RF Calibration Algorithms and Procedures
For
MSM3100/MSM5105 chip set

(Version 0.4)
July 23, 2001

Revision History

Rev #	Date	Description	Prepared
V0.1	10/05/00	Initial Draft for RF Calibration algorithms	Stephen Sek
V0.2	10/23/00	Added specific step by step procedures for RF Cal algorithms. All known RF Cal related NVM items are included.	Stephen Sek
V0.3	11/17/00	Refined RX cal procedures to include Qualcomm's engineers' recommendations and actual behaviour of MSM3100. Use of certain poorly supported Qualcomm serial commands are removed. Added details regarding Qualcomm specific RX AGC implementation.	Stephen Sek
V0.4	07/23/01	Added details regarding MSM5105	Yanlan Li

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1. PURPOSE

The purpose of this document is to provide a general concept as well as specific algorithms on RF Calibration for the Qualcomm MSM3100 and MSM5105 chip sets. Specific step by step procedures for each algorithm which take into account the actual behavior of the chip set are also provided in this document. Serial commands that will be obsolete in the MSM5105 are avoided to ensure forward compatibility and smooth transition of the RF Calibration software as the product migrates from the MSM3100 development platform to the MSM5105 product platform.

This is a living document. The RF Calibration efficiency and procedures will be improved as the behavior of the chip set is better understood over time.

2. RF CALIBRATION

2.1. Overview of RAS RAM linearizer curves

RX

- Divided into 16 equally spaced segments
- 17 points or offsets
- 1st point = CDMA_RX_LIN_OFF_0 (corresponds to MinRSSIofInterest)
- 2nd point = CDMA_RX_LIN_OFF_0 + CDMA_RX_LIN_SLP[0] (MinRSSIofInterest + DynamicRange/16)
- 3rd point = CDMA_RX_LIN_OFF_0 + CDMA_RX_LIN_SLP[0] + [1]

TX

- 85.3dB Divided into 32 segments (2.66dB/seg) decreasing order Hi->Lo power
- Plus 2 segments – High Power
- Plus 2 segments – Low Power
- Real Dynamic Range = (32+2+2) seg X 2.66dB/seg = 96.00dB
- TX_COMP0 – TX_COMP3 (UHF circuits. How about 1900MHz??)
    - 4 PA Range States X 8 fixed temperature offsets (CDMA_TX_LIN_VS_TEMP[7:0]
    - 4 PA Range States X 8 gradual (proportional to index) offsets (CDMA_TX_SLP_VS_TEMP[7:0])
    - 4 PA Range States X 16 frequency compensations (one for each of 16 CDMA physical freq chan) (CDMA_TX_COMP_VS_FREQ[15:0])

2.2 STEP BY STEP CALIBRATION PROCEDURES

2.2.1 CDMA_RX_LIN_OFF_0
AND
2.2.2 CDMA_RX_LIN_SLP[0:15] (Lo -> Hi, increasing RSSI at RX antenna)

CDMA_RX_LIN_OFF_0 represents the initial point or offset 0 of the RX linearizer curve.
CDMA_RX_LIN_SLP[0..15] represents the "slope" of each of the 16 segments of the RX linearizer curve. Its value is the difference in PDM values between 2 consecutive and equally spaced segment.).
[Line segments are written to the RAS RAM using the registers RAS_RAM_DATA_MSB and RAS_RAM_DATA_LSB when AGC_RDWR_CTL:RAS_RAM_WR is set to 1. This operation should be automatically executed whenever the MSM chip set is initialized or reset to ensure that the linearizer curve is loaded into the RAS RAM.]

