Qualcomm Technologies, Inc.

Comprehensive MSM8909/MSM89x7 Family RF NV Items

80-NT112-100 C

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Revision history

Revision	Date	Description
A	March 2015	Initial release
B	April 2015	Added Sections 3.22, 5.1.2.1, 5.2.1.23, 6.1.1.8, 6.1.2.1, 6.1.2.10, 6.2.1.32-6.2.1.33, 6.2.1.35, 6.2.1.43, 7.1.1.1, 7.1.2.1, 7.2.1.19, 7.2.1.36, 8.1.2.1, 9.3.1.9-9.3.1.10, and Chapter 12
C	December 2015	Added Sections 7.2.1.40 and 7.2.1.41 on the new NVs included for MSM89x7

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1 Introduction

1.1 Purpose

This application note describes the format and usage of RF NV items for the MSM8909/89x7 chipsets.

An Excel spreadsheet attached to this PDF file provides a complete item name and number listing of all current RF NV items. It includes a brief description and format information. A document column provides the DCN for the document that describes the most comprehensive item description, which includes this document.

This application note is for software and hardware engineers involved with the RF calibration of MSM8909/89x7 mobile devices.

NOTE: MSM8909/89x7 platform does not support ET calibration.

1.2 Conventions

Function declarations, function names, type declarations, attributes, and code samples appear in a different font, for example, `#include`.

NV items with ID numbers less than 20,000 are referred to by their names starting with NV_. NV items with ID numbers greater than or equal to 20,000 are referred to by their names starting with RFNV_.

When using shorthand notation and referring to multiple NV items with IDs greater than and less than 20,000, use the NV_ notation, for example, NV_LTE_<band>_RX_CAL_CHAN_I.

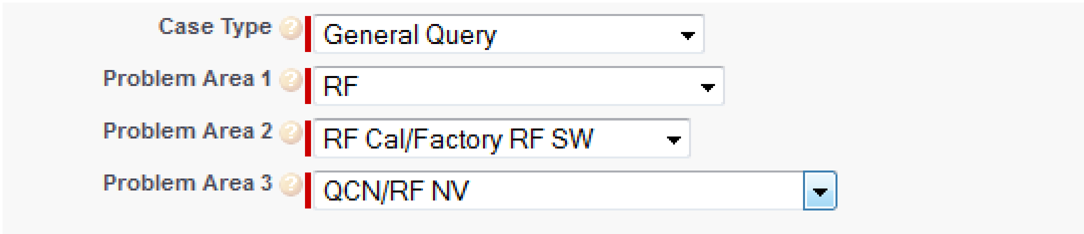
Shading indicates content that has been added or changed in this revision of the document.

1.3 Technical assistance

For assistance or clarification on information in this document, submit a case to Qualcomm Technologies, Inc. (QTI) at https://createpoint.qti.qualcomm.com/.

If you do not have access to the CDMATech Support website, register for access or send email to support.cdmatech@qti.qualcomm.com.

It is important to correctly file an RF NV case with the proper problem area code. This ensures problem assignments are sent to the RF NV support team for a more prompt resolution.


Case Type
General Query
Problem Area 1
RF
Problem Area 2
RF Cal/Factory RF SW
Problem Area 3
QCN/RF NV

2 Terminology

The following terms are used throughout this document. Values for these terms must be defined prior to calibration. Consistency is vital for defining the values of these terms. Once these values are selected, they must remain constant throughout the calibration process for both receive and transmit paths.

- MinRSSIofInterest – This value represents the minimum CDMA/WCDMA Rx power level of interest at the mobile station antenna.
  - For CDMA, this value must be -115 for proper chipset operation.
  - For WCDMA, this value must be -106 for proper chipset operation.
- OffsetPower – This item represents the CDMA offset power, or turnaround constant. Ignoring both closed-loop and open-loop power control corrections, the desired Tx power is:
  - Desired Tx power level = **-** (mean Rx power level) - OffsetPower
  - See Table 2-1 for OffsetPower of various band classes.
- MinTxPower – This term is the minimum Tx power that can be represented, which is -70 dBm. This only applies to WCDMA, LTE, and TD-SCDMA mode.
- Dynamic range – The value represents the dynamic range, measured in decibels, corresponding to the total range of various hardware registers. The dynamic range represents the difference in power levels corresponding to the minimum and maximum values of hardware registers that indicate the Rx power level or Tx power level. Dynamic range must be 102.4 dB for proper chipset operation in CDMA, WCDMA, LTE, and TD-SCDMA.
- NV items contain the various calibration values in nonvolatile memory.
- Static RF NV items – RF NV items with values that do not change for the same design.
- Calibrated RF NV items – RF NV items with values determined by RF calibration. Each device may contain a different value as a result of RF calibration.
- Band class names – Various CDMA and WCDMA operating bands are represented by band class 0 to 15 (e.g., BCy = BC0, BC1, BC3, BC4, BC5, BC6, BC11, BC14, BC15), although not all band classes are necessarily supported by any particular hardware or software version. To distinguish between primary and diversity receiver NV items, C0 and C1 (C2 and C3 for the SV radio) prefix their names, respectively. Table 2-1 lists the band classes.
- Table 2-2 lists the WCDMA, LTE, TD-SCDMA, and GSM bands.
- NV item IDs – Each NV item is associated with a unique ID number. The specific number-to-name mapping can be found in the AMSS file, rfnv_items.h. Numbers are also included in this document.

- TxState – This term replaces *PA Range*, the previous Tx state-machine name. The reason for the change is that the term PA Range can be misleading, since different states might be a function of a block other than the just PA, such as the driver amplifier (in some chipsets). Also, the change avoids confusion with the PA_RANGE0 and PA_RANGE1 pins. (This terminology change does not necessarily apply to GSM.)
- RxState – This term replaces *LNA Range*, the previous Rx state-machine name. The reason for the change is that the term LNA Range can be misleading, since the different states might be a function of a block other than the just LNA, such as the mixer.

Table 2-1 CDMA band class name to band and OffsetPower mapping

CDMA band class name	Band	OffsetPower (turnaround constant)
BC0	Cell	73
BC1	PCS	76
BC3	JCDMA	73
BC4	KPCS	76
BC5	CDMA 450	73
BC6	IMT	76
BC7	700 MHz	73
BC10	Secondary 800 MHz	73
BC11	400 MHz European	73
BC14	PCS 1.9 GHz	76
BC15	AWS	76

Table 2-2 WCDMA/LTE/TD-SCDMA/GSM operating band mapping

UMTS band class name	Band	Frequency band
B1	IMT	2100
B2	PCS	1900
B3	DCS	1800
B4	AWS	1700
B5	Cell	850
B6	UMTS 800	800
B7	UMTS 2600	2600
B8	UMTS 900	900
B9	UMTS 1700	1800
—	GSM 850	850
—	EGSM	900
—	DCS	1800
—	PCS	1900

3 Configuration items and common items

3.1 Static, configuration items and common items

3.1.1 NV_RF_HW_CONFIG_I

Data type: 8-bit unsigned

This NV item specifies the RF Rx and Tx hardware configuration in use.

Technically, each RF platform listed in rfcom.h corresponds to a particular QTI-designed card. Schematics for some RF cards/designs can be downloaded from https://downloads.cdmatech.com. Choose the NV_RF_HW_CONFIG_I value corresponding to the QTI card/design configuration most closely matching the target design. The static NV xml files released with the AMSS software may provide good examples.

The rfcom.h file is located at \modem_proc\rfa\api\common\rfcom.h.

Another approach for selecting the correct NV_RF_HW_CONFIG_I value is to refer to the appropriate static NV xml file in the particular AMSS software build in use. Generally a particular build has several static NV xml directories; each applies to a different RF card. However, RF card choices are limited, making the correct directory obvious. Also, information regarding the supported bands can be determined by the static NV xml files (useful if the band information is not included in the above table).

The chipset device specifications and/or design guidelines contain more information regarding cobanding.

3.1.2 NV_RF_BC_CONFIG_I and NV_RF_BC_CONFIG_DIV_I, RFNV_RF_BC_CONFIG_C2_I, RFNV_RF_BC_CONFIG_C3_I

Data type: uint64 value

The NV item NV_RF_BC_CONFIG_I specifies the bit mask position for supported bands on the primary receiver path. The NV item NV_RF_BC_CONFIG_DIV_I specifies the bit mask position for supported bands on the secondary receiver path.

Similarly, RFNV_RF_BC_CONFIG_C2_I/ RFNV_RF_BC_CONFIG_C3_I are for Rx path 2 and Rx path 3 used in SV, DR-DSDS, et al. For example, in CDMA SV, C2 is for the SV chain primary path while C3 is for the SV chain secondary path. Table 3-1 provides the bit mask position for each band with the bit mask position being the same for both the primary and the secondary receiver paths.

NOTE: When enabling the bit mask for the secondary receiver path, the corresponding bit position for the primary receiver path must also be enabled. Otherwise, the secondary path operation does not function properly. For example, if BC1 Rx diversity is to be enabled, then bit position 2 must be set (1) for both NV_RF_BC_CONFIG_I and NV_RF_BC_CONFIG_DIV_I.

Table 3-1 RF_BC_CONFIG bitmask

NV_RF_BC_CONFIG_I NV_RF_BC_CONFIG_DIV_I RFNV_RF_BC_CONFIG_C2 RFNV_RF_BC_CONFIG_C3	Band
0	Band class 0, GSM 850 Band A-System
1	Band class 0, GSM 850 Band B-System
2	Band class 1, all blocks
3	Band class 2 placeholder
4	Band class 3, A-System
5	Band class 4, all blocks
6	Band class 5, all blocks
7	GSM DCS band
8	GSM extended GSM (E-GSM) band
9	GSM primary GSM (P-GSM) band
10	Band class 6
11	Band class 7
12	Band class 8
13	Band class 9
14	Band class 10
15	Band class 11
16	GSM 450 band
17	GSM 480 band
18	GSM 750 band
19	GSM 850 band
20	GSM Railways GSM band
21	GSM PCS band
22	WCDMA Europe Japan and China IMT 2100 band
23	WCDMA US PCS 1900 band
24	WCDMA Europe and China DCS 1800 band
25	WCDMA US 1700 band
26	WCDMA US 850 band
27	WCDMA JAPAN 800 band
28	Band class 12
29	Band class 14
30	Reserved
31	Band class 15
32	Reserved (was WLAN US 2400 band)
33	Reserved (was WLAN ETSI 2400 band)

NV_RF_BC_CONFIG_I **NV_RF_BC_CONFIG_DIV_I** **RFNV_RF_BC_CONFIG_C2** **RFNV_RF_BC_CONFIG_C3**	**Band**
34	Reserved (was WLAN France 2400 band)
35	Reserved (was WLAN Spain 2400 band)
36	Reserved (was WLAN Japan 2400 band)
37	Reserved (was WLAN US 2400 band)
38	Reserved (was WLAN Europe 5000 band)
39	Reserved (was WLAN France 5000 band)
40	Reserved (was WLAN Spain 5000 band)
41	Reserved (was WLAN Japan 5000 band)
42	Reserved
43	Reserved
44	Reserved
45	Reserved
46	Reserved
47	Reserved
48	WCDMA Europe 2600 band
49	WCDMA Europe and Japan 900 band
50	WCDMA Japan 1700 band
51	Reserved
52	Reserved
53	Reserved
54	Reserved
55	Reserved
56	Band class 16
57	Band class 17
58	Band class 18
59	Band class 19
60	WCDMA Japan 850 band
61	WCDMA 1500 band
62	Reserved
63	Reserved

For example, if the design only supports CDMA BC0 and BC1 bands, configure NV_RF_BC_CONFIG_I (NV #1877) as 0x00000007.

For new bands established after this document revision, refer to the enumeration sys_sband_e_type in the file sys.h. (the file location is \modem_proc\modem\api\mmode\sys.h.)

3.1.3 RFNV_LTE_BC_CONFIG_I

Data type: Array of two uint64 values. Presently, only the first uint64 value is used.

The NV item NV_LTE_BC_CONFIG_I specifies the bit mask position for supported LTE bands. Table 3-2 provides the bit mask position for each band.

Table 3-2 LTE Band class configuration

Bit position in NV	Band
Bit position 0	1
Bit position 1	2
Bit position 2	3
…	…

For example, to enable LTE bands 13, 17, 7, and 1, populate NV_LTE_BC_CONFIG_I with:

- Binary: 1 0001 0000 0100 0001
- Decimal: 69697
- Hex: 0x11041

3.1.4 NV_TDSCDMA_BC_CONFIG_I

Data type: uint64 value

This NV item specifies the bit mask position for supported bands on the primary receiver path.

Table 3-3 shows the bit position and its representation.

Table 3-3 Bit position and its representation

Bit position	Band	Frequency (MHz)	Alias
0	34	2010 to 2025	Band A
5	39	1880 to 1920	Band F
4	40	2300 to 2400	Band E

3.1.5 NV_CDMA_RX_DIVERSITY_CTRL_I and NV_HDR_RX_DIVERSITY_CTRL_I

Data type: Single value, 0 or 1 (CDMA is uint16, HDR is uint8)

These NV items enable/disable the receive diversity in AMSS software for CDMA and EV-DO, respectively. If the least significant bit (LSB) (bit 0) of this NV item is set to 1, the Rx diversity is enabled for traffic-state operation. Otherwise, it is disabled. AMSS may need appropriate feature definitions to enable the CDMA Rx diversity functionality.

3.1.6 NV_WCDMA_VBATT_I

Data type: Array of two, unit8 values

Use this NV item to calibrate battery voltage. This item specifies the voltage limits. It is also used for the LCD battery charger indicator and to shut off the phone when critically low battery voltage impedes reliable operation.

The NV item NV_VBATT_I[1:0] contains two elements, one for minimum voltage and one for maximum voltage.

NV_WCDMA_VBATT_I[0] is the minimum battery voltage ADC reading required for reliable phone operation. NV_WCDMA_VBATT_I[1] is the maximum battery voltage ADC reading expected.

NV_WCDMA_VBATT_I is not used in all software builds.

3.1.7 NV_FTM_MODE_I

Data type: 8-bit unsigned

When 0, software boots up in AMSS mode (normal phone operation). When 1, software boots up in FTM mode for phone calibration.

3.1.8 NV_ENH_THERM_I

Data type: 32-bit signed (array of two values)

The first value corresponds to the maximum temperature. The second value corresponds to the minimum temperature. GSM, WCDMA, LTE, and TD-SCDMA use this NV item.

NV_ENH_THERM.min = minimum value in ADC counts, corresponds to the maximum temperature.

NV_ENH_THERM.max = maximum value in ADC counts, corresponds to minimum temperature.

NOTE: This item does not require characterization; use the default value in the static NV xml file.

3.1.9 NV_THERM_BINS_I, RFNV_C2_THERM_BINS_I

Data type: Array of eight, uint16 values

Valid range: Each element has a valid range from 0 to 4095.

NOTE: NV_THERM_BINS_I corresponds to the primary radio and RFNV_C2_THERM_BINS_I to the Rx Chain 2.

This NV item contains eight elements used to calibrate the temperature ADC readings for CDMA software. Each element of NV_<C2_>THERM_BINS_I contains the ADC reading corresponding to the index temperature of interest. NV_<C2_>THERM_BINS_I[0] corresponds to the minimum thermistor ADC value of interest, which typically corresponds to the maximum temperature of interest. NV_<C2_>THERM_BINS_I[7] corresponds to the maximum thermistor ADC value of interest, which typically corresponds to the minimum temperature of interest. The eight temperature indexes used in TV_<C2_>BCy_TX_LIM_VS_TEMP_I are based on the

NV_<C2_>THERM_BINS_I values. The thermistor ADC reading space is divided into seven segments (it takes eight points). The eight temperature index points are defined as follows:

- Index 0: temperature corresponding to NV_<C2_>THERM_BINS_I[0]
- Index 1: temperature corresponding to NV_<C2_>THERM_BINS_I[1]
- Index 2: temperature corresponding to NV_<C2_>THERM_BINS_I[2]
- Index 3: temperature corresponding to NV_<C2_>THERM_BINS_I[3]
- Index 4: temperature corresponding to NV_<C2_>THERM_BINS_I[4]
- Index 5: temperature corresponding to NV_<C2_>THERM_BINS_I[5]
- Index 6: temperature corresponding to NV_<C2_>THERM_BINS_I[6]
- Index 7: temperature corresponding to NV_<C2_>THERM_BINS_I[7]

NOTE: If FTM_GET_ENH_THERM is used to read the thermistor ADC, the device must first be put into a given mode of operation by calling the FTM_SET_MODE command (any supported band will suffice).

3.2 Calibrated, common items

3.2.1 NV_XO_FACTORY_CALIBRATION_I

Data type: structure; int32: “c3,” int32: “c2,” int32: “c1,” int32: “c0,” int32: “t0,” int32: “t0p,” int32: “p,” int64: “timestamp,” uint16: “ft_qual_ind,” uint8: “xo_trim.”

This NV item is automatically updated during the XO calibration process on the factory floor. It contains the XO factory calibration values, primarily for recordkeeping purposes. Software actually does not use these values, but rather uses the values in the NV item 67300 – Field calibration params, which software updates and maintains automatically.

NOTE: NV item 67300 does not reside in the RFNV domain. Since NV item 67300 is not an RF NV item, it is not easily viewed with tools such as QRCT. However, it can be viewed and modified using the QXDM NV browser.

3.2.2 NV_VCO_TEMP_I, NV_RGS_TYPE_I, NV_RGS_TEMP_I, NV_RGS_TIME_I, NV_RGS_VCO_I, and NV_RGS_ROT_I

These NV items represent recently good system parameters. They are automatically written and updated by AMSS software. It is not necessary to store these NV items during factory calibration.

3.2.3 NV_XO_TRIM_VALUES_I

Data type: Structure of two uint8 values

This NV item stores capacitor trim values that can be used before factory XO calibration, or if XO factory calibration is not performed, for quick development purposes. Currently, QSPR loads 39 into this item by default, before factory calibration is performed. After XO factory calibration, this item is overridden. Refer to the *XO Training Topics* (80-NT112-7) and the *XO Calibration Manual Test Procedure* (80-VR839-1) documents for details.

3.3 Miscellaneous, common items

The purposes of the NV items in this section are flexible. The intended goal of each miscellaneous, common item is outlined below, but these goals are not hard requirements. The manufacturer can change or even ignore the goals if it is so desired.

3.3.1 NV_SYS_SW_VER_I

Data type: Array of eight, uint8 values

This NV item is to be automatically written by the RF calibration program. The PC-side RF calibration program can query the embedded AMSS software program running on the ARM microprocessor for its version number and store it in NV. The purpose of this NV item is for tracking. The details of this NV item are left to the handset manufacturer’s discretion.

3.3.2 NV_RF_CAL_VER_I

Data type: Array of eight, unit8 values

This NV item is to be automatically written by the RF calibration program. The PC-side RF calibration program can query its version number and store it in NV. The purpose of this NV item is for tracking. The details of this NV item are left to the handset manufacturer’s discretion.

3.3.3 NV_RF_CONFIG_VER_I

Data type: Array of eight, uint8 values

This NV item is to be automatically written by the RF calibration program. The PC-side RF calibration program knows the version number of the configuration file selected so it can store it in NV. The configuration file contains those NV items that are not calibrated on the factory floor, but are rather calibrated or chosen on a design-by-design basis. The purpose of this NV item is for tracking. The details of this NV item are left to the handset manufacturer’s discretion.

3.3.4 NV_RF_CAL_DATE_I

Data type: uint32 value

This NV item is automatically written by the RF calibration program. The PC-side RF calibration program knows the date that calibration is done and writes the date to this NV item. This NV item is to have the same attribute as NV_ESN_I. This item should only be able to be written to if it is not initialized. The purpose of this NV item is to determine whether the calibration data currently loaded into the phone came from an original factory floor calibration station or were modified at some point later. The details of this NV item are left to the handset manufacturer’s discretion.

3.3.5 NV_RF_NV_LOADED_DATE_I

Data type: uint32 value

This NV item is to be automatically written by the RF calibration program. The PC-side RF calibration program knows the date that the NV data was loaded and writes that date to this NV item. This date and NV_RF_CAL_DATE_I are equal when an original calibration station calibrates a unit for the first time. The desired goal is that if at any time the NV data are modified by any means, QPST, QXDM, etc., this NV item is updated with a new loaded date. This helps determine if the data in the unit came from a factory floor calibration station. If NV_RF_LOADED_DATE_I does not equal to NV_RF_CAL_DATE_I, then the NV data were modified by some other means. The details of this NV item are left to the handset manufacturer’s discretion.

3.3.6 NV_RF_CAL_DAT_FILE_I

Data type: Array of nine, uint8 values

This NV item is to be automatically written by the RF calibration program. The PC-side RF calibration program knows the name of the dat file and writes it to this NV item. This NV item is to have the same attributes as NV_ESN_I. This NV item should only be able to be written to if it is not initialized. This NV item can help determine the dat file used to load the NV data. The purpose of this NV item is for tracking. The details of this NV item are left to the handset manufacturer’s discretion.

4 Autocalibration items

4.1 RFNV_MSM_SELF_CAL_I (item 22982)

Data type: Structure of 16384 int8 values

This item stores the baseband Tx DAC-related calibration data. Calibration occurs automatically (no measurements from external test equipment) and is triggered by calling the FTM_DO_SELF_CAL command. In this NV, the first value is the validity flag, then a maximum of four DAC cal results appear for both DACs-ET and Non ET results.

5 CDMA RF NV items

To reduce NV naming confusion, the new Tx NV items associated with the Simultaneous voice (SV) path Chain 2 ensure that Rx C1 items used to configure and calibrate the receive diversity path of the data modem are not confused with the Tx items of the SV path. C0 includes items for primary Rx and Tx (the LTE/EV-DO data modem primary path). C1 only includes items for secondary Rx (the LTE/EV-DO data modem diversity path). C2 includes items for the SV Rx and Tx (the 1X voice modem), and C3 for SV diversity. A summary is shown in Table 5-1.

Table 5-1 SV RF NV item naming convention

Chain naming convention	Description	Usage
C0 (or blank)	Primary Rx and Tx	WCDMA voice and data, LTE, EV-DO, GSM
C1	Secondary Rx (diversity)	WCDMA, LTE, EV-DO; (diversity)
C2	SV path, Rx, and Tx	CDMA2000® 1X voice, CDMA2000 1X data (and in SVLTE-SHDR configurations, EV-DO)
C3	SV secondary Rx (diversity)	CDMA2000 1X voice, CDMA2000 1X data (and in SVLTE-SHDR configurations, EV-DO)

5.1 CDMA Rx RF NV items

5.1.1 Static, Rx RF NV items

5.1.1.1 RFNV_CDMA_Cx_BCy_1X_RX_SWITCHPOINTS_I

Data type: See Table 5-2.

This item consolidates all receiver switch point configuration data into a single data structure.

The CDMA 1X architecture supports up to five LNA gain states, requiring up to four switch points. In most current chipsets, four gain states per three switch points are implemented. To optimize power consumption, the RF driver supports independently configurable switch points in each IntelliCeiver Power mode (linearity modes). This NV item supports up to three power modes; however, only two power modes are supported on the most current chipsets (such as the WTR4905 device).

RF software supports two types of switch point configurations:

1. The rise and fall points can be set at a fixed location in the input power dynamic range. This setting is useful when the radio switch points must be set at a specific level due to standards requirements, or when radio performance is not sensitive to noise-figure optimized gain switching.
2. Control switch points automatically by using the optimized LNA threshold algorithm (OLTA). Set the rise point to a calculated level below the point at which ADC saturation occurs, based on receiver calibration data. Set the fall point at a specified level below the rise point. This setting is useful when maximum receiver carrier-to-noise (C/N) performance is desired.

In addition to the power hysteresis provided by the rise and fall points, RF software supports time hysteresis after transitioning up or down across a switch point.

Table 5-2 shows the data structure of each switch point in NV memory.

Table 5-2 Format of individual switch points (9 bytes each)

Data		Size
Switch point type (OLTA or FIXED) 0 = OLTA, 1 = FIXED		1 byte
If OLTA	**If FIXED**	–
Fall hysteresis (dB × 10)	Fall threshold (dBm × 10)	2 bytes (signed)
Backoff from max ADC (dB × 10)	Rise threshold (dBm × 10)	2 bytes (signed)
Post-fall hold time (in µs)		2 bytes
Post-rise hold time (in µs)		2 bytes

Absolute rise and fall values are stored as signed dBm10. To program a fall point of -80.2 dBm, store -802.

ADC saturation backoff and fall hysteresis are stored as signed dB10. To program an ADC backoff of 3 dB, store 30. To program a hysteresis of 4 dB, store 40.

The switch point NV item format is shown in Table 5-3.

Table 5-3 RFNV_CDMA_Cx_BCx_1X_RX_SWITCHPOINTS_I format

IntelliCeiver linearity mode	Data	Size
Mode 0 (Normal Power mode, High-Linearity mode)	IntelliCeiver mode 0 active	1 byte (0 inactive, 1 active)
	RxState state 0↔1 switch point	9 bytes (Table 5-2 structure)
	RxState state 1↔2 switch point	9 bytes (Table 5-2 structure)
	RxState state 2↔3 switch point	9 bytes (Table 5-2 structure)
	RxState state 3↔4 switch point	9 bytes (Table 5-2 structure)
Mode 1 (Low-Power mode 1)	IntelliCeiver mode 1 active	1 byte (0 inactive, 1 active)
	RxState state 0↔1 switch point	9 bytes (Table 5-2 structure)
	RxState state 1↔2 switch point	9 bytes (Table 5-2 structure)
	RxState state 2↔3 switch point	9 bytes (Table 5-2 structure)
	RxState state 3↔4 switch point	9 bytes (Table 5-2 structure)

IntelliCeiver linearity mode	Data	Size
Mode 2 (Low-Power mode 2)	IntelliCeiver mode 2 active	1 byte (0 inactive, 1 active)
	RxState state 0↔1 switch point	9 bytes (Table 5-2 structure)
	RxState state 1↔2 switch point	9 bytes (Table 5-2 structure)
	RxState state 2↔3 switch point	9 bytes (Table 5-2 structure)
	RxState state 3↔4 switch point	9 bytes (Table 5-2 structure)

The IntelliCeiver mode active bit indicates if the switch point data for that IntelliCeiver mode is valid. For example, the RTR8600 device only supports modes 0 (High-Linearity mode) and 1 (Low-Linearity mode). So when using the RTR8600 device, the state 0 and state 1 active byte must be set to 1, and the state 2 active byte set to 0.

For this NV item, use the values found in the static NV xml file distributed in the corresponding release of AMSS software.

5.1.1.2 RFNV_CDMA_Cx_BCy_DOR0_A_RX_SWITCHPOINTS_I

See Section 5.1.1.1. These items apply to EV-DO Rev 0 and Rev A.

5.1.1.3 RFNV_CDMA_Cx_BCy_DORB_SC_RX_SWITCHPOINTS_I

See Section 5.1.1.1. These items apply to EV-DO Rev B, Single Carrier (SC) mode.

5.1.1.4 RFNV_CDMA_Cx_BCy_DORB_MC_RX_SWITCHPOINTS_I

See Section 5.1.1.1. These items apply to EV-DO Rev B, Multicarrier (MC) mode.

5.1.1.5 RFNV_CDMA_Cx_1X_SPUR_TABLE_I, RFNV_CDMA_Cx_HDR_SPUR_TABLE_I

Data type: Array of 30 elements of the following structure:

unit32 freq_Hz

unit8 K

This NV item specifies the frequencies and depths of any desired notch filters to remove CW spurs within the useful Rx bandwidth. Depending on specific board design characteristics, spurs have the potential to degrade minimum sensitivity performance.

This particular NV item is specific to the technology and Rx chain (*x* in the name above refers to the Rx chain). However, the item covers all bands. Each NV item element specifies the absolute frequency of the spur, regardless of the band. Up to 30 spur frequencies can be specified (per NV item).

Each of the 30 elements contains two parameters, freq_Hz and K.

The parameter freq_Hz specifies the absolute RF frequency of the spur in units of Hz. For example, to create a notch filter for the 39th XO harmonic at 748.8 MHz, store a value of 748800000 (decimal).

The parameter K specifies the notch width. It also disables the element (disable all elements not specifying spur frequencies if the NV item is populated). The relationship between K value and notch width is in Table 5-4 (based on simulation).

Table 5-4 K value and typical notch width

Notch setting (K value)	Attenuation at 100 Hz offset (dB)
0	21
1	25
2	33
3	39
4	45
5	51
6	57
7	63
8	69
9	75
10	81
11	87
15	Disable

NOTE: The values in Table 5-4 are only typical attenuations based on simulation. The actual implementation is more advanced, such that the notch filter width and depth are a function of the Rx signal strength.

Although the notch filters themselves are implemented at digital baseband, the freq_Hz parameters are entered in absolute RF frequency. The implementation algorithm automatically calculates which freq_Hz elements listed in the NV table happen to fall within the useful channel bandwidth being received. Only those spurs within the useful channel bandwidth are considered for notch filtering.

The order of the elements in the NV item need not be stored in order of frequency, rather store them in the order of priority.

These NV items are not necessarily populated in the default static NV XML files released with software. However, they are available for use, if necessary, based on the particular board design characteristics.

5.1.2 Calibrated, Rx RF NV items

NOTE: When calibrating the NV_Cx_BCy_VGA_GAIN_OFFSET_I, NV_Cx_BCy_VGA_GAIN_OFFSET_VS_FREQ_I, NV_Cx_BCy_LNA_z_OFFSET_I, and NV_Cx_BCy_LNA_z_OFFSET_VS_FREQ_I items, maintaining the following proper order is crucial when taking measurements:

1. DVGA offset
2. LNA_1 offset
3. LNA_2 offset
4. LNA_3 offset

Perform measurements in order for a given frequency channel before moving to the next frequency. This is necessary because the associated FTM functions not only return measured values, but they also prepare the internal hardware registers for the next expected measurement.

The *Tx/Rx Frequency Cal Sweep* (used for composite calibration) and/or the *Enhanced Sweep* calibration are not capable of calibrating multiple Linearity modes at once. When using such an automated sweep, calibrate the DVGA offset and all LNA offsets for a specific Linearity mode, in order, before switching linearity modes, and all before changing frequencies.

5.1.2.1 NV_Cx_BCy_RX_CAL_CHAN_I

Data type: Array of 16, uint16 values

This NV item is used to automatically keep track of the Rx channels on which the calibration has been performed. Two to sixteen channel numbers are allowed. Channel numbers must be in order of increasing RF frequency. A value of 0 indicates element is not used, and all following elements must be zero.

5.1.2.2 NV_Cx_BCy_VGA_GAIN_OFFSET_I

Data type: int16 (16-bits signed)

This NV item specifies the average of the maximum and the minimum DVGA gain offset across all the calibration channels and power modes for the given Rx chain, in 1/10 dB resolution.

To arrive at the value of this item, use the following equation:

NV_Cx_BCy_VGA_GAIN_OFFSET_I = (LargestVgaGainOffsetVsFreq + SmallestVgaGainOffsetVsFreq)/2

NOTE: DVGA offsets are calibrated with the specific goal of causing the RSSI to match the power level of the received signal, as measured at the phone’s antenna connector, particularly when the LNA is in its highest gain state (LNA offsets are used to account for the LNA gain state differences). DVGA offsets account for all losses and gains in the Rx chain from the antenna connector to baseband, when the LNA is in its highest gain state. Thermal noise is ignored when calibrating DVGA offsets. Some RSSI error is expected at very low Rx power levels, near the thermal noise floor. For this reason, calibrate DVGA offsets at Rx power levels above the thermal noise floor. Choosing the Rx power level near the switch points of the first gain step ensures the Rx power level is above the thermal noise floor and below saturation. However, there is considerable flexibility in choosing power levels. Power levels in default QSPR test trees provide good examples.

5.1.2.3 NV_Cx_BCy_VGA_GAIN_OFFSET_VS_FREQ_I

Actual size: 36 bytes (16 × 2 × 8 bits)

Data type: Array of 16 × 2 int8

This NV item stores the variation of the average DVGA gain offset, defined in Section 5.1.2.1, of each channel-of-interest and Power mode, in 1/10 dB resolution. Each element of this NV item stores the difference between the average DVGA gain offset and the DVGA gain offset of each frequency-of-interest in the power mode-of-interest. Elements 0 through 15 represents the relative DVGA gain offset for normal power mode, and elements 16 through 31 represents the relative DVGA gain offset for lower Power mode 1.

To calibrate this NV item, perform the following:

1. Tune the mobile to the channel of interest using the *Set Channel* FTM command.
2. Configure the LNA to the appropriate Linearity mode (if there is more than one Linearity mode for the particular Rx chain and band).
3. Apply the Rx power level to be above the noise floor, but not so much above that saturation/distortion occurs (all external losses must be accounted for). Example power levels can be found in the appropriate QSPR test tree provided with QDART.
4. Call the FTM command API *Get LNA Offset* with an index of 0.

   Use the following formula to calculate the RxAGC value:

   CalculatedAGCValue = (1024/**DynamicRange**) × (RxPower - **MinRSSIofInterest**) -512

   Assuming **DynamicRange** = 102.4 dB and **MinRSSIofInterest** = -115 dB, this equation reduces to:

   CalculatedAGCValue = (RxPower + 115 dB) × 10 - 512

   Example: RxPower = -80 dBm
   CalculatedAGCValue = [-80 - (-115)] × 10 - 512 = -162

   The *Get LNA Offset* FTM command automatically performs the necessary averaging and completes the necessary equations.

5. Store the new DVGA gain offset values in a table, e.g., VgaOffsetVsFreq [channel_index + 16 × power_mode_index], where chan_index ranges from 0 to 15, corresponding to each frequency-of-interest index, and power_mode_index ranges from 0 to 1, corresponding to Normal-Power mode and Low-Power mode 1, respectively. NV_Cx_BCy_VGA_GAIN_OFFSET_I stores the average of the maximum and minimum values of VgaOffsetVsFreq across channel_index and all power modes. After that step, calculate the values for NV_Cx_BCy_VGA_GAIN_OFFSET_VS_FREQ_I using the following formula:

   NV_Cx_BCy_VGA_GAIN_OFFSET_VS_FREQ_I [channel_index + 16 × power_mode_index] = (VgaOffsetVsFreq[channel_index + 16 × power_mode_index] - NV_Cx_BCy_VGA_GAIN_OFFSET_I)

5.1.2.4 NV_Cx_BCy_LNA_1_OFFSET_I

Data type: int16 (16 bits signed)

This NV item compensates for the gain step when the gain of the LNA circuit is reduced from LNA range state 0 to state 1. Note that only 10 bits out of the possible 16 bits are used, and the resolution is 10 counts per dB (1024/**DynamicRange** = 1024/102.4).

Conceptually, this item represents LNA 1 offset = DVGA offset - (10 × (difference in gain between RxState state 0 and state 1)).

NOTE: Before the LNA offset calibration, the DVGA offset must be calibrated.

The LNA offset NV item is the average of the largest and smallest LNA offset across all calibration frequencies and power modes using the following equation:

NV_Cx_BCy_LNA_1_OFFSET_I = (LargestLnaGainStepVsFreq + SmallestLnaGainStepVsFreq)/2

5.1.2.5 NV_Cx_BCy_LNA_2_OFFSET_I

Data type: 16-bit signed

This NV item compensates for the gain step when the gain of the LNA circuit is reduced from gain state 0 to gain state 2. See the discussion in Section 5.1.2.4 for details about the calibration procedure and relevant calculations.

5.1.2.6 NV_Cx_BCy_LNA_3_OFFSET_I

Actual size: 10 bits

Data type: 16-bit signed

This NV item compensates for the gain step when the gain of the LNA circuit is reduced from gain state 0 to gain state 3. Follow the discussion in Section 5.1.2.4 for details about the calibration procedure and relevant calculations.

5.1.2.7 NV_Cx_BCy_LNA_1_OFFSET_VS_FREQ_I

Actual size: 48 bytes (16 × 2 × 8 bits)

Data type: Array of 16 × 2, int8 values

This NV item stores the gain variations of the LNA when in gain state 1 relative to the average LNA gain-step value (NV_Cx_BCy_LNA_1_OFFSET_I), as defined in Section 5.1.2.4, for each channel-of-interest and Power mode, in 1/10 dB resolution. Each set of elements 0 through 15 and 16 through 31 represents the LNA gain-step values for normal Power mode and Low Power mode 1, respectively. Each entry stores the delta between NV_Cx_BCy_LNA_1_OFFSET_I and the LNA gain-step value of the frequency of interest.

To calibrate this NV item, use the following procedure on each calibration channel:

1. Tune the mobile to the channel of interest using the *Set Channel* FTM command.
2. Choose the Linearity mode and calibrate the DVGA offset as discussed in Section 5.1.2.3.

3. Apply an Rx power level that is within the linear region of the particular gain state (LNA Range state 1 for this case). The power level should be above the thermal noise floor but below saturation. Example power levels are in the appropriate QSPR test tree provided with QDART.
4. Call the FTM command API *Get LNA Offset* with index of 1. The Rx AGC value can be calculated using the following formula:

   CalculatedAGCValue = (1024/**DynamicRange**) × (RxPower **- MinRSSIofInterest**) - 512

   Assuming **DynamicRange** = 102.4 dB and **MinRSSIofInterest** = -115 dB, this equation reduces to:

   CalculatedAGCValue = (RxPower + 115 dB) × 10 - 512.

   Example: RxPower = -70 dBm
   CalculatedAGCValue = [-70 - (-115)] × 10 - 512 = -62

   The *Get LNA Offset* FTM command automatically performs the necessary averaging and completes the necessary equations.
5. Store the new LNA gain steps values in a table; for example: LnaGainStepVsFreq[channel_index + 16 × power_mode_index], where channel_index ranges from 0 to 15, corresponding to the frequency index, and power_mode_index ranges from 0 to 1, corresponding to normal-power mode and low-power mode 1 respectively. NV_Cx_BCy_LNA_1_OFFSET_I stores the average of the maximum and the minimum LnaGainStepVsFreq across all channel_index and power_mode_index. After that step, the contents of NV_Cx_BCy_LNA_1_OFFSET_VS_FREQ_I are calculated as follows:

   NV_Cx_BCy_LNA_1_OFFSET_VS_FREQ [channel_index + 16 × power_mode_index] = LnaGainStepVsFreq [channel_index + 16 × power_mode_index] - NV_Cx_BCy_LNA_1_OFFSET

5.1.2.8 NV_Cx_BCy_LNA_2_OFFSET_VS_FREQ_I

Actual size: 48 bytes (16 × 2 × 8 bits)

Data type: Array of 16 × 2, int8 values

This NV item stores gain variations of the LNA when in gain state 2 relative to the average LNA gain step (NV_Cx_BCy_LNA_2_OFFSET_I), as defined in Section 5.1.2.5, for each channel of interest and power mode, in 1/10 dB resolution. Each set of elements, 0 through 15 and 16 through 31, represent the LNA gain-step values for normal power mode and low-power mode 1, respectively. Each entry stores the delta between NV_Cx_BCy_LNA_2_OFFSET_I and the LNA gain-step value of the frequency of interest. See the description in Section 5.1.2.7 for details about the calibration procedure and relevant calculations. Use *Get LNA Offset* with index of 2.

