

# **Interfacing an S-Com 7330 to a GE Mastr II Repeater/Station**

(As implemented by Justin Reed (NØUJQ) for the K-Link Repeater System, December 2009)

## **The Goal**

After reading this paper and following the directions you will have your 7330 interfaced to your GE Mastr II station using only a single point connection (the Mastr Controller jack J1).

## **Introduction**

For many years, the GE Mastr II series of repeaters and stations have been known for their audio quality, robustness in harsh conditions and all-around reliability. In the past, there have been many different controllers available to the amateur radio repeater builder that allow a Mastr II to be adapted to conform to Part 97 rules of the Amateur Service, but perhaps none of those are as versatile or as easy to install as the new S-Com 7330 Repeater Controller. The method of interfacing the controller detailed in this paper is the result of years of study, work, and careful evaluation of each installation to provide the maximum utility of both the repeater and the controller, while maintaining maximum audio quality and squelch response.

This paper describes interfacing the 7330 controller to the Mastr II repeater/station with the original motherboard and card cage (19D417214G1, G2) using the Mastr Controller jack on the backplane. It does not cover interfacing to the newer IDA shelf or the Mastr IIe shelf. This article assumes you already have a fully working Mastr II base station or repeater tuned up on your frequency. If this is not the case, consult the proper LBI for tuning your station. Band or frequency specific items are not discussed in this paper. Be sure to align your Audio/Squelch (IFAS) card, receiver and transmitter exactly as described in the alignment portions of the GE LBI set.

If you have a Repeater Control board, and the Repeat Audio card for the Mastr II station, you can use those cards in a back-up situation should the 7330 fail for any reason. It is important, though to use only the Remote Audio card (Remove the Repeater Control card) while the 7330 is connected.

In most cases in the K-Link system, Port 1 of the 7330 is for the local “busy” or “club” repeater, usually the 2 meter one if the site has both 2 meter and 70cm repeaters. Port 2 is connected to the 70cm “backbone” repeater, and Port 3 is connected to the link transceiver that provides the connection to the rest of the K-Link network. In a couple of special cases where K-Link is bridged to another link system, Port 1 is connected to the repeater, Port 2 is connected to the link transceiver for the system we are bridging to, and Port 3 is connected to the link transceiver that connects to K-Link. In yet another special case, Port 1 is connected to the “hub” repeater of K-Link, Port 2 is connected to the 2 meter wide-area repeater, and Port 3 is interfaced to an Echolink box. All ports of the 7330 have equal functionality so it is not important which radio is connected to which port. The important thing is to develop a standard way of doing things for your system, and document it well so that others that may have to work on it while you are not available can have an easier time understanding how the system works.

## Items required to complete this installation

### You will need the following tools:

- Communications Service Monitor
- (Preferably) Fluke True RMS Multimeter
- Set of alignment tools
- Soldering station & solder
- Assorted basic hand tools
- Molex pin extraction tool (Mouser 538-11-03-0006)
- Molex pin crimp tool (Mouser 538-63811-1000)

### You will need the following parts:

- Your 7330 controller complete with hardware
- Mastr II station with RF shelf and PA, your band(s) of choice, including
  - Crystals on your frequency
  - TS-32M2 or TS-64M2 plug-in CG decoder/encoder set to your tone (OEM PL Decoder can be used in a pinch, but may not stay locked on tone during voice transients. This part may be omitted if not using CG decode.
  - Old-style motherboard (19D417214G1, G2) (not the IDA or the Mastr IIe shelf)
  - 10V regulator card (19D417401G1)
  - Remote audio card (19A129924G3)
  - Plug-in channel guard filter board (if using CG decode) (19C320627G1)
- One (Mouser 538-03-09-2151) Molex 15 Circuit Plug for each station
- Ten (Mouser 538-02-09-2118) Molex crimp Pin for each station (order extra in case of mis-crimp)
- Two (Mouser 538-02-09-1119) Molex crimp Socket for each station (order extra in case of mis-crimp)
- Two (Mouser 80-T354E475M35AT) 35V 4.7uF 20% dipped Radial Tantalum Capacitors per station.
- One 680 Ohm resistor, 1/4watt or larger, per station
- One length of Belden 9539 shielded 9 conductor + ground cable. Enough to reach from the 7330 repeater port to the Mastr II's "Local Mastr Controller" jack (J1 on backplane) including a nice sweep loop on each end inside the cabinet. Order 100 feet of it here: <https://www.tselectronic.com>
- One length of (Mouser 602-1897C-100) Alpha 2C 18AWG DC power cable, long enough to reach from the 7330 power connector to the 10V terminals on the Mastr II station backplane, including a sweep loop on each end inside the cabinet.
- Ten spade terminals for 18AWG to be used on the Mastr II backplane screw terminals.

