GE Master II Basics

‘North Alabama Repeater Association’

http://www.qsl.net/NARA

by
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Preface

Several years ago as the new NARA (North Alabama Repeater Association's) 'Technical Advisor' I decided to standardize our six repeater systems around the GE Master II series. Fortunately long ago our flagship 146.940 repeater, a GE Master II, was ordered factory direct from GE. However, all of our other 5 machines were a mixed collection of manufacturers. In standardizing on GE Master II's this allowed easy stocking of backup equipment and maintenance of only one type of hardware. This has been a multi-year project due to time/budget constraints.

This document was created to train members of our 'Technical Committee' to help in maintaining our repeater systems.

GE Master II Topics to be covered

- **GE Master II Base & Repeater Stations**
- **GE Master II Mobiles converted to a full-duplex repeater or link radio**
- **GE Master II Access Points for adding a ham controller**
- **+10 VDC regulator plug in card**
- **Repeat and Remote/Repeat Audio cards**
- **'Repeater' control card**
- **SOR Squelch Operated Relay card (used for COS)**
- **Base station System Interconnect Board**
- **GE and Communication Specialist PL encoder/decoders**
- **ICOM 'Channel Elements'**
- **Receiver preamps**
- **GE exciter and receiver modules**
- **FAN cooling**
- **12 VDC 30 Amp Continuous Duty Power Supply**
- **GE's 'NEW' IDA controller**
- **GE Voters**
- **Satellite voter receiver**
- **GE Test Set**

GE MASTER II Repeater
Front View

TX/RX Pull down drawer

Rotate knobs
to open

GE Rack
with Doors
removed

+13.8 VDC @ 30 A
Power supply

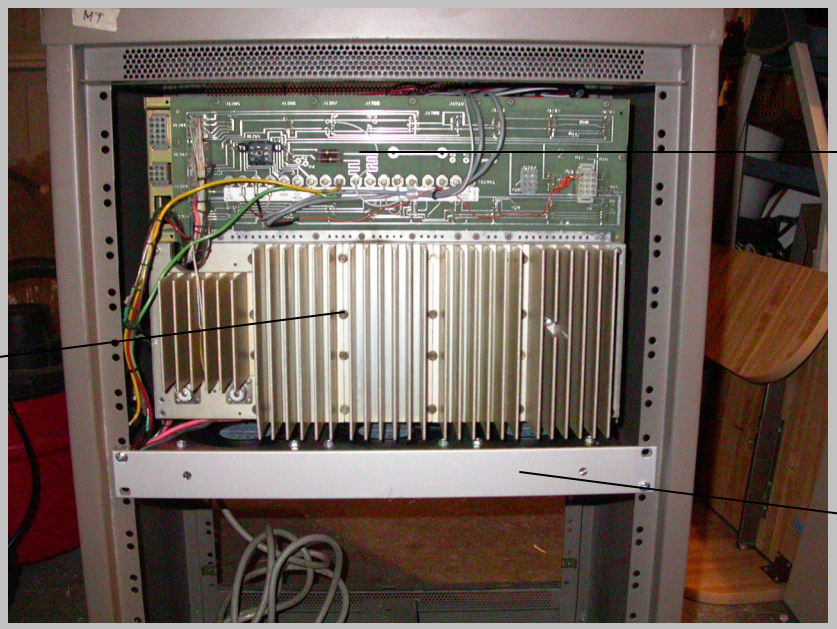
Control card rack

Space
for
Ham
cntlr

RF
PA

Top cover on RF deck
removed for photo.

GE Master II rear view



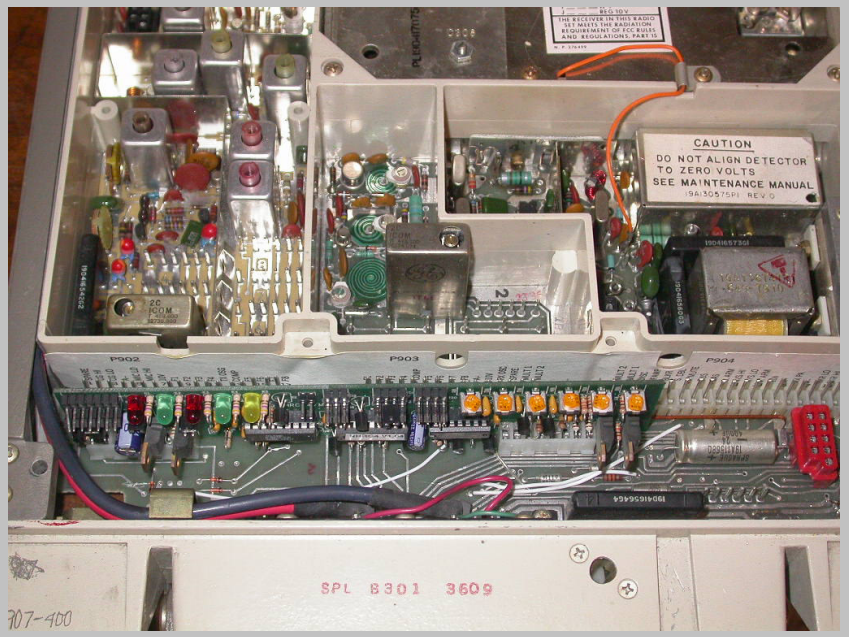
Rear of Card Rack

110 Watt Continuous duty PA.

1U rack mount Triple cooling Fans. (aftermarket)

GE Master II mobiles.

We convert these to backup repeaters and remote voter link radios.
UHF mobile shown with drop in NHRC-4 repeater controller



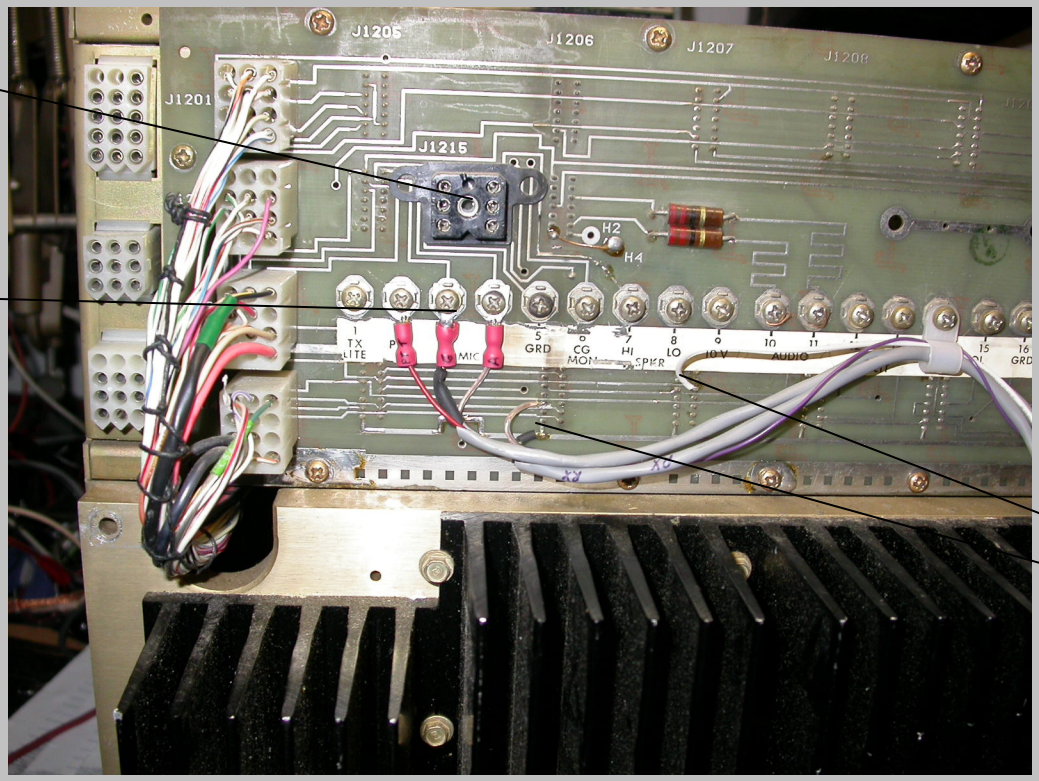
Mobile is modified for full duplex operation. Receiver can be swapped for other bands for remote voter applications..

Ham Controller Access Points

Along the back of the GE Master II card rack, we gain access to all points for tying this to a ham external rptr controller.

Local Hand Mike

TX connections

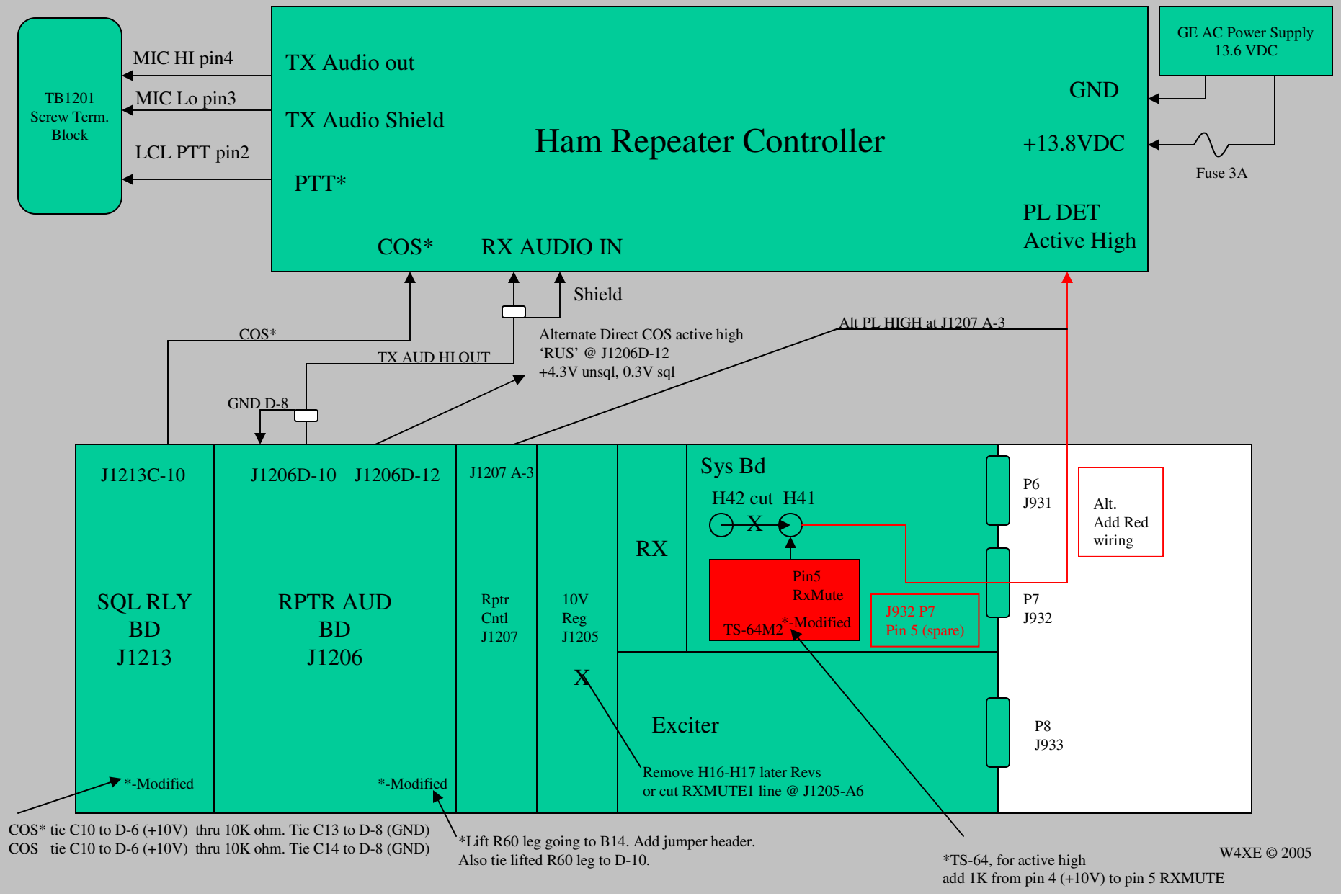


Receiver Access Points

Connection points to HAM repeater controller.
Screw terminals: TX audio (hi/lo) & PTT
Soldered points: Receiver audio and PL decode
Molex on Far right (not shown): COS from SOR relay card