5.1.2.9 NV_Cx_BCy_LNA_3_OFFSET_VS_FREQ_I

Actual size: 48 bytes (16 × 2 × 8 bits)

Data type: Array of 16 × 2, int8 values

This NV item stores gain variations of the LNA when in gain state 3 relative to the average LNA gain step (NV_Cx_BCy_LNA_3_OFFSET_I), as defined in Section 5.1.2.6, for each channel of interest and power mode, in 1/10 dB resolution. Each set of elements, 0 through 15 and 16 through 31, represent the LNA gain-step values for normal power mode and low-power mode 1, respectively. Each entry stores the delta between NV_Cx_BCy_LNA_3_OFFSET_I and the LNA gain-step value of the frequency of interest. See the description in Section 5.1.2.7 for details about the calibration procedure and relevant calculations. Use *Get LNA Offset* with index of 3.

5.2 CDMA Tx RF NV items

5.2.1 Static, Tx RF NV items

5.2.1.1 NV_BCy_ENC_BTF_I, RFNV_CDMA_C2_BCy_1X_ENC_BTF_I

Data type: uint13

The baseband modulator contains a back-to-the-future (BTF) counter that compensates for the delays in the phone.

NOTE: Set the pilot Ec/Io of the CDMA call box to less than or equal to -8 dB. Problems can occur if the pilot Ec/Io is high when using some call box models.

Perform the following to correctly set the BTF:

1. Initiate a call.
2. Record the time offset displayed on the call box (note that this parameter is often shared with the frequency offset parameter). It is measured in microseconds.

   If it is greater than ± several tenths of a microsecond, an adjustment is needed.
3. Convert the time offset from microseconds to units of ⅛ PN chips.

   Time_in_PN_Chips = Time_in_µs × 1.2288 chips/microsec.
4. Add the time offset (in units of ⅛ PN chip; time offset can be positive or negative) to the value NV_BCy_ENC_BTF.
5. Load the new values into NV and reboot the phone so the new NV values are used.
6. Remeasure the time offset with a call up to make sure it is near 0 µs.

NOTE: A typical value for this NV item is 3220 decimal. The actual value is phone-design dependent.

5.2.1.2 NV_BCy_PA_R_MAP_I, RFNV_CDMA_C2_BCy_PA_R_MAP_I

The hardware PA_RANGE[1:0] hardware pin states can be altogether different than the TxState state-machine states. Although the names are similar, they should not be confused with each other. This NV provide the mapping table for Tx State and PA Range. TxState refers to the controlling state-machine , PA_RANGE[1:0] corresponds to the hardware voltage state of PA_RANGE1 and PA_RANGE0 pins in GRFC controlling PA .For MIPI PA , PA_RANGE[1:0] is not stand for any hardware voltage, but two bits forms the PA range value used in MIPI PA driver.

This item specifies the PA_RANGE[1:0] pin voltages corresponding to each TxState state. In normal online operation, the TxState state-machine controls which set of Tx linearizer-related NV items are used at any given time. In other words, the state-machine controls particular sections that are used within NV_CDMA_Cx_BCy_TX_PWR_TEMP_COMP_I, NV_CDMA_Cx_BCy_TX_MULTI_LIN_DATA_I, NV_CDMA_Cx_BCy_1X_TX_ACCESS_SWITCHPOINTS_I, NV_CDMA_Cx_BCy_1X_TX_VOICE_SWITCHPOINTS_I, and NV_CDMA_Cx_BCy_1X_TX_DATA_SWITCHPOINTS_I. The state of the TxState state-machine must *always* take the form described in Table 5-5.

Table 5-5 TxState (state-machine) state definition

TxState state	Corresponding Tx power
0	Lowest Tx power mode (also the highest Tx power mode for single gain state systems).
1	Second lowest Tx power mode (highest Tx power mode for two gain state systems). Unused for systems using only a single Tx Gain state.
2	Third lowest Tx power mode (highest Tx power mode for three gain state systems). Unused for systems using only two or fewer Tx gain states.
3	Fourth lowest Tx Power mode (highest Tx power mode for four gain state systems). Unused for systems using only three or fewer Tx gain states.

Figure 5-1 shows how the individual bits of NV_<CDMA_C2_>BCy_PA_R_MAP_I specify the relationship between the particular TxState state and the PA_RANGE[1:0] pins. The bits use positive logic; i.e., 1 corresponds to high voltage and 0 corresponds to GND.

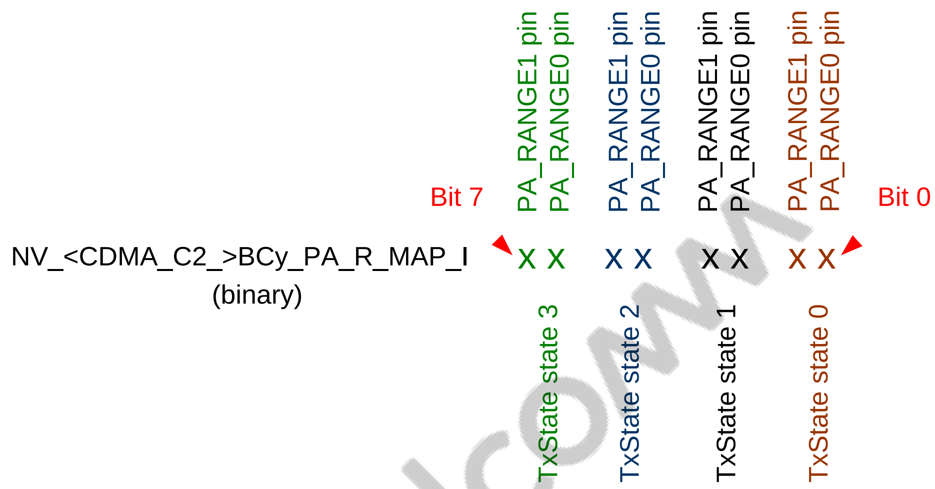


Figure 5-1 Relationship between TxState state and PA_RANGE[1:0] pins

Two examples are given below.

Example 1

In this example, suppose that a PA is used that supports only two gain states. The PA_RANGE0 pin is connected to the PA to control the gain state. The PA_RANGE1 pin is not connected, and left floating as shown in Figure 5-2. The example control logic, as dictated by the hardware PA module, is shown in Table 5-6.

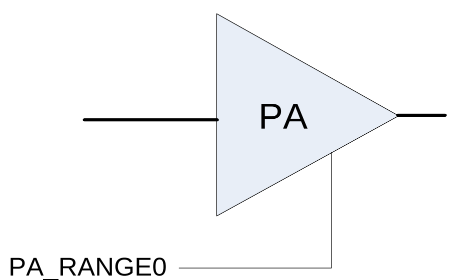


Figure 5-2 Example of a two gain state system

Table 5-6 Hypothetical PA gain state hardware logic for example 1

PA gain state	PA_RANGE1 pin state	PA_RANGE0 pin state
Low Tx power state	Do not care, not connected	V_{DD}
High Tx power state	Do not care, not connected	GND

The necessary RFNV_<CDMA_C2_>BCy_PA_R_MAP_I configuration is shown in Figure 5-3. Each ‘d’ represents a *do not care* condition.

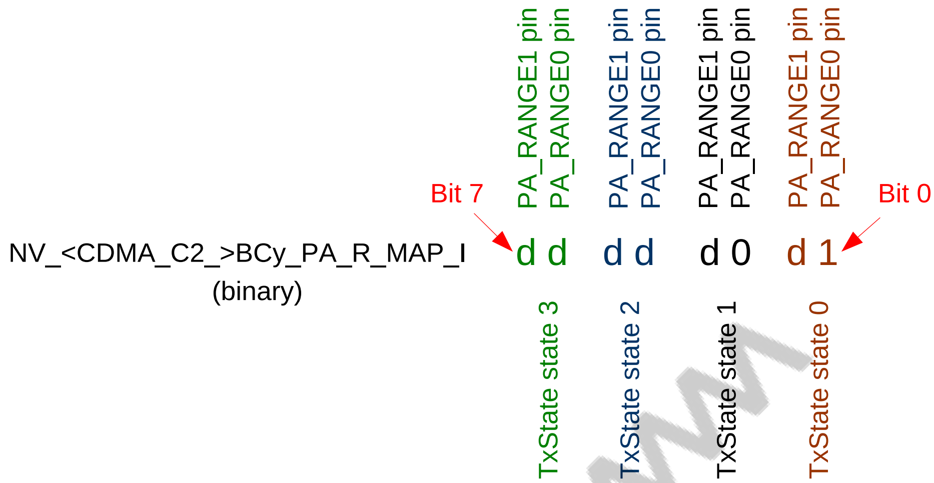


Figure 5-3 Necessary PA_R_MAP configuration for example 1

The do not care conditions are arbitrarily chosen to be 0 in this example. The value stored in the item is as follows:

00 00 00 01 (binary) = 0x01.

Example 2

In this hypothetical example, the PA supports three gain states. Both PA_RANGE0 and PA_RANGE1 pins are connected as shown in Figure 5-4. The example control logic, as dictated by the hardware PA module, is shown in Table 5-7.

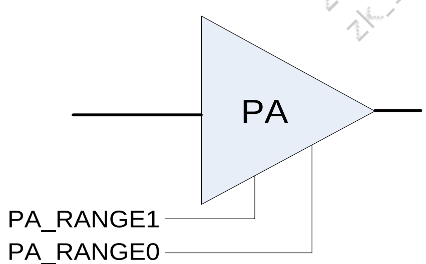


Figure 5-4 Example of a three gain state system

Table 5-7 Hypothetical PA gain state hardware logic for example 2

PA gain state	PA_RANGE1 pin state	PA_RANGE0 pin state
Low Tx power state	V_{DD}	V_{DD}
Mid Tx power state	V_{DD}	GND
High Tx power state	GND	GND

The necessary RFNV_<CDMA_C2_>BCy_PA_R_MAP_I configuration is shown in Figure 5-5. Each “d” represents a *do not care* condition.

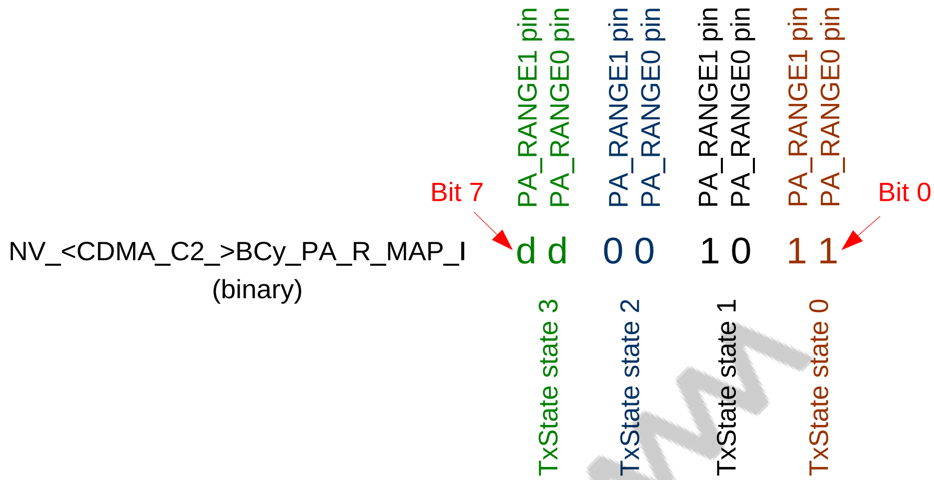


Figure 5-5 Necessary PA_R_MAP configuration for example 2

The do not care conditions are arbitrarily chosen to be 0 in this example. The value stored in the item is:

00 00 10 11 (binary) = 0x0B.

5.2.1.3 RFNV_CDMA_Cx_BCy_1X_TX_ACCESS_SWITCHPOINTS_I

Data type: Array of seven, int16 values

This item configures the Tx AGC PA state switch points used on the 1X access channel (R-ACH). These switch points can be different than 1X voice switch points in order to optimize performance on the standardized access probe output power tests.

The format of the item is shown in Table 5-8.

Table 5-8 Access channel switch point item format

Element	Data	Size
0	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
1	TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
2	TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
3	TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
4	TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
5	TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
6	Fall time hysteresis (microseconds)	2 bytes (signed)

Absolute rise and fall values are stored as signed dBm10. For example, to program a fall point of -2.0 dBm, store -20. To program a rise point of 12.5 dBm, store 125.

For typical example values/switch points, consult the static xml file distributed in the corresponding release of AMSS software.

If this NV item is not populated, the 1X_TX_VOICE switch points are used instead.

5.2.1.4 RFNV_CDMA_Cx_BCy_1X_TX_VOICE_SWITCHPOINTS_I

Data type: Structure of seven, int16 values

This item configures the Tx AGC PA state switch points used when the 1X radio is in voice traffic state. (Supplemental channel is not active.)

The format is shown in Table 5-9.

Table 5-9 Voice traffic state switch point item format

Element	Data	Size
0	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
1	TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
2	TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
3	TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
4	TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
5	TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
6	Fall time hysteresis (microseconds)	2 bytes (signed)

Absolute rise and fall values are stored as signed dBm10. For example, to program a fall point of -2.0 dBm, store -20. To program a rise point of 12.5 dBm, store 125.

For typical example values/switch points, consult the static xml file distributed in the corresponding release of AMSS software.

5.2.1.5 RFNV_CDMA_Cx_BCy_1X_TX_DATA_SWITCHPOINTS_I

Data type: Array of six blocks. Each block is a structure of seven, int16 values

This item configures the Tx AGC PA state switch points used when the 1X radio is in the data traffic state. Distinct switch points are programmable for reverse supplemental channel (R-SCH) rates to optimize power consumption and code domain power performance of each rate.

The format is shown in Table 5-10.

Table 5-10 1X data switch point item format

Element	Rate	Data	Size
0	R-SCH rate 1 (9600 bps)	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
1		TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
2		TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
3		TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
4		TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
5		TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
6		Fall time hysteresis (microseconds)	2 bytes (signed)

Element	Rate	Data	Size
7	R-SCH rate 2 (19200 bps)	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
8		TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
9		TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
10		TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
11		TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
12		TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
13		Fall time hysteresis (microseconds)	2 bytes (signed)
14	R-SCH rate 3 (38400 bps)	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
15		TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
16		TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
17		TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
18		TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
19		TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
20		Fall time hysteresis (microseconds)	2 bytes (signed)
21	R-SCH rate 4 (76800 bps)	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
22		TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
23		TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
24		TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
25		TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
26		TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
27		Fall time hysteresis (microseconds)	2 bytes (signed)
28	R-SCH rate 5 (153600 bps)	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
29		TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
30		TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
31		TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
32		TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
33		TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
34		Fall time hysteresis (microseconds)	2 bytes (signed)
35	R-SCH Rate 6 (307200 bps)	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
36		TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
37		TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
38		TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
39		TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
40		TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
41		Fall time hysteresis (microseconds)	2 bytes (signed)

Absolute rise and fall values are stored as signed dBm10. For example, to program a fall point of -10.0 dBm, store -100.

For typical example values/switch points, consult the static xml file distributed in the corresponding release of AMSS software.

If this NV item is unpopulated, the effective switch points are as follows:

1X_TX_VOICE_SWITCHPOINTS – 17 dB for low bands

1X_TX_VOICE_SWITCHPOINTS – 20 dB for high bands

5.2.1.6 RFNV_CDMA_Cx_BCy_HDR_TX_ACCESS_SWITCHPOINTS_I

Data type: Structure of seven, int16 values

This item configures the Tx AGC PA state switch points used on the EV-DO access channel. These switch points can be different from 1X voice switch points in order to optimize performance on the standardized access probe output power tests.

The format of the item is shown in Table 5-11.

Table 5-11 EV-DO access channel switch point item format

Element	Data	Size
0	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
1	TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
2	TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
3	TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
4	TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
5	TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
6	Fall time hysteresis (microseconds)	2 bytes (signed)

Absolute rise and fall values are stored as signed dBm10. For example, to program a fall point of -2.0 dBm, store -20. To program a rise point of 12.5 dBm, store 125.

For typical example values/switch points, see the static xml file distributed in the corresponding release of AMSS software.

If this NV item is unpopulated, the 1X_TX_VOICE switch points are used instead.

5.2.1.7 RFNV_CDMA_Cx_BCy_HDR_TX_DOR0_SWITCHPOINTS_I

Data type: Array of 6 blocks. Each block is a structure of seven int16 values

This item configures the Tx AGC PA state switch points used when data radio is in the EV-DO Rev. 0 (i.e., EV-DO subtype 0 and subtype 1 physical layer) state. Distinct switch points are programmable for reverse rate indicator (RRI) rates to optimize power consumption and code domain power performance of each rate.

The format is shown in Table 5-12.

Table 5-12 EV-DO Rev 0 Tx switch point item format

Element	Rate	Data	Size
0	RRI 0 (0 bps)	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
1		TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
2		TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)

Element	Rate	Data	Size
3	RRI 0 (0 bps)	TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
4		TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
5		TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
6		Fall time hysteresis (microseconds)	2 bytes (signed)
7	RRI 1 (9600 bps)	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
8		TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
9		TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
10		TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
11		TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
12		TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
13		Fall time hysteresis (microseconds)	2 bytes (signed)
14	RRI 2 (19200 bps)	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
15		TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
16		TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
17		TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
18		TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
19		TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
20		Fall time hysteresis (microseconds)	2 bytes (signed)
21	RRI 3 (38400 bps)	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
22		TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
23		TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
24		TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
24		TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
26		TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
27		Fall time hysteresis (microseconds)	2 bytes (signed)
28	RRI 4 (76800 bps)	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
29		TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
30		TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
31		TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
32		TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
33		TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
34		Fall time hysteresis (microseconds)	2 bytes (signed)
35	RRI 5 (153600 bps)	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
36		TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
37		TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
38		TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
39		TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
40		TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
41		Fall time hysteresis (microseconds)	2 bytes (signed)

Absolute rise and fall values are stored as signed dBm10. For example, to program a fall point of -10.0 dBm, store -100.

For typical example values/switch points, see the static xml file distributed in the corresponding release of AMSS software.

If this NV item is unpopulated, the 1X_TX_VOICE switch points are used instead.

5.2.1.8 RFNV_CDMA_Cx_BCy_HDR_TX_DORA_SWITCHPOINTS_I

Data type: Structure of seven, int16 values

This item configures the Tx AGC PA state switch points that are used when data radio is in the EV-DO Rev. A (i.e., EV-DO subtype 2 physical layer) state.

The format of the item is shown in Table 5-13.

Table 5-13 EV-DO Rev. A Tx switch point item format

Element	Data	Size
0	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
1	TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
2	TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
3	TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)
4	TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
5	TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
6	Fall time hysteresis (microseconds)	2 bytes (signed)

Absolute rise and fall values are stored as signed dBm10. For example, to program a fall point of -2.0 dBm, store -20. To program a rise point of 12.5 dBm, store 125.

For typical example values/switch points, see the static xml file distributed in the corresponding release of AMSS software.

If this NV item is unpopulated, the HDR_TX_DOR0_SWITCHPOINTS are used instead.

5.2.1.9 RFNV_CDMA_Cx_BCy_HDR_TX_DORB_MC_SWITCHPOINTS_I

Data type: Structure of seven, int16 values

This item configures the Tx AGC PA state switch points used when data radio is in the EV-DO Rev. B multicarrier (MC) state.

The format of the item is shown in Table 5-14.

Table 5-14 EV-DO Rev. B multicarrier (MC) Tx switch point item format

Element	Data	Size
0	TxState state 1 → 0, fall (dBm × 10)	2 bytes (signed)
1	TxState state 0 → 1, rise (dBm × 10)	2 bytes (signed)
2	TxState state 2 → 1, fall (dBm × 10)	2 bytes (signed)
3	TxState state 1 → 2, rise (dBm × 10)	2 bytes (signed)

Element	Data	Size
4	TxState state 3 → 2, fall (dBm × 10)	2 bytes (signed)
5	TxState state 2 → 3, rise (dBm × 10)	2 bytes (signed)
6	Fall time hysteresis (microseconds)	2 bytes (signed)

Absolute rise and fall values are stored as signed dBm10. For example, to program a fall point of -2.0 dBm, store -20. To program a rise point of 12.5 dBm, store 125.

For typical example values/switch points, see the static xml file distributed in the corresponding release of AMSS software.

If this NV item is unpopulated, the HDR_TX_DORA_SWITCHPOINTS switch points are used instead.

5.2.1.10 RFNV_CDMA_Cx_BCy_TX_MULTI_LIN_APT_ADJ_I

This item describes how the Tx linearizers stored in the RFNV_CDMA_Cx_BCy_TX_MULTI_LIN_DATA_I items are adjusted based on the reverse link data configuration. To optimize voice performance, it may be desirable to aggressively reduce PA bias for voice waveforms, which may not satisfy ACPR/ACLR/code domain power specifications if used for data waveforms. This NV item contains power adjustments made to the linearizer table and the Tx DAC set point when transmitting waveforms not 1X RC3 FCH-only. The format is shown in Table 5-15.

Table 5-15 RFNV_CDMA_Cx_BCy_TX_MULTI_LIN_APT_ADJ_I format

Data	Size
Reserved. Must be set to 0.	1 byte
Power adjustment for 1X Pilot only	1 byte
Power adjustment for 1X RC1 and RC2	1 byte
Power adjustment for 1X RC3 or RC4 FCH-only (voice)	1 byte
Power adjustment for 1X RC3 or RC4 SCH (data)	1 byte
Power adjustment for 1X RC8 FCH-only (voice)	1 byte
Power adjustment for 1X RC8 SCH (data)	1 byte
Power adjustment for DOr0 – Pilot only	1 byte
Power adjustment for DOr0 – RRI1 (9.6 kbsp)	1 byte
Power adjustment for DOr0 – RRI2 (19.2 kbsp)	1 byte
Power adjustment for DOr0 – RRI3 (38.4 kbsp)	1 byte
Power adjustment for DOr0 – RRI4 (76.8 kbsp)	1 byte
Power adjustment for DOr0 – RRI5 (153.6 kbsp)	1 byte
Power adjustment for DOrA – PS0 (payload size 0)	1 byte
Power adjustment for DOrA – PS1 (payload size 128)	1 byte
Power adjustment for DOrA – PS2 (payload size 256)	1 byte
Power adjustment for DOrA – PS3 (payload size 512)	1 byte
Power adjustment for DOrA – PS4 (payload size 768)	1 byte
Power adjustment for DOrA – PS5 (payload size 1024)	1 byte
Power adjustment for DOrA – PS6 (payload size 1536)	1 byte

Data	Size
Power adjustment for DOrA – PS7 (payload size 2048)	1 byte
Power adjustment for DOrA – PS8 (payload size 3072)	1 byte
Power adjustment for DOrA – PS9 (payload size 4096)	1byte
Power adjustment for DOrA – PS10 (payload size 6144)	1 byte
Power adjustment for DOrA – PS11 (payload size 8192)	1 byte
Power adjustment for DOrA – PS12 (payload size 12288)	1 byte

The first byte is reserved for future use and must be set to 0.

Each following byte is a signed, $1/10^{th}$ dB power adjustment that is applied to all linearizer entries in each of the respective modes, as well as the adjustment applied to the Tx DAC set point. All values should be greater than or equal to zero for proper system operation, otherwise excessive DAC saturation may occur.

The set point and linearizer adjustments are not applied in calibration mode – the software-provided default values are used. This means that RF calibration is performed with the RC1 waveform and no adjustment. In online operation, the NV-based adjust values are applied as provided by the structure above.

This NV item affects normal online mode operation by effectively reducing the Tx power values in the Tx linearizer table, by the amount stored in this NV item element (the element corresponding to the particular data configuration), without changing the RGI or APT (SMPS PDM) values. The baseband Tx power is also reduced by the same amount.

Because the Tx power elements in the linearizer table are effectively reduced, a larger RGI and a correspondingly larger APT value are chosen for a given, desired Tx power level. All else being the same, this alone would cause an increase in Tx power equal to the amount specified by the element. However, in addition to the above, the baseband Tx power is reduced by the same amount, thus the resulting Tx power remains as desired. The net effect is summarized by the APT value being increased. And since the RGI and APT value relationships remain unchanged (from the Tx linearizer table), the calibration data remains valid.

The format of the elements in this NV item are a measure of Tx power delta. But this NV item usage does not have an effect on the Tx power level in normal operation. The elements of this NV item can be interpreted as the necessary Tx power reduction, relative to voice calibration, necessary to meet ACPR/ACLR/code domain power specifications, for *a given* APT value (SMPS PDM).

5.2.1.11 RFNV_CDMA_Cx_BCy_TX_PWR_TEMP_COMP_I

Data type: See Table 5-16.

This NV item stores the temperature compensation data for the CDMA transmitter.

Table 5-16 RFNV_CDMA_Cx_BCy_TX_PWR_TEMP_COMP_I format

Elements	Data		Element size
0	Reserved. Must be set to 0.		1 byte
1-8	TxState state 0	Array of 8 CompOffset values, one for each temperature bin (format: dB10)	1 byte (signed)
9-16		Array of 8 CompSlope values, one for each temperature bin (format 16Q15)	2 bytes (unsigned)
17-24	TxState state 1	Array of 8 CompOffset values, one for each temperature bin (format: dB10)	1 byte (signed)
25-32		Array of 8 CompSlope values, one for each temperature bin (format 16Q15)	2 bytes (unsigned)
33-40	TxState state 2	Array of 8 CompOffset values, one for each temperature bin (format: dB10)	1 byte (signed)
41-48		Array of 8 CompSlope values, one for each temperature bin (format 16Q15)	2 bytes (unsigned)
49-56	TxState state 3	Array of 8 CompOffset values, one for each temperature bin (format: dB10)	1 byte (signed)
57-64		Array of 8 CompSlope values, one for each temperature bin (format 16Q15)	2 bytes (unsigned)

For a given TxState state, CompOffset[*i*] represents an overall offset for all the elements in RFNV_CDMA_Cx_BCy_TX_LIN_z_I, for a given temperature index *i*. For example, a CompOffset[*i*] value of 20 represents a 2 dB shift of all elements in RFNV_CDMA_Cx_BCy_TX_LIN_z_I, when at temperature index *i*. This would be appropriate if the Tx output power is a constant 2 dB larger at temperature index *i* than it is at reference temperature, for the same RGI values.

CompSlope is the temperature-interpolated slope scale factor in unsigned 16Q15 format. 16Q15 format means the number is a 16-bit number, with an assumed radix point left of the 15 least significant bits. The radix point is ignored when the item is stored. In binary form, this is represented by:

a.aaa aaaa aaaa aaaa

where each ‘a’ is a 0 or 1. The range of a 16Q15 number is defined on the interval [0, 2]. The minimum value is 0. The maximum value is nearly 2, (specifically 65535/32768). For example a value of 1.0 is:

1.000 0000 0000 0000 (binary).

When stored in 16Q15 format, the radix point is assumed (and thus ignored), and the number is stored as:

1000 0000 0000 0000 (binary) = 0x8000 = 32768 (decimal).

To convert a 16Q15 number from its stored value to its floating representation, divide it by 32768.

Linearizer temperature compensation is applied to the RFNV_CDMA_C2_BCy_TX_LIN_z_I items according to the following formula:

$$TX\_LIN_{effective} = TX\_LIN_{fromNVtable} \times (CompSlope/32768) + CompOffset.$$

Using CompOffset alone

Temperature compensation can be accomplished using CompOffset only and not utilizing CompSlope. For such configurations, store 32768 (floating equivalent of 1.0) in all 8 elements of CompSlope. Figure 5-6 shows a graphical representation of how CompOffset[*i*] is used by embedded software.

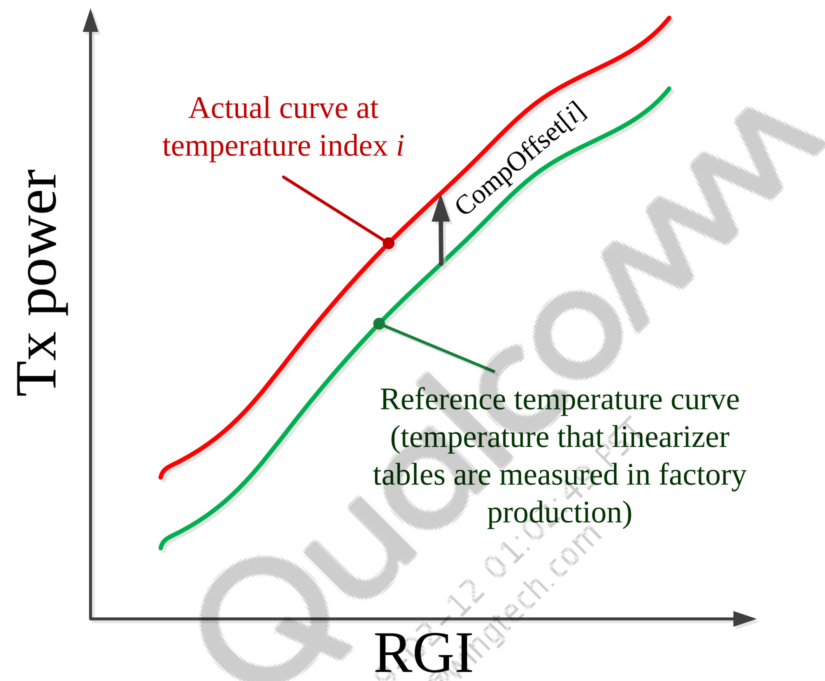


Figure 5-6 Temperature compensation with CompOffset only

To calibrate CompOffset (without utilizing CompSlope), the following procedure can be used. This method can be done in FTM RF mode.

1. Pick an appropriate RGI in the useful range for the given TxState state.
2. Measure the Tx power at reference temperature for that RGI. Record it as TxPowerRef.
3. Change the phone's temperature to temperature index *i*. Tools such as QRCT should be used to monitor the thermistor ADC value to ensure the correct temperature. Record the Tx power at that temperature, using the same RGI, as TxPower[*i*].
4. Store the NV item element as CompOffset[*i*] = 10 × (TxPower[*i*] - TxPowerRef).
5. Repeat for all temperature indexes.
6. Average the results from several phones if desired.

Using CompOffset and CompSlope together

Using CompOffset alone, without utilizing CompSlope, assumes that the Tx power vs. RGI curve is shifted by a constant power for all RGIs. This might not be a valid assumption. More generally, the effects of temperature on the Tx power vs. RGI curve may also be a function of the Tx power. Figure 5-7 shows a graphical example of a curve that varies not only as a function of temperature, but also with Tx power. Changing temperature not only shifts the curve by an offset, but also changes the slope of the curve.

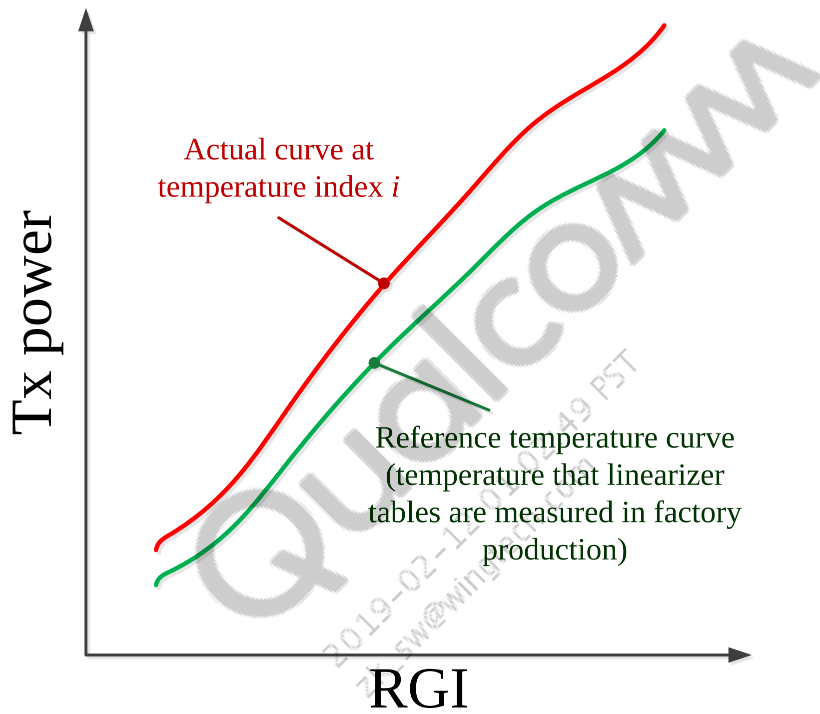


Figure 5-7 Tx power vs. RGI curve, showing slope change

NOTE: There is no single CompOffset alone that can shift the reference curve up to the actual curve. However, when using CompSlope together with CompOffset, the temperature compensation can be made to shift the reference curve correctly.

Embedded software first applies the CompSlope to the reference Tx power vs. RGI curve. The process is done by multiplying all values in the RFNV_CDMA_C2_BCy_TX_LIN_z_I by the floating point representation of CompSlope[*i*]. Two examples of how CompSlope[*i*] affects the curve are shown in Figure 5-8. Note that applying a value near 2 effectively doubles the curve's slope. Applying a value of 0.5 effectively halves the curve's slope. In all cases, the 'pivot' point is at 0 dBm.

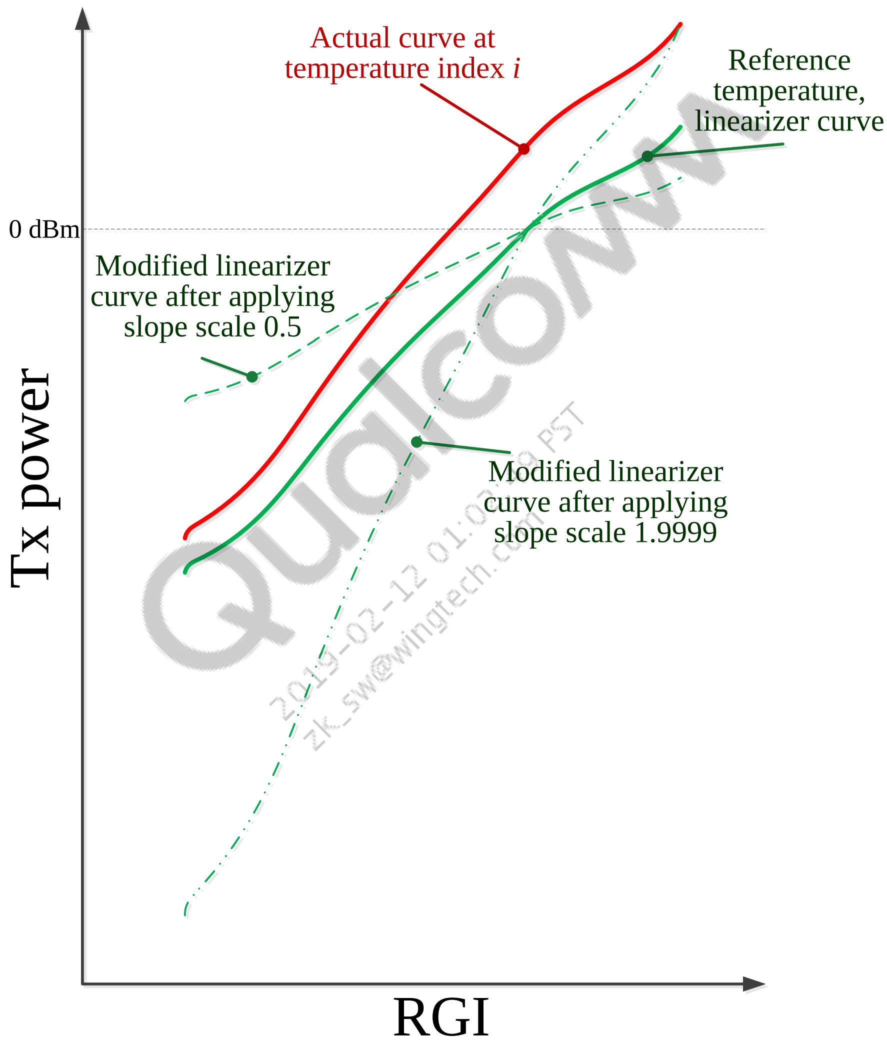


Figure 5-8 Effect of CompSlope[*i*] on effective linearizer curve

Back to the previous example, software first applies the appropriate CompSlope[*i*] to the curve, as shown in Figure 5-9. Again, note that the effect of CompSlope has little to no effect on the curve near 0 dBm, being its 'pivot' point. After the application, the modified linearizer curve and the actual curve (at temperature index *i*) differ only by a constant offset.

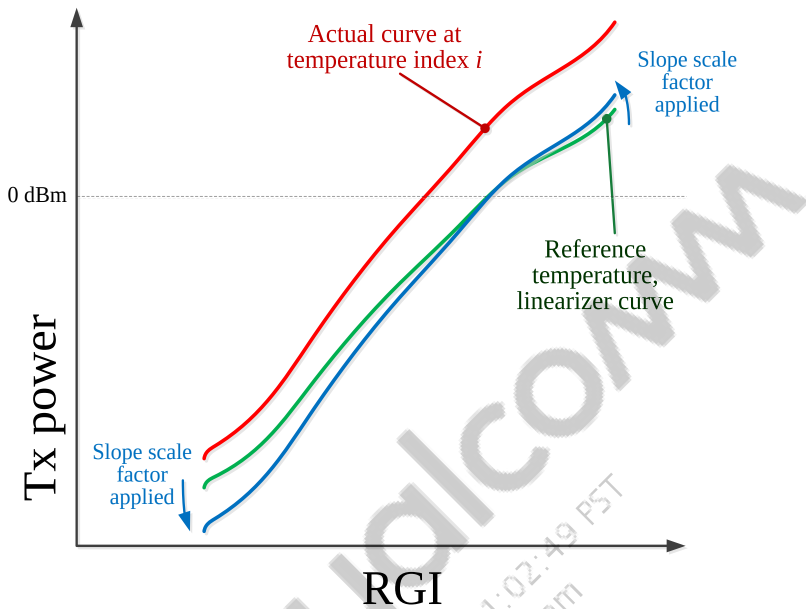


Figure 5-9 Embedded software applying CompSlope[*i*] to linearizer curve

Embedded software then simply applies the CompOffset as discussed previously. Figure 5-10 shows the application.

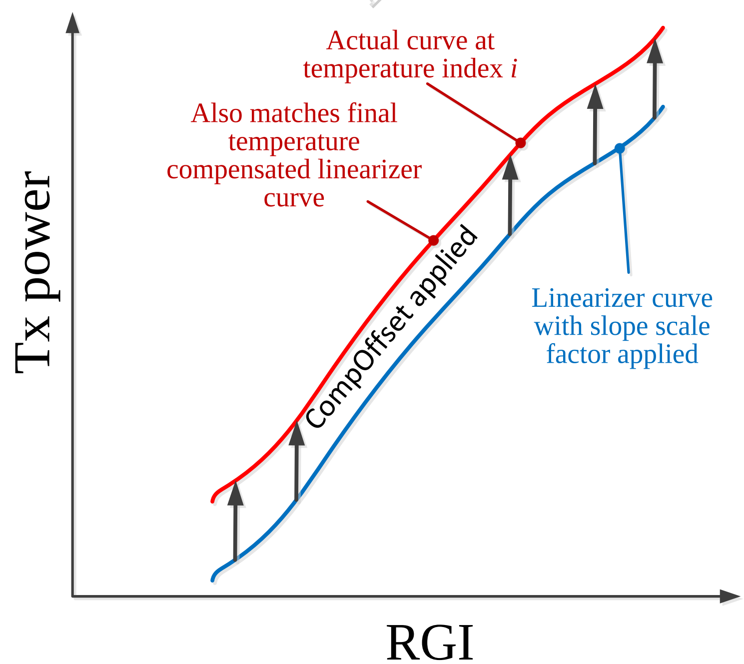


Figure 5-10 Applying both CompOffset together with CompSlope

To calibrate CompOffset together with CompSlope, the following procedure can be used. For brevity, the temperature index '[*i*]' notation is omitted in the *CompOffset* and *CompSlope* terms in the following procedure. Appropriate temperature indexes are assumed in the context.

