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## **TEST & ALIGNMENT SPECIFICATION**

### **LinkNet LNKA800 800-900MHz Amplifier Modules**

**DCT000000044**

**Revision 13  
31 March, 2003**

## TABLE OF CONTENTS

Revision Record.....	3
Proprietary Notice.....	3
1. Introduction .....	4
2. REFERENCES.....	5
3. TEST Equipment.....	5
4. Programming.....	5
5. LinkNet AMPLIFIER Test Jig.....	6
6. Equipment Setup.....	7
7. LinkNet LNKA AMPLIFIER DC Testing – Description FOR REFERENCE.....	7
8. LinkNet LNKA AMPLIFIER RF Alignment and Testing - REFERENCE .....	8
7.1 Preliminary Gain Check.....	8
• TABLE 3 GAIN SETTINGS VS TEST LEVEL, GAIN:.....	8
7.2 Intermodulation Test – diagnostic only – see section 8.5 for post calibration version of test. ....	9
• Table 5 GAIN SETTINGS VS TEST LEVEL, IMD:.....	9
7.3 Detailed Gain, Bandpass And Return Loss Testing.....	11
7.3.1 Fine Gain Control Verification – diagnostic testing for attenuator errors.....	11
7.3.2 Accurate Gain Measurements – for single channel verification .....	12
• Table 6 – Frequencies For Gain Measurements .....	12
7.3.3 Input Return Loss .....	13
7.4 1dB Compression – Data gathering only .....	13
7.5 DC Current.....	14
7.6 Forward Power Range.....	14
7.7 AGC Range – 3 point version.....	14
7.8 Test of Digital (remote) Control AGC.....	14
7.9 Spurious Tests: Near Spurs.....	15
7.10 Spurious Tests: Harmonics.....	15
7.11 Spurious Tests: Noise Floor.....	15
7.12 Calibration Data Entry.....	16
9. FINAL TEST (After calibration) .....	17
• 8.1 GAIN:.....	17
• 8.2 AGCBIAS .....	17
• 8.3 TxCURR.....	17
• 8.4 FORWARD POWER .....	17
• 8.5 IP3.....	17
9.0.....	18
Test Complete .....	18
• Table 4 CALIBRATION DATA & RF TEST SHEET:.....	19
• Table 9 FINAL TEST SHEET: (After calibration).....	20
• 10.0 Prototype Characterization Testing .....	21
10.1 DC Testing.....	21
10.2 RF Testing.....	21
• Table 8 – Testing Map.....	21
• TABLE 7: PROTOTYPE TEST SHEET.....	22

## REVISION RECORD

0	April 19, 2001	Original Release	Pierre Mihok
1	May 16 2001	Release with software updates	Pierre Mihok
2	June 6 2001	More software updates	Pierre Mihok
4	July 13 2001	More software updates	Pierre Mihok, Roman Gurvich
5	July 19 2001	More software updates	Roman Gurvich
6	July 24 2001	More software updates	Roman Gurvich
7	August 20, 2001	Changes to reflect KATs results	Pierre Mihok, Roman Gurvich
8	October 12, 2001	Changes to reduce KATS test time	Pierre Mihok, Roman Gurvich
9	October 15, 2001	More Changes to reduce KATS time	Pierre Mihok, Roman Gurvich
10	January 10, 2002	Programming Information	Pierre Mihok, Roman Gurvich
11	March 21, 2002	Add Noise Test	Pierre Mihok
12	June 27, 2002	Remove References to AGCLINE	Pierre Mihok
13	31 March 2003	Clarify FACTORY 0 description	Pierre Mihok

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## 1. INTRODUCTION

This procedure describes how to test circuitry and calibrate variable elements in **Kaval 800-900 MHz LinkNet BroadBand Amplifiers** (LNKA) to optimize RF performance, and verify performance against specifications. It applies to products built in accordance with schematic SCH000000045 on PCB000000059.

The Kaval Amplifiers are multi-stage broadband amplifiers with gains ranging from 34 to 84 dB in two ranges of 34-44 and 42-84 dB. These units are capable of outputting up to 6 W, and are intended for the amplification of multi-carrier signals in the bands 800 to 940 MHz. Exact operating frequency is determined by internal bandpass filters.

The amplifiers are equipped with a wide range digital gain selection, which selects the gain between the limits of 34 to 84dB without degrading IP3 specifications. Additionally, there is a 31 dB analogue gain control that can be programmed to respond to digital control inputs, or digitally set to respond to analogue AGC signals from the output RF RMS power detector. The analogue AGC has a programmable output power activation threshold, adjustable between 8 and 38 dBm but specified to operate from 15-30dBm.

The amplifier unit is mounted in a standard LinkNet machined/extruded aluminum chassis, which fits into the LinkNet card cage.

After DC bias tests and first operational checks, the unit should be tested with shield covers on, and with the lid screwed down. Improper measurements can result from possible feedback, ingress signals or self-oscillation and there are possible effects of the shield walls on the gain and frequency response. During DC tests, the PCB must be attached to the chassis using the two power amplifier screws (if the Power Amplifier module has been attached to the board at that point) and two circulator screws (if circulator is attached), plus at least 6 PC Board mounting screws. Otherwise, certain parts may overheat, or spurious oscillations might occur causing false overcurrent alarms. This precaution is important during debug and rework also. The input and output cables should be connected to the board. This allows the attachment of RF loads during DC test, which may be necessary to prevent self-oscillation and incorrect readings. The unit will not be damaged if it self oscillates.

At all times, do not apply power to UUT unless both input and output are properly RF terminated. Be especially careful not to connect UUT with input and output reversed since this unit has ample capability to destroy network or spectrum analyzers. Keep fingers off RF output traces during tests, especially 1 dB compression test. There is enough RF energy present to cause burns. Be careful to turn the power supply off before connecting or disconnecting the control connector.

## 2. REFERENCES

SCH000000045	LinkNet LNKA800 amplifier schematic
PCB000000059	PCB layout
DCA000000086	LinkNet LNKA800 amplifier assembly instructions
DCA000000087	LinkNet LNKA800 amplifier board assembly instructions
DCM000000054	LinkNet LNKA800 Amplifiers equipment manual
DCD000000009	LinkNet LNKA800 Amplifiers Functional Specifications
DCT000000045	LinkNet LNKA800 Amplifiers Board Test

## 3. TEST EQUIPMENT

The following equipment is needed for execution of this procedure. Cable and attenuator losses must be calibrated out of readings to an accuracy of at least 0.1 dB. Since losses may be frequency dependent, it is important to calibrate losses after the power amp at the specific frequency being studied.

