R-390A Fix Non-Linear and Low Deflecting Carrier Level Meter
Version 3, Larry Haney, 05-13-2024

Fixing these two problems, that I have also experienced, requires that the AGC system is working correctly (except for these two items). This means that you have gone through Charles Steinmetz's and my AGC trouble shooting quides (on our R-390A.net website) and repaired all problems discovered there. And, on listening to a very strong station (50mv to 100mv), the AGC voltage is from -9 to -14 vdc, and the Diode Load (DL) (in AGC mode) is between -9 and -18 vdc, and there is no audio distortion (with the Noise Limiter Off). Make sure that V501 – V504, V506, V508 and V509 are very good. The ideal level for the DL is -17 vdc and the AGC is -12 vdc with 100 mv RMS in to J513 on the IF deck (with a 50 ohm impedance adapter being used).

It is imperative that the Diode Load and AGC voltages are in synchronization with each other so that the Diode Load voltage can be set correctly. This only can happen when the gain of V504 and V508 are correct. Adjusting the IF gain, R519, can not compensate for any insufficiency in this area. When those voltages are good, then adjust the Diode Load for -7 vdc (in MGC Mode) with a 150 uv signal (RMS with a 50 ohm load) fed into J513 (IF deck input).

With your sig gen still hooked up to J513, switch to AGC mode and feed a 1 mv rms signal into it. The Carrier Level should read about 20 db. Now feed a 10 mv rms signal into it. The Carrier Level (CL) should read about 60 db. Finally, feed a 100 mv rms signal into it. The Carrier Level should read about 100 db.

This is where you find out if the meter you have installed matches the meter driving circuit V506A, R548 in the cathode of V506A (and R549 in the plate circuit) are the right value for the meter being used. If you have a meter that matches the original specs (17 ohm coil (careful if you measure it)), or it has an alternative. If your meter is reading close to 100 db, then all is good. If not, see the section later on about 'Non-standard meters' on page 4. Version 3. Resolve this before continuing on. Version 3 end.

The important measurement here is that the AGC be about -12 vdc. If it is more than 8% low or high, look at the gain of V504 and V508. Some brands of 6AK6's and 6BA6's have higher gain than other brands, even when new.

Here's a chart showing the readings you should be seeing in the IF deck in AGC mode:

in J513	DL	CL	AGC
150 uv	-6.3	0	-.15
1 mv	-9.5	20	-2
10 mv	-12.6	60	-6.5
100 mv	-17	100	-12

Now that you've verified that the IF deck is working correctly, it's time to check out the RF deck.

Reconnect the IF deck for normal operation and connect the sig gen to the 'balanced antenna' input with an appropriate impedance matching device (if required for the sig gen to indicate the correct signal level output). If you use the recommended DA-121, then remember that the signal level that reaches the rx is reduced by 55% (multiply by 4/9 or .444) from the sig gen reading.

Here's a chart showing the readings you should be seeing:

in Bal Ant	CL	AGC
5 uv	10	-1.3
10 uv	20	-2.0
100 uv	40	-4.3
1 mv	60	-7.0
10 mv	80	-10
100 mv	100	-12.8

If the maximum reading on the CL meter is less than 99 db and the AGC voltage is less than -11 vdc (eg: -9 vdc), then the cause may be the brand of 6DC6 RF amp being used. Some 6DC6's have a sharper cut off voltage than others. Some Sylvania and PhilipsECG (thanks Jacques Fortin for this tidbit) tubes cutoff sooner with a smaller AGC voltage than the original design, thus causing a reduced output of the RF deck at higher input levels. If you have an RCA or Hallicrafters brand 6DC6, try them. Unfortunately, I don't have more brands to try, so if you come across different ones, let me know how they perform in the circuit so I can include that information here.

If you are satisfied that the AGC is now workng correctly, and your CL meter is not right on 100 db with 100 mv in, try different tubes in V201 through V204 and conversion oscillators in the RF deck, and the tubes in V501 through V504 and V508 in the IF deck. Because each specific tube (that tests good) can have a different gain or cutoff point, the AGC circuit will work a little differently, even in the same tube brand. Version 3. There are lots of different kinds of tube testers in use. Some will indicate the minimum good reading and the new tube reading. Usually, the minimum good reading is 60% of the new tube reading, so if your tester does not indicate both new and minimum readings, you can calculate the missing one. Version 3 end.