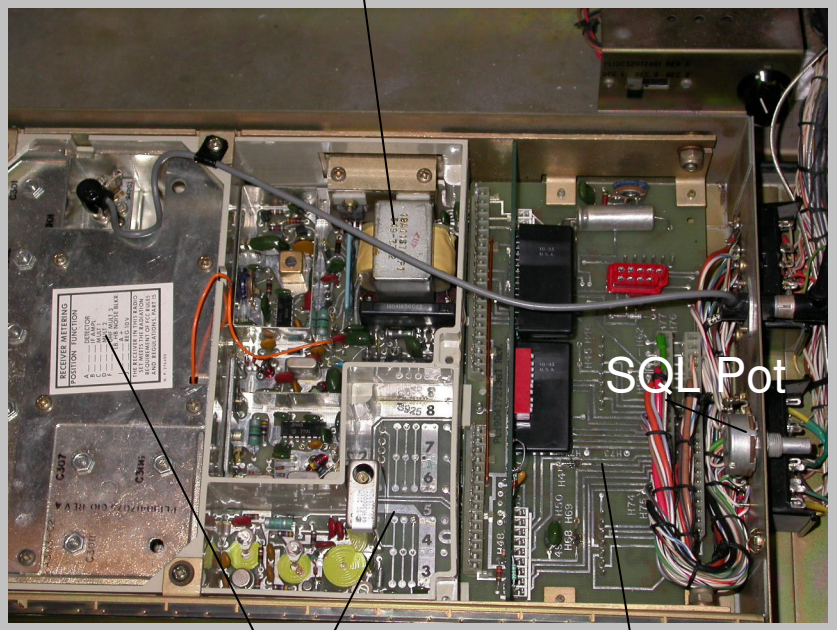
GE Master II BASE/REPEATER CONNECTIONS

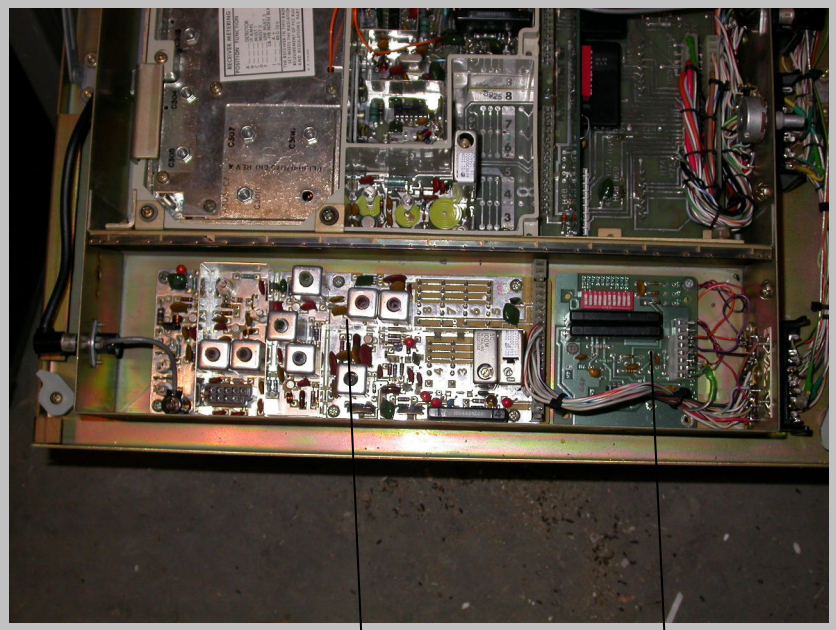
GE Master II
Repeater/Controller
W4XE 3/8/03 Rev 1



Radio Drawer
Pulls down for servicing

Audio/Squelch board





Receiver

System Board
(w/PL decoder)

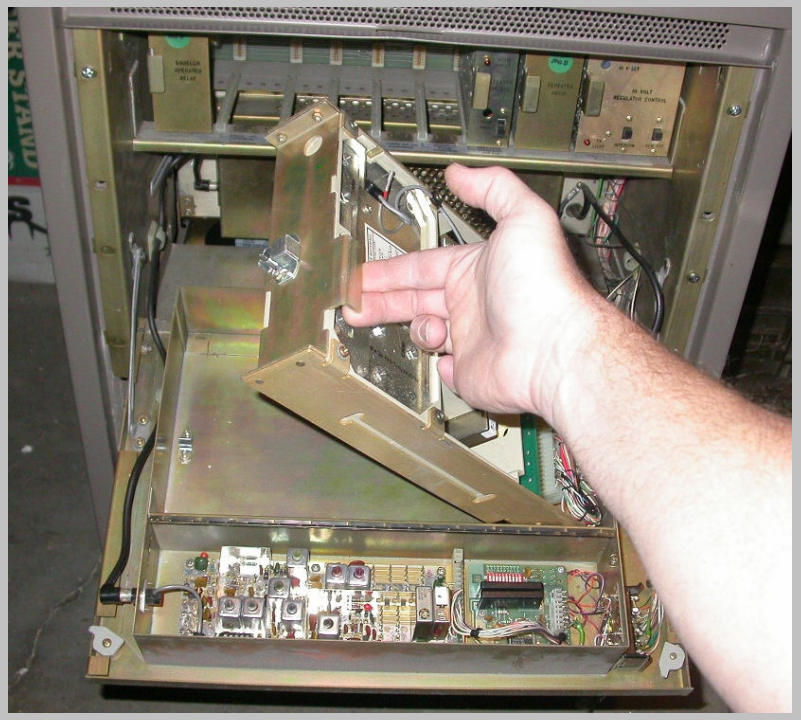
Exciter (250 mW)

PL encoder

Note: Rx and TX take separate ‘2C’ crystal/channel elements.

Service Access

RF Shield plates



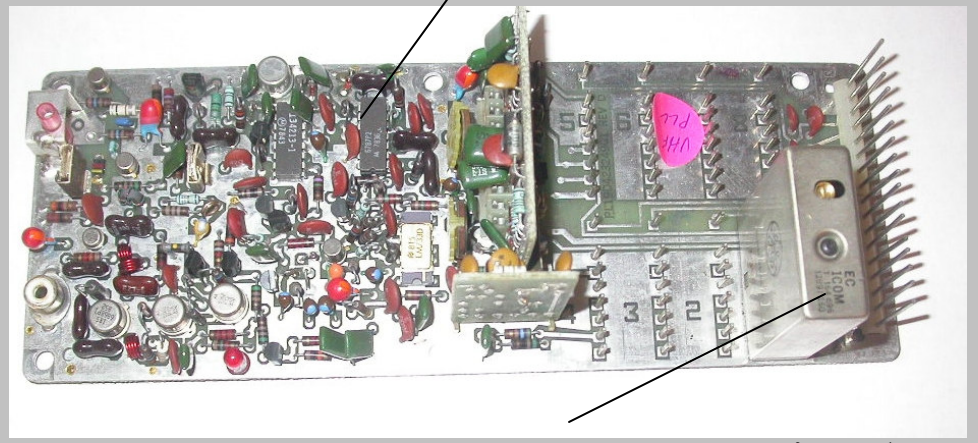
The RF drawer swings up to service the rear of the Receiver. To swap a module remove shields and screws.

Note-screws are different! Replace EXACTLY where they were originally!

GE Master II exciters @ 250 mW

Standard
Non-PLL (6 mtr shown)

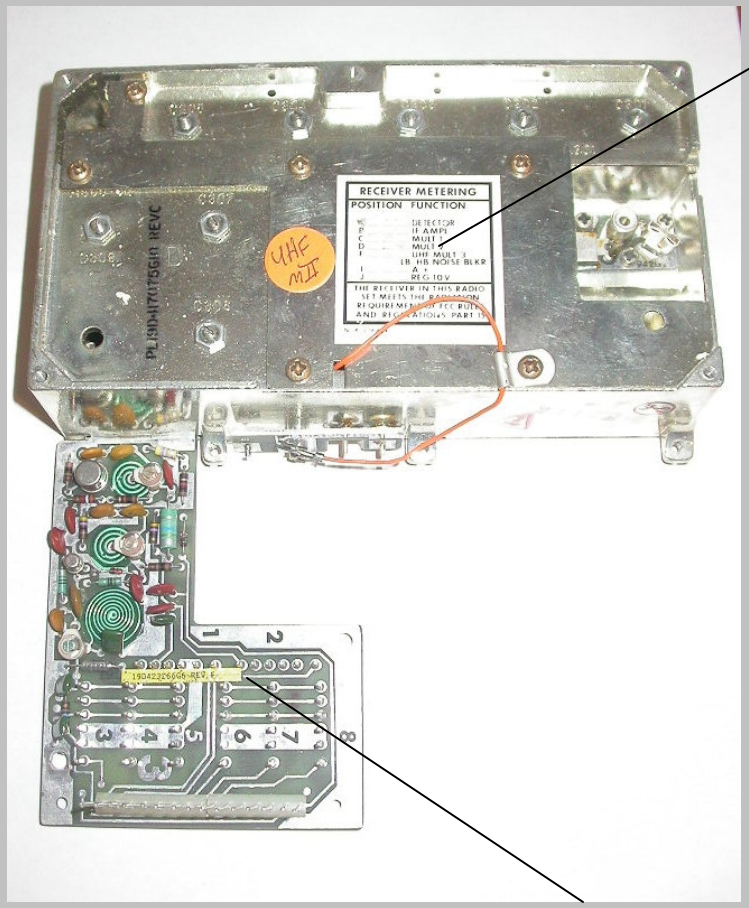
PLL (2 mtr shown)



All bands have identical
Form factor!

Note-oversized
ICOM

GE Master II Receiver Modules



RX RF section (UHF shown)
All bands have same form factor!

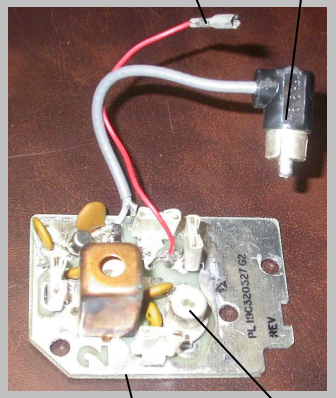
Audio/Sql card

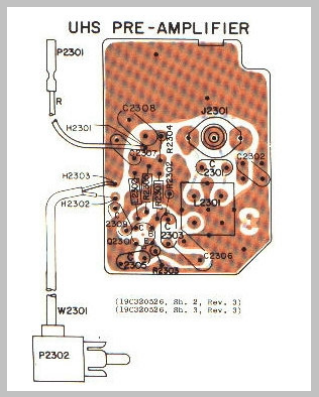
Icom / Osc section

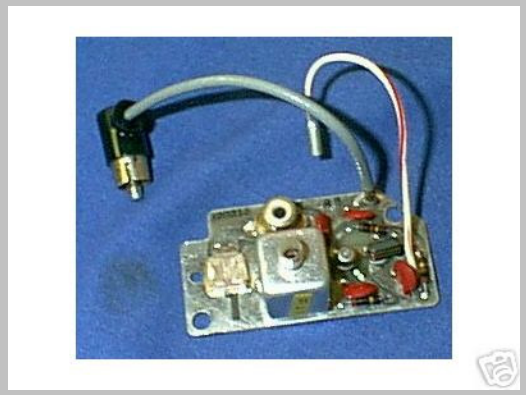
Audio board is universal to all bands.

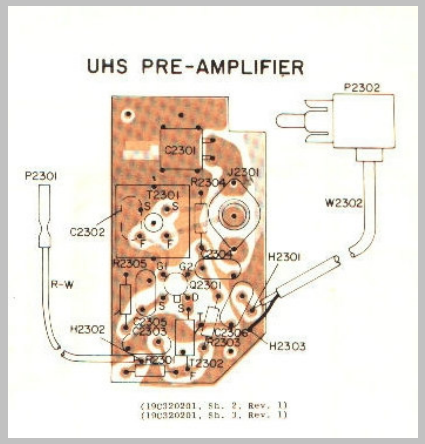
GE Preamps

+10V RF out







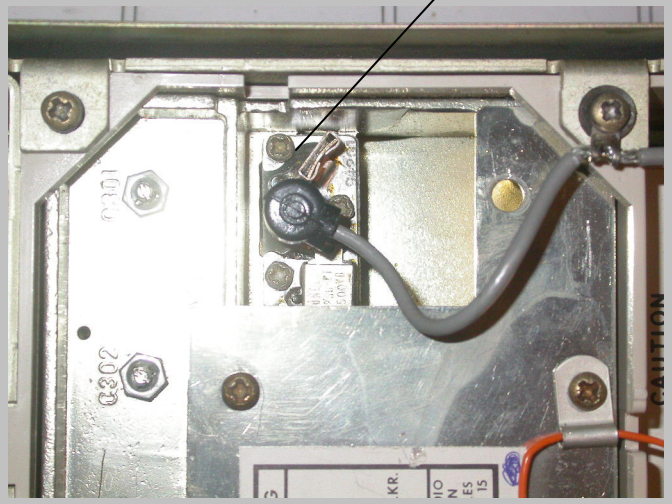


UHF Rf in VHF.

A receiver can be retrofitted if it did not come with one installed. You must remove the bottom shielding cover on the receiver to add a preamp. These provide 10-12 dB of gain. While newer technology preamps have 18+ dB gain, these can introduce desense problems.