- Scalar Network analyzer, 1 GHz capable. Analyzer must be normalized and calibrated per manufacturer's instructions prior to any test session and at 1-hour intervals thereafter.
- Termination calibration kit for above (type N)
- Spectrum Analyzer, 1 GHz capable, input dynamic range up to +25 dBm with input intermod < -60 dBc
- 10W 20 or 30 dB Attenuator good to 1 GHz.
- Multimeter
- 800-1000 MHz Splitter/Combiner, Isolation > 20 dB 800 MHz to 1000 MHz. (Narda 4322-2 or equivalent)
- Two synthesized signal generators capable of tuning over 800-900 MHz band with output capability of +5 dBm minimum.
- DC Dual Power supply capable of 2A at 28 VDC and 2A at 12VDC with variable current limiting and current meters on each output.
- RF interconnection cables as required. Do not use between series adaptors between network analyzer and UUT RF input or between UUT RF output and high power attenuator.
- LinkNet BackplaneTest Board as per Schematic in Section 4.

## 4. PROGRAMMING

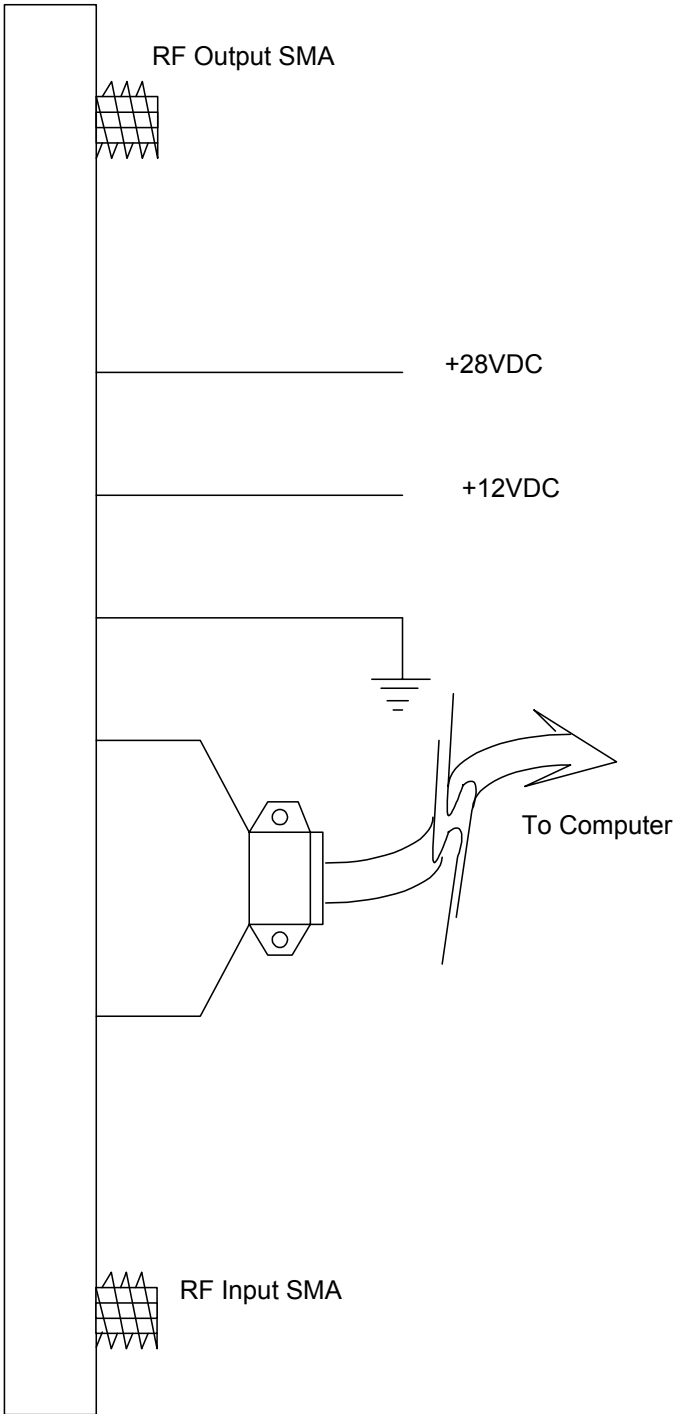
If the unit is to be reprogrammed with new operating software, connect it up first, before programming, power it up and type **LIST**, and record the existing software version number.

The software version number will indicate whether the updated software is compatible with the existing software's calibration data. Software updates are usually designed to leave the calibration data undisturbed.

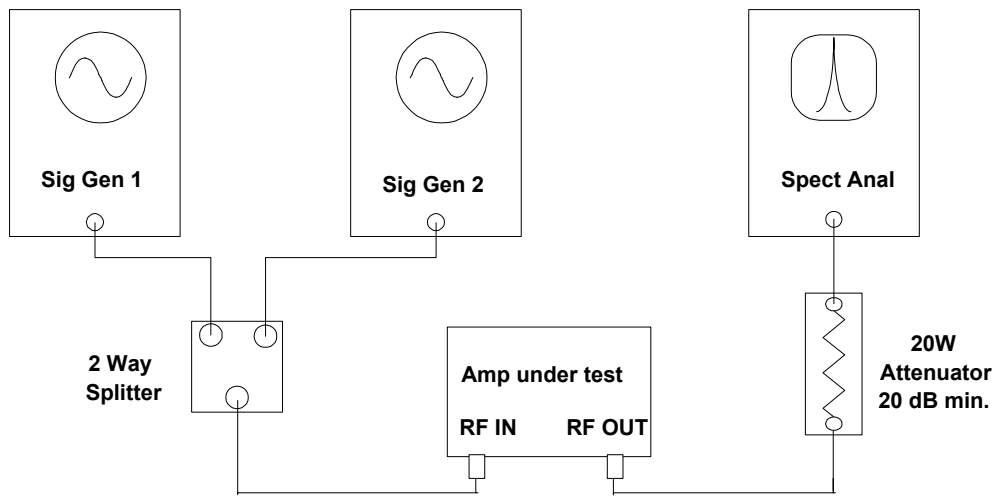
*However, if you have not been definitely informed that the new software can use the old calibration data, then **it is necessary** to perform the complete check and calibration procedure after loading the new operating software.*

