8.2 RF Output Power Adjustment

Test Equipment

Anritsu ML2437A Power Meter & MA2472D Sensor (or equivalent) & CLI port interface to computer (Ref. Appendix at end of this document).

Set Up

Turn on power meter and make sure it is warmed up and stabilized per the manufacturers' recommendations. Calibrate the RF power meter and set the meter's calibration factor % setting according the meter's calibration chart, and the frequency range of the transmitter being tested. Connect RF Power meter to the BNC antenna connector on the transmitter. Connect a PC to the Ethernet jack to access the command line interface (CLI). Refer to the appendix "Setting up and using the P10T CLI" at the end of this document for information on how to set up and use the CLI interface to control the transmitter. Turn both the main power and RF Mute switches on both the channels of the transmitter front panel off. Connect a +15V, -15V, and +5V power supply to the transmitter at CON13004.

The RF Power calibration will be performed at each of 12 "Bin" center frequencies shown in the "RF power tune table" below. The frequency bins are determined by dividing the frequency ranges for each board group in to 12 equal bandwidth bins. During calibration, the transmitter frequency will be programmed using the CLI. This is because setting of the frequency by the front panel controls may be limited depending on what band the transmitter is limited to for each frequency range. The CLI is able to override this front panel band limitation.
Note: All Frequencies shown are in MHz. Also, the entire frequency range for each board group is shown, even though some of the individual bands may not occupy the entire frequency range.

Procedure

1. Turn on **only** the transmitter main power switch; **leave the RF switch turned off**.
2. Check the current draw from the power supply. It should be around 750mA from +5V supply, 135mA from +15V supply and 13mA from -15V supply with the RF power and VCO OFF.
3. We have to make sure that the drain current is set to '0' on both channels using the following commands:
   <DCS set ch1rfpavgate 0> and <DCS set ch2 rfpavgate 0>
4. Connect two DMMs to measure the drain current (across the 1Ω 1206 resistor R5052/R10052 near the PA) and drain voltage (one end of 1Ω 1206 resistor to ground).
5. Turn ON the RF power by using the command:
   <Debug set ch1 rfpower true>
   Drain current and voltage should be around 0mA and 8.0V respectively. The gate voltage is around
   -4.0V±0.2V.
   Make sure the VCO is OFF by using the CLI command "*debug set ch1 rfvco false*".
6. Using "*DCS set ch1 rfpavgate xxx*", we can tune the value to achieve a *drain current* of about 250mA to 260mA (not to exceed 350mA). Start with xxx of about '120' and increment in steps of 2 until the required current is achieved. The corresponding *drain voltage* should be around 7.3V to 8.0 V. The *gate voltage* should be around -1.5V to -2.0V.
   Eg. *<Dcs set ch1 rfpavgate 158>*
7. Set the RF VCO ON by using CLI <*debug set ch1 rfvco true*> (for channel 1). The next step is to set the RF coarse tune values for the VCO.

Table 8.1: for RF coarse tune frequency start bins (all frequencies in MHz):

Group	Band	Frequency Range	Total Bandwidth	Bin #0 Start Frequency	Bin #1 Start Frequency	Bin #2 Start Frequency	Bin #3 Start Frequency	Bin #4 Start Frequency	Bin #5 Start Frequency
A	G10,G10E, G10J, G11	470-542	72	470	482	494	506	518	530
B	J8,J8E, J8J	554-626	72	554	566	578	590	602	614
C	K10E	596-668	72	596	608	620	632	644	656
D	L8, L8E, L8J	626-698	72	626	638	650	662	674	686
E	L9E, L10, L11J	670-742	72	670	682	694	706	718	730
F	P8	710-790	80	710	723.350	736.675	750	763.350	776.675
G	Q21,Q23,Q22E,R26,R27,A24	750-822	72	750	762	774	786	798	810
J	X1, X2, X7	925-952	27	NO	COARSE	TUNE	For	This	Band
K	H8Z, H22	518-584	64	518	528.675	539.350	550	560.675	571.350

Using a DMM, monitor the fine tune voltage after the ferrite bead E5003. Set the frequency to bin 0 from the table above for the frequency group being tuned using CLI *<rfs set ch1 freq xxxxxx> (xxxxxx in kHz).*

