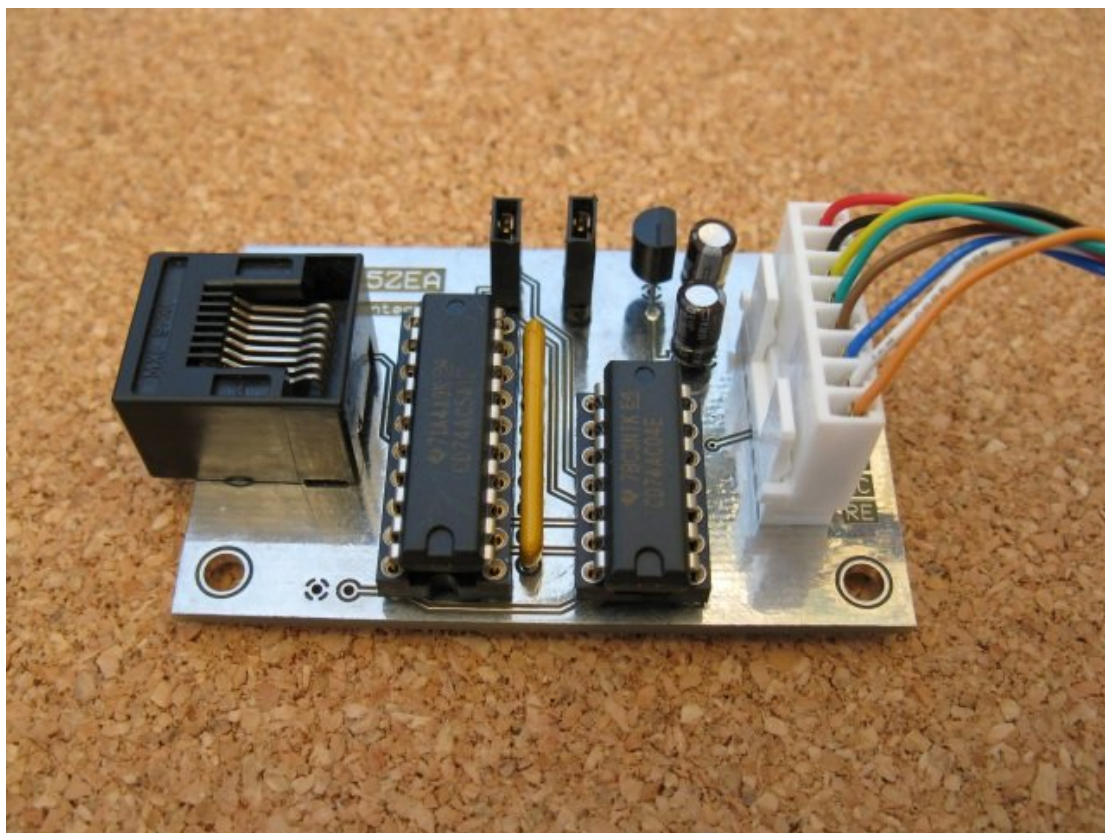


# Icom ID-RP2C to DV Node Adapter Interface



## Implementation Guide v1.1

by

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## Document Revision History.

V0.1	Original test draft.
V0.2	Add Revision History on Page 2.
V0.3	Proof reading and grammar checking.
V0.4	Add extra picture. Change wording in some sections.
V0.5	More changes, improving readability.
V0.6	Add tables, more tweaking.
V1.0	Release version 1/1/2011.
V1.1	Minor changes to punctuation.

## **What does it do?**

This simple interface circuit can be used to connect a DV Node Adapter and suitable RF hardware to an Icom ID-RP2C D-Star controller.

The ID-RP2C Interface is for owner/operators with an existing D-Star repeater using the Icom ID-RP2C D-Star controller who wish to experiment with or implement alternative RF hardware.