## **Mastr II Alignment and Initial Setup**

At this point you should have a complete GE Mastr II repeater, or single channel base-station that is working as if pulled directly from operational status. If you have a multi-frequency base-station, it may need converted to single channel as per GE's documentation.

### **Building the Interface Cable**

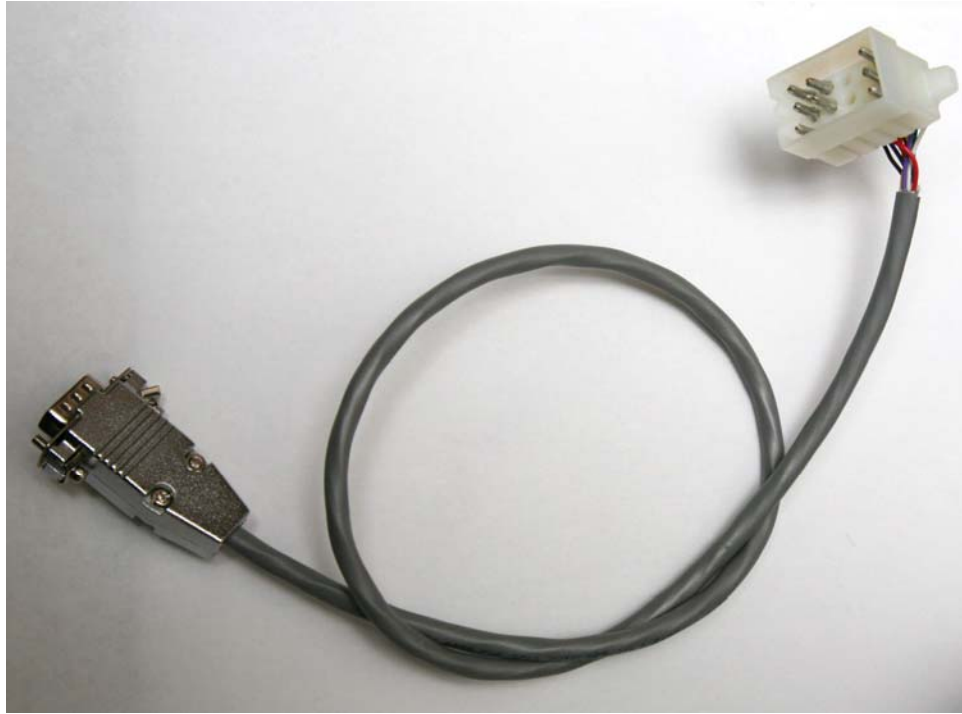
You'll need a piece of Belden 9539 multi-conductor cable. Strip back about 1.5" of the outer jacket on one end. Strip and tin just enough of the conductor of each wire of this cable to solder onto the DB9 connector (included with your 7330). The wires connect as follows:

- Pin 1 (RX Audio): White
- Pin 2 (RX CAS): Purple
- Pin 3 (RX CG Decode): Green
- Pin 4 (TX PTT): Red
- Pin 5 (TX Audio): Blue
- Pin 6 (RX Audio Ground): Orange
- Pin 7 (TX CG Ground): Brown
- Pin 8 (TX CG Out): Yellow
- Pin 9 (TX Audio Ground): Black & Shield

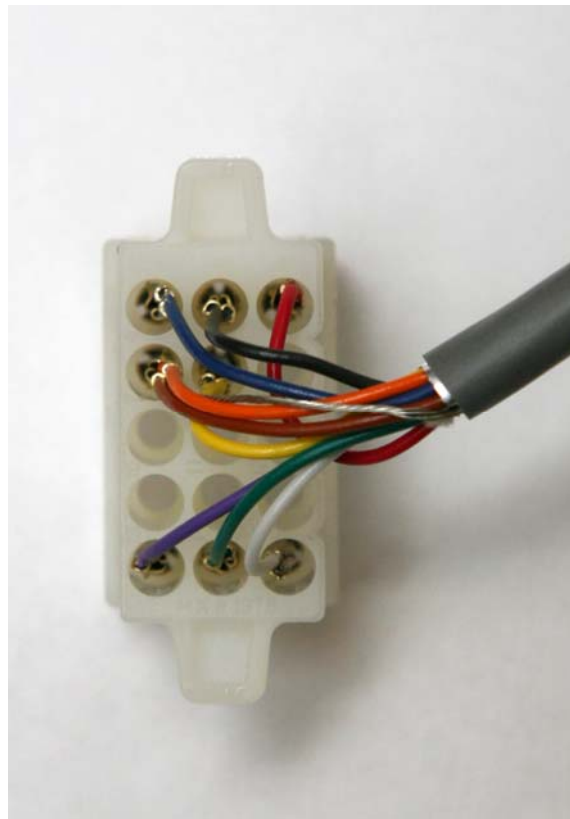
After each conductor is soldered to the DB9, double-verify your work, then fasten the metal hood. This completes this half of the cable. Next, strip back about 2 inches of the outer jacket from the opposite end, strip back about 3/16" of conductor, and carefully crimp a Molex pin (Mouser 538-02-09-2118) on the end of each conductor **except** for the shield, brown, and orange wires. Those three wires are grounds and they get crimped together into one pin. When each of the conductors are crimped, check them to make sure they are crimped securely. Using a small flat screwdriver, gently push each of the Molex pins into the Molex plug (Mouser 538-03-09-2151) as follows:

- Pin 1 (TX Audio): Blue
- Pin 2 (TX Audio Ground): Black
- Pin 3 (TX PTT): Red
- Pin 4 (Grounds): Shield, Orange, Brown
- Pin 5 (TX CG Out): Yellow
- Pins 6 through 12 *have no connection*
- Pin 13 (RX CAS): Purple
- Pin 14 (RX CG Decode): Green
- Pin 15 (RX Audio): White

When this is complete double-verify your work to make sure each pin is in the proper position. Your cable should look like the one featured on the next page.



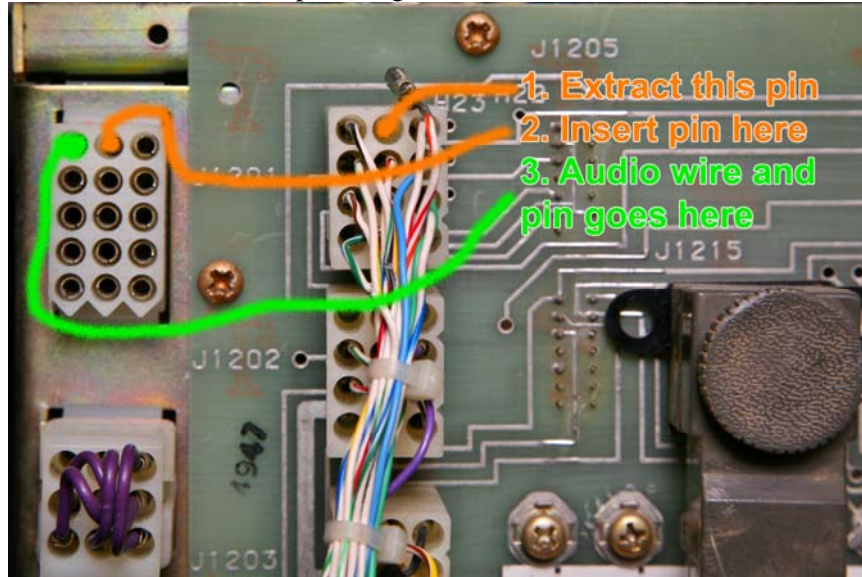
The completed 7330 to Mastr II interface cable (above).



A close-up view of the molex plug (above).

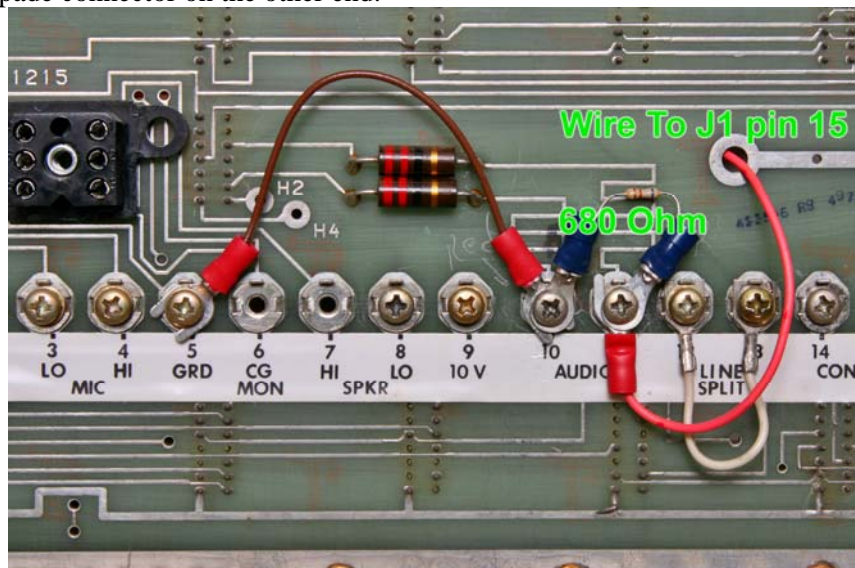
## Re-wiring the Mastr II Station Harness

