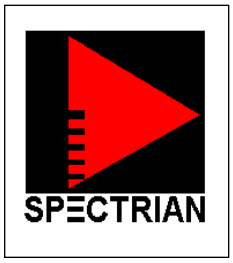


PCS MCPA Top Level Amplifier Alignment Procedure (Version 1.7)

December 6, 2001
Rev 1.7

1 Purpose:

The intent of this document is to describe the specifics of a method to tune and align the PCS MCPA Power Amplifier. This procedure is based upon the Universal Method proposed by Steve Avis. At the beginning of the procedure the operator (engineer, technician or otherwise) will have an un-tuned, complete assembly. If the unit successfully passes through the procedure the assembly will be a fully tuned and functional unit.

2 Outline:

This document is divided into 4 major sections to show below. The document will elaborate on each step, giving step-by-step instructions for all portions of the procedure.

PROCESS STEPS:

I. Prep

Check connections and quality of assembly
Set default settings for each of the loops

II. Network Analyzer Measurements

Small signal alignment of Loop1
Small signal alignment of loop2

III. Spectrum Analyzer Measurements

Verification of proper Loop1 Carrier Cancellation
Verification of proper Loop2 performance/targets

IV. Detector Calibration and Alarm settings

3 Procedure

3.1 Prep

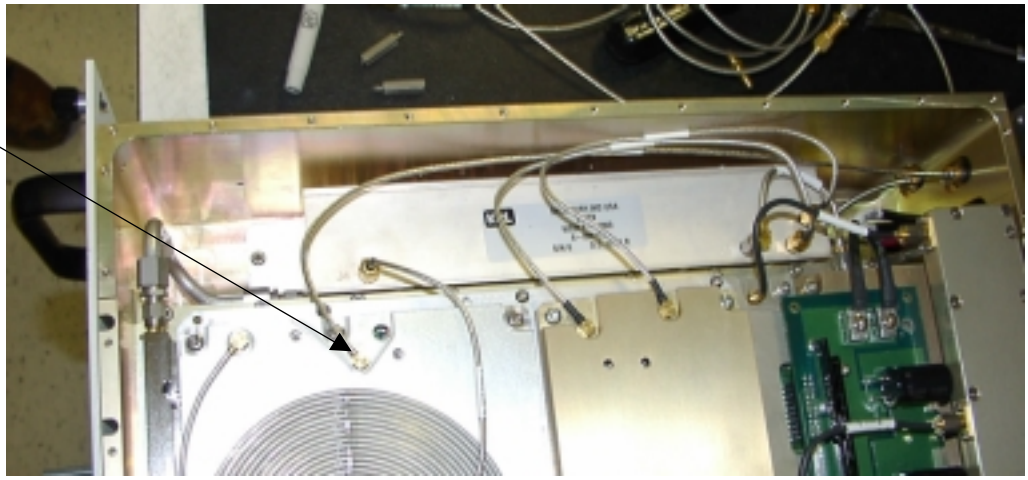
3.1.1 Inspection

Inspect all RF and DC connections for proper installation. [Refer to the AI-02-000174] Make sure all DC connections are present and firmly plugged in. Make sure all RF cables are installed and firmly plugged in.

3.1.2 Setting Defaults

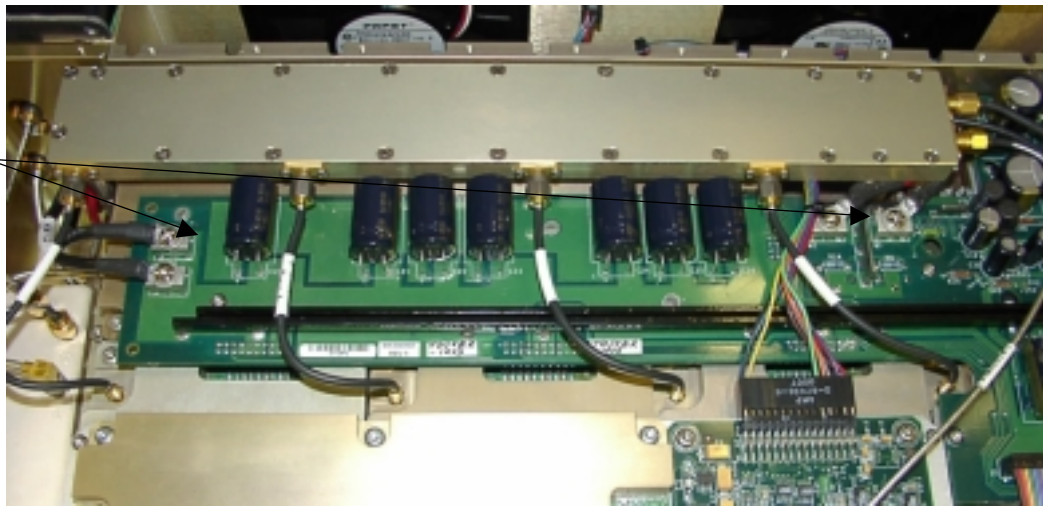
A. Start the GUI
B. Attach the cable adapter to the RF/DC connector on the PA. Affix with 4 screws to secure the connection.
C. Disconnect RF in from the unit, at the input to the preamp.