The ID-RP2C Interface plus a DV Node Adapter PCB and suitable RF equipment can then plug directly into one of the RJ45 sockets on the back of an Icom ID-RP2C D-Star controller instead of, in place of or in addition to an existing Icom repeater module/s.

This interface also opens up exciting possibilities with establishing a D-Star repeater on bands not supported by Icom RF hardware. With the release of the Icom IC-9100 radio that can operate D-Star on 6m and 10m, plus other homebrew methods of operating D-Star on the lower bands, the operational range of a single D-Star repeater could extend across an entire continent or even around the world!

I won't go into how to check and/or configure the ID-RP2C D-Star controller in order to add another repeater module. There are plenty of resources available on the Internet that covers how to do this. If you have existing experience in establishing an ID-RP2C based D-Star repeater, you should have no trouble with using this interface together with a DV Node Adapter and suitable RF hardware.

Likewise, will I not be describing how to perform a fresh install of the RS-RP2C Icom G2 software, updates and add-on software if you do not have an existing operational ID-RP2C based gateway. As mentioned before, there are plenty of resources on the Internet to help you with this.

## Why?

There are two main applications where this the ID-RP2C Interface would be used:

- 1) To augment an existing operational Icom G2 repeater system with another band. As mentioned before, this could include amateur bands not currently supported by Icom RF hardware.
- 2) To replace an existing Icom repeater module connected to an Icom G2 repeater system due to hardware failure or other reasons.

If you don't already have access to an ID-RP2C controller based repeater/gateway, there are other options you can explore that don't require you to purchase an ID-RP2C D-Star controller!

You can use the popular Windows based DVAR Hot Spot software to build a D-Star compatible repeater with Dplus linking. Or you can use the G4ULF NI-Star (StarGate) software to build a fully Icom G2 compliant repeater with all the functionality of a "genuine" Icom G2 system.

At the time of writing, the DUTCH\*Star firmware will soon allow a DV Node Adapter to support stand-alone D-Star GMSK repeating without the need for an attached PC.

There are other software based D-Star repeater and gateway software solutions "out there" that can be used instead of Icom hardware and software, but these fall beyond the scope of this document. If you are interested in this avenue, Jonathan Naylor G4KLX is doing fantastic work with PC sound card based D-Star repeaters, gateways and client software. Check out these Yahoo Groups:

<http://groups.yahoo.com/group/pcrepeatercontroller/>  
[http://groups.yahoo.com/group/dstar\\_development/](http://groups.yahoo.com/group/dstar_development/)  
<http://groups.yahoo.com/group/ircDDBGateway/>

Basically, if you don't already have an Icom ID-RP2C controller, don't go buying one just to use this interface... unless it's real cheap!!

## Prerequisites

In this document, the term DV Node Adapter refers the many currently available USB connected GMSK modems that are commonly used to create “Hot Spots”, simplex connections into the Dplus internet linking system using analog FM radios to transmit/receive D-Star compatible GMSK data. There are several suppliers of DV Node Adapters.

Satoshi Yasuda 7M3TJZ is the original designer of the DV Node Adapter hardware and more info can be found at his web site. He currently sells pre-assembled DV Node Adapters with his own firmware.

[http://d-star.dyndns.org/node\\_adapter.html.en](http://d-star.dyndns.org/node_adapter.html.en)

Fred van Kempen PA4YBR from Microwalt/DUTCH\*Star sells both DV Node Adapter kits and his own DV Node Adapter firmware.

<http://www.dutch-star.eu/>

Mark Phillips G7LTT/NI2O from ENIComms sells DV Node Adapter kits with PICs programmed with the DUTCH\*Star firmware.

<http://www.gmskhotspot.com/>

I based my ID-RP2C Interface experiments around a v01.01 Satoshi DV Node Adapter running DUTCH\*Star v01.0.00F firmware.