Set the coarse tune value using CLI *<debug set ch1 rfcoarsetune xx>* such that fine tune is as shown in the table below:

Table 8.2

Bin number		Min	Max	
RfCoarseTune Bin0	TP5014, TP10019	0.85	1.4	Vdc
RfCoarseTune Bin0_DAC		0	255	--
RfCoarseTune Bin1	TP5014, TP10019	1.0	1.4	Vdc
RfCoarseTune Bin1_DAC		0	255	--
RfCoarseTune Bin2	TP5014, TP10019	1.0	1.4	Vdc
RfCoarseTune Bin2_DAC		0	255	--
RfCoarseTune Bin3	TP5014, TP10019	1.0	1.4	Vdc
RfCoarseTune Bin3_DAC		0	255	--
RfCoarseTune Bin4	TP5014, TP10019	1.0	2.0	Vdc
RfCoarseTune Bin4_DAC		0	255	--
RfCoarseTune Bin5	TP5014, TP10019	1.0	2.7	Vdc
RfCoarseTune Bin5_DAC		0	255	--

(Remains the same for both CH1 and CH2)

Change the frequency to the next bin and repeat the procedure. Record the values for coarse tune and load them in the table.

Use the following CLI command to program in the coarse tune values for each channel:

Eg. *DCS set ch1 rfcoarsetunetable 0 xx*
DCS set ch1 rfcoarsetunetable 1 xx
DCS set ch1 rfcoarsetunetable 2 xx
DCS set ch1 rfcoarsetunetable 3 xx
DCS set ch1 rfcoarsetunetable 4 xx
DCS set ch1 rfcoarsetunetable 5 xx

8. The VCO tuning is complete here.

9. The pad2 value is set such that the transmitter outputs 100mW. Eg. "*Debug set ch1 rfpad2 14"*

10. Set transmitter frequency to **lowest** bin frequency for the board group being tested using the CLI command
"*rfs set ch1 freq XXXXXX*" where *XXXXXX* is the desired bin frequency in kHz (using the RF power tune table below).

11. Set the pad1 value to get an output power of about 19.5dBm to 20dBm on the power meter. Repeat this for each bin by changing the frequency accordingly and note down the values. Make sure the rfpad1 value is set each time the frequency is changed.
Eg. *"debug set ch1 rfpad1 35"*
CAUTION: Do not set XX to less than 10 or it could damage the transmitter PA.

Table 8.3: RF power tune table:

Group	Band	Frequency Range	Total Bandwidth	Bin #0 Center Frequency	Bin #1 Center Frequency	Bin #2 Center Frequency	Bin #3 Center Frequency	Bin #4 Center Frequency	Bin #5 Center Frequency
A	G10,G10E, G10J, G11	470-542	72	473	479	485	491	497	503
B	J8, J8E, J8J	554-626	72	557	563	569	575	581	587
C	K10E	596-668	72	599	605	611	617	623	629
D	L8, L8E, L8J	626-698	72	629	635	641	647	653	659
E	L9E, L10, L11J	670-742	72	673	679	685	691	697	703
F	P8	710-790	80	713.3	720	726.7	733.4	740	746.7
G	Q21,Q23,Q22E,R26,R27,A24	750-822	72	753	759	765	771	777	783
J	X1, X2, X7	925-952	27	926	928	931	933	935	937
K	H8Z, H22	518-584	64	520.7	526.1	531.5	536.9	542.3	547.7

Continued

Group	Band	Frequency Range	Bin #6 Center Frequency	Bin #7 Center Frequency	Bin #8 Center Frequency	Bin #9 Center Frequency	Bin #10 Center Frequency	Bin #11 Center Frequency
A	G10,G10E, G10J, G11	470-542	509	515	521	527	533	539
B	J8,J8E, J8J	554-626	593	599	605	611	617	623
C	K10E	596-668	635	641	647	653	659	665
D	L8, L8E, L8J	626-698	665	671	677	683	689	695
E	L9E, L10, L11J	670-742	709	715	721	727	733	739
F	P8	710-790	753.4	760.1	766.7	773.4	780.1	786.8
G	Q21,Q23,Q22E,R26,R27,A24	750-822	789	795	801	807	813	819
J	X1, X2, X7	925-952	940	942	944	946	948	951
K	H8Z, H22	518-584	553.1	558.5	563.9	569.3	574.7	580.1

Once the rfpad1 values are recorded for all 12 bins (refer to RF power tune table below), store them in the tune table using CLI: "*dcs set ch1 rfpad1tunetable x yy"* where 'x' is bin number and 'yy' is the bin value recorded. The command only changes the value in 1 frequency bin; thus, 12 commands are required to change the values of all 12 bins.