1. Set MS LNA to highest gain
   AT cmd: Set Switched LNA Message Request
   Novatel: CMD_CODE=114(MSM3100), 134(MSM5105)
   LNA_MSG_TYPE=0, LNA_VALUE=1(Force LNA on)
2. Set MS to reference frequency
   AT cmd: Set Channel Message Request
   Novatel: CMD_CODE=110(MSM3100), 130(MSM5105), CHANNEL= 600
3. Make sure MS is at room temperature
4. Set the initial RX linearizer offset to 0 (i.e. CDMA_RX_LIN_OFF_0 = 0)
5. Set the slope of all the 16 entries of the RX linearizer table to 14.
6. Reset the MSM3100/MSM5105 by resetting the surf board or mobile device being calibrated. This will load the linearizer table from NVM to the RAS RAM
7. Set Sig Gen to output a CW sine wave corresponding to MinRSSIofInterest (Typical = –106dBm, Sprint = -106.5dBm) at the reference frequency.
8. Read the RX_AGC_ADJ_RD value corresponding to MinRSSIofInterest at the antenna.
   AT cmd: Read PDM Message Request
   Novatel: CMD_CODE=112(MSM3100), 132(MSM5105)
   PDM_TYPE=0x01, PDM_VALUE=RX_AGC_ADJ(2bytes)
9. Set the Sig Gen to 5.33dB (DynamicRange/16) above the previous setting and read RX_AGC_ADJ_RD.
10. Repeat step 9 until all 16 RX_AGC_ADJ_RD values are obtained (Sig Gen should be at –20.7dBm after the 16^{th} point). Label the 16 readings as RX_AGC_ADJ_RD[n] where n = 0..15 with n=0 corresponding to the lowest power (-106 + 5.33)dBm and n=15 corresponding to –20.7dBm.
11. Make sure to embed the path loss from Sig Gen to the connector of the antenna.
12. Check to make sure that the RX_AGC_ADJ_RD values are not saturated at the last 3 (n=13,14,15) high signal level points. If saturation occurs, increase the linearizer slope by a value of 2 to 16 in step 5 and repeat steps 6-11.
13. If no saturation is observed, store the RX_AGC_ADJ_RD value read in step 8 into NVM item **CDMA_RX_LIN_OFF_0**.
14. For n=0,
    set NVM item **CDMA_RX_LIN_SLP[0]** = RX_AGC_ADJ_RD[0] – CDMA_RX_LIN_OFF_0
15. For n=1…15 (For default NV_CDMA_RX_LIN_SIZ=16)
    set NVM items **CDMA_RX_LIN_SLP[n]** = RX_AGC_ADJ_RD[n] – RX_AGC_ADJ_RD[n-1]

For example, if MinRSSIofInterest = -106dBm, DynamicRange = 85.3dB, then the 17 offset points correspond to –106 + (m X 5.3) dBm, where m = 0...16.

(The PDM value for CDMA_RX_LIN_OFF_0 is not unique. If desired, the linearizer curve may be adjusted to slide up/down by adjusting CDMA_RX_LIN_OFF_0 to optimize the dynamic/operating range of the RX AGC).

2.2.2 CDMA_RX_LIN_SLP[0:15] (Lo -> Hi, increasing RSSI at RX antenna)

Since calibrating CDMA_RX_LIN_OFF_0 requires the calibration of the last 3 or more slope values of CDMA_RX_LIN_SLP, the calibration of the entire CDMA_RX_LIN_SLP is incorporated into that of the CDMA_RX_LIN_OFF_0 to improve calibration efficiency/time. Please refer to CDMA_RS_LIN_OFF_0 for details.

2.2.3 Software Setup for CDMA_RX_LIN_OFF_0, CDMA_RX_LIN_SLP[0:15]

Software name: 5105_RX_LIN_SLP_OFF (in 5105_RF_CAL.lib)

Setup: Reference Channel (default 600)
Path loss (dB) from Sig Gen to the connector of the antenna (default 2 dB)
IO port name, click arrow to choose the IO port name

Display: RX_Slope & RX_Offset show the CDMA_RX_LIN_SLP[0:15] and CDMA_RX_LIN_OFF_0 written in the NVM.
RX_Amp shows amplitude setting on the Sig Gen

2.2.4 CDMA_TX_LIN_MASTER0,1,2,3 [1], [0:35] (Hi -> Lo, decreasing TX power)

(For each of the PA Range states 0,1,2,3: first parameter is CDMA_TX_LIN_MASTER_OFF_0, second parameter is CDMA_TX_LIN_MASTER_SLP[0:35] representing the 36 TX_AGC_ADJ PDM values for different desired TX power level.
Note that linear interpolation will be used to calculate the best 16 PDM values to be loaded into the hardware TX RAS RAM linearizer.)
(Offsets are 9 bit values, Slopes are 7 bit values)

