



North Raleigh Model Railroad Club

Digitrax Duplex System

Setup & Train Operations with Digitrax Duplex Throttles & Radio

May 8, 2011

Questions, comments, corrections and suggestions should be addressed to the NRMRC Standards Committee at wallisjm@att.net

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Introduction

Several years ago Digitrax introduced wireless throttles and receivers utilizing Infra-Red (IR) or radio signals. IR operation is exactly like using a TV remote control — point the throttle at the IR receiver (UR90 or UR91) and press the button or turn the knob. Unlike the IR mode, radio operation does not require the throttle to be pointed in any particular direction. Both types of signal are one-way (Simplex) only, going from the throttle to the LocoNet network. As a result, only certain throttle activities can be done wirelessly. All other tasks require the throttle to be plugged into LocoNet.

In 2009 Digitrax introduced wireless throttles and a transceiver that provides two-way (Duplex) communications between the throttles and the transceiver (UR92). With this system nearly all throttle operations can be done wirelessly. The UR92 transceiver can also receive IR signals to support wireless throttles that operate in that communications mode.

This publication provides the information and recommendations needed for the successful and reliable operation of the Digitrax Duplex System and its components, as well as an explanation of the underlying theory and issues.

Description

The Digitrax Duplex System currently consists of two duplex throttles, the DT402D and the UT4D, and a duplex radio transceiver, the UR92, as shown in the pictures on the next page.

The UR92 Duplex Radio Transceiver is physically similar in construction to the UR90 and UR91 receivers, and the UP5 Universal Panel. Unlike the UR91, the UR92 does not have antenna wires sticking up from its radio module. The antenna is completely built-into the radio module.

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DT402D Throttle



UT4D Throttle



UR92 Duplex Radio Transceiver

The RF24 radio modules in the duplex throttles and the UR92 are identical. Their specific functions are controlled by software.

The UR92, UR91 and UR90 units are compatible and can co-exist on the same LocoNet system. See Appendix C for more information.

Technical Considerations

2.4GHz Frequency Band Interference Sources

Digitrax duplex operates in the 2.4GHz ISM (industrial, scientific, medical) band. Other users of this band are microwave ovens, cordless phones, Bluetooth (on cellular telephones), wireless cameras, security systems and Wi-Fi (IEEE 802.11B/G), any of which can interfere with Digitrax duplex. Since microwave ovens and cordless phones do not operate all the time they do not transmit continuously.

We know that Digitrax duplex uses the IEEE 802.15.4 Wireless Networking physical layer. This physical layer divides the 2.4GHz spectrum into channels numbered from 11 to 26. All but 4 of these may interfere with an IEEE 802.11 Wi-Fi network. The 4 channels with the least interference are channels 15, 20, 25 and 26. The default channel for Digitrax UR92 Duplex

transceivers is channel 11. Interference can be minimized by choosing one of these four channels.

Digitrax has made available software named DigiGroupSetup that allows scanning the frequency spectrum between channels 11 and 26. The software requires a Windows PC with a working connection to LocoNet via a Digitrax PR3 or MS100 and a UR92 transceiver also connected to the LocoNet. A LocoBuffer will not work with this program. When the software is running it provides a graphical representation of "signal strength" on each channel. Any signal the UR92(s) see will be considered part of that signal strength. The scan process looks at each channel for about 1 second at a time then goes to the next channel, and re-starts with the lowest channel number after it scans the highest valid channel number. The process runs for about 60 seconds unless manually stopped. Based on the graphical results of the scan we can set the duplex channel to the most idle channel, and thus minimize interference during operation. See Appendices B and C for more information.

Note: When running the channel frequency scan all Digitrax Duplex throttles must be unplugged from LocoNet and their batteries removed. Otherwise the throttle signals will influence the scan. Since Digitrax Simplex throttles ("R" throttles) operate at 916MHz they do not interfere with duplex and do not need to be disabled during the channel scan.

In addition to the Digitrax software for scanning the frequency spectrum, there are Wi-Fi scanning apps available for the iPhone, iPod Touch and Android phones that can be used. Note however, that while Digitrax numbers their channels from 11 to 26, these Wi-Fi analyzer apps only scan the first fourteen channels (Digitrax channels 11 to 24) and number them from 1 to 14. The apps do not scan Digitrax channels 25 and 26.

Building Environment

Aside from devices that operate directly in the 2.4GHz frequency band, there are many other potential sources of environmental interference in the building where the layout is located, and from nearby outside sources. These include noisy fluorescent lights, older neon signs, floor and vacuum cleaners, garage door openers, a welder, etc. These devices inject their "noise" into the power line, which then gets injected into the DCC equipment. The recommended solution is to place an Uninterruptible Power Supply (UPS) in the power circuit leading to the DCC equipment, especially the Command Station. This also ensures the DCC equipment will not be damaged by outside power spikes, with the added benefit of backup battery power should the 120VAC power fail.

Other Sources of Interference

There are a couple of other items of concern that can contribute interference to duplex operations.

- **Cellular Telephones.** Although cellular telephones do not operate in the 2.4GHz frequency band, they can cause interference by proximity. Almost all of us carry a cellphone at all times located somewhere in our clothes or attached to our belt. Cellular telephones when turned on emit small amounts of radio frequency radiation at many frequencies. The closer you hold your throttle to your cellular phone the more likely you will have some interference from the cellular phone.
- **Bluetooth Communications.** The small earpieces that some people use for handsfree communications via their cellular phones use Bluetooth technology for the link between the phone and the earpiece. Even though the cellular phone does not operate in the 2.4GHz frequency band, Bluetooth does operate at 2.4GHz and is thus a potentially major interference source for our duplex throttles.

If you have a Bluetooth earpiece you should turn it off and disable Bluetooth in your cellular telephone while operating on a layout with Duplex throttles. Since most current cellular telephones are capable of Bluetooth transmission, even if you do not use a Bluetooth earpiece you should make sure that Bluetooth capability is turned off in your phone.