1. Calibrate the Tx linearizer tables at normal factory temperature, as normal, such that the data is stored in the linearizer section of RFNV_CDMA_Cx_BCy_TX_MULTI_LIN_DATA_I. Pick one of the linearizer tables, used in the calibration, near the center of the band, that corresponds to the appropriate TxState state. Copy the results of the Tx power values into an array called LinRefTemp[*n*], where *n* is the element number. Copy only calibrated values into LinRefTemp[*n*] (not filler values). The index *n* ranges from 0 to as much as 63. Also copy the RGI values into a table called RGIRefTemp[*n*].
2. Change the phone's temperature to a particular temperature index. It may be useful to use QRCT to monitor the phone's thermistor ADC to ensure the correct temperature index is reached.
3. Repeat step 1 at the new temperature, except copy the values into an array called LinNewTemp[*n*] and RGINewTemp[*n*]. Ensure the "Starting RGI" ("Starting PDM" value) in the Tx Sweep Cal routine is the same as it was in the reference temperature case.
4. Create a set of simultaneous equations of the form:

   $$\text{LinNewTemp}[n] = (\text{LinRefTemp}[n] \times (\text{CompSlope}/32768)) + \text{CompOffset}$$

   where CompSlope and CompOffset are the two unknowns. There are up to 64 simultaneous equations and two unknowns. This type of system, where there are more equations than unknowns is called an *overdetermined* system.
5. Use a method such as ordinary least squares to solve for the two unknowns, CompSlope and CompOffset. A tool such as MATLAB may prove useful.
6. Repeat for all TxState states.
7. Repeat for all 8 temperature indexes.

Average the individual results over multiple phones.

5.2.1.12 NV_BCy_TX_LIM_VS_TEMP_I, RFNV_CDMA_C2_BCy_TX_LIM_VS_TEMP_I

Data type: Array of eight, uint8 elements

The NV item NV_BCy_TX_LIM_VS_TEMP_I [7:0] specifies the desired Tx power-limit threshold (based on desired output power) for each of eight temperature values, all at reference frequencies.

It may be advantageous to choose the maximum Tx power limit based on compression, ACPR, or a parameter of your Tx circuitry that is temperature dependent.

Most NV items of the form XXX_VS_TEMP contain adjustment values, or deltas, based on temperature (so that the room temperature element is 0). This is *not* the case with NV_BCy_TX_LIM_VS_TEMP_I. Each element of NV_BCy_TX_LIM_VS_TEMP_I contains the absolute power-limit information (one element for each temperature index).

For each element of NV_BCy_TX_LIM_VS_TEMP_I [7:0], choose the value so that it satisfies the following equation:

NV_BCy_TX_LIM_VS_TEMP_I [i] = ([1024/**DynamicRange]** × [DesiredPowerLimit + **MinRSSIofInterest** + **OffsetPower** + **DynamicRange**]) -1 - 768

Where DesiredPowerLimit is the desired Tx power limit, in dBm, for temperature index i. Assuming **MinRSSIofInterest** is -115 dBm, **OffsetPower** is 73, and **DynamicRange** is 102.4 dB, the above equation simplifies to:

NV_BCy_TX_LIM_VS_TEMP_I = 10 × (DesiredPowerLimit + 60.3) - 768

Where **OffsetPower** is 76, the equation simplifies to:

NV_BCy_TX_LIM_VS_TEMP_I = 10 × (DesiredPowerLimit + 63.3) - 768

As an example, if the desired Tx power limit is 24 dBm in BC0, the corresponding value for NV_BCy_TX_LIM_VS_TEMP_I is 10 × (24 + 60.3) - 768 = 76 = 0x4B.

Subtracting 768 (binary 11 0000 0000) allows the storage of each element as an 8-bit number. Software automatically adds 768 to the value read from NV and reformats the value for proper writing to the TX_GAIN_LIMIT register. The final value written to the TX_GAIN_LIMIT register is adjusted based upon NV_BCy_TX_LIM_VS_FREQ_I, feedback from the HDET circuit, and corresponding HDET-related NV items.

Ideally, all eight elements of NV_BCy_TX_LIM_VS_TEMP_I should be identical for a given band class y. However, for practical reasons, it is acceptable to make slight adjustments to the values to compensate for HDET-related temperature dependencies. If during phone development, it is found that the phone's steady-state maximum Tx power is not quite flat across temperature, adjust the values of NV_BCy_TX_LIM_VS_TEMP_I to compensate. (The term *steady-state* is important here. After initiating a call or after performing a hard handoff, wait about 30 seconds before taking measurements to make sure all Tx power transients settle.)

Element 0 represents the hottest temperature and element 7 represents the coldest. Each element corresponds to a thermistor ADC reading found in NV_THERM_BINS_I.

5.2.1.13 RFNV_CDMA_Cx_BCy_HDR_TX_PWR_LIM_DATA_I

Data type: See Table 5-17.

These NV items store the absolute maximum output allowed based on band class, channel configuration, channel number, and reverse link bandwidth. The format (for a particular pattern) is shown in Table 5-17.

Table 5-17 RFNV_CDMA_C0_BCy_HDR_TX_PWR_LIM_DATA_I format

Record name	Data type	Description	Size
bw	unit8	Indicates the reverse link bandwidth in terms of 1.25 MHz. For example, a value of 4 specifies that carriers are spread over 1.25 MHz × 4 = 5.00 MHz.	1 byte
carrier_config_pattern	uint16	Indicates how 1 or 2 or 3 carriers are spread across the 5x bandwidth. When read as a binary number in a 5-bit pattern, there cannot be more than 3 ones. The bit on the right (near or at LSB) indicates higher frequency than the ones on the left. So a pattern in terms of frequency looks like low, medium, high from left to right. For each frequency (bit) a ‘1’ indicates a carrier is present; a ‘0’ indicates a carrier is not present.	2 bytes
lowest_freq_channel	uint16	Indicates the channel with lowest frequency in kHz for the given band class.	2 bytes
highest_freq_channel	uint16	Indicates the channel with highest frequency in kHz for the given band class.	2 bytes
tx_pwr_limit_dBm10	int16	Indicates the maximum power in dBm × 10 for the given band class and carrier combination. There are 8 such entries covering 8 temperature bins.	2 bytes × 8 bins = 16 bytes
RESERVED	–	Reserved	64 bytes
Total	–	–	87 bytes

These items hold maximum power limits for 1x EV-DO (Rev 0, Rev A, Rev B) across eight temperature bins. These also hold the left and right compensations. The HDR Tx power calculations derived from this table are used in conjunction with SAR power, and the lower of the two is used in online mode operation.

Each NV item is of variable size and a multiple of 87 bytes. Each band class may have one or more combinations of patterns based on the reverse bandwidth. An entry of 0xFF or 0xFFFF indicates a wildcard. For example, a BW (in terms of 1.25 MHz) of 255 indicates the given power is applied for 1x, 2x, 3x, 4x, or 5x reverse link bandwidth, for 1 or 2 or 3 carriers. When lowest_freq_channel and highest_freq_channel are 0xFFFF, it indicates that for any valid channel and carrier combination, the given power can be applied.

5.2.1.14 RFNV_BCy_ANT_GAIN_DELTA_I

Data type: single, int16 value

This NV item only applies to platform architectures that configure the primary receive path (PRx) to use a different antenna than the transmit (Tx) path antenna (e.g., Fusion 1, RF front-end architecture 2). For architectures that use a common antenna for both the PRx and Tx, this item can be ignored.

Use this NV item to store the difference in radiated antenna gain of antenna0 relative to antenna1, in 1/10 dB resolution. For example, if the radiated gain of antenna0 is 3 dB higher than antenna1, store 30 in this NV item.

In normal operation, this NV item is used to compensate for radiated open-loop power errors due to antenna gain differences between the PRx and Tx antennas.

5.2.1.15 RFNV_CDMA1X_BCy_DO_BCz_SAR_I, and RFNV_CDMA1X_BCy_LTE_BCz_SAR_I

Data type: 5 × 2 matrix of int16 values

These NV items apply only to platforms that support simultaneous transmission of voice and data, such as simultaneous CDMA2000 1X and 1x EV-DO (SVDO); and/or simultaneous CDMA2000 1X and LTE (SVLTE).

Because there are two signals being transmitted at once, special consideration must be taken to comply with specific absorption rate (SAR) specifications.

Each SAR NV item represents a 5 × 2 matrix of int16 data type. Each entry is Tx power with 1/10 dB accuracy (e.g., 183 is 18.3 dBm). Currently there are 21 NVs, and the number of SAR NVs depends on the band combination supported by the target. The format of the items is illustrated by the following example.

<NvItem id="20000" name="RFNV_CDMA1X_BC0_DO_BC0_SAR_I" mapping="direct" encoding="dec" index="0">150,230,170,210,190,190,210,170,230,150</NvItem>

The name of the NV indicates the band combination and the purpose of the NV. This example considers the 1X and 1x EV-DO combination on the BC0 band. The 10 numerical numbers represent the matrix. Translating the above NV into a matrix, it becomes:

- 1X power EV-DO max power limit
- 15.0 dBm 23.0 dBm
- 17.0 dBm 21.0 dBm
- 19.0 dBm 19.0 dBm
- 21.0 dBm 17.0 dBm
- 23.0 dBm 15.0 dBm

Row one is read as, “If the 1X Tx power is ≥ 15 dBm but < 17 dBm, EV-DO max power limit is 23 dbm.”

There is a monotonic requirement on entering the values for SAR. The 1X Tx power column must be in non-decreasing order, and the EV-DO (or LTE) Tx power limit column must be in non-increasing order.

If the corresponding SAR NV item is not populated in NV memory, no backoff is provided for the data max power (data being EV-DO or LTE).

5.2.1.16 RFNV_CDMA1X_BCx_DO_BCz_DSI_SAR_I, RFNV_CDMA1X_BCy_LTE_Bz_DSI_SAR_I

Data type: 8 × 2 matrix of int16 values

This item effectively modifies the values in the corresponding RFNV_CDMA1X_BCx_DO_BCy_SAR_I NV item to allow adjustments based on DSI level. For the given DSI level, all the 1X voice power levels in RFNV_CDMA1X_BCx_DO_BCy_SAR_I are effectively adjusted by “bias_input.” The RFNV_CDMA1X_BCx_DO_BCy_SAR_I DO data power levels are effectively adjusted by “bias_output.” Adjustments are performed by addition.

Values are grouped in an array of eight structures; where each structure contains two int16 values. Each structure corresponds to a SAR, DSI level. Structure 0 corresponds to DSI 1, structure 1 to DSI 2, and so on up to DSI 8. Each structure contains two values. The first is “bias_input” and the second, “bias_output.” Resolution is 10 counts per dB.

5.2.1.17 RFNV_BCy_TX_LIM_VS_TEMP_SAR_LVLS, RFNV_C2_BCy_TX_LIM_VS_TEMP_SAR_LVLS

Data type: Array of 64 uint16 values

The band-specific NV items are 64-element arrays, where each DSI is defined by a contiguous block of 8 elements that replace the values for the entire 8-element NV<_CDMA_C2>_BCx_TX_LIM_VS_TEMP_I array. In the NV items below, array elements 0 to 7 specify NV<_CDMA_C2>_BCx_TX_LIM_VS_TEMP_I elements 0 to 7 for DSI 1, elements 8 to 15 specify NV<_CDMA_C2>_BCx_TX_LIM_VS_TEMP_I elements 0 to 7 for DSI 2, and so on. The mapping is illustrated below.

DSI	**1**								**2**								**3**							
Temp bin	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
NV index	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23

DSI	**4**								**5**								**6**							
Temp bin	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
NV index	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47

DSI	**7**								**8**							
Temp bin	0	1	2	3	4	5	6	7	0	1	2	3	4	5	6	7
NV index	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63

The maximum Tx power limit may be set to any power level within the calibrated Tx range. The Tx power-limit algorithm uses HDET, if present, to minimize the error in the actual power level and achieve the best accuracy. The typical error is within ±1 dB. For power-limit settings below the HDET active range (< +18 dBm), the error is typically within ±2 dB.

See the *Dynamic Maximum Tx Power Limits* document (80-VP146-8) for details.

5.2.1.18 RFNV_CDMA_Cx_BCy_TX_EPT_DPD_CONFIG_PARAMS_I

Data type: Structure of 32, uint32 values

There is one DPD configuration NV item per band to store parameters for DPD software operation. All parameter changes should be discussed with QTI. Such changes must be characterized carefully in the QTI system design, and customers are not expected to make changes.

Table 5-18 shows an example of how this NV item appears. This is an example only, refer to latest static NV release for actual value.

Table 5-18 DPD configuration NV item format (all elements are uint32 type)

Field offset	Name	Description
0	Xpt_config	3 – User default 2 – ET 1 – EPT 0 – APT
1	Exp_scale	Reserved
2	Search_Center	Tx and Rx data are correlated in the window [searchCenter-searchWidth, searchCenter+searchWidth]
3	Search_Width	
4	Q_factor	Reserved
5	Lin_Tx_Mag	Reserved
6	Pm_order	Reserved
7	EPT_Env_scale_unity	EPT envelope scale – Provides freedom to adjust the tradeoff between power and ACLR/EVM; QTI has the recommended value, which customers cannot change
8	IQ_gain_Unity	IQ_gain
9	RGI_SEL_MAX_Power	Reserved
10	RGI_SEL_offset_low_0	Reserved
11	RGI_SEL_offset_low_1	Reserved
12	RGI_SEL_offset_low_2	Reserved
13	REF_PIN_ET	Offset for ET Pin values
14	REF_PIN_EPT	Offset for EPT Pin values
15	RGI_SEL_offset_high_2	Reserved
16	DPD_CFG_EXTRAP_BIN	DPD algorithm parameters for EPT and ET
17	DPD_CFG_FIRST _BIN	DPD algorithm parameters for EPT and ET
18	DPD_CFG_MIN_BIN_COUNT	DPD algorithm parameters for EPT and ET
19	DPD_CFG_MIN_FIRST_BIN_COUNT	DPD algorithm parameters for EPT and ET
20	DPD_CFG_MIN_LAST_BIN_COUNT	DPD algorithm parameters for EPT and ET
21	DPD_CFG_RX_COMPACT	FBRX
22	DPD_CFG_SPEC_INV	DPD algorithm parameters for EPT and ET

Field offset	Name	Description
23	XPT_CFG_CMN_ENV_SCALE_ET_UNITY	ET envelope scale – Provides freedom to adjust the tradeoff between power and ACLR/EVM. QTI provides the recommended value, which cannot be changed
24	SELFTEST_CFG_SEARCH_CENTER	Correlation between Tx and Rx capture is needed in self-test EVM and VSWR processing
25	Reserved[8]	Reserved
26	Reserved[9]	Reserved
27	Reserved[10]	Reserved
28	Reserved[11]	Reserved
29	Reserved[12]	Reserved
30	Reserved[13]	Reserved
31	Reserved[14]	Reserved

Note: Use values from the appropriate, static NV, xml file distributed with the AMSS software.

5.2.1.19 NV_Cx_BCy_TX_CAL_CHAN_I

Data type: Array of 16, uint16 values

This item has been repurposed for use in TX_LIN_VS_TEMP_VS_FREQ_P_IN and TX_LIN_VS_TEMP_VS_FREQ_P_OUT characterization. It contains the list of up to 16 channels used for the characterization.

5.2.1.20 RFNV_CDMA_Cx_BCy_TX_LIN_VS_TEMP_VS_FREQ_P_IN_I

This item provides PA input power compensation offsets in a two-dimensional grid of temperature and frequency points for each Tx linearizer. The offset is described in dB10 units, and is calculated by software through bi-linear interpolation across temperature and frequency points with known values. The item is associated with eight temperature bins provided by NV_THERM_BINS_I and up to 16 frequencies of interest provided by the NV_Cx_BCy_TX_CAL_CHAN_I channel list.

The pin compensation values are characterized across the range of channels and temperature bins. The characterization provides how far the applied pin is from the desired pin, for optimal spurious emissions at a specific temperature and frequency of operation.

For example, the pin compensation at room temperature and at reference frequency (centerband) is assumed to be zero. If for the same RGI, at temperature T1 and frequency F1, the desired pin compensation is 0.6 dB higher for optimal ACPR, then the NV item should contain a value of -6 at T1, F1. That is,

NV value = current Pin – desired Pin

= 0 – 6 = -6 dB10

This NV item is used for frequency and temperature compensation in PA power input for each PA state (R0, R1, R2, and R3). Each PA state has its frequency offset value for each of eight temperature index values, all relative to reference frequencies. The data is from PinPout alignment characterization. See *Application Note: QFE1100 xPT Software Design Guide* (80-NG201-2) for details about the characterization procedure. The format is shown in Table 5-19.

Table 5-19 RFNV_CDMA_Cx_BCy_TX_LIN_VS_TEMP_VS_FREQ_P_IN_I format

Type			Data	Size
Reserved			Stores 0 in this byte	uint8
PA_State[0]	Temp[0]	Freq[0]	Offset value in maximum temperature of interest, frequency index 0	int16
		…	…	…
		Freq[15]	Offset value in maximum temperature of interest, frequency index 15	int16
	Temp[1]	Freq[0]	Offset value in temperature index 1, frequency index 0	int16
		…	…	…
		Freq[15]	Offset value in temperature index 1, frequency index 15	int16
	Temp[2]	Freq[0]	Offset value in temperature index 2, frequency index 0	int16
		…	…	…
		Freq[15]	Offset value in temperature index 2, frequency index 15	int16
	…	…	…	…
	Temp[7]	Freq[0]	Offset value in temperature index 7, frequency index 0	int16
		…	…	…
		Freq[15]	Offset value in temperature index 7, frequency index 15	int16
PA_State[1]	…	…	…	…
PA_State[2]	…	…	…	…
PA_State[3]	…	…	…	…

5.2.1.21 RFNV_CDMA_Cx_BCy_TX_LIN_VS_TEMP_VS_FREQ_P_OUT_I

This item provides Tx output power compensation offsets in a two-dimensional grid of temperature and frequency points for each Tx linearizer. The offset is described in dB10 units, and is calculated in software through bi-linear interpolation across temperature and frequency points with known values. The item is associated with eight temperature bins provided by NV_THERM_BINS_I and up to 16 frequencies of interest provided by the NV_Cx_BCy_TX_CAL_CHAN_I list.

The statically characterized Pout offset is provided relative to the calibrated lin vs. frequency Pout offset, across the range of calibration channels and temperature bins. Characterization provides how far the measured Pout is from the desired Pout, at a specific temperature and frequency of operation.

For example, the Pout measured at room temperature (T0) and at reference frequency (F0, centerband) is assumed to have zero offset from the calibration. If for the same RGI, at temperature T1 and frequency F1, the measured Pout (after pin compensation) is 0.6 dB higher, then the NV item should contain a value of 6 at T1, F1. That is,

NV value = measured Pout – Pout at T0, F0

= 246 – 240 = 6 dB10

This NV item is used for frequency and temperature compensation in PA power output for each PA state (R0, R1, R2, and R3). Each PA state has its frequency offset value for each of eight temperature index values, all relative to reference frequencies. The data is from PinPout alignment characterization. Refer to *QFE1100 xPT Software Design Guide* (80-NG201-2) for details of the characterization procedure. The format is shown in Table 5-20.

Table 5-20 RFNV_CDMA_Cx_BCy_TX_LIN_VS_TEMP_VS_FREQ_P_OUT_I format

Type			Data	Size
Reserved			Store 0 in this byte	uint8
PA_State[0]	Temp[0]	Freq[0]	Offset value in maximum temperature of interest, frequency index 0	int16
		…	…	…
		Freq[15]	Offset value in maximum temperature of interest, frequency index 15	int16
	Temp[1]	Freq[0]	Offset value in temperature index 1, frequency index 0	int16
		…	…	…
		Freq[15]	Offset value in temperature index 1, frequency index 15	int16
	Temp[2]	Freq[0]	Offset value in temperature index 2, frequency index 0	int16
		…	…	…
		Freq[15]	Offset value in temperature index 2, frequency index 15	int16
	…	…	…	…
	Temp[7]	Freq[0]	Offset value in temperature index 7, frequency index 0	int16
		…	…	…
		Freq[15]	Offset value in temperature index 7, frequency index 15	int16
PA_State[1]	…	…	…	…
PA_State[2]	…	…	…	…
PA_State[3]	…	…	…	…

5.2.1.22 RFNV_CDMA_Cx_BCy_TX_XPT_DPD_SCALING_I

Data type: Variant Type, see Table 5-21.

This NV stores scaling factors for AMPM for each channel in the given band. Scaling value in NV equals scaling factor from characteriation times 1000.

Table 5-21 RFNV_<tech>_<chain>_<band>_TX_XPT_DPD_SCALING_I

Element number	Element name	What is stored	Size
0	version	Version of the NV item	Single, uint16 value
	number of elements	The value of N, the total number of elements in this table, excluding Varient_Marker (see the bottom left corner of this table for N).	Single, uint16 value
1	datatype	113	Single, uint16 value
	Element data	RFNV_DATA_TYPE_ID_XPT_DPD_SCALING_V1	Array of 16, int32

5.2.1.23 RFNV_CDMA_Cx_BCy_PRED_CLIP_POWER_THRESH_I

Data type: See Table 5-23

This NV item stores the parameter used for enabling/disabling the predictive clipper dynamically based on the TxAGC power level. This NV gives users the configurability so that they can only allow the desired power levels to be affected by the predictive clipper. If the NV is not active, the software falls back to the default power thresholds—enable predictive clipping for Tx power above 21.5 dBm, and disable predictive clipping for Tx power below 19.5 dBm.

The format of the NV is in Table 5-23.

Table 5-22 RFNV_CDMA_Cx_BCy_PRED_CLIP_POWER_THRESH_I

Name	Size	Description
Reserved	uint8	Reserved for future use
Enable	int16	Enable Power Threshold in dBm10
Disable	int16	Disable Power Threshold in dBm10

5.2.2 Calibrated, Tx RF NV items

5.2.2.1 RFNV_CDMA_Cx_BCy_TX_MULTI_LIN_V3_DATA_I

This NV item contains the multi-linearizer ET feature of the RF driver. It allows independent XPT (XPT stands for APT/EPT/ET) curves to be used for different regions of channels within a band. Thus, NV items and calibration software contains certain changes. Table 5-23 summarizes all elements, including those that are added. As with the multi-linearizer V2 NV item, there is one multi-linearizer V3 NV item per band. Refer to *QFE1100 xPT Software Design Guide* (80-NG201-2) for more information on calibrating this NV item. The general format is defined in Table 5-23 and is shown in Figure 5-11.

Table 5-23 TX_MULTI_LIN_V3_DATA general format

Element number	Element name	Subelement	What is stored	Size
0	Varient_Marker	Version	Version of NV item	Single uint16 value
		Number of elements	The value of N, the total number of elements in this table, excluding Varient_Marker (see the bottom left corner of this table for N).	Single uint16 value
1	<variable, depends on block type>	datatype	100, 101, 102, 104, 105, or 111. This value determines the block type.	uint16
		Element data	<variable, depends on block type>	<variable, depends on block type>
2	<variable, depends on block type>	datatype	100, 101, 102, 104, 105, or 111. This value determines the block type.	uint16
		Element data	<variable, depends on block type>	<variable, depends on block type>
…	…	…	…	…
N - 1	<variable, depends on block type>	datatype	100, 101, 102, 104, 105, or 111. This value determines the block type.	uint16
		Element data	<variable, depends on block type>	<variable, depends on block type>
N	<variable, depends on block type>	datatype	100, 101, 102, 104, 105, or 111. This value determines the block type.	uint16
		Element data	<variable, depends on block type>	<variable, depends on block type>

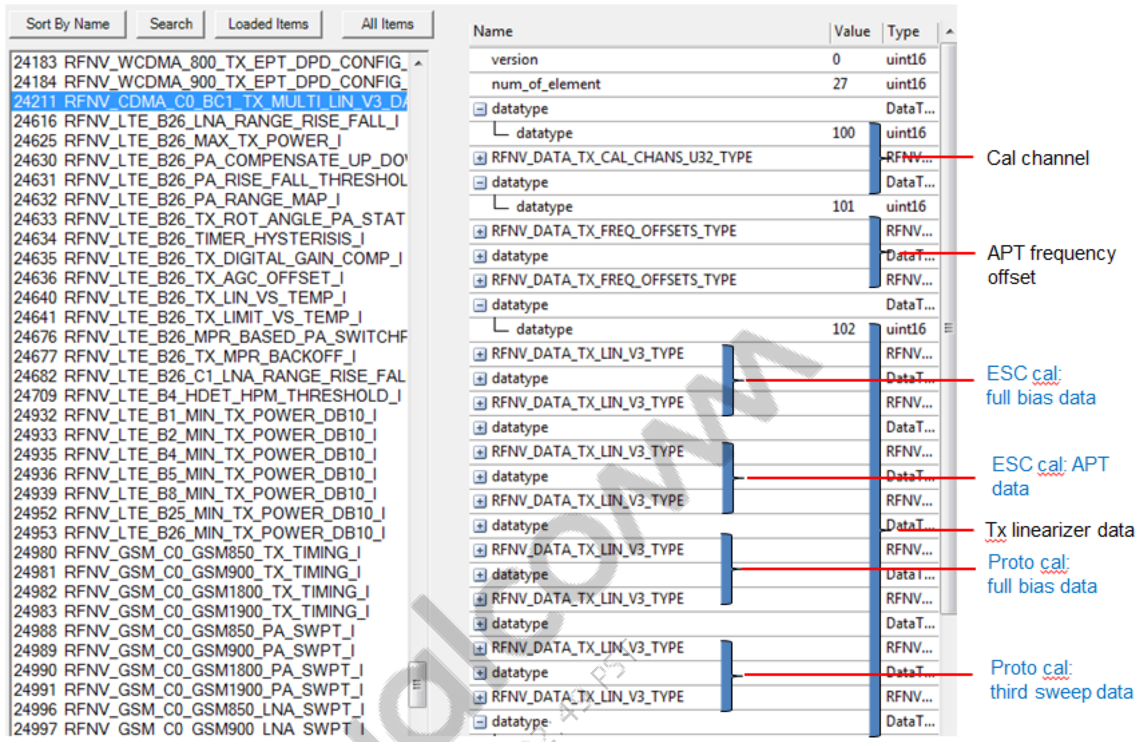


Figure 5-11 TX_MULTI_LIN_V3_DATA general format

Table 5-24 shows the supported block types (datatypes).

Table 5-25Table 5-25 through Table 5-30 describe the format of each block type.

Table 5-24 Supported block types

Block (stored in the datatype subelement)	Type
100	TX_CAL_CHANS_U32_TYPE
101	TX_FREQ_OFFSETS_TYPE
102	TX_LIN_V3_TYPE
104	TX_EPT_DPD_V2_TYPE
105	TX_ET_DPD_TYPE
111	LIN_TEMP_ADC_TYPE

Table 5-25 TX_CAL_CHANS_U32_TYPE (block type 100) element data format

Data	Size
Array of 16 Tx calibration channel list. This is the channel list used for frequency compensation.	16 uint32 values

Table 5-26 TX_FREQ_OFFSETS_TYPE (block type 101) element data format

Element	Data	Size
pa_state	▪ CDMA/WCDMA ▫ PA state 0, 1 – APT ▫ PA state 2 – EPT ▫ PA state 3 – ET ▪ LTE ▫ PA state 0 – ET ▫ PA state 1 – EPT ▫ PA state 2, 3 – APT	uint8
fcomp_sweep_type	▪ 0 – XPT full bias ▪ 1 – XPT third sweep	uint8
fcomp_index	FreqComp mapping table index ▪ 0 – APT ▪ 0 to 3 EPT/ET	uint16
freq_offsets	Array of 16 Tx calibration channels	16 int8 values

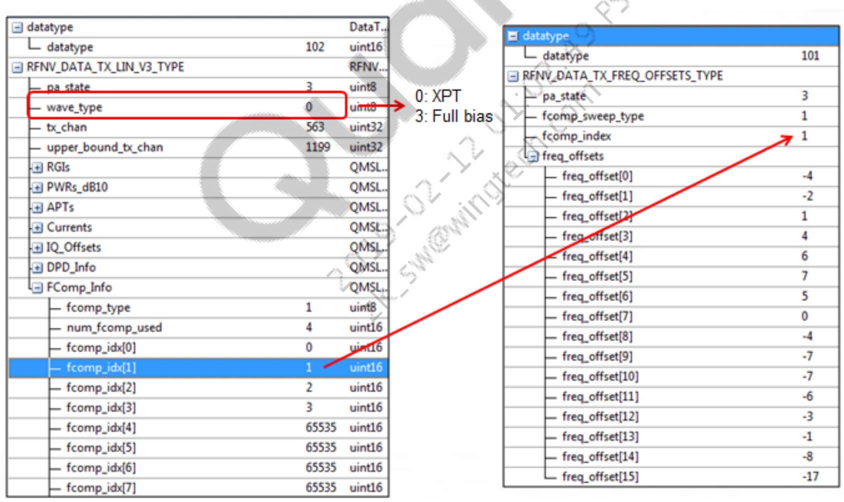


Table 5-27 TX_LIN_V3_TYPE (block type 102) element data format

Element	Data	Size
pa_state	▪ CDMA/WCDMA ▫ PA state 0, 1 – APT ▫ PA state 2 – EPT ▫ PA state 3 – ET ▪ LTE ▫ PA state 0 – ET ▫ PA state 1 – EPT ▫ PA state 2, 3 – APT	uint8
wave_type	▪ XPT: 0 ▪ LTE XPT: 1 ▪ Full bias: 3	uint8

Element		Data	Size
tx_chan		Reference channel	uint32
upper_bound_chan		Upper bound channel	uint32
RGI		Array of 64 RGI values	64 uint16 values
PWRs_db10		Array of 64 power levels, in dBm10 format (dBm × 10)	64 int16 values
APTs		Array of 64 APT values	64 uint32 values
Currents		Array of 64 ICQ (PA current) values. Each ICQ element is two bytes.	64 uint16 values
IQ_Offset		Array of 64 IQ offset values. Each IQ offset element is two bytes.	64 uint16 values
DPD_info	Idpd_type_used	Use to recognize EPT DPD or ET DOD ▪ 0 – First sweep ▪ 2 – EPT third sweep ▪ 3 – ET third sweep	uint8
	num_dpd_used	▪ 0 – First sweep ▪ 4 – EPT/ET third sweep	uint16
	dpd_idx	Array of 64; DPD element is 2 bytes DPD index is maintained in the linearizer and must match the indices in the DPD data that follows. This is the mechanism to link the DPD data to a particular linearizer row.	Array of 64 uint16 values
FComp_Info	fcomp_type	Use to recognize sweep 1 or sweep 3 ▪ 0 – XPT full bias ▪ 1 – XPT third sweep	uint8
	num_fcomp_used	▪ 1 – XPT full bias ▪ 1 – APT ▪ 4 – EPT/ET	uint16
	fcomp_idx	Fcomp index is maintained in the linearizer and must match the indices in the frequency offset table. This is the mechanism to link the frequency offset data to a particular linearizer row. Unused elements need to be populated with maximum value of its type (e.g., uint16 type is 0xFFFF). ▪ Array of 64 ▪ APT: number of index depends on number of RGI in APT mode ▪ XPT full bias: number of index depends on number of RGI in first sweep ▪ EPT: idx[0] to idx[7] ▪ ET: idx[0] to idx[3]	Array of 64 uint16 values

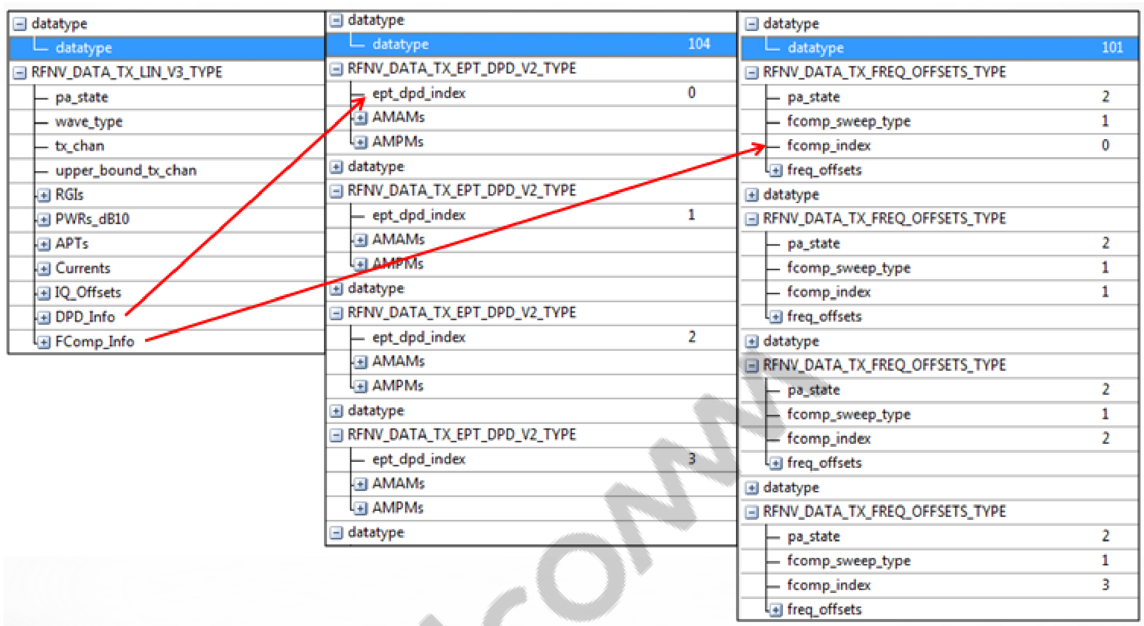


Table 5-28 TX_EPT_DPD_V2_TYPE (block type 104) element data format

Element	Data	Size
ept_dpd_index	EPT DPD mapping table index: 0 to 3	uint16
AMAM	Array of 16 AMAM coefficients Each AMAM element is 2 bytes.	16 uint32 values
AMPM	Array of 16 AMPM coefficients Each AMPM element is 2 bytes.	16 int32 values

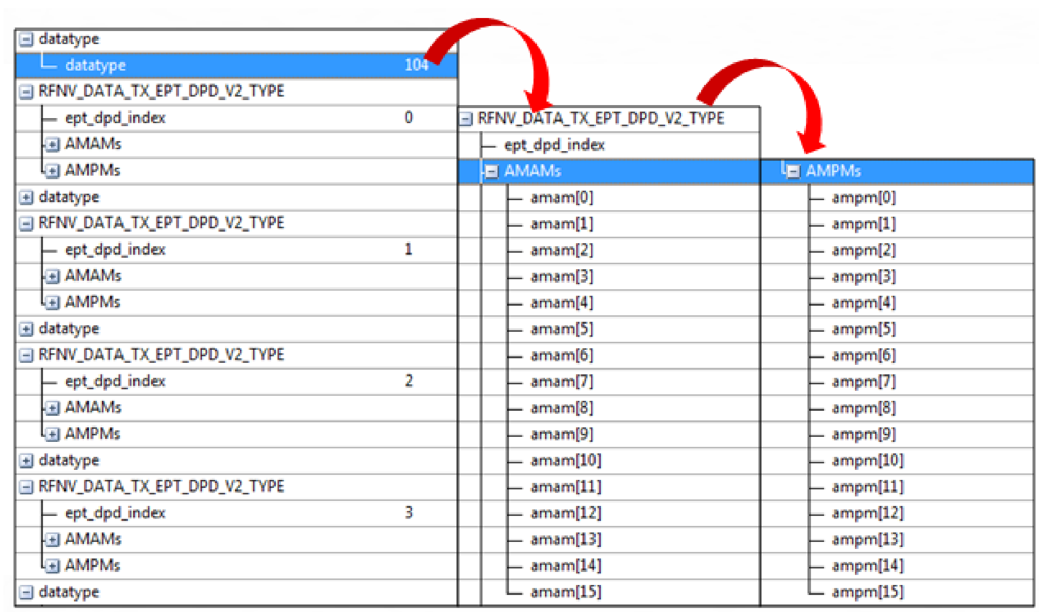


Figure 5-12 EPT DPD table format

Table 5-29 TX_ET_DPD_TYPE (block type 105) element data format

Element	Data	Size
et_dpd_index	ET DPD mapping table index: 0 to 3	uint16
AMAM	Array of 16 AMAM coefficients. Each AMAM element is 2 bytes.	16 uint32 values
AMPM	Array of 16 AMPM coefficients. Each AMPM element is 2 bytes.	16 int32 values
EPDT	Array of 16 EPDT coefficients. Each EPDT element is 2 bytes.	16 uint32 values

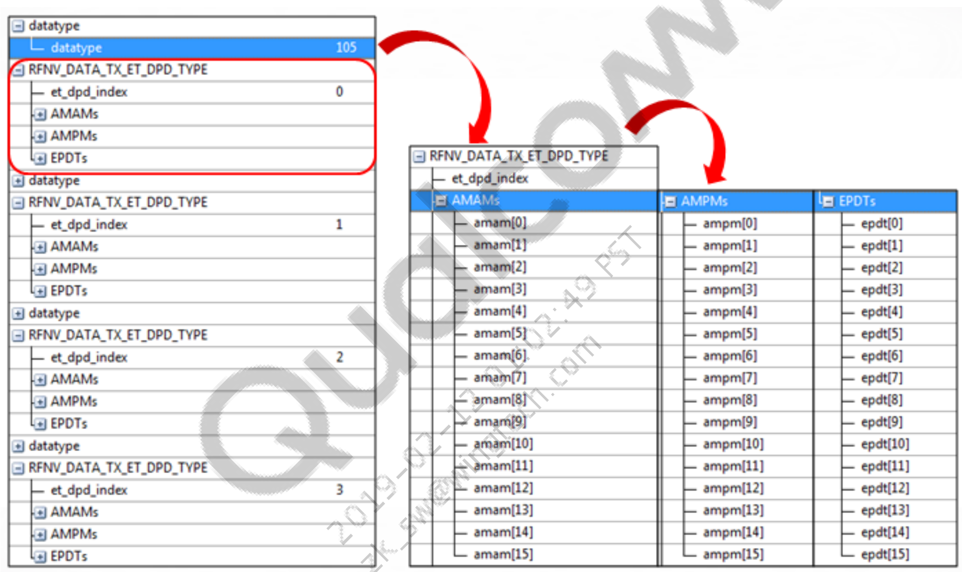


Figure 5-13 ET DPD table format

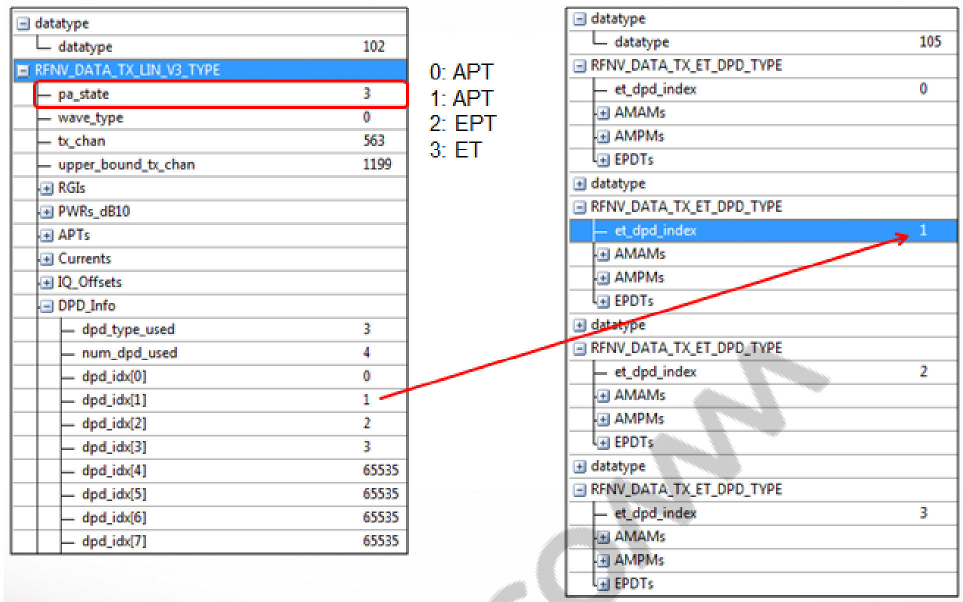


Figure 5-14 DPD index mapping

Table 5-30 LIN_TEMP_ADC_TYPE (block type 111) element data format

Element	Data	Size
Temperature_ADC	Array of eight temperature ADC values used for FreqComp	Eight uint16 values

5.2.2.2 NV_BCy_TX_LIM_VS_FREQ_I, RFNV_CDMA_C2_BCy_TX_LIM_VS_FREQ_I

Data type: Array of 16, int8 values

The purpose of calibrating this item is to establish a relationship of Tx power variation over frequency channel, for a given HDET reading. This NV item effects the phone's steady-state, maximum Tx power variation over frequency channel.