Next we need to extract a few mox pins and move them around a bit to provide the required signals to the controller. The first pin you'll need to move is pin 11 of J1201 on the backplane using the mox extractor tool. This pin is labeled "CG Detect Out". This pin provides the logic from the CG Decoder (high when valid CG is received) and requires the use of the CTCSS pull-up jumper on the 7330, which will be discussed later. Pictured below is the location of the pin being removed:



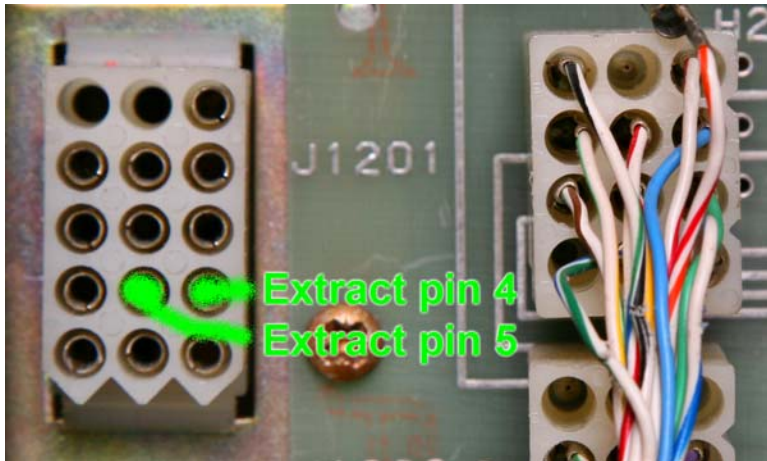
Gently fish this wire back through the loom all the way to the inside of the motherboard until it meets the "Y" where some of the harness goes to J1 and the rest goes to the motherboard connectors. Push the pin into #14 on J1 (pictured above).

Next, find a length of 22 AWG wire about 14 inches long. Crimp a female mox pin (02-09-1119) on one end, and crimp a spade connector on the other end.

