



*Simple Solutions for  
Serious Situations*

# AN INTRODUCTION TO HIGH POWERED REPEATERS

from



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## An Introduction to **HIGH POWERED REPEATERS**

We are often asked for information on high powered repeaters for VHF and UHF operation by amateur, commercial, and governmental users. As a general rule, we do not support the idea of using repeaters with over 50 watts of power, mainly for operational reasons as well as cost, not to mention issues with the FCC in requesting high powered stations (Motorola is limited to 10 watts on VHF at the time this material is being prepared. Additional information is available at: <http://falconinfo.blogspot.com/2012/02/mototrbo-vhf-systems-now-limited-to-10.html>). Still, there are applications where high power may be warranted. We are OK with this as long as the user has not been "sold" for reasons that are more of benefit to the seller than to the user.

For starters, let's address the real benefit of power. In radio communications, power has one function - to increase the audio level of the transmitter. Operating range is based on height above average terrain, receiver sensitivity, and power, in that order. In other words 200 watts at 20 feet above average terrain will not equal the range of 20 watts at 200 feet. There are other factors, such as bandwidth (at least as it applies to analog), selectivity (or the ability to reject adjacent channel interference), ambient noise (electrical interference at the site), and the gain or loss of antennas, duplexers or other filtering devices, but the big three are height, receiver sensitivity, and power.

In Europe, 5 watt repeaters are very common with 20 watts being considered high power for private radio systems. Our European friends take a more holistic approach to system planning (in general) than we do in the USA. They put their effort into reducing noise by using high noise rejection receivers, additional filtering where required and good site selection.

Now, having said that, let's deal only with the real difference applicable to increasing power. Without putting you through engineering theory, let us give you an example of a 50 watt VHF transmitter, using a 100 foot tower at a site that provides an average ground elevation of 200 feet above average terrain. We will assume the use of a popular base station antenna, the DB-224 which has a nominal gain of 6 dB (4X power) which provides an Effective Radiated Power that is determined by multiplying the input power (50 watts) less the coaxial line and duplexer loss of around 3 dB (2X power). In this example, our station would have an ERP of 100 watts (4X - 2X = 2X times 50 watts = 100 watts).

Operating range is calculated on talk-out range, which can vary depending on whether we are talking to another station (100 miles is common), a mobile about a quarter of that range (25 miles), a pager or a portable with about 4/5th the range of a mobile (20 miles). Output power from the station has nothing to do with the talk-back power of an associated mobile or portable which will normally be equal to that of the repeater (50 watts) or the portable being about 1/10th that of the portable (5 watts).

To explain the benefits of power, let's look at a typical situation where we have a talk-out range of 20/25 miles and a talk-back range of 15/25 miles for portables and mobiles. If we want to increase the talk-out power of our 50 watt station by increasing the power to 100 watts, here is what happens....

The talk-back range of portables and mobiles is REDUCED by approximately 10% due to additional filtering required by the duplexer to handle higher power. We can offset this to some degree by adding a pre-selector on the transmitter without incurring receiver loss. We can also add a pre-amplifier on the receiver to increase audio for incoming signals. Unfortunately, noise is amplified as well as the desired signal.

So, if we increase power, we have the potential of reducing talk-back range from portables and mobiles plus increasing cost for additional filtering, receiver amplification or both. Now the question is, *What is our net benefit in increasing the station power from 50 to 100 watts?*

One would think that doubling power would double range. Not so! Increasing power increases only audio. In other words, increased power might allow you to clearly hear a received signal better when listening to 100 watts than 50 watts. However the increase is not double. It is a WHOLE lot less.

To double audio received power requires SQUARING of transmitter power (i.e. to sound twice as good as 50 watts would require 625 watts of power, not 100). Your real increase in audio (i.e. usable range as determined primarily by antenna height above average terrain) would be LESS THAN 10%!

NOW you know why we are not big fans of high power base/repeater stations. That doesn't mean that 100 watt stations don't have their place. They do, but for most of us the benefit is almost incalculable! So, before moving on to our offerings for high power repeaters, we would like to share some information on our mid-power repeaters.

The information on our mid-power repeaters (45-50 watts) will provide some basic information on some of the choices available on the following page. In the meantime, we will return to our original subject of high power repeaters with the understanding that a high power repeater is simply a mid-power repeater with an additional amplifier, a bigger power supply to accommodate the additional amperage requirements for 100 watts or more, a larger duplexer to provide better isolation and less transmitter effect on the receiver, and maybe an optional cabinet housing.

There is one consideration that is common to both mid-power and high power stations and that is one of connecting to another repeater or network through a wired connection (commonly known as E&M Signaling). For years, we have used DC or tone remote controls for remote repeater control or 4 wire E&M signaling or other analog devices to connect or bridge to microwave networks. The advent of the IP address puts an end to all of this. We'll be talking more about this shortly. Now, let's learn more about mid-power repeaters.