Disconnect input cable here.



D. Set Power Supply to +27V. When brought up, the unit should have about 19.3A of current. (18.6 - 21.5 A spec range)
E. Measure the voltage at points and insure the voltage is 27±.1 Vdc

Measure voltage between these 2 points



F. On the GUI Hit "Cal DC" The DC input should read 26.97V on the GUI.
G. Hit "Disable" on the GUI (Note: The fans will turn off when this is done). Unit should be drawing 0.9-1.1A
H. Open the "Loop1" window and with Loop1 disabled, and Manual control set to ON, set the DAC Sliders On Loop1 to the following setting:

Slider Name	***Slider Value***
PA	**275**
PP	**512**
L1A2	**210**
L1P3	**512**
L1A1	90
L1P1	120

L1P2	120
L1P4	"ON"

Insert a picture of the GUI

1. Click on <Save to Flash>
2. Click on <Revert>
3. Click on <Manual Control> OFF then <Manual Control> ON to make sure the values got stores.
4. Hit quit and go back to main GUI screen when done.

I. Open the "Loop2B" window,
   1. make sure Loop2 is disabled,
   2. manual control is ON and
   3. set the DAC Sliders On Loop2 to the following settings:

Slider Name	***Slider Value***
L2A2	**210**
L2P3	**512**
L2A1	90
L2P2	120
L2P1	120
L2P4	"ON"

Insert a picture of the GUI

4. Click on <Revert>
5. Click on <Manual Control> OFF then <Manual Control> ON to make sure the values got stores.
6. Hit quit and go back to main GUI screen when done.

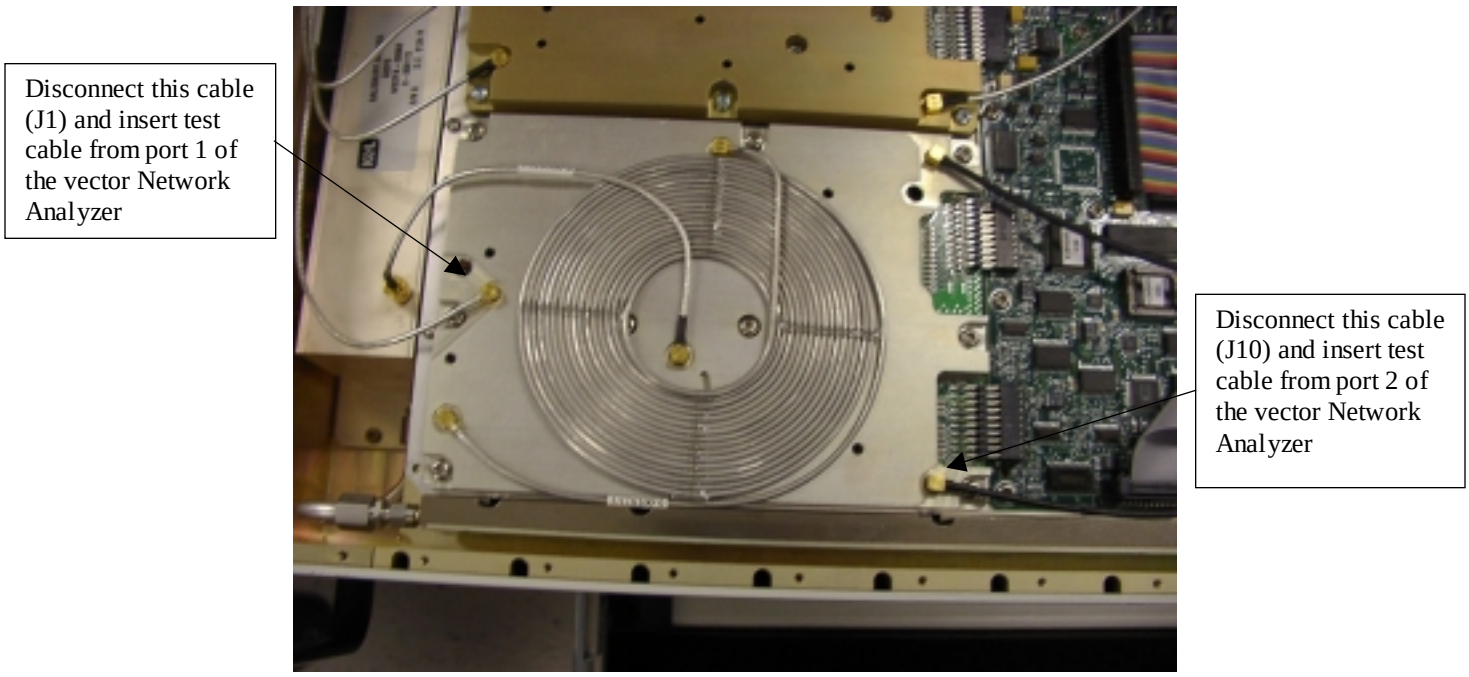
Finished with Initial Setup – Go to next section!