# 5. LINKNET AMPLIFIER TEST JIG

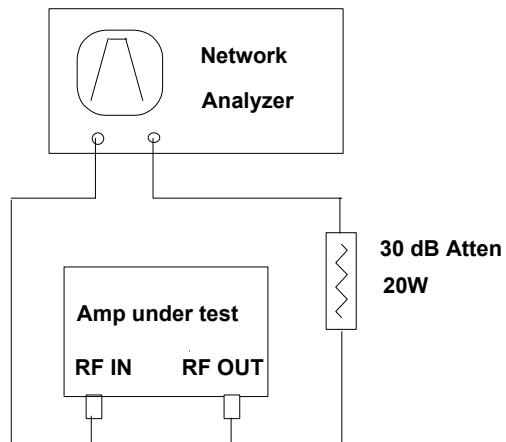
LINKnet Backplane  
Test Board



## 6. EQUIPMENT SETUP



**Figure 2: Test setup for AGC and Intermodulation testing**



**Figure 3: Test setup for Gain and Return Loss testing**

## 7. LINKNET LNKA AMPLIFIER DC TESTING – DESCRIPTION FOR REFERENCE

*Refer to DCT000000045.*

## 8. LINKNET LNKA AMPLIFIER RF ALIGNMENT AND TESTING - REFERENCE

These tests will normally be performed by an ATS (Automated Test System.) They are described here for reference purposes and for situations where the ATS is not available or appropriate.

**NOTE** – the access command, “ACCESS LAB”, must be typed into the terminal software to gain access to the setup and testing commands. This time limited access may expire and need to be refreshed by typing this command in again. If a command does not work, or you receive a “time out” message, type “ACCESS LAB”.

-If tests are interrupted, turn power OFF and ON or type “Reset UMC” into the terminal software, then restart.

-Note, **FACTORY 0**, **MODEL** (model number) and **ENABLE 1** must be typed into a new unit to start the UMC.

**FACTORY 0** clears any existing calibration data and sets the unit to defaults.

Before performing any RF tests, install the shield covers. Install at least half the screws at each end of the amplifier board. Put the top cover on and install at least half of the cover screws in a distributed pattern.

### 7.1 Preliminary Gain Check

**If readings are outside the expected range at any time during the following measurements, a FAULT may be present in the amplifier. Consult with your supervisor if unsure how to deal with the fault.**

This preliminary testing is merely to confirm proper operation of the amplifier. More detailed testing is done in Section 7.3.

1. Connect the UUT (Unit Under Test) to the test equipment as shown in **Figure 2**. Connect the amplifier to the Backplane Test Board, with the Power switch Off. Power supplies are set to 28.0 VDC, current limited to 1.5A, and 12.2 VDC, current limited to 1.5A.
2. Turn the output of one Generator off. Set the frequency of the other one to the center of the band for the amplifier being tested. Set the generator level according to the table below, to give the desired levels **at the amplifier input**: (Take into account the losses in the splitter/combiner and the connecting cables connected to the generators.)

• **TABLE 3 GAIN SETTINGS VS TEST LEVEL, GAIN:**

Amplifier Gain Settings	Amplifier Input Test Level
GAIN LO MIN	-5 dBm
GAIN HI MIN/GAIN LO MAX	-20 dBm
GAIN HI MAX	-70 dBm

3. Type the following into the Software Terminal: “ACCESS LAB”, “FACTORY 0”, “MODEL *number from 0 to 5*” (0 for LINKA800-A, 1 for B, 2 for C, 3 for D, 4 for E, 5 for F). See DCM000000054. Then “ENABLE 1”.
4. Type the following into the Software Terminal: “READ 2” this returns for example: +Ok 28128 \$6de0 4.29V.
5. Record first five digits (28128) into the Table 4, Measurement 1. It is TXCURR calibration data.
6. Type the following into the Software Terminal: “AGCEN 0”, “ENABLE 1” (this turns Off AGC and turns ON Power Amplifier).
7. Type the following into the Terminal Software: “TCEN 0”, “DIGATTN 0 0”, “DIGATTN 1 0”, “DIGATTN 2 0”, “DIGATTN 3 0” (these are equivalent to “GAIN HI MAX”) with the RF Level set appropriately as per Table 3 above.
8. Measure the output level on the spectrum analyzer. This level minus the input level is the gain. Record this gain in Table 4, Measurement 2.
9. Type the following into the Terminal Software: “DIGATTN 0 155”, “DIGATTN 1 155”, “DIGATTN 2 155” “DIGATTN 3 155”(equivalent to “GAIN HI MIN”) and set the level according to Table 3.
10. Measure the output level on the Spectrum Analyzer and record it as Measurement 3.
11. Type the following into the Terminal Software: “DIGATTN 2 0”, “DIGATTN 3 0”, and “BYPASS 1”. (Equivalent to GAIN LO MAX). Set the level according to Table 3.
12. Measure the output level on the Spectrum Analyzer and record it as Measurement 4.
13. Type the following into the Terminal Software: “DIGATTN 2 155”, “DIGATTN 3 155” (GAIN LO MIN) and set the level according to Table 3.
14. Measure the output level on the Spectrum Analyzer and record it as Measurement 5.
15. Now turn on the output of the second signal generator in preparation for the Intermodulation Measurements.



**7.2 Intermodulation Test – diagnostic only – see section 8.5 for post calibration version of test.**

This test will verify that the Amplifier performs with adequately low Intermodulation products being generated. Two equal RF signals are used, at an appropriate output signal level, to verify the Third-Order Intercept Point, **IP3**. IP3 is determined by comparing the RF Power Level of the two signals to the highest Intermodulation product. The calculation is...

$$IP3 \text{ (dBm)} = (\text{Test Signal Level}) + 1/2 (\text{Test Signal Level} - \text{Highest Intermod Product Level})$$

As an example, if the two Test Signals are coming out from the Amplifier at +27dBm each, and the difference between the Test Signal Level and highest Intermodulation Product is 43 dB, then the IP3 is calculated as...

$$IP3 = (+27\text{dBm}) + 1/2 (43 \text{ dBm}) = +48.5\text{dBm}$$

(Absolute level is approximate. Use signals within +/- 1 dB of target but within +/- 0.1 dBm of each other). Results will be entered into Table 4.