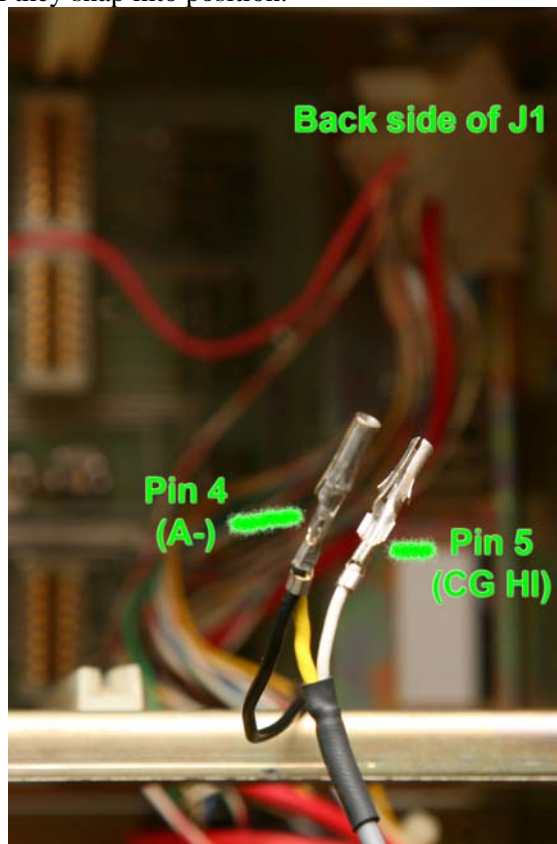


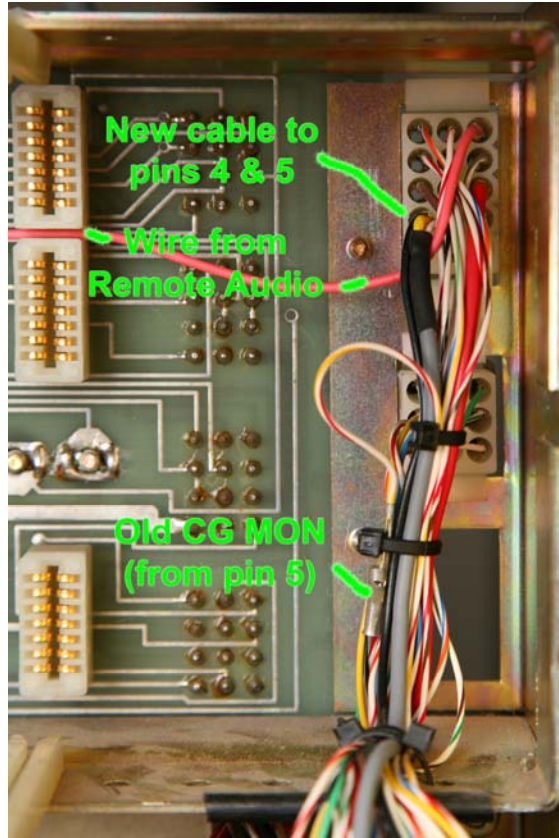
Use the photo above as your connections guide for your controller audio tap, how to place the 680 ohm termination resistor, and how to strap the "line split". You'll also need to strap GRD to the other side of the audio output. The female mox end of the audio wire connects to J1-15 as pictured in the first image on this page.



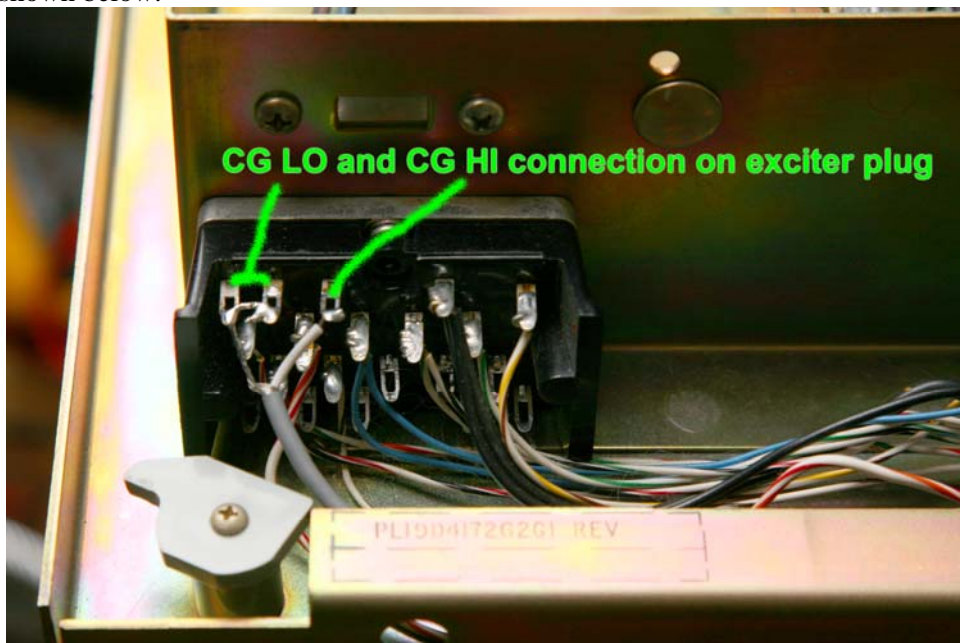


Now we're ready to wire from J1-5 to the CG HI connection on the exciter. First, extract J1 pins 4 and 5 as pictured above. Pin 5 is CG MONITOR from the factory, but we are going to re-assign it to CG HI, which will connect the CTCSS OUTPUT of the 7330 into the exciter. Pin 4 is A- (ground). Once you have extracted the pins, locate a piece of #22 long enough to follow the wiring harness from the back side of J1-5 all the way to the exciter plug on the RF drawer with sufficient slack so that the drawer can open and close fully without binding the wire. Preferably, this will be a piece of the shielded audio wire that can be found in Mastr II stations. After you have extracted pins 4 and 5, use a flat-bladed screwdriver and carefully press the ear of the molex jack (J1) to remove it from its mounting. If you have the shielded audio wire that GE uses in these stations (pictured below) you'll need to fish the A- (pin 4) wire out far enough to work with, and cut off the female molex pin. Grab a new pin and crimp the shield of your new wire along with the black A- wire. Then crimp a new molex pin onto the center conductor of the CG HI wire. Carefully push these two pins back into 4 and 5 together until they snap into position.