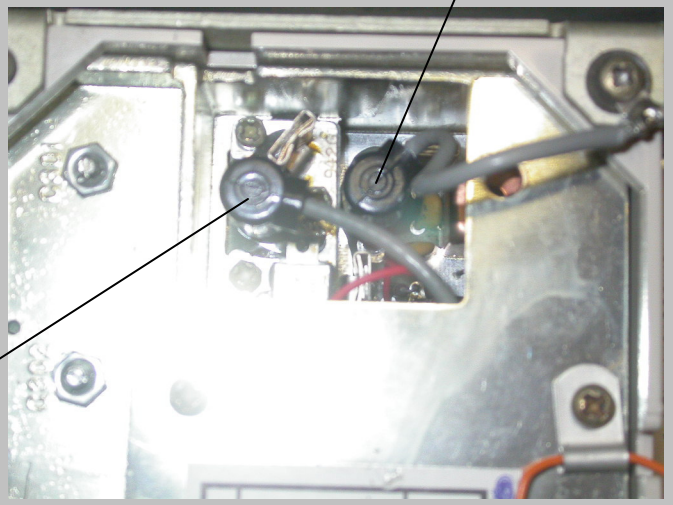
Preamp location in Receiver

RX ant input



No preamp installed

RX Ant cable installed
into female RCA on preamp



Preamp installed

RCA male cable from
Preamp installs into
Original receiver female RCA

Basic Complement of Rack Cards

Stock GE Repeater Controller

A note on use of GE control cards

Besides the necessary +10V regulator card, we keep the repeater audio and repeater controller card. If the ham controller dies, the GE controller can be quickly re-enabled to keep the repeater alive, especially in an emergency situation. The GE doesn't provide a CWID. But in an emergency, the users can ID the repeater manually. Some GE owners use a Comspec ID-8 for CWID and courtesy tone in the basic configuration..

10 VDC Regulator Card

Local Hand Mic
Level adj

Adjust 10V
Setting
(normally don't
Touch!)

Push Down
For local PTT
(tuning)

TX activity
LED

Remote Intercom

This card MUST be present at all times!

Notes on +10 VDC regulator

If you are converting to or from a Carrier Access to PL radio, there are some option jumper pads (1-4) on this card dealing with this. Normally there are two jumpers: 1-3 and 1-2 installed.
If you are swapping out this card for a spare, make sure these jumpers are set the same way.

The PTT momentary slide switch can be used to enable the TX. This is handy for taking BIRD wattmeter readings for power & SWR. Also handy while you are measuring the TX frequency on a Counter or service monitor.

Repeater Control Card
(tail, time out adjust & rptr enable)

Adjustable Time out Timer

Local GE
Rptr controller
Disabled LED

Repeater Enable
(push down to disable
GE controller. This
Does Not disable your
External ham controller)

Adjustable Tail Timer

Repeater Control Card Notes

While you are using an external ham controller (NHRC, ACC, LINK, etc.) leave this switched in the repeater DISABLE Position. This disables the stock GE controller. If the External controller is removed for servicing, you can re-enable the internal GE repeater control card.

The time out timer and tail pots only effect the stock GE controller. Not the external ham controller programmable settings.

Repeater Audio Card

TX
Deviation
Adj

Note on GE audio cards

The GE audio card gives us the 'good' GE audio sound. It provides audio muting during no COS, which some controllers like ACC requires. It provides de-emphasis of the RX audio so you don't have a tinny sounding repeater. It provides removal (filtering) of the user's PL tone using optional HPF. If you don't filter out the users PL tone it will beat with the repeaters pl encoder tone. We break the TX audio feed path and use this as our RX audio to the ham controller. The ham controller's TX audio out is then fed back to the GE exciter.

If your external ham controller does audio processing, make sure to disable it's processing which is usually an option on the controller. Else you might end up with double de-emphasis and terrible audio.

There are several versions of Stock GE audio cards which we will now look at.

Audio card notes continued

The audio card is modified to break the signal going to the TX audio hi. The path is changed to an unused card edge pin. This is fed to the RX audio input of the controller. The TX audio out of the controller is fed back to the TX audio input screw terminals. This requires a slight modification to a stock GE audio card. It also requires soldering a wire onto the back rack PCB. While some don't like this method, it was done before my time.

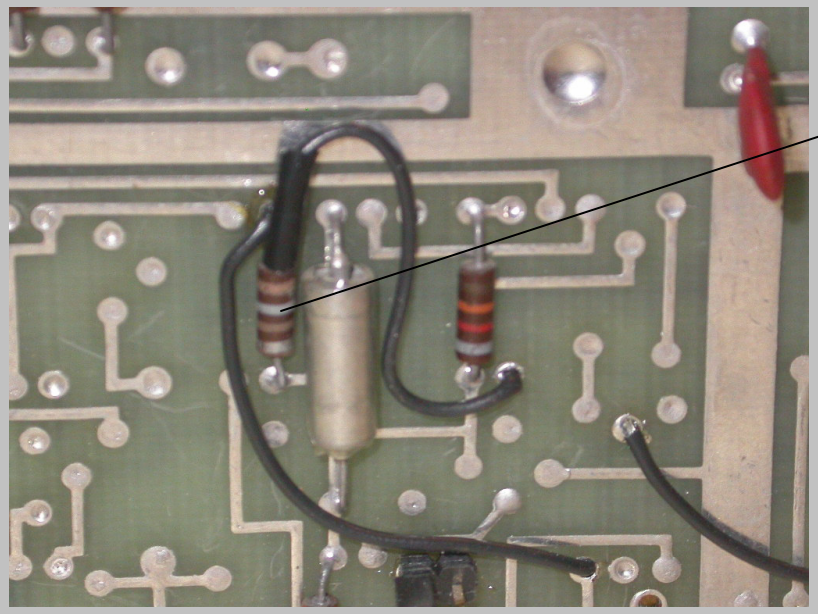
A no mod solution is to make up an extender one to one molex cable assembly for J1203. Break the tx audio path on pins J1203-7 and J1203-11 inside this extender cable. The extender Cable can be removed for stock GE controller functionality.

‘Repeater’ (only) Audio card

Optional High Pass Filter (remove User’s PL Tone)

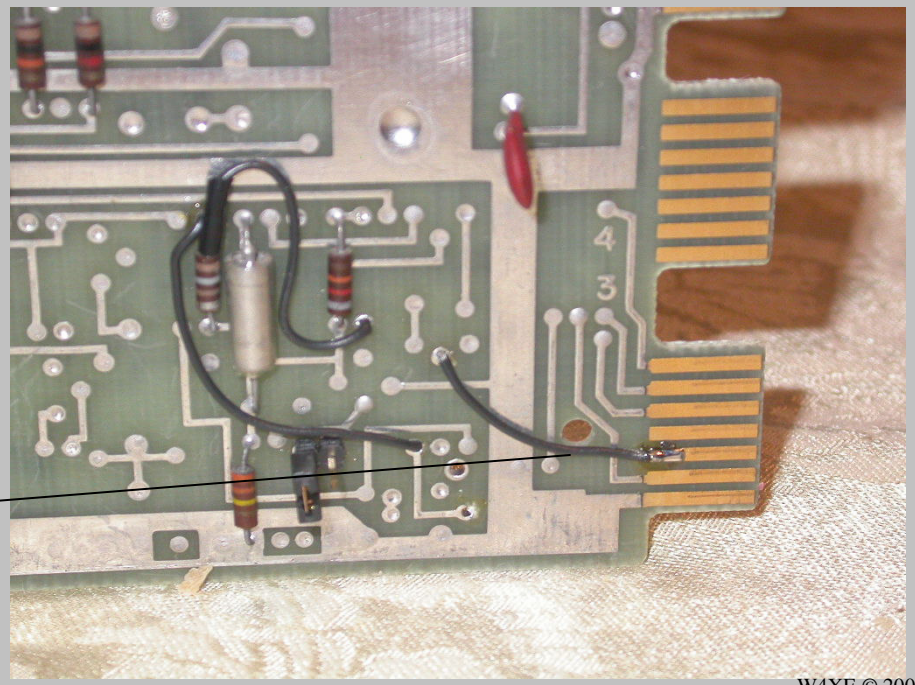
External Controller Audio Mod (intercept old Audio path to exciter. Use as rx audio to ham controller)

Repeater Audio Card Modification



Lift end of resistor R60 180 ohm
Feeding B14 edge pin.

Tie lifted pin
To D10 (unused
Edge pin)



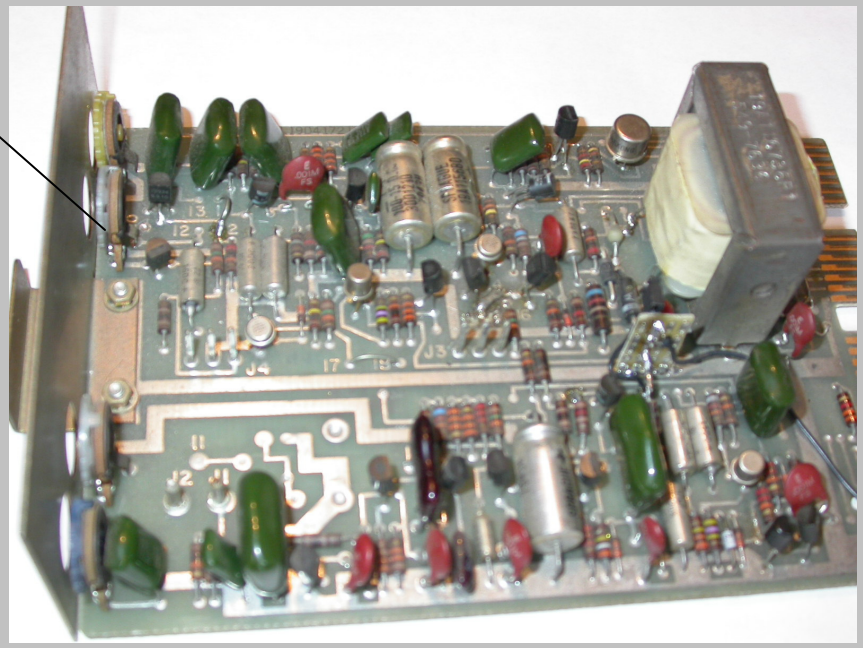
GE Remote/Repeat audio card

The Remote/Repeat card was used originally to interface to 600 ohm Remote 4 wire audio/control lines. It does include the Repeater audio Circuitry we need.

Repeater Level Adj

Stock GE Remote/Repeat Audio card

The 2nd pot DOES affect
Rx level to ham controller

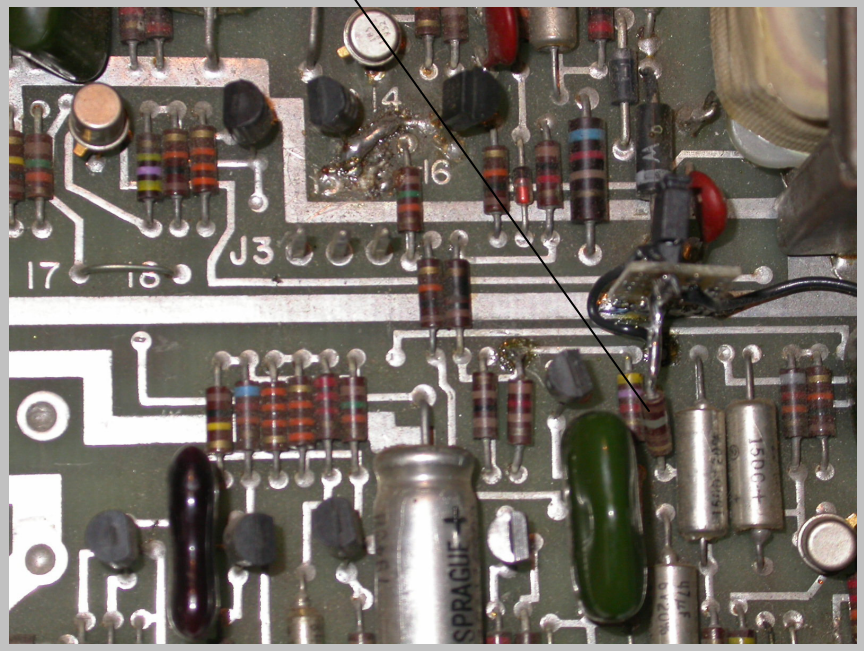


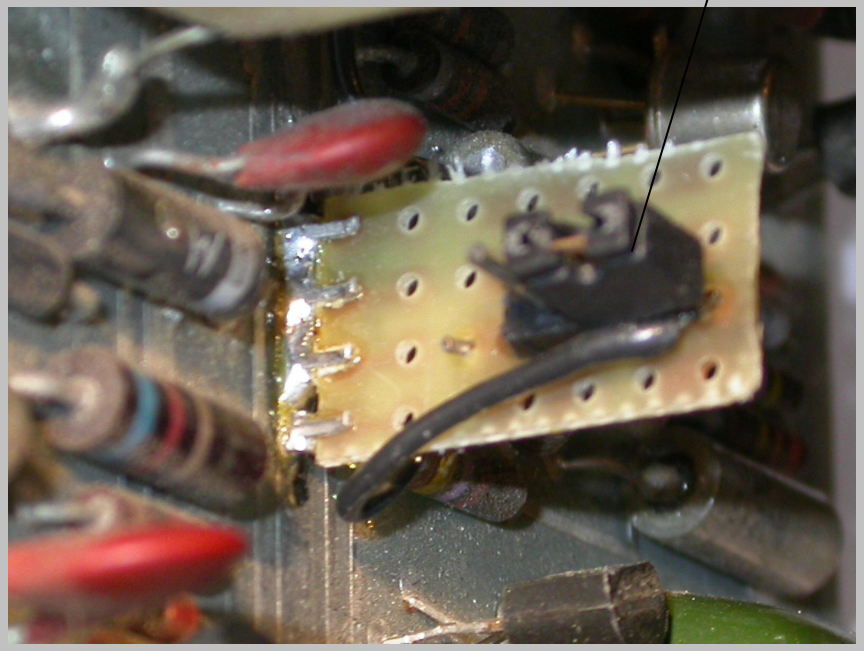
We use this receiver audio path to give us the Great ‘GE’ audio quality.
It does rx mute on no signal that some controllers require.