3.2 Network Analyzer Measurements

3.2.1 Loop 1 Carrier Cancellation Alignment

Steps

1. From the Main GUI enable the amplifier
2. Select the Loop 1 GUI
3. In the lower left hand corner of the GUI are the Main amp and Error amp controls. Select off for these amplifiers and click on <Change>. Current should be 6.3-7.2A (6.9A typ).
4. Select <Disable> for the loop.
5. Recall "Loop1" calibration on network analyzer – the calibration should be from 1910MHz to 2010MHz. Note that the measurement bandwidth is 1930-1990MHz in this case.
6. Connect the VNA port 1 to the input to the preamp (if applicable) and port 2 to the output of the carrier cancellation board. (insert a photo here)
7. Disconnect the main path sample cable from J9 and terminate that port in 50 ohms.
8. Go into the manual mode (Manual mode ON)



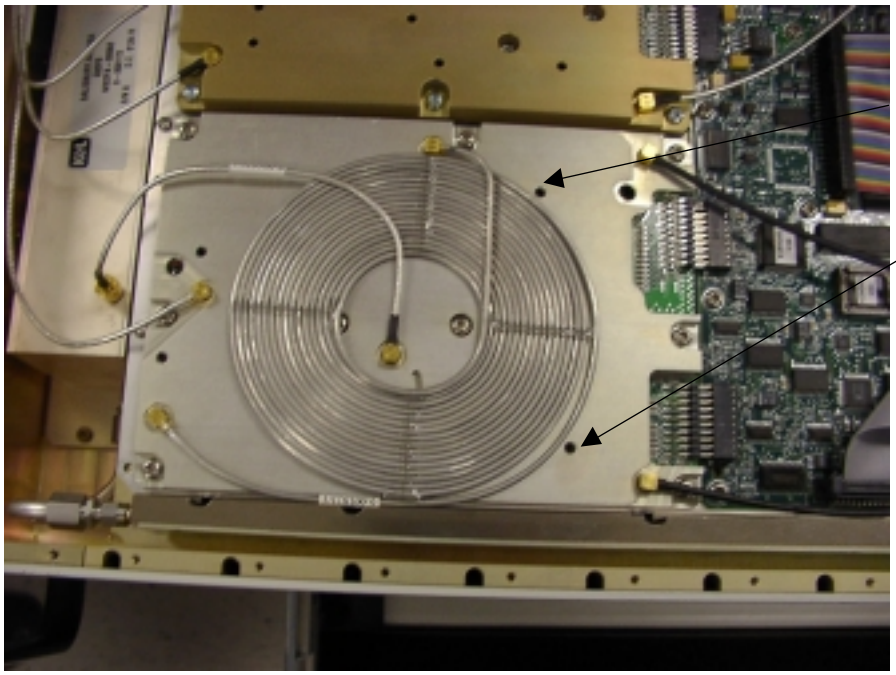
9. Measure the reference delay path from 1930-1990MHz. Use split screen display on VNA to measure gain and phase at the same time. Set Marker 1 to 1930MHz, Marker 2 to 1960MHz, Marker 3 to 1990MHz.