The “brain” of the DV Node Adapter is a PIC18F2550 processor; this can be loaded with several different versions of firmware. While the PIC is not used for data I/O in this application, it is required to control the receive section of the CMX589 GMSK modem chip and as such needs to remain connected to the DV Node Adapter PCB.

It is assumed that you are familiar with the hardware aspect of the various DV Node Adapters that are currently available and how to connect them to suitable duplex RF hardware. If you haven’t already, I suggest you head over and join the gmsk\_dv\_node Yahoo Group for more information and to find amateurs experienced with the different DV Node Adapter hardware variations.

[http://groups.yahoo.com/group/gmsk\\_dv\\_node/](http://groups.yahoo.com/group/gmsk_dv_node/)

## What radios should I use?

Here are some quick tips to selecting suitable radios to build a DV Node Adapter based GMSK repeater.

- 1) Your repeater radios need to be pure FM and not PM (Phase Modulation). During my initial DV Node Adapter experiments, I had lots of trouble with transmitting GMSK on a commercial radio that was eventually tracked down to phase modulation on transmit.
- 2) They need Narrow FM mode (12.5KHz spacing). A 6.25KHz spacing radio would be better, but these are far less common.
- 3) The transmit radio needs to be suitable for high duty cycle operation at the power levels you want. If your repeater is linked to a busy Dplus reflector the duty cycle can be very close to 100% for extended periods during popular nets. This requirement will rule out a lot of “amateur” style radios. Most of these radios will not tolerate high duty cycle operation and will quickly fail due to overheating, even with external fan cooling.
- 4) The DV Node Adapter needs flat discriminator audio output from the receiver with no de-emphasis or other filtering. Audio input also needs to be flat with no filtering and good LF response. If your radio has a data or telemetry mode you should enable it.
- 5) Setting the correct transmit deviation is very important for reliable operation, as is making sure the audio input of the DV Node Adapter is receiving the correct audio level. It is recommended that you follow the appropriate DV Node Adapter instructions for radio interfacing and visit the gmsk\_dv\_node Yahoo Group for further information.  
I set my DV Node Adapters so that transmit deviation is in the +/- 1.3-1.6 kHz range.

There is one potentially serious limitation imposed with the ID-RP2C Interface that you do need to be aware of. This is that you cannot increase the transmit delay if your selected transmit radio can't key up fast enough. In a traditional DV Node Adapter/DVAR Hot Spot combination, you can adjust the TX Delay Time in the DVAR Hot Spot settings to allow for radios with a slow(er) transmit key up time. The transmit delay is preset in the ID-RP2C D-Star controller and cannot be changed... at least not that I know of.

If your transmit radio cannot key up fast enough, it's quite possible that receiving stations will not decode the D-Star header correctly. Technically, this also means that your repeater will not be identifying properly and this might be in violation of your repeater licence conditions.

It's possible that some kind of digital delay circuit could be inserted in the Transmit Data line to delay the transmitted data until after the radio has properly keyed up. But then you could run into issues at the other end of the transmission with the radio un-keying before all the data has been transmitted. It's far easier to use a different radio for transmit!

Generally speaking, I can't see that the transmit delay issue will be much of a problem with most modern radios... but it is something that you do need to be aware of.

## The Prototype/Experimental Repeater

The VK5REX C 2m D-Star repeater uses two Simoco SRM9000 series VHF radios. I found the SRM9000 radios to perform admirably as GMSK/D-star compatible radios with an efficient RF PA section and excellent receive front-end selectivity and sensitivity. During the initial testing phase, VK5REX C was running on two vertically separated antennas with NO extra external RF filtering.



Image 1 – The SRM9000 based VK5REX C 2m D-Star repeater with the prototype ID-RP2C Interface.

You can find some demonstration videos showing the VK5REX C D-Star repeater on YouTube. Search for VK5REX or VK5ZEA.



## Interface Description

The interface consists of a 74AC541 line driver/buffer IC, a 74AC04 hex inverter IC, a 3.3V regulator and a handful of discrete supporting components including an RJ45 socket.