**1. Initial Conditions**

- Connect the equipment as shown in **Figure 2**.
- Turn on the power. When the terminal indicates that the UMC is ready, type "**ACCESS LAB**", then "TCEN 0 " to disable temperature compensation
- Type the following into the Terminal Software: "DIGATTN 0 0", "DIGATTN 1 0 ", "DIGATTN 2 0", "DIGATTN 3 0", "BYPASS 0", "AGCDIG 0 " and "AGCEN 0". (These settings put the amplifier at max. gain with the trim attenuator off and the AGC off.
- Turn the output of both generators ON. Set one 500 kHz above, and the other 500 kHz below the mid-band frequency of the amplifier. Ensure that the signal coming out of the combiner/splitter has an intermod. Level lower than – 60dBc.

**2. Four Gain-Setting-Points Intermod Test:**

Intermod will be measured at one (or two) output levels, and at four gain levels which are set by typing into the terminal software:

- 1) "DIGATTN 0 0", "DIGATTN 1 0 ", "DIGATTN 2 0", "DIGATTN 3 0", (GAIN HI MAX) Table 4, Meas. 7
- 2) "DIGATTN 0 155", "DIGATTN 1 155 ", "DIGATTN 2 60", "DIGATTN 3 155", (GAIN HI MIN +9.5dB) –Table 4, Meas. 8
- 3) "BYPASS 1", "DIGATTN 2 0", "DIGATTN 3 0" (GAIN LO MAX) Table 4, Meas. 9
- 4) "DIGATTN 2 30", "DIGATTN 3 155" (GAIN LO MIN +12.5dB)—Table 4, Meas. 10

These settings comprise the upper and lower limits of normal operation of the amplifier.

**3. Apply two test signals at the appropriate level from the table below, as measured at the amplifier input:**

- **Table 5 GAIN SETTINGS VS TEST LEVEL, IMD:**

Amplifier Gain Settings	Amplifier Input Test Level
GAIN LO MIN+12.5dB (31dB)	-5 dBm, -8dBm
GAIN HI MIN -6dB/GAIN LO MAX +12.5dB (44dB)	-20 dBm, -17dBm
GAIN HI MAX+9.5dB (84dB)	-60 dBm, -57dBm

4. Adjust the level of both generators to obtain +24 dBm per carrier +/- 0.1 dBm at output of the Amplifier. Record the output level.
5. Turn spectrum analyzer video averaging on (16 sweeps). Using the delta marker, measure & record the difference in level between the highest output carrier and the highest intermod product. Divide this dB reading by two and add to the carrier level. This is the Output

Third Order Intercept Point; **OIP3 Level**. Enter the measurement in each case, into Table 4 as noted above.

## 7.3 Detailed Gain, Bandpass And Return Loss Testing

Connect the amplifier as shown in Figure 3. Make sure the network analyzer RF output level is set to -50dBm to avoid compression. Note, this test can also be made using a Spectrum Analyzer and Tracking Generator if properly calibrated. Use a marker delta function to track the change in the gain.

### 7.3.1 Fine Gain Control Verification – diagnostic testing for attenuator errors.

After typing "[ACCESS](#) LAB", "TCEN 0" and "BYPASS 0" type the following into the terminal software to clear all attenuators: "DIGATTN 0 0", "DIGATTN 1 0", "DIGATTN 2 0", "DIGATTN 3 0", "AGCEN 0".

Sequentially enter the following and observe the network analyzer trace. Verify that the gain reduces by about the amount of dB shown at each step, and proceeds monotonically. (The idea is to look for stuck bits on the digital control lines.) The following is the minimum pattern to test all the bits.

"DIGATTN 0 5 <ENTER>"	0.5dB
"DIGATTN 0 10 <ENTER>"	1dB
DIGATTN 0 20	2dB
DIGATTN 0 40	4dB
DIGATTN 0 80	8dB
DIGATTN 0 0	
DIGATTN 1 5	0.5dB
DIGATTN 1 10	1dB
DIGATTN 1 20	2dB
DIGATTN 1 40	4dB
DIGATTN 1 80	8dB
DIGATTN 2 0	
DIGATTN 2 5	0.5dB
DIGATTN 2 10	1dB
DIGATTN 2 20	2dB
DIGATTN 2 40	4dB
DIGATTN 2 80	8dB
DIGATTN 2 0	
DIGATTN 3 5	0.5dB
DIGATTN 3 10	1dB
DIGATTN 3 20	2dB
DIGATTN 3 40	4dB
DIGATTN 3 80	8dB

Restore the gain to maximum usable by typing "DIGATTN 0 0", "DIGATTN 1 0", "DIGATTN 2 60", "DIGATTN 3 0"

**NOTE** - These readings are optional, for completeness only, and may be omitted if there is good reason to believe the attenuators are functioning normally.

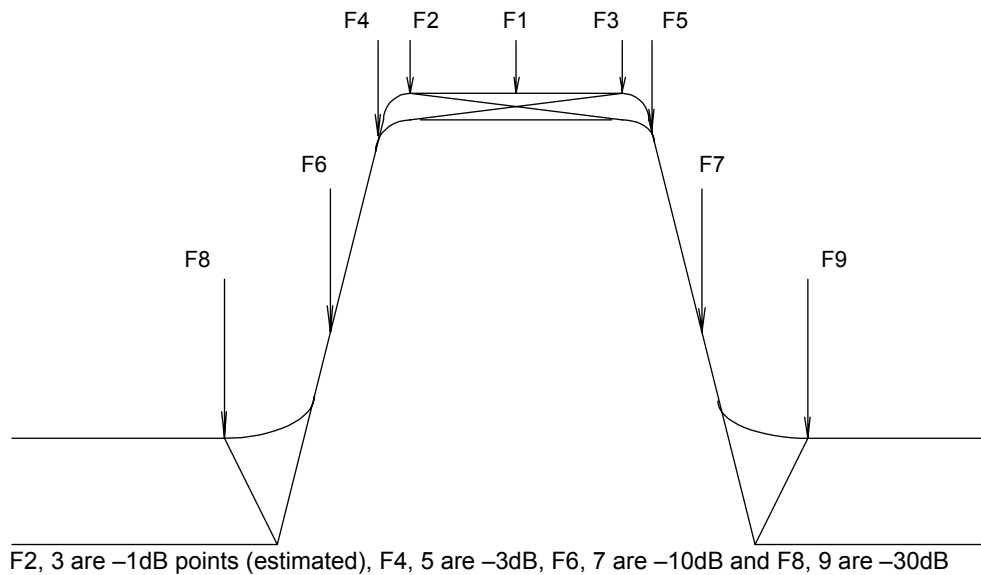
### 7.3.2 Accurate Gain Measurements – for single channel verification

In these tests, the gain must be measured accurately, either with a network analyzer or a precisely calibrated signal generator and spectrum analyzer. The mean gain, passband and rejection band are to be measured over a sampling of frequencies, to give an accurate picture of the amplifier's performance.