Phase, Channel 1, scale=2°/div, buttons sequence.

a) Make Marker 2 active (1960MHz)
b) Press <Marker Function>, <Marker to delay>, <Marker to reference>
c) <Scale>, <Electrical delay>
d) Adjust delay for flattest phase response 1930-1990MHz (scale 2°/div), <Marker to reference>
e) Peak to peak flatness should be less than 2 degrees, if it is more than 2 degrees, then there is something wrong with the reference path – move the unit to the troubleshooting area and mark the test as FAIL and indicate REFERENCE PATH PHASE FLATNESS OUT OF SPEC.
f) <Display>, <Data to Memory>, <Data – Memory>
g) <Scale>, <phase offset>, on the keypad put in 180 and hit the <x> button.

Gain, Channel 2, scale=.2dB/div, buttons sequence.

a) <scale>, <marker to reference>
b) Using R279 adjust the loop 2 gain slope adjuster for optimum flatness.
c) Repeat step a). ** Peak to peak flatness should be less than 1.0dB, if it is more than 1.0dB, then there is something wrong with the reference path – move the unit to the troubleshooting area and mark the test as FAIL and indicate REFERENCE PATH AMPLITUDE FLATNESS OUT OF SPEC.



<Display>, <Data to Memory>, <Data – Memory>

10. Reconnect the main path sample cable to the carrier cancellation board.
11. Enable main amplifier (Loop1 -> Main Amp ON, Error Amp OFF)
12. Using manual gain slider (L1A1) adjust gain to reference value. Use the Loop1 slope adjustment (R34) if necessary to match gain flatness with reference path. *This must be done prior to adjusting the phase as it can modify the delay.*

    Main Path should have a flatness of less than 1.0dB peak to peak. This should match the trace that was stored in memory.

    (If the unit has flatness worse than 1.0dB, the unit has FAILED. Place unit is troubleshooting area and mark unit FAILED LOOP1 ALIGN, MAIN PATH GAIN FLATNESS)

    (If you are unable to achieve the gain level of the reference path, then the unit has FAILED. Center the L1A1 to the starting value and note the gain level. Write down the following in the paperwork: FAILED LOOP1 ALIGN, UNABLE TO SET MAIN PATH TO REF PATH. NOMINAL GAIN DELTA <gain level at 1960MHz>. Place unit in troubleshooting area)

13. Using manual phase sliders (L1P1, L1P2, and L1P4) adjust phase to reference value on channel 1. The phase at 1930MHz should be within 1 degree (+/-0.5 degrees) of the phase at 1990MHz. The peak to peak ripple should not exceed 2 degrees.

    If the phase difference of 1930 & 1990MHz is different by more than 0.5 degrees, then the Loop1 select at test cable needs to be changed. Modify according to the table below and repeat steps 6-7:

Condition	**Response**
Marker 1 < Marker 3	Choose Longer Cable
Marker 1 > Marker 3	Choose Shorter Cable

If the ripple is larger than 2 degrees, then there is something wrong with the Main Path Flatness. Put the unit in the troubleshooting area and mark the unit FAILED LOOP1 ALIGN, MAIN PATH PHASE FLATNESS

14. At this point the gain, phase, and delay should be matched.
15. The test setup is now ready to test for the conformation of correction and alignment. Follow the next few steps.

    Gain, Channel 2, scale=5dB/div, buttons sequence.
    a) <Display>, <Data / Memory>
    b) <scale>, <reference value>, –30 ‘x1`

16. Adjust manual gain (L1A1) and phase controls (L1P1, L1P2) to make the trace from 1930-1990MHz is below the –30dB reference.