The 74AC541 and 74AC04 IC's are powered by the 3.3V regulator which is in turn powered by 5V from the DV Node Adapter. Powering the 74AC541 with 3.3V was done to retain voltage level compatibility with the ID-RP2C repeater ports. In "genuine" Icom D-Star RF hardware, the data interface is also based around a 74AC541 line driver/buffer IC and a 3.3V rail powers it. The DV Node Adapter circuit has no problems being driven by 3.3V logic levels.

I chose the LP2950ACZ-3.3 3.3V regulator as it was readily available from my component supplier. Virtually any TO92 package 3.3V regulator will work fine with this circuit, just make sure to get the input, output and ground pins defined properly for your device and install appropriate bypass capacitors as needed, especially if your "umbilical" cable is long. Remember... repeater sites can often be a potential RF nightmare!

All eight 74AC541 inputs (including the two unused inputs) are tied low with an 8 way bussed 3.3k resistor pack. There is some flexibility with this and if a 3.3k resistor pack isn't readily available, a 10k pack has been proven to work satisfactorily as well. Alternatively, discrete resistors can be bussed to make your own "homebrew" resistor pack if you cannot source a ready made one.

The RJ45 sockets found on the back of an ID-RP2C controller each have six control lines plus ground and a RSSI input. RSSI is not used by the ID-RP2C and can be ignored.

1	TC (Transmit Clock)
2	TD (Transmit Data)
3	Ground
4	TE (Transmit Enable)/(PTT)
5	RE (Receive Enable)/(COS)
6	RSSI (Receive Signal Strength Indicator)
7	RC (Receive Clock)
8	RD (Receive Data)

TE (PTT) and TD are outputs from the ID-RP2C to the repeater, all other lines are inputs from the repeater to the ID-RP2C.

All lines in and out are buffered through the 74AC541 IC on the ID-RP2C Interface.

The PTT and Transmit Data (TD) pins (both configured as outputs) of the PIC18F2550 chip on the DV Node Adapter PCB need to be isolated from the rest of the DV Node Adapter circuit. This is to prevent any potential for data corruption or accidental keying of the RF hardware due to the action of the PIC firmware.

The COS (RE) line on the DV Node Adapter PIC socket is inverted to what the ID-RP2C expects to see (active high on a received signal); so one inverter in the 74AC04 IC takes care of that. If the receive radio has an active high COS, this is taken care of by selecting various jumpers on the DV Node Adapter (refer to the appropriate radio interfacing instructions). The PIC firmware expects a low going COS signal to indicate that the radio is receiving.

It is also possible to utilise a Signal to Noise ratio based COS on the DV Node Adapters that have an onboard or add-on Digital COS circuit. This monitors the S/N pin on the GMSK modem chip to indicate that a valid incoming D-Star signal is present and then sends the COS pin on the PIC chip a low logic level. If this option is used then a COS line from the receive radio is not required and the ID-RP2C Interface will utilise the S/N ratio derived COS from the Digital COS circuit instead.

The polarity of the TE (PTT) line from the ID-RP2C is correct and the buffered TE signal from the ID-RP2C Interface directly controls the PTT transistor on the DV Node Adapter PCB. The PTT LED can either be connected directly to the PTT transistor control line or can be controlled by it's own PIC output depending if the DV Node Adapter board has been modified or can be hardware jumpered for RSSI reporting or not.

Two other inverters in the 74AC04 IC are used to invert the TD and/or RD lines if needed.

In a normal DV Node Adapter application, the PIC firmware handles the need for any polarity inversion of the data streams to/from the GMSK modem IC. The receive data polarity can either be auto detected by the PIC firmware or set to normal or inverted. The transmit data polarity can also be inverted in the PIC firmware. These settings are changed via the DV Node Adapter setting software (NAWinCFG for the DUTCH\*Star firmware).