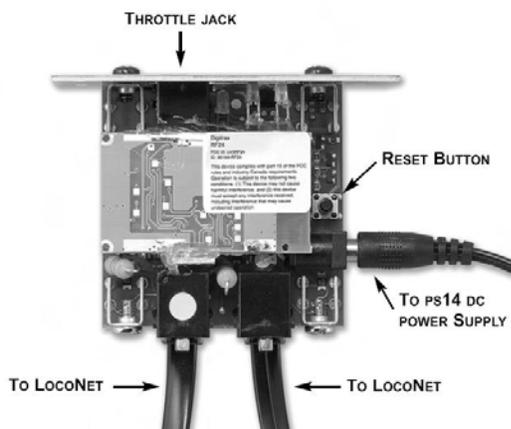
Some computers and laptops are equipped with Bluetooth technology. Bluetooth should be turned off in these devices also.

Setup Recommendations

Locating UR92 Duplex Radio Transceivers

The UR92 Duplex Radio transceiver is simple to install and use on NTRAK layouts. Mount the UR92 as high as possible and located centrally in the desired coverage area of the transceiver. The duplex range is approximately a 300 ft. diameter circle. Some layouts may need more than one UR92 for adequate signal coverage; adding multiple UR92s will automatically provide space-diversity and reliability.

Once mounted connect the UR92(s) to LocoNet and 14V power as shown in the following diagram:



For layouts with UR91 receivers as well as UR92 transceivers, where convenient these can share a mounting pole and PS14 power supply.

Setup of UR92 Duplex Radio Transceivers

For the best operating experience with the UR92 Duplex Radio transceiver, do the following:

- Be sure all UR92s have been updated to the latest software release provided by Digitrax, using the procedure in Appendix B.
- Mount the UR92(s) as described in the "Locating" section.
- Be sure to power each UR92 individually with a PS14 or equivalent power supply.
- Once the UR92s are powered up and connected to LocoNet use the Digitrax DigiGroupSetup software to scan the 2.4GHz spectrum and then decide which is the most idle channel; this will reduce the chance of interference from other devices. See "Setup Using DigiGroupSetup Software" on the next page for step-by-step instructions.
- Using the DigiGroupSetup software program the UR92(s) with a unique Duplex Group name and the channel selected in the previous step. There are a maximum of 8 characters available for the Duplex Group Name. See "Setting the Duplex Group Name and Channel" on the next page for step-by-step instructions. A DT402D throttle can also be used to set the Duplex Group Name and channel.

If you do not program in a Duplex Group Name the UR92(s) will select a name on its (their) own, a combination of letters and numbers. If there are more than one Digitrax Duplex Group in operation this may make it difficult to know which group is which. Program in a Duplex Group Name that everyone will recognize (such as NRMRC for our club).

- As well as setting the Duplex Group name be sure to set a LocoNet ID in the UR92. This ID should be the same as the LocoNet ID used in any UR91 simplex receivers and UR90 IR receivers that are part of the layout's LocoNet.
- After changing the Duplex Group Name and/or the Channel all duplex throttles must join the Group, either by plugging into LocoNet or wirelessly; see section below.
- **Password** In addition to the Duplex Group Name and Channel the UR92 has the ability to apply a 4-digit password. This is rarely required for NTRAK layouts and is thus not covered in this publication; refer to the DT402D manual for instruction on how to set a password.

The default password shipped with the UR92 is 0, which means that passwords are disabled.

If an additional UR92 is added later than the initial layout setup you must re-enter the Duplex Group Name, Channel Number and LocoNet ID. If the Group name or Channel is changed then all duplex throttles must rejoin the Duplex Group (either by plugging in or wirelessly).

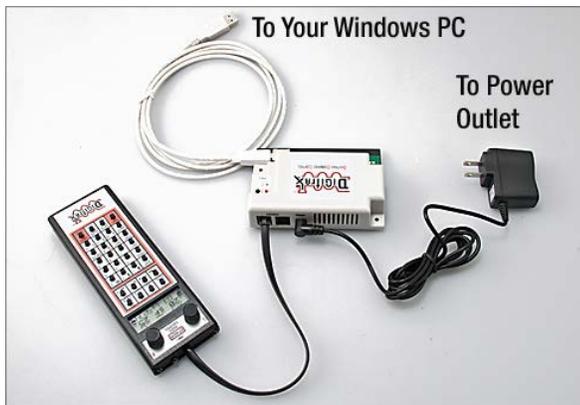
Important Note: Be sure to re-enter the Duplex Group Name and Channel Number after adding an additional UR92. If this is not done, and track power is turned OFF then back ON, the UR92s will automatically negotiate a common Duplex Group name and Channel Number, which will probably be different from the desired Duplex Group name and Channel Number.

Setting the Duplex Group Name and Channel, and the LocoNet ID

Digitrax has provided two methods to set the Duplex Group Name and Channel into UR92 Duplex Radio Transceivers — use special software named DigiGroupSetup or use a DT402D throttle.

Setup Using DigiGroupSetup Software

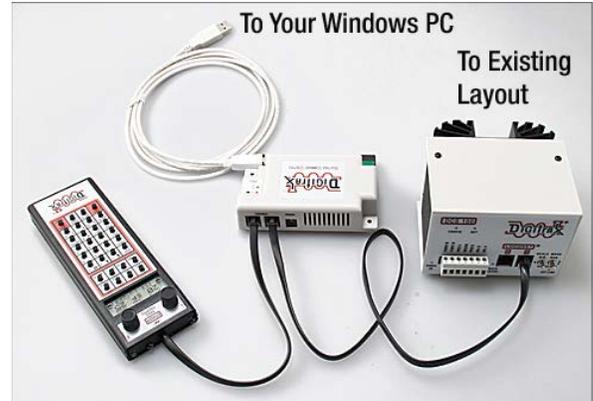
The DigiGroupSetup software can use the UR92 to scan the radio frequencies in the 2.4GHz band, allowing you to determine the most idle channel to use for duplex communications. You can then use the same program to set the Duplex Group Name and the desired channel into the UR92(s). This requires a Windows computer running the appropriate Digitrax DigiGroupSetup software and a Digitrax PR3 interface. DigiGroupSetup software will not work with the RR-Cirkits LocoBuffer. There are two connection options as shown in the following diagrams:



PR3 Connection without Digitrax Command Station
(Requires PS14 Power Supply for PR3)

Be sure you have correctly installed on your computer the drivers for the PR3, and that you know the computer COM port to which they are attached.

