LKX (the B module on 70 cm), and he wants to route his transmissions to the B module of the JP1YDS repeater near Katori, Japan.

MYCALL: W7GH
URCALL: /JP1YDSB
RPT1: KE7LKX B
RPT2: KE7LKX G

If someone is already transmitting on the JP1YDS repeater node B when W7GH starts transmitting, then W7GH's transmission will be blocked on the remote repeater, and W7GH's radio will display "RPT?KE7LKX" to notify him that his transmission didn't go through.

Call sign routing to the repeater and node last used by a specific ham

W7GH is on his local repeater KE7LKX, and his buddy K7BBS is on vacation; W7GH wants to route his transmissions to whatever repeater his buddy K7BBS used most recently, in the hope of talking to his buddy.

MYCALL: W7GH
URCALL: K7BBS
RPT1: KE7LKX B
RPT2: KE7LKX G

In this example it might look as though W7GH is calling person-to-person, but it's actually *repeater-to-repeater*, and anyone listening to either repeater will hear the conversation.

When calling another repeater using call sign routing, one should announce what repeater and node one is calling from, for example "This is W7GH calling CQ from repeater KE7LKK, node B, in Grants Pass, Oregon, USA. CQ CQ CQ from W7GH on repeater KE7LKK node B, CQ." Saying the repeater and node you're calling from out loud allows people on the other repeater to set up their radios manually if they can't use their "RX->CS" buttons for some reason. (More on the "RX->CS" button later.) Be patient and wait at least a couple minutes, so that an operator on the other repeater can stop what he or she is doing and program the radio to route his or her transmissions to your repeater and node.

It's important to note that it's easy to cause unintentional interference with call sign routing, because you won't hear transmissions from people using the other repeater unless they set up their radios to talk to you. If you're routing your transmissions to another repeater, either to call CQ or to call a specific ham, you might be interrupting a QSO or a net, so keep your transmission short and don't call more than once or twice. But don't be afraid to do it, because meeting new people on the air is what ham radio is all about!

If you use call sign routing to talk to someone on another repeater, be sure to change URCALL back to "CQCQCQ" immediately after you've finished. If you forget, your transmissions for your next QSO with someone on the local repeater will be inadvertently routed to the other repeater you were routing to earlier!

By the way, when D-STAR users outside the US are looking for a QSO then they are more likely to call CQ, similar to the way it's done on SSB, rather than announce that they are "monitoring".

Every Icom D-STAR radio has an "RX->CS" button. The "RX->CS" button gives you an easy way to automatically set URCALL, RPT1, and RPT2 to route your transmissions to the repeater and node that the previous caller, or any one of the last several callers, called from. Read your radio's manual to discover exactly how to use "RX->CS".

DPlus Linking

Call sign transmission routing works well, but there are a couple disadvantages: there is no easy way to link more than two repeaters, and a caller routing his or her transmissions to another repeater has no idea whether the other repeater is busy or not. Along came a very clever fellow, Robin Cutshaw AA4RC, who invented very clever software called DPlus, which can be installed on the gateway computer that connects a D-STAR repeater to the internet. DPlus adds several functions, most importantly the ability to link a repeater to another repeater, or to a D-STAR reflector. With DPlus-style linking, a lasting link to another repeater or a reflector can be set up. Anything said on any linked repeater will automatically be routed to every other linked repeater, with no special radio configuration required.

A D-STAR reflector is a computer connected to the internet that runs special software. The nice thing about reflectors is that lots of repeaters can be connected to one reflector. For instance, reflector 14C "fourteen-charlie" is the popular reflector for D-STAR repeaters on the West Coast of the US and Canada; link your local repeater to reflector 14C, and half the D-STAR users from San Diego to Vancouver will hear you when you transmit. And then there is reflector 1C, the "D-STAR Mega Reflector", used world-wide. That one is really fun! There is a list of reflectors [here](#).

DPlus Linking to Another Repeater

W7GH wants to link his local repeater KE7LKK to the 70cm "B" module of repeater KE7MVI.

MYCALL: W7GH
URCALL: KE7MVIBL

RPT1: KE7LKX B
RPT2: KE7LKX G

After setting up the radio, the operator should key the microphone for about one second to transmit the command. If the command succeeds, the repeater will play a recording saying "remote system linked". After linking, the operator should immediately change URCALL back to CQCQCQ.

DPlus Linking to a Reflector

W7GH wants to link his local repeater to Reflector 14C, to which many other West Coast repeaters are already linked.

MYCALL: W7GH
URCALL: REF014CL
RPT1: KE7LKX B
RPT2: KE7LKX G

After setting up the radio, the operator should key the microphone for about one second to transmit the command. If the command succeeds, the repeater will play a recording saying "remote system linked". After linking, the operator should immediately change URCALL back to CQCQCQ.

Unlinking

W7GH wants to unlink his local repeater KE7LKX from the reflector or other repeater that it's currently linked to.

MYCALL: W7GH
URCALL: <space><space><space><space>
<space><space><space>U
RPT1: KE7LKX B
RPT2: KE7LKX G

After setting up the radio, the operator should key the microphone for about one second to transmit the command. If the command succeeds, the repeater will play a

recording saying "remote system unlinked". After unlinking, the operator should immediately change URCALL back to CQCQCQ.