This is to take into account the various radios that can be used with the DV Node Adapter hardware and the effect their audio stages have on the polarity of the GMSK data.

When a DV Node Adapter is used with the ID-RP2C Interface, D-Star data does not flow through the PIC in the usual way so any data inversion (if needed) needs to be taken care of in hardware... also be aware that some commercial data radios can perform this function internally via programming.

Some dual band VHF/UHF radios have been shown to require different inversion depending on which band is being used. This is very much a “suck it and see” situation with the inversion setting depending on what radios you are using with the DV Node Adapter.

As an incoming received D-Star signal is still processed by the PIC firmware in order to control the receive section of the GMSK modem IC, it is recommended to leave the PIC receive polarity setting in auto detect. This is done through the firmware setting software, NAWinCFG for the DUTCH\*Star firmware.

You also need to verify if your DV Node Adapter hardware and PIC firmware has the RSSI (S/N) reporting mode enabled or not. Although the RSSI reporting information is not used by the ID-RP2C Interface, this mode reassigns the function of several of the PIC I/O pins. If this isn't taken into account when connecting the ID-RP2C Interface to the DV Node Adapter, it will prevent proper operation of the ID-RP2C Interface

The DUTCH\*Star PIC firmware also has an option that detects an incoming D-Star signal by trying to identify the D-Star transmission header data in real time. This is called a softCOS and does not provide a logic indication on the COS pin of the PIC for the ID-RP2C Interface to operate from. This mode will not allow proper operation of the ID-RP2C Interface and I recommend that this be disabled and either a radio based COS or Digital COS input be used. Make sure there is a tick in the COS Check box in the NAWinCFG Mode Settings window.

## Construction

The ID-RP2C Interface isn't overly complicated and construction technique isn't critical.

The prototype/development unit was constructed on stripboard and at the time of writing this document is still in operation at the VK5REX repeater site. What you see in the various VK5REX D-Star YouTube videos is how the repeater has remained for almost a year! As an RJ45 socket does not lend itself to be easily placed on a grid based prototyping board, I used a small RJ45/PCB assembly with a short ribbon cable. In true junk box special fashion, you could even terminate the cable between the ID-RP2C and the interface directly to the interface board thus bypassing the need for another plug/socket.