1. Set MS to reference frequency.
   AT cmd: Set Channel Message Request
   Novatel: CMD_CODE=110(MSM3100), 130(MSM5105), CHANNEL= 600
2. Make sure MS is at room temperature.
3. Divide the Dynamic Range into 32 equally spaced segments. (2.66dB each if Dynamic Range is 85.3dB)
4. Add 2 more segments to the high power side (Offset[0,1])
5. Add 2 more segments to the low power side (Offset[34,35])
   (Note the 36 segments now represent actual dynamic range of 36X2.66dB = 96.01dB. The extra 2 segments representing 5.32dB extended beyond the two ends of the dynamic range are required for temperature and frequency compensation.)
6. Determine TX power at offset[0] (highest) which is equal to
   (-MinRSSIofInterest) – (OffsetPower) + (DynamicRange/16)

If
   MinRSSIofInterest = -106dBm,
   OffsetPower = 76dB for PCS,
   DynamicRange = 85.3dB,

Then
   TX power at offset[0] = 35.33dBm

7. Calculate the remaining TX power levels which correspond to offsets[i],
   = 35.33 - i X (DynamicRange/32)
   = 35.33 - (i X 2.66) dBm, where i = 1...35
8. Set the TX_AGC_ADJ PDM until the desired power level is reached. This can be verified by using a high quality low noise floor VSA or spectrum analyzer with CDMA personality.
   AT cmd: Set PDM Message Request
   Novatel: CMD_CODE=1112(MSM3100), 131(MSM5105)
   PDM_TYPE=0x01, PDM_VALUE=TX_AGC_ADJ(2bytes)
9. If certain end points of the linearizer curve are not reachable due to equipment or MS limitations, extrapolation of PDM values is required. If the last 2 linearizer segments (3 offsets) are rolling off, the slope of the last measurable segment can be used for extrapolations of the remaining linearizer curve; otherwise, the average of the slopes of the last 2 segments can be used.
10. Set offset[i] to PDM value of TX_AGC_ADJ
11. Store CDMA_TX_LIN_MASTER_OFF_0 = offset[0]
12. Store CDMA_TX_LIN_MASTER_SLP[i] = offset[i+1] – offset[i]

2.2.5 Software Setup for CDMA_TX_LIN_MASTER0,1,2,3 [1], [0:35]

Software name: 5105_TX_LIN_MASTER0 (in 5105_RF_CAL.lib)

Setup: Reference Channel (default 600)
Path loss (dB) from VSA to the connector of the antenna (default 2 dB)
IO port name, click arrow to choose the IO port name
Start Power, click arrow to increase/decrease 2.66dB each step. (default 22dBm)
Measurement accuracy, since CDMA channel power is not very stable, 20times average is used on VSA. Define how accurate the power measurement can be done in measurement accuracy (default 0.5dB)

Display: TX_MASTER0 show the CDMA_TX_LIN_MASTER0[0:35] written in the NVM
TX_PWR shows power output from Tx measured by VSA (path loss is embedded)

2.2.6 CDMA_RX_COMP_VS_FREQ[0:15]

(16 RX_AGC_ADJ PDM adjustments to be added to the offsets in the RX RAS RAM linearizer when the MS is assigned to a particular frequency index. Note, 0x00 adjustment corresponds to the reference frequency index.)

1. Select reference frequency corresponding to one of 16 CDMA frequency indexes.
2. Set MS to the reference frequency.
3. Select a reference RSSI at RX antenna (SSS: Choice should reflect typical CDMA coverage).
4. Record the RX_AGC_ADJ PDM corresponding to this reference RSSI
5. Change to a different frequency index
6. Keep the reference RSSI unchanged
7. Set the RX_AGC_ADJ PDM until the appropriate gain is achieved that corresponds to the reference RSSI.
8. Calculate the difference between this PDM value and that for the reference frequency index.
9. Write the difference into CDMA_RX_COMP_VS_FREQ[n].