The DigiGroupSetup software can be downloaded from the Digitrax web site.

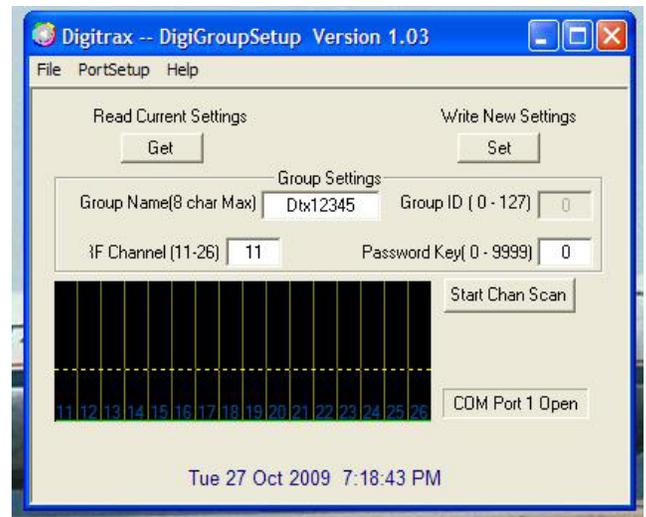


PR3 Connection Including Digitrax Command Station

Be sure that all UR92, UR91s and UR90s are connected to the LocoNet before performing the following procedures. This will ensure that all units have the same Duplex Group Name (UR92s), duplex channel (UR92s), and LocoNet ID (all URs) programmed into them.

Do the following:

- Connect the PC to LocoNet via a PR3 (USB-> Com) or MS100 (COM port).
- Start the DigiGroupSetup program. The DigiGroupSetup screen is shown below.



- Use the "Portsetup" menu to select the correct computer port that is connecting the PC to the PR3.
- If the software can detect a UR92 on LocoNet you can use the "Get" button to read the current Duplex Group Name, RF Duplex Channel and the Password (a Password value of 0 disables Password usage). You can edit any of these settings and then use the "Set" button to download these values to any UR92(s) connected to LocoNet.

- The "start channel scan" allows you to use the UR92 to make a quick scan of the available channels to see how much signal (and possibly interference) may be present at your location. The graphics show the peak signal and average detected while you let the scan run.

Setup Using a DT402D Throttle

A DT402D throttle can be used to set/edit the Duplex Group Name and the Channel. Note that all UR92s that will be part of the LocoNet should be connected prior to changing the Group Name and Channel or they will automatically renegotiate and may change the preferred name to a default. This process should be repeated if another UR92 is added to LocoNet. All UR92s that are connected to LocoNet will be changed at the same time. See previous "Important Note".

Setting Duplex Group Name and Channel: Do the following:

- Connect the DT402D throttle to any jack on the LocoNet.
- On the DT402D press the **OPTN** button and then the **EDIT** button.
- The 8-character Duplex Group Name will now appear in the center of the throttle display, and the Channel Number will appear in the lower left side of the throttle display.
- Use the **R** throttle knob to change the first character value. It will blink as it is changed. When the desired character is seen use the **L** throttle knob to move across and select the next character to modify.
- Use the **Y/+** button to change to a higher channel in the available range of 11 through 26 or the **N/-** button to change to a lower channel.
- Press the **ENTER** button to update the UR92 on the LocoNet system. To skip making any changes, press the **EXIT** button.

Setting the LocoNet ID

UR90, UR91 and UR92 radio receivers should have a unique LocoNet ID associated with them to distinguish the layout from other layouts at a show. The range of ID values is 0 – 7, with 0 being the default. Using the default value 0 should be avoided.

The LocoNet ID can be set using either a DT-type throttle, or with JMRI or LocoNet Checker software.

DT4xx Throttles. Do the following:

- Start with the throttle disconnected from LocoNet, but with a battery installed.
- Press and hold **EDIT** on the throttle and plug back into LocoNet. Release **EDIT** after plugging in the throttle.
- The throttle will display **E1** in Mode Indicator and current LocoNet ID "**Ir:0n**" or "**rA:0n**," where "**n**" is the current

LocoNet ID. Use the **Right** throttle knob to change the ID, which can be 0 to 7.

- Press **ENTER** to set the system to the new LocoNet ID.
- The throttle used to change the ID will automatically log on to new LocoNet ID.

DT100/100R, DT300/300R, DT400/400R, and DT402/402R throttles can also be used to set the LocoNet ID.

JMRI or LocoNet Checker Software. Connect the computer to LocoNet via a PR3, MS100 or LocoBuffer, Start the desired program and use the Set LocoNet ID tool to set the desired LocoNet ID.

Setup of Duplex Throttles

For most reliable operation with duplex throttles, please do the following steps:

- Be sure the DT402D throttle has been updated to the latest software release provided by Digitrax. See the procedure in Appendix B.
- Do not use normal alkaline 9V batteries. Purchase and use the recommended Powerex Model MHR9v, Part No. MH-96V230 9.6V 230mAh NiMH Rechargeable Battery, See Appendix A for technical and purchase information.
- Using the procedure described in Appendix B, change the throttle options (DT402D only) as recommended in the Appendix, especially the following:
 - Change the Backlight setting to the lowest value to save power.
 - Turn off IR mode.

Your duplex throttle is now ready for train operations on the layout.