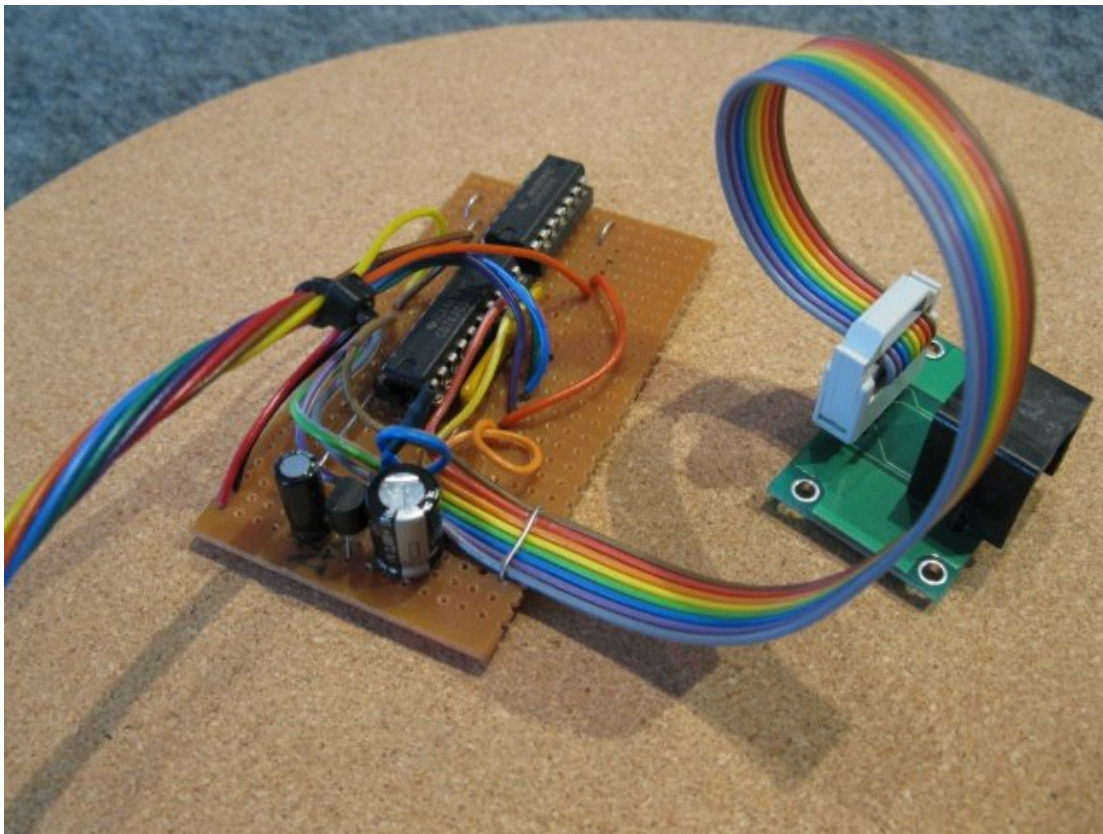


Image 2 – The prototype ID-RP2C Interface built on stripboard.

The ID-RP2C Interface connects to the DV Node Adapter PCB via the PIC18F2550 socket. The pins that you need to connect to are as follows;

	Non RSSI mode	RSSI mode
TD	2*	7*
TC	22	22
TE (PTT)	3	3
RD	24	24
RC	21	21
RE (COS)	25	25
5V	20	20
GND	8	8

\* This is the pin that will change depending if the DV Node Adapter PCB and firmware is enabled for RSSI Reporting or not.

When I started experimenting with the prototype ID-RP2C Interface I did not want to permanently modify the DV Node Adapter PCB. I also wanted something that could easily be removed and the DV Node Adapter returned to normal operation without too much trouble.

I came up with the idea of a 0.3" 28-pin header matched to a 28-pin IC socket with a short cable loom to connect the interface to the DV Node Adapter. This method allowed an easy way to keep the PIC in circuit but isolate the TD and PTT pins of the PIC from the DV Node Adapter. By cutting these pins short on the IC socket before it is soldered on top of the header, I didn't need to modify the DV Node Adapter PCB at all.

As I was not able to find a 0.3" 28-pin header from my regular component suppliers in Australia, I glued two 14-pin headers together with cyanoacrylate adhesive. Eight wires are soldered to the appropriate pins on the header (see table above), and then a 0.3" 28-pin IC socket (with the TD and PTT pins cut short) is carefully soldered on top of the header. These wires are then terminated on the ID-RP2C Interface circuit board.

I have used the free ExpressPCB software to design a simple double-sided PCB for those that want a more professional looking ID-RP2C Interface. This board can be seen on the front page of this document. I was fortunate that Dan Woodie KC8ZUM had enough faith in my design to get a run of PCB's made and send me a couple out of the batch. I can email the ExpressPCB file to anyone interested. My email address is also on the front page.