Five frequency points in band and four out of band are to be measured. The frequencies to be measured for each band are shown in Table 6. Type "ACCESS LAB", "TCEN 0", "DIGATTN 0 0", "DIGATTN 1 0", "DIGATTN 2 60", "DIGATTN 3 0". Enter the appropriate readings into Table 4, Measurements 30-38. Mean gain can be roughly expressed as the average of F1, F2 and F3, or  $(F1+F2+F3)/3$ . (A more accurate arithmetic mean would require a much larger number of measurements.) If the response is very lumpy, the maximum and minimum levels between the points F2 and F3 should be used instead of F2, F3, but this type of response may mean the unit is oscillating; if not sure, consult your supervisor.

• **Table 6 – Frequencies For Gain Measurements**

Band	F1,Meas't.30	F2,M't.31	F3,M't.32	F4,M't.33	F5,M't.34	F6,M't.35	F7,M't.36	F8,M't.37	F9,M't.38
806-824 MHz	815.5	806	824	803.5	826.5	795.5	835.5	785.5	845.5
851-869 MHz	860.5	851	869	848.5	871.5	840.5	880.5	830.5	890.5
824-849 MHz	836.5	824	849	820.8	852.2	811.5	861.5	799	874
869-894 MHz	881.5	869	894	865.8	897.2	856.5	906.5	844	919
896-902 MHz	899	896	902	895.2	902.8	893	905	890	908
935-941 MHz	938	935	941	934.2	941.8	932	944	926	950
925-941 MHz	933	925	941	929.8	944.2	908	958	893.5	970.5



### 7.3.3 Input Return Loss

This can be measured with a network analyzer or Spectrum Analyzer with Signal Generator and Directional Coupler, as it is a PASS/FAIL test. Don't forget to type "[ACCESS](#) LAB", "AGCEN 0" & "TCEN 0" in the terminal software before doing the following:

1. Measure Input Return loss and record the worst-case loss within passband. Verify this is greater than 14 dB. Record this value on Table 4, Measurement 12. It's with AGC off, so the AGC won't affect readings.
2. Repeat the measurement after typing into the terminal: "AGCEN 0", "AGCDIG 1", "PWM 0 254 " (or "AGCBIAS 254")  
Record this value on Table 4, Measurement 13. It's the Return Loss in Worst Case (Maximum attenuation)
3. Type: "AGCEN 1", "AGCEN 0 " This restores the bias levels to default settings.

### 7.4 1dB Compression – Data gathering only

1 dB compression is usually measured by increasing the input in 1 dB steps until the output no longer follows the input by rising in 1dB steps itself; the 1dB compression point occurs (for example) at the lowest level at which you have increased the input by 2dB and the output has risen by only 1dB, and is confirmed by lowering the input by 10dB and seeing if the output falls by 9dB.

The following procedure, however, merely confirms that the 1dB compression point is approximately where it belongs.

1. Connect the equipment as shown in **Figure 2**.
2. Type into the Terminal Software: "[ACCESS](#) LAB", "TCEN 0", "BYPASS 0", "AGCEN 0", "DIGATTN 0 0", "DIGATTN 1 0", "DIGATTN 2 60", "DIGATTN 3 0". This sets the amplifier to maximum usable gain without AGC action.
3. Turn the output of one Generator off. Set the frequency of the other one to the center of the band for the amplifier being tested. Adjust the level to get +37 dBm of power at the output. Record the output level in Table 4, Measurement 11.
4. Reduce the input level by 10 dB. Record the new output level. It should be less than or equal to +28 dBm. The exact level will depend upon gain of the amplifier under test. Observe output level with a spectrum analyzer with a level accuracy of +/- 0.1 dBm. Do not forget to use a 20-30 dB attenuator at Amplifier output.

## 7.5 DC Current

This test measures the DC current drain of the amplifier.

1. Connect equipment as in **Figure 2**.  
Type into the Terminal Software, or leave as in the previous test:  
"ACCESS LAB", "TCEN 0", "AGCEN 0", "DIGATTN 0 0", "DIGATTN 1 0", "DIGATTN 2 60", "DIGATTN 3 0".
2. Adjust the RF level of one generator to obtain an output level of +37 dBm.
3. Record total supply current on the 28V supply line. Verify this to be less than 1A. Measurement 14.
4. Record total supply current on the 12V supply line. Verify this to be less than 0.9A. Measurement 15.
5. Turn input RF off. Record the total supply current on both lines, Measurements 16 and 17.  
Verify this is less than 0.95 A on the 28V supply line and 0.95A on the 12V supply line.

## 7.6 Forward Power Range

This test measures the calibration points for the FWDPOW and REVPOW reading, using forward power measurements.

1. Type into the Software Terminal: "ACCESS LAB", "TCEN 0", "BYPASS 0", "AGCEN 1".  
Set the gain approx 60dB ("DIGATTN 0 155", "DIGATTN 1 0", "DIGATTN 2 155", "DIGATTN 3 0") and AGC to maximum output ("AGCBIAS 0").
2. Apply a single carrier at mid-band at -55dBm. Adjust the level of generator to obtain +5dBm carrier +/- 0.1 dBm at output of the Amplifier.
3. Type into the Software Terminal: "READ 0" and record first five digits of the software output into the table 4 measurement 6.
4. Repeat the test for an output level of 10dBm (measurement 6a), 15, 20, 25, 30 and 35 dBm (6b, c, d, e, f).

## 7.7 AGC Range – 3 point version

This test measures the calibration points for the old style 3-point AGC setting. A new 5-point AGC calibration will be implemented in a later version of the software.