Most D-STAR users outside Japan use DPlus linking rather than call sign routing. So why did I tell you about call sign routing? Well, I think every D-STAR radio owner should know how to use call sign routing, because that was the original intent of the designers of D-STAR. It works great, and knowing how to use it will allow you to talk to the thousands of D-STAR users who prefer connecting that way.

There are a couple other useful tools available to users of DPlus-equipped repeaters: echo testing and the information message. An echo test is a good way to find out how you sound on the local repeater; when you key up a few seconds of your audio are recorded, and then the recording is played back. The information message tells the linking status of the repeater. See the examples for more information.

Echo Test

W7GH wants to hear how he sounds on his local D-STAR repeater, KE7LKX.

MYCALL: W7GH
URCALL: KE7LKX E
RPT1: KE7LKX B
RPT2: KE7LKX G

After setting up the radio, W7GH keys up the radio and announces an echo test: "This is W7GH performing an echo test, hello test test test". The repeater records the audio and then plays it back. After an echo test, URCALL should be changed back to CQCQCQ.

Information Message

W7GH wants to discover whether his local repeater KE7LKX is currently linked.

MYCALL: W7GH
URCALL: KE7LKX I
RPT1: KE7LKX B
RPT2: KE7LKX G

After setting up the radio, W7GH keys up the radio for about one second (no need to speak into the microphone). If the repeater is linked, he will hear the message "remote system linked", and a text message should

scroll across the screen announcing what the repeater is linked to. After asking for the information message, URCALL should be changed back to CQCQCQ.

There's one other thing to mention, and that is that call sign routing and DPlus linking don't mix very well. I wonder what would happen if the local repeater were linked to a reflector, and then someone used call sign routing to route his transmissions to the local repeater and node. It's very possible that his transmissions would go out to the reflector, but he wouldn't be able to hear the traffic on the reflector. In other words, the calling ham could inadvertently interfere with possibly dozens of linked repeaters! So if anyone on a different repeater uses call sign routing to talk on your repeater when it's linked via DPlus to another repeater or a reflector, then you should immediately unlink the local repeater to avoid accidental interference to the linked repeater or reflector. Once you've unlinked you could reply to the caller using call sign routing.

DV Dongles, DVAPs, and Hotspots

Lots of hams get onto D-STAR without using a repeater. You'll hear people talking about their DV Dongles, DVAPs, and Hotspots a lot, so you might as well know what these things are. A [DV Dongle](#) is a little plastic box that plugs into a computer's USB port. The computer user can then connect to a repeater or reflector, talking through a headset plugged into the computer, without using a radio at all.

A [DVAP](#) plugs into the the computer like a DV Dongle, but has a small antenna. Instead of using a headset, the ham uses a D-STAR radio to talk to the DVAP using DV simplex. The range is very limited, but the ham can use his or her radio (and computer) to connect to a repeater or reflector without a D-STAR repeater in range.

A [D-STAR Hotspot](#) is like a homemade DVAP made using an FM radio with a data port, a GMSK adapter board, and a computer. The idea is that a hotspot costs less than a DVAP, yet has better range. It's even possible to upgrade the hotspot to a full-duplex non-Icom D-STAR repeater.

DV Dongles, DVAPs, and D-STAR Hotspots allow their users to link to repeaters or reflectors using DPlus linking, but not call sign routing. Call sign routing requires a D-STAR radio and a D-STAR repeater.

Programming Your Radio for D-STAR

You may have noticed that MYCALL, RPT1, and RPT2 never changed in the examples. MYCALL changes only when the operator changes, of course. RPT1 and RPT2 change when the local repeater changes. (All the examples used the same local repeater.) When you program a D-STAR repeater into a memory channel of your radio, the memory saves the frequency and offset of course, but also the mode (DV or FM), and for a D-STAR repeater, RPT1 and RPT2. Once a D-STAR repeater is saved to a memory channel, you can change D-STAR repeaters by turning a knob or pushing a button just like you can change FM repeaters, and RPT1 and RPT2 will be set for you along with the frequency and offset. D-STAR repeaters can be included in a channel scan just like FM repeaters.

The examples showed how URCALL is used. In call sign routing, URCALL holds routing information. In DPlus linking, URCALL holds either CQCQCQ or a command to be briefly transmitted. Once you have programmed repeaters into memory channels, typically only URCALL will be changed in ordinary day-to-day operating. In order to make things easier for the operator, D-STAR radios have several memory slots just for stored URCALLs.

When you're programming your radio with the computer software, in addition to setting up all the channel memories, you'll also want to set the D-STAR specific features. You can set the 20-character transmit message, the one that will scroll across other operators' radios when you transmit, and also the URCALL memories. Be sure to set the first URCALL memory to "CQCQCQ", because that's the one you'll use the most.