2.2.7 Software Setup for CDMA_RX_VS_FREQ[0:15]

Software name: 5105_Rx_COMP_FREQ (in 5105_RF_CAL.lib)

Setup: Reference Channel (default 600)
IO port name, click arrow to choose the IO port name
Cross-band channel, 16 channels to be set through the whole band

Display: RX_COMP_FREQ show the CDMA_RX_VS_FREQ[0:15] written in the NVM
FREQ_Setting shows CW frequency setting on Sig Gen

2.2.8 TX_COMP0,1,2,3 (Qualcomm to provide temperature increments).

(Each contains 3 tables for TX linearizer corresponding to PA Range State 0,1,2,3)

- 4 PA Range States X 8 fixed temperature offsets (CDMA_TX_LIN_VS_TEMP[7:0]
- 4 PA Range States X 8 gradual (proportional to index) offsets (CDMA_TX_SLP_VS_TEMP[7:0])
- 4 PA Range States X 16 frequency compensations (one for each of 16 CDMA physical freq chan) (CDMA_TX_COMP_VS_FREQ[15:0])

2.2.8.1 TX_COMP0,1,2,3 -> CDMA_TX_LIN_VS_TEMP[7:0]

(Constant amount adjustment based on temperature)

1. Set to reference frequency.
2. Set temperature chamber to room temperature (25C???)
3. Select a nominal TX power level.
4. Record the corresponding TX_AGC_ADJ PDM value.
5. Change the temperature chamber settings over a range of 7 other temperatures.
6. Record TX_AGC_ADJ PDM values required to maintain the same nominal TX power level.
7. Store in CDMA_TX_LIN_VS_TEMP[I] the difference in PDM values between temperature I and reference temperature. (SSS: temp increment, horizontal axis scale???)

2.2.8.2 TX_COMP0,1,2,3 -> CDMA_TX_SLP_VS_TEMP[7:0] (SSS: Qualcomm to provide temp increments and exact formula for the index based proportional adjustments)

(Gradual adjustment based on temperature and proportional to index of offset)

1. Set to reference frequency.
2. Set temperature chamber to room temperature (25C???)
3. Select a nominal TX power level.
4. Record the corresponding TX_AGC_ADJ PDM value.
5. Change the temperature chamber settings over a range of 7 other temperatures.
6. Record TX_AGC_ADJ PDM values required to maintain the same nominal TX power level.
7. Store in CDMA_TX_SLP_VS_TEMP[I] the difference in PDM values between temperature I and reference temperature. (SSS: temp increment, horizontal axis scale???)

2.2.8.3 TX_COMP0,1,2,3 -> CDMA_TX_COMP_VS_FREQ[15:0]

(For calibrating TX linearizer over frequency channel).

1. Set to reference frequency.
2. Make MS is at room temperature.
3. Override TX_AGC_ADJ PDM
4. Select a nominal TX power level.
5. Hold TX_AGC_ADJ PDM value constant corresponding to the nominal TX power selected.
6. Measure the MS output power (in dB) at the antenna. Call this PowerRef.
7. Change the frequency channel to correspond to all the 16 frequency channels (including reference channel).
8. Measure TX power level (in dB) for each frequency channel. Call these Power[i] (i = 0..15)
9. Store CDMA_TX_COMP_VS_FREQ[i]
   = (Power[i] – PowerRef) X (1024/DynamicRange)
   = (Power[i] – PowerRef) X 12 (if DynamicRange = 85.33dB)

2.2.8.4 Software Setup for TX_COMP0,1,2,3 -> CDMA_TX_COMP_VS_FREQ[15:0]

Software name: 5105_Tx_COMP_FREQ (in 5105_RF_CAL.lib)
Setup: Reference Channel (default 600)
IO port name, click arrow to choose the IO port name
Cross-band channel, 16 channels to be set through the whole band
Display: TX_COMP_FREQ show the CDMA_TX_VS_FREQ[0:15] written in the NVM
FREQ_Setting shows CW frequency setting on Sig Gen

2.2.9 CDMA_TX_LIM_VS_FREQ[15:0]

(Since TX power limit is very sensitive to the feedback from the HDET circuit which in turn is frequency dependent, this NVM item is used to compensate the ADC readings at the HDET circuits for such frequency dependencies).

1. Override TX_AGC_ADJ PDM
2. Set to a reference frequency
3. Write to TX_AGC_ADJ PDM (trial and error) until the MS generate an output power level near or at the limiting.
4. Keep this PDM value constant
5. Measure the output power (in dBm) at the antenna. Call this “PowerRef”.
6. Measure the HDET reading from the ADC. Call this “HdetRef”.
7. Change to one of the 16 frequency channels. Call this ith frequency channel.
8. For each frequency channel, adjust TX_AGC_ADJ until the HDET reading equals HdetRef.
9. Measure the TX power level (dB). Call this “Power[i]”, i = 0..15.
10. Calculate

    CDMA_TX_LIM_VS_FREQ[i]
    = (PowerRef - Power[i])X(1024/DynamicRange)
    = (PowerRef - Power[i])X 12 (if DynamicRange=85.33dB)
11. Record the value into NV item.
12. Change to a different frequency channel and repeat procedures.