1. Turn Amplifier's AGC switch on by typing into the Software Terminal: "AGCEN 1".  
Set the gain to the maximum ("DIGATTN 0 0", "DIGATTN 1 0", "DIGATTN 2 0", "DIGATTN 3 0").
2. Apply a single carrier at mid-band at -45dBm
3. Type into the Terminal Software: "AGCBIAS 240" or "PWM 0 240". Record output level as Measurement 18.
4. Type: "AGCBIAS 220" or "PWM 0 220". Record output level as Measurement 19.
5. Type "AGCBIAS 150" or "PWM 0 150". Record output level as Measurement 20.
6. Type "AGCBIAS 0" or "PWM 0 0". Record output level as Measurement 21.

## 7.8 Test of Digital (remote) Control AGC

This test confirms the proper operation of the direct bias control from the UMC board.

1. Set the RF level to -45dBm
2. Set the gain to 70dB (GAIN 700)
3. Type into the Terminal Software: "AGCDIG 1"; "AGCBIAS 0"
4. Measure the output level and record it as Measurement 22
5. Type into the Terminal Software: "AGCDIG 0"; "AGCBIAS 180".

## 7.9 Spurious Tests: Near Spurs

This test looks for AGC-caused spurious signals near the carrier.

Type into the terminal, "ACCESS LAB", "TCEN 0", "BYPASS 0", "DIGATTN 0 30", "DIGATTN 1 30", "DIGATTN 2 30", "DIGATTN 3 30", "AGCEN 1", "AGCBIAS 220"

Set the Spectrum Analyzer to 500 KHz span, centre frequency in the centre of the passband, reference level 30dBm, autobandwidth on

Set the Signal Generator to the centre frequency, -60dBm, modulation OFF

Use the Marker Peak to locate the signal, and then check for next peak right or next peak left.

Change the Signal Generator output to -50dBm and repeat the test.

The spurious signals if any should be at the noise floor, or at least 55dB down. If spurious signals are detected, record their level and frequency in Measurement 39.

## 7.10 Spurious Tests: Harmonics

This test looks at harmonics and spurious signals out of the amplifier output from 50 MHz to 5GHz.

Type into the terminal, "ACCESS LAB", "TCEN 0", "BYPASS 0", "AGCEN 0", "DIGATTN 0 30", "DIGATTN 1 30", "DIGATTN 2 30", "DIGATTN 3 30"

Set the Spectrum Analyzer to start 50MHz, stop 5GHz, and reference level 30dBm

Set the Signal Generator to the unit's centre frequency, level -65dBm, modulation OFF

Use the Marker Peak to locate any spurious signals in the range. These should be at least 50dB down. Spurious signals at the 2<sup>nd</sup> and 3<sup>rd</sup> harmonics are expected, but no other spurious are expected; however, it's possible that there may be "ingress" of off air signals entering the cabling of the test assembly. If there are unusual signals seen, consult your supervisor.

Record the highest spurious signal level and frequency as Measurement 40.

## 7.11 Spurious Tests: Noise Floor

This test measures the noise floor in band and out of band without a signal present.

Type into the terminal, "ACCESS LAB", "TCEN 0", "AGCEN 0", "GAIN 840"

Set the Spectrum analyzer to the unit's centre frequency, reference level -30dBm, span 200 MHz, marker noise function on, averaging set to 7

Test and record the marker levels at Centre Frequency and CF-80 MHz. Record as Measurements 41 and 42.

Note, this test has no pass/fail limits. It is for statistical gathering purposes. However, if signals are greater than the limits shown in the table, it is possible that there might be an ingress signal (from the air) interfering with the measurement.

## 7.12 Calibration Data Entry

Calibration data can be entered into the UMC's lookup tables at this point. Using Table 4 as a reference, enter the following information (don't type in the <angle brackets> which are just used for clarity below). (Don't forget to first type "[ACCESS](#) LAB" and "TCEN 0" in the terminal software!)

**"CALCURRE** < Measurement 1>"

This calibrates TX current reading.

**"CALGAIN** <Measurement 2x10> <Measurement 3x10> <Measurement 4x10> <Measurement 5x10> "  
example: CALGAIN 70 200 280 350 where 70 is 7(dBm)x10 etc.

This enters the Gain Range Data into the UMC lookup table and, except for the confirmation tests below, completes the gain calibration.

Now to enter the AGC information:

**"CALAGC** <Measurement 18x10> <Measurement 19x10> < Measurement 20x10> <Measurement 21x10>"

This calibrates the AGCTHRESH settings, which will be confirmation tested below.

**"CALFWD** (Meas. 6) (Meas. 6a) (Meas. 6b) (Meas. 6c) (Meas. 6d) (Meas. 6e) (Meas. 6f)"

This calibrates Forward Power readings.

Now the UMC can respond accurately to "GAIN" and "AGCTHRESH" requests at the time of preparation for customer requirements.



## 9. FINAL TEST (After calibration)

### • 8.1 GAIN:

To test the "GAIN" entry accuracy, type in the following settings and measure on the spectrum analyzer, entering them into the respective MEASUREMENT settings in Table 9.

Set one of the signal generators to the center frequency and set Input level -60dBm.

Type "RESET UMC". When software is ready type the following into the software terminal: "[ACCESS LAB](#)", "TCEN 0", and "AGCEN 0".

Type "GAIN 340" to setup gain for 34dB, write the measurement to table 9, meas. 1. Repeat test for 40, 44, 50, 60, 70 and 80 dB.

Measurement 1 - "GAIN 33"

Measurement 2 - "GAIN 40"

Measurement 3 - "GAIN 44"

Measurement 4 - "GAIN 50"

Measurement 5 - "GAIN 60"

Measurement 6 - "GAIN 70"

Measurement 7 - "GAIN 80"

If any of these settings is more than 2dB off, tag the unit and consult your supervisor. The settings SHOULD be less than 1dB off. However, do note that the spectrum analyzer is only +/-1.5dB accurate and must be calibrated frequently if higher accuracy is desired.

### • 8.2 AGCBIAS

To test the "AGCBIAS" entry accuracy, type in the following settings and with an input of -45dBm to the amplifier, measure the output levels on the spectrum analyzer and enter them into the MEASUREMENT settings on Table 9. Type: "[ACCESS LAB](#)", "TCEN 0", "GAIN 840" and "AGCEN 1" and "AGCTHRESH 300". These setup AGC for 30dBm max output. Repeat test for 20, 15 and 10 dBm.

Measurement 8 - "AGCTHRESH 300"

Measurement 9 - "AGCTHRESH 200"

Measurement 10 - "AGCTHRESH 150"

Measurement 11 - "AGCTHRESH 100"

If the results do not match to expected values, tag the unit and consult your supervisor.