# A Layman's Guide to Mid-Power Repeaters

If you haven't already seen our Blog introduction on repeaters, please visit <http://falconinfo.blogspot.com> and see our March 13, 2012 posting. This is a continuation of the subject first addressed in our Blog to provide a basic overview of the functions of a repeater with an introduction to basic repeater system components.

We now know that a repeater is essentially a duplex radio used to provide extended communications between mobiles and portables through a centralized "repeater". There are four basic types of repeaters commonly used in the USA. They are Analog only plus three different types of repeaters capable of operating in either or both analog and digital modes. The three different types of digital modes are fully explained at [www.info4u.us/Analog\\_Planner.pdf](http://www.info4u.us/Analog_Planner.pdf). This presentation deals with a digital technology generically known as NXDN and in particular the ICOM offerings of this technology under the IDAS name.



This is a 50 watt VHF analog/digital repeater. The ICOM Model number is UR-FR5000 in VHF or UR-FR6000 for UHF. You can learn more about it at <http://www.bestpriceradio.com>. Just type the word URNX (Like "Your Next" repeater) in the Search Block. This will bring up a listing of all models, both VHF and UHF in our family of repeaters. It can be used as a vehicular repeater by connecting to DC power and connecting to a pair of antennas. As a fixed repeater, it can be connected to an existing AC power supply antennas or duplexer as applicable or purchased in other configurations as listed below. See also [www.info4u.us/URNX.pdf](http://www.info4u.us/URNX.pdf).



This is the same repeater mounted in a cabinet that can be desk or 19" rack mounted. This cabinet contains a built in AC power supply and provisions for adding an optional internal duplexer and narrow band preselector. More information is provided on our store page referenced above. The internal duplexer option requires a minimum frequency spread of 3.5 MHz in VHF or 5.0 MHz in UHF. Otherwise, a larger external duplexer is required. The ICOM model number for this "repeater" is IC-CY5000 for VHF or IC-CY6000 for UHF.



The same UR Series repeater is also used in this console model repeater. Behind that LCD display and channel/option selector buttons on the right hand side is the UR-FR5000/6000 "repeater". What you get here is a cabinet that allows you to include an optional AC power supply, duplexer, or a second UR-FR5000 or UR-FR6000 repeater radio. When used with two antennas, this model allows you to change channels from the front panel. When using with a duplexer, channel changing generally is not recommended but this is useful for tactical applications using two antennas.

The basic "repeater" is \$969. The CY and FR models are \$1,495 each as shown above. All are covered by a 2 year factory warranty. A complete listing of accessories used with these repeaters is listed on our main store section for repeaters at [www.s287847904.e-shop.info/shop/catalog/search?shop\\_param=](http://www.s287847904.e-shop.info/shop/catalog/search?shop_param=) The standard ICOM model numbers are used with the prefix of URNX1, 2, etc. to accommodate our inventory control system. If you have any questions, or if we may be of service in any way please email [ServingU@falcondirect.com](mailto:ServingU@falcondirect.com), or call us at 800.489.2611. Now, it is time to return to our discussion on high power repeaters as we continue on the next page.

Most of our amateur radio users call for high power as do many of our public safety users. Commercial users are generally satisfied with using mid-power offerings, but all want a repeater capable doing narrow band. As they review some of the issues with narrow band analog FM, many will make the decision to go digital, either initially, or over time with a staged migration plan.

On the following page, we have listed five popular repeaters, all capable of producing 100 watts of power or more. One of these, the Motorola MTR5000 is no longer offered by Falcon Direct. There are a number of reasons as to why we do not recommend the MTR5000 (or even Motorola), but that is a subject for another day. For now, let us just say that Motorola is in the process of making significant changes in what they do, to whom, and with whom they do it. See <http://www.info4u.us/R.I.P.Motorola.pdf> for one example of how a once proud American company is slowly but surely abandoning the customers and channel partners that have made them so successful over the years.

The practical reason for not recommending the MTR5000 is that it simply is not up to par with competitive offerings. With the other models, we can give you a choice of analog, analog upgradeable to the P25 federal standard, DMR (the digital operating system used by Hytera and Motorola), or NXDN (the digital operating system favored by ICOM and Kenwood).

As you will note on the following chart, the price of a 100 watt replacement repeater ranges from \$3,895 for the Hytera model to \$9,090 for the full P25 digital model. The Hytera and Motorola models are designed for both analog and DMR digital operation (\$3,895 and \$4,650 respectively). The ICOM model, priced at \$4,718 is capable of both analog and NXDN digital operation and is the only one available with dual power supplies for automatic changeover to the second power supply in the event of failure of the primary power supply.