Operating Trains with Duplex Throttles

For wireless operation of duplex throttles be sure to install a 9V battery. See Appendix A.

Join the Throttle to the Duplex Group

DT402D Throttle. A DT402D throttle can join the Duplex Group by plugging into LocoNet or wirelessly. Plugging into LocoNet is easier, but is subject to occasional failures.

It is strongly urged that you learn and use the wireless join as the preferred way to join a DT402D throttle to a Duplex Group.

Note: If the throttle has not yet joined or failed to join the Duplex Group the display will show **Idle**. If the throttle was plugged in and failed to get the Duplex Group information then it may display **IR:nn** indicating it is operating in infra-red (IR) mode.

To join the Duplex Group by plugging into LocoNet do the following:

- Plug the DT402D throttle into a LocoNet jack for a period of approximately 5 seconds until the throttle initializes.
- Disconnect the DT402D from the LocoNet jack. The DT402D should briefly display an 8 character Duplex Group Name and the Channel number (#11 through #26) being used by the Group.

If the DT402D displays **Idle** at this point, plug into LocoNet again and wait several seconds to allow the throttle to reinitialize.

If joining the group fails and the throttle goes into IR mode then the display will show IR:nn, again plug into LocoNet and wait several seconds for the throttle to reinitialize and join the duplex group.

- The DT402D has now joined the Duplex Group and can now be operated wirelessly, just as if it were plugged into LocoNet.
- For the remainder of the operating session or train show, **do not plug the DT402D into LocoNet again**, unless the Duplex group name or Channel are changed.

If the DT402D throttle stops operating normally or appears to “lock up”, do not plug it back into LocoNet. Simply remove and replace the battery and the throttle will re-initialize and rejoin the Duplex Group. You may also have to reacquire the locomotives that you were controlling using the **LOCO** and **ENTER** buttons.

If you do plug back into the LocoNet, it is possible that the throttle will lose the Duplex Group information. Follow the steps above to confirm that the throttle has joined the Duplex Group.

- DT402D throttles remember the last Duplex Group Name and Channel they joined, even if the battery is removed, and thus will automatically rejoin this particular Group if it is within duplex radio range without being plugged in to LocoNet.

To join the Duplex Group wirelessly do the following:

- Press the **OPTN** button. If the throttle was displaying **Idle** hold the **OPTN** button for 3 seconds to power up the throttle. The display will show **Options/OpEdit**.
- Press the **Find** button to display the rf search mode and scan the last active channel. **ScanNets** will briefly appear in the display and if there is no Duplex Group available on the last channel used **No RfNet** will appear on the display.

- Press the **Y/+** or **N/-** buttons to change the Channel up or down. At each channel the display will show **Hit FIND** to search for a Duplex Group Name operating on that channel.

If you know the channel that the layout is using then you can use the **Y/+** or **N/-** buttons to go directly to that channel and then press **FIND**.

- When the DT402D discovers a Duplex Group, the name will blink in the display. If this is the correct Duplex Group press the **ENTER** button to join the Group. If it is not the correct Duplex Group then continue searching as described in the steps above.
- It is strongly urged that you learn and use the wireless join as the preferred way to join a DT402D throttle to a Duplex Group.

UT4D Throttle. Do the following:

- Insert a known good 9 volt battery into the UT4D.
- Plug the UT4D into a LocoNet port on a layout equipped with a UR92 transceiver to join that layout's Duplex Group.
- After the UT4D has joined a Duplex Group, any time a battery is inserted into the UT4D while it is unplugged, it will search for that Duplex Group and will join the Group if it is within range.
- When the throttle has joined or re-joined the Group, the Status light will blink Green 5 times. The UT4D then will attempt to select the Loco address on the 4 rotary address selectors.
- If the UT4D's Status light blinks red 5 times this means that no UR92 with the Group Name is within range. You may need to move closer to the UR92 for the Duplex group to re-join the Group or you can simply plug in to LocoNet to join another Duplex Group that is available
- When the UT4D is unplugged from LocoNet, the unit will automatically change to Duplex mode and generally operate as if it were plugged in.

Hints for Optimal Throttle Operation

The following are a couple of good operating practices that will improve radio throttle operations.

- **Throttle Knob Movements.** When operating in radio mode, throttle knob tracking will feel slightly different than when connected to LocoNet. In radio mode, slow movement of the throttle knob will result in improved response. It will also provide less congestion to the radio receivers and LocoNet.
- **Throttle Orientation.** The optimum orientation to hold the throttle in normal usage is from horizontal to 30° upward in a natural hand position about 12" out from your body. This

gives the best radio coverage. However, there may be small areas of poor radio reception. Moving about 6" – 24" in any direction or varying the orientation of the duplex throttle will typically overcome any dropouts.

- Your body can shield the throttle from the UR92 transceiver. If your throttle loses communication with the UR92 try turning about 90 degrees either left or right to see if this corrects the problem.

Running Trains with a Duplex Throttle

Once you have powered up the throttle and joined the Duplex Group do the following:

- Once a duplex throttle has successfully joined the Duplex Group, try to avoid plugging the throttle into the LocoNet unless absolutely necessary.
- If the throttle seems to lock up and stops controlling trains, do not plug the throttle into LocoNet. Instead remove the battery from the throttle and then replace the battery. The throttle should then resume normal train operations. You may also have to reacquire the locomotives that you were controlling using the **LOCO** and **ENTER** buttons.

If the throttle appears to be continually resetting itself when plugged into LocoNet this is not lock up as described above. This means the throttle is drawing power off the jack and cannot get enough power from the LocoNet. It indicates a low-voltage issue with LocoNet. Exception: Some DT300 throttles with faulty capacitors will also continually reset; such throttles need to be returned to Digitrax for repair.

- Flashes of the white LED on the throttles indicate the throttle is not communicating with the UR92. Occasional flashes of the white LED can be ignored. Continuous flashes lasting more than about 10 seconds may indicate the throttle has

locked up. Do not plug the throttle into LocoNet. Instead remove the battery from the throttle and then replace the battery. The throttle should then resume normal train operations. You may also have to reacquire the locomotives that you were controlling using the **LOCO** and **ENTER** buttons.