### • 8.3 TxCURR

To test TX Current readings type: "[ACCESS LAB](#)", "TCEN 0", "GAIN 600", "AGCEN 0" and "ENABLE 0". Then type: "TXCURR" and record returned value to table 9, meas. 12.

Apply signal -55dBm to the input, type "ENABLE 1" then type "TXCURR" and record returned value to table 9, meas. 13.

### • 8.4 FORWARD POWER

To test Forward Power keep settings as in previous test. Adjust signal generator to obtain 5dBm output from the amplifier. Type "FWDPOW" then record returned value to table 9, meas. 14. Repeat the test for 15, 25 and 35dBm output. Measurements 15, 16, 17

### • 8.5 IP3

The IP3 has to be tested at 34dB, 44dB and 84dB gain. Type the following into the terminal software:

**GAIN XX0** where XX is the gain level and 0 is a zero at the end (to give GAINx10). **AGCEN 0, ENABLE 1**

Apply two test signals as in 7.2 at the same level to the input, to give an output level of 24dBm. Measure the largest spur at a frequency of (Signal 2 Frequency - Signal 1 Frequency)+/- Signal1/Signal 2. Plug it into the IP3 formula of (OUTPUT LEVEL+ (1/2(OUTPUT LEVEL-SPURIOUS LEVEL))).

Gain Setting	Input Level to start
34	-10
44	-20
84	-60

Record your IP3 measurements as Measurements 18, 19 and 20 in Table 9.

## 9.0

### Test Complete

Type into the terminal software: "[ACCESS](#) LAB", "AGCEN 1", "AGCTHRESH 300", and "GAIN 840".  
Type: "RESET UMC". After UMC is reset type "LIST" to the software terminal and make sure the model number and frequency band setup right, AGC and ENABLE are ON, AGCTHRESH and GAIN have right value.

Inspect unit for missing screws, bad scratches or dents and verify the unit is properly and completely labeled.

Initial the serial number sticker, or if it is inaccessible, initial a fresh sticker and put it on.

Unit is ready to ship!

• **Table 4 CALIBRATION DATA & RF TEST SHEET:**

**LinkNet LNKA-800-900 Board (ASY000116) RF Test Sheet**

Serial #: \_\_\_\_\_ : \_\_\_\_\_ Tested by: \_\_\_\_\_ Test Date: \_\_\_\_\_

Meas#	COMMANDS and explanation	MEASURED VALUE	Min Value	Max Value
1	READ 2; (enable 0)			
2	GAIN HI MAX; (all attenuators 0)		89	102
3	GAIN HI MIN; (all attenuators 155)		27	45
4	GAIN LO MAX; (bypass 1, all attenuators 0)		39	54
5	GAIN LO MIN; (bypass 1,all attenuators 155)		12	24
6	(attens 0&2=155, attens 1&3=0), output level 5dBm, READ 0			
6a	(attens 0&2=155, attens 1&3=0), output level 10dBm, READ 0			
6b	(attens 0&2=155, attens 1&3=0), output level 15dBm, READ 0			
6c	(attens 0&2=155, attens 1&3=0), output level 20dBm, READ 0			
6d	(attens 0&2=155, attens 1&3=0), output level 25dBm, READ 0			
6e	(attens 0&2=155, attens 1&3=0), output level 30dBm, READ 0			
6f	(attens 0&2=155, attens 1&3=0), output level 35dBm, READ 0			
7	GAIN HI MAX; (all attens 0) IP3 test, o/p 24dBm		45	54
8	GAIN HI MIN; -6dB att2; (all attens max but 2=60) IP3 test, o/p 24dBm		42	54
9	GAIN LO MAX; (Bypass 1) IP3 test, o/p 24dBm		45	54
10	GAIN LO MIN; -3dBatt2; (Bypass 1; Attn max Att.2=30) IP3 test, i/p24dBm		40	54
11	GAIN HI MAX; -6dB att2; AGCEN 0; (All attens 0 except 2=60) P1dB test		6.5dB	10.5dB
12	GAIN HI MAX; -6dB att2; AGCEN 0; Input Return Loss test		-14	-44
13	AGCEN 0; AGCDIG 1; AGCBIAS 254; Input Return Loss Test		-12	-44
14	GAIN HI MAX; -6dB att2; AGCEN 0; Supply Current Test-28V, Max RF		0.8	1
15	GAIN HI MAX; -6dB att2; AGCEN 0; Supply Current Test-12V, Max RF		0.75	0.95
16	GAIN HI MAX; -6dB att2; AGCEN 0; Supply Current Test-28V, Min RF		0.8	1
17	GAIN HI MAX; -6dB att2; AGCEN 0; Supply Current Test-12V, Min RF		0.75	0.95
18	In-45dBm, GAIN HI MAX; AGCEN 1; AGCBIAS 240; AGC test		-8	12
19	GAIN HI MAX; AGCEN 1; AGCBIAS 220; AGC test		15	25
20	GAIN HI MAX; AGCEN 1; AGCBIAS 150; AGC test		25	33
21	GAIN HI MAX; AGCEN 1; AGCBIAS 0; AGC test		33	39
22	GAIN 700; AGCEN 0;AGCDIG 1;AGCBIAS 0; AGC test		-22	0
30	(GAIN HI MAX & 6dB on digattn 2) Gain, F1		83	93
31	(GAIN HI MAX & 6dB on digattn 2) Gain, F2		83	93
32	(GAIN HI MAX & 6dB on digattn 2) Gain, F3		83	93
33	(GAIN HI MAX & 6dB on digattn 2) Gain, F4		80	93
34	(GAIN HI MAX & 6dB on digattn 2) Gain, F5		80	93
35	(GAIN HI MAX & 6dB on digattn 2) Gain, F6		50	90
36	(GAIN HI MAX & 6dB on digattn 2) Gain, F7		50	90
37	(GAIN HI MAX & 6dB on digattn 2) Gain, F8		30	80
38	(GAIN HI MAX & 6dB on digattn 2) Gain, F9		30	80
39	(Near Spurs)			-50
40	(Harmonics)			-50
41	(GAIN 840) Noise at CF, dBm/Hz			-80
42	(GAIN 840) Noise at -80MHz, dBm/Hz			-80

Notes:

• **Table 9 FINAL TEST SHEET: (After calibration)**

**LinkNet LNKA-800-900 Board (ASY000116) RF Test Sheet**

Meas#	COMMANDS and explanation	MEASURED VALUE	Minimum Expected Value	Maximum Expected Value
1	GAIN 340 (AGCEN 0)		31	36
2	GAIN 400 (AGCEN 0)		38	42
3	GAIN 440 (AGCEN 0)		42	46
4	GAIN 500 (AGCEN 0)		48	52
5	GAIN 600 (AGCEN 0)		58	62
6	GAIN 700 (AGCEN 0)		68	72
7	GAIN 800 (AGCEN 0)		78	82
8	GAIN 840, i/p -45dBm, AGCEN 1; AGCTHRESH 300, o/p level		29	31.5
9	GAIN 840, i/p -45dBm, AGCEN 1; AGCTHRESH 200, o/p level		19	22
10	GAIN 840, i/p -45dBm, AGCEN 1; AGCTHRESH 150, o/p level		14	16.5
11	GAIN 840, i/p -45dBm, AGCEN 1; AGCTHRESH 100, o/p level		4	12
12	TXCURR; Enable 0; GAIN 600; AGCEN 0		0.0	0.05
13	TXCURR; Enable 1; GAIN 600; i/p -55dBm; AGCEN 0		0.8	1
14	FWDPOW (o/p=5dBm; AGCEN 0)		4	6
15	FWDPOW (o/p=15dBm; AGCEN 0)		14	16
16	FWDPOW (o/p=25dBm; AGCEN 0)		24	26
17	FWDPOW (o/p=35dBm; AGCEN 0)		34	36
18	GAIN 340,AGCEN 0,IP3=(O/P level+1/2(O/P level-spur))		46.5	54
19	GAIN 440,AGCEN 0,IP3=(O/P level+1/2(O/P level-spur))		46.5	54
20	GAIN 840,AGCEN 0,IP3=(O/P level+1/2(O/P level-spur))		46.5	54

• **10.0 Prototype Characterization Testing**

This testing is for characterization of the prototype run, or any MAJOR revision, only. It is in the form of a checklist and tables, as it is assumed the user knows or can refer to the appropriate procedures for each.

**10.1 DC Testing**

Perform an appropriate subset of the DC testing above, see DCT000000045.

**10.2 RF Testing**

Standard Tests –

Perform an appropriate subset of the standard RF testing above; see Table 4, for each board to ensure correct operation before statistical gathering, below.

Statistical Gathering –

The following tests are required for the gathering of statistics and compilation of reference tables. Where temperature tests are indicated, the readings must be taken after the unit has stabilized at that temperature (about 2 hours of operation.) Since this takes a long time, it's recommended that as many tests as possible be performed on a unit once it has reached stable operating temperature in the appropriate environment.

Temperatures (0,25,50C) Suggested sample points are 815, 831, 860, 876, 899, 938 MHz.

Three Temperatures, at all bands

Temperatures, Three bands

–TEMP\_TX (Chip) Reading, bypass mode and non bypass mode, AGC on, AGCBIAS 180, Max Signal Input, Three Temperatures, one band. Comparison to temperature probes readings on all power devices.

Three Temperatures, sample of two frequency bands (low freq. and high freq.) and 38dBm, Three Temperatures, sample of two frequency bands (low and high) also TRBias values (Current through output IC as read from READ 2.) settings (see 7.3.1 for list of minimum attenuator settings) Bypass and non-bypass.

• **Table 8 – Testing Map**

Measurement	Band 1	Band 2	Band 3	Band 4	Band 5	Band 6	
Mean Gain, RL	√	√	√	√	√	√	Temp 1 (0°C)
Full AGC	√			√		√	
Temp Tx Reading	√						
AGC Impulse	√					√	
O/P Detectors	√					√	
Signal Level-Idrain, TRBIAS	√						
Gain Attenuator Accuracy	√	√	√	√	√	√	
Mean Gain, RL	√	√	√	√	√	√	Temp 2 (25°C)
Full AGC	√			√		√	
Temp Tx Reading	√						
AGC Impulse	√					√	
O/P Detectors	√					√	
Signal Level-Idrain, TRBIAS	√						
Gain Attenuator Accuracy	√	√	√	√	√	√	
Mean Gain, RL	√	√	√	√	√	√	Temp 3 (50°C)
Full AGC	√			√		√	
Temp Tx Reading	√						
AGC Impulse	√					√	
O/P Detectors	√					√	
Signal Level-Idrain, TRBIAS	√						
Gain Attenuator Accuracy	√	√	√	√	√	√	

**• TABLE 7: PROTOTYPE TEST SHEET**

Title: \_\_\_\_\_ Number: \_\_\_\_\_

Date: \_\_\_\_\_ Saved Files: \_\_\_\_\_

Signature: \_\_\_\_\_

Charts: \_\_\_\_\_

Gain Mode	AGC state	AGCBias	Input Level	Bypass	Reading, Description	Reading	Max	Min	Temp

Wide Open Amplifier – Gain, RL, without filters or AGC, Bypass and Non Bypass, 5-10 sample points, Three Temperatures (0,25,50C) Suggested sample points are 815, 831, 860, 876, 899, 938 MHz.

Mean Gain and RL (worst case and average) plus 9 band samples (table 6) at Four Gain Set Points (no AGC), at Three Temperatures, at each band

Full AGC Characteristics at Four Gain Set Points, ten AGCBIAS points (MAXHI, MINHI, MAXLO, MINLO), at Three Temperatures, each band

TEMP\_TX (Chip) Reading, bypass mode and non bypass mode, AGC on, AGCBIAS 180, Max Signal Input, Three Temperatures, one band. Comparison to temperature probes readings on all power devices.

AGC Impulse Response and Overshoot, Four Gain Set Points, Five Input Levels between -30 and -60dBm, AGC on, Three Temperatures, sample of two frequency bands (low freq. and high freq.)

Readings from Output Power Detector, Minimum of Eight Output Levels between 0 and 38dBm, Three Temperatures, sample of two frequency bands (low and high)

Readings from Reflected Power Detector, Minimum of Eight Output Levels, Three Temperatures, sample of two frequency bands (low and high)

- Current drain vs Signal Level, supplies, Non-bypass mode, AGC and non-AGC, Three Temperatures, plus TRBIAS readings
- Gain and Attenuation Accuracy, All Bands, AGC off, three temperatures, 9 freq. points (Table 6) all attenuation settings (see 7.3.1 for list) Bypass and non-Bypass.