‘Remote/Repeater Audio’ Card Modification

R60, end toward B14

Install header to enable GE controller. Remove for Ham controller.



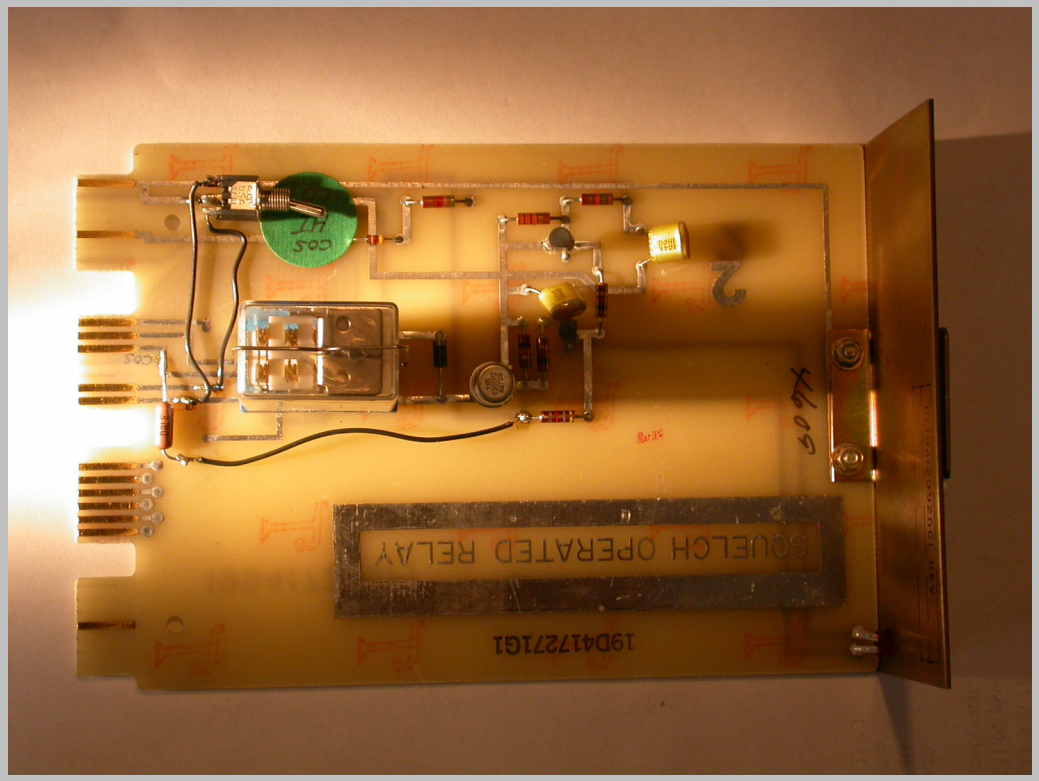


We modify the output of this card to break the path from the output of this card to the GE tx.
I add a small header which can be used to restore this path. If our fancy ham controller dies, you
Can unhook that controller (db9), reinstall this jumper and enable the stock GE repeater controller.
It’s plain jane functionality, but the repeater will stay alive until we can fix the ham controller.

GE ‘Remote audio’ card

This card is seen a lot but isn’t too useful for repeater use. It is missing all of the components for the repeater audio feed. While you can add these parts, it is easier to find a rem/rep or repeat audio card.

GE Squelch Operated Relay (SOR) board.



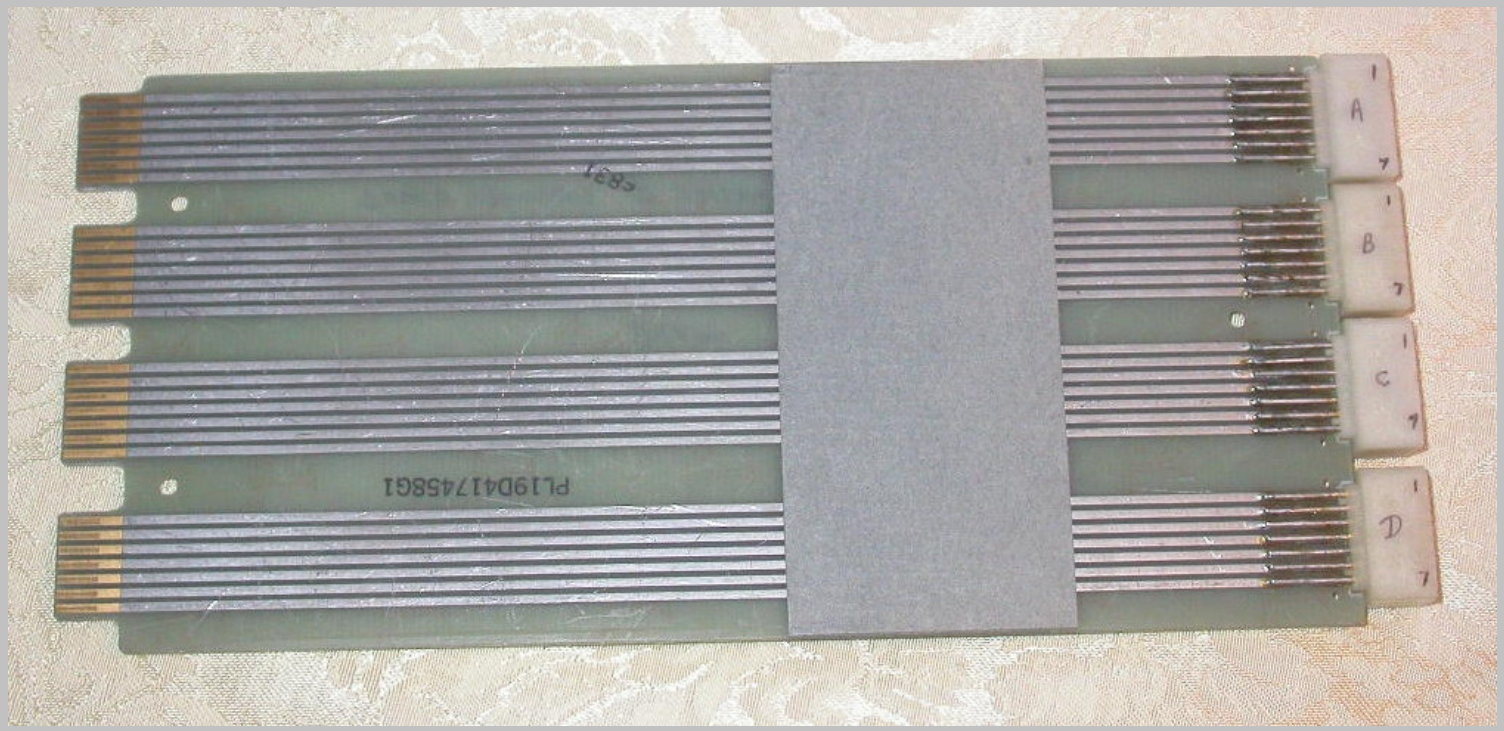
While some Scorn relays, It does provide a stock solution for the need to buffer the CAS signal.

It is modified to give us active hi or active low true COS 'carrier operated squelch' signal activity indicator to our ham repeater controller (NHRC,CAT1000,RC85).
The signal comes out on the right upper corner molex connector.
You don't want to directly load down the GE rx's internal CAS Signal if you can help it. This acts as a safety buffer.

Notes on audio level adjustments

The TX level adjust pot on the audio card adjusts the RX audio into to the ham Controller. The ham controllers TX audio pot adjust audio toward the exciter. The audio adjust pot on the Exciter is used to set the max clipping deviation limit (see GE manual for adjustment). First adjust the repeater using the stock GE Controller setup. Then install the ham controller and only adjust the ham controller pots for final level adjustments. Don't go back and touch the GE controls. It will mess up the deviation settings for going back to a stock GE emergency backup controller. The system is balanced for exact 1:1 deviation using a signal generator and service monitor. For example a 1 KHz deviated RX input signal results in 1 KHz exciter deviation and 5 KHz in = 5 KHz out.