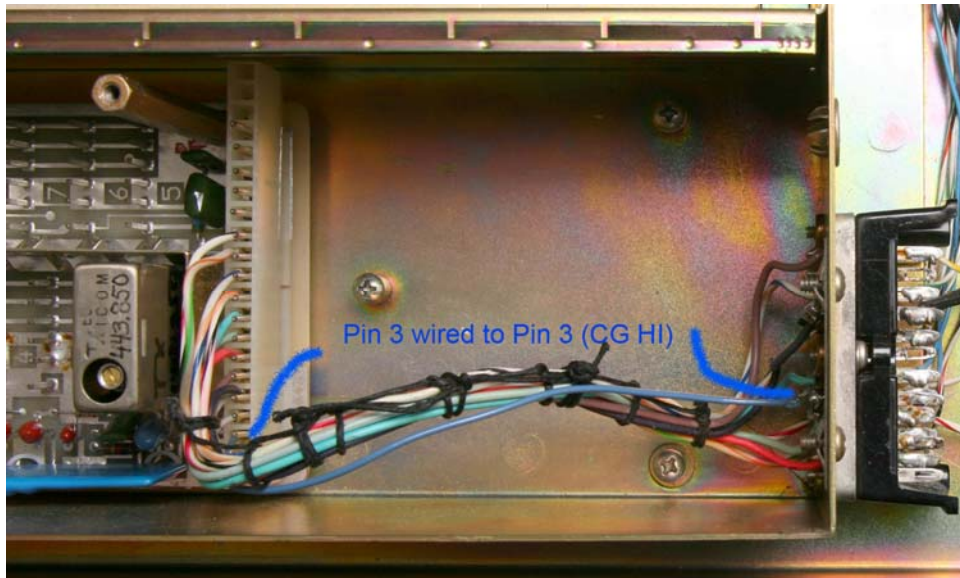




Once you have pushed pins 4 and 5 back into the shell of J1, you can remount the shell into the backplane. Use small zip-ties to dress the wires neatly along the side as it originally were, using one of the ties to secure the old CG Monitor pin so that it doesn't touch anything inside the station. The other end of the CG HI wire is cut slightly longer than needed, stripped and tinned, and soldered onto pins 1&2 for ground/A- and pin 3 for CG HI as shown below.



You will also need to make sure that the exciter board plug J933 pin 3 is wired to P901 pin 3 as pictured below (the blue wire is CG HI).

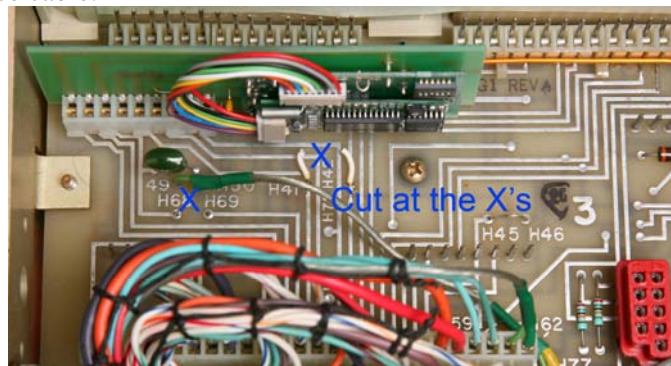


### Configuring the Master II Station System Board and 10V Regulator Card Options

Now we need to address some of the option jumpers on the station itself. You will need to setup your 10V regulator card for full duplex station operation as described by the LBI. If your station was a Channel Guard Repeater or Channel Guard Remote Station, the 10V card is probably setup correctly for you. If not, make the necessary changes then go on to the next section.

Take a quick look at your Remote Audio card. If the CG Filter board is installed, make sure jumper 1-2 is cut. If the CG filter board is not installed, make sure jumper 1-2 is present. While you have the card out, spray some tuner cleaner onto the Line Output pot and swish it back and forth many times to make sure the pot is cleaned. Then preset it at about the 1/3 clockwise position.

Now check the jumper configuration on the system board located at the front of the RF drawer near where the CG decode board plugs in. Make sure jumper 41-42 (couples RX MUTE to CG DET OUT) is removed. This allows the Remote Audio card to pass audio even if the signal doesn't have valid CG. Also, if you have the TS-64M2 decoder/encoder installed, jumper 68-69 (PTT path) must be removed. If no CG board is used, jumper 68-69 must be present. Since this is a single frequency station, install a jumper at 47-48. At this point you can install the interface cable.