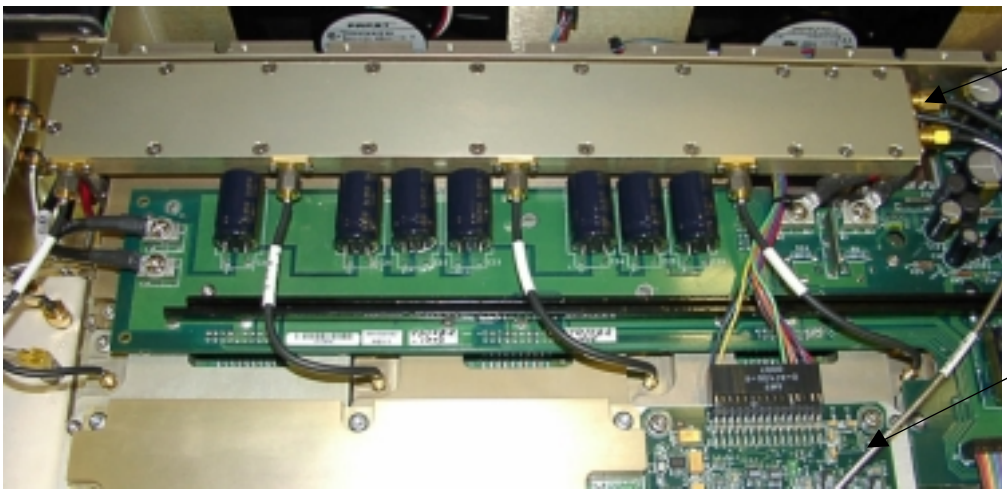
    If you are unable to achieve this repeat steps 9-14. If you repeated 9-14 *several times (3 times minimum)* and cannot achieve the required performance, the unit FAILS. Place in troubleshooting area and write: FAILS LOOP1 ALIGNMENT, UNABLE TO ACHIEVE 30DB NWA CANCELLATION.

17. Save settings to flash, make sure they were saved (SAVE TO FLASH -> REVERT -> MANUAL CONTROL OFF -> MANUAL CONTROL ON).
18. Done! – Turn off MAIN AMP, reconnect J1and J10, and Go to Loop2 Alignment

3.2.2 Loop 2 Alignment

Steps

1. From the Main GUI enable the PA.
2. Select the Loop 1 GUI and turn off the bias for the Main and Error Amps.
3. From this GUI “Disable” Loop 1.
4. RECALL VNA calibration for Loop2. This should cover 1880-2030MHz. Place markers at the following frequencies: Marker1: 1900MHz, Marker 2: 1930MHz, Marker3: 1960MHz, Marker4: 1990MHz, Marker 5: 2020MHz.
5. Connect the VNA port 1 to the input to the input of the divider (J1).
6. Enable Main Amp and make sure Output Power is ***under 28dBm***. If it is higher, adjust VNA output power lower until it is.
7. Disable Main Amp.
8. Attach port 2 to the output of the top-level assembly (RFOUT).
9. Disconnect the pilot tone input to the main path.



10. Enable the Main Amp. Current should be less than ___ amps.
11. Quit Loop 1 GUI.
12. Select the Loop 2B GUI.
13. Disable the loop and go into manual mode (DISABLE->MANUAL MODE->ON)
14. Measure the main path. Use split screen display on VNA to measure gain and phase at the same time.

    Phase, Channel 1, scale=2°/div, buttons sequence.
    a) Press <Markers>, <Marker 3>
    b) Press <Marker Function>, <Marker to delay>, <Marker to reference>
    c) <Scale>, <Electrical delay>
    d) Adjust delay for flattest phase response over frequency Marker1 to Marker5 (scale 2°/div), <Marker to reference>
    e) <Display>, <Data to Memory>, <Data – Memory>
    f) <Scale>, <reference value>, set to (current value +/- 180°)

    Gain, Channel 2, scale=0.2dB/div, buttons sequence.
    a) <scale>, <marker to reference>
    b) <Display>, <Data to Memory>, <Data – Memory>

15. Enable error amplifier
16. Using manual gain slider (L2A1) adjust gain to reference value. Use the Loop-2 slope adjustment (R279) if necessary to match gain flatness with reference path. This must be done prior to adjusting the phase as it can modify the delay.

    The Error Path should have a flatness of less than 0.2dB peak to peak from 1900-2020MHz. If the unit has flatness worse than 0.2dB, the unit has FAILED. Place unit is troubleshooting area and mark unit FAILED LOOP2 ALIGN, ERROR PATH GAIN FLATNESS

    If you are unable to achieve the gain level of the reference path, then the unit has FAILED. Center the L2A1 to the starting value and note the gain level. Write down the following in the paperwork: FAILED LOOP2 ALIGN, UNABLE TO

SET ERROR PATH TO MAIN PATH. NOMINAL GAIN DELTA <gain level at 1960MHz>. Place unit in troubleshooting area.