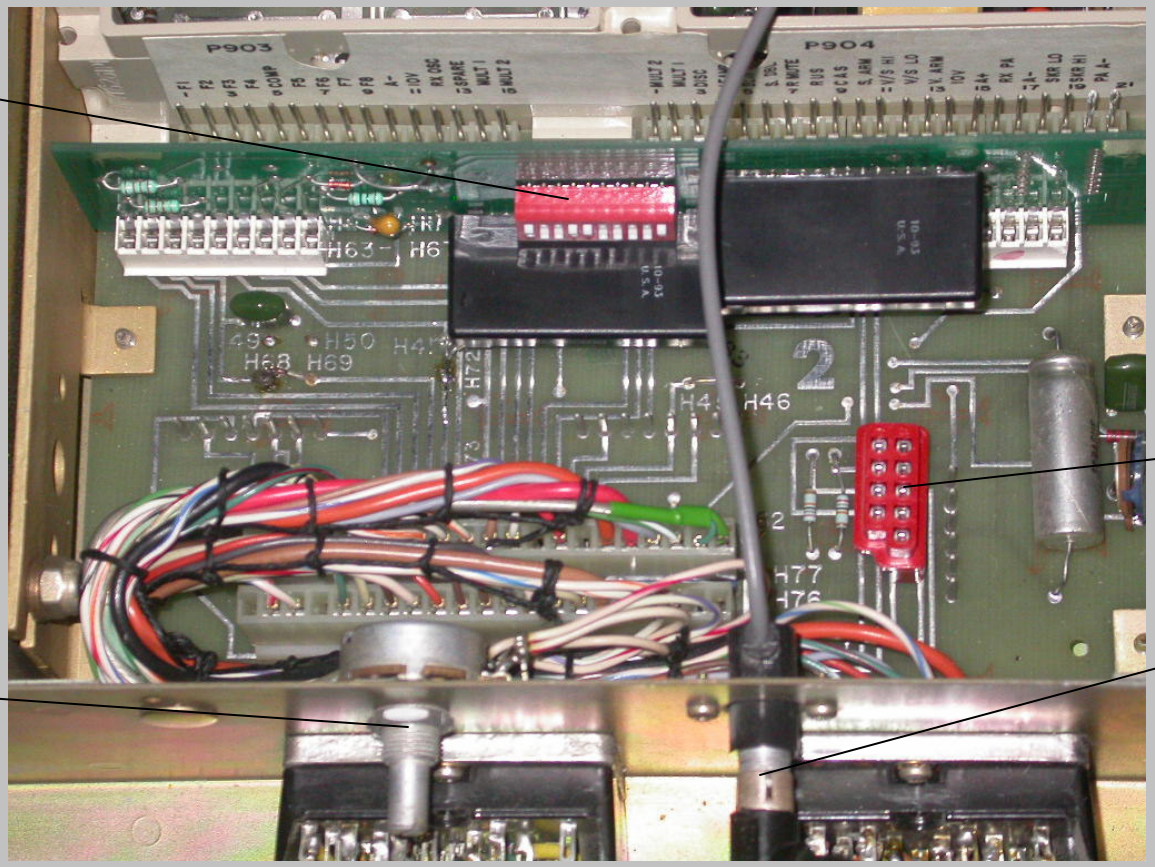
Card extender



A useful tool for working on GE Master II card racks

System Interconnect Board

Stock digital
PL decoder

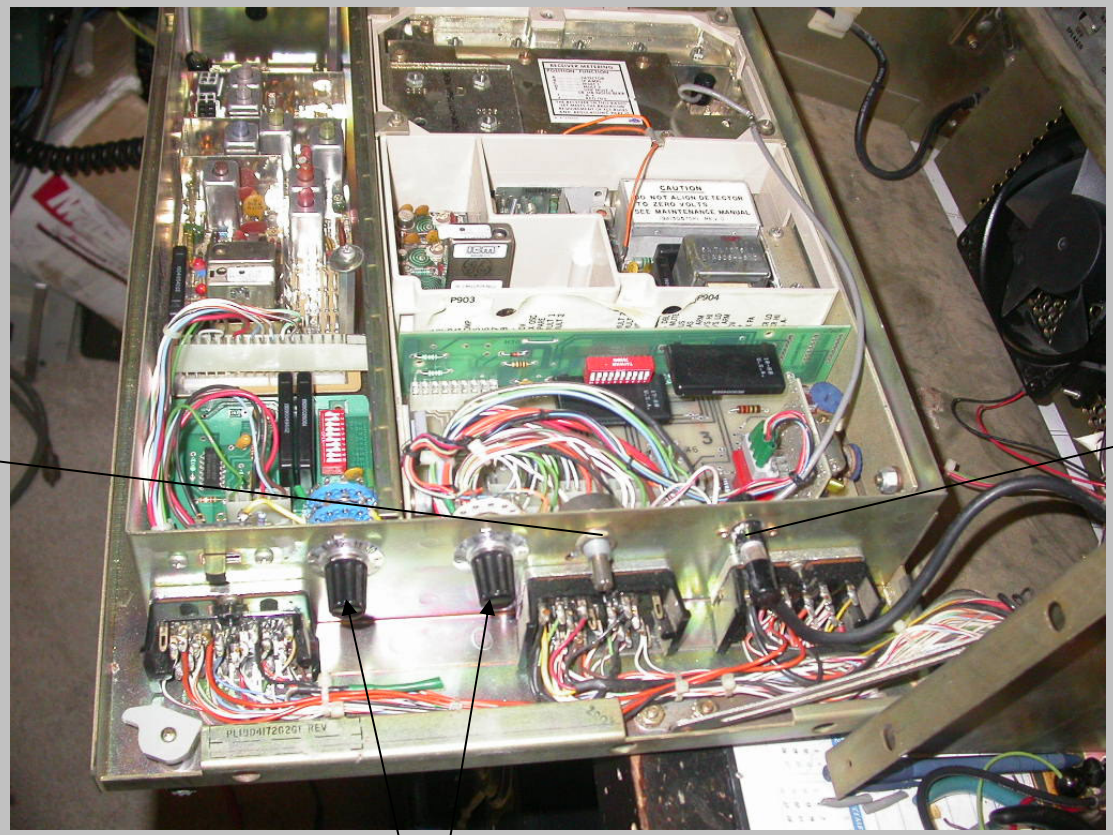


Test Set
connector

Squelch
Adj Pot

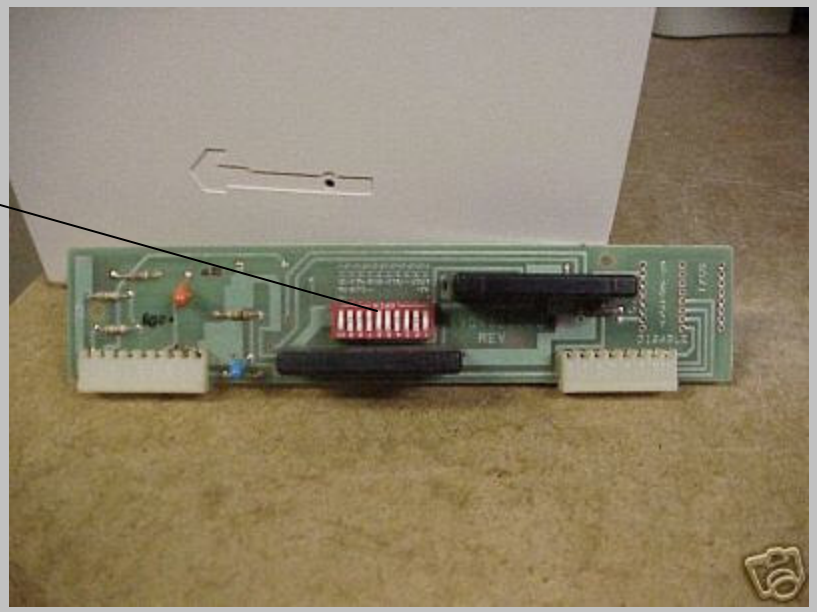
RX ant
input

Twenty pin connectors used for RF deck to control rack (cap feed-through)



GE Digital PL card

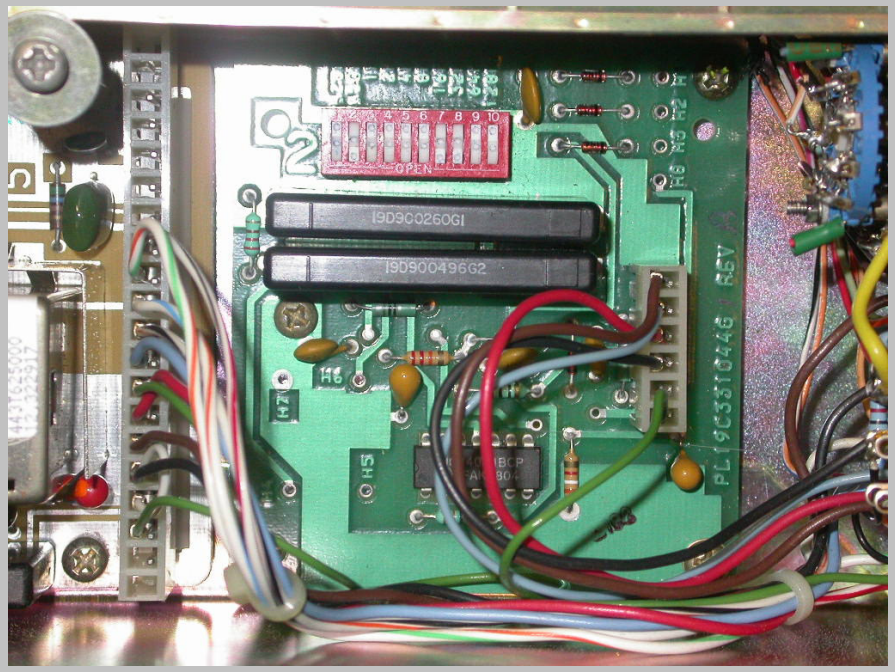
Dip Switch
PL tone
Selection.
See PDF file
for settings.



This card can do PL encode OR PL decode
But not both at the same time (no full duplex)!

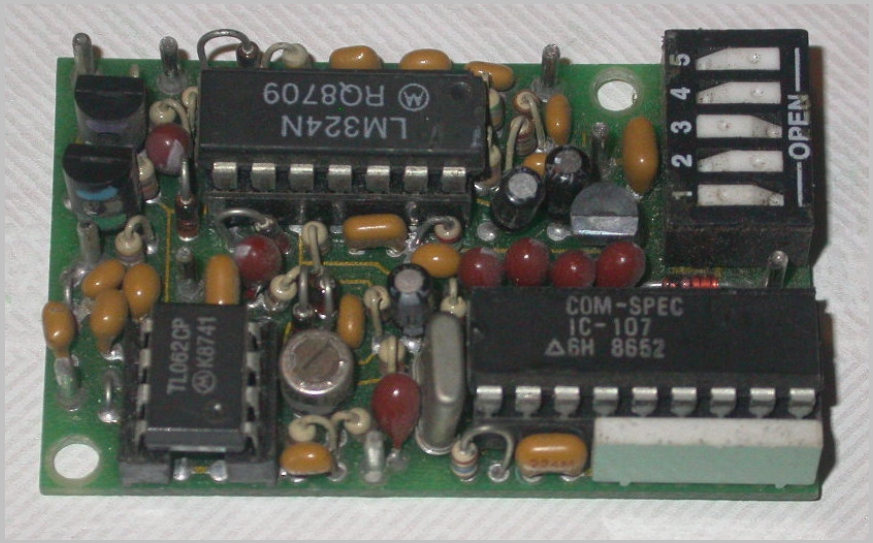
In a GE base station, we use it for repeater PL decoding only.

GE PL encoder



This card is located next to the exciter. It provides PL tone encoding of the repeater output signal. The PTT signal goes into this board as PTT And back out as ‘Delayed PTT’ for ‘reverse burst’ applications.
A Com-spec SS-64 can also be used.

Communications specialist TS-32

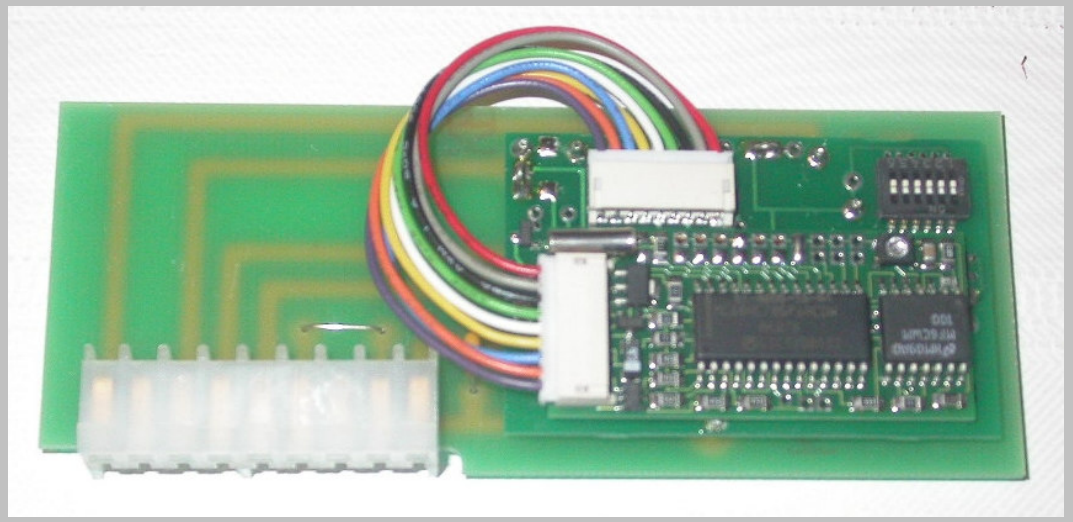


This is an extremely popular after-market PL deck.

Full duplex PL Encode (dip sw sets pl tone) and PL decode.
Audio High pass filter/audio mute (used to remove pl from Users signal)
The TS-32 was discontinued but is still very popular.

Communications specialist TS-64MSTII

An after market version that plugs directly into the GE



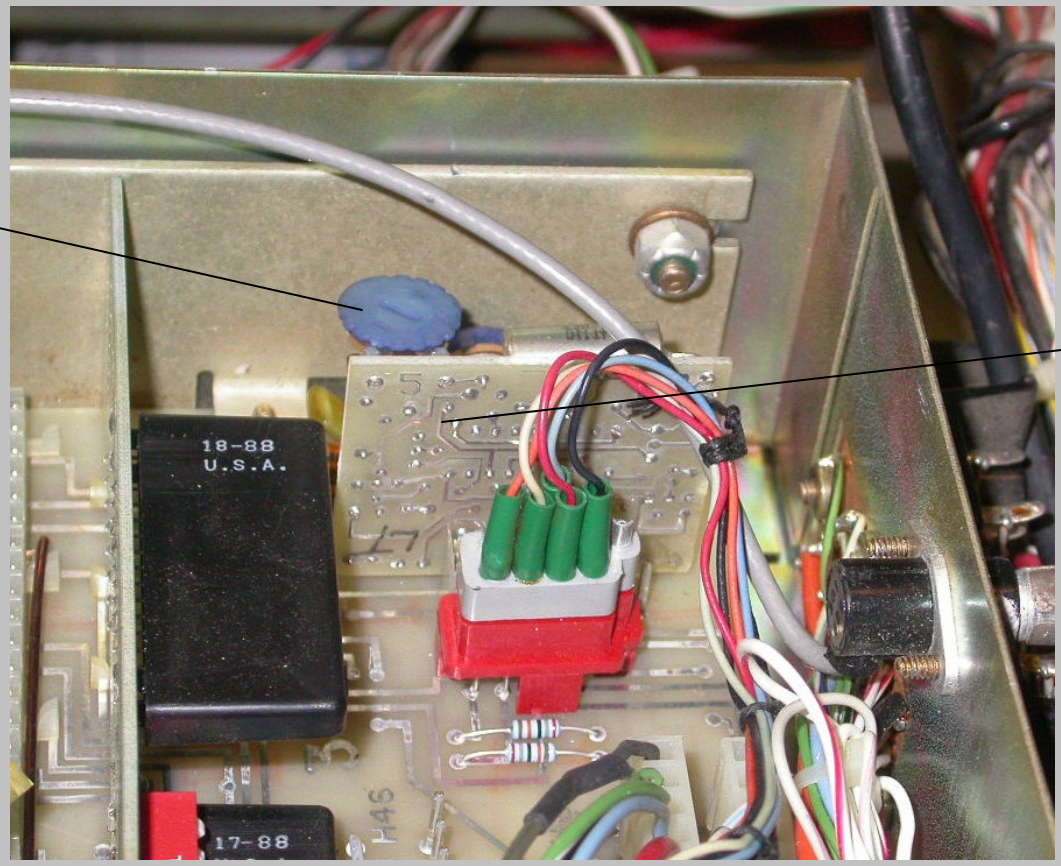
New Surface Mount packaging
PL Encode (dip sw sets pl tone) & PL decode (same tone as encode)
PL High pass filter (use to remove pl from Users signal)

New feature is it is capable of ‘Reverse Burst’. Reverse Burst is usually not seen on ham radio models. It provides removal of the long Squelch burst after a user signal goes away. Hams use audio delay in the controller to provide this feature.

Note: When plugged into the rptr system board, it works with the receive on PL decode.. However you must provide a path to the transmitter for PL encoder use.