- When a duplex throttle joins a Duplex Group it communicates with only one UR92 at a time even though there may be several UR92s present. For layouts with more than one UR92 the throttle communications may switch from the initial UR92 to another UR92 connected to the layout. The switchover from one UR92 to another may take up to 10 seconds, although 3 – 4 seconds is more likely. During the switchover the white LED on the throttle will flash as the throttle knob is turned, and there will be no train control for the duration of the switchover.

It is important to avoid plugging a duplex throttle into LocoNet after it has been successfully joined to the Duplex Group.

References

- Digitrax Product Manuals for DT402 and UT4D Throttles, and UR92 Duplex Radio Transceiver.
- Digitrax Technical Support Documents
- Relevant email correspondence on the Digitrax Yahoo Groups list.
- Author's personal email correspondence with other DCC knowledgeable modelers.

The author acknowledges the direct and substantial contribution to this document by Frank Fezzie Jr. of the Grand Strand Model Railroad Club in Myrtle Beach, SC.

Appendix A

Batteries for DT402D and UT4D Duplex Throttles

This Appendix provides information on the battery drain of DT402D duplex throttles, as these throttles consume batteries much more rapidly than simplex throttles.

Battery Drain

Unlike simplex throttles which only transmit commands to the LocoNet via the UR91 or UR90 receiver, the duplex throttles also contain a receiver that requires power all the time. For this and other reasons, the duplex throttles have a higher power drain than the older simplex throttles. Consider the following:

- Duplex throttles become unstable when the battery voltage falls to somewhere between 7.8 and 8.2 volts. Note that a simplex throttle becomes unstable when the battery voltage falls to around 7 volts.
- Normal output of a fresh 9V alkaline battery (such as Duracell or Energizer) is 8.7V, not 9V.
- Some of these batteries can be discharged to 8.2V in just a couple of hours by a DT402D throttle.

Recommended 9V Battery for DT402D Throttle

Based on current draw measurements on a DT402D throttle and an investigation of available batteries the recommended battery is a NiMH rechargeable battery made by Powerex that starts at 9.6V when fully charged. Go to <http://www.mahaenergy.com> for more information. In particular, the following are recommended.

- Model MHR9v, Part No. MH-96V230 9.6V 230mAh NiMH Rechargeable Battery, MSRP \$13.95
 - Same physical size as regular 9V battery
 - Charges in 2 hours
 - Maintains 80% charge for one year
 - No memory effect if charged before full discharge
 - Good for 1,000 recharges

The charger to be used with this battery is the Model MH-C490F which charges 4 of these 9.6V batteries at the same time in 2 hours. Once fully charged the charger puts a trickle charge into the battery to maintain it at full charge, although the battery should not be left in the charger longer than needed, and definitely not longer than 12 hours. The charger comes with both a 120VAC wall-wart supply and a cable to plug into your car electrical outlet. MSRP: \$34.95

You can purchase a kit which contains this charger and 3 of the batteries. It is Model MH-C490F396VDC. MSRP is \$64.95 (vs. \$76.85 if purchased separately).

Google the model numbers. There are several vendors and you can search for the best price. Some Batteries Plus stores also carry these batteries and charger.

Using the recommended battery we can realistically expect something in the range of 18-20 hours of power from a battery charge assuming normal usage of the throttle (small time knob turning, most time non-use) and the back Lite set at MIN.

This time can be lengthened by plugging in the throttle into the LocoNet **as long as the LocoNet voltage is higher than the battery voltage.**

Note: There are other brands of rechargeable batteries that are electrically suitable to power Digitrax duplex throttles. Be aware, however, that these may have slightly different dimensions, and thus may not fit well in the throttle battery compartment. Larger-sized batteries can be difficult to remove.

Recommended Battery for UT4D Throttle

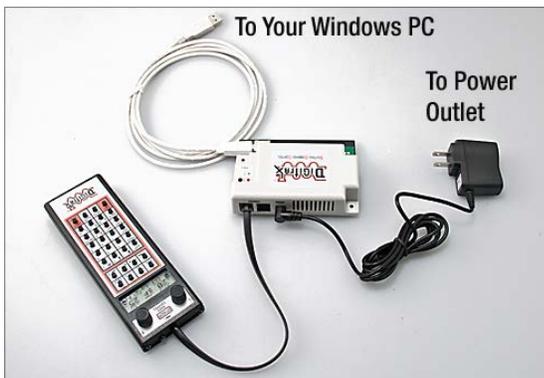
Although UT4D duplex throttles do not have an LCD display and therefore use a lower current drain than the DT402D throttle, use of the same battery as recommended for the DT402D is advised.

Appendix B

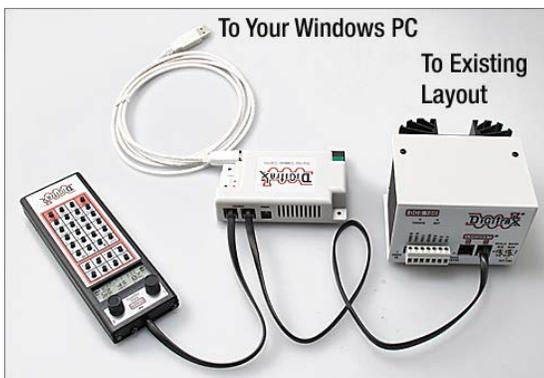
Update Duplex Software & Set DT402D Throttle Options Reset UR92 Transceiver

Updating Duplex Software/Firmware

Digitrax has designed the ability to upgrade firmware and software in the duplex components — DT402D throttle and UR92 Duplex Radio Transceiver. This requires a Windows computer running the appropriate Digitrax DigilPL software and an interface such as the Digitrax PR3, MS100 and/or the RR-Cirklits LocoBuffer. There are two connection options for the PR3 as shown below:



PR3 Connection without Digitrax Command Station
(Requires PS14 Power Supply for PR3)



PR3 Connection Including Digitrax Command Station

Be sure you have correctly installed on your computer the drivers for the interface device you are using, and that you know the computer COM port to which they are attached.