2.2.10 Software Setup for CDMA_TX_LIM_VS_FREQ[15:0]

Software name: 5105_Rx_COMP_FREQ (in 5105_RF_CAL.lib)
Setup: Reference Channel (default 600)
IO port name, click arrow to choose the IO port name
Tx Limit Power, Maximum TX limit power (default 23dBm)
Path loss (dB) from VSA to the connector of the antenna (default 2 dB)
Cross-band channel, 16 channels to be set through the whole band
Measurement accuracy, since CDMA channel power is not very stable, 20times average is used on VSA. Define how accurate the power measurement can be done in measurement accuracy
Display: TX_LIM_FREQ show the CDMA_TX_LIM_VS_FREQ[15:0] written in the NVM
FREQ_Setting shows CW frequency setting on Sig Gen

2.2.11 CDMA_TX_LIM_VS_TEMP[7:0]

1. Set to reference frequency
2. Select 8 temperature values over which the calibration is to be conducted
3. Set MS to the ith temperature setting

4. CDMA_TX_LIM_VS_TEMP[i] = (1024/DynamicRange) X (DesiredPowerLimit + MinRSSIofInterest + OffsetPower + DynamicRange) – 768

   If

   DynamicRange = 85.33dB,
   OffsetPower=76dB for PCS,
   MinRSSIofInterest = -106dBm

   Then

   CDMA_TX_LIM_VS_TEMP[i]=12 X (DesiredPowerLimit + 55.33)–768

(The TX power limit should be chosen based on compression, ACPR and other temperature dependent components of Novatel's TX circuitry.)

2.2.12 CDMA_RX_LIN_VS_TEMP[7:0]

(Constant amount adjustment based on temperature)

1. Set to reference frequency.
2. Set temperature chamber to reference temperature (room temperature 25C???)
3. Select a nominal RX power level.
4, Record the RX_AGC_ADJ PDM corresponding to this reference RSSI
5. Set the temperature chamber to one of the other 7 temperatures.
6. Keep the reference RSSI unchanged
7. Set the RX_AGC_ADJ PDM until the appropriate gain is achieved that corresponds to the reference RSSI.
8. Calculate the difference between this PDM value and that for the reference temperature.
9. Write the difference into CDMA_RX_LIN_VS_TEMP[n], where n is the nth temperature setting. (SSS: temp increment, spacing, horizontal axis scale, ???)

2.2.13 CDMA_RX_SLP_VS_TEMP[7:0] (SSS Qualcomm to provide temp increments and exact formula for the index based proportional adjustments)

(Gradual adjustment based on temperature and proportional to index of offset)

1. Set to reference frequency.
2. Set temperature chamber to reference temperature (room temperature 25C???)
3. Select a nominal RX power level.
4. Record the RX_AGC_ADJ PDM corresponding to this reference RSSI
5. Set the temperature chamber to one of the other 7 temperatures.
6. Keep the reference RSSI unchanged
7. Set the RX_AGC_ADJ PDM until the appropriate gain is achieved that corresponds to the reference RSSI.
8. Calculate the difference between this PDM value and that for the reference temperature.
9. Write the difference into CDMA_RX_SLP_VS_TEMP[n], where n is the nth temperature setting. (SSS: temp increent, spacing, horizontal axis scale, ???)

2.2.14 THERM[1:0]

- ADC reading corresponding to the coldest and hottest temperature of interest.
- No calibration. Set defaults to the average of a statistically reliable number of samples

2.2.15 FR_TEMP_OFFSET

1. Calibrate while RX demodulating valid CDMA signal.
2. Vary temperature of MS
3. Step through 6 MSBits of temperature ADC
4. For each ADC value, read the 8 MSBits of CARRIER_FREQ_ERR_RD.
5. Store CARRIER_FREQ_ERR_RD value in FR_TEMP_OFFSET [I] where I = 0-63

(Note: Self calibrated NV item by DMSS. Typical value preloaded as part of factory calibration process. Precise calibration not necessary.)