17. Using manual phase sliders (L2P1, L2P2, and L2P4) adjust phase to reference value on channel 1. The phase at 1930MHz should be within 1 degree (+/-0.5 degrees) of the phase at 1990MHz. The peak to peak ripple should not exceed 2 degrees.

    If the phase difference of 1900 & 2020MHz is different by more than 0.5 degrees, then the Loop2 select in test cable needs to be changed. Modify according to the table below and repeat steps 6-7:

Condition	**Response**
Marker 1 > Marker 3	Choose Longer Cable
Marker 1 < Marker 3	Choose Shorter Cable

    If the ripple is larger than 2 degrees, then there is something wrong with the Error Path Flatness. Put the unit in the troubleshooting area and mark the unit FAILED LOOP2 ALIGN, ERROR PATH PHASE FLATNESS

18. At this point the gain, phase, and delay should be matched.
19. The test setup is now ready to test for the conformation of correction and alignment. Follow the next few steps.

    Gain, Channel 2, scale=5dB/div, buttons sequence.
    a) <scale>, <reference level>, change to –30dB
    b) <Display>, <Data / Memory>

20. Adjust manual gain (L2A1) and phase controls (L2P1, L2P2) to make the trace from 1930-1990MHz is below the –30dB reference. Continue adjusting until the marker 1 (1900MHz) has the maximum cancellation possible. The rest of the band to 2020MHz should be at –30dBc or better.

    If you are unable to achieve this, repeat steps 14-18. If you repeated 14-18 *several times (3 times minimum)* and cannot achieve the required performance, the unit FAILS. Place in troubleshooting area and write: FAILS LOOP2 ALIGNMENT, UNABLE TO ACHIEVE 30DB NWA CANCELLATION

21. Save settings to flash, make sure they were saved (SAVE TO FLASH -> REVERT -> MANUAL CONTROL OFF -> MANUAL CONTROL ON).
22. Done! Quit Loop 2 GUI.
23. Disable the Amplifier.
24. Disconnect the VNA and proceed to section 3.3 Spectrum Analyzer Measurement.

3.3 Spectrum Analyzer Measurements

3.3.1 Carrier Cancellation at Full Power

Steps

1. Turn down input signal source all the way.

2. Connect the signal source to the input of the amplifier.
3. Connect the output of the amplifier to the high power load.
4. Connect the output of the carrier cancellation board (J10) to the spectrum analyzer.
5. Insure the source is centered at 1960MHz.
6. Apply DC power to the PA.
7. Enable the amplifier.
8. Select the Loop 1 GUI.
9. DISABLE the main amp and error amp.
10. Disable the loop and go into manual mode.
11. Enable Main Amp.
12. Using the external attenuator drive the output power to 29dBm
13. Disable the Main Amp
14. Set Top of signal to 20dB below the top of the graticule of the Spectrum Analyzer
15. Enable Main Amp
16. Slowly raise the power level to *typical* power output (49dBm) [Note that maximum power output is 50dBm and that this step assures proper operation at 50dBm]
17. Enable Loop1
18. The signal on the spectrum analyzer should be 30dB below the top of the graticule.
19. If this is the case then go to the Loop1 GUI and do the follow these steps.

    a) Confirm that L1A2 and L1P3 are within acceptable ranges.
    b) Save settings to flash.

20. If the settings are not adequate then adjust L1P1, L1P2, and L1A1 for best results and save settings to flash.
21. Confirm carrier cancellation is 30dB minimum.
22. Done! Turn down input signal source. Reconnect cable from J10 to the Error Amp.

3.3.2 Loop 2 Correction at Typical Power

Steps

1. Connect the signal source to the input of the amplifier and the output of the amplifier to the spectrum analyzer.
2. Enable the amplifier and raise the output power to 49dBm.
3. Next raise the power from the typical power level of 49dBm to the maximum power level of 50dBm.

3.3.2.1 Cancelled Pilot

1. Open the Loop 2B GUI and disable the loop and go to manual operation.
2. Center the spectrum analyzer display on the pilot tone with a 2MHz span.
3. Adjust L2A2 and L2P3 for best cancellation of the pilot tone.
4. Save the settings to flash and enable the loop.
5. At 1960 confirm –66dBc minimum performance.
6. Measure at 1930 and 1990MHz and confirm a minimum –66dBc.