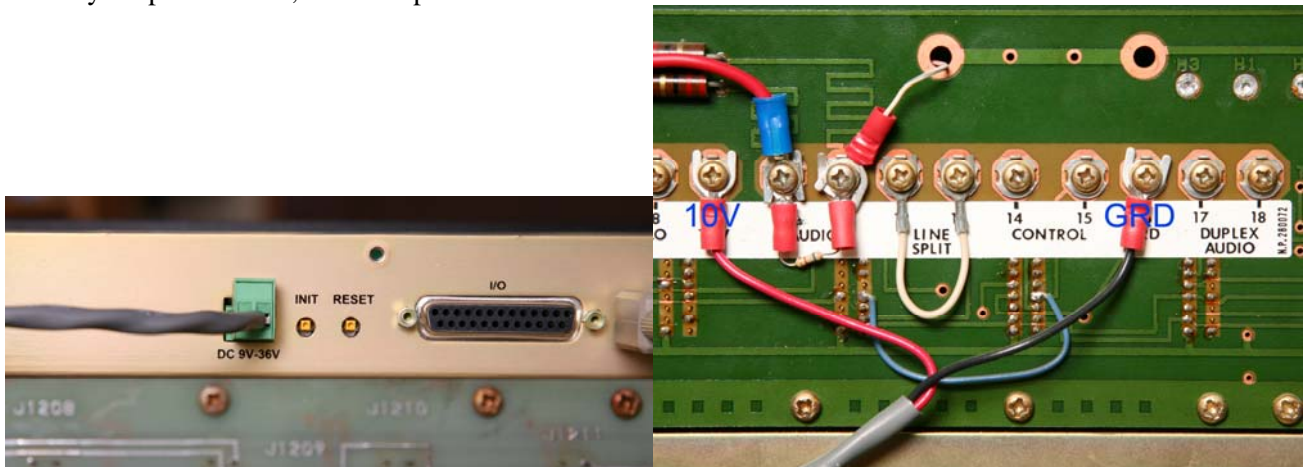
## Configuring the 7330 Input/Output Jumpers

Each of the 7330 RF Ports has a series of push-on jumpers (shunts) that allow you to invert the sense logic of inputs or outputs, or provide pull-up voltage for COR or CTCSS inputs. S-Com was kind enough to send a small bag with extra push-on shunts to facilitate virtually every possible configuration. With your Mastr II connected to the 7330, you'll need to configure the jumpers as follows (assuming you are using Port 1):

- Pull the shunt from J25 (COR1 PULLUP) and place it on J31 COR1
- Leave J26 (CTCSS1 PULLUP) in place
- If you are using CG Decode, place a shunt on J31 CTCSS1
- J10 jumpers should be set as follows:
  - Shunt OFF Deemphasis
  - Shunt ON Flat
  - Shunt OFF High
  - Shunt ON Norm
  - Shunt ON DLY
  - Shunt OFF NO DLY
- Make sure J37 #1 is set to CTCSS, not logic. This allows the CTCSS audio to be output to the exciter

## Building the Power Cable

Now you need to fabricate the power cable. This is straightforward, and the 7330 will accept anything from 9 to 36 VDC. The best place to get power is the 10V output on the backplane of the Mastr II, as there is one screw terminal that provides +10V and a screw terminal that provides A-. Belden 9409, or Alpha 602-1897C-100 (available at Mouser) is a PVC jacketed two-conductor 18AWG cable that works perfectly for this application. Of course any DC power cable will work. S-Com has supplied the push-in connector for one end of your power cable, and use spade terminals for the other end.



At this point it is safe to power up the repeater and controller. You should hear a power-on initialization message from the controller, after which the transmitter should un-key and none of the front status LEDs should be on (except the ON LED). A brief key-up on frequency should light up the COR, CTCSS (if used) and PTT for that channel.

## Modifying the Mastr II Fast/Slow Squelch Circuit

This is a modification that dramatically improves the squelch action of Mastr II stations and mobiles alike. The problem is two-fold. The slow squelch on the mobiles is not slow enough to hang on to weak signals as they flutter, and the fast squelch on station IFAS boards has been disabled by removing C630 (4.7uF) from the board. In addition, the slow squelch on the stations isn't really all that slow, just slow enough to leave a nasty "crunch" at the end of each transmission. That problem is easy enough to fix.

First, after verifying the repeater is powered down, you'll need to flip up the Receiver/System board tray to access the bottom, and remove the shield covering the bottom of the IFAS board. Then you may check to see if C630 is installed on your IFAS (Audio-Squelch) board. It can be either a metal can or a tantalum capacitor. If your IFAS board came out of a mobile, it should have it. If this is the case, you may leave it installed. If you suspect this capacitor is no longer good, replace it with a new 4.7uF tantalum (Mouser 80-T354E475M35AT). If your IFAS board does not have C630, then install it now. This capacitor enables the fast squelch circuit that provides a nice clean "click" when the repeater user un-keys their mike.