The NV item NV_BCy_TX_LIM_VS_FREQ_I contains a table of 16 adjustment values of Tx power level, based on frequency. The steady-state Tx power limit is based on the feedback from the HDET circuit. Because the relationship between the ADC readings of the HDET circuit and the corresponding Tx power level may have some frequency dependencies, this NV item can be used to compensate for such dependencies.

Conceptually, this NV item represents the overall Tx power change across frequency, where the Tx power level is adjusted at each frequency (via RGI) to produce a common HDET reading. PowerRef is the Tx power used to produce a given HDET reading at the reference frequency. Power[i] is the Tx power at each frequency index ‘i,’ which produces the same HDET reading:

NV_BCy_TX_LIM_VS_FREQ_I [i] = (PowerRef **-** Power[i]) × (1024/**DynamicRange**).

If **DynamicRange** is 102.4 dB, then the above function simplifies to:

NV_BCy_TX_LIM_VS_FREQ_I [i] = (PowerRef **-** Power[i]) × 10.

However, given the coarse RGI resolution and due to the discontinuities in the device’s Tx power vs. RGI curve, it is not practical to use the straightforward approach of calibrating this NV item. Furthermore, such a search operation is not compatible with using the preferred *Enhanced Sweep* calibration. The recommended calibration approach is as follows. Although it is less straightforward, it is more practical and faster.

To calibrate this NV item use the following procedure:

1. For each frequency index i, measure the HDET reading and the corresponding Tx power level, at a specific RGI (a.k.a. Tx AGC PDM value), with the PA in its high-gain state. The RGI used should be such that the Tx power level is near, or moderately below, the desired maximum Tx power at reference frequency. The RGI used can be constant across all i. Record the data as HDETReading[i], and the power as Power[i].
2. At each frequency index i, interpolate HDETReading[i] into the raw data obtained in the enhanced sweep (which is also used to produce NV_BCy_EXP_HDET_VS_AGC_V2_I and RFNV_CDMA_Cx_BCy_TX_MULTI_LIN_DATA_I). The raw data contains a list of HDET readings for known Tx power levels (at reference frequency). Interpolate HDETReading[i] between two HDET elements of the raw data to obtain a calculated power level. Record that as ExpPower[i].
3. Record the NV item so that:

   NV_BCy_TX_LIM_VS_FREQ_I [i] = (ExpPower[i] - Power[i]) × 10.

The element value corresponding to the reference frequency should be approximately 0.

5.2.2.3 NV_BCy_EXP_HDET_VS_AGC_V2_I, RFNV_CDMA_C2_BCy_EXP_HDET_VS_AGC_V2_I

Data type: Array of 16, uint16 values

Valid range: 0 to 4095

AMSS software uses this NV item to build a lookup table that indexes Tx power estimation via a scaled RGI (representing the desired Tx power) to the associated HDET circuit values at reference temperature and the reference frequency.

The straightforward approach to calibrating this item is described here. Break up the upper 1/4 of Tx dynamic range into 16 segments. For example, for low bands, the Tx dynamic range is from -60.4 to 42.0 dBm. The 16 segments associated with NV_BCy_EXP_HDET_VS_AGC_V2_I range from 16.4 to 42 dBm (16.4, 18, 19.6, 21.2, 22.8, 24.4, 26, 27.6, 29.2, 30.8, 32.4, 34, 35.6, 37.2, 38.8, and 40.4). For high bands, the Tx dynamic range is from -63.4 to 39 dBm. The 16 segments associated with NV_BCy_EXP_HDET_VS_AGC range from 13.4 to 39 dBm (13.4, 15, 16.6, 18.2, 19.8, 21.4, 23, 24.6, 26.2, 27.8, 29.4, 31, 32.6, 34.2, 35.8, and 37.4). Vary the desired Tx power by adjusting the Tx AGC PDM so that the Tx output power corresponds to the proper power level for each index. Read the value of the HDET ADC for each index and store in NV_BCy_EXP_HDET_VS_AGC_V2_I [15:0], extrapolating data for the higher power levels. (It may not practical to take measurements for extremely high Tx power levels.)

However, it is not recommended to use the straightforward approach to calibrate this NV item. The measurements for this NV item can be easily gathered as part of the enhanced sweep calibration, which is much faster. The FTM command produces a relationship between measured Tx power levels and their associated HDET readings. Use interpolation to create a list of HDET values associated with the specified power levels listed in the above paragraph. Once created, store those HDET values (generated using interpolation) in this NV item.

5.2.2.4 NV_BCy_HDET_OFF_V2_I, RFNV_CDMA_C2_BCy_HDET_OFF_V2_I

Data type: uint16 value

This NV item contains the HDET ADC reading that corresponds to approximately the desired Tx limit power minus 6 dB. For example, if the desired maximum power limit is 24 dBm, this value corresponds to the HDET reading when the Tx power is 24 - 6 = 18 dBm.

Conceptually, this NV item can be calibrated by adjusting the RGI, at reference frequency, until the Tx power is 6 dB below the desired maximum Tx power limit, then reading the HDET and storing the value in this NV item.

However, due to the discontinuities in the device's Tx power vs. RGI curve, using the straightforward approach of calibrating this NV item is not recommended. The straightforward approach would require searching for a desired Tx power level while varying the RGI. The discontinuities in the Tx power vs. RGI curve makes this approach impractical. The recommended calibration approach is as follows. Although it is less straightforward, it is more practical and faster.

To calibrate this NV item:

1. Interpolate the desired maximum Tx power - 6 dB into the raw data obtained in the Enhanced sweep calibration (which is also used to produce NV_BCy_EXP_HDET_VS_AGC_V2_I and RFNV_CDMA_Cx_BCy_TX_MULTI_LIN_DATA_I). The raw data contains a list of HDET readings for known Tx power levels (at reference frequency). Interpolate this power level (6 dB below max Tx power) between two known power level elements of the raw data to obtain a calculated HDET reading.
2. Record the calculated HDET reading in NV_BCy_HDET_OFF_V2_I.

In normal online mode operation, this NV item only affects the maximum Tx power in extreme circumstances; circumstances that should not happen often (if ever) in a well-calibrated phone. However, NV_BCy_HDET_OFF_V2_I is still useful as a failsafe, in case such extreme conditions arise. If the HDET reading is below NV_BCy_HDET_OFF_V2_I (after being automatically compensated for frequency channel per AMSS software algorithms), and the phone is currently limiting the maximum Tx power, the power limit is immediately raised. In a well-calibrated phone, this should rarely happen.

5.2.2.5 NV_BCy_HDET_SPN_V2_I, RFNV_CDMA_C2_BCy_HDET_SPN_V2_I

Data type: uint16 value

This NV item contains the HDET ADC reading that corresponds to approximately the desired Tx limit power plus 2 dB, minus NV_BCy_HDET_OFF_V2_I. For example, if the desired maximum power limit is 24 dBm, this value corresponds to the HDET reading when the Tx power is 24 + 2 = 26 dBm. Subtract NV_BCy_HDET_OFF_V2_I from this HDET reading and store it in NV_BCy_HDET_SPN_V2_I.

Conceptually, this NV item can be calibrated by modifying the RGI, at reference frequency, until the Tx power is 2 dB above the desired maximum Tx power limit, then reading the HDET, subtracting NV_BCy_HDET_OFF_V2_I, and storing the value in this NV item.

However, due to the discontinuities in the device's Tx power vs. RGI curve, it is not recommended that the straightforward approach of calibrating this NV item be used. The straightforward approach would require searching for a desired Tx power level while varying the RGI. The discontinuities in the Tx power vs. RGI curve could make such a search operation impractical. The recommended calibration approach is given below. Although it is less straightforward, it is more practical and faster.

To calibrate this NV item:

1. Interpolate the desired maximum Tx power + 2 dB into the raw data obtained in the enhanced sweep calibration (which is also used to produce NV_BCy_EXP_HDET_VS_AGC_V2_I and RFNV_CDMA_Cx_BCy_TX_MULTI_LIN_DATA_I). The raw data contains a list of HDET readings for known Tx power levels (at reference frequency). Interpolate this power level (corresponding to 2 dB above max Tx power) between two known power level elements of the raw data to obtain a calculated HDET reading.
2. Subtract NV_BCy_HDET_OFF_V2_I from the calculated HDET reading.
3. Store the result in NV_BCy_HDET_SPN_V2_I.

In normal online mode operation, this NV item only affects the maximum Tx power in extreme circumstances – circumstances that should not happen often (if ever) in a well-calibrated phone. However, NV_BCy_HDET_SPN_V2_I is still useful as a failsafe, in case such extreme conditions arise. If the HDET reading is above NV_BCy_HDET_OFF_V2_I + NV_BCy_HDET_SPN_V2_I (after being automatically compensated for frequency channel per AMSS software algorithms), the maximum Tx power limit is immediately lowered. In a well-calibrated phone, this should rarely happen.

5.2.2.6 RFNV_CDMA_Cx_BCy_TX_EXP_LPM_HDET_I

This NV item stores the HDET vs. Tx power curve for the lower power mode (LPM) power detection circuit (HDET). The format of the item is described in Table 5-31.

Table 5-31 RFNV_CDMA_C0_BCy_TX_EXP_LPM_HDET_I format

Field	Data type	Description	Size
LPM_enable	uint8	Flag indicating if LPM is to be used	1 byte
LPM_offset	uint16	Specifies the ADC reading corresponding to the lower boundary of the LPM HDET feedback loop range	2 bytes
LPM_span	unit16	Specifies the ADC reading corresponding to the upper boundary of the LPM HDET feedback loop range, minus LPM_offset	2 bytes
LPM_threshold	uint16	Defines the switching threshold between LPM and normal power mode HDET	2 bytes
LPM_exp_hdet_vs_agc_tbl	uint16	Starting power (dBm10 units)	17 × 2 bytes = 34 bytes
	16 × uint16	HDET values	
Total	–	–	41 bytes

A more detailed description of each field appears below.

- LPM_enable: This Boolean-like field is used to enable the usage of the LPM HDET. A 0 setting prevents usage of the LPM HDET feedback loop. A value of 1 enables the LPM usage. Note that this item is disabled by default (i.e., if the NV item is unpopulated) meaning that under all conditions, the normal (high) Power mode (HPM) power detector is only available.
- LPM_offset: This NV item represents the lowest LPM HDET ADC reading for the transmit power limiting loop. Typically this is the HDET ADC reading that corresponds to the LPM_threshold power minus 7 dB (roughly). For example, if the desired LPM_threshold is 18 dBm, then the power level corresponding to LPM_offset is typically 18 - 7 = 11 dBm. The associated LPM_offset power should be above the highest PA_Rz_RISE switch point. Interpolate the data from the *Tx Sweep Cal* routine to find the ADC reading corresponding to the desired power level.
- LPM_span: This NV item represents the highest LPM HDET ADC reading for the transmit power limiting loop. Typically this is the HDET ADC reading that corresponds to the LPM_threshold power plus 3 dB (roughly); minus LPM_offset. For example, if the desired LPM_threshold is 18 dBm, then the power level corresponding to LPM_span is typically 18 + 3 = 21 dBm. Interpolate the data from the *Tx Sweep Cal* routine to find the ADC reading corresponding to the desired power level. LPM_offset + LPM_span = ADC reading that corresponds to the LPM threshold power plus roughly 3 dB.

- LPM_threshold: The LPM_threshold is the value used by AMSS to determine whether the HPM or LPM is to be used. The selection of this value must avoid operating at the noise floor of the power detector during HPM as well as avoid saturating the power detector during LPM. LPM_threshold is represented in dBm10 units. For example, to set the LPM_threshold to 18 dBm, store 18 × 10 = 180.
- LPM_exp_hdet_vs_agc_tbl: This table stores the HDET data vs. Tx power at reference frequency.
  - Index 0: This element stores the Tx power level associated with the ADC value stored in index 1, in dBm10 units. This is the lowest Tx output power level for which HDET AGC is characterized in low-power mode, and this shall be stored in 16-bit signed 2’s complement format. For example, if the power level is 9 dBm, store 9 × 10 = 90. As another example, if the power level is -2 dBm, store -2 × 10 = -20, in 2’s complement format, 0xFFEC.
  - Indices 1 to 16: The value of index 1 is the HDET reading associated with the Tx power level stored in index 0. Subsequent HDET ADC readings stored at indices 2 through 16 correspond to monotonically increasing Tx output power level in 1.6 dB steps. Interpolation and extrapolation from the *Tx Sweep Cal* data can be used to determine the HDET ADC values.

LPM HDET data is gathered along with the normal power mode HDET data during the FTM *Tx Sweep Cal* procedure. Besides enabling the LPM data gathering, and post-processing the data for NV storage, no extra calibration procedures are necessary.

5.2.2.7 RFNV_CDMA_Cx_<band>_PIN_CAL_VS_FREQ _I

Data type: Array of 8*16, int16 values

See Section 6.2.2.4.

6 WCDMA RF NV items

This chapter describes WCDMA Rx RF NV items. These descriptions apply to all WCDMA bands. Table 6-1 lists examples of the naming convention of the NV items for band classes and RF paths.

Table 6-1 NV item band classes

Band	Name and frequency	Example NV name	Diversity
1	UMTS 2100 or IMT	NV_WCDMA_IM_LEVEL_I	NV_C1_WCDMA_2100_IM_LEVEL_I
2	UMTS 1900	NV_WCDMA_1900_IM_LEVEL_I	NV_C1_WCDMA_1900_IM_LEVEL_I
9	UMTS 1800	NV_WCDMA_1800_IM_LEVEL_I	NV_C1_WCDMA_1800_IM_LEVEL_I
4	AWS	NV_WCDMA_BC4_IM_LEVEL_I	NV_C1_WCDMA_BC4_IM_LEVEL_I
5/6	UMTS 850/UMTS 800	NV_WCDMA_800_IM_LEVEL_I	NV_C1_WCDMA_800_IM_LEVEL_I
8	UMTS 900	NV_WCDMA_900_IM_LEVEL_I	NV_C1_WCDMA_900_IM_LEVEL_I

6.1 WCDMA Rx RF NV items

6.1.1 Static, Rx RF NV items

6.1.1.1 NV_<C1_>WCDMA<band>_LNA_RANGE_RISE_I

Data type: int16 value

This NV item specifies the Rx power level threshold for which the LNA/mixer is intended to switch from gain state 0 to gain state 1. The resolution of this NV item is 10 counts per dB.

NV_WCDMA_LNA_RANGE_RISE_I = (1023/DynamicRange) × (rise_level_in_dBm - [MinRSSIofInterest + DynamicRange/2])

If DynamicRange = 102.3 dB and MinRSSIofInterest = -106 dBm, the above equation simplifies to:

NV_WCDMA_LNA_RANGE_RISE_I = 10 × (rise_level_in_dBm + 106) - 512.

6.1.1.2 NV_<C1_>WCDMA<band>_LNA_RANGE_RISE_2_I

Data type: int16 value

This NV item specifies the Rx power level threshold for which the LNA/mixer is intended to switch from gain state 1 to gain state 2. The resolution of this NV item is 10 counts per dB.

6.1.1.3 NV_<C1_>WCDMA<band>_LNA_RANGE_RISE_3_I

Data type: int16 value

This NV item specifies the Rx power level threshold for which the LNA/mixer is intended to switch from gain state 2 to gain state 3. The resolution of this NV item is 10 counts per dB.

6.1.1.4 NV_<C1_>WCDMA<band>_LNA_RANGE_FALL_I

Data type: int16 value

This NV item specifies the Rx power level threshold for which the LNA/mixer is intended to switch from gain state 1 to gain state 0. Note that only 10 bits out of the possible 16 bits are used; thus, this item has a resolution of 10 counts per dB or 1023/102.3.

NV_WCDMA_LNA_RANGE_FALL_I = (1023/DynamicRange) × (fall_level_in_dBm - [MinRSSIofInterest + DynamicRange/2])

If DynamicRange = 102.3 dB and MinRSSIofInterest = -106 dBm, the above equation simplifies to:

NV_WCDMA_LNA_RANGE_FALL_I = 10 × (fall_level_in_dBm + 106) - 512

Refer to the static RFNV file (xml and qcn) shipped with the latest software release

6.1.1.5 NV_<C1_>WCDMA<band>_LNA_RANGE_FALL_2_I

Data type: int16 value

This NV item specifies the Rx power level threshold for which the LNA/mixer is intended to switch from gain state 2 to gain state 1. Note that only 10 bits out of the possible 16 bits are used; thus, this item has a resolution of 10 counts per dB or 1024/102.4.

6.1.1.6 NV_<C1_>WCDMA<band>_LNA_RANGE_FALL_3_I

Data type: int16 value

This NV item specifies the Rx power level threshold for which the LNA/mixer is intended to switch from gain state 3 to gain state 2. Note that only 10 bits out of the possible 16 bits are used; thus, this item has a resolution of 10 counts per dB or 1024/102.4.

6.1.1.7 NV_WCDMA<band>_HS_LNA_RANGE_RISE_<#_>I, NV_WCDMA<band>_HS_LNA_RANGE_FALL_<#_>I

The descriptions of these NV items are the same as NV_WCDMA<band>_LNA_RANGE_RISE_<#_>_I and NV_WCDMA<band>_LNA_RANGE_FALL_<#_>_I, but they are applicable to HSPA operation. Duplicate the approach taken in the Static NV, xml file.

6.1.1.8 RFNV_<C1_>WCDMA<band>_LNA_RANGE_RISE_<#_>CAR1_I, RFNV_<C1_>WCDMA<band>_LNA_RANGE_FALL_<#_>CAR1

The descriptions of these NV items are the same asNV_WCDMA<band>_LNA_RANGE_RISE_<#_>I and

NV_WCDMA<band>_LNA_RANGE_FALL_<#_>I, but they are applicable to DC-HSDPA operation.

Dual carrier mode requires different LNA rise/fall switchpoints. However, both carriers share a common NV item (one value for both carriers), all stored in the CAR1 naming convention. The naming convention follows Table 6-2 for the primary Rx and Table 6-3 for the secondary Rx.

NOTE: Although there are NV items that exist with CAR0 in their names, these items are not used (with the exception of ICI calibration-related items, but ICI items are not presently used). Only the CAR1 items are used.

Table 6-2 NV item band classes for DC-HSDPA static primary Rx NVs

Band	Name and frequency	Example NV name
1	UMTS 2100 or IMT	NV_WCDMA_2100_LNA_RANGE_RISE_CAR1_I
2	UMTS 1900	RFNV_WCDMA_1900_LNA_RANGE_RISE_CAR1_I
3/9	UMTS 1800	RFNV_WCDMA_1800_LNA_RANGE_RISE_CAR1_I
4	AWS	RFNV_WCDMA_B4_LNA_RANGE_RISE_CAR1_I
5/6/19	UMTS 850 / 800	NV_WCDMA_DC1_LNA_RANGE_RISE_CAR1_I
8	UMTS 900	RFNV_WCDMA_900_LNA_RANGE_RISE_CAR1_I
11	UMTS 1500	RFNV_WCDMA_B11_LNA_RANGE_RISE_CAR1_I

Table 6-3 NV item band classes for DC-HSDPA static secondary Rx NVs

Band	Name and frequency	Example NV name
1	UMTS 2100 or IMT	RFNV_C1_WCDMA_2100_LNA_RANGE_RISE_CAR1_I
2	UMTS 1900	RFNV_C1_WCDMA_1900_LNA_RANGE_RISE_CAR1_I
3/9	UMTS 1800	RFNV_C1_WCDMA_1800_LNA_RANGE_RISE_CAR1_I
4	AWS	RFNV_C1_WCDMA_BC4_LNA_RANGE_RISE_CAR1_I
5/6/19	UMTS 850 / 800	RFNV_C1_WCDMA_800_LNA_RANGE_RISE_CAR1_I
8	UMTS 900	RFNV_C1_WCDMA_900_LNA_RANGE_RISE_CAR1_I
11	UMTS 1500	RFNV_C1_WCDMA_1500_LNA_RANGE_RISE_CAR1_I

6.1.1.9 NV_<C1_>WCDMA<band>_VGA_GAIN_OFFSET_VS_TEMP_I

Data type: Array of eight, int8 values

This item contains eight VGA gain offset values based on temperature. The values are the delta between the room temperature VGA gain offset value and the VGA gain offset value at the temperature of interest.

This NV item is required to get an accurate RSSI reading across a range of different temperatures.

The following formula is used to calculate the NV value:

NV_WCDMA_VGA_GAIN_OFFSET_VS_TEMP_I[i] = (VgaOffsetVstemp[i] - VgaOffsetVstemp[room temperature])

NOTE: Element 0 represents the hottest temperature and element 7 the coldest.

6.1.1.10 RFNV_WCDMA_Cx_SPURS_TABLE_I

This NV item specifies the frequencies and depths of any desired notch filters to remove CW spurs within the useful Rx bandwidth. Depending on specific board design characteristics, spurs have the potential to degrade minimum sensitivity performance.

See Section 5.1.1.5 for details.

6.1.1.11 RFNV_WCDMA_Cx_<Band>_RX_STATIC_DATA_V3_I

Data type: See Table 6-4.

This new item consolidates all LNA rise/fall point configuration data for all carriers(SC/DC/3C) into a single data structure. One static NV item per band per RF chain(C0/C1/C2/C3).

The new NV is aimed at supporting variant length.

This NV item specifies the Rx power level threshold for which the LNA/mixer is intended to switch from one gain state to another. The resolution of this NV item is 10 counts per dB.

LNA rise/fall NV value = (1023/DynamicRange) x (rise/fall_level_in_dBm – [MinRSSIofInterest + DynamicRange/2])

If DynamicRange = 102.3 dB and MinRSSIofInterest = -106 dBm, the above equation simplifies to:

NV value = 10 x (rise/fall_level_in_dBm + 106) – 512.

Table 6-4 RFNV_WCDMA_Cx_<Band>_RX_STATIC_DATA_V3_I

Block	Type	Data	Size
Variant_ Marker	Version	NV version value	uint16
	Num_of_element	Total Number of datatypes contained in this NV	uint16
Data Type Header	Data Type	122 RFNV_DATA_TYPE_LNA_SWPTS_V3	uint16
122 RFNV_DATA_TYPE_LNA_SWPTS_V3	Carr_id	Carrier information	uint8
	Hs_config	HSPA configuration, 0 for R99, 1 for HSPA	uint8
	LNA rise points(G0, G1, G2,G3,G4) , Array of 5 int16		
	LNA Rise[0]	LNA rise offset	int16
	LNA Rise[1]	LNA rise offset	int16
	LNA Rise[2]	LNA rise offset	int16
	LNA Rise[3]	LNA rise offset	int16
	LNA Rise[4]	LNA rise offset	int16
	LNA fall points(G0, G1, G2,G3,G4) , Array of 5 int16		
	LNA Fall[0]	LNA Fall offset	int16
	LNA Fall[1]	LNA Fall offset	int16
	LNA Fall[2]	LNA Fall offset	int16
	LNA Fall[3]	LNA Fall offset	int16
	LNA Fall[4]	LNA Fall offset	int16

6.1.1.12 RFNV_<C1_>WCDMA<Band>NOISE_FLOOR_I, RFNV_<C1_>WCDMA<Band>NOISE_FLOOR_CARy_I

Data type: int16 value

This NV item has noise floor characterized for each band per chain per carrier. Use this NV item to compensate for noise floor in the received RxAGC (in FW) and report the compensated RxAGC value to upper layers.

Each NV item is of type 16-bit signed integer and represents RxAGC value in dB10 units.

RxAGC value in dBm = (RxAGC value in dB10 - Minimum RxAGC value) /10 + Minimum Rx Power in dBm

Minimum RxAGC value = -512; Minimum Rx Power in dBm = -106

Table 6-5 Noise Floor NV item types

NV item	Chain	Carrier	Data type	Size
RFNV_WCDMA_xxxx_NOISE_FLOOR_I	0	0	16-bit signed	2 bytes
RFNV_WCDMA_xxxx_NOISE_FLOOR_CAR1_I	0	1	16-bit signed	2 bytes
RFNV_WCDMA_xxxx_NOISE_FLOOR_CAR2_I	0	2	16-bit signed	2 bytes
RFNV_C1_WCDMA_xxxx_NOISE_FLOOR_CAR0_I	1	0	16-bit signed	2 bytes
RFNV_C1_WCDMA_xxxx_NOISE_FLOOR_CAR1_I	1	1	16-bit signed	2 bytes
RFNV_C1_WCDMA_xxxx_NOISE_FLOOR_CAR2_I	1	2	16-bit signed	2 bytes

6.1.2 Calibrated, Rx RF NV items

NOTE: When calibrating the NV_<C1_>WCDMA<band>_VGA_GAIN_OFFSET_I, NV_<C1_>WCDMA<band>_VGA_GAIN_OFFSET_VS_FREQ_I, NV_<C1_>WCDMA<band>_LNA_RANGE_OFFSET_[z]_I, and NV_<C1_>WCDMA<band>_LNA_OFFSET_VS_FREQ_[z]_I items, it is crucial when taking measurements to maintain the proper order as follows:

1. DVGA offset
2. LNA_1 offset
3. LNA_2 offset
4. LNA_3 offset

Take measurements in the proper order for a given frequency channel before moving to the next frequency. This is because the associated FTM functions not only return measured values, but they also prepare the internal hardware registers for the next expected measurement.

6.1.2.1 NV_<C1_>WCDMA<band>_RX_CAL_CHAN_I

Data type: Array of 16, int16 values

This NV item holds the Rx channel list on which the RF calibration is carried out. Channel numbers must be in the order of increasing RF frequency. QTI uses 16 calibration channels, but fewer can be utilized. If using less than 16 channels, clear the unused elements to zero.

Data type: Array of six, uint16 values

This NV item has been added to compensate for RF distortions that are caused due to sudden jumps in the phase at LNA switch points. This phase jump is programmed in the NV. The value of this NV item is different for the different baseband chips. Some implementations of this NV item contain information about the LNA Gain state. Zeroing this item may cause problems. Refer to the static RF NV file (.xml and .qcn) shipped with the latest software release for the default value, and duplicate.

6.1.2.2 NV_<C1_>WCDMA<band>_VGA_GAIN_OFFSET_I

Data type: int16 value

Data range: -512 to 511

The purpose of calibrating this NV is to map -512 (the RxAGC value) to MinRSSIofInterest (-106 dBm). The VGA gain offset is the process where the VGA varies its gain so that it compensates for the front-end path loss (thus an RxAGC value of -512 corresponds to MinRSSIofInterest).

After proper calibration, the DVGA gain value has an ideal mapping of minimum RxAGC to -512 and maximum RxAGC to 511.

Use the following procedure to calibrate NV_WCDMA_VGA_GAIN_OFFSET_I:

1. Set the phone in WCDMA mode.
2. Set the phone to the reference channel (such as ARFCN = channel 9739).
3. Set the phone to the highest LNA gain state.
4. Set the signal generator to produce a WCDMA waveform, as defined by the 3GPP standard, at reference frequency. Set the input power to -74 dBm (all external losses and fixturing must be accounted for).
5. Use the FTM command GetLNAOffset, index 0, with -192 as its parameter. This FTM command calculates and returns the DVGA offset for the current channel of operation. When calling this FTM command, an RxAGC value equivalent to the applied receive power level must be passed. The RxAGC value corresponding to Rx power level applied when doing the DVGA gain offset can be calculated using the following formula:

   CalculatedAGCValue = (1023/DynamicRange) × (RxPower - RxMin) - 512

   Example: Rx Power = -74 dBm, DynamicRange = 102.3 dB, RxMin = -106 dBm

   Calculated AGC Value = (1023/102.3) * [-74 - (-106)] - 512 = -192

   GetDVGAOffset automatically sets the correct DVGA offset.

The value returned from GetDVGAOffset should be stored in this NV item: NV_<C1_>WCDMA<band>_VGA_GAIN_OFFSET_I. The calibration of LNA offset NV items requires that the DVGA offset register is initialized, prior to their calibration.

DVGA offsets are calibrated with the specific goal of causing the RSSI to match the power level of the received signal, as measured at the phone’s antenna connector; particularly when the LNA is in its highest gain state (LNA offsets are used to account for the LNA gain state differences). DVGA offsets account for all losses and gains in the Rx chain from the antenna connector to baseband, when the LNA is in its highest gain state. Thermal noise is ignored when calibrating DVGA offsets – it is expected that there be some RSSI error at very low Rx power levels, near the thermal noise floor. For this reason, DVGA offsets should be calibrated at Rx power levels above the thermal noise floor. Choosing the Rx power level to be near the switch points of the first gain step ensures the Rx power level is above the thermal noise floor, and below saturation.

6.1.2.3 NV_<C1_>WCDMA<band>_VGA_GAIN_OFFSET_VS_FREQ_I

Data type: Array of 16, int8 values

The gain offset is the process where the VGA varies its gain so that it compensates for the front-end path loss.

This NV item contains the 16 VGA gain offset values relative to a reference frequency. These values are the delta between the reference frequency VGA gain offset value and the VGA gain offset value at the frequency of interest.

This NV item is required to ensure receiver response is flat across the entire Rx band.

To calibrate this NV item, follow these steps:

1. Calibrate NV_<C1_>WCDMA<band>_VGA_GAIN_OFFSET_I, as described in Section 6.1.2.1, but do so at each of the 16 frequency indexes.
2. Store the new VGA offset values in an array; call it VgaOffsetVsFreq[channel_index], where channel_index ranges from 0 to 15.

   The contents of NV_<C1_>WCDMA<band>_VGA_GAIN_OFFSET_VS_FREQ_I are calculated as follows:

   NV_<C1_>WCDMA<band>_VGA_GAIN_OFFSET_VS_FREQ_I [channel_index] = (VgaOffsetVsFreq [channel_index] - VgaOffsetVsFreq [reference_channel_index])

NOTE: Each frequency index corresponds to a channel number in NV_<C1_>WCDMA<band>_RX_CAL_CHAN_I.

6.1.2.4 NV_<C1_>WCDMA<band>_LNA_RANGE_OFFSET_I

Data type: uint16 value

Data range: 0 to 1023

This NV item compensates for the gain-step, when the gain of the LNA circuit is reduced from gain state 0 to gain state 1. The resolution of this NV item is 10 counts per dB.

NOTE: Before performing any LNA range offset calibration, NV_WCDMA_VGA_GAIN_OFFSET_I must be calibrated.

To calibrate this NV item, perform the following:

1. At reference channel, apply Rx power level equivalent to NV_WCDMA_LNA_RANGE_RISE_I to the antenna port.
2. Call FTM Command *GetLNAOffset()*. This FTM command requires two arguments to pass; the first argument is the LNA offset index. For NV_WCDMA_LNA_RANGE_OFFSET_I calibration, the LNA offset index is 1. The second argument is LNA offset; it is the calculated Rx AGC value equivalent to the Rx power level applied to the antenna port. The Rx AGC value can be calculated using the following formula:

CalculatedAGCValue = (1023/DynamicRange) × (RxPower - RxMin) - 512

Example: Rx Power = -70 dBm, DynamicRange = 102.3 dB, RxMin = -106 dBm

CalculatedAGCValue = 10 × (-70 - (-106)) - 512 = -152

6.1.2.5 NV_<C1_>WCDMA<band>_LNA_RANGE_OFFSET_2_I

Data type: int16 value

This NV item compensates for the gain-step, when the gain of the LNA circuit is reduced from gain state 0 to gain state 2. Use *GetLNAOffset()* with index 2. The resolution of this NV item is 10 counts per dB.

NOTE: The DVGA offset and LNA_1 offset must be measured before performing measurements for this item.

6.1.2.6 NV_<C1_>WCDMA<band>_LNA_RANGE_OFFSET_3_I

Data type: int16 value

This NV item compensates for the gain-step, when the gain of the LNA circuit is reduced from gain state 0 to gain state 3. Use *GetLNAOffset()* with index 3. The resolution of this NV item is 10 counts per dB.

NOTE: The DVGA offset, LNA_1 offset and LNA_2 offset must be measured before performing measurements for this item.

6.1.2.7 NV_<C1_>WCDMA<band>_LNA_OFFSET_VS_FREQ_I

Data type: Array of 16, int8 values

This NV item contains 16 adjustment values relative to the reference frequency for the NV_<C1_>WCDMA<band>_LNA_RANGE_OFFSET_I item.

These 16 NV values should be considered as adjustments for gain variation of the LNA gain-step, based on the frequency index. The values are the change between the reference frequency LNA gain-step and the LNA gain-step at the frequency index of interest.

To calibrate this NV item:

1. Perform the calibration procedure for NV_<C1_>WCDMA<band>_LNA_RANGE_OFFSET_I, but at each of the 16 frequency indexes.
2. Store the new LNA offset values in an array; call it LnaOffsetVsFreq[i], where i ranges from 0 to 15, corresponding to the frequency index.

The contents of NV_<C1_>WCDMA<band>_LNA_OFFSET_VS_FREQ_I are calculated as follows:

NV_<C1_>WCDMA<band>_LNA_OFFSET_VS_FREQ_I [i] = LnaOffsetVsFreq[i] - NV_<C1_>WCDMA<band>_LNA_RANGE_OFFSET_I

NOTE: Each frequency index corresponds to a channel number in NV_<C1_>WCDMA<band>_RX_CAL_CHAN_I.

6.1.2.8 NV_<C1_>WCDMA<band>_LNA_OFFSET_VS_FREQ_2_I

Data type: Array of 16, int8 values

This NV item contains 16 adjustment values relative to the reference frequency for the NV_<C1_>WCDMA<band>_LNA_RANGE_OFFSET_2_I item.

These 16 NV values should be considered as adjustments for gain variation of the LNA gain-step, based on the frequency index. The values are the change between the reference frequency LNA gain-step and the LNA gain-step at the frequency index of interest.

To calibrate this NV item:

1. Perform the calibration procedure for NV_<C1_>WCDMA<band>_LNA_RANGE_OFFSET_2_I, but at each of the 16 frequency indexes.
2. Store the new LNA offset values in an array; call it LnaOffsetVsFreq2[i], where i ranges from 0 to 15.

The contents of NV_<C1_>WCDMA<band>_LNA_OFFSET_VS_FREQ_2_I are calculated as follows:

NV_<C1_>WCDMA<band>_LNA_OFFSET_VS_FREQ_2_I [i] = LnaOffsetVsFreq2[i] - NV_<C1_>WCDMA<band>_LNA_RANGE_OFFSET_2_I

NOTE: Each frequency index corresponds to a channel number in NV_<C1_>WCDMA<band>_RX_CAL_CHAN_I.

6.1.2.9 NV_<C1_>WCDMA<band>_LNA_OFFSET_VS_FREQ_3_I

Data type: Array of 16, int8 values

This NV item contains 16 adjustment values relative to the reference frequency for the NV_<C1_>WCDMA<band>_LNA_RANGE_OFFSET_3_I item.

These 16 NV values should be considered as adjustments for gain variation of the LNA gain-step, based on the frequency index. The values are the change between the reference frequency LNA gain-step and the LNA gain-step at the frequency index of interest.

To calibrate this NV item:

1. Perform the calibration procedure for NV_<C1_>WCDMA<band>_LNA_RANGE_OFFSET_3_I, but at each of the 16 frequency indexes.
2. Store the new LNA offset values in an array; call it LnaOffsetVsFreq3[i], where i ranges from 0 to 15.

The contents of NV_<C1_>WCDMA<band>_LNA_OFFSET_VS_FREQ_3_I are calculated as follows:

NV_<C1_>WCDMA<band>_LNA_OFFSET_VS_FREQ_3_I [i] = LnaOffsetVsFreq3[i] - NV_<C1_>WCDMA<band>_LNA_RANGE_OFFSET_3_I.

NOTE: Each frequency index corresponds to a channel number in NV_<C1_>WCDMA<band>_RX_CAL_CHAN_I.

6.1.2.10 NV_<C1_>WCDMA_<band>_VGA_GAIN_OFFSET_CAR1_I

The descriptions of these NV items are the same as NV_<C1_>WCDMA<band>_VGA_GAIN_OFFSET_CAR1_I, but they are applicable to DC-HSDPA operation.

Factory calibration for dual carrier need only be done at the reference frequency. There are not any frequency compensation NV items for dual carrier. In normal online mode, frequency compensation comes from the single carrier data. There is no need to recalibrate over frequency.

To calibrate the dual carrier data:

1. Place the phone in Dual Carrier mode using the FTM command FTM_SET_MULTI_CHAN.
2. Configure the call box to place an Rx signal at Carrier 1 frequency.
3. Then calibrate the DVGA and LNA offsets as normal, except use the FTM_GET_DUAL_CARRIER_DVGA_OFFSET for the DVGA offset calibration.(The FTM_GET_LNA_OFFSET command is the same command as in Single Carrier mode). The phone will stay in Dual Carrier mode until the frequency channel is changed, or the phone is placed back into Single Carrier mode.

In Dual Carrier mode, both carriers share the same switchpoints and offsets, all stored in the CAR1 naming convention — it is not necessary to store separate data for each carrier.

Single Carrier mode has its own switchpoints and DVGA and LNA offset information. Dual Carrier has its own switchpoints and reference frequency DVGA and LNA offsets, but both of the dual carrier carriers share the same values for switchpoints and offsets. Everything shares the same freq-comp data.

The naming convention follows Table 6-6 for primary Rx and Table 6-7 for secondary Rx.