Note: If you have problems getting a PR3 to work correctly do the following:

- Be sure you installed the PR3 drivers supplied by Digitrax, exactly as instructed by Digitrax — the drivers and

instructions are on their web site. The process can be a little tricky so be sure to follow it carefully. You cannot use the driver built into Windows.

- Check the USB cable connecting the PR3 to the computer. Some PR3s were shipped with a faulty USB cable.
- To check the operation of the PR3 follow the procedure in the last section of this Appendix.

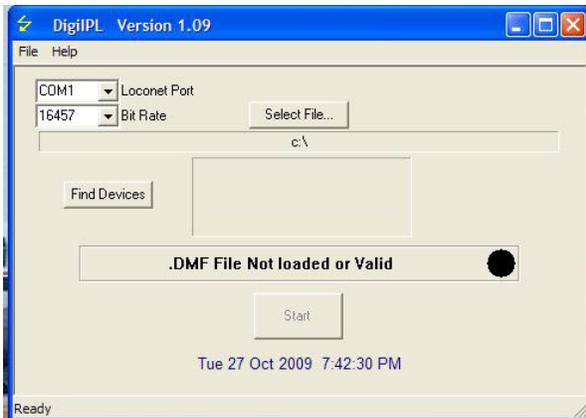
The diagrams show a DT402D throttle. If you are working with a UR92 plug it in place of the throttle in the above diagrams.

The DigilPL software can be downloaded from the Digitrax web site, as can the latest software/firmware files.

The DigilPL program allows DT402 type throttles (DT402, DT402R, DT402D) to be updated when plugged into LocoNet.

DigilPL also allows for software/firmware updating of other Digitrax devices such as the UR92 Duplex Radio Transceiver, the LocoNet Repeater (LNRP) and the PR3. The process described below is the same for all these devices, using the appropriate DMF file.

- Copy DigilPL109.exe and DT402xxx.dmf files (or the dmf files for the device to be updated) to a Windows folder on your PC that you can execute programs from.
- Connect the PC to LocoNet via a PR3 (USB > Com) or MS100 (COM port) or LocoBuffer– USB.
- All traffic on a LocoNet being used to install software upgrades must be stopped prior to doing the upgrade. It is preferable to use a dedicated LocoNet system for the upgrade process.
- Only one device being upgraded can be connected to the LocoNet at a time when the upgrade process is run.
- Connect the DT402 throttle to be updated to LocoNet
- Start the DigilPL program. See screenshot on next page.
- Use the pull-down menu to select the correct LocoNet port that is connecting the PC to LocoNet. [If using an MS100, select a 16457 bit rate, most other units ignore this setting.]
- Select "Find Devices". Any device that can be updated using DigilPL should be identified. Be sure only one device to be updated is connected at a time, e.g. only one throttle.



Some devices may not show up in this step, but they can normally be updated using the following process.

The current software version of the device will be shown.

Close the window opened by the "Find devices" button.

- "Select File" to the DT402xxx.dmf file to be used (or dmf file for the device to be updated), then press the "Start" icon.

- If the .dmf file selected is correct for the DT402 and the software revision is the same or higher than the DT402 currently has, the DT402 will start to IPL, flash the white LED and put the text "IPL run" on the display.

Note: even if the device does not show up when selecting "Find Device" attempt the update by clicking the "Start" icon. LEDs on the device should flash as the update takes place.

- When the IPL has completed the throttle (or selected device) will automatically restart and display its version number on the start screen.

If the IPL process is interrupted or fails, the DT402 will remain in IPL mode or will fail to properly restart. You can rerun the upgrade process by clicking on the "Start" button until a successful update has completed.

If power is removed from the throttle while in the IPL mode, the display will just be blank when power is restored to the throttle. The throttle will still accept the upgrade program when you click on the DigilPL start button.

Changing DT402D Throttle Options

The DT402D throttle has a number of option settings that can be adjusted to customize operation of the throttle. Changes can be made to a DT402D either plugged into LocoNet or unplugged with a battery installed. A Command Station is not needed to customize the throttle. Do the following:

- Press the **OPTN** button to access the Options menu. The display will show **Options/OpEdit**.

- Use the **R** throttle knob to scroll through the options. The names will blink during this part of the process.
- Use the **Y/+** or **N/-** buttons to toggle through the values for each option until the desired value appears on the screen.
- To change another option, repeat the previous two steps.
- When you have completed making the desired changes, press the **ENTER** button to set all of the changes at once or press the **EXIT** button to cancel all changes..
- The throttle can be returned to factory defaults by resetting the option, **FactoryD** to On and pressing the **ENTER** button.

User Changeable Options — DT402R and DT402D

The following is a list of user changeable options in the DT402R and DT402D throttles. For each there is a function definition, and the setting recommended for optimum use. Where the recommended setting is different from the default it is shown in bold and underlined.