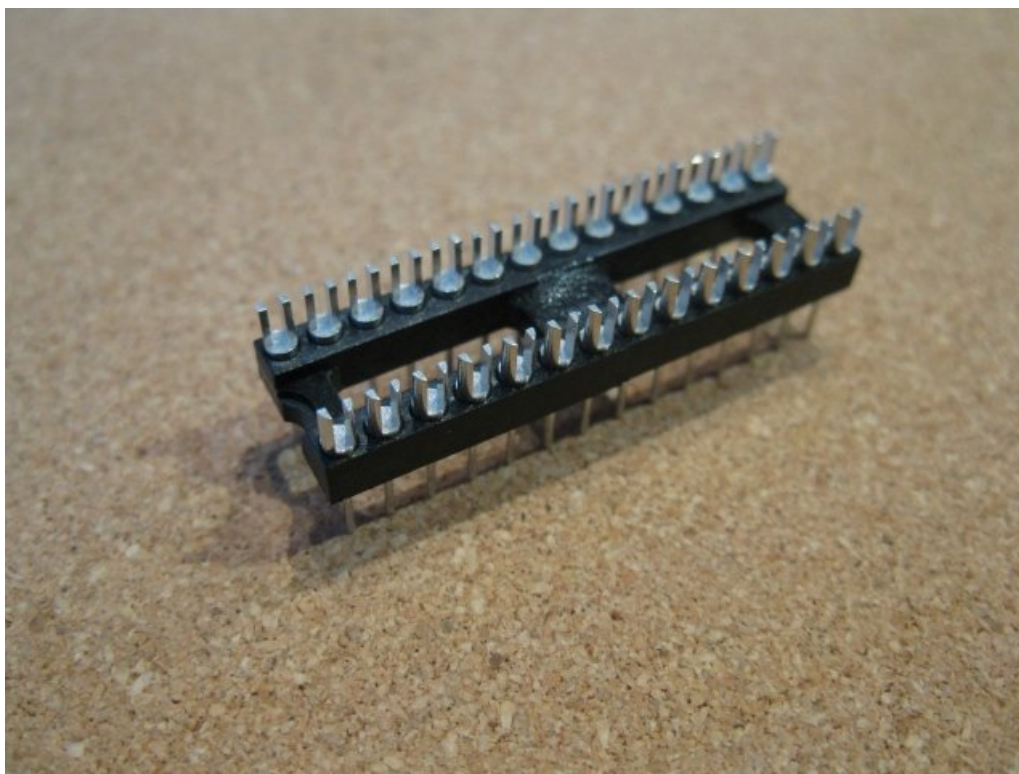


Image 3 – Two 14pin headers glued together.