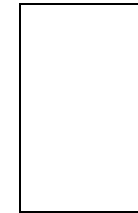
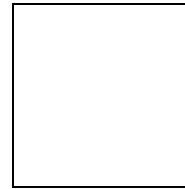
The ICOM IAS/RFT, priced at \$6.995, is an analog repeater that can be upgraded to full P25 mixed mode capability when desired and is our recommended choice for most users. The Midland repeater offers the highest power (110 watts) with full P25 capability at the lowest price of any P25 repeater. The Midland and Hytera models are the only repeaters available with a full 5 year factory warranty.

In the analog mode, any of these repeaters can communicate with any radio whether it be analog, DMR, NXDN, or P25. You can choose that one that is right for YOUR needs! More information on DMR is available at: [www.info4u.us/DMR.pdf](http://www.info4u.us/DMR.pdf). More information on NXDN is available at: [www.info4u.us/Narrowband-Planner.pdf](http://www.info4u.us/Narrowband-Planner.pdf). More information on P25 is available at: [www.info4u.us/P25Guide.pdf](http://www.info4u.us/P25Guide.pdf).

The prices on the following page are based on Federal GSA pricing which is offered to all of our customers, whether Amateur, commercial, or governmental. Some items, such as duplexers may vary in type and price depending on channel spacing, site conditions (number of other channels at the site, type of stations, etc) but for most users, these prices should reflect current average cost. We do not offer DC/Tone remotes or E&M devices since these are third party vendor items that would not be required on either of the ICOM offerings. Thanks for considering Falcon Direct!

# Are you looking for.....

the best value in public safety repeaters? Look no further! We offer the best prices, fastest delivery, free programming, and your choice of DTR (Hytera and MotoTRBO), NXDN (ICOM) or P25 (APCO-25) by Midland plus an incredible new modular repeater that allows you to start today with conventional 12.5 kHz narrow band and upgrade later to full P25 capability (Eclipse II). A quick Review Chart is provided below with the main features and pricing of our most popular 100/110 watt mixed mode analog/digital repeaters. Best of all, we back them all with the best service and support program available anywhere. We call it TimeShare. You'll call it INCREDIBLE! For additional information or a demonstration, call Falcon Direct at 205.854.2611 or email [Help4U@falcondirect.com](mailto:Help4U@falcondirect.com).



<b>Manufacturer</b>	<b>Hytera</b>	<b>Motorola</b>	<b>ICOM</b>	<b>IAS/RFT</b>	<b>Midland</b>
<b>Model</b>	RD982/100	MTR3000	IAS 100DVC PS	Eclipse II	Base Tech III
VHF/UHF Power Output	100W VHF or UHF	100W VHF or UHF	100W VHF or UHF	100W VHF or UHF	110W VHF – 100W UHF
Analog 25 – 12.5 kHz	Yes	Yes	Yes	Yes	Yes
Very NB 6.25 Capable	No	No	Yes	No	No
Digital Capable - Type	Yes – DMR	Yes – DMR	Yes - NXDN	Yes – P25	Yes – P25
Factory warranty	5 years	2 years	3 years	2 years	5 years
Time Share Service	Available	Not available	Available	Available	Available
Remote diagnostics	No	No	No	Yes	No
Remote programming	No	No	No	Yes	No
Upgradable to P25	No	No	No	Yes	Standard
DHS/SAFECOM approved	No	No	No	Yes with P25 upgrade	Yes
Approved for federal funding	No	No	No	Yes with P25 upgrade	Yes
Additional information at	<a href="http://www.info4u.us/RD982.pdf">www.info4u.us/RD982.pdf</a>	<a href="http://www.info4u.us/MTR3000.pdf">www.info4u.us/MTR3000.pdf</a>	<a href="http://www.info4u.us/IAS100D.pdf">www.info4u.us/IAS100D.pdf</a>	<a href="http://www.info4u.us/Eclipse2.pdf">www.info4u.us/Eclipse2.pdf</a>	<a href="http://www.info4u.us/BT3.pdf">www.info4u.us/BT3.pdf</a>
<b>Public Safety Price</b>	<b>\$3,895</b>	<b>\$4,650</b>	<b>\$4,718</b>	<b>\$6,995</b>	<b>\$9,090</b>
Program, test, and ship	100	250	150	150	150
On-site setup and test	250	250	250	250	150
30" Cabinet	595	595	595	595	Included
Open rack in lieu of cabinet	182	182	182	182	Not applicable
AC Power supply	Included	Included	Included	Included	Included
High Spec Duplexer	1,374	1,374	1,374	1,374	1,374
AC Surge Protector	55	55	Included	55	Included
Coaxial lightning protector	55	55	55	55	55
Redundant power supply	Not available	Not available	Standard	630	630
PC Programming kit	\$45	\$500	\$129	\$334	\$232
Upgrade to P25	Not available	Not available	Not available	\$3,000	Standard