Verify RFPAD1 values are within ±6** of the values listed in the table below for each frequency bin. Do this using the CLI command "*dcs get ch1 rfpad1tunetable 0*" and so on. If they are not, then the values have likely been modified since the PCB was originally tested and tuned in the test fixture. If the values have been modified, they must be reset by following the above procedure. The values should be close to the values in the table below before proceeding**. Use the same CLI command *"dcs set ch1 rfpad1tunetable x yy"* for each frequency bin where "x" is the bin number and "yy" is the bin value in the table.

For example *"dcs set ch1 rfpad1tunetable 0 33"* sets the value in bin#0 to 33. Then set the transmitter frequency to the highest bin frequency and then back to the lowest bin frequency before proceeding.

** (In some cases, the values might deviate more than ±6 from the below listed values. It can be ignored as long as the pad values being set keep decreasing with increasing bin numbers in steps of 1 or 2 at a time from bin to bin. It is unacceptable when a pad value increases as bin number increases.)

Table 8.4

FREQ BIN:	Group A	Group B	Group C	Group D	Group E	Group F	Group G	Group J	Group K
Bin 0	40	35	25	31	29	28	21	23	35
Bin 1	40	34	24	30	28	28	21	22	34
Bin 2	39	34	23	29	27	28	20	21	34
Bin 3	39	33	23	29	26	27	20	21	33
Bin 4	38	32	22	28	26	27	19	20	32
Bin 5	37	32	22	27	25	26	18	20	32
Bin 6	36	31	21	27	24	25	17	19	31
Bin 7	35	31	21	26	24	24	17	18	30
Bin 8	35	30	20	25	23	23	16	17	30
Bin 9	34	29	20	24	22	22	16	16	29
Bin 10	34	28	19	23	21	21	15	15	28
Bin 11	27	28	18	21	20	20	14	13	27

Note: These bin values are nominal settings used by ATE during program, and the actual values can vary from board to board. In some cases, the values might deviate more than ±6 from the above listed values. It can be ignored as long as the pad values being set keep decreasing with increasing bin numbers in steps of 1 or 2 at a time from bin to bin. It is unacceptable when a pad value increases as bin number increases.

12. Allow the transmitter to warm up for a minimum of 5 minutes. The transmitter RF output power will drop approximately 1.5 to 2.5 dB from the level when it was first turned on, until it is fully warmed up. This is normal. Set the frequency to the lowest bin and set RFPAD2 to 7 dB using the CLI command "***debug set ch1 rfpad2 14***." This sets the transmitter output power level to the 100mW setting. The current draw with the RF power and RF VCO ON should be around +950mA from +5V supply, +300mA from +15V supply and 13mA from -15V supply.

13. Change the rfpad2 value to 20, 34 and 39 which correspond to 50mW, 10mW and 6mW, and measure the output power. The RF level should meet the requirements in Section 7 above: "**Conducted RF Power Output @ Room Temp."** Each time a new frequency is entered, the value of RFPAD1 will update automatically once the RFPAD1TUNETABLE variable has been programmed correctly. Wait 10 seconds or more after changing the transmitter frequency prior to measuring/verifying the power level.

14. Once the tuning is complete, use the CLI to set:
    "DCS set ch1 chantuned1"

15. Repeat the entire procedure 1-13 for channel 2 on the board (use ch2 instead of ch1 everywhere for CLI).
    Once channel2 is tuned, use
    "DCS set ch2 chantuned 1" and then finally *"DCS set systuned 1"*

    If any tuned value gets changed accidently, an error message "NOT TUNED" will be displayed on the front panel LCD. The system has to be retuned in that case.