GE Time out Timer

0-60 sec adj

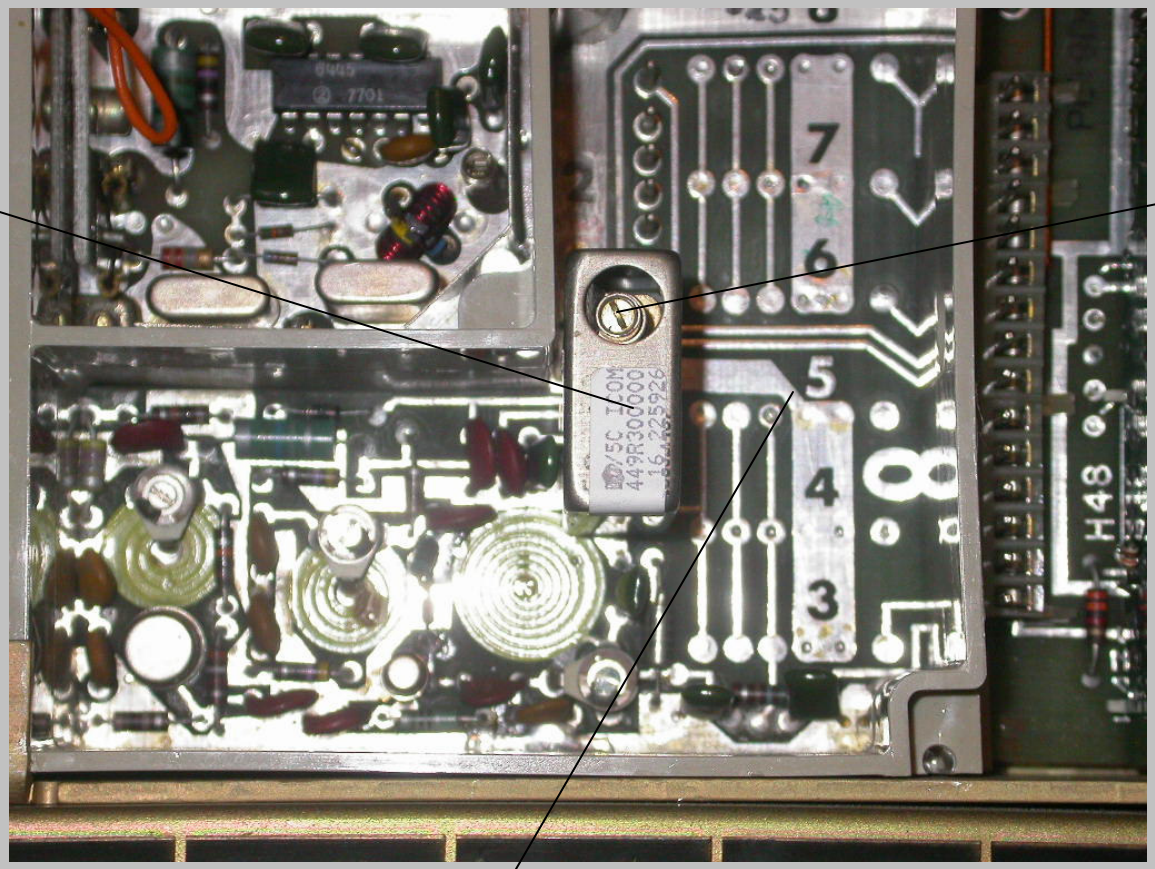


Plug in TOT board

The stock 60 second time out is usually too short for ham use. Most people remove this. Alternatively you can increase the Electrolytic cap value to increase this to 5-10 minute range.

Receiver Channel Element

Channel Element '5C'



RX Freq Adj

Note the ICOM channel numbers are on the silk screen.
Always use Channel # 1 as the default for a repeater.

Exciter Channel Element(s)

(to add temp compensation since an EC doesn't produce this.
Any 5C on any band will work. Doesn't matter what the xtal freq is)

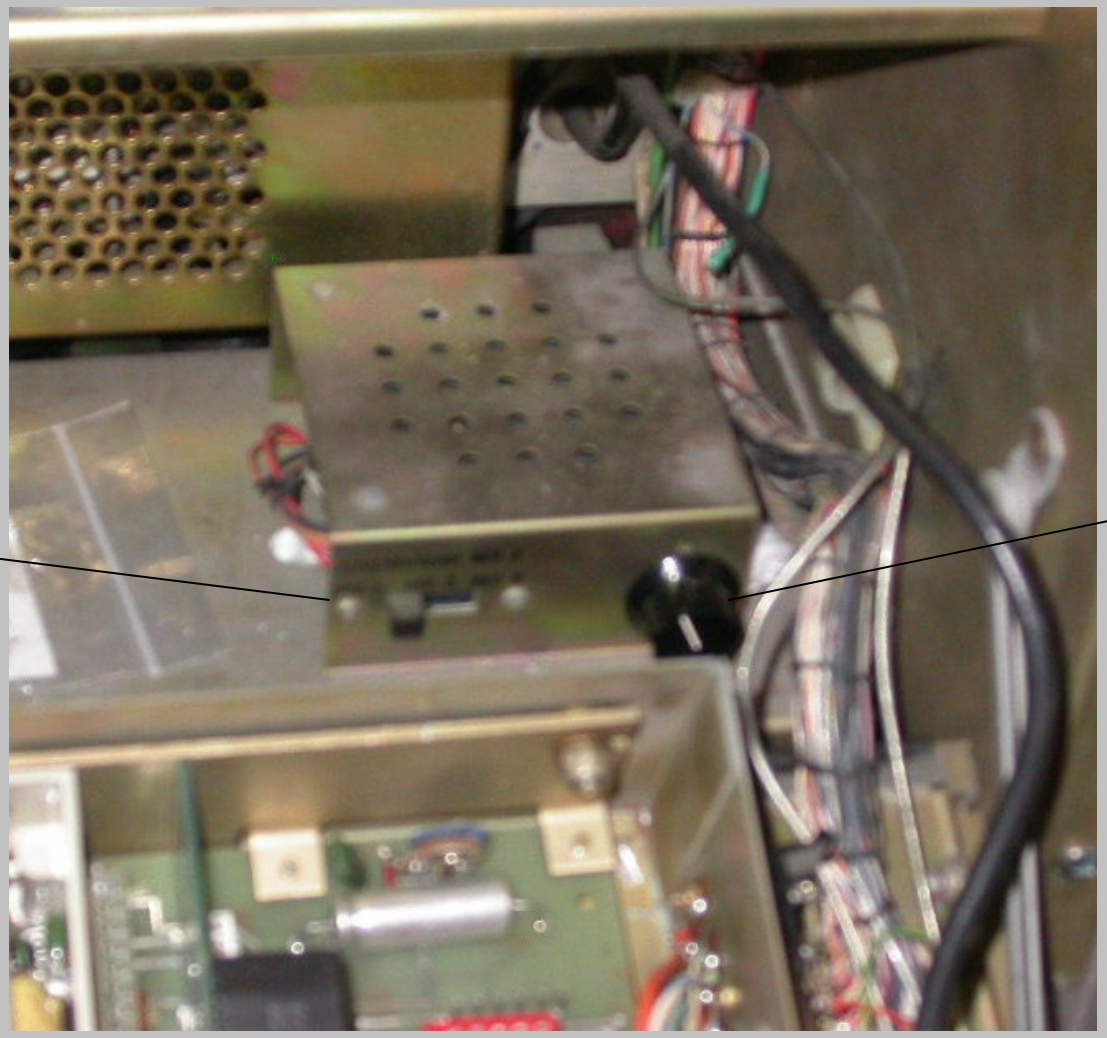
A word on Channel Elements

The channel element (ICOM) contains the crystal cut for your frequency.
The TX and RX require separate ICOMs. You can order the crystals
from International Crystal Mfgr (ICM) and install them yourself into
an existing used ICOM, or for a fee you can mail in your channel element and
have ICM temperature compensate it for you after they cut the crystal.
Your call on which way to go.
If it's exposed to extreme temp shifts, I highly recommend to *get it compensated!*

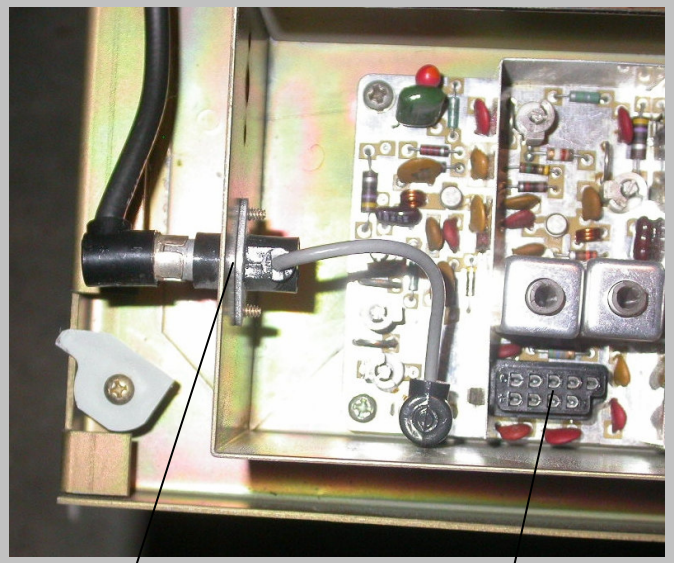
There are three basic types of channel elements.
An 'EC' takes its temp compensation voltage from a '5C' element.
A '5C' has temp compensation and generates it for other ICOM's.
A '2C' has temp compensation but doesn't generate it for others.

In a repeater, you MUST use 2C's (or 5C) in both TX and RX.
In a pinch you can use an EC and a 5C next to it.
In a mobile, you only have to have one 5C and the rest EC's in the entire radio.

Local Monitor Speaker

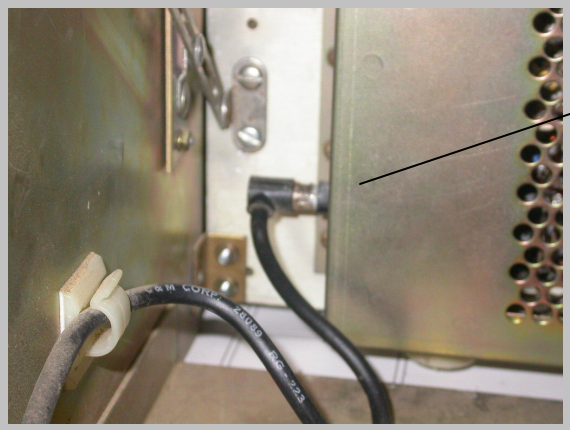


Exciter output (50 ohm @ 250 mW) feeds PA input

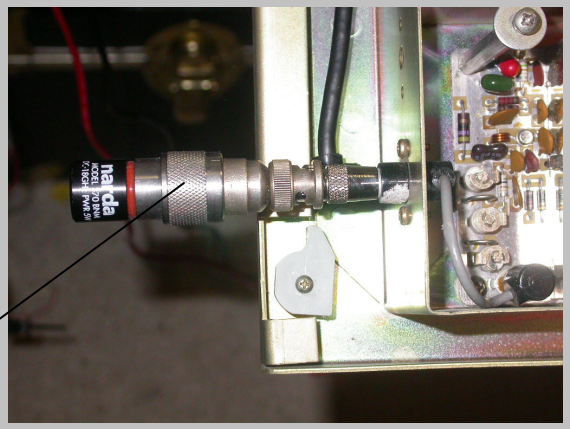


RCA to RCA
Cable To PA

Test Set
connector

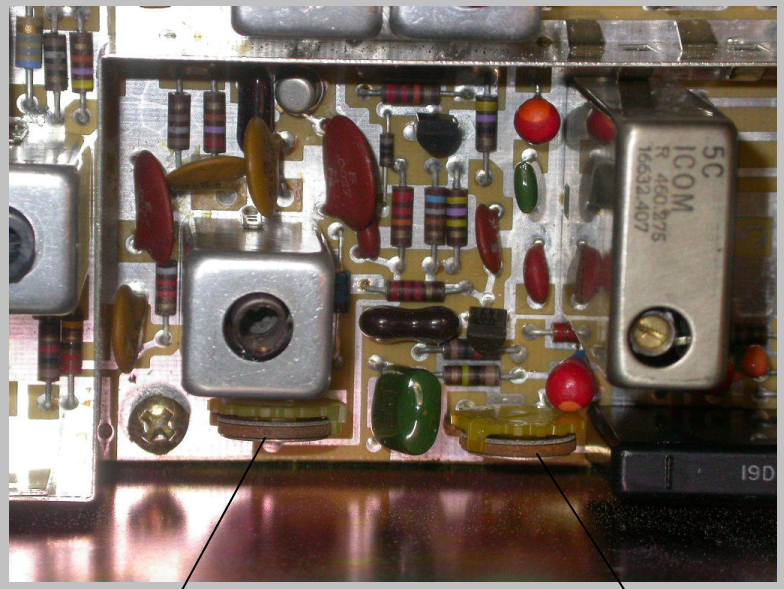


RF PA input



50 ohm dummy load shown for testing exciter w/o RF PA.