2.2.16 CDMA_EXP_HDET_VS_AGC[15:0]

(Use by DMSS to build a lookup table that indexes TX power estimation via a scaled TX_GAIN_CTL, to associated HDET circuit values at ref temp and freq.)

1. Disable TX power limit feedback loop
2. Disable closed loop power control
3. Divide the upper ¼ (highest TX pwr) of TX_GAIN_CTL into 16 segments (SSS: equally spaced??)
   (e.g. if TX_GAIN_CTL ranges from –52 to 33dBm, CDMA_EXP_HDET_VS_AGC covers 11.66 – 33 dBm range)
4. Vary the desired TX power such that the output varies across the 16 segments. (Higher power points may require extrapolation of data). This can be accomplished by either
   - Varying the RX power, OR
   - Varying the TX_AGC_ADJ PDM
5. Record the HDET circuit readings over each of the 16 segments into CDMA_EXP_HDET_VS_AGC[15:0].

2.2.17 HDET_OFF

(Represents the lowest HDET ADC value in feedback algorithm for power limiting.)

1. Set to reference frequency
2. Make sure MS is at room temperature.
3. Determine the desired max TX limit power (24dBm per IS-98C)
4. Key the MS to generate a TX power of 6dB below the desired max TX limit power
5. Store the HDET ADC reading into HDET_OFF.

(For example, if desired max power limit is 24dBm, this HDET_OFF value is the HDET ADC reading when TX power equals 24 – 6 = 18 dBm).

2.2.18 HDET_SPN

(Represents the highest HDET ADC value in the feedback algorithm for power limiting minus HDET_OFF).

1. Set to reference frequency
2. Make sure MS is at room temperature
3. Determine the desired max TX limit power
4. Key the MS to generate a TX power of 2dB above the desired max TX limit power
5. Store the (HDET ADC reading – HDET_OFF) into HDET_SPN.

(For example, if desired max power limit is 24dBm, this HDET_SPN value is the HDET ADC reading when TX power equals 24+2 = 26dBm minus HDET_OFF)

2.2.19 Software Setup for HDET_OFF & HDET_SPN

Software name: 5105_HDET_OFF_SPN (in 5105_RF_CAL.lib)

Setup: Reference Channel (default 600)
Path loss (dB) from VSA to the connector of the antenna (default 2 dB)
IO port name, click arrow to choose the IO port name
Tx Limit Power, Maximum TX limit power (default 23dBm)
Measurement accuracy, since CDMA channel power is not very stable, 20times average is used on VSA. Define how accurate the power measurement can be done in measurement accuracy (default 0.5dB)

Display: HDET_OFF, HDET_SPN show the HDET_OFF and HDET_SPN written in the NVM

2.2.20 R1_RISE [8bits] (SSS: Discuss with h/w team)

(Specifies the PA_R1_RISE threshold in PA Range state machine, positive 1/3 dB resolution, value automatically s/w compensated over temperature).

2.2.21 R1_FALL [8bits] (SSS Discuss with h/w team)

(Specifies the PA_R1_FALL threshold in PA Range state machine, positive 1/3 dB resolution, value automatically s/w compensated over temperature).

2.2.22 R2_RISE [8bits] (SSS: Discuss with h/w team)

(Specifies the PA_R2_RISE threshold in PA Range state machine, positive 1/3 dB resolution, value NOT automatically compensated over temperature).

2.2.23 R2_FALL [8bits] (SSS Discuss with h/w team)

(Specifies the PA_R2_FALL threshold in PA Range state machine, positive 1/3 dB resolution, value NOT automatically compensated over temperature).

2.2.24 R3_RISE [8bits] (SSS: Discuss with h/w team)

(Specifies the PA_R3_RISE threshold in PA Range state machine, positive 1/3 dB resolution, value NOT automatically compensated over temperature).

2.2.25 R3_FALL [8bits] (SSS: Discuss with h/w team)

(Specifies the PA_R3_FALL threshold in PA Range state machine, positive 1/3 dB resolution, value NOT automatically compensated over temperature).

2.2.26 LNA_RANGE_POL (SSS: Discuss with h/w team) (Non calibration item)

- Set the polarity of the LNA_RANGE pin which is open-drain and therefore, requires a pull-up resistor.