NOTE: Although there are NV items that exist with CAR0 in their names, these items are not used (with the exception of ICI calibration-related items, but ICI items are not presently used). Only the CAR1 items are used.

Table 6-6 NV item band classes for DC-HSDPA calibrated primary Rx NVs

Band	Name and frequency	Example NV name
1	UMTS 2100 or IMT	NV_WCDMA_2100_VGA_GAIN_OFFSET_CAR1_I
2	UMTS 1900	RFNV_WCDMA_1900_VGA_GAIN_OFFSET_CAR1_I
3/9	UMTS 1800	RFNV_WCDMA_1800_VGA_GAIN_OFFSET_CAR1_I
4	AWS	RFNV_WCDMA_B4_VGA_GAIN_OFFSET_CAR1_I
5/6/19	UMTS 850 / 800	NV_WCDMA_DC1_VGA_GAIN_OFFSET_CAR1_I
8	UMTS 900	RFNV_WCDMA_900_VGA_GAIN_OFFSET_CAR1_I
11	UMTS 1500	RFNV_WCDMA_B11_VGA_GAIN_OFFSET_CAR1_I

Table 6-7 NV item band classes for DC-HSDPA calibrated secondary Rx NVs

Band	Name and frequency	Example NV name
1	UMTS 2100 or IMT	NV_C1_WCDMA_2100_VGA_GAIN_OFFSET_CAR1_I
2	UMTS 1900	RFNV_C1_WCDMA_1900_VGA_GAIN_OFFSET_CAR1_I
3/9	UMTS 1800	RFNV_DIV_WCDMA_1800_VGA_GAIN_OFFSET_CAR1_I
4	AWS	RFNV_C1_WCDMA_B4_VGA_GAIN_OFFSET_CAR1_I
5/6/19	UMTS 850 / 800	NV_C1_WCDMA_DC1_VGA_GAIN_OFFSET_CAR1_I
8	UMTS 900	RFNV_C1_WCDMA_900_VGA_GAIN_OFFSET_CAR1_I
11	UMTS 1500	RFNV_C1_WCDMA_B11_VGA_GAIN_OFFSET_CAR1_I

6.1.2.11 NV_<C1_>WCDMA_<band>_LNA_RANGE_OFFSET_<#_>CAR1_I

The descriptions of these NV items are the same as NV_<C1_>WCDMA<band>_LNA_RANGE_OFFSET_<#_>I, but they are applicable to DC-HSDPA operation.

The naming convention follows Table 6-6 for primary Rx and Table 6-7 for secondary Rx.

6.2 WCDMA Tx RF NV items

6.2.1 Static, Tx RF NV items

6.2.1.1 NV_WCDMA_<band>_ENC_BTF_I

Data type: 32-bit signed

The digital transmit signal is advanced by NV item NV_WCDMA_ENC_BTF_I in 1/8 chip units. This compensates for system delay. Determine the system delay value by measuring the transmit signal of the mobile station at the base station to obtain a delay of 1024 chips, with respect to the downlink signal.

Calibrate this NV item by performing the following:

1. Load the phone with the latest software.
2. Make a voice call with the call box under a single-cell condition (no fading).
3. Make sure that main finger Ec/Io is around -15 dB, as observed in the QXDM WCDMA temporal analyzer, by suitably adjusting the CPICH power on the call box. This ensures that a weak side-lobe of the earliest arriving path does not get assigned a reference finger and eventually ruin the timing error measurement.
4. The timing error should be almost constant (can move up to ±0.125 cx16).
5. End the call.
6. If timing error is more than 0.5 cx1, adjust the BTF-DELAY value in NV and repeat Steps 2 to 6.
7. If timing error is less than 0.5 cx1, end the procedure. The last written value in NV is then the calibrated value.

NOTE: cx1 means chip rate x1 internal (~260 ns); cx16 means chip rate x16 internal (~16 ns).

6.2.1.2 NV_WCDMA<band>_MAX_TX_POWER_I

Data type: int8 value

This item specifies the maximum power a phone can transmit in random access channel RACH (channel). Only integers are allowed as values. For example, the maximum Tx power can be specified as 23 dBm but not 23.5 dBm.

NV_WCDMA_TX_LIM_VS_TEMP_I is the NV item used for limiting Tx output power.

6.2.1.3 NV_WCDMA<band>_AGC_PA_ON_RISE_DELAY_I

Data type: uint16 value

This item is the time delta between PA_ON signal rise and the start of the Tx frame boundary in chip resolution. It is used to time align the PA_ON signal at the beginning of the Tx time line. This NV item is used in PRACH and DPCH.

6.2.1.4 NV_WCDMA<band>_AGC_PA_ON_FALL_DELAY_I

Data type: uint16 value

This item is the time delta between the PA_ON signal falls after the end of the Tx frame boundary in chip resolution. It is used to time align the PA_ON signal at the end of the Tx time line. This NV item is used in PRACH and DPCH.

6.2.1.5 NV_WCDMA<band>_AGC_TX_ON_RISE_DELAY_I

Data type: uint16 value

Use this NV item to adjust the time mask during PRACH. This item is the time delta between TX_ON signal rise and the start of the Tx frame boundary in chip resolution. It is used to time align the TX_ON signal at the beginning of the Tx time line. This item is used in PRACH and DPCH.

6.2.1.6 NV_WCDMA<band>_AGC_TX_ON_FALL_DELAY_I

Data type: uint16 value

This item is the time delta between the TX_ON signal falls after the end of the Tx frame boundary in chip resolution. It is used to time align the TX_ON signal at the end of the Tx timeline. This NV item is used in PRACH and DPCH.

6.2.1.7 NV_WCDMA<band>_TX_ROT_ANGLE_PA_STATE_00_I

Data type: uint16 value

This item contains a rotation angle in degrees, with a resolution of 360/1024 = 0.3516 degrees/count in two's complement format. The rotation value is applied to the Tx signal while in TxState state 0. Use this item to compensate for the phase discontinuity while in state 00. For negative amounts of compensation, the value needs to be subtracted from 512. Note also that these NV items are relative to the amount of compensation applied for other gain states.

Original values:

- NV_WCDMA_TX_ROT_ANGLE_PA_STATE_00_I = 0
- NV_WCDMA_TX_ROT_ANGLE_PA_STATE_01_I = 20 (20 additional counts of compensation required for this transition)
- NV_WCDMA_TX_ROT_ANGLE_PA_STATE_10_I = 37 = 20 +17 (17 additional counts of compensation required for this transition)
- NV_WCDMA_TX_ROT_ANGLE_PA_STATE_11_I = 37 = 37 + 0 (0 additional counts of compensation required for this transition)

If it is determined that 7.3 degrees less compensation for STATE_01 were needed, populate these values:

- NV_WCDMA_TX_ROT_ANGLE_PA_STATE_00_I = 0
- NV_WCDMA_TX_ROT_ANGLE_PA_STATE_01_I = 511 = -1 mod 512 = 20 - 21 (1 less count now required for this transition instead of 20 additional ones)
- NV_WCDMA_TX_ROT_ANGLE_PA_STATE_10_I = 16 = 511+ 17 (17 additional counts of compensation required for this transition)
- NV_WCDMA_TX_ROT_ANGLE_PA _STATE_11_I = 16 = 16 + 0 (0 additional counts of compensation for this transition)

6.2.1.8 NV_WCDMA<band>_TX_ROT_ANGLE_PA_STATE_01_I

Data type: uint16 value

This item contains a rotation angle in degrees with a resolution of 360/1024 = 0.3516 degrees/count. The rotation value is applied to the Tx signal while in TxState state 1. Use this item to compensate for the phase discontinuity while in state 01. For negative amounts of compensation, subtract the value from 512. Note also that these NV items are relative to the amount of compensation applied for other gain states.

6.2.1.9 NV_WCDMA<band>_TX_ROT_ANGLE_PA_STATE_10_I

Data type: uint16 value

This item contains a rotation angle in degrees with a resolution of 360/1024 = 0.3516 degrees/count. The rotation value is applied to the Tx signal while in TxState state 2. Use this item to compensate for the phase discontinuity while in state 10. For negative amounts of compensation, subtract the value from 512. Note also that these NV items are relative to the amount of compensation applied for other gain states.

6.2.1.10 NV_WCDMA<band>_TX_ROT_ANGLE_PA_STATE_11_I

Data type: uint16 value

This item contains a rotation angle in degrees with a resolution of 360/1024 = 0.3516 degrees/count. The rotation value is applied to the Tx signal while in TxState state 3. Use this item to compensate for the phase discontinuity while in state 11. For negative amounts of compensation, subtract the value from 512. Note also that these NV items are relative to the amount of compensation applied for other gain states.

6.2.1.11 NV_PA_COMPENSATE_UP_I (WCDMA 2100 MHz, Band 1), NV_WCDMA_<band>_PA_COMPENSATE_UP_I

Data type: int16 value

This item contains a Tx AGC offset in 1/10 dB resolution. This offset is only applied to the slot following a PA state transition from TxState 0 to state 1. The total duration of this offset is only for that one slot (the duration of one slot is 666 µs). The value specified in this NV item can be positive or negative. Note that this NV item just averages out the spike in ILPC performance (when looking at the ILPC delta level, not the absolute level) over two consecutive slots. Essentially, the offset that is applied on one slot propagates to next slot. Accordingly, a 0.5 dB upward spike could be averaged out to be a 0.25 dB downward spike and a 0.25 dB upward spike with the use of this NV item. Table 6-8 describes which NV item to apply for a given PA gain state transition.

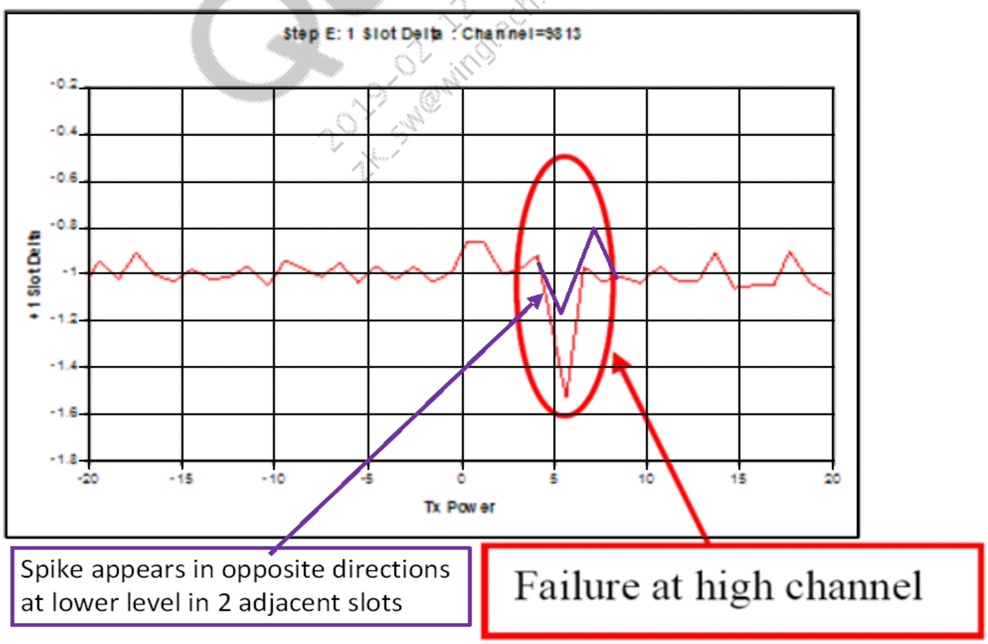


Figure 6-1 ILPC failure in step E before and after applying compensation

Table 6-8 Tx gain state transition for PA compensate up/down

TxState gain state transition		Effective item
From	**To**	
0	1	NV_PA_COMPENSATE_UP_I
0	2	NV_PA_COMPENSATE_UP_R2_I
1		
0	3	NV_PA_COMPENSATE_UP_R3_I
1		
2		
1	0	NV_PA_COMPENSATE_DOWN_I
2		
3		
2	1	NV_PA_COMPENSATE_DOWN_R2_I
3		
3	2	NV_PA_COMPENSATE_DOWN_R3_I

6.2.1.12 NV_PA_COMPENSATE_UP_R2_I (WCDMA 2100 MHz, Band 1), NV_WCDMA_<band>_PA_COMPENSATE_UP_R2_I

Data type: int16 value

This NV item is the same as NV_PA_COMPENSATE_UP_I, except the offset is only applied to the slot following a PA gain state transition from TxState state 1 to state 2.

6.2.1.13 NV_PA_COMPENSATE_UP_R3_I (WCDMA 2100 MHz, Band 1), NV_WCDMA_<band>_PA_COMPENSATE_UP_R3_I

Data type: int16 value

This NV item is the same as NV_PA_COMPENSATE_UP_I, except the offset is only applied to the slot following a PA gain state transition from TxState state 2 to state 3.

6.2.1.14 NV_PA_COMPENSATE_DOWN_I (WCDMA 2100 MHz, Band 1), NV_WCDMA_<band>_PA_COMPENSATE_DOWN_I

Data type: int16 value

This NV item contains a Tx AGC offset in 1/10 dB resolution. This offset is only applied to the slot following a PA gain state transition from TxState state 1 to state 0. The total duration of this offset is only for that one slot (the duration for one slot is 666 µs).

6.2.1.15 NV_PA_COMPENSATE_DOWN_R2_I (WCDMA 2100 MHz, Band 1), NV_WCDMA_<band>_PA_COMPENSATE_DOWN_R2_I

Data type: int16 value

This NV item is the same as NV_PA_COMPENSATE_DOWN_I, except the offset is only applied to the slot following a PA gain state transition from TxState state 2 to state 1.

6.2.1.16 NV_PA_COMPENSATE_DOWN_R3_I (WCDMA 2100 MHz, Band 1), NV_WCDMA_<band>_PA_COMPENSATE_DOWN_R3_I

Data type: 16-bit signed

This NV item is the same as NV_PA_COMPENSATE_DOWN_I, except the offset is only applied to the slot following a PA gain state transition from TxState state 3 to state 2.

6.2.1.17 RFNV_WCDMA_<band>_PA_COMPENSATE_UP_R1_VS_FREQ_I, RFNV_WCDMA_<band>_PA_COMPENSATE_UP_R2_VS_FREQ_I, RFNV_WCDMA_<band>_PA_COMPENSATE_UP_R3_VS_FREQ_I, RFNV_WCDMA_<band>_PA_COMPENSATE_DOWN_R1_VS_FREQ_I, RFNV_WCDMA_<band>_PA_COMPENSATE_DOWN_R2_VS_FREQ_I, RFNV_WCDMA_<band>_PA_COMPENSATE_DOWN_R3_VS_FREQ_I

Data type: Array of 16, int16 values

These NV items are similar to the NV_<band>_PA_COMPENSATE_UP_I, NV_<band>_PA_COMPENSATE_UP_R[3:2]_I, NV_<band>_PA_COMPENSATE_DOWN_I, and NV_<band>_PA_COMPENSATE_DOWN_R[3:2]_I, discussed in the previous few sections. The _VS_FREQ items in this section are identical in function to the previous PA_COMPENSATE_UP/DOWN, but have the flexibility to vary the compensation as a function of frequency.

These _VS_FREQ items can be used as a more flexible replacement of the PA_COMPENSATE_UP/DOWN items. Alternatively, these _VS_FREQ items can be used together with the previous PA_COMPENSATE_UP/DOWN items. If both sets are populated in NV, The resulting compensation at a given frequency index channel is the sum of the PA_COMPENSATE_UP/DOWN item and the _VS_FREQ element corresponding to the present frequency index.

NOTE: The index of each element corresponds to the frequency channel in the frequency channel list embedded in the RFNV_WCDMA_<band>_TX_MULTI_LIN_DATA_I item.

6.2.1.18 NV_WCDMA<band>_TX_LIN_VS_TEMP_0_I

Data type: Array of eight, int8 values

The NV item NV_WCDMA_TX_LIN_VS_TEMP_0 contains a table of eight adjustment values for the Tx linearizer in TxState state 0 (lowest PA power state), based on temperature. The temperature range for the phone is divided into eight segments. Each element corresponds to a segment. For a given temperature, each offset in the Tx linearizer curve is adjusted by a constant amount based on this table. For example, if for a given temperature index, the element in this table is 5, each of the Tx power elements in the Tx linearizer tables (RFNV_WCDMA_<band>_TX_MULTI_LIN_V3_DATA_I) is increased by 5 (0.5 dB), when the temperature corresponds to that given index (The APT data is also shifted accordingly). Based on the temperature, an appropriate bin in the array is picked for compensation. See Section 3.1.8, NV_ENH_THERM_I for a description of the temperatures bins.

The NV is not actived used, the fuctionality has been replaced by RFNV_WCDMA_<band>_TX_LIN_VS_TEMP_VS_FREQ_P_OUT_I

NOTE: Resolution is 1/10 dB per count. For example, at a given temperature index, if the uncompensated, measured Tx power is 2 dB above the reported (desired) Tx power, populate the corresponding element with +20. If the measured Tx power is 2 dB below the reported (desired) Tx power, populate the corresponding element with -20.

NOTE: Element 0 represents the hottest temperature and element 7 the coldest.

6.2.1.19 NV_WCDMA<band>_TX_LIN_VS_TEMP_1_I

Data type: Array of eight, int8 values

The same description as NV_WCDMA<band>_TX_LIN_VS_TEMP_0_I applies, but it is used for Tx linearizer in TxState state 1.

6.2.1.20 NV_WCDMA<band>_TX_LIN_VS_TEMP_2_I

Data type: Array of eight, int8 values

The same description as NV_WCDMA<band>_TX_LIN_VS_TEMP_0_I applies, but it is used for Tx linearizer in TxState state 2.

6.2.1.21 NV_WCDMA<band>_TX_LIN_VS_TEMP_3_I

Data type: Array of eight, int8 values

The same description as NV_WCDMA<band>_TX_LIN_VS_TEMP_0_I applies, but it is used for Tx linearizer in TxState state 3.

6.2.1.22 RFNV_WCDMA_B<band>_TX_LIN_VS_TEMP_0_ADDL_I, RFNV_WCDMA_B<band>_TX_LIN_VS_TEMP_1_ADDL_I, RFNV_WCDMA_B<band>_TX_LIN_VS_TEMP_2_ADDL_I, RFNV_WCDMA_B<band>_TX_LIN_VS_TEMP_3_ADDL_I

Data type: 16 × 8, two-dimensional array of int8 values.

Units: dB10 (10 counts per dB)

These items allow separate Tx linearizer temperature compensation across frequency channels. There exists an individual RFNV_WCDMA_B<band>_TX_LIN_VS_TEMP_z_ADDL_I for each TxState ‘z’. Table 6-9 shows the format of the NV item.

Table 6-9 RFNV_WCDMA_B<band>_TX_LIN_VS_TEMP_z_ADDL_I format

NV item element index	Frequency channel index	Temperature bin index
0	Channel index 0	0 (hot)
1		1
2		2
… …		… …
5		5
6		6
7		7 (cold)
8	Channel index1	0 (hot)
9		1
10		2
… …		… …
… …	… …	… …
… …	Channel index 15	… …
125		5
126		6
127		7 (cold)

The 128 bytes stored in each NV item can be considered to be broken up into 16 blocks. Each block index corresponds to a frequency channel specified by the frequency channel list embedded within the corresponding RFNV_WCDMA_<band>_TX_MULTI_LIN_DATA_I item. Each block contains eight int8 elements. The index of each element corresponds to a temperature bin. Index 0 corresponds to hot and index 7 to cold. The value of each element is a temperature adjustment value with resolution of 10 counts per dB.

The temperature compensation value, for a given frequency channel, is similar to that of NV_WCDMA<band>_TX_LIN_VS_TEMP_z_I. Positive values have the effect of increasing the reported Tx power with respect to the measured Tx power (equivalent to decreasing the measured power with respect to the reported).

This item can be used in conjunction with NV_WCDMA<band>_TX_LIN_VS_TEMP_z_I, or can replace its functionality altogether.

The recommended approach is to characterize NV_WCDMA<band>_TX_LIN_VS_TEMP_z_I at reference frequency as is normally done. Then, if additional adjustments are desired or required as a function of the frequency channel, those can be done by characterizing the NV_WCDMA<band>_TX_LIN_VS_TEMP_z_ADDL_I elements. Using this approach, each element in RFNV_WCDMA_B<band>_TX_LIN_VS_TEMP_z_ADDL_I stores an adjustment *relative* to the NV_WCDMA<band>_TX_LIN_VS_TEMP_z_I compensation.

6.2.1.23 NV_WCDMA<band>_PA_RANGE_MAP_I

Data type: Array of four, int8 values

Data range: 0, 1, 2, 3

The software divides the Tx output dynamic range into four linearizer tables. This NV item defines what state the PA should be in for each of those linearizer tables. This NV item sets the bits that control the pins PA_RANGE1 and PA_RANGE0 used to set the gain state of the PA for each portion of the dynamic range defined by the linearizer tables.

This NV item is required to tell the software how to configure the PA for each of the four linearizer tables.

Once it is determined what state the PA should be in for the different transmitter ranges defined by the linearizer tables, the values in this NV item should be added to the customer’s static QCN file. The PA_R1 and PA_R0 settings should be matched to the data sheet for the particular PA that is being used. Note the first value represents the lowest gain linearizer table (which corresponds to the minimum Tx output power).

Table 6-10 defines how to populate the NV item for given PA_RANGE1 and PA_RANGE0 settings.

Table 6-10 NV_WCDMA_PA_RANGE_MAP_I configuration

Bit 1 (PA_RANGE1)	Bit 0 (PA_RANGE 0)	NV_WCDMA_<band>_PA_RANGE_MAP_I [*i*]
Low	Low	0
Low	High	1
High	Low	2
High	High	3

The first element ($i = 0$) represents the lowest Tx power TxState. The second element ($i = 1$) represents the next highest Tx power TxState, and so on.

1 corresponds to HIGH, and 0 corresponds to LOW. The values in this NV item reflect this positive logic. This represents a difference from some previous chipset implementations.

6.2.1.24 NV_WCDMA<band>_TIMER_HYSTERISIS_I

Data type: int16 value

This NV item contains the count value for how long the AGC block waits before switching gain states during timer hysteresis. Timer hysteresis is only used when switching from higher- to lower-gain states and not lower- to higher-gain states. For a more detailed explanation of timer hysteresis, refer to *Hysteresis for UMTS PA Switchpoints* (80-VF846-15).

The resolution of this NV item is 66 µs. A value of 1 is a 66 µs wait period. QTI recommends using the default value given in the static QCN file.

6.2.1.25 NV_WCDMA<band>_R1_RISE_I

Data type: uint16 value

This item specifies the Tx power level threshold for which the PA is intended to switch from TxState state 0 (lowest PA gain state) to state 1.

NV_WCDMA_R1_RISE_I = (1024/DynamicRange) × (Rise_threshold - [min Tx pwr + DynamicRange/2])

Example: Rise threshold = 2 dBm, minimum Tx power = -70 dBm (non-extrapolated value), DynamicRange = 102.4.

NV_WCDMA_R1_RISE_I = (1024/102.4) × (2 - (-70 + 102.4/2)) = 208.

NOTE: Unused switch points should contain the maximum value for a two's complement, 16-bit number, which is 32767.

6.2.1.26 NV_WCDMA<band>_R2_RISE_I

Data type: uint16 value

This NV item has the same description as NV_WCDMA<band>_R1_RISE_I, but specifies the Tx power level threshold for which the PA is intended to switch from TxState state 1 to state 2.

6.2.1.27 NV_WCDMA<band>_R1_FALL_I

Data type: uint16 value

This NV item specifies the Tx power level threshold for which the PA is intended to switch from TxState state 1 to state 0. With the timer hysteresis implementation, the PA may switch to a lower-gain state before the FALL switch point is reached if the Tx power is below the RISE switch point and the hysteresis timer expires.

NV_WCDMA_R1_FALL_I = (1024/102.4) × (fall threshold - (minimum Tx power + 102.4/2))

Example: Fall threshold = -1 dBm, minimum Tx power = -70 dBm (non-extrapolated value), result = 178.

NOTE: Unused switch points should contain the maximum value for a two's complement, 16-bit number, which is 32767.

6.2.1.28 NV_WCDMA<band>_R2_FALL_I

Data type: uint16 value

This NV item has the same description as NV_WCDMA<band>_R1_FALL_I, but specifies the Tx power level threshold for which the PA is intended to switch from TxState state 2 to state 1. With the timer hysteresis implementation, the PA may switch to a lower-gain state before the FALL switch point is reached if the Tx power is below the RISE switch point and the hysteresis timer expires.

6.2.1.29 NV_WCDMA<band>_TX_LIM_VS_TEMP_I

Data type: Array of eight uint8 values

This NV item specifies the desired Tx power limit for DCH channel for each of eight temperature values, all at the reference frequency.

It may be advantageous to choose the maximum Tx power limit based on compression, ACPR, or some parameter of the Tx circuitry that is temperature dependent. This item can also be used for fine adjustment of max Tx power over temperature at the end of the development cycle (if any deviations exist from the ideal formula below).

For each element of NV_WCDMA<band>_TX_LIM_VS_TEMP_I, choose the value so that it satisfies the following equation:

NV_WCDMA<band>_TX_LIM_VS_TEMP[*i*] = 10 × (DesiredTxLimdBm - 6.8),

where the DesiredTxLimdBm is the desired Tx power limit (in dBm) for temperature index *i*. As an example, if the desired Tx power limit is 24 dBm, the corresponding value for

NV_WCDMA<band>_TX_LIM_VS_TEMP_I is 10 × (24 - 6.8) = 172.

Because this NV item is used to specify the maximum output power level, it should be nonzero even if temperature compensation is not required. If temperature compensation is not required, every element of this NV item can be populated with the same value.

Element 0 represents the hottest temperature and element 7 the coldest.

6.2.1.30 NV_WCDMA_UTRAN_TX_LIM_VS_TEMP_OFFSET_I

Data type: Array of eight, int16 values

This NV item is used in instances where the base station sets a maximum Tx power level that is lower than the maximum Tx power level specified by NV_WCDMA<band>_TX_LIM_VS_TEMP_I. If the elements in this NV item are set to 0, no temperature compensation curve is applied at the maximum Tx power. The units for this NV item are dB10 (10 counts equals 1 dB) and are relative to the maximum power as set by the base station; therefore, positive or negative values can be entered. Note that the temperature bin corresponding to the reference temperature should be set to zero.

This NV item is an array of eight elements that represent eight different temperatures.

QTI provides starting values in the static .xml provided with the AMSS build, but it is recommended that customers determine values applicable for their handset.

Element 0 represents the hottest temperature and element 7 the coldest.

6.2.1.31 NV_WCDMA<band>_REL6_TX_MPR_BACKOFF_I

Data type: Array of seven, uint8 values

This NV item holds backoff values in dB10 for different sets of release 6 waveforms based on cubic metric (CM). This NV item holds seven backoff values corresponding to the seven bins, with the first placeholder equal to minimum backoff, and the last placeholder equal to maximum backoff. This item only applies to release 6 and release 7 waveforms.

NV_WCDMA<band>_TX_REL6_MPR_BACKOFF_I has seven elements that can be used to apply Tx power backoff as follows:

- Element 0: Release 99
- Element 1: MPR = 0 dB
- Element 2: MPR = 0.5 dB
- Element 3: MPR = 1.0 dB
- Element 4: MPR = 1.5 dB
- Element 5: MPR = 2.0 dB
- Element 6: MPR = 2.5 dB

NOTE: This NV item is currently unused and may be obsolete. Use values found in the default, static NV xml file.

6.2.1.32 NV_WCDMA<band>_REL6_TX_BETA_SCALING_COMP_I

Data type: Array of seven uint16 values

This NV item holds beta scaling applied to different sets of Rel 6 waveforms. Beta scaling values are configurable through this NV. The actual scaling factor is (NV_WCDMA<band>_REL6_TX_BETA_SCALING_COMP[i]/32768). This item only applies to Rel 6 and 7.

6.2.1.33 NV_WCDMA<band>_REL6_TX_AGC_OFFSET_I

Data type: Array of seven uint8 values

This NV item holds Tx AGC offset to compensate for beta scaling that is applied to different sets of release 6 waveforms. This item only applies to Rel 6 and 7.

6.2.1.34 NV_WCDMA_REL7_PA_MPR_BACKOFF_I

Data type: Array of six, uint16 values

Identification number: 6756 (This NV item applies to all WCDMA bands.)

For release 6 (HSUPA) and release 7 (HSPA+) waveforms, the maximum power reduction (MPR) for the nominal maximum output power is based on the cubic metric (CM) value computed from the UE transmit channel configuration, as shown in Table 6-11, from 3GPP TC 25.101.

Table 6-11 UE transmit channel configuration

UE transmit channel configuration	CM (dB)	MPR (dB)
For all combinations of: DPDCH, DPCCH, HS-DPCCH, E-DPDCH, and E-DPCCH	0 ≤ CM ≤ 3.5	Max (CM-1, 0)

Note: CM = 1 for βc/βd = 12/15, βhs/βc = 24/15. For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH, and E-DPCCH, the MPR is based on the relative CM difference.

To optimize the UE performance, new NV items have been introduced to enable the PA switch points to be backed off, based on the applicable MPR.

Table 6-12 shows which NV item applies vs. the amount of backoff.

Table 6-12 NV identification vs. backoff in dBm

NV item array element	Backoff in dBm	NV setting
1	0	10
2	0.5	15
3	1	20
4	1.5	25
5	2.	30
6	2.5	35

6.2.1.35 RFNV_WCDMA_<band>_MPR_BACKOFF_I

This NV item has MPR back off value, which includes single band and dual bands. Each NV is two arrays. One for the SC mode, and the other for DC mode. If mpr_table_entries value from the NV is 0, that means that this NV item is not present, it will use the previous version back off value.

Table 6-13 MPR backoff format

Data	Datatype	Size
mpr_table_entries	8-bit unsigned	1byte1 x 1 = 1 byte
Array of 8, sc_tx_beta_scaling_comp	16-bit unsigned	2bytes x 8 = 16 bytes
Array of 8, sc_tx_agc_offset	16-bit unsigned	2bytes x 8 = 16 bytes
Array of 8,sc_ tx_mpr_backoff	16-bit unsigned	2 bytes x 8 = 16 bytes
Array of 7,sc_ pa_mpr_backoff	16-bit unsigned	2 bytes x 7 = 14 bytes
Array of 8, dc_tx_beta_scaling_comp	16-bit unsigned	2 bytes x 8 = 16 bytes
Array of 8, dc_tx_agc_offset	16-bit unsigned	2 bytes x 8 = 16 bytes
Array of 8, dc_ tx_mpr_backoff	16-bit unsigned	2 bytes x 8 = 16 bytes
Array of 7, dc_ pa_mpr_backoff	16-bit unsigned	2 bytes x 7 = 14 bytes

6.2.1.36 RFNV_WCDMA_B<band>_DB10_SAR_BACK_OFF_LIMIT

Data type: Array of eight, int16 values

Each index corresponds to a specific DSI state set by the rfm_common_sar_set_state() software API function (method). Element 1 is DSI1 and element 8 is DSI8. The value of each element is the desired max Tx power corresponding to the specific DSI, in the format of dBm × 10.

The maximum Tx power limit may be set to any power level within the calibrated Tx range. The Tx power-limit algorithm uses HDET, if present, to minimize the error in the actual power level and achieve best accuracy. The typical error is within ±1 dB. For power-limit settings below the HDET active range (typically < +18 dBm), the error is typically within ± 2 dB.

Refer to *Dynamic Maximum Tx Power Limits* (80-VP146-8) for details.

6.2.1.37 RFNV_WCDMA_<band>_TX_EPT_DPD_CONFIG_PARAMS_I

There is one DPD configuration NV item per band to store parameters for DPD software operation. See Section **Error! Reference source not found.** for format descriptions and details.

6.2.1.38 NV_WCDMA<band>_TX_CAL_CHAN_I

Data type: Array of 16, int16 values

This item has been repurposed for use in TX_LIN_VS_TEMP_VS_FREQ_P_IN and TX_LIN_VS_TEMP_VS_FREQ_P_OUT characterization. It contains the list of up to 16 channels used for the characterization.

6.2.1.39 RFNV_WCDMA_<band>_TX_LIN_VS_TEMP_VS_FREQ_P_IN_I

This NV item is used for frequency and temperature compensation in PA power input for each PA state (R0, R1, R2, and R3). See Section 5.2.1.20 for the format description and details.

6.2.1.40 RFNV_WCDMA_<band>_TX_LIN_VS_TEMP_VS_FREQ_P_OUT_I

This NV item is used for frequency and temperature compensation in PA power output for each PA state (R0, R1, R2, and R3). See Section 5.2.1.21 for the format description and details.

6.2.1.41 NV_WCDMA_MIN_TX_POWER_I

Data type: Single, int16 value

This item can be used to place a minimum on the WCDMA Tx power. It is required that FEATURE_WCDMA_MIN_INIT_TX_PWR be defined in software in order to take effect.

Conversion formula is NvValue = [(MinPower_dBm + 70) × 10] - 512.

6.2.1.42 RFNV_WCDMA_<band>_TX_XPT_DPD_SCALING_I

See 5.2.1.22.

6.2.1.43 RFNV_WCDMA_<band>_MTPL_VS_FREQ_I

Data type: Array of 16, int8 values

This item contains Maximum Transmit Power Limit (MTPL) adjustment over frequency. The value of each element maps to the MTPL offset in dB10 of the frequency bin from Tx calibration.

NOTE: Use values in the default, static NV, xml file if they exist in the file.

6.2.2 Calibrated, Tx RF NV items

6.2.2.1 RFNV_WCDMA_<band>_TX_MULTI_LIN_V3_DATA_I

For format and function details (except WCDMA rather than CDMA) see Section 5.2.2.1.

6.2.2.2 NV_WCDMA_<band>_EXP_HDET_VS_AGC_V2_I

Data type: Array of 16, unit16 values

AMSS software uses this NV item to build a lookup table, which indexes Tx power estimation via a scaled TxAGC (representing the desired Tx power) to the associated HDET circuit values at reference temperature and the reference frequency.

The straightforward approach to calibrating this item is described here. Break up the upper 1/4 of the Tx dynamic range into 16 segments. For example, the Tx dynamic range is from -70 to 32.4 dBm. The 16 segments associated with NV_WCDMA_EXP_HDET_VS_AGC_V2_I range from 6.8 to 32.4 dBm (6.8, 8.4, 10.0, 11.6, 13.2, 14.8, 16.4, 18.0, 19.6, 21.2, 22.8, 24.4, 26.0, 27.6, 29.2, and 30.8). Vary the desired Tx power by adjusting the Tx gain index (RGI) so that the Tx output power corresponds to the proper power level for each NV item index. Read the value of the HDET ADC for each index and store it in

NV_WCDMA_<band>_EXP_HDET_VS_AGC_V2_I [15:0], extrapolating data for the higher power levels. (It may not be practical to take measurements for extremely high Tx power levels.)

However, QTI recommends using the straightforward approach to calibrate this NV item. The measurements for this NV item can be easily gathered as part of the FTM Tx Sweep Cal command, which is more practical and much faster. The FTM command produces a relationship between measured Tx power levels and their associated HDET readings. Use interpolation to create a list of HDET values associated with the specified power levels listed in the above paragraph. Once created, store those HDET values (generated using interpolation) in this NV item.

6.2.2.3 NV_WCDMA_TX_LIM_VS_FREQ_I

Data type: Array of 16, int16 values

The NV item NV_WCDMA_TX_LIM_VS_FREQ contains a table of 16 adjustment values for the Tx power limit, based on frequency. The Tx power limit is heavily based on the feedback from the HDET circuit. This NV item is used to compensate for the frequency response of the HDET circuit and the RF components between that circuit and the RF output.

Perform these steps to calibrate this NV item:

1. Set the phone to the highest gain state.
2. Set the phone to the first RF cal channel.
3. Set phone to output power level where limiting should occur (maximum power) by adjusting the RGI (also called Tx PDM). Record the exact power level measured by the power measuring device of the cal station and the corresponding RGI. Let the recorded power be Power[i], and the RGI value be Pdm[i] where ‘i’ is the channel index 0 to 15.
4. Read and record the HDET from the appropriate ADC; take an average of several readings. Let the average HDET reading be HDET[i].
5. Repeat Steps 3 and 4 for all remaining RF calibration channels.
6. Calculate NV_WCDMA_TX_LIM_VS_FREQ:

   First calculate the HDET scale using the high PA range Tx linearizer power vs. HDET data collected during the Tx Sweep Cal routine. The HDET scale is calculated by finding the linear slope of power vs. HDET of the last two readings and multiplying by a scale factor of 10.

   Let HiPALinMaster1Pow[i]: Array holding Tx power of high PA range Tx linearizer

   HiPALinMaster1Hdet[i]: Array holding the corresponding HDET values

   Master1ListSize: The size of measured Tx linearizer data, up to maximum power

   ChIndex: RFCal channel index (index 0 through 15)

   RefChIndex: Reference channel index (for example, index 7)

   hdetScale = 10 × ((HiPALinMaster1Pow[Master1ListSize - 1] - HiPALinMaster1Pow[Master1ListSize - 2]) / (HiPALinMaster1Hdet[Master1ListSize - 1] - HiPALinMaster1Hdet [Master1ListSize - 2]))

   NV_WCDMA_TX_LIM_VS_FREQ[ChIndex]

= ((HDET[ChIndex] - HDET[RefChIndex]) × hdetScale) + 10 × (Power[RefChIndex] - Power[ChIndex])

Example:

Master1ListSize =14

HiPALinMaster1Pow[Master1ListSize - 1] = 23.4225 dBm

HiPALinMaster1Pow[Master1ListSize - 2] = 21.5758 dBm

HiPALinMaster1Hdet[Master1ListSize - 1] = 1805; this is the HDET value at 23.4225 dBm

HiPALinMaster1Hdet[Master1ListSize - 2] = 1292; this is the HDET value at 21.5758 dBm

ChIndex = 0

RefChIndex = 7

HDET[ChIndex] = 1761

HDET[RefChIndex] = 1570

Power [RefChIndex] = 22.6842 dBm

Power [ChIndex] = 23.0497 dBm

hdetScale = [(23.4225 - 21.5758)/(1805 - 1292)] × 10 = 0.036

NV_WCDMA_TX_LIM_VS_FREQ[0] = (1761 - 1570) × 0.036 + (22.6842 - 23.0497) × 10 = 6.876 - 3.655 = 3.

6.2.2.4 RFNV_WCDMA_<band>_PIN_CAL_VS_FREQ _I

Data type: Array of 8*16, int16 values

This NV item has Pin compensation calibrated across 16 frequency channels for all 8 PA states in one band. So, each NV is a two-dimensional array of 8 x 16, representing calibrated Pin value across 16 channels for all PA states. If the Pin Cal value from the NV is 32767 (0x7FFF), then the Pin for that particular PA state is not calibrated.

Table 6-14 Pin Cal versus Freq structure

NV item	Data type	Size
RFNV_WCDMA_<band>_PIN_CAL_VS_FREQ_I	16-bit signed	2 bytes x 8 x 16 = 256 bytes

7 LTE RF NV items

This chapter describes the LTE NV items. These descriptions apply to all LTE bands. Several of the NV items may have more than one identification number, depending on the band. Table 7-1 lists these band classes, identifying the corresponding name and frequency.