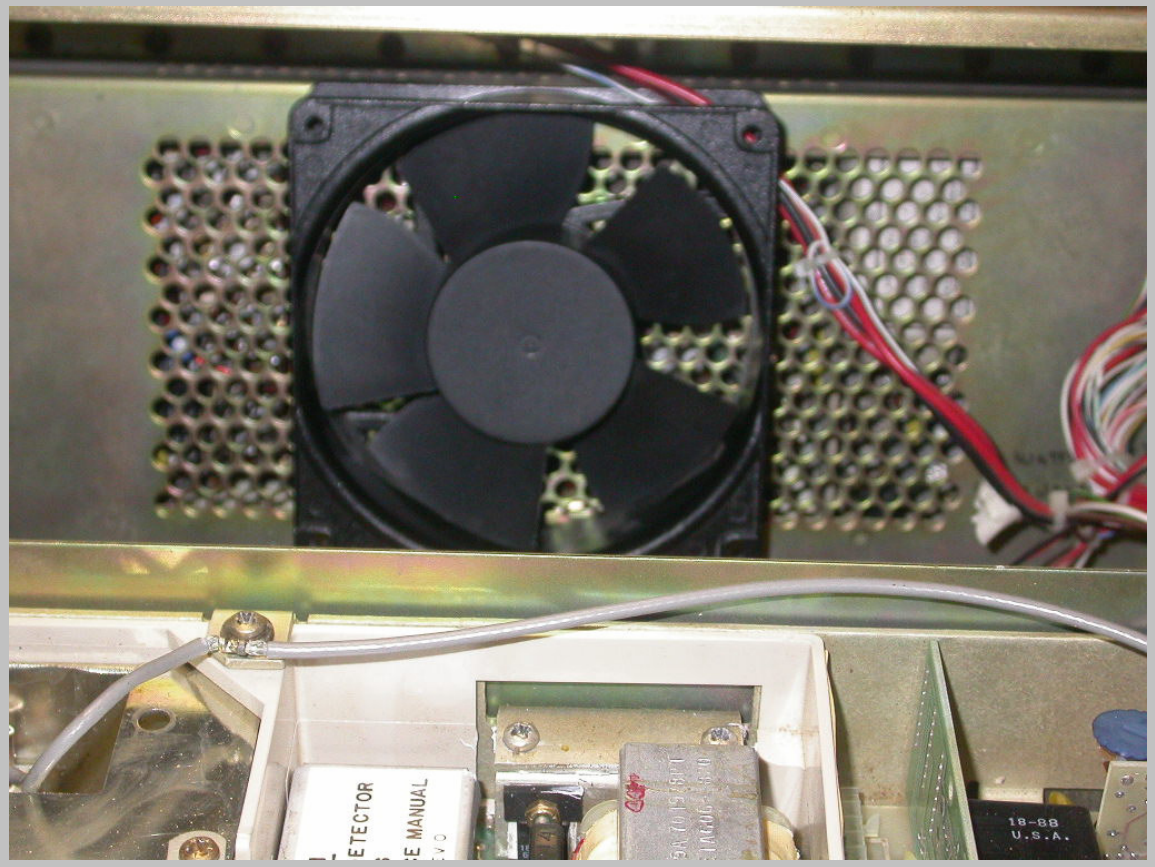
Exciter Audio Pots



Tx Mike preamp level Adjustment

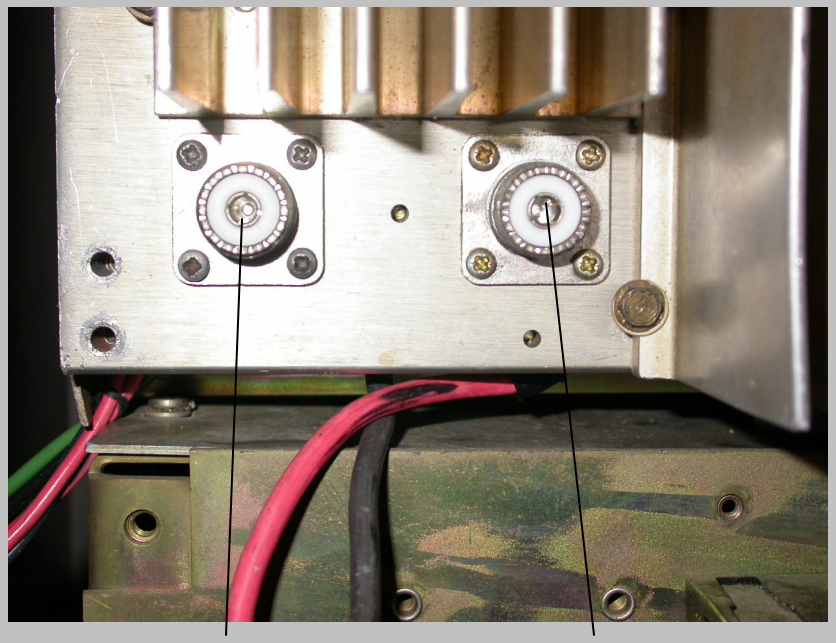
PL tone encoder Adjustment.
Set for 600 to 750 Hz deviation.

Fan cooling for PA



This was a GE option. However you can easily add this yourself as shown above.
For longevity of the PA, this is a MUST! Beware of DC fans, as they can introduce noise into your audio if you don't use proper in-line filtering (inductors) in the power leads.
You can add a thermal switch to only turn on the fan when the Heat sink exceeds set-point..

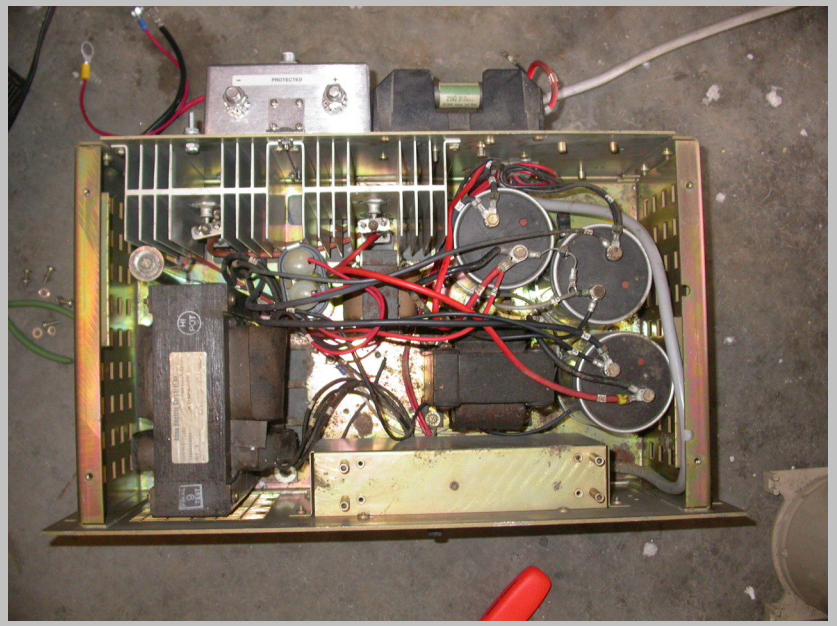
Left bottom corner of 110W PA.



RECEIVER TRANSMITTER

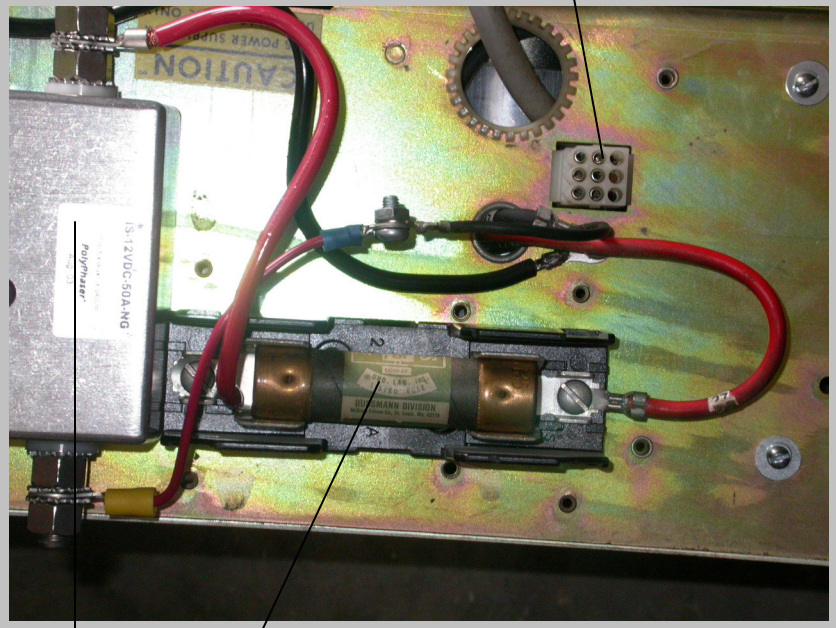
These route directly to Duplexer through double shielded coax.

GE Master II Power supply
12 VDC @ 30 A



Internals: Ferro-resonant design
(no voltage regulator or
Pass transistors to burn out). Open
Circuit voltage reaches 15 VDC.
Design handles AC transients (lightning) well.

Molex plug powers RF deck



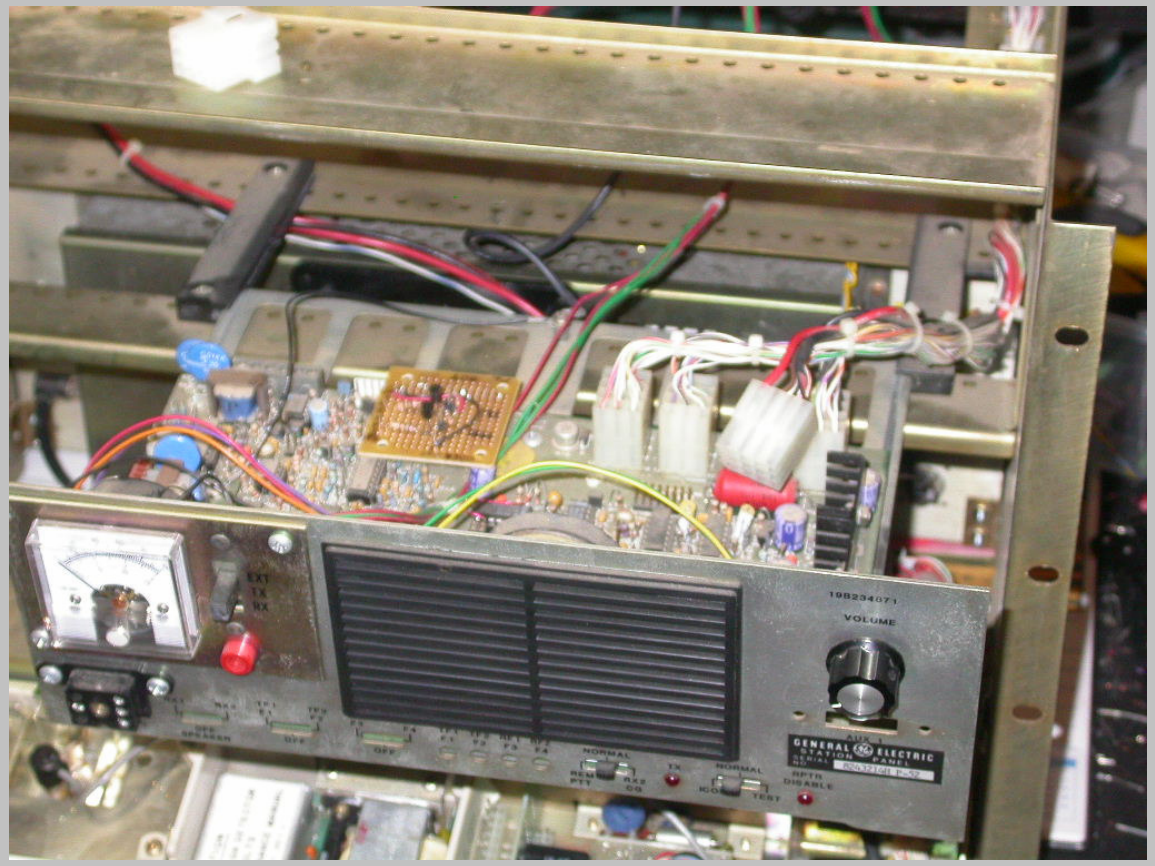
Large Fuse (old style)
PA is fused through here.

12V Polyphaser over-voltage
Surge protection.