- **IR Mode**
On enables IR mode when disconnected and IR receiver detected on LocoNet.
Default: On — **Recommended Setting: Off (for DT402D)**
- **RF1 Mode**
On enables simplex radio (for DT402R)
Default: Off — **Recommended Setting: Off (for DT402D)**
Recommended Setting: On (for DT402R)
- **Clicks**
On enables clicking when making keypad or knob changes.
Default: On — Recommended Setting: On
- **Fclock**
On enables Fast Clock in center display.
Default: Off — Recommended Setting: Off
- **12HrClock**
On selects 12Hr vs. 24Hr clock display mode.
Default: On — Recommended Setting: On
- **NoBlastic**
Off enables ballistic tracking by providing rate sensitive knob steps so faster turning gives bigger step changes.
Default: Off — Recommended Setting: Off
- **STimeout**
On selects short unit timeouts.
Default: On — Recommended Setting: On
- **F3Static**
On makes F3 key On/Off action
Default: On — Recommended Setting: On

- F2 Mom
On makes F2 key momentary action.
Default: On — Recommended Setting: On
- F2Analog
On enables optional F2 key pressure- sensitive analog mode.
Default: Off — Recommended Setting: Off
If your sound locomotive supports this mode, change this option to “On”. Pressing softer or harder on F2 will change the sound coming from the horn/whistle on the locomotive.
- MsgFilter
On stops throttle messages from displaying when selecting locomotives.
Default: On — Recommended Setting: On
- SLFollow
On enables slot following mode for locomotives selected in multiple throttles.
Default: On — Recommended Setting: On
- ES->Idle
On freezes all locomotives when Emerg-Stop key pressed. Off stops only locomotive selected in throttle.
Default: Off — Recommended Setting: Off
Off is mandatory on NTRAK layouts.
- PWRSaver
On enables Radio/IR mode power save on throttle inactivity.
Default: On — Recommended Setting: On
If the throttle is inactive for about 3minutes it will switch to power saver mode and show “r-ps” on the screen. To wake up the throttle press and hold the PWR button for a few seconds. The throttle will wake up and resume normal operations. Do not twirl knobs or press function buttons to wake the throttle.
- IRRelease
On allows IR/Simplex Radio throttles to release loco addresses when unplugged.
Default: Off — Recommended setting: Off
- DplxBad
On enables white flashlight LED to blink when repeated Duplex radio messages fail.
Default: On — Recommended setting: On
- DxRXIPwr
On enables maximum Duplex power saving, and disables continuous update of slot following
Default: On — Recommended setting: On
- New Types
On allows throttle to override command station new- type loco speed step settings
Default: On — Recommended setting: On
- Nu Type=
128 speed step setting/ 14 speed step setting / reserved / 28 speed step setting / Advanced 128 speed step setting / reserved / Advanced 28 speed step setting
Default: 128 — Recommended setting: 128
- Recall#
Recall stack set at last 4 entries / Recall stack set at last 8 entries / Recall stack set at last 16 entries
Default: 4 — Recommended setting: 4
- BackLite
Maximum backlight brightness. Maximum backlight brightness means highest power consumption and lowest Battery life.
Default: 2 — Recommended setting: MIN
A lower setting means longer battery life.
- RF1 Freq
RF1 channel-info only.
Default: A — Recommended setting: A. Do not change.
- Throt ID
Optional unique throttle ID#
Default: Factory set — Recommended setting: Do not change
- XPFnHold
On allows multiple expanded function keys per X1 or X2 choice.
Default: On — Recommended setting: On
- XP Slots
Reserved to Digitrax
Default: On — Recommended setting: Do not change
- Duplex RF
On enables RF24 to operate in Duplex mode. Off turns off Duplex choice.
Default: On — Recommended setting: On (for DT402D)
Recommended Setting: Off (for DT402R)
- noIDLSho
On shows normal flashing dot between F11 and F12 function indicator on the throttle. Off flashes “Trk=Idle” when the system is in the Track Idle State.
Default: On — Recommended setting: Off
- FactoryD
Select ON and press enter key to force all options settings to factory defaults.
Default: Off — Recommended setting: Change as needed

Reset a UR92 to Factory Defaults:

In the event of a problem with a UR92 do the following to reset it to factory defaults:

- Disconnect the UR92 from LocoNet. A factory reset can only be done on one UR92 at a time.
- Disconnect any throttle that is plugged into the UR92.
- Leave the PS14 power supply connected to the UR92.
- Press and hold the momentary switch (next to the power supply jack) for two seconds or until both the red and green LEDs begin to blink. Release the switch.
- When the LEDs stop blinking, unplug the power supply.
- Reconnect the PS14 power supply to the UR92. The green and red LEDs should blink and the red LED should stay on.
- Connect the UR92 to LocoNet using one of the RJ12 jacks at the rear of the UR92. The red LED will go off and the green "radio" LED will wink at a 2-second intervals to indicate that it is duplex configured and operational.
- The UR92 is now set to the factory default Group name of Dtxnnnn, where "nnnn" is the unit serial number, and to Channel 11.
- To restore the desired group name, channel, and LocoNet ID, follow the procedure on page 4 – Setting the Duplex Group Name and Channel, and the LocoNet ID.

Testing and Verifying PR3 Operation

Once you have successfully installed the PR3 drivers and know the correct COM PORT (look in Device Manager), do the following to test the connection between the computer and the PR3, and between the PR3 and LocoNet:

- Start with the PR3 not connected to anything.
- Start up the LocoNet system (e.g. Command Station).
- Turn on the computer and let it boot to the Desktop.

- Connect the PR3 to LocoNet. Do not connect a power supply to the PR3. On the PR3 you should see the following:
 - The green LED is mostly off and blinks on once per second.
 - Red LED is off.
 - STAT LED is off.
- Connect the PR3 to the computer using a USB cable. Be sure to plug it into the same COM PORT that you used when installing the drivers. On the PR3 you should see the following:
 - Green LED goes on and winks off once per second.
 - Red LED is off.
 - STAT LED is off.
- Connect a throttle to LocoNet and acquire a locomotive (use any address), and turn the speed up and down. The STAT LED on the PR3 will blink with each click of the throttle indicating that the PR3 is seeing LocoNet traffic.
- Start the DIGIMON program, then click Port Setup and set the COM PORT as determined earlier. Then set the bit rate to 16457. The bottom of the window should say COM PORT x (where x is the number of your port). Turn the throttle knob with the selected address. LocoNet traffic codes should appear in the DigiMon window.

These steps will confirm that the PR3 is functioning and that the Digitrax software will run on your computer and can access the PR3.

Note that only one program at a time (DigiMon, DigiGroupSetup, DigiIPL or JMRI DecoderPro) can be running when the PR3 is accessed.