The following post by David Wise helps explain tube variances. Thank you Dave, for your very helpful post on our 390 forum about this subject.

Date: Tue, 28 Aug 2007 10:08:30 -0700
From: "David Wise" <David_Wise 'at' Phoenix.com>
Subject: RE: [R-390] Call for measurements - 100dB carrier reading

Thanks for all the info, Graham. Except for R504, all my resistors are within tolerance. I was able to duplicate your AGC voltage by substituting tubes. It appears that my gain-controlled IF signal chain (V501, V502, and V503) has a wider cutoff characteristic than yours. (For the record, they are JAN Sylvania 5749W's.) I substituted 6BA6's that have sharper cutoff and about the same gain. This, plus a

new 6AK6 (so my IF gain is normalized lower) got my 100mV AGC down from 14-somthing to 12-something. My AGC amp, V508, has unusually high gain. After replacing it with my weakest spare, and putting in my sharpest 6DC6, I got -11.8V . (I also tried substituting mixers; they affect the gain curve very little.) So there you have it - it was just normal variation.

Quick recap of factors that can contribute to low AGC when the circuit tests okay and the IF gain is normal.
1. Low RF deck gain: weak 6DC6, 6C4's, or 6AK5's, or misalignment. There's less output than normal which results in less AGC.
2. Sharper than normal cutoff 6DC6 or V501-V503 6BA6. A given AGC is unusually effective in reducing the gain.
3. Weak V508 6BA6 AGC amp. For a given output, less AGC is developed.

Diagnostic tip: for a given 6AK6 and AGC voltage, unusually high diode load voltage points to a weak V508. The manual's procedure for setting the IF gain depends on uniform 6AK6 gain. Since 6AK6's are not all alike, every deck will in fact be different, as far as the gain control loop is concerned. If the goal is to achieve uniform AGC action, it would be better to normalize the IF OUTPUT level. (No doubt this was not done because (a) it would require more test equipment, and (b) it wasn't worth the effort.) But this doesn't help; since 6BA6's vary in their cutoff characteristic and (V508) gain, every deck would be different even if the 6AK6's weren't. The R-390x is not a voltmeter; we should not expect every set to read the same. The carrier meter is an approximation only.

I have five different brands of 6BA6/5749's, and they fit into two different groups by gain. Tungsol, Sylvania, Zenith, and Raytheon result in the correct lower gain in the IF deck than the five GE tubes that I have. The GE tubes produce too much AGC, so I'd only use them knowing the result. So, before you start changing tubes, make sure that the RF and IF decks are in correct operation and alignment (including all mechanical filters having similar loss (gain)).

I'm hopeful that at this point your CL meter is working quite well and it's indicating 100 db when it should be.

Now let's look at the low end of the CL readings. With 10 uv in, it should be reading about 20 db. There's an interesting characteristic about the IF gain adjustment: making a small change to it affects the low end CL reading without affecting the full scale reading of 100 db. So, if the reading is close to 20 db (+/- 3 db), try adjusting the IF gain slightly for exactly 20 db with 10 uv in to the balanced antenna. Now when you step through the input signal levels on your sig gen (10 uv, 100 uv, 1 mv, 10 mv and 100 mv) feeding into your rx, the CL meter should read: 20 db, 40 db, 60 db, 80 db and 100 db. In reality, you will see some variance from these numbers, but that would be very difficult to correct (as the R-390A was not designed to be that exact). Version 3. Two CL meter reading levels are imortant, 20 db and 100 db to get very close (so the linearity can be as good as it can be). On the 390 series receivers, an S9 signal level is equal to 34 db. See my comparison chart in my document 'DB and S Signal level relations' on our website. Version 3 end.

Because the CL meter reading is sensitive to the overall gain of the RF and IF decks, the output of the

second crystal oscillator could affect the readings from one 1-MH segment to the other, as the oscillator output can be different from one 1-MH segment to the other. However, you should not see a lot of variance due to this as the oscillator level (2 to 5 v RMS) is a lot higher than the received (or test) signal (.1 v RMS) going into the mixers.