GE Master II newer ‘IDA’ all in one controller

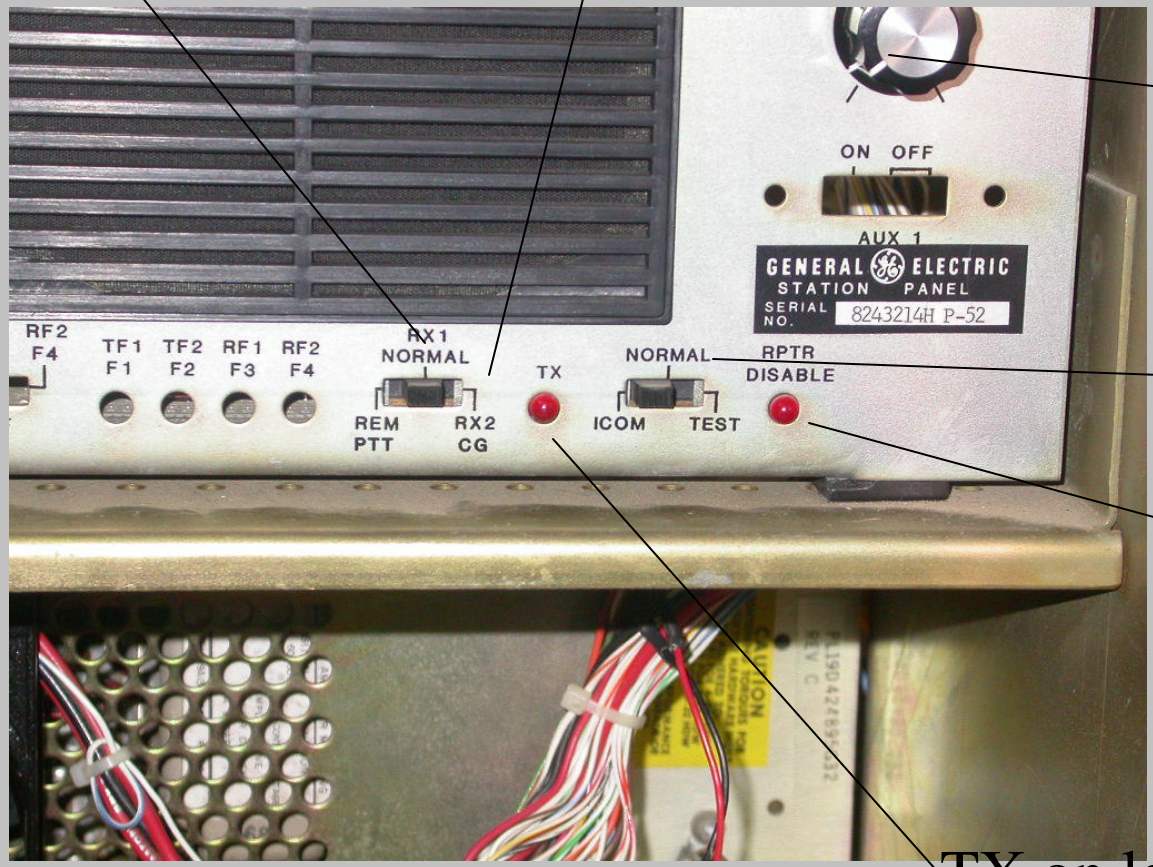
IDA in Remote-Repeat configuration

IDA servicing



IDA slides out for servicing

IDA Controls

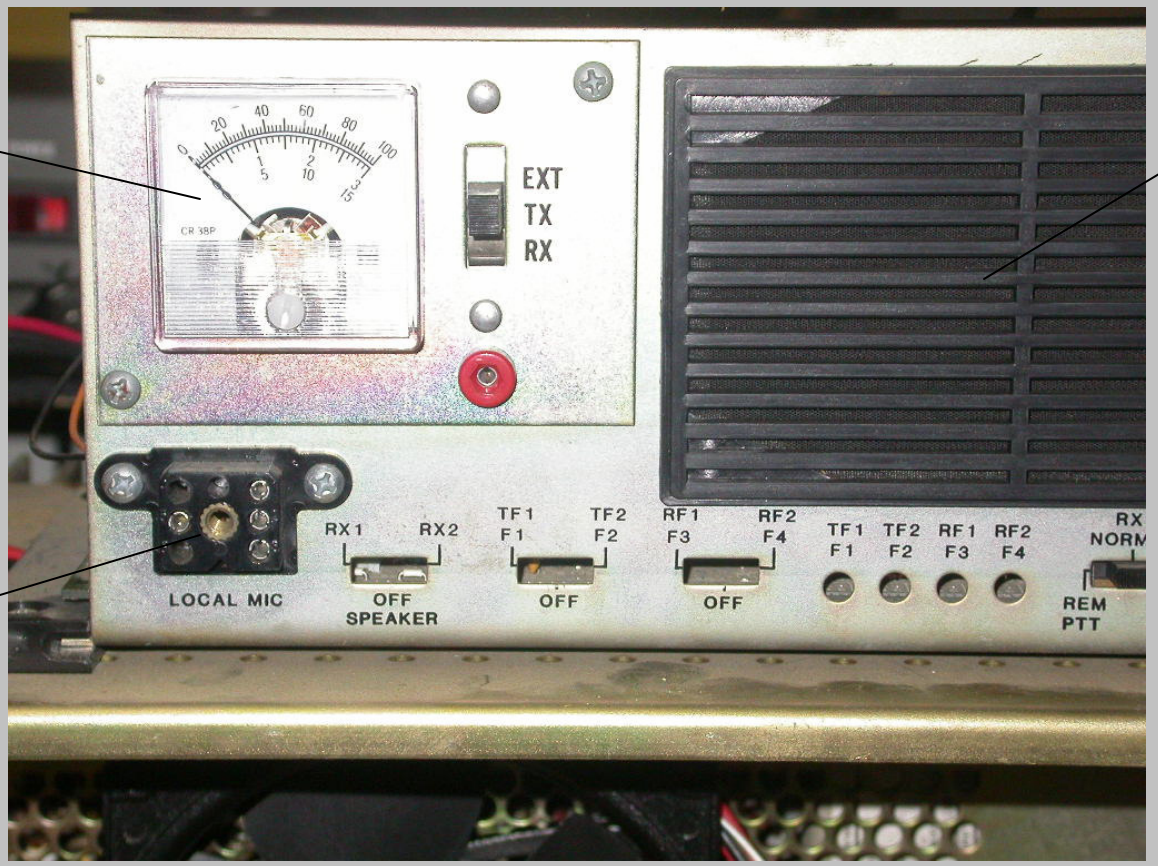


*-only COS using aux ham controller

IDA left hand side

Integrated Test set metering

Local hand mic



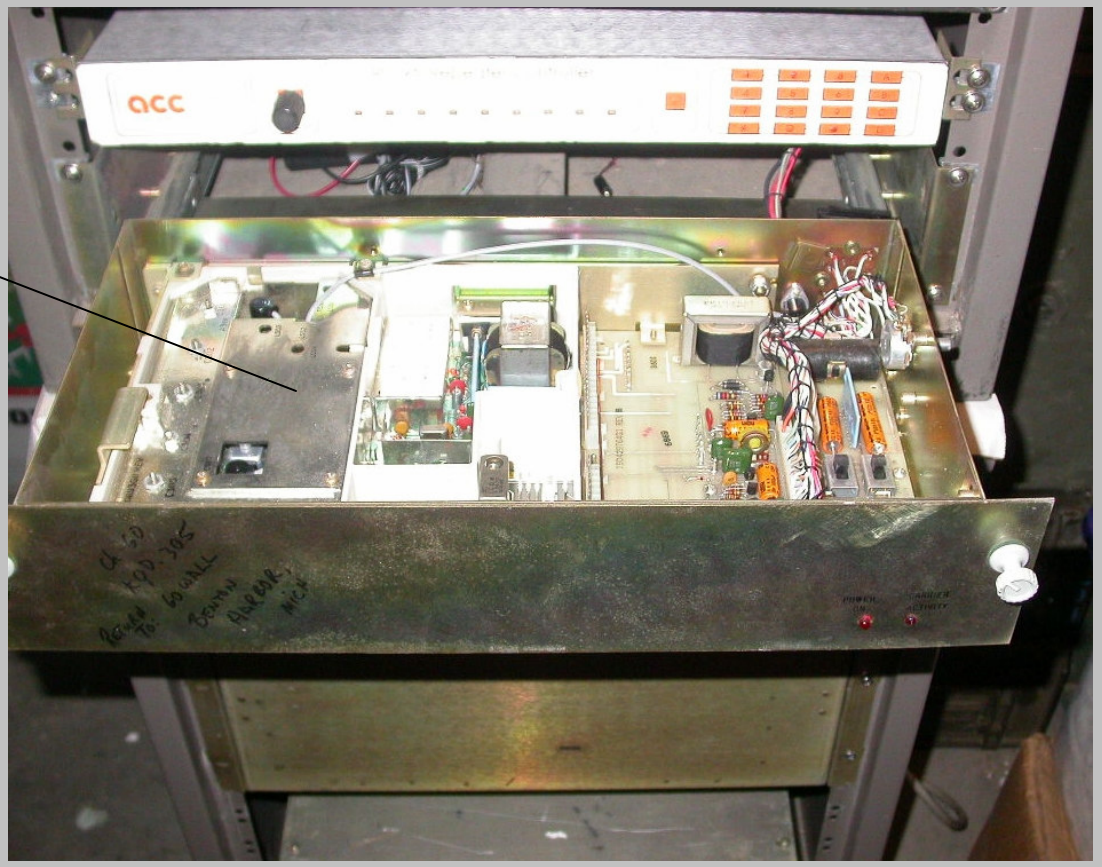
Mon spkr

*-stay tuned for another presentation on wiring this to a ham controller

GE Master2 Remote voter Rx

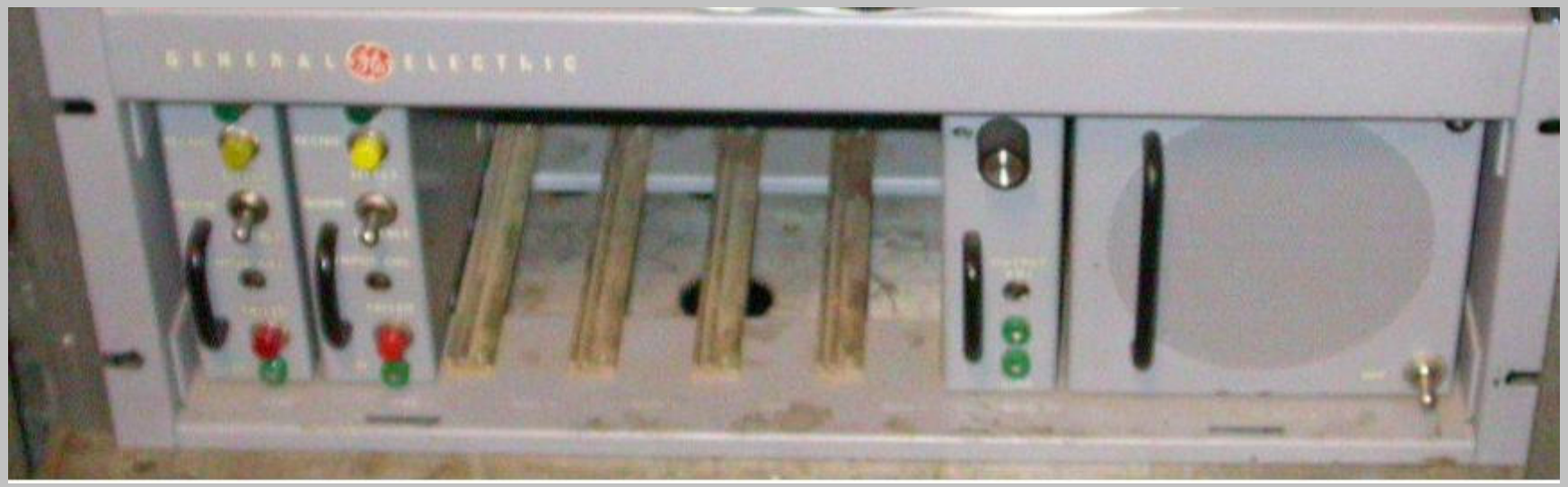
You need one each of these for every remote site you have.

Same RF Modules As Mobile And repeater



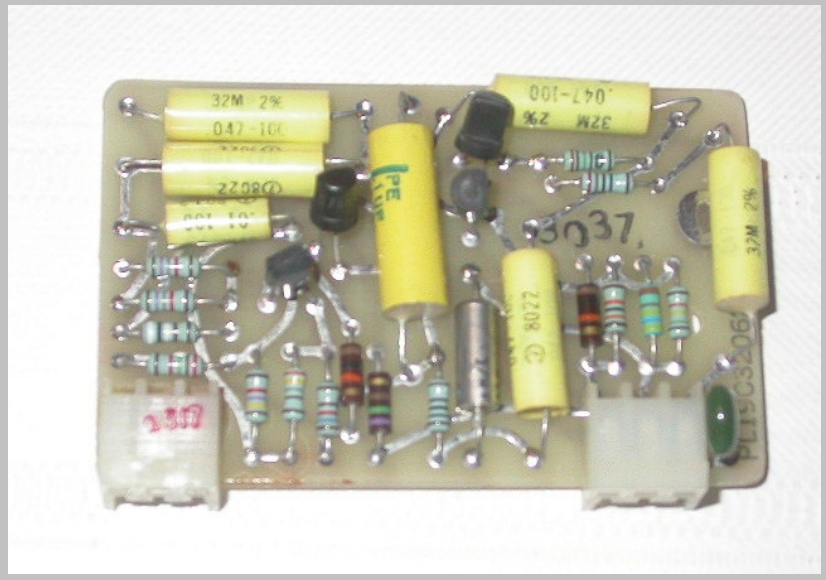
Linking is typically done on UHF.

GE Voter chassis



Up to six plug in cards support remote voter sites. Each remote site requires an associated repeater site local receiver. Each RX must be on a unique UHF frequency. The voter chassis picks the best signal from the 5 remote sites (phone line or RF) or main site RX for the repeater to rebroadcast on a continuous basis. Simple twisted-pair wire is used for interconnect wiring.

Voter Tone Generator



This plug in card is used in the GE remote Receiver chassis for voting. It generates a 1950 Hz Tone for the GE voter denoting no-signal condition.

TEST SET

GE Master Pro (single black plug)

GE Master II/Exec2/MVP (Y cable black/red plugs)

While the receiver and transmitter can be tuned up with a Volt meter, these test sets allow easy selection of the tuning Points. A microphone connector and PTT button are provided. Also, access to speaker audio is provided.

Standard GE Master II hand mike.
Can be plugged into GE repeater for
Local communication at site.

The GE Master II is a cost effective robust modular repeater system. It is extremely popular in the ham community.

The modularity of the system and it's compatible use of RF components between base/repeater stations and mobiles will provide years of dependable service with a large base of spare parts from the used commercial services.

For more information on building repeaters see this excellent site:

http://www.repeater-builder.com/rbtip/