Table 7-1 NV item band examples

Band	Name and frequency	Example NV name
1	2100	NV_LTE_B1_RX_CAL_CHAN_I
4	1700/2100	NV_LTE_B4_RX_CAL_CHAN_I
7	2600	NV_LTE_B7_RX_CAL_CHAN_I
11	1500	NV_LTE_B11_RX_CAL_CHAN_I
13	H700	NV_LTE_B13_RX_CAL_CHAN_I
17	L700	NV_LTE_B17_RX_CAL_CHAN_I
40	2300	NV_LTE_B40_RX_CAL_CHAN_I
3	1700/1800	NV_LTE_B3_RX_CAL_CHAN_I

Secondary chain (diversity chain) items have “C1” in their names, such as NV_LTE_B13_C1_RX_CAL_CHAN_I.

7.1 LTE Rx RF NV items

7.1.1 Static, Rx RF NV items

7.1.1.1 NV_WCDMA_<band>_EXP_HDET_VS_AGC_V2_I

Data type: Array of 16, unit16 values

AMSS software uses this NV item to build a lookup table, which indexes Tx power estimation via a scaled TxAGC (representing the desired Tx power) to the associated HDET circuit values at reference temperature and the reference frequency.

Described here is the straightforward approach to calibrating this item. Break up the upper 1/4 of the Tx dynamic range into 16 segments, e.g., the Tx dynamic range is from -70 to 32.4 dBm. The 16 segments associated with NV_WCDMA_EXP_HDET_VS_AGC_V2_I range from 6.8 to 32.4 dBm (6.8, 8.4, 10.0, 11.6, 13.2, 14.8, 16.4, 18.0, 19.6, 21.2, 22.8, 24.4, 26.0, 27.6, 29.2, 30.8). Vary the desired Tx power by adjusting the Tx gain index (RGI) so that the Tx output power corresponds to the proper power level for each NV item index. Read the value of the HDET ADC for each index and store it in NV_WCDMA_<band>_EXP_HDET_VS_AGC_V2_I [15:0], extrapolating data for the higher power levels. (It may not be practical to take measurements for extremely high Tx power levels.)

However, it is not recommended to use the straightforward approach to calibrate this NV item. The measurements for this NV item can be easily gathered as part of the FTM Tx Sweep Cal command, which is more practical and much faster. The FTM command produces a relationship between measured Tx power levels and their associated HDET readings. Use interpolation to create a list of HDET values associated with the specified power levels listed in the above paragraph. Once created, store those HDET values (generated using interpolation) in this NV item.

7.1.1.2 RFNV_LTE_<band>_CA_BC_CONFIG_I

Data type: uint64

This NV item determines which LTE bands are capable of being used by the device for carrier aggregation (CA). Bit position 0 corresponds to band 1, bit 1 to band 2, bit 2 to band 3, etc. The <band> part of the NV item's name specifies the primary cell (PCell) band. Each bit in the bitfield represents a potential secondary cell (SCell) band for use in CA. A bit value of '1' indicates the band is supported by the device for CA as an SCell band.

7.1.1.3 NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I

Data type: Array of 32, int16 values. These can be thought of as organized into an array of 16 structures, such that element 0 within the structure is the rise value, and element 1 within the structure is the fall value.

This NV item specifies the Rx power level threshold for which the LNA/mixer is intended to switch from one gain state to another (gain state 0 is the high gain state). The NV item is an array of 16 structures with each structure containing the rise and fall values corresponding to each gain transition. They are arranged in the order shown in Table 7-2 and Table 7-3.

Table 7-2 Rise and fall thresholds for gain-state pair

Element	Rise and fall thresholds for gain-state pair
NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I[0]	G0/G1
NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I[1]	G1/G2
NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I[2]	G2/G3
NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I[3]	G3/G4
NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I[4]	G4/G5

The rise and fall switch points can be accessed as shown in Table 7-3.

Table 7-3 Rise and fall switch points

Element	Switch point
NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I[0] – rise_threshold	RISE G0 – G1
NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I[0] – fall_threshold	FALL G1 – G0
NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I[1] – rise_threshold	RISE G1 – G2
NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I[1] – fall_threshold	FALL G2 – G1
NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I[2] – rise_threshold	RISE G2 – G3
NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I[2] – fall_threshold	FALL G3 – G2
NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I[3] – rise_threshold	RISE G3 – G4
NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I[3] – fall_threshold	FALL G4 – G3
NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I[4] – rise_threshold	RISE G4 – G5
NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I[4] – fall_threshold	FALL G5 – G4

There are six gain states; the rise and fall switch points must be specified for each gain state change. The resolution of this NV item is 10 counts per dB.

Example data:

Values in QCN: -600, -640, -550, -590, -440, -480, -330, -370, -220, -260

Values in dBm: -60 dBm, -64 dBm, -55 dBm, -59 dBm, -44 dBm, -48 dBm, -33 dBm, -37 dBm, -22 dBm, -26 dBm

This data is for example purposes only; refer to the static NV xml file for the latest settings.

7.1.1.4 RFNV_LTE_<band>_C2_LNA_RANGE_RISE_FALL_I, RFNV_LTE_<band>_C3_LNA_RANGE_RISE_FALL_I

These NV items are identical in functionality to the NV_LTE_<band>_<C1_>LNA_RANGE_RISE_FALL_I items described in Section 7.1.1.3 except that they are used for inter-band CA.

7.1.1.5 NV_LTE_<band>_<C1_>LNA_PHASE_CTRL_I

Data type: Array of 16, uint16 values

This NV item has been added to compensate for RF distortions caused by sudden jumps in the phase at the LNA switch points. This phase jump is programmed in NV. Duplicate the approach used in the static NV xml file.

7.1.1.6 RFNV_LTE_Cx_SPURS_TABLE_I

This NV item specifies the frequencies and depths of any desired notch filters to remove CW spurs within the useful Rx bandwidth. Depending on specific board design characteristics, spurs have the potential to degrade minimum sensitivity performance.

See Section 5.1.1.5 for details.

7.1.1.7 RFNV_LTE_CA_BC_CONFIG_I

Data type: See Table 7-4.

This is a LTE common NV to consolidate CA BC CONFIG NVs to support up to 5DLCA scenarios. Currently, this NV is only used by 3DLCA scenarios. 2DLCA scenarios still use the legacy NVs described in Section 3.1.1. The format of this NV is defined in Table 7-4.

Table 7-4 RFNV_LTE_CA_BC_CONFIG_I format

Name	Data Type	Size	Description
version	uint8	1	NV version value
lte_dl_ca_band_combo	QMSL_LTE_DL_CA_COMBO_DATA_TYPE	128	See Table 7-5

Table 7-5 QMSL_LTE_DL_CA_COMBO_DATA_TYPE format

Element	Type	Size	Description	Example
pcc band	uint8	1	PCell band in the DLCA combination	1
scc0 band	uint8	1	SCell0 band in the DLCA combination	3
scc1 band	uint8	1	SCell1 band in the DLCA combination	5
scc2 band	uint8	1	SCell2 band in the DLCA combination	0
scc3 band	uint8	1	SCell3 band in the DLCA combination	0

If this NV is missing in EFS, hardcoded 3DLCA combinations are used. MSM8909/89x7 does not support 3DCLA yet. So there is no current use for this NV.

7.1.2 Calibrated, Rx RF NV items

7.1.2.1 NV_LTE_<band>_<C1_>RX_CAL_CHAN_I

Data type: Array of 16, uint16 values

This NV item holds the Rx channel list on which the RF calibration is carried out. QTI provides a default channel list; customers can modify it according to their specific requirements. QTI uses 16 calibration channels.

NOTE: Althoughthis item is technically a static NV item, it is typically populated in the phone at factory calibration time.

7.1.2.2 NV_LTE_<band>_<C1_>RX_GAIN_I

Data type: Array of 16, int16 values

A table of hardcoded nominal Rx gain values for each LNA state is used as a starting point. NV_LTE_RX_GAIN_I[x] contains an offset to the hardcoded values at the reference channel.

Table 7-6 Gain-state transition per NV element

Element	Offset for gain transition
NV_LTE_<band>_RX_GAIN_I [0]	G0
NV_LTE_<band>_RX_GAIN_I [1]	G1
NV_LTE_<band>_RX_GAIN_I [2]	G2
NV_LTE_<band>_RX_GAIN_I [3]	G3
NV_LTE_<band>_RX_GAIN_I [4]	G4
NV_LTE_<band>_RX_GAIN_I [5]	G5

To calibrate this NV item, perform the following:

1. Configure the device for LTE mode and specify the band using FTM_SET_MODE.
2. Set the receiver bandwidth to 10 MHz using FTM_LTE_SET_RX_BANDWIDTH.
3. Set the device reference frequency using FTM_SET_CHAN.
4. Repeat Steps 5 through 8 for each Rx gain state, starting from G5 to G0.
5. Set the receiver gain state to the current Rx gain state using FTM_SET_LNA_RANGE.
6. Apply a CW tone offset by 500 kHz from the Rx frequency at the phone primary receive antenna connector, with the power level shown in Table 7-7. The power levels shown are examples only. Refer to the corresponding test tree released with QDART for updated values.

Table 7-7 Rx calibration input power

LNA gain state	Input tone power (dBm)
G0	-52
G1	-50
G2	-44
G3	-33

LNA gain state	Input tone power (dBm)
G4	-30
G5	-30

7. Get the Rx gain offset for the current gain state using FTM_GET_LNA_OFFSET.
8. Write the returned value into RFNV_LTE_<band>_<C1_>RX_GAIN_I [current Rx gain state], which is the gain variation from the nominal Rx gain.

There is some flexibility in choosing the actual power level used in calibration. The power level must be above the thermal noise floor, yet below saturation for the particular gain state being calibrated. For the very latest suggested power levels, refer to the appropriate QSPR test tree in the latest version of QDART.

NOTE: For certain LTE bands, e.g., B1, B7, B13, B17, B40, the NV_LTE_<band>_<C1_>RX_GAIN_I had an incorrect data type of 16-bit unsigned (uint16). For these LTE bands, new RF NV items were created with a correct data type of 16-bit signed (int16), i.e., NV_LTE_<band>_<C1_>RX_GAIN_I_I. The QSPR calibration tool was updated to write into these new NVs for these LTE bands. If these new NVs are not populated, e.g., for some older devices already in use, the RF software still reads values from the old NVs. For B1, B7, B13, B17, B40, use NV_LTE_<band>_<C1_>RX_GAIN_I_I instead of NV_LTE_<band>_<C1_>RX_GAIN_I.

7.1.2.3 RFNV_LTE_<band>_C2_RX_GAIN_I, RFNV_LTE_<band>_C3_RX_GAIN_I

These NV items are identical in function to the NV_LTE_<band>_<C1_>RX_GAIN_I items described in Section 7.1.2.1, except they are used for inter-band CA.

7.1.2.4 NV_LTE_<band>_<C1_>RX_GAIN_VS_FREQ_I

Data type: Array of 128, int8 values. Not all elements are used.

This item stores the gain offsets differences of the different calibration channels, compared to the reference frequency item NV_LTE_<band>_<Cy_>RX_GAIN_I. These NV values should be considered as adjustments for gain variation of the LNA gain step, based on the frequency index. The values are the change between the reference frequency LNA gain step and the LNA gain step at the frequency index of interest.

The set of 128 values can be considered an array of six gain index arrays each containing an array of 16 frequency offset values. Only the first six gain indexes are used (gain indexes 0–5). Gain index 0 represents the gain offset when the LNA/mixer is in its highest gain. Incremental gain indexes store gain offsets at subsequently lower gains. Each frequency index corresponds to a frequency channel in NV_LTE_<band>_<Cy_>RX_CAL_CHAN_I. Ultimately each element value is a gain offset.

To calibrate this NV item, perform the following procedure:

1. Repeat Steps 5 through 8 that were performed during the compensation for RFNV_LTE_<band>_<C1_>RX_GAIN_I for the number of frequency channels desired (up to 16 frequency channels may be used).
2. Calculate the delta between the compensation for each frequency channel and the values determined for the reference channel (stored in NV_LTE_<band>_<C1_>RX_GAIN_I).

3. Write the delta values into NV_LTE_<band>_<C1_>RX_GAIN_VS_FREQ_I[Rx gain state][freq] = RxGainAtNewFreqChannel[Rx gain state][freq] - NV_LTE_<band>_<C1_>RX_GAIN_I[Rx gain state]

NOTE: To clarify Step 3, the polarity is NVvalue[freq] = Value[freq] - Value[reference freq].

NOTE: For LTE B17, NV_LTE_B17_C1_RX_GAIN_VS_FREQ_I (item# 6642) had an incorrect size of 64, so a new item, NV_LTE_B17_C1_RX_GAIN_VS_FREQ_I_I (item# 7225), with a size of 128, was created to correct this error. NV_LTE_B17_C1_RX_GAIN_VS_FREQ_I (item# 6642) is not supported in software; use NV_LTE_B17_C1_RX_GAIN_VS_FREQ_I_I (item# 7225) instead.

7.1.2.5 RFNV_LTE_<band>_C2_RX_GAIN_VS_FREQ_I, RFNV_LTE_<band>_C3_RX_GAIN_VS_FREQ_I

These NV items are identical in function to the NV_LTE_<band>_<C1_>RX_GAIN_VS_FREQ_I items described in Section 7.1.2.4, except that they are used for inter-band CA.

7.1.2.6 RFNV_LTE_<band>_INTRA_CA_RX_GAIN_VS_FREQ_I

Data type: Array of 384, int8 values

RFNV_LTE_B<Band>_INTRA_CA_RX_GAIN_VS_FREQ_I[Rx chain][gain state][freq index] stores the gain offsets differences of the different calibration channels, compared to the sum of the items NV_LTE_Bx_<Cy_>RX_GAIN_I[gain state] + NV_LTE_Bx_<Cy_>RX_GAIN_VS_FREQ_I[gain state][freq index], for use in intra-band CA. Gain offset values are in dB10 units. The format is shown in Table 7-8.

Table 7-8 RFNV_LTE_<band>_INTRA_CA_RX_GAIN_VS_FREQ_I format

Element index	Rx chain	Gain index	Element (single int8 value each)
0	Rx chain 0	RxState 0 (high gain)	Gain offset for frequency index 0
1			Gain offset for frequency index 1
...			…
15			Gain offset for frequency index 15
16		RxState 1	Gain offset for frequency index 0
17			Gain offset for frequency index 1
…			…
31			Gain offset for frequency index 15
…		…	…
80		RxState 5 (low gain)	Gain offset for frequency index 0
81			Gain offset for frequency index 1
…			…
95			Gain offset for frequency index 15
96	Rx chain 1	RxState 0 (high gain)	Gain offset for frequency index 0
97			Gain offset for frequency index 1
..			…

Element index	Rx chain	Gain index	Element (single int8 value each)
111			Gain offset for frequency index 15
112		RxState 1	Gain offset for frequency index 0
113			Gain offset for frequency index 1
…			…
127			Gain offset for frequency index 15
…		…	…
176		RxState 5 (low gain)	Gain offset for frequency index 0
177			Gain offset for frequency index 1
…			…
191			Gain offset for frequency index 15
…			
288	Rx chain 3	RxState 0 (high gain)	Gain offset for frequency index 0
289			Gain offset for frequency index 1
…			…
303			Gain offset for frequency index 15
304		RxState 1	Gain offset for frequency index 0
305			Gain offset for frequency index 1
…			…
319			Gain offset for frequency index 15
…		…	…
368		RxState 5 (low gain)	Gain offset for frequency index 0
369			Gain offset for frequency index 1
…			…
383			Gain offset for frequency index 15

7.1.2.7 NV_LTE_<band>_<C1_>IM2_VALUES_I

Data type: Array of three, uint8 values;

Element[0] is IM2 I, Element[1] IM2 Q. Element[3] is transconductance and is not used.

LTE IM2 calibration is not presently required. Any new requirements will be updated in a future document release.

7.1.2.8 RFNV_LTE_<band>_RX_CAL_DATA_V2_I

Data type: See Table 7-9.

This NV store Rx gain offsets versus frequency for all RF chain and path combination. The motivation for this NV item is to better support multiple path calibration in LTE. This approach may eliminate the need to introduce new NV items for each new path.

General format of the item is shown in Table 7-9.

Table 7-9 RFNV_LTE_<band>_RX_CAL_DATA_V2_I general format

Element number	Element name	What is stored	Size
0	version	Version of the NV item	Single, uint16 value
	number of elements	The value of N, the total number of elements in this table, excluding Varient_Marker (see the bottom left corner of this table for N).	Single, uint16 value
1	datatype	118	Single, uint16 value
	Element data	RFNV_DATA_TYPE_RX_CAL_OFFSET_V2	
2	datatype	118	Single, uint16 value
	Element data	RFNV_DATA_TYPE_RX_CAL_OFFSET_V2	
…	…	…	…
N-1	datatype	118	Single, uint16 value
	Element data	RFNV_DATA_TYPE_RX_CAL_OFFSET_V2	
N	datatype	118	Single, uint16 value
	Element data	RFNV_DATA_TYPE_RX_CAL_OFFSET_V2	

Table 7-10 RFNV_DATA_TYPE_RX_CAL_OFFSET_V2 (type id 118)

Element	Data	Size
nv_container_index	Corresponding NV container index (specified in RF card for a band) for the calibration data	Single, uint16 value
cal_type	Denotes what type of calibration data is stored. See Table 7-11.	Single, unit16 value
channel_list	Array of up to 16 channel list numbers. The list must be in ascending order in terms of frequency.	16 × unit16 values
freq_offsets_lna0	List of LNA Offset 0 values for LNA state 0. Each value corresponds to a different frequency index.	16 × int16 values
freq_offsets_lna1	List of LNA Offset 0 values for LNA state 1. Each value corresponds to a different frequency index.	16 × int16 values
…	…	…
freq_offsets_lna7	List of LNA Offset 0 values for LNA state 7. Each value corresponds to a different frequency index.	16 × int16 values

Table 7-11 cal_type used by LTE

Cal Type	Type Number
RFNV_RX_CAL_DATA_NV_TYPE_LTE_BW_1p4	5001
RFNV_RX_CAL_DATA_NV_TYPE_LTE_BW_3p5	5002
RFNV_RX_CAL_DATA_NV_TYPE_LTE_BW_5p0	5003
RFNV_RX_CAL_DATA_NV_TYPE_LTE_BW_10p0	5004
RFNV_RX_CAL_DATA_NV_TYPE_LTE_BW_15p0	5005
RFNV_RX_CAL_DATA_NV_TYPE_LTE_BW_20p0	5006
RFNV_RX_CAL_DATA_NV_TYPE_LTE_BW_40p0	5007
RFNV_RX_CAL_DATA_NV_TYPE_LTE_INTRA_BW_1p4	5008
RFNV_RX_CAL_DATA_NV_TYPE_LTE_INTRA_BW_3p5	5009
RFNV_RX_CAL_DATA_NV_TYPE_LTE_INTRA_BW_5p0	5010
RFNV_RX_CAL_DATA_NV_TYPE_LTE_INTRA_BW_10p0	5011
RFNV_RX_CAL_DATA_NV_TYPE_LTE_INTRA_BW_15p0	5012
RFNV_RX_CAL_DATA_NV_TYPE_LTE_INTRA_BW_20p0	5013
RFNV_RX_CAL_DATA_NV_TYPE_LTE_INTRA_BW_40p0	5014

Once the new NV is populated, software does not load any old legacy Rx calibration data for all Rx chains including interband/intraband CA calibration. As a result, there is no mix and match between new consolidated Rx cal NV and legacy Rx NVs.

7.2 LTE Tx RF NV items

7.2.1 Static, Tx RF NV items

7.2.1.1 NV_LTE_<band>_MAX_TX_POWER_I

Data type: uint8 value

This NV item specifies the absolute maximum power that a phone can transmit in the PUSCH, i.e., in the traffic channel. For example, the maximum Tx power can be specified as 23 dBm but not 23.5 dBm, since only integer values are allowed.

NOTE: A different NV item, RFNV_LTE_<band>_MAX_TX_POWER_DB10_I, is more flexible and can replace this NV item. See Section 7.2.1.2 for details.

7.2.1.2 RFNV_LTE_<band>_MAX_TX_POWER_DB10_I

Data type: Array of two, uint16 values

This NV item is similar to RFNV_LTE_<band>_MAX_TX_POWER_I as specified in Section 7.2.1.1, but in units of dBm10 (i.e., 10 counts per dB).

The NV item is an array of two elements. The first element in the array, RFNV_LTE_<band>_MAX_TX_POWER_DB10_I[0], enables this feature when set to a nonzero value. The second element in the array, RFNV_LTE_<band>_MAX_TX_POWER_DB10_I[1], defines the absolute maximum power that a phone can transmit in the PUSCH in units of dBm × 10.

Example

[1, 224] indicates this NV is enabled, and the absolute maximum power that a phone can transmit is defined as 22.4 dBm.

[0, 224] indicates this NV is disabled, and the second entry is ignored.

7.2.1.3 RFNV_LTE_MIN_TX_POWER_DB10_I

Data type: Structure of a uint16 value and an int16 value

Data range: Element[0] (uint16): ‘0’ for disable or ‘1’ for enable (see below for details)
Element [1] (int16): -700 to -440 (see below regarding sign)

This NV item, if enabled, allows the LTE minimum Tx power to be at or above the specified value. By default, the LTE minimum Tx power is determined by a hardcoded value (presently -44 dBm). This NV item allows the minimum Tx power to be lower than that (but no lower than -70 dBm).

Element 0 of this NV item (a uint16 value) enables the feature. Any nonzero value enables the feature, and ‘0’ disables the feature. If the feature is enabled, the LTE minimum Tx power is determined by the next element in the NV item. Otherwise, the LTE minimum Tx power is determined by the default value hardcoded in software.

Element 1 of this NV item (an int16 value) specifies the LTE minimum Tx power if the feature is enabled. Units are dBm × 10. AMSS treats it as a signed value. However, there may be a discrepancy in the NvDefintion.xml file that treats it as an unsigned uint16 value. Therefore, it is important that proper sign extension is used if it is treated as an unsigned value by any tools used to handle the item. This can be done using the following formula:

NV_value = 65536 + (LTEminPower_dBm × 10)

For example, if the desired LTE minimum Tx power is -50 dBm, the value stored in the value element is

65536 + (-50 × 10) = 65536 - 500 = 65036.

Alternately, if the tool treats the value as a signed int16 value, the additional step of adding 66536 is not necessary.

Values are restricted by software to be between power levels corresponding to -70 and -44 dBm.

This NV item applies to all LTE bands.

7.2.1.4 RFNV_LTE_Bx_MIN_TX_POWER_DB10_I

Data type: Structure of a uint16 value and an int16 value.

Data range: Element[0] (uint16): ‘0’ for disable or ‘1’ for enable (see below for details)
Element[1] (int16): -700 to -440 (see below regarding sign)

This NV item, if enabled, allows the LTE minimum Tx power to be at or above the specified value. By default, the LTE minimum Tx power is determined by a hardcoded value (presently -44 dBm). This NV item allows the minimum Tx power to be lower than that (but no lower than -70 dBm).

Element 0 of this NV item (a uint16 value) enables the feature. Any nonzero value enables the feature, and ‘0’ disables the feature. If the feature is enabled, the LTE minimum Tx power is determined by the next element in the NV item. Otherwise, the LTE minimum Tx power is determined by the default value hardcoded in software.

Element 1 of this NV item (an int16 value) specifies the LTE minimum Tx power if the feature is enabled. Units are dBm × 10. AMSS treats it as a signed value in db10 format.

Values are restricted by software to be between power levels corresponding to -70 and -44 dBm.

This NV item is band specific and it overrides the common LTE Min power NV RFNV_LTE_MIN_TX_POWER_DB10_I. If the band-specific NV is not present, RFNV_LTE_MIN_TX_POWER_DB10_I takes effect. If both the NVs are absent, a hardcoded value is used.

QTI recommends using the band specific NV, RFNV_LTE_Bx_MIN_TX_POWER_DB10_I.

7.2.1.5 NV_LTE_<band>_TX_LIMIT_VS_TEMP_I

Data type: Array of eight, int8 values. Index 0 corresponds to hot and index 7 corresponds to cold.

This NV item specifies the desired Tx power limit offset for the traffic channel for each of eight temperature values, all at the reference frequencies.

The NV item NV_LTE_<band>_TX_LIMIT_VS_TEMP_I contains a table of eight adjustment values relative to NV_LTE_<band>_MAX_TX_POWER_I or RFNV_LTE_<band>_MAX_TX_POWER_DB10_I, based on temperature. The temperature range for the phone is divided into eight segments. Each element corresponds to a segment. For a given temperature, each offset in the NV_LTE_<band>_MAX_POWER_I (or RFNV_LET_<band>_MAX_TX_POWER_DB10_I) is adjusted by a constant amount based on this table.

Example 1: If, for a given temperature index, the element in this table is 5, the maximum Tx power is increased by 0.5 dB when the temperature corresponds to that given index. Based on the temperature, an appropriate bin in the array is picked for compensation. The default value is set to all zeros if there is no temperature compensation required.

The resolution of this NV item is 10 counts per.

Example 2: If the desired power is 22.7 dBm but, at a certain temperature, the uncompensated power is measured as 22 dBm, 0.7 dB of compensation would be applied. In NV, however, 7 would be populated because the NV item reflects the delta in the actual measurement from the desired level.

NOTE: This item functionality can be replaced by the more flexible RFNV_LTE_<band>_TX_LIM_VS_TEMP_VS_FREQ_I item functionality, if desired (see Section 7.2.1.6).

7.2.1.6 RFNV_LTE_Bx_TX_LIM_VS_TEMP_VS_FREQ_I

Data type: Structure of a single uint8 element followed by a 2-dimensional 16 × 8 array of int8 values.

Units: matrix_enable (first uint8 value): none.
tx_lim_vs_temp_vs_freq (16 × 8 array of int8 values): dB10 (10 counts per dB)

This NV item can replace the NV_LTE_<band>_TX_LIMIT_VS_TEMP_I item (see Section 7.2.1.5), but with the additional functionality of being configurable over frequency channel. If enabled this NV item is used. If not enabled or not populated, the older NV_LTE_<band>_TX_LIMIT_VS_TEMP_I item is used.

The first element (Element[0]) in the NV item, a uint8 value, is the matrix_enable element. If this element's value is '1', the 2-D temperature-vs.-frequency feature is enabled. (Technically, any nonzero value enables the feature). A value of 0 disables the feature.

NOTE: If this NV item is enabled, the NV_LTE_<band>_TX_LIMIT_VS_TEMP_I is ignored. Although both items can be populated in NV memory, this NV item is not used in conjunction with NV_LTE_Bx_TX_LIMIT_VS_TEMP_I. Their functionalities are mutually exclusive.

The remaining data stored in the NV item is in the form of a two-dimensional array called lim_vs_temp_vs_freq. The array format is outlined in Table 7-9 (the table does not show the matrix_enable element).

Table 7-12 RFNV_LTE_Bx_TX_LIM_VS_TEMP_VS_FREQ_I 2-D array format

2-D array element index (does not include the 'matrix_enable' byte)	Frequency channel index	Temperature bin index
0	Channel index 0	0 (hot)
1		1
2		2
… …		… …
5		5
6		6
7		7 (cold)
8	Channel index 1	0 (hot)
9		1
10		2
… …		… …
… …	… …	… …
… …	Channel index 15	… …
125		5
126		6
127		7 (cold)

Each frequency channel index corresponds to a channel number stored in the frequency channel list in the RFNV_LTE_Bx_TX_MULTI_LIN_DATA_I item.

Each temperature index corresponds to a temperature bin. Index 0 corresponds to hot and index 7 to cold.

Each int8 element in the array has units of dB10 (10 counts per dB). Positive values increase the measured maximum Tx power level at the given frequency channel and given temperature. Compensation is linearly interpolated over temperature.

7.2.1.7 NV_LTE_<band>_AGC_PA_ON_RISE_FALL_DELAY_I

Data type: Array of two, uint16 values

NV_LTE_<band>_AGC_PA_ON_RISE_FALL_DELAY_I[0] is the time delta between the PA_ON signal rise and the start of the Tx frame boundary in chip resolution. It is used to time-align the PA_ON signal at the beginning of the Tx time line. This NV item is used in PRACH and PUSCH. A value 0 of causes the PA_ON signal to rise 20 microseconds before the start of the Tx signal. Positive values reduce this time interval.

NOTE: Although NV_LTE_<band>_AGC_PA_ON_RISE_FALL_DELAY_I[0] is technically an unsigned value, software treats it as though it was an signed, 16-bit, 2s-complement number. Therefore negative values are possible by adding the negative representation to 65536. For example, to represent -3.3 microseconds, store "-100" as 65436 (This causes the PA_ON signal to rise 23.3 microseconds before the start of the signal).

NV_LTE_<band>_AGC_PA_ON_RISE_FALL_DELAY_I[1] is the time delta between when the PA_ON signal falls after the end of the Tx frame boundary in chip resolution. It is used to time align the PA_ON signal at the end of the Tx time line. This NV item is used in PRACH and PUSCH.

Example data:

Values in QCN: 1, 460

Values in time: 33 ns, 15 µs

This data is an example only. QTI recommends using the values provided in the static NV xml file.

NOTE: This item may be obsolete moving forward. Use values in the default static NV xml file if they exist in the file.

7.2.1.8 NV_LTE_<band>_AGC_TX_ON_RISE_FALL_DELAY_I

Data type: Array of two, uint16 values

NV_LTE_<band>_AGC_TX_ON_RISE_FALL_DELAY_I[0] is used to adjust the time mask during PRACH and PUSCH. This item is the time delta between TX_ON signal rise and the start of the Tx frame boundary in chip resolution. It is used to time align the TX_ON signal at the beginning of the Tx time line. This item is used in PRACH and PUSCH.

NV_LTE_<band>_AGC_TX_ON_RISE_FALL_DELAY_I[1] is the time delta between when the TX_ON signal falls after the end of the Tx frame boundary in chip resolution. It is used to time align the TX_ON signal at the end of the Tx timeline. This NV item is used in PRACH and PUSCH.

Example data:

Values in QCN: 5, 455

Values in time: 163 ns, 14.84 µs

This data is an example only. QTI recommends using the values provided in the static NV xml file.

NOTE: This item may be obsolete moving forward. Use values in the default static NV xml file, if they exist in the file.

7.2.1.9 NV_LTE_<band>_PA_GAIN_UP_DOWN_TIME_I

Data type: Array of two, uint16 values

NV_LTE_<band>_PA_GAIN_UP_DOWN_TIME_I[0] contains the time delta between the time reference signal and the PA_RANGE updated for the transition from low- to the high-gain state. Tuning this item influences the relative timing between the PA_RANGE transition and the RF gain update signal in the transmit chain. Generally, customers do not need to tune this NV item; instead, refer to the value in the static NV, xml file that comes with the software build.

NV_LTE_<band>_PA_GAIN_UP_DOWN_TIME_I[1] contains the time delta between the time reference signal arrival and PA_RANGE updated for the transition from high- to low-gain state. Tuning this item influences the relative timing between the PA_RANGE transition and the RF gain update signal in the transmit chain. Generally, tuning this NV item is unnecessary; instead, refer to the value in the static NV xml file that comes with the software build.

Example data:

Values in QCN: 34, 31

Values in time: 1.1 µs, 1 µs

This data is an example only. QTI recommends using values provided in the static NV xml file.

NOTE: This item may be obsolete moving forward. Use values in the default, static NV, xml file if they exist in the file.

7.2.1.10 NV_LTE_<band>_TX_ROT_ANGLE_PA_STATE_I

Data type: Array of eight, unit16 values

This NV item contains a rotation angle in degrees with a resolution of 360/256 = 1.406 degrees. The rotation value is applied to the Tx signal per PA range. For example, NV_LTE_<band>_TX_ROT_ANGLE_PA_STATE_I[0] could be used to compensate for the phase discontinuity while in state 00, NV_LTE_TX_ROT_ANGLE_PA_STATE_I[1] for state 1, etc. For negative amounts of compensation, the value needs to be subtracted from 255. Note also that these NV items are relative to the amount of compensation applied for other gain states.

Example calculations

Original values:

- NV_LTE_<band>_TX_ROT_ANGLE_PA_STATE_00_I = 0
- NV_LTE_<band>_TX_ROT_ANGLE_PA_STATE_01_I = 20 (20 additional counts of compensation required for this transition)
- NV_LTE_<band>_TX_ROT_ANGLE_PA_STATE_10_I = 37 = 20 + 17 (17 additional counts of compensation required for this transition)
- NV_LTE_<band>_TX_ROT_ANGLE_PA_STATE_11_I = 37 = 37 + 0 (0 additional counts of compensation required for this transition)

If 30 degrees less compensation than originally used is needed for STATE_01, populate the following values:

- NV_LTE_<band>_TX_ROT_ANGLE_PA_STATE_00_I = 0
- NV_LTE_<band>_TX_ROT_ANGLE_PA_STATE_01_I = 255 = -1 mod 256 = 20 - 21 (1 less count required for this transition instead of 20 additional ones)
- NV_LTE_<band>_TX_ROT_ANGLE_PA_STATE_10_I = 16 = 255 + 17 (17 additional counts of compensation required for this transition)
- NV_LTE_<band>_TX_ROT_ANGLE_PA _STATE_11_I = 16 = 16 + 0 (0 additional counts of compensation for this transition)

QTI recommends using the values provided in the static NV xml file as a starting point.

7.2.1.11 NV_LTE_<band>_PA_COMPENSATE_UP_DOWN_I

Data type: Array of sixteen int16 values. However, the format can be better thought of as an array of eight structures, where each structure contains two elements. Each structure corresponds to a TxState (PA gain state). Structure 0 corresponds to TxState 0, structure 1 to TxState 1, and so on. Not all structures are necessarily used. Element 0 of each structure contains the up compensation and element 1 contains the down compensation. Each element has a resolution of 10 counts per dB. Table 7-13 shows the format.

Table 7-13 Gain-state transition per NV element

Element	Compensation applied during the transition
NV_LTE_<band>_PA_COMPENSATE_UP_DOWN_I[0] – comp_up	RISE PA1 – PA0
NV_LTE_<band>_PA_COMPENSATE_UP_DOWN_I[0] – comp_down	FALL PA0 – PA1
NV_LTE_<band>_PA_COMPENSATE_UP_DOWN_I[1] – comp_up	RISE PA2 – PA1
NV_LTE_<band>_PA_COMPENSATE_UP_DOWN_I[1] – comp_down	FALL PA1 – PA2
NV_LTE_<band>_PA_COMPENSATE_UP_DOWN_I[2] – comp_up	RISE PA3 – PA2
NV_LTE_<band>_PA_COMPENSATE_UP_DOWN_I[2] – comp_down	FALL PA2 – PA3

This item contains a TxAGC offset for aid in meeting ILPC specifications. This offset is only applied to the slot following a PA range transition from one PA range to another. The total duration of this offset is only for that one slot. Because ILPC specifications are generally not an issue with LTE, this item is rarely populated, and may be unnecessary.

The value specified in this NV item can be positive or negative. Note that this NV item only averages out the spike in ILPC performance (when looking at the ILPC delta level, not the absolute level) over two consecutive slots. Essentially, the offset that is applied on one slot propagates to the next slot. Accordingly, a 0.5 dB upward spike could be averaged out to be a 0.25 dB downward spike and a 0.25 dB upward spike with the use of this NV item. Figure 7-1 illustrates which NV item to apply for a given PA gain-state transition.

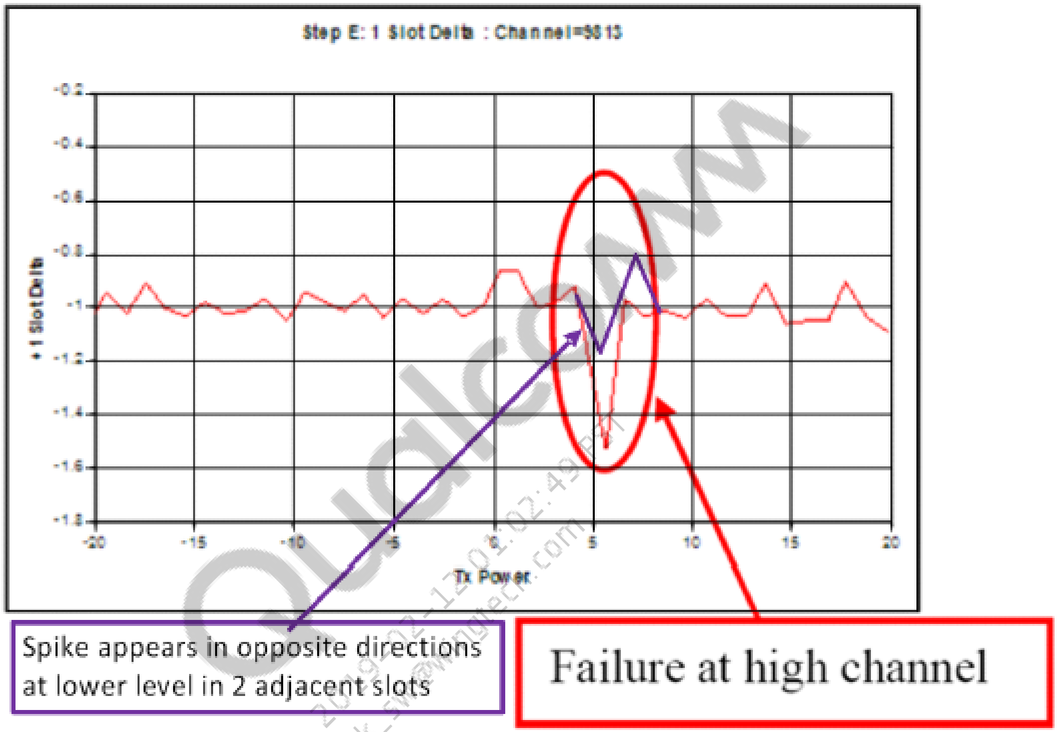


Figure 7-1 NV items to apply for a given PA gain-state transition

7.2.1.12 NV_LTE_<band>_TX_LIN_VS_TEMP_I

Data type: Array of 64, int8 values. However, the format can be better thought of as an array of eight TxState arrays, where each TxState array contains eight temperature elements. Each TxState array corresponds to a TxState (PA gain state). TxState array 0 corresponds to TxState 0, TxState array 1 to TxState 1, and so on. Not all TxState arrays are necessarily used. Index 0 of each TxState array corresponds to hot and 7 corresponds to cold. Each element has a resolution of 10 counts per dB. Positive values increase the reported Tx power relative to the actual Tx power.

The NV item NV_LTE_<band>_TX_LIN_VS_TEMP_I contains a table of eight adjustment values for the Tx linearizer per PA state, based on temperature. The temperature range for the phone is divided into eight segments. Each element corresponds to a segment. For a given temperature, each offset in the Tx linearizer curve is adjusted by a constant amount based on this table.

Example 1: If, for a given temperature index, the element in this table is 0x05, each of the elements in the adjusted Tx power in the linearizer curve (NV_LTE_<band>_TX_MULTI_LIN_DATA_I) is increased by five when the temperature corresponds to that given index. Based on the temperature, an appropriate bin in the array is selected for compensation. The default value is set to all zeros if there is no temperature compensation required. This NV item must be calibrated.

The resolution of this NV item is 10 counts per dB, and it is populated with the same polarity as the uncompensated response.