There is still one other situation that needs to be addressed – the CL meter can read differently below 8 MH and above 8 MH. This is because the first mixer is switched in and out of the circuit. The output of its 6AK5 oscillator or gain of the 6C4 mixer will affect this.
Version 2. My 390 has this issue a little bit (above 8 MH is about 2 db higher). So, I got all my 6C4's and 6C4WA's out and tried six different ones (including one that had a little lower gain than the new ones). I have only three different brands (GE, Sylvania and RCA), two of each. The result is that there was no significant difference among them (as far as the CL meter operation goes). Next, I changed the 6AK5 first oscillator from a Sylvania to a new GE and peaked its transformer, T207. It was very close in adjustment to before and no difference in CL meter reading. Just to make sure it wasn't the alignment, I verfied the first variabe IF's were correct – they were, and of course, still no difference. I checked the oscillator output by measuring the -v dc on test point E209 in standby and it is high at -12.4 v dc (-8.5 v dc is a good high). As an extra check, I measured the plate and cathode voltages and they are right on. The below 8 MH still has good CL meter indications and above 8 MH is still a couple db above that. I don't know what's causing the difference. I'm accepting it for now.
End Version 2.

I hope this document has helped you correct your CL meter readings to the point that you are satisfied with it's operation. I've read through the 'Pearls' section on 'panel meters' and appreciate all the helpful posts made on our forum on this subject. Thanks Wei-i Li for doing the Pearls.

Non-standard meters

David Wise and Gary Gitzen did a very nice piece of work on this subject in 2007. Dave's final post on it on our 390 forum follows. Thanks Dave.

Date: Wed, 29 Oct 2014 12:35:29 -0700
From: David Wise <David_Wise 'at' Phoenix.com>
Subject: Re: [R-390] Panel meters again

In 2007, Gary Gitzen and I worked out an IF deck modification that permits use of just about any panel meter in place of the special 17-ohm meter originally used. Any 1mA meter of 100 ohms or less will work, including the original. Most meters with lower FS current can also be used. As an added benefit, the zero adjust action becomes smooth and linear.

Here's a textual description. Full writeup and schematic available on request.
Disclaimer: This mod may rub some people the wrong way. If you hold the R-390(*)/URR design sacred, then read no further. Get an original meter, or emulate it with external circuitry a la Jan Skirrow. I don't mind, it's a matter of personal taste and an attitude I sympathize with. But the carrier meter circuit is a bad design. I REALLY get off on fixing bad designs. If you do to...

0. This mod assumes you have the original 100-ohm R523 zero adjust pot.
Don't worry, the mod also fixes the problems with that pot that may have driven you to replace it.
1. Add a 1N914 or similar Si diode, with cathode grounded and anode connected to the junction of R544, R546, and R547;
2. Change R549 from 82K to 75K;
3. Change R548 from 27 ohms to 150 ohms;
4. On R523, cut the link between slider and clockwise end, leaving R524 connected to slider, and R537 and M102 connected to CW;
5. Change R537 from 22 ohms to 68 ohms;
6. Change R524 from 680 ohms to 620 ohms.
The circuit is now calibrated for a 100-ohm 1mA meter, and can handle lower-resistance meters by the simple expedient of adding a series resistor. Most meters with lower FS current (500uA, 50uA, etc) can also be used, again adding series resistance depending on the meter.
7. Mark the deck or otherwise record the mod.
WISE/GITZEN 2007 M102 CARRIER METER MOD - CALIBRATED FOR 100 OHM 1MA METER. [Or whatever yours is.] TO OPERATE WITH ORIGINAL METER, ADD 82 OHMS IN SERIES. [Or "CHANGE SERIES RESISTOR TO 82 OHMS."]

In step 1 of the mod, a 1N914 ‘clamping diode’ is added to prevent the AGC line from going plus (this is bad for the tubes in the signal line and AGC operation). This can happen under other circumstances, even before this mod is installed (very low noise antenna being used or no antenna used during testing), so it’s beneficial to install the clamp in any case (version 3: which I have done and like the operation) version 3 end. I’ve not installed this mod, but looks good to me. If my meter was non-standard, I’d install it. Larry Haney