Next, carefully remove C631 and discard it. Take another 4.7uF tantalum capacitor and install in its place. This will increase the delay of the slow squelch, making a dramatic improvement in squelch action as a mobile station starts to flutter in and out on the fringe of repeater coverage. The way the dual squelch works is that any incoming signal that is "full quieting" will get the fast squelch closure when the signal disappears, but incoming signals that are weaker than "full quieting" will get the slow squelch closure.



When this squelch modification is coupled with the built-in Digital Audio Delay feature of the S-Com 7330, you can set 50 milliseconds of delay, which will eliminate the fast squelch burst from the repeater audio. However, weak signals with a slow squelch burst will still cause the 7330 to pass about 150 milliseconds of squelch noise through the repeated audio. This is actually useful, as the transmitting station can often hear their own delayed squelch burst just as they un-key their transmitter. At this point they can decide to move to a better location or use a higher output power.

## Making Your Repeater Sound Good

This is perhaps the most crucial but often overlooked part of building a repeater. A repeater with low, poor, distorted, or just plain loud audio is not pleasant for anybody to use. Fortunately, the S-Com 7330 has test points that allow you to set the audio on all three ports perfectly. The following instructions assume we're working with port 1 of the 7330.

First it is important to note that the 7330 transmit audio is being routed into the local mike audio, and is affected by the Local Mic adjustment on the 10V regulator card. I highly advise that you connect a microphone to the mic jack on the Mastr II backplane, say "ahhhhhh" loudly and adjust the Local Mic pot so that you just start to hit the exciter limiter at 4.4kHz deviation. You can turn the pot all the way up and then start to decrease it until you see the deviation start to drop. Be sure the microphone is not sounding too loud or distorted on another receiver. Now proceed to setting levels on the 7330.

You want to start out by injecting an on-frequency signal at the 1000uV level with a 1000Hz tone deviated at 3 kHz. This should key the repeater. Adjust the Line Output pot on the Mastr II shelf for an audio output of 1V RMS on the Mastr II backplane terminals marked "Audio". Briefly drop the signal so the time-out timer will reset.

Next, inject the same signal, and adjust the RX1 pot for 354mV RMS between TP9 and Ground on the 7330. At this point you have the proper audio level driving the DTMF decoder.

Now, turn the TX1 pot all the way up, and adjust the Mastr II exciter deviation pot to limit the deviation to +- 4.4 kHz. Now turn the TX1 pot down until the transmitter deviation is 3.0kHz. At this point you should be able to inject any amount of deviation and the exciter output will match it with good linearity up until about +-4.4kHz. Now, set the Mastr II exciter CG Deviation control to the half-way point, which is with the indicator tab straight up. Now, after programming the desired CTCSS tone into the 7330 you can adjust the CTCSS1 pot for +- 600Hz deviation. The total deviation of the transmitter should not exceed +- 5kHz.

**As of this writing**, the speech library in the 7330 is recorded 6db too low. Resist the temptation to compensate for this by running the RX audio too low and turning the TX audio up louder to make the speech louder. S-Com is working on re-recording the speech library at the proper level, and when this happens your audio will already be set at the proper level. You will also notice that your custom audio files sound just fine when played back. Save yourself a future trip to the site with the service monitor and set the levels correctly the first time!

## **Programming Your S-Com 7330**

The 7330 is such a powerful and flexible controller that there are literally an infinite number of functions it can provide for your repeater and your site in general. Therefore, it is beyond the scope of this paper to provide help with programming. You should, however, take advantage of the serial interface provided, which allows you to create and maintain the programming script in a simple text (.txt) file that can be readily uploaded to the controller.

### **If You Have Trouble**

If you reached this point and something is not working correctly, re-read the instructions and make sure you didn't miss anything. The most common problem that I run into is not getting Receive audio from the remote audio card. This is usually caused by either the jumper OR or the CG filter board is missing from the Remote Audio card, or perhaps the jumpers on the 10V Regulator card are not optioned correctly, which is causing the RX Audio to mute when the transmitter goes active.

### **In Closing**

I hope this paper has made the 7330 to GE Mastr II station easy and enjoyable for you. Several of the repeaters on the K-Link System were built exactly as described here, and we really enjoy them. Plus, they are easy to maintain!

Feel free to visit the K-Link website at:

<http://KSØLNK.wavedsl.net>

73 de NØUJQ

Justin Reed

K-Link Senior Technician