Example 2: If the desired power is 18 dBm, but at a certain temperature, the uncompensated power is measured as 16 dBm, 2 dB of compensation would be applied. In NV, however, the value to populate would be -20, because the NV item reflects the delta in the actual measurement from the desired level.

To calibrate this NV item, perform the following:

1. Power up the UE in a temperature chamber at -30°C and let it soak.
2. Read the thermistor ADC value as follows:
   a. Open the WCDMA or CDMA RF command window in QRCT.
   b. With the UE in FTM mode, read the ADC channel number 0.
3. Given that the maximum and minimum scaled thermistor values are 0 and 255, determine which of the eight bins the temperature falls into (divide the range of 0–255 into eight evenly spaced bins).
4. Run the Tx linearizer sweep calibration using the QSPR test tree.
5. From the Tx linearizer sweep for each PA gain range, pick a power level that is near the PA switch point.
6. Determine the delta in power between the linearizer sweep taken in step 4 with the linearizer sweep data taken during normal room temperature RF calibration (as close as possible to factory calibration conditions).
7. Populate the appropriate bin of NV_LTE_<band>_TX_LIN_VS_TEMP according to the example above.
8. Repeat Steps 1 to 7 for the seven remaining bins in NV_LTE_<band>_TX_LIN_VS_TEMP, increasing the temperature of the chamber in Step 1 each time until all the bins are populated.

7.2.1.13 NV_LTE_<band>_PA_RANGE_MAP_I

Data type: Array of eight, int8 values.

Each element index corresponds to a TxState (PA gain state). Index 0 corresponds to TxState 0, index 1 to TxState 1, and so on (not all indexes are necessarily used). In any given element, bit 0 (the LSBit) corresponds to the PA_RANGE0 pin state. Bit 1 corresponds to the PA_RANGE1 pin state. A bit value of '1' corresponds to VDD. A bit value of '0' corresponds to GND.

The Qualcomm AMSS software divides the Tx output dynamic range into four linearizer ranges (with overlap). This NV item defines what state the PA should be in for each of those linearizer ranges. This NV item sets the bits that control the PA_RANGE0 and PA_RANGE1, used to set the gain state of the PA for each portion of the dynamic range defined by the linearizer tables.

The PA_RANGE0 and PA_RANGE1 settings should be matched to the data sheet for the particular PA that is being used. Note that the first value represents the lowest linearizer table (which corresponds to the minimum Tx output power). Table 7-14 defines how the NV item would be populated for given PA_RANGE0 and PA_RANGE1 settings.

Table 7-14 shows a particular Qualcomm MTP example. Table 7-15 shows a different example.

Table 7-14 Example NV item population

Gain	Bit 0 (PA_R0)	Bit 1 (PA_R1)	RFNV_LTE_PA_RANGE_MAP_I[i]
Low gain	High	High	NV_LTE_<band>_PA_RANGE_MAP_I[3] = 3
Mid gain	Low	High	NV_LTE_<band>_PA_RANGE_MAP_I[2] = 2
Mid gain	Low	High	NV_LTE_<band>_PA_RANGE_MAP_I[1] = x (do not care)
High gain	Low	Low	NV_LTE_<band>_PA_RANGE_MAP_I[0] = 0

For the configuration in Table 7-14, set the PA switch points as follows:

- RISE_FALL_1 and RISE_FALL_2 set to the same level (switching between low and mid PA gain).

Table 7-15 Example NV item population for a two gain-state PA

Gain	Bit 0 (PA_R0)	Bit 1 (PA_R1)	NV_LTE_PA_RANGE_MAP_I[i]
Low gain	High	Low	NV_LTE_<band>_PA_RANGE_MAP_I[3] = 1
Mid gain	Low	Low	NV_LTE_<band>_PA_RANGE_MAP_I[2] = 0
Mid gain	Low	Low	NV_LTE_<band>_PA_RANGE_MAP_I[1] = 0
High gain	Low	Low	NV_LTE_<band>_PA_RANGE_MAP_I[0] = 0

For the configuration in Table 7-15, all the RISE_FALL_I switch points set to the same value.

7.2.1.14 NV_LTE_<band>_TIMER_HYSTERISIS_I

Data type: int16 value

This NV item contains the count value for how long the AGC block waits before switching gain states during timer hysteresis. Timer hysteresis is only used when switching from higher to lower gain states and not lower to higher gain states. The resolution is in microseconds.

QTI recommends using the values provided in the static NV xml file.

7.2.1.15 NV_LTE_<band>_PA_RISE_FALL_THRESHOLD_I

Data type: Array of 16, int16 values. However, the format can be better thought of as an array of eight structures, where each structure contains two elements. Each structure corresponds to a TxState (PA gain state). Structure 0 corresponds to TxState 0, structure 1 to TxState 1, and so on (not all structures are necessarily used). Element 0 of each structure contains the RISE threshold and element 1 contains the FALL threshold. Each element has a resolution of 10 counts per dB, and given in TxAGC units.

This NV item specifies the Tx power levels threshold for which the PA is intended to switch from one PA range to another. The array is populated with switch points organized as shown in Table 7-16. This NV item also specifies the level where the hysteresis timer is activated when the power level is decreasing.

Table 7-16 Gain-state transitions per NV element

Element	Rise and fall thresholds for PA gain-state pair
NV_LTE_<band>_PA_RISE_FALL_I[0]	PA0/PA1
NV_LTE_<band>_PA_RISE_FALL_I[1]	PA1/PA2
NV_LTE_<band>_PA_RISE_FALL_I[2]	PA2/PA3

Table 7-17 Gain-state transitions per NV element and sub-element

Element	Switch point
NV_LTE_<band>_PA_RISE_FALL_I[0] → rise_threshold	RISE PA1 – PA0
NV_LTE_<band>_PA_RISE_FALL_I[0] → fall_threshold	FALL PA0 – PA1
NV_LTE_<band>_PA_RISE_FALL_I[1] → rise_threshold	RISE PA2 – PA1
NV_LTE_<band>_PA_RISE_FALL_I[1] → fall_threshold	FALL PA1 – PA2
NV_LTE_<band>_PA_RISE_FALL_I[2] → rise_threshold	RISE PA3 – PA2
NV_LTE_<band>_PA_RISE_FALL_I[2] → fall_threshold	FALL PA2 – PA3

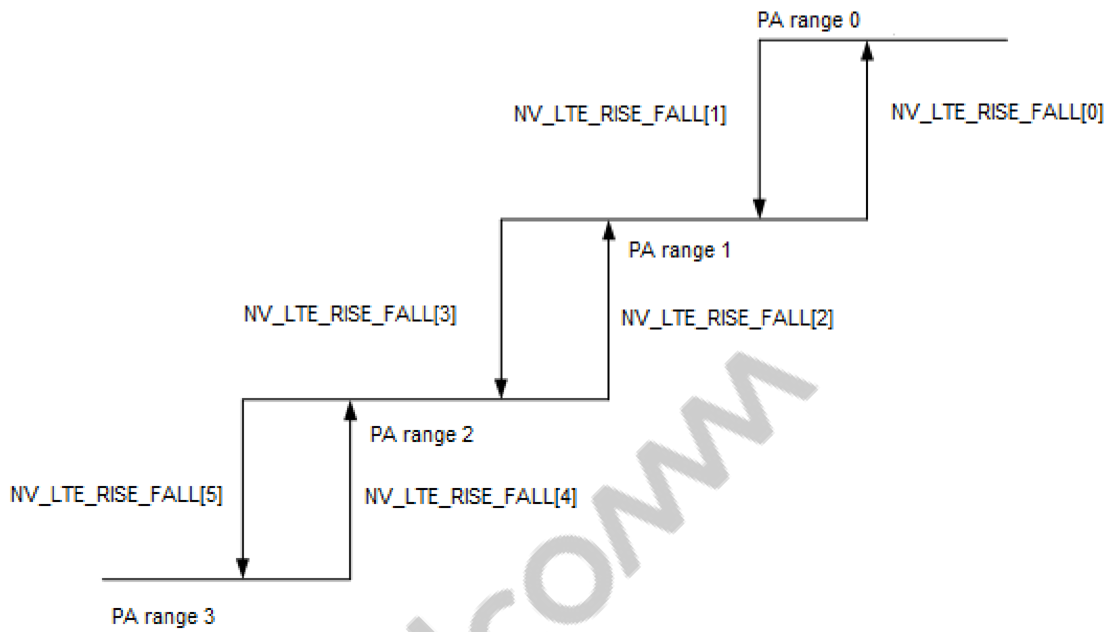


Figure 7-2 Gain-state diagram

The formula to calculate the switch points is as follows:

NV_LTE_<band>_PA_RISE_FALL_THRESHOLD_I[i] = [Switchpoint_in_dBm - (MinRSSI)] × 10

Example: Switch point at 8.5 dBm, MinRSSI = -70 dBm

NV_LTE_<band>_PA_RISE_FALL_THRESHOLD_I[i] = [8.5 - (-70)] × 10 = 785

7.2.1.16 NV_LTE_<band>_TX_MPR_BACKOFF_I

Data type: Array of 16, uint16 values

This NV item holds backoff values in units of dB10 (10 counts represents 1 dB) for different sets of LTE waveforms, based on the constellation and RB allocation. The backoff is hardcoded in the software; however, if the MPR values need to be customized, this NV item can be used in association with the 3GPP 36.101 standard. Table 7-18 shows which NV item element maps to which particular backoff scenario. The units of this NV item are dB10, except for the first entry, which activates or deactivates the use of this NV item.

NOTE: NV_LTE_MPR_BACKOFF_I[0] specifies if the NV item is activated (by setting this item to 1), or the internal hardcoded values are used (by setting to 0).

Table 7-18 MPR backoff vs. NV_LTE_TX_MPR_BACKOFF_I[i]

Modulation	Bandwidth	RBs	NV_LTE_TX_MPR_BACKOFF_I[i]
QPSK	1.4 MHz	> 5	NV_LTE_<band>_MPR_BACKOFF_I[1]
QPSK	3.0 MHz	> 4	NV_LTE_<band>_MPR_BACKOFF_I[2]
QPSK	5.0 MHz	> 8	NV_LTE_<band>_MPR_BACKOFF_I[3]
QPSK	10 MHz	> 12	NV_LTE_<band>_MPR_BACKOFF_I[4]
QPSK	15 MHz	> 16	NV_LTE_<band>_MPR_BACKOFF_I[5]
QPSK	20 MHz	> 18	NV_LTE_<band>_MPR_BACKOFF_I[6]
16QAM	1.4 MHz	≤ 5	NV_LTE_<band>_MPR_BACKOFF_I[8]
16QAM	3.0 MHz	≤ 4	NV_LTE_<band>_MPR_BACKOFF_I[8]
16QAM	5.0 MHz	≤ 8	NV_LTE_<band>_MPR_BACKOFF_I[8]
16QAM	10 MHz	≤ 12	NV_LTE_<band>_MPR_BACKOFF_I[8]
16QAM	15 MHz	≤ 16	NV_LTE_<band>_MPR_BACKOFF_I[8]
16QAM	20 MHz	≤ 18	NV_LTE_<band>_MPR_BACKOFF_I[8]
16QAM	1.4 MHz	> 5	NV_LTE_<band>_MPR_BACKOFF_I[1] + NV_LTE_<band>_MPR_BACKOFF_I[7]
16QAM	3.0 MHz	> 4	NV_LTE_<band>_MPR_BACKOFF_I[2] + NV_LTE_<band>_MPR_BACKOFF_I[7]
16QAM	5.0 MHz	> 8	NV_LTE_<band>_MPR_BACKOFF_I[3] + NV_LTE_<band>_MPR_BACKOFF_I[7]
16QAM	10 MHz	> 12	NV_LTE_<band>_MPR_BACKOFF_I[4] + NV_LTE_<band>_MPR_BACKOFF_I[7]
16QAM	15 MHz	> 16	NV_LTE_<band>_MPR_BACKOFF_I[5] + NV_LTE_<band>_MPR_BACKOFF_I[7]
16QAM	20 MHz	> 18	NV_LTE_<band>_MPR_BACKOFF_I[6] + NV_LTE_<band>_MPR_BACKOFF_I[7]

7.2.1.17 NV_LTE_<band>_AMPR_NS_05_I, NV_LTE_<band>_AMPR_NS_03_I (currently not active), NV_LTE_<band>_AMPR_NS_07_I, NV_LTE_<band>_AMPR_NS_10_I (currently not active)

Data type: Array of 16, uint8 elements

These NV items holds AMPR backoff values in dB10 for different sets of LTE waveforms, based on the constellation and RB allocation. Like other AMPR NV items, bit 0 specifies whether the NV item is used or the hardcoded values are used (1 indicates NV item values, 0 indicates hardcoded values).

NV_LTE_B13_AMPR_NS_07_I has special considerations, to account for Verizon's new AMPR_NS_07 requirements. Unlike other AMPR NV items, NV_LTE_B13_AMPR_NS_07_I[0] can range from 0 to 3. Specific usage is shown in Table 7-19, Table 7-20, Table 7-21, and Table 7-22.

Table 7-19 NV_LTE_B13_AMPR_NS_07_I[0] = 0, (Original 3GPP specification)

Resource block region	Number of resource blocks	AMPR (dB10)
Region A (0–12)	6 to 8	80 (hardcoded)
Region A (0–12)	1 to 5 or 9 to 50	120 (hardcoded)
Region B1 (13–18)	≥ 8	120 (hardcoded)
Region B2 (19–42)	≥ 18	60 (hardcoded)
Region C (43–49)	0, 1, 2	30 (hardcoded)

Table 7-20 NV_LTE_B13_AMPR_NS_07_I[0] = 1, (Original 3GPP specification)

Resource block region	Number of resource blocks	NV_LTE_B13_AMPR _NS_07_I[i]
Region A (0–12)	6 to 8	NV_LTE_B13_NS_07_I[1]
Region A (0–12)	1 to 5 or 9 to 50	NV_LTE_B13_NS_07_I[2]
Region B1 (13–18)	≥ 8	NV_LTE_B13_NS_07_I[3]
Region B2 (19–42)	≥ 18	NV_LTE_B13_NS_07_I[4]
Region C (43–49)	0, 1, 2	NV_LTE_B13_NS_07_I[5]

Table 7-21 NV_LTE_B13_AMPR_NS_07_I[0] = 2, (New Verizon specification)

Resource block region	Number of resource blocks	AMPR (dB10)
Region A (0–12)	≥ 16	40 (hardcoded)
Region B1 (13–18)	≥ 25	30 (hardcoded)
Region B2 (19–42)	≤ 30	0 (hardcoded)
Region C (43–49)	≤ 7	0 (hardcoded)

Table 7-22 NV_LTE_B13_AMPR_NS_07_I[0] = 3, (New Verizon specification)

Resource block region	Number of resource blocks	AMPR (dB10)
Region A (0–12)	≥ 16	NV_LTE_B13_NS_07_I[1]
Region B1 (13–18)	≥ 25	NV_LTE_B13_NS_07_I[2]
Region B2 (19–42)	≤ 30	NV_LTE_B13_NS_07_I[3]
Region C (43–49)	≤ 7	NV_LTE_B13_NS_07_I[4]

NOTE: NV_LTE_B1_AMPR_NS_05_I[0] specifies if the NV item is used (setting of 1) or if the internal hardcoded value (setting of 0) is used.

Table 7-23 NV_LTE_B1_AMPR_NS_05_I[i]

Resource block region	Number of resource blocks	RFNV_LTE_B1_AMPR_NS_05_I[i]
Any	≥ 50	NV_LTE_B1_NS_05_I[1]

7.2.1.18 NV_LTE_<band>_AMPR_NS_07_OFFSET

Data type: Array of three, uint8 elements

This NV item specifies the additional AMPR backoff amount for NS_07 for all RB allocation cases, whether or not defined by the standard. When AMPR is defined by the standard, this amount is added to the backoff amount specified in NV_LTE_<band>_AMPR_NS_07_I. The backoff amount may be adjusted based on the uplink modulation chosen (QPSK or 16QAM).

This NV item is an array of three elements. The first element in the array, NV_LTE_<band>_AMPR_NS_07_OFFSET[0], enables this feature when set to a nonzero value. The second element in the array, NV_LTE_<band>_AMPR_NS_07_OFFSET[1], defines the amount of additional backoff for QPSK modulation in units of dB10. The third element in the array, NV_LTE_<band>_AMPR_NS_07_OFFSET[2], defines the amount of additional backoff for 16QAM modulation in units of dB10.

Example

[1, 5, 10] means this NV item is enabled, 0.5 dB backoff is used for QPSK, and 1.0 dB backoff is used for 16QAM.

7.2.1.19 RFNV_LTE_B28_AMPR_NS_18_I

Data type: Array of sixteen, uint8 values

This item can optionally be used to store AMPR backoff values for NS 18. Units for backoff values are dB10.

The item is an array of 16 elements, but only the first three elements are being used.

The elements of the array are interpreted in Table 7-24

Table 7-24 RFNV_LTE_B28_AMPR_NS_18_I format

Element	Number of resource blocks	Interpretation
0		Boolean flag to enable/disable using the AMPR backoff from NV; when this is 1, AMPR backoff specified in following elements [indices 1 and 2] of the NV is used for backoff; else the AMPR backoff values used are the ones hardcoded (per the standard) in the code.
1	≥ 1	AMPR backoff for BW = 10 MHz,15 MHz and 20 MHz, in dB10 unit. If Element 0 is 0, the hardcoded default value is 40 (4 dB).
2	≥ 2	AMPR backoff for BW = 5 MHz, in dB10 unit. If Element 0 is 0, the hardcoded default value is 10 (1 dB).

7.2.1.20 RFNV_LTE_B41_AMPR_NS_04_I

Data type: Array of 16, uint16 values

Data range: 0–100

This item can optionally be used to store AMPR backoff values for NS 04. Units for backoff values are dB10.

The item is an array of 16 elements. The elements of the array are interpreted in Table 7-25.

Table 7-25 RFNV_LTE_B41_AMPR_NS_04_I format

Element	Interpretation
RFNV_LTE_B41_AMPR_NS_04_I **[0]**	Boolean flag to enable/disable using the AMPR backoff from NV; when this is ‘1,’ AMPR backoff specified in following elements [indices 1 and onwards] of the NV is used for backoff; else the AMPR backoff values used are the ones hardcoded (per the standard) in the code. The hardcoded values are as per the standard 3GPP 36.101 Release 10 table 6.2.4-1 for NS 04.
RFNV_LTE_B41_AMPR_NS_04_I **[1]**	AMPR backoff for BW = 5 MHz
RFNV_LTE_B41_AMPR_NS_04_I **[2]**	AMPR backoff for BW = 10 MHz in Region A
RFNV_LTE_B41_AMPR_NS_04_I **[3]**	AMPR backoff for BW = 10 MHz in Region B
RFNV_LTE_B41_AMPR_NS_04_I **[4]**	AMPR backoff for BW = 10 MHz in Region C
RFNV_LTE_B41_AMPR_NS_04_I **[5]**	AMPR backoff for BW = 15 MHz in Region A
RFNV_LTE_B41_AMPR_NS_04_I **[6]**	AMPR backoff for BW = 15 MHz in Region B
RFNV_LTE_B41_AMPR_NS_04_I **[7]**	AMPR backoff for BW = 15 MHz in Region C
RFNV_LTE_B41_AMPR_NS_04_I **[8]**	AMPR backoff for BW = 20 MHz in Region A
RFNV_LTE_B41_AMPR_NS_04_I **[9]**	AMPR backoff for BW = 20 MHz in Region B
RFNV_LTE_B41_AMPR_NS_04_I **[10]**	AMPR backoff for BW = 20 MHz in Region C
RFNV_LTE_B41_AMPR_NS_04_I **[11-15]**	Unused

7.2.1.21 NV_LTE_<band>_AMPR_PA_BACKOFF

Data type: Array of two, unit8 elements

This NV item is used for AMPR PA switch point backoff for NS_07.

This item is currently supported only for B13 NS 07.

The NV item is an array of two elements.

The first element in the array, NV_LTE_<band>_AMPR_PA_BACKOFF [0], enables this feature when set to a nonzero value. The second element in the array, NV_LTE_<band>_AMPR_PA_BACKOFF [1], defines the amount of AMPR PA switch point backoff for NS_07 in units of dB10.

Example

[1, 50] means this NV is enabled and 5 dB + MPR backoff for the PA switch point if NS07 is signaled.

[0, 50] means this NV is disabled and the second entry is ignored; the PA backoff is the hardcoded value in software.

7.2.1.22 RFNV_LTE_<band>_AMPR_NS_#_BW_#_#MHZ_AND_LOWER_I, RFNV_LTE_<band>_AMPR_NS_#_BW_#_#MHZ_AND_HIGHER_I, RFNV_LTE_<band>_AMPR_NS_#_BW_#_I

Data type: array of 16, uint16 values.

Element[0]: Boolean flag to enable/disable using the AMPR backoff from NV; when this is '1,' AMPR backoff specified in following elements [indices 1 and onwards] of the NV is used for backoff; else the AMPR backoff values used are the ones hardcoded (per the standard) in the code.

The rest of the elements represent the AMPR backoff values in a format that follows the format of the corresponding table entry in 3GPP TS 36.521-1 in Section 6.2.4.

7.2.1.23 NV_LTE_<band>_TX_DIGITAL_GAIN_COMP_I

Data type: Array of 16, int16 values

This NV item holds beta scaling values applied to different sets of LTE waveforms requiring baseband backoff to avoid DAC saturation. The constellation of the waveform, i.e., QPSK or 16-QAM is the key deciding factor that affects the baseband backoff value (beta scaling). Beta scaling values are configurable through this NV, and this NV is used in conjunction with the NV_LTE_<band>_TX_AGC_OFFSET_I item.

QTI recommends that customers use the values provided in the static NV, xml file.

7.2.1.24 NV_LTE_<band>_TX_AGC_OFFSET_I

Data type: Array of 16, int16 values

This NV item holds TxAGC offset in dB10 to compensate for beta scaling that is applied to different sets of LTE waveforms using NV_LTE_<band>_TX_DIGITAL_GAIN_COMP_I. Baseband backoff essentially reduces both the RMS value of the I & Q samples and the input level at the RTR DAC. The calibration is performed with a different baseband scaling (without the backoff), and the TxAGC populated in the linearizers in RFNV_LTE_<band>_TX_MULTI_LIN_DATA_I item would now differ from the actual TxAGC (after the backoff resulting transmit calibration error). To prevent this from happening, the Tx AGC values obtained from the linearizer are offset by the corresponding TxAGC offset obtained from this NV item.

This NV item can hold up to eight elements.

QTI recommends that customers use the values provided in the static NV, xml file.

7.2.1.25 NV_LTE_<band>_HDET_HPM_LPM_SWITCH_POINT_I

Data type: uint16 value

This NV item specifies the Tx power levels threshold at which the HDET calibration table is designed to switch from one mode to another. For LTE band 13, a more accurate HDET calibration is required at lower power levels. To accomplish this, a second set of HDET calibration data is collected during the normal Tx linearizer sweep. This NV item tells the AMSS at which power level to switch between the high power HDET table to the lower power HDET table.

The units are dB10 and the formula for calibration is the same as the TxAGC formula:

NV_LTE_HDET_HPM_LPM_SWITCH_POINT_I = [Switchpoint_in_dBm - (MinRSSI)] × 10

Where MinRSSI = -70 dBm

QTI recommends using the value found in the static NV, xml file.

NOTE: This feature is currently only used for LTE band 13.

7.2.1.26 RFNV_LTE_B<band>_DB10_SAR_BACK_OFF_LIMIT_I

Data type: Array of eight, uint16 values.

Each index corresponds to a specific DSI state set by the rfm_common_sar_set_state() software API function (method). Element 1 is DSI1 and element 8 is DSI8. The value of each element is the desired max Tx power corresponding to the specific DSI, in the format of dBm × 10.

The maximum Tx power limit may be set to any power level within the calibrated Tx range. The Tx power limit algorithm uses HDET, if present, to minimize the error in the actual power level and achieve best accuracy. The typical error is within ±1 dB. For power limit settings below the HDET active range (typically < +18 dBm), the error is typically within ±2 dB.

Refer to *Dynamic Maximum Tx Power Limits* (80-VP146-8) for details.

7.2.1.27 RFNV_LTE_Bx_DEFAULT_SMPS_BIAS_I

Data type: uint16 value

Data range: 0 to 1023

This NV is used to specify the PA SMPS PDM (APT bias) in the case of older Cal v2, or if ever the case arises where the LTE PA is turned on in FTM RF mode, but without the SMPS voltage explicitly being set with FTM commands. This value is parked to 780 for TDD and should not be changed.

Initially this was hardcoded in software, but now this static NV is used to override the hardcoded value. If the NV is unpopulated, it takes the default value of 780.

Other examples where this item might be applicable are manual debugging using QRCT RF commands, or XO calibration in LTE mode if the SMPS PDM (APT bias) is not explicitly configured.

7.2.1.28 RFNV_LTE_BANDEDGE_MAXPOWER_RELAXATION_ENABLE

Data type: uint16 value

Data range: 0 or 1*

*A 0 value disables the Maxpower Backoff at Bandedges feature. Any other value enables the feature.

The Maxpower Backoff at Bandedges feature allows the backing off of max Tx power (and PA switch point power) if the entire allocated resource block (RB) bandwidth is within 4 MHz of the bandedges.

If this NV item is populated with 0 (or not populated at all) the feature is disabled and no backoff occurs even if the entire allocated RB bandwidth is within 4 MHz of the band edges.

If this item is enabled, the max Tx power is backed off if the entire allocated RB bandwidth is within 4 MHz of the band edges. Per the 3GPP TS 36.521-1 standard, this backoff is 1.5 dB. The actual amount of backoff can be modified by using RFNV_LTE_Bx_BANDEDGE_MAXPOWER_BACKOFF_I, if desired (see Section 7.2.1.29). Also, the PA switch points can also be adjusted by using RFNV_LTE_Bx_BANDEDGE_MAXPOWER_PA_BACKOFF_I if desired (see Section 0).

The entire allocated RB bandwidth, and how that relates to the band edges, depends upon

- The band
- The uplink RF channel
- The uplink LTE channel bandwidth
- The number of allocated RBs
- The starting RB

Band 8 is used here as an example. According to 3GPP TS 36.521-1, Section 5.4.4, valid channel uplink numbers for band 8 range from 21450 – 21799 inclusive. That corresponds to the range of valid channels from 880.0 MHz to 914.9 MHz. So to be in the lower 4 MHz of the band, the entire allocated RB bandwidth must be below 884.0 MHz. To be in the upper 4 MHz of the band, the entire allocated RB bandwidth must be above 910.9 MHz.

Uplink channel to frequency, for band 8, is determined by F(MHz) = 880 + 0.1(N - 21450).

Two completely hypothetical examples are shown below. One example shows a situation where the entire allocated RB bandwidth is not within 4 MHz of the band edges, thus the backoff is not applied. The other example shows a situation where backoff is applied.

Example 1:

- Uplink RF channel: 21772 (912.2 MHz)
- LTE bandwidth: 3 MHz
- Number of allocated RBs: 15 RBs
- Start RB index: 0

There are 15 resource RBs in a 3 MHz LTE channel bandwidth (refer to 3GPP TS 36.521-1, Section 5.4.2). Each RB spans 180 kHz. The RF carrier is in the center of RB 7, and there are seven RBs below the center RB and another seven above. RB 0 starts at a frequency of 1.35 MHz below the RF carrier (using 7.5 × 180 kHz), putting the lowest transmitted frequency at 910.85 MHz. This is slightly below the threshold of 910.9 MHz for the total allocated RB bandwidth to be considered within 4 MHz of the band edge. Therefore, backoff is not applied.

Example 2:

- Uplink RF channel: 21773 (912.3 MHz)
- All else the same as in Example 1

In this case, the lowest frequency in the transmitted bandwidth is 910.95 MHz, above the 910.9 MHz threshold. Backoff is applied.

7.2.1.29 RFNV_LTE_Bx_BANDEDGE_MAXPOWER_BACKOFF_I

Data type: three, unit8 values.

This NV item specifies the backoff value from the current max TX power that needs to be applied when entire RB allocation is within the 4 MHz of the band edges.

Element 0 is called "enable." Any nonzero enables the software to use the backoff values specified in below mentioned fields (Element [1] & Element[2]). If the value is zero, a hardcoded value of 1.5 dB is applied as backoff, as per the standard.

Element 1 is called "lowerband_backoff" and contains the absolute max Tx power backoff in db10 units for the lower bandedge. For example, a 5 dB backoff is represented by a value of 50. Valid range of element is 0 to 100.

Element 2 is called "upperband_backoff" and contains the absolute max Tx power backoff in db10 units for the upper bandedge. For example, a 5 dB backoff is represented by a value of 50. Valid range of element is 0 to 100.

NOTE: Usage of this NV item requires RFNV_LTE_BANDEDGE_MAXPOWER_RELAXATION_ENABLE (see Section 7.2.1.28) to be enabled.

Table 7-26 shows various configuration examples. Examples assume the total allocated RB bandwidth is within the upper or lower 4 MHz of the band.

Table 7-26 Bandedge max power backoff examples

RFNV_LTE_BANDEDGE_ MAXPOWER_RELAXATION_ ENABLE	RFNV_LTE_Bx_ BANDEDGE_MAXPOWER_ BACKOFF_I	Resulting backoff
Unpopulated	Any setting	0 dB at lower edge, 0 dB at upper edge (no backoff).
0	Any setting	0 dB at lower edge, 0 dB at upper edge (no backoff).
1	1, 0, 10	0 dB at lower edge, 1 dB at upper edge.
1	0, 0, 10	1.5 dB at lower edge, 1.5 dB at upper edge.
1	1, 20 ,10	2 dB at lower edge, 1 dB at upper edge.
1	1, 0, 0	0 dB at lower edge, 0 dB at upper edge (no backoff).

7.2.1.30 RFNV_LTE_Bx_BANDEDGE_MAXPOWER_PA_BACKOFF_I

Data type: three, uint8 values.

This NV item specifies the PA switch point backoff value from the current PA switch point that needs to be applied when entire RB allocation is within the 4 MHz of the band edges.

Element 0 is called “enable.” Any nonzero enables the software to use the backoff values specified in below mentioned fields (Element [1] & Element[2]).

Element 1 is called “lowerband_pa_switchpoint_backoff” and contains the PA switch point backoff in db10 units for the lower bandedge. For example, a 5 dB backoff is represented by a value of 50. Valid range of element is 0 to 120.

Element 2 is called “upperband_pa_switchpoint_backoff” and contains the PA switch point backoff in db10 units for the upper bandedge. For example, a 5 dB backoff is represented by a value of 50. Valid range of element is 0 to 120.

NOTE: Usage of this NV item requires RFNV_LTE_BANDEDGE_MAXPOWER_RELAXATION_ENABLE (see Section 7.2.1.28) to be enabled.

7.2.1.31 RFNV_LTE_<band>_TX_EPT_DPD_CONFIG_PARAMS_I

There is one DPD configure NV item per band to store parameters for DPD software operation. See Section 5.2.1.18 for format descriptions and details.

7.2.1.32 RFNV_LTE_<band>_TX_CAL_CHAN_I

Data type: Array of 16 uint16 values

This item has been repurposed for use in TX_LIN_VS_TEMP_VS_FREQ_P_IN and TX_LIN_VS_TEMP_VS_FREQ_P_OUT characterization. It contains the list of up to 16 channels used for the characterization.

7.2.1.33 RFNV_LTE_<band>_TX_LIN_VS_TEMP_VS_FREQ_P_IN_I

This NV item is used for frequency and temperature compensation in PA power input for each PA state (R0, R1, R2, and R3). See Section 5.2.1.20 for the format description and details.

7.2.1.34 RFNV_LTE_<band>_TX_LIN_VS_TEMP_VS_FREQ_P_OUT_I

This NV item is used for frequency and temperature compensation in PA power output for each PA state (R0, R1, R2, and R3). See Section 5.2.1.21 for the format description and details.

7.2.1.35 RFNV_LTE_<band>_HDET_HPM_THRESHOLD_I

Data type: structure of two, uint16 values

This NV item allows the adjustment of the minimum power level threshold for the HDET feedback loop when the HDET is in high power mode. Table 7-27 shows the format of the item.

Table 7-27 RFNV_LTE_<band>_HDET_HPM_THRESHOLD_I

Element	Description	Size
enable	0 – Disables the feature. 1 – (or any nonzero value) enables the feature	Single, uint16 value
value	Threshold. Formula: ([Threshold_in_dBm - 70] × 10)	Single, uint16 value

A 0 stored in enable disables the use of the item (or if the item is not populated). If the item is not enabled, the software defaults are used for the threshold. Storing any other value in enable enables the use of the item. The value element contains the threshold in the format ([Threshold_in_dBm - 70] × 10). The software automatically limits the effective value to be at least a minimum value (currently 800, corresponding to dBm10). If the band also supports LPM HDET operation, value must be less than or equal to NV_LTE_<band>_HDET_HPM_LPM_SWITCH_POINT_I, or unexpected results can occur.

7.2.1.36 RFNV_LTE_Cx_<band>_PA_SWITCHPOINT_ADJUST_I

Data type: A single, uint8 value, followed by a single int8 value

Table 7-28 RFNV_LTE_Cx_<band>_PA_SWITCHPOINT_ADJUST_I format

Element	Description	Type
pa_switchpoint_adjust_enable	This value can take 0 (disable)/1 (enable).	Single, uint8 value
pa_switchpoint_adjust_value_dB10	This can take up to ±127 which translates to 12.7 dB of adjustment on each switchpoint.	

This NV item introduces a convienent way to adjust all the PA switchpoints of a given path and band, together as a group, by a specified amount.

Although this NV item is shown here in the “static” section, conceivably this item could be calibrated on a phone-to-phone basis.

7.2.1.37 RFNV_LTE_SAR_BACK_OFF_SWAP_POS_LIMIT_I

Actual size: 50 x 17 bytes (max size)

Data type: QMSL_SAR_BACK_OFF_SWAP_POS_LIMITS_Data_type (This structure constitutes a unint8 variable and an array of 8 unint16 elements)

This is an array of structures of type QMSL_SAR_BACK_OFF_SWAP_POS_LIMITS_Data_type, which holds the LTE band and the corresponding eight-element array which specifies the absolute Tx power limit in dBm with dB/10 resolution for DSI 1 to 8. These Tx power limits are for the antenna at ASDiv switch position 1.

This LTE-specific NV item holds the SAR Tx power limits for all the LTE bands. Since the NV is of variable size, not all bands need to be populated. Only the bands for which ASDiv switch position SAR Tx power limit is to apply should be populated. For all other bands, the SAR Tx power limit for ASDiv switch position 1 is the same as that for the default position.

The NV needs to be populated with the Band Identifier value followed by 8 SAR Tx power limit values (for the 8 DSI).

<NvItem id="28570" name="RFNV_LTE_SAR_BACK_OFF_SWAP_POS_LIMIT_I" mapping="direct" encoding="dec"><Band Identifier>,<SAR back-off value 1>,< SAR back-off value 2>,< SAR back-off value 3>,< SAR back-off value 4>,< SAR back-off value 5>,< SAR back-off value 6>,< SAR back-off value 7>,< SAR back-off value 8> … and so on</NvItem>

For instance, the SAR Tx power limit values are populated for band 7 and band 40, then the NV populated as follows:

<NvItem id="28570" name="RFNV_LTE_SAR_BACK_OFF_SWAP_POS_LIMIT_I" mapping="direct" encoding="dec">6,180,180,180,180,120,120,120,120,39,180,180,180,180,120,120,120,120</NvItem>

Table 7-29 shows the band identifier values.

Table 7-29 LTE band identifiers

Band class	Band identifier	Band class	Band identifier	Band class	Band identifier
LTE B1	0	LTE B18	17	LTE B35	34
LTE B2	1	LTE B19	18	LTE B36	35
LTE B3	2	LTE B20	19	LTE B37	36
LTE B4	3	LTE B21	20	LTE B38	37
LTE B5	4	LTE B22	21	LTE B39	38
LTE B6	5	LTE B23	22	LTE B40	39
LTE B7	6	LTE B24	23	LTE B41	40
LTE B8	7	LTE B25	24	LTE B42	41
LTE B9	8	LTE B26	25	LTE B43	42
LTE B10	9	LTE B27	26	LTE B44	43
LTE B11	10	LTE B28	27	Split bands	
LTE B12	11	LTE B29	28	LTE B28_B	44
LTE B13	12	LTE B30	29	LTE B40_B	45
LTE B14	13	LTE B31	30	LTE B41_B	46
LTE B15	14	LTE B32	31	LTE B41_C	47
LTE B16	15	LTE B33	32	LTE B39_B	48
LTE B17	16	LTE B34	33	—	

NOTE: The order of the bands do not matter. However, each band should be followed by the 8 SAR Tx power limit values.

NOTE: This new NV RFNV_LTE_SAR_BACK_OFF_SWAP_POS_LIMIT_I does not replace the existing NVs: RFNV_LTE_B<LTE band>_DB10_SAR_BACK_OFF_LIMIT_I. The existing band-specific NVs continue to be used for the default ASDiv switch position. The new NV should only be populated if ASDiv switch position specific SAR Tx power limit is to be applied. In the event this new NV is not populated, the same SAR Tx power limit is applied irrespective of the ASDiv switch position.

7.2.1.38 RFNV_LTE_B1_NS_05_RESTRICTED_REGION_BACKOFF

Data type: uint8

RFNV_LTE_B1_NS_05_RESTRICTED_REGION_BACKOFF is created to enable customers to pass TELEC PHS emissions requirements. This feature allows the UE to take power backoff for UL configurations that are explicitly prohibited by 3GPP.

Force the UE to take a generous backoff in such cases. The default value is set to 130, which is 13dB.

7.2.1.39 RFNV_LTE_Cx_<band>_TX_XPT_DPD_SCALING_I

See Section 5.2.1.22 .

7.2.1.40 RFNV_LTE_AMPR

NOTE: This section was added to this document revision.

Data type: Structure with data type as shown in Table 7-30

These NV items holds AMPR backoff values in dB10 for different sets of LTE waveforms, to meet different operator requirements, based on the following parameters:

- EARFCN
- Channel bandwidth
- Modulation type
- MPR
- RB allocation
- Network signalling type

If this NV is not enabled, AMPR Backoff settings will be as per RFNV_LTE_B1_AMPR_NS_05_I NV.

Table 7-30 RFNV_DATA_TYPE_LTE_AMPR

Variables	Data type	Definition
nv_container_index	uint8	Represents NV container index 0 – NV container 0 1 – NV container 1
Reserved	uint8	
ns_number	uint32	Represents network signaling value 1 – NS_01, 2 – NS_02 32 – NS_32
RFNV_LTE_AMPR_TABLE_TYPE[15]		
RFNV_LTE_AMPR_TABLE_TYPE		
tx_earfcn_min	int32	Includes the range of tx earfcn's (inclusive) -1 – matches any EARFCN If tx_earfcn_min is -1 then it checks for tx_earfcn_max. if tx_earfcn_max is -1 then it checks for tx_earfcn_min if both are -1 then it is an automatic match.
tx_earfcn_max	int32	
modulation_type_mask	uint32	1 – BPSK 2 – QPSK 3 – 16 QAM 4 – 64 QAM All bits set – includes all modulation

Variables	Data type	Definition
bandwidth_mask	Uint32	0x1 – 1.4 MHz 0x2 – 3 MHz 0x4 – 5 MHz 0x8 – 10 MHz 0x10 – 20 MHz 0x20 – 40 MHz All bits set – includes all bandwidth
mpr_min	int16	Allows the table to select different AMPR backoffs based on the MPR value computed before AMPR. If not applicable, set this to -1.
mpr_max	int16	
rb_start_min	int16	Provides the boundaries for rb_start. If not applicable, set this to -1.
rb_start_max	int16	
rb_block_min	int16	Provides the boundaries for rb_block. If not applicable, set it to -1.
rb_block_max	int16	
ampr_db10	int16	AMPR backoff value in db10

7.2.1.41 RFNV_LTE_TX_MAX_POWER_BASED_ON_EARFCN

NOTE: This section was added to this document revision.