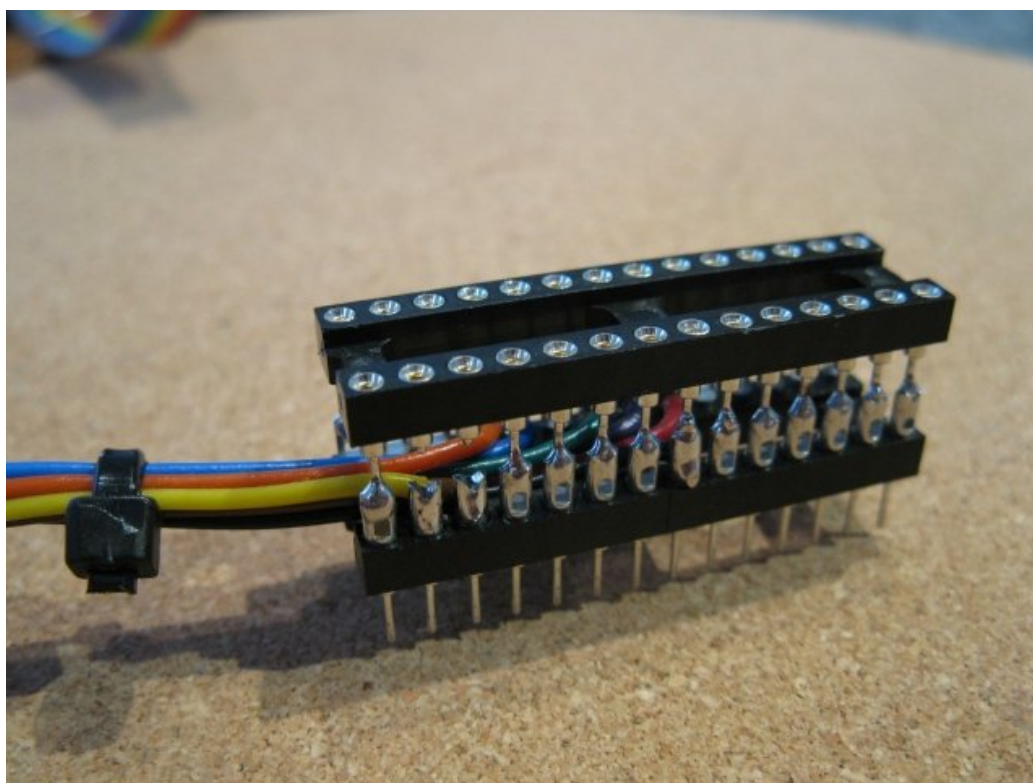


Image 4 – Completed Header/IC socket assembly (note pins 2 and 3 cut short).



Another way to connect the ID-RP2C Interface is to directly solder wires to the PIC socket on the bottom of the DV Node Adapter PCB. This method requires you to remove the PIC from the socket and carefully bend the TD and PTT pins PIC outwards so they do not engage into the IC socket when the PIC is replaced.

Both of these connection methods require the PIC on the DV Node Adapter board to be socketed. This might present a problem to those with the newer versions of Satoshi Yasuda's pre-built DV Node Adapter as the PIC is soldered directly to the PCB. It might be possible to remove the PIC from the board and fit a socket, but I would recommend that this only be attempted by those confident with desoldering techniques... it's very easy to damage the PIC and/or PCB with too much heat.



Image 5 – Header/Socket with installed PIC plugged into my DV Node Adapter PCB.

## Testing

I recommend that you test your DV Node Adapter based repeater with the DVAR Hot Spot software before using it with the ID-RP2C Interface and your ID-RP2C based repeater and gateway. This ensures that you have interfaced the radio/s to the DV Node Adapter properly, thus helping to eliminate the possibility of future frustration at the repeater site. You can also use the Echo Test function of the DUTCH\*Star Test Utility software to test the DV Node Adapter & radio hardware.

As mentioned before in this document, transmit deviation is critical for proper operation and over deviating will cause many problems. If you have access to a radio service monitor, aim for a ballpark deviation around +/- 1.5 KHz. You can roughly set the transmit deviation level by ear, judging how "loud" the transmitted audio sounds compared to an Icom D-Star radio while listening to both via an ordinary N-FM radio. You don't want your repeaters transmissions to sound any "louder" than those from an Icom D-Star radio. The Utah VHF Society has some great info on their web page on how to use conventional radio test equipment with D-Star systems. [http://utahvhfs.org/dstar\\_testing.html](http://utahvhfs.org/dstar_testing.html)

Once you have your DV Node Adapter based repeater working properly with the DVAR Hot Spot software or the DUTCH\*Star NATools Test Utility software, you can then be confident that it will work when connected to your ID-RP2C Controller via the ID-RP2C Interface. Remember, you may need to experiment with the hardware data inversion after connecting the IR-RP2C Interface to the DV Node Adapter board.

If you are using your new ID-RP2C Interface/DV Node Adapter based repeater in addition to an existing Icom repeater on your gateway, you will also need to re-run the D-Star Monitor install script to add the details of the new repeater to your gateway and `dstarmonitor.properties` configuration file.

While the new repeater will work without doing this, you will find that any GPS enabled D-Star transmissions might not find their way into the APRS-IS system. Transmissions also might not appear on the [www.dstarusers.org](http://www.dstarusers.org) web page.

As mentioned before, it is very important to ensure that your repeaters transmit radio can key up fast enough to properly transmit the D-Star header data. Please check this after connecting your ID-RP2C Interface/DV Node Adapter repeater to your ID-RP2C based gateway. This is how your repeater identifies its transmissions!!