Appendix C

Simplex vs. Duplex — Technical Information

Simplex vs. Duplex Quick Comparison

Parameter	Simplex	Duplex
Relevant Definition	One way transmission — throttle to receiver	Two-way transmission between throttle and transceiver
Frequency Band	916.5 MHz ISM (Industrial/Scientific/Medical) for low-powered digital communications with unlicensed devices	2.4GHz ISM (industrial/Scientific/Medical) for low-powered digital communications with unlicensed devices. IEEE 802.15.4 radio interface. More information below.
Other users of the band	Cordless phones NCE DCC two-way radio	Wi-Fi (IEEE 802.11b/g) Bluetooth (for Cellular Phones) Microwave ovens Cordless phones Wireless cameras Security systems
Digitrax Throttles	DT100R, DT300R, DT400R, DT402R, UT4R	DT402D, UT4D
Transmission Time	Burst transmission — only when a throttle knob is turned or a button is pushed.	Burst transmit when a throttle knob is turned or a button is pushed / continuous receive.
Current Draw	Lower	Higher
Battery Life	Longer	Shorter
Recommended Battery	Powerex Model MHR9v is recommended, but any 9V alkaline battery will work.	Powerex Model MHR9v, Part No. MH-96V230 9.6V 230mAh NiMH Rechargeable Battery, MSRP \$13.95. See Appendix A for details.

Digitrax Duplex Technical Information

Digitrax duplex throttles have both transmit and receive capability via the IEEE 802.15.4 radio physical (PHY) interface. The system has a carrier-detect mechanism for back off, and a retry mechanism for packet acknowledgement and retry. This means the Digitrax duplex system is a more reliable radio system than the Digitrax simplex system.

Digitrax duplex uses RF24 transceiver modules in the DT402D and UT4D throttles, and in the UR92 transceiver. The specific function (throttle or UR92) is software controlled.

The RF24 is a Direct Sequence Spread Spectrum transceiver module, which implements the IEEE 802.15.4 PHY specification, but not fully the MAC specification; it does use "reserved" codes in the 802.15.4 MAC specification. The spread spectrum signal is centered on any one of a number of RF frequencies in the 2.4GHz band. These frequencies are shared among multiple

users, and overlap with frequencies provided for other services. Spread spectrum is able to discern between overlapping signals provided they have different spreading codes.

Direct Sequence Spread Spectrum radio signals are modulated by a pseudo-noise code, which is the same for all 2.4GHz 802.15.4-compliant transceivers. Any mismatched codes are decoded only as noise, which correctly coded signals will override.

Digitrax duplex throttles recognize which UR92s they can communicate with by comparing the Duplex Group Name and the Duplex Group Password. A duplex throttle will not communicate with a UR92 on another channel, and will not communicate with a UR92 on the same channel if the throttle is not set to the same Duplex Group Name and Duplex Group Password as the UR92.

Simplex and Duplex on the Same Layout

Layouts with both Simplex and Duplex throttles and receivers/transceivers will also be capable of using throttles in IR mode. The layout will be equipped with UR91 Simplex Radio Receiver(s) and UR92 Duplex Radio Transceiver(s). It is also possible for UR90 IR-only receivers to be present.

As throttles are plugged into LocoNet or unplugged from LocoNet the display will indicate IR:nn, RA:nn or a Duplex Name (depending on the throttle type) and the response it receives from a receiver. This indication could be different from what the user expects to see based on his/her type of throttle.

IR:nn vs. RA:nn vs. Duplex Name. When a duplex throttle (either DT402D or UT4D) powers up (putting in a battery, not connected to LocoNet) the throttle displays (on the DT402D) the last Duplex Group Name and Channel Number it used. The throttle then queries for a Group Name on that Channel. If the throttle doesn't get a response that matches what it last used the throttle screen will display IDLE (on DT402D, red LED on UT4D). If it does get a matching response the display shows the Duplex Group name and Channel (DT402D, green LED on UT4D), and normal throttle operations should occur.

When a radio throttle is plugged into LocoNet it sends a request to LocoNet for a LocoNet ID/Duplex Group Name. It receives a response from the UR91 or UR92 that "answers" first. What the display on the throttle shows depends on the type of throttle and whether a UR91 or a UR92 responds first. Following are the possible responses:

- DT402D with UR91 responding first: Since the DT402D did not see a duplex transceiver, upon unplugging it will assume IR and the throttle will display IR:nn. If IR has been disabled in the throttle options then the throttle will display Idle.
- DT402D with UR92 responding first: Since the DT402D did see a duplex transceiver, it will briefly display the Duplex

Group Name and the Channel Number. Upon unplugging it will operate in duplex radio mode.

- DT100R/DT300R/DT400R/DT402R with UR91 responding first: Since the throttle sees a simplex radio receiver, upon unplugging it will operate in simplex radio mode and will display RA:nn.
- DT100R/DT300R/DT400R/DT402R with UR92 responding first: Since the throttle does not see a simplex radio receiver, upon unplugging it will assume IR and will display IR:nn.
- UT4D with UR91 responding first: Since the UT4D does not see a duplex radio transceiver, upon unplugging it will assume IR mode.
- UT4D with UR92 responding first: Since the UT4D sees a duplex radio transceiver, upon unplugging it will operate in duplex radio mode.
- UT4R with UR91 responding first: Since the UT4R sees a simplex radio receiver, upon unplugging it will operate in simplex radio mode.
- UT4R with UR92 responding first: Since the UT4R does not see a simplex radio receiver, upon unplugging it will assume IR mode.

Note: when a throttle is plugged into the same LocoNet jack multiple times the URs may respond in a different order. If you plug a throttle into LocoNet at other places around the layout you may again get a different order of response.

If a UR90 receiver responds first the throttle will assume IR mode when it is unplugged. DT400 and DT402 throttles will display IR:nn. If IR mode has been disabled in the throttle options a DT402 throttle will display Idle.