- Setting 0x00 implies Lo = High gain; Hi = Low gain
- Setting 0x01 implies Hi = High gain; Lo = Low gain

2.2.27 LNA_RANGE_RISE

(Specifies the RX power level at which the LNA switches from the high gain state to low gain state as RSSI increases).

RiseThreshold [dBm]
= (LNA_RANGE_RISE X 256/DynamicRange) + MinRSSIofInterest[dBm] + (DynamicRange/2)
= (LNA_RANGE_RISE/3) - 63.35 dBm
LNA_RANGE_RISE
    = 3 X (RiseThreshold + 63.35) dBm

2.2.28 LNA_RANGE_FALL

(Specifies the RX power level at which the LNA switches from the low gain state to high gain state as RSSI decreases).

FallThreshold [dBm]
= (LNA_RANGE_FALL X 256/DynamicRange) + MinRSSIofInterest[dBm] + (DynamicRange/2)
= (LNA_RANGE_FALL/3) - 63.35 dBm
LNA_RANGE_FALL
    = 3 X (FallThreshold + 63.35) dBm

2.2.29 LNA_RANGE_OFFSET

(Gain compensation when the LNA circuit gain is decrease by increasing gain at IF)

1. Override LNA_RANGE pin state forcing the LNA to be in the circuit, i.e. high gain state.
2. Clear LNA_OFFSET register (0x0000)
3. Calibrate the RX linearizer with the LNA in the circuit.
4. Load the new calibrated curve into the RAS RAM
5. Set the MS to generate a RX

2.2.30 PA_RANGE_OFFSETS[3:0]

- Clear (i.e. set to 0x0000)

2.2.31 CDMA_ADJ_FACTOR (Non calibration item)

(Software filter time constant in power limiting algorithm)
Set to 0x02 per Qualcomm recommendation

2.2.32 RX_AGC_MINMAX

(Specifies AGC_VALUE_MIN and AGC_VALUE_MAX).

3. APPENDIX:

3.1 MINRSSIOFINTEREST
- 106dBm measured at antenna (typical)

3.2 OffsetPower (76 for 1800/1900MHz, 73 for 800MHz)
- Desired TX pwr level = -(mean RX pwr level) – OffsetPower

3.3 DYNAMICRANGE
- 85.33dB only for MSM3100. Note that the 102.4dB mode is not supported. However, the dynamic range can be artificially expanded by scaling each RX/TX linearizer step size to correspond to a different value than 5.33dB (16 steps for RX) and 2.66dB (32 steps for RX)

3.4 Software filter time constant in power limiting algorithm (CDMA_ADJ_FACTOR)
- 0x02

3.5 RSSI phasing should be the first of the power control algorithm routines performed since heating of radio may cause the phasing routine less accurate.

3.6 16 frequency compensation indexes (based on Qualcomm reference to UHF radio) may be increased to up to 48 to cover PCS 1930 – 1990MHz (MS rx) and 1850 –1910MHz (MS tx)

3.7 MS RX (PCS Band) - 48 Channels X 1.25MHz
1930 – 1990 MHz
Channels 1 – 48 = 1.25 X N + 1930 MHz

3.8 MS TX (PCS Band) - 48 Channels X 1.25 MHz
1850 – 1910 MHz
Channels 1 – 48 = 1.25 X N + 1850 MHz

3.9 PCS Standard Channels to be tested:

Band	Channel	RX (MHz)	TX (MHz)
Low	1	1931.25	1851.25
Mid	24	1960.00	1880.00
High	48	1988.75	1908.75

3.10 Set LNA_RANGE_FILT_SEL to use the lowpass filtered version of AGC_VALUE for the hard LNA decision block

3.11 Set LNA_GAIN_FILT_SEL to use the lowpass filtered version of AGC_VALUE for the softw LNA decision block

3.12 Set LNA_FILT_BW sets the filter bandwidth

3.13 Set LNA_FILT_OVERRIDE to freeze filtered version of AGC_VALUE (can be overwritten by writing to LNA_FILT_WR.

4. REFERENCES

- Supplemental Software Test Commands For CDMA 1xRTT Products, Novatel Wireless, Inc., October 24, 2000.
- MSM3000 Application Note RF Interface, Qualcomm, Inc., April 15, 1999.
- CDMA DMSS Serial Data Interface Control Document, Qualcomm, Inc., April 26, 2000.