Once the repeater memory channels and the URCALL memory slots have been programmed, regular D-STAR operating is easy. For example, here's how I link my local repeater to reflector 14C using my ID-880H and then change URCALL back to CQCQCQ afterwards:

1. Long-press (one second) the "UR" button; display shows the current contents of URCALL (usually CQCQCQ)
2. Turn the big knob to scroll through the URCALL memory slots until the display shows "REF014CL"
3. Press the "UR" button to copy "REF014CL" to URCALL
4. Key the microphone for about one second to transmit the link command; repeater should play the message "remote system linked", and then establish the link to the reflector
5. Long-press the "UR" button again; display shows the current contents of URCALL
6. Turn the big knob until the display shows "CQCQCQ"
7. Press the "UR" button to copy "CQCQCQ" to URCALL

This might seem like many steps, but it soon becomes second nature. I can easily do this as I drive down a quiet road, only taking my eyes off the road for a second or two.

Practical Considerations

D-STAR radios include a DR mode, which seems to be another way to set up the radio to use various D-STAR repeaters saved in a special memory bank. I get the impression that it's most useful to people who talk to dozens and dozens of D-STAR repeaters. I've never used it, and I don't plan to.

Our local repeater seems to get kicked off a reflector very quickly when the repeater is idle. I'm not sure why that is, but one result is that almost every time I go to use the repeater, it's not linked. Most of the time this is only a minor annoyance.

Etiquette

If you'd like to link your local D-STAR repeater to a reflector, at a minimum check the info message to find out if the repeater is already linked. Then if the repeater isn't linked, change URCALL to CQCQCQ and announce your call sign and your intention on the repeater before linking, for example "This is W7GH linking to reflector fourteen charlie."

If you're in another town listening to someone else's D-STAR repeater and you'd like to link it, most people probably wouldn't mind, assuming the repeater is idle. But please be as polite as possible; if you can, ask a local operator what the linking policy is. At a minimum, ask on the repeater if anyone minds before linking. Urban D-STAR repeaters with many users probably have stricter policies than rural repeaters with fewer users.

More Information

Hopefully this is enough information to get you started. If you use D-STAR more than just occasionally, you should learn more. The best resource to learn how to use D-STAR is [The Nifty E-Z Guide to D-STAR Operation](#), by Bernie Lafreniere, N6FN. Bernie also publishes a "Nifty! Mini-Manual" for each of the Icom D-STAR radios; I have the one for the ID-880H, and it's better-organized, easier to read, and much sturdier than the official Icom manual.

Here are some links to useful and interesting web sites about D-STAR:

dstarusers.org

dstarinfo.com

Have fun!

73,
- Rob W7GH

Appendix: D-STAR Controversies

It seems that every time I bring up D-STAR with hams who don't already have a D-STAR radio, some controversy or other is brought up. In my opinion most of these controversies are way overblown, but I'll give my opinion on them anyway.

D-STAR isn't in the true spirit of ham radio because it uses the internet to go 99% of the way. Actually I agree with this statement somewhat; to get the most from ham radio, a ham should explore modes that don't involve internet linking. And everyone should keep in mind that a D-STAR radio won't be the best way to communicate out from the zone of a large-scale disaster, because if the internet is down, then a D-STAR repeater is just a stand-alone VHF or UHF repeater. But so what? It's fun to link repeaters over the internet, so I do it.

D-STAR isn't in the true spirit of ham radio because it uses a proprietary codec. Government and business users have been using digital voice on VHF and UHF for something like 20 years now. It was inevitable that digital voice on UHF and VHF would come to ham radio. Almost all digital voice modes for VHF and UHF use codecs made by a single company, Digital Voice Systems, Inc. An open-source codec called [codec2](#) is now available, but wasn't available when D-STAR was being created. (A different version of D-STAR could be created using codec2, but it wouldn't be compatible with the existing version of D-STAR using the AMBE codec made by DVSI.) Everything about D-STAR but the codec is an open standard. The inventors of D-STAR made it as open as possible with what was available at the time. If we insist on only open-source codecs for digital voice, then amateur radio will be forced to lag fifteen years or more behind the state of the art. Amateur radio built the first non-government spacecraft, the satellite [Oscar 1](#); do we now want to trade our traditional role at the forefront of technological advance in exchange for ideological purity of dubious usefulness?

D-STAR is elitist. It's true that D-STAR radios are much more expensive than otherwise-similar radios that only have FM. Most D-STAR radios use a hardware codec chip that is said to cost about \$20 or less. Therefore about \$20 or so of the extra price of a D-STAR radio over an FM radio can be explained by hardware. The rest of the increase is probably Icom recouping their research and development expenses, and taking profit. Once D-STAR becomes more widespread, other manufacturers will decide to make D-STAR radios, and the cost will come down. I suppose anything expensive attracts snobs, but personally I've never heard anybody on the air being snobby about D-STAR over FM.

The sound quality of D-STAR stinks. Personally I prefer the sound of a nice full-quieting FM signal over a D-STAR signal, but when the FM signal is getting weak and scratchy, the D-STAR signal sounds much better under the same conditions. Of course when conditions are truly bad, D-STAR has fallen off the "digital cliff", while the FM signal is still readable with difficulty. I'd say that if someone really doesn't like the sound of a D-STAR signal, it's probably personal preference at work.