3.4 Detector Calibration, Final Gain Set and Alarm Setting

Gain Setting

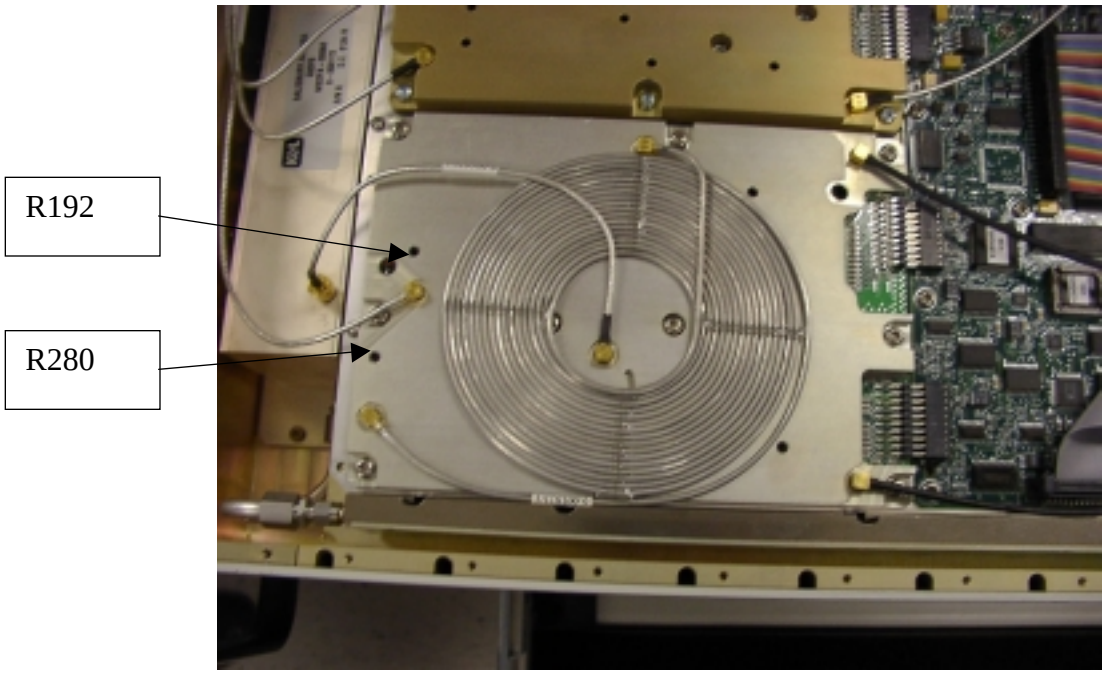
1. Disconnect the input to the amplifier.
2. Connect input cable to a power meter and adjust input signal to –6dBm Pavg.
3. Adjust external attenuator to add –20dB to measured level (-26dBm).
4. Reconnect input cable to amplifier.
5. Enable the Amplifier.
6. Select the Loop 1 GUI.
7. Using the external attenuator increase input power 20dB (-6dBm measured).
8. Adjust PA until the output power is exactly 49dBm. (This is at 55dB gain at the typical power level)
9. Turn the power up the maximum power output of 50dBm and confirm the gain is still 55dB.
10. Save PA to Flash.

Detector Calibration

1. Run Detector calibration on unit
2. Confirm that the input, output and reverse power are within spec limits.

Setting Error Amp SLAM

1. Set output power to 50dBm (maximum power level), and confirm acceptable unit performance.
2. Decrease output Power to 39dBm
3. Disconnect Sample Cable
4. Slowly adjust R280 (EA_OVD SLAM set) until Error Amp overdrive trips.
5. Reconnect Sample Cable – Slam should clear.



Setting Input Overdrive SLAM

1. Turn on unit, disable main and error amps. Disconnect main amp cable, error amp cable.
2. Raise input power to 0dBm
3. Slowly adjust the IN_OVD Pot (R192) to alarm at 0dBm
4. Lower and raise input power – the SLAM should turn on at 0dBm minimum, and clear at –1dBm maximum.
5. DONE! Turn down input signal below –6dBm, and reconnect all cables.