Data type: Structure with data type as shown in Table 7-31

This NV item specifies the absolute maximum power that a phone can transmit based on EARFCN. Only integers are allowed as values. For example, the maximum Tx power can be specified as 23 dBm but not 23.5 dBm.

This NV has been included for MSM89x7 and is not present in the MSM8909 chipset.

Table 7-31 RFNV_DATA_TYPE_ LTE_TX_MAX_POWER_BASED_ON_EARFCN

Variables	Data type	Definition
nv_container_index	uint8	Represents NV container index 0 – NV container 0 1 – NV container 1
TX_EARFCN[0..15]	uint32	Upper bound channel. Any channel less than or equal to TX_EARFCN[i] will set max Tx power as PWR_DBM10[i], where i = [0..15]
PWR_DBM10 [0..15]	int16	Max Tx power in dB10

Example: Assume max Tx power NV allowed is 24 dBm below Tx channel 18190 and 26 dBm above Tx channel 18190 in band 1. Then set TX_EARFCN[0] as 18190 and PWR_DB10 as 240. Also, set TX_EARFCN[1] as 18599 and PWR_DB10 as 260.

NOTE: TX_EARFCN must be mentioned in increasing order.

NOTE: If the last channel in the table is less than the largest allowed channel in the standard, then the last channel is set to the default of 230.

7.2.2 Calibrated, Tx RF NV items

NOTE: For MSM8909 device targets, use waveform LTE PUSH, six RBs, and start RB 22 for Tx Linearizer calibration.

NOTE: In general, calibration procedures for LTE TDD are the same as for LTE FDD. However, due to the nature of LTE TDD, Tx and Rx calibration must be staggered so that no Tx activity is scheduled during segments where Rx calibration takes place. To ensure that no Tx activity takes place during an Rx calibration segment, enter 255 in the "PA range list." Also, turn off the RF output power of the test equipment during segments in which Tx activity takes place. Refer to *Factory Test Mode Test Procedure for LTE RF Calibration* (80-VA360-13) for details.

7.2.2.1 RFNV_LTE_<band>_TX_MULTI_LIN_V3_DATA_I

See Section 5.2.2.1. This item applies to LTE.

7.2.2.2 NV_LTE_<band>_EXP_HDET_VS_AGC_I (measured – per phone)

Data type: Array of 16, uint16 values

AMSS uses this NV item to build a lookup table, which indexes Tx power estimation via a scaled TX_GAIN_CTL (representing the desired Tx power) to associated HDET circuit values at reference temperature and the reference frequency.

Break the upper quarter (1/4) of the Tx dynamic range into 16 segments.

Vary the desired Tx power such that the Tx output power varies over the 16 segments. If necessary, extrapolate data for the higher power levels. Read the value of the HDET circuit over each of the 16 segments, and store the results in NV_LTE_<band>_EXP_HDET_VS_AGC_I.

The HDET circuit is calibrated by measuring the level at the input to the power detector during the normal Tx linearizer sweep calibration. Then the readings are interpolated and extrapolated to determine what the HDET readings would be at the predefined power levels shown in the Tx power column in Table 7-32. The second column in Table 7-32 is sample calibration data from a Qualcomm FFA.

The power levels in the Tx power column were chosen by breaking up the top 25% of the dynamic range into 16 evenly spaced bins:

- MinRSSI = -70 dBm
- Dynamic range = 102.4 dB
- Max Power = 32.4 dBm
- Top 25% = 6.8 dBm to 32.4 dBm (the last point is explicitly known by AMSS and is not listed in the table)

Table 7-32 NV_LTE_<band>_EXP_HDET_VS_AGC_I

Tx power (dBm)	NV_LTE_<band>_EXP_HDET_VS_AGC_I (example calibration data)
6.8	701
8.4	764
10	832
11.6	923
13.2	1057
14.8	1214
16.4	1423
18	1674
19.6	1969
21.2	2333
22.8	2799
24.4	3408
26	3926
27.6	4095
29.2	4095
30.8	4095

7.2.2.3 NV_LTE_<band>_EXP_LPM_HDET_VS_AGC_I (measured – per phone)

Data type: Array of 16, uint16 values

This NV item is the same as NV_LTE_EXP_HDET_VS_AGC_I except that it covers a secondary HDET sweep over slightly different but lower Tx power. This extra HDET calibration is only required for band 13 to improve Tx power control at lower power for improved performance.

The range is 22.5 dBm to -3 dBm (note the last point is explicitly known by AMSS and is not listed in Table 7-33).

Table 7-33 NV_LTE_<band>_EXP_LPM_HDET_VS_AGC_I

Tx power (dBm)	NV_LTE_<band>EXP_LPM_HDET_VS_AGC_I (example calibration data)
-3.1	966
-1.5	1009
0.1	1068
1.7	1167
3.3	1288
4.9	1504
6.5	1720
8.1	2069
9.7	2475
11.3	2954
12.9	3631
14.5	4051

Tx power (dBm)	NV_LTE_<band>EXP_LPM_HDET_VS_AGC_I (example calibration data)
16.1	4095
17.7	4095
19.3	4095
20.9	4095

7.2.2.4 NV_LTE_<band>_TX_LIMIT_VS_FREQ_I

Data type: Array of 16, int8 values

The NV item NV_LTE_<band>_TX_LIMIT_VS_FREQ_I contains a table of 16 adjustment values for the Tx power limit, based on frequency. The Tx power limit is heavily based on the feedback from the HDET circuit. This NV item is used to compensate for the frequency response of the HDET circuit and the RF components between that circuit and the RF output.

The units are in dB10 and values can be positive or negative.

Conceptually, the value of this NV item represents

NV_LTE_<band>_TX_LIMIT_VS_FREQ_I[i] = TxPower[RefChan] - TxPower[i]

such that both TxPower[RefChan] and TxPower[i] are measured by adjusting the Tx power by any means such that they have identical HDET values (each at a different frequency channel), and Tx power levels in the vicinity of the desired max Tx power.

However, it is not practical to perform the measurements this way. Instead, the TxPower[RefChan] is determined by linearly interpolating the HDET value measured at channel 'i' into the raw HDET data obtained during the Tx sweep (at reference frequency). The result is a calculated value for TxPower[RefChan], which can be used in the above formula.

7.2.2.5 RFNV_LTE_Cx_<band>_PIN_CAL_VS_FREQ _I

Data type: Array of 8*16, int16 values

See Section 6.2.2.4.

7.3 LTE miscellaneous RF NV items

7.3.1 RFNV_LTE_ENABLE_TXPL_DEBUG_MSG

Data type: uint8 value

This NV item gates debug messages for LTE. Any nonzero value enables the output of the F3 messages; a zero value (default) disables their output.

8 TD-SCDMA RF NV items

This chapter describes the TD-SCDMA RF NV items. These descriptions apply to all TD-SCDMA bands. Several NV items may have more than one identification number, depending on the band.

Table 8-1 lists the band classes, identifying the corresponding name and frequency.

Table 8-1 TD-SCDMA bands

Band	Frequency	Example NV name
34	2010 to 2025 MHz	NV_TDSCDMA_B34_RX_CAL_CHAN_I
39	1880 to 1920 MHz	NV_TDSCDMA_B39_RX_CAL_CHAN_I
40	2300 to 2400 MHz	NV_TDSCDMA_B40_RX_CAL_CHAN_I

8.1 TD-SCDMA Rx RF NV items

8.1.1 Static, Rx RF NV items

8.1.1.1 RFNV_TDSCDMA_<band>_LNA_RANGE_RISE_FALL_NB_MODE_ACQ_I

Data type: Array of twelve uint8 values

Data unit: dBFS (decibels relative to full scale)

Resolution: 0.5 dB

This NV item includes the switch points in acquisition mode between different RxState states in dBFS units based on inband measured power if acquisition is successful. This NV item has the following format:

- G0_1, G0_2, G0_3
- G1_0, G1_2, G1_3
- G2_0, G2_1, G2_3
- G3_0, G3_1, G3_2
- Gx_y means AGC transition from LNA gain range x to range y

NOTE: Use the values found in the default static NV, xml file released with the AMSS.

8.1.1.2 RFNV_TDSCDMA_<band>_LNA_RANGE_RISE_FALL_WB_MODE_ACQ_I

Data type: Array of 12, uint8 values

Data unit: dBFS (decibels relative to full scale)

This NV item includes the switch points in acquisition mode between different RxState states in dBFS units based on total measured power, if acquisition is successful.

NOTE: Use the values found in the default static NV, xml file released with the AMSS.

8.1.1.3 RFNV_TDSCDMA_<band>_LNA_RANGE_RISE_FALL_NB_MODE_ACQ_2_I

Data type: Array of 12, uint8 values

Data unit: dBFS (decibels relative to full scale)

This NV item includes the switch points in acquisition mode between different RxState states in dBFS units based on inband measured power, if acquisition fails.

NOTE: Use the values found in the default static NV, xml file released with the AMSS.

8.1.1.4 RFNV_TDSCDMA_<band>_LNA_RANGE_RISE_FALL_WB_MODE_ACQ_2_I

Data type: Array of 12, uint8 values

Data unit: dBFS (decibels relative to full scale)

This NV item includes the switch points in acquisition mode between different RxState states in dBFS units based on total measured power, if acquisition fails.

NOTE: Use the values found in the default static NV, xml file released with the AMSS.

8.1.1.5 RFNV_TDSCDMA_<band>_LNA_RANGE_RISE_FALL_NB_MODE_IDLE_I

Data type: Array of 12, uint8 values

Data unit: dBFS (decibels relative to full scale)

This NV item includes the switch points in idle mode between different RxState states in dBFS units based on inband measured power.

NOTE: Use the values found in the default static NV, xml file released with the AMSS.

8.1.1.6 RFNV_TDSCDMA_<band>_LNA_RANGE_RISE_FALL_WB_MODE_IDLE_I

Data type: Array of 12, uint8 values

Data unit: dBFS (decibels relative to full scale)

This NV item includes the switch points in idle mode between different RxState states in dBFS units based on total measured power.

NOTE: Use the values found in the default static NV, xml file released with the AMSS.

8.1.1.7 RFNV_TDSCDMA_<band>_LNA_RANGE_RISE_FALL_NB_MODE_IFREQ_I

Data type: Array of 12, uint8 values

Data unit: dBFS (decibels relative to full scale)

This NV item includes the switch points in inter-frequency mode between different RxState states in dBFS units based on inband measured power.

NOTE: Use the values found in the default static NV xml file released with the AMSS.

8.1.1.8 RFNV_TDSCDMA_<band>_LNA_RANGE_RISE_FALL_WB_MODE_IFREQ_I

Data type: Array of 12, uint8 values

Data unit: dBFS (decibels relative to full scale)

This NV item includes the switch points in inter-frequency mode between different RxState states in dBFS units based on total measured power.

NOTE: Use the values found in the default static NV xml file released with the AMSS.

8.1.1.9 RFNV_TDSCDMA_<band>_LNA_RANGE_RISE_FALL_NB_MODE_TRACKING_I

Data type: Array of 12, uint8 values

Data unit: dBFS (decibels relative to full scale)

This NV item includes the switch points in tracking mode between different RxState states in dBFS units based on inband measured power.

The formula to convert switch point in dBFS to RF input is as below:

Pin(dBm) = (Switch Point in dBFS)/2 + (LNA_offset) / 10 + 48

For example, from Gain Range 0 → Gain Range 1:

Pin(dBm) = -65/2 + -843/10 + 48 = -68.8 dBm.

NOTE: Use the values found in the default static NV xml file released with the AMSS.

8.1.1.10 RFNV_TDSCDMA_<band>_LNA_RANGE_RISE_FALL_WB_MODE_TRACKING_I

Data type: Array of 12, uint8 values

Data unit: dBFS (decibels relative to full scale)

This NV item includes the switch points in tracking mode between different RxState states in dBFS units based on total measured power.

NOTE: Use the values found in the default static NV xml file released with the AMSS.

8.1.1.11 RFNV_TDSCDMA_<band>_LNA_RANGE_RISE_FALL_NB_MODE_POWER_SCAN_I

Data type: Array of 12, uint8 values

Data unit: dBFS (decibels relative to full scale)

This NV item includes the switch points in Power Scan mode between different LNA states in dBFS units based on inband measured power.

In Power Scan mode, not all RxState states are necessarily used.

NOTE: Use the values found in the default static NV xml file released with the AMSS.

8.1.1.12 RFNV_TDSCDMA_<band>_LNA_RANGE_RISE_FALL_WB_MODE_POWER_SCAN_I

Data type: Array of 12, uint8 values

Data unit: dBFS (decibels relative to full scale)

This NV item includes the switch points in Power Scan mode between different RxState states in dBFS units based on total measured power.

In Power Scan mode, not all LNA ranges are being used.

NOTE: Use the values found in the default static NV xml file released with the AMSS.

8.1.1.13 RFNV_TDSCDMA_<band>_HS_LNA_RANGE_RISE_FALL_NB_MODE_TRACKING_I

Data type: Array of 12, uint8 values

Data unit: dBFS (decibels relative to full scale)

This NV item includes the switch points in tracking mode between different RxState states in dBFS units based on inband measured power. This NV item is applicable only to HSPA operation.

NOTE: Use the values found in the default static NV xml file released with the AMSS.

8.1.1.14 RFNV_TDSCDMA_<band>_HS_LNA_RANGE_RISE_FALL_WB_MODE_TRACKING_I

Data type: Array of 12, uint8 values

Data unit: dBFS (decibels relative to full scale)

This NV item includes the switch points in tracking mode between different RxState states in dBFS units based on total measured power. This NV item is applicable only to HSPA operation.

This NV item is one per band.

NOTE: Use the values found in the default static NV xml file released with the AMSS.

8.1.2 Calibrated, Rx RF NV items

8.1.2.1 RFNV_TDSCDMA_<band>_RX_<DIV_>CAL_CHAN_I

Data Type: Array of sixteen uint16 values

This NV item holds the Rx channel list on which the RF calibration is carried out. QTI provides a default channel list that can be modified according to specific requirements. Two to 16 channel numbers are allowed. Channel numbers must be in order of increasing RF frequency. A value of 0 indicates that the element is not used, and all following elements must be 0.

NOTE: QTI uses 16 channels. To save factory calibration time, Band 34 may reduce to three cal channels; Band 39 may reduce to six cal channels.

NOTE: Although this NV item is technically static, it is typically populated at factory calibration time.

8.1.2.2 RFNV_TDSCDMA_<band>_RX_<DIV_>GAIN_VS_FREQ_I

Data type: Array of 64, int16 values. Four (gain ranges) × 16 (frequencies) element two-dimensional array. This item can be thought of as containing 16 frequency blocks. The index of each block corresponds to the frequency channel in the same NV_TDSCDMA_<band>_RX_CAL_CHAN_I item index. Within a given frequency block there are four elements. Each element index corresponds to a RxState state (LNA gain state). Index 0 is the highest gain RxState and index 3 the lowest. Each element is in dBFS units.

Data unit: 1/10 dB (dB10) – Note that 1/10 dB = 0.1 dB.

This NV item contains 16 values for the gain of the RF path from the antenna connector to the baseband corresponding to each of the gain ranges. These NV values should be considered as absolute gain of the LNA gain step, based on the frequency index.

The purpose of calibrating this NV item is to account for unit-to-unit and frequency-to-frequency variance when mapping Rx AGC to dBFS scale.

To calibrate this NV item:

1. Set the phone to TD-SCDMA mode, at the desired band and channel index x.
2. Set the phone to LNA range y.
3. Set the signal generator to produce a continuous waveform (CW) at frequency offset 500 kHz.
4. Set the input power to the values in Table 8-2 (must account for all external losses).
5. Use the FTM command to read LNA offset.
6. The result of Step 5 is written to the $(y,x)^{th}$ element of this array.
7. Repeat Steps 1 through 5 for all Rx cal channels x = 0 to15 and all LNA ranges y = 0 to 3.

Table 8-2 LNA gain range – Calibration input power level (dBm)

LNA gain range	Calibration input power level (dBm)
G0	-50
G1	-50
G2	-50
G3	-45

NOTE: The values in Table 8-2 are examples only. Refer to the appropriate QSPR test tree for the latest values.

8.1.2.3 RFNV_TDSCDMA_<band>_RX_CAL_DATA_V2_I

See Section 6.1.2.10.

8.2 TD-SCDMA Tx RF NV items

8.2.1 Static, Tx RF NV items

8.2.1.1 RFNV_TDSCDMA_<band>_MAX_TX_POWER_I

Data type: int16 value

Data range: 0 to 28 dBm (700 to 980)

Data unit: 1/10 dB (dB10) – Note that 1/10 dB = 0.1 dB

This NV item specifies the absolute maximum power that a phone can transmit in the traffic channel, e.g., the maximum Tx power can be specified as 23 dBm by value of 23 × 10 + 700 = 930.

Notes:

- Depending on carrier requirement, power consumption optimization, and front-end loss, this value could be adjusted per band, while still within the 3GPP compliance requirement and carrier-specific requirement.
- This value shall be within the HDET circuit operating range.

NOTE: This NV item applies to DCH and PRACH.

8.2.1.2 RFNV_TDSCDMA_<band>_TX_LIN_VS_TEMP_I

Data type: Array of 32, int8 values. Four (PA gain states) × 8 (temperature bins) two- dimensional array. The format can be thought of as an array of four TxState arrays, where each TxState array contains eight temperature elements. Each TxState array corresponds to a TxState (PA gain state). TxState array 0 corresponds to TxState 0, TxState array 1 to TxState 1, and so on. Index 0 of each TxState array corresponds to hot and seven corresponds to cold. Each element has a resolution of 10 counts per dB. Positive values increase the reported Tx power relative to the actual Tx power.

Data range: -8 to 8 dB

Data unit: 1/10 dB (dB10) – Note that 1/10 dB = 0.1 dB

This NV item contains a table of eight adjustment values for the Tx linearizer per PA state, based on temperature. The temperature range for the phone is divided into eight segments. Each element corresponds to a segment. For a given temperature, each offset in the Tx linearizer curve is adjusted by a constant amount based on this table.

- Example 1 – If for a given temperature index, the element in this table is 0x05, each of the elements in the adjusted master curve table (within the RFNV_TDSCDMA_<band>_TX_MULTI_LIN_DATA_I item) is increased by 5 when the temperature corresponds to that given index. Based on the temperature, an appropriate bin in the array is picked for compensation. The default value is set to all zeroes if there is no temperature compensation required. This NV item must be calibrated. The resolution of this NV item is 10 counts per dB and it is populated with the same polarity as the uncompensated response.
- Example 2 – If the desired power is 18 dBm, but at a certain temperature the uncompensated power is measured as 16 dBm, 2 dB of compensation would be applied. In NV, however, the value to populate would be -2 × 16, because the NV item reflects the delta in the actual measurement from the desired level.

Perform the characterization procedure as follows:

1. Power up the UE in a temperature chamber at -30°C and let it soak.
2. Read the thermistor ADC value as follows:
   a. Open the TDS-CDMA RF command window in QRCT.
   b. With the UE in FTM mode, read the ADC channel corresponding to therm.
3. Given that the maximum and minimum scaled thermistor values are 0 and 4095, determine which of the eight bins the temperature falls into (divide the range of 0 to 4095 into eight evenly spaced bins).
4. Run the Tx linearizer sweep calibration using the QSPR test tree.
5. From the Tx linearizer sweep for each PA gain range, pick a power level that is near the PA switch point.
6. Determine the delta in power between the linearizer sweeps taken in step 4 with the linearizer sweep data taken during normal room temperature RF calibration.
7. Populate the appropriate bin of NV_TX_LIN_VS_TEMP according to the example above.

Repeat Steps 1 to 7 for the seven remaining bins in NV_TX_LIN_VS_TEMP, increasing the temperature of the chamber in Step 1 each time until all the bins are populated.

8.2.1.3 RFNV_TDSCDMA_<band>_TX_LIM_VS_TEMP_I

Data type: Array of eight, int8 values

Data range: -8 to 8 dB

Data unit: 1/10 dB (dB10) – Note that 1/10 dB = 0.1 dB

This NV item specifies the desired Tx power limit offset for the traffic channel for each of eight temperature values, all at the reference frequencies.

The NV item RFNV_TDSCDMA_<band>_TX_LIM_VS_TEMP_I contains a table of eight adjustment values for RFNV_TDSCDMA_<band>_MAX_TX_POWER, based on temperature. The temperature range for the phone is divided into eight segments. Each element corresponds to a segment. For a given temperature, each offset in the RFNV_TDSCDMA_<band>_MAX_TX_POWER curve is adjusted by a constant amount based on this table.

NOTE: Element 0 represents the hottest temperature and element 7 the coldest.

- Example 1 – For a given temperature index, the element in this table of 0x05 causes the max Tx power to be increased by 0.5 dB when the temperature corresponds to that given index. Based on the temperature, an appropriate bin in the array is picked for compensation. The default value is set to all zeroes if no temperature compensation is required.
  - The resolution of this NV item is 10 counts per dB, and it is populated with the same polarity as the uncompensated response.
- Example 2 – If the desired power is 23 dBm but at a certain temperature the uncompensated power is measured as 21 dBm, 2 dB of compensation would be applied. In NV, however, 2 × 10 = 20 would be populated because the NV item reflects the delta in the actual measurement from the desired level.

Perform the calibration procedure as follows:

1. Power up the UE in a temperature chamber at -30°C and let it soak.
2. Set up a TD-SCDMA call at the reference channel at a maximum Tx power of 23 dBm or a desired maximum Tx power level for the current band.
3. Read the thermistor ADC.
4. Given that the maximum and minimum scaled thermistor values are 0 and 4095, determine which of the eight bins the temperature falls into (divide the range of 0 to 4095 into eight evenly spaced bins).
5. Determine the delta in power from the measured value on the callbox and the power the phone indicates that it is transmitting.
6. Populate the appropriate bin of TX_LIM_VS_TEMP according to the example above.

Repeat Steps 1 to 6 for the seven remaining bins in TX_LIM_VS_TEMP, increasing the temperature of the chamber in Step 1 each time until all the bins are populated.

8.2.1.4 RFNV_TDSCDMA_<band>_PA_RANGE_MAP_I

Data type: Array of four, int8 values

Data range: 0, 1, 2, 3

The Qualcomm AMSS software divides the Tx output dynamic range into four linearizer tables. This NV item defines what state the PA should be in for each of those linearizer tables. This NV item sets the bits that control the pins PA_RANGE0 and PA_RANGE1 used to set the gain state of the PA for each portion of the dynamic range defined by the linearizer tables. This NV item is required to tell the software how to configure the PA for each of the four linearizer tables.

The PA_RANGE0 and PA_RANGE1 settings should be matched to the data sheet for the particular PA that is being used. Note that the first value represents the lowest linearizer table (which corresponds to the minimum Tx output power).

8.2.1.5 RFNV_TDSCDMA_<band>_PA_RISE_FALL_I

Data type: Array of six, uint16 items. The item can be thought of as an array of three structures. Each structure index corresponds to a TxState (PA state) transition. Index 0 is TxState 0<=>1, index 2 is TxState 1<=>2. Index 3 is TxState 2<=>3. Each structure contains two elements, a rise and a fall threshold.

Data unit: dB10 in dBm scale

This NV item specifies the Tx power levels threshold for which the PA is intended to switch from one PA range to another. The formula to convert the PA switch point values from dBm to the NV format is (PA_swpt_in_dBm × 10) + 700.

8.2.1.6 RFNV_TDSCDMA_<band>_AGC_PA_ON_RISE_FALL_DELAY_I

Data type: Array of two, uint16 values. Chip resolution (~33 ns per count). Element 0 is the rise delay, and element 1 is the fall delay.

Time delta

- RFNV_TDSCDMA_<band>_AGC_PA_ON_RISE_FALL_DELAY_I[0] – Time delta between the PA_ON signal rise and the start of the Tx frame boundary in chip resolution. It is used to time-align the PA_ON signal at the beginning of the Tx timeline.
- RFNV_TDSCDMA_<band>_AGC_PA_ON_RISE_FALL_DELAY_I[1] – Time delta between when the PA_ON signal falls after the end of the Tx frame boundary in chip resolution. It is used to time-align the PA_ON signal at the end of the Tx timeline.

Example:

- Values in QCN – 1, 460
- Values in time – 33 ns, 15 μs

This data is provided only as an example. QTI recommends using the values provided in the static NV xml file. This NV item is reserved for future use.

8.2.1.7 RFNV_TDSCDMA_<band>_AGC_TX_ON_RISE_FALL_DELAY_I

Data type: Array of two, uint16 values. Chip resolution (~33 ns per count). Element 0 is the rise delay and element 1 is the fall delay.

Time delta

- RFNV_TDSCDMA_<band>_AGC_TX_ON_RISE_FALL_DELAY_I[0] is used to adjust the time mask. This item is the time delta between the TX_ON signal rise and the start of the Tx frame boundary in chip resolution. It is used to time-align the TX_ON signal at the beginning of the Tx timeline.
- RFNV_TDSCDMA_<band>_AGC_TX_ON_RISE_FALL_DELAY_I[1] is the time delta between when the TX_ON signal falls after the end of the Tx frame boundary in chip resolution. It is used to time-align the TX_ON signal at the end of the Tx timeline.

Example:

- Values in QCN – 5, 455
- Values in time – 163 ns, 14.84 µs

This data is provided only as an example. QTI recommends using the values provided in the static NV xml file. This NV item is reserved for future use.

8.2.1.8 RFNV_TDSCDMA_<band>_AGC_UPDATE_TX_AGC_TIME_I

Data type: uint16 value

This NV item is the time delta between the RF analog gain change signal and the start of the Tx frame boundary. It is used to time-align the RF gain update signal in the Tx chain to the Tx timeline.

QTI recommends using the values provided in the static NV xml file. This NV item is reserved for future use.

8.2.1.9 RFNV_TDSCDMA_<band>_PA_GAIN_UP_DOWN_TIME_I

Data type: Array of two, uint16 values. Chip resolution (~33 ns per count). Element 0 is the Up time and element 1 is the Down time.

Data range: 0 to 3800

Time delta

- RFNV_TDSCDMA_<band>_PA_GAIN_UP_DOWN_TIME_I[0] contains the time delta between the time reference signal and the PA_RANGE updated for the transition from the low- to the high-gain state. Tuning this item influences the relative timing between the PA_RANGE transition and the RF gain update signal in the Tx chain. Generally, customers should not need to tune this NV item; instead, they should refer to the value in the static NV, xml file that comes with the AMSS build.

- RFNV_TDSCDMA_<band>_PA_GAIN_UP_DOWN_TIME_I[1] contains the time delta between the time reference signal arrival and PA_RANGE updated for the transition from the high- to low-gain state. Tuning this item influences the relative timing between the PA_RANGE transition and the RF gain update signal in the Tx chain. This NV item generally does not need tuning; instead, refer to the value in the static NV xml file that comes with the AMSS build.

Example:

- Values in QCN – 123, 92
- Values in time – 4 μs, 3 μs

This data is provided only as an example. QTI recommends using the values provided in the static NV xml file. This NV item is reserved for future use.

8.2.1.10 RFNV_TDSCDMA_<band>_TX_ROT_ANGLE_PA_STATE_I

Data type: Array of four, uint16 values

This NV item contains a rotation angle in degrees with a resolution of 360/512 = 0.703°. The rotation value is applied to the Tx signal per PA range, e.g., NV_TDSCDMA_TX_ROT_ANGLE_PA_STATE_I[0] could be used to compensate for the phase discontinuity while in state 00, NV_TDSCDMA_TX_ROT_ANGLE_PA_STATE_I[1] for state 1, etc.

For negative amounts of compensation, the value needs to be subtracted from 512. Note also that these NV items are relative to the amount of compensation applied for other gain states. Currently, this NV item is reserved for future usage.

8.2.1.11 RFNV_TDSCDMA_<band>_PA_COMPENSATE_UP_DOWN_I

Data type: Array of six, uint16 values. This item can be thought of as an array of three structures. Each structure contains two compensation values, an up value and a down value. Structure index 0 corresponds to the TxState 0<=>1 transition, index 1 to the 1<=>2 transition and so on. Resolution is 10 counts per dB.

This item contains a TxAGC offset. This offset is only applied to the slot following a PA range transition from one PA range to another. The total duration of this offset is only for that one slot. Note that currently, this NV item is reserved for future usage.

8.2.1.12 RFNV_TDSCDMA_<band>_TIMER_HYSTERISIS_I

Data type: int16 value

This NV item contains the count value for how long the AGC block waits before switching gain states during timer hysteresis. Timer hysteresis is only used when switching from higher to lower gain states and not from lower to higher gain states.

The resolution of this NV item is 66 μs; a value of 1 enforces a 66 μs wait period. It is recommended that customers use the default value given in the static NV, xml file.

This NV item is reserved for future use.

8.2.1.13 RFNV_TDSCDMA_<band>_MPR_BASED_PA_SWITCHPOINTS_SHIFT_I

Data type: Array of seven, uint16 values

This NV item holds the PA switch points shift corresponding to RFNV_TDSCDMA_<band>_TX_GAIN_SHIFT_I.

This NV item is reserved for future use.

8.2.1.14 RFNV_TDSCDMA_<band>_TX_GAIN_SHIFT_I

Data type: Array of seven, int16 values. Each index corresponds to a particular TD-SCDMA waveform. The value of each element is a shift in units of dB10 (10 counts per dB).

Data range: 0 to 23 (array of 7)

This NV item holds Tx AGC offset in dB10 to be used for digital gain scaling that is applied to different sets of TD-SCDMA waveforms. Baseband backoff essentially reduces both the RMS value of the I & Q samples and the input level at the RTR DAC. In order to prevent changes in baseband signal level from altering Tx power, the baseband signal level power changes are compensated in RF by automatically adjusting the TxAGC values in the RFNV_TDSCDMA_<band>_TX_MULTI_LIN_DATA_I NV item by the value in the appropriate element of this NV item.

Duplicate the values found in the default, static NV, xml file.

8.2.1.15 RFNV_TDSCDMA_<band>_PA_MPR_BACKOFF_I

Data type: Array of seven, uint16 values

This NV item holds TxAGC analog offset for the maximum power reduction (MPR) based on the cubic metric (CM) value computed from the UE Tx channel configuration. At this time, QTI recommends using the values in the default, static NV xml file.

8.2.1.16 RFNV_TDSCDMA_<band>_MPR_VAL_I

Data type: Array of seven, uint16 values

The maximum power reduction (MPR) for the nominal maximum output power is based on the cubic metric (CM) value computed from the UE Tx channel configuration. At this time QTI recommends using the values in the default, static NV xml file.

8.2.1.17 RFNV_TDSCDMA_<band>_TX_EPT_DPD_CONFIG_PARAMS_I

There is one DPD configure NV item per band to store parameters for DPD software operation. See Section 5.2.1.18 for format descriptions and details.

8.2.1.18 RFNV_TDSCDMA_<band>_TX_CAL_CHAN_I

Data type: Array of 16 uint16 values

This item has been repurposed for use in TX_LIN_VS_TEMP_VS_FREQ_P_IN and TX_LIN_VS_TEMP_VS_FREQ_P_OUT characterization. It contains the list of up to 16 channels used for the characterization.

8.2.1.19 RFNV_TDSCDMA_<band>_TX_LIN_VS_TEMP_VS_FREQ_P_IN_I

This NV item is used for frequency and temperature compensation in PA power input for each PA state (R0, R1, R2, and R3). See Section 5.2.1.20 for the format description and details.

8.2.1.20 RFNV_TDSCDMA_<band>_TX_LIN_VS_TEMP_VS_FREQ_P_OUT_I

This NV item is used for frequency and temperature compensation in PA power output for each PA state (R0, R1, R2, and R3). See Section 5.2.1.21 for the format description and details.

8.2.2 Calibrated, Tx RF NV items

8.2.2.1 RFNV_TDSCDMA_<band>_TX_MULTI_LIN_V3_DATA_I

See Section 5.2.2.1. This item applies to TD-SCDMA.

8.2.2.2 RFNV_TDSCDMA_<band>_EXP_HDET_VS_AGC_I

Data type: Array of 16, uint16 values.

Data range: 0 to 4095 (only the 12 least significant bits are used)

AMSS uses this NV item to build a lookup table, which indexes Tx power estimation via a scaled TX_GAIN_CTL (representing the desired Tx power) to associated HDET circuit values at reference temperature and the reference frequency.

For the calibration procedure, the HDET readings can be obtained from the Tx linearizer sweep. The firmware reads HDET during high PA range sweep for all Tx on slots.

The power levels in the Tx power column were chosen by breaking up the top 25% of the dynamic range into 16 evenly spaced bins:

- MinRSSI = -70 dBm
- Dynamic range = 102.4 dB
- Max Power = 32.4 dBm
- Top 25% = 6.8 dBm to 32.4 dBm (the last point is explicitly known by AMSS and is not listed in the table)

Table 8-3 shows example calibration data.

Table 8-3 RFNV_TDSCDMA_<band>_EXP_HDET_VS_AGC_I

Tx power (dBm)	RFNV_TDSCDMA_<band>_EXP_HDET_VS_AGC_I (example calibration data)
6.8	701
8.4	764
10	832
11.6	923
13.2	1057
14.8	1214
16.4	1423
18	1674

Tx power (dBm)	RFNV_TDSCDMA_<band>_EXP_HDET_VS_AGC_I (example calibration data)
19.6	1969
21.2	2333
22.8	2799
24.4	3408
26	3926
27.6	4095
29.2	4095
30.8	4095

8.2.2.3 RFNV_TDSCDMA_<band>_TX_LIM_VS_FREQ_I

Data type: Array of 16, int8 values

Data unit: dB10

The NV item RFNV_TDSCDMA_<band>_TX_LIM_VS_FREQ_I contains a table of 16 adjustment values for the Tx power limit based on frequency. The Tx power limit is heavily based on the feedback from the HDET circuit. This NV item is used to compensate for the frequency response of the HDET circuit and the RF components between that circuit and the RF output.

The units are in dB10 and values can be positive or negative.

Perform the following to calibrate this NV item:

1. Set the phone to the highest gain state.
2. Set the phone to the first RF cal channel.
3. Set the phone to an output power level where limiting should occur (maximum power) by adjusting the Tx gain index. Record the exact power level and the corresponding Tx gain index.

   Let the recorded power be Power[i], and the gain index value be gainIndex[i], where ‘i’ is the channel index 0 to 15.
4. Read and record the HDET from the appropriate ADC; take an average of several readings.

   Let the average HDET reading be HDET[i].
5. Repeat Steps 3 and 4 for all remaining RF calibration channels.
6. Calculate RFNV_TDSCDMA_<band>_TX_LIM_VS_FREQ_I.

First, calculate the HDET scale using the high PA range Tx linearizer power vs. HDET data collected during the Tx sweep cal routine. The HDET scale is calculated by finding the linear slope of power vs. HDET of the last two readings and multiplying by a scale factor of 10.

- Let HiPALinMaster1Pow[i] – Array holding Tx power of high PA range Tx linearizer
- HiPALinMaster1Hdet[i] – Array holding the corresponding HDET values
- Master1ListSize – The size of measured Tx linearizer data, up to maximum power
- ChIndex – RFCal channel index (index 0 through 15)
- RefChIndex – Reference channel index, e.g., index 7

- hdetScale = 10 × ((HiPALinMaster1Pow[Master1ListSize - 1] HiPALinMaster1Pow[Master1ListSize - 2]) / (HiPALinMaster1Hdet[Master1ListSize - 1] - HiPALinMaster1Hdet [Master1ListSize - 2]))
- NV_TDSCDMA_TX_LIM_VS_FREQ[ChIndex] = ((HDET[ChIndex] HDET[RefChIndex]) × hdetScale) + 10 × (Power[RefChIndex] - Power[ChIndex])

Example

- Master1ListSize = 14
- HiPALinMaster1Pow[Master1ListSize - 1] = 23.4225 dBm
- HiPALinMaster1Pow[Master1ListSize - 2] = 21.5758 dBm
- HiPALinMaster1Hdet[Master1ListSize - 1] = 1805; this is the HDET value at 23.4225 dBm
- HiPALinMaster1Hdet[Master1ListSize - 2] = 1292; this is the HDET value at 21.5758 dBm
- ChIndex = 0
- RefChIndex = 7
- HDET[ChIndex] = 1761
- HDET[RefChIndex] = 1570
- Power [RefChIndex] = 22.6842 dBm
- Power [ChIndex] = 23.0497 dBm
- hdetScale = [(23.4225 - 21.5758)/(1805 - 1292)] × 10 = 0.036
- NV_TDSCDMA_TX_LIM_VS_FREQ[0] = (1761 - 1570) × 0.036 + (22.6842 - 23.0497) × 10 = 6.876 - 3.655 = 3

9 GSM RF NV items

9.1 Naming conventions for GSM RF NV items

The naming convention/format for each of the NV items is:

- RFNV_GSM_Cx_GSM<band>_<nv_name>

Fill in the <chain> and the <band> with the following:

Cx	C0, C2 (C0 only for MSM8974/MDM9x25) ▪ Transceiver 1 – C0 for primary, C1 for diversity ▪ Transceiver 2 – C2 for primary, C3 for diversity
GSM<band>	GSM850, GSM900, GSM1800, GSM1900

Examples of the naming convention include:

- RFNV_GSM_C0_GSM850_RX_CAL_DATA_I
- RFNV_GSM_C2_GSM1800_RX_CAL_DATA_I

GSM vs. EDGE indicator

The modulation type (GMSK and 8PSK for GSM and EDGE, respectively) are used in NV names only for NV items, which are different for GSM and EDGE. For NV items that have GSM and EDGE data as two fields of the same NV (calibration data NV), the proper field names distinguish the data.

9.2 GSM Rx RF NV items

9.2.1 Static, Rx RF NV items

9.2.1.1 RFNV_GSM_Cx_GSM<band>_LNA_SWPT_I

This NV item stores the switch points for each LNA gain state. These NV items contain eight, dBFS (dB full-scale) values corresponding to gain range 1 up, gain range 2 down, gain range 2 up, gain range 3 down, gain range 3 up, gain range 4 down, gain range 4 up, and gain range 5 down. Table 9-1 describes the format of the item.

Figure 9-1 shows the LNA gain ranges and gain switch points.

Table 9-1 RFNV_GSM_Cx_GSM<band>_LNA_SWPT_I format

Index	Element name	Size
0	max_gainrange_1	Single, int8 value
1	min_gainrange_2	Single, int8 value
2	max_gainrange_2	Single, int8 value
3	min_gainrange_3	Single, int8 value
4	max_gainrange_3	Single, int8 value
5	min_gainrange_4	Single, int8 value
6	max_gainrange_4	Single, int8 value
7	min_gainrange_5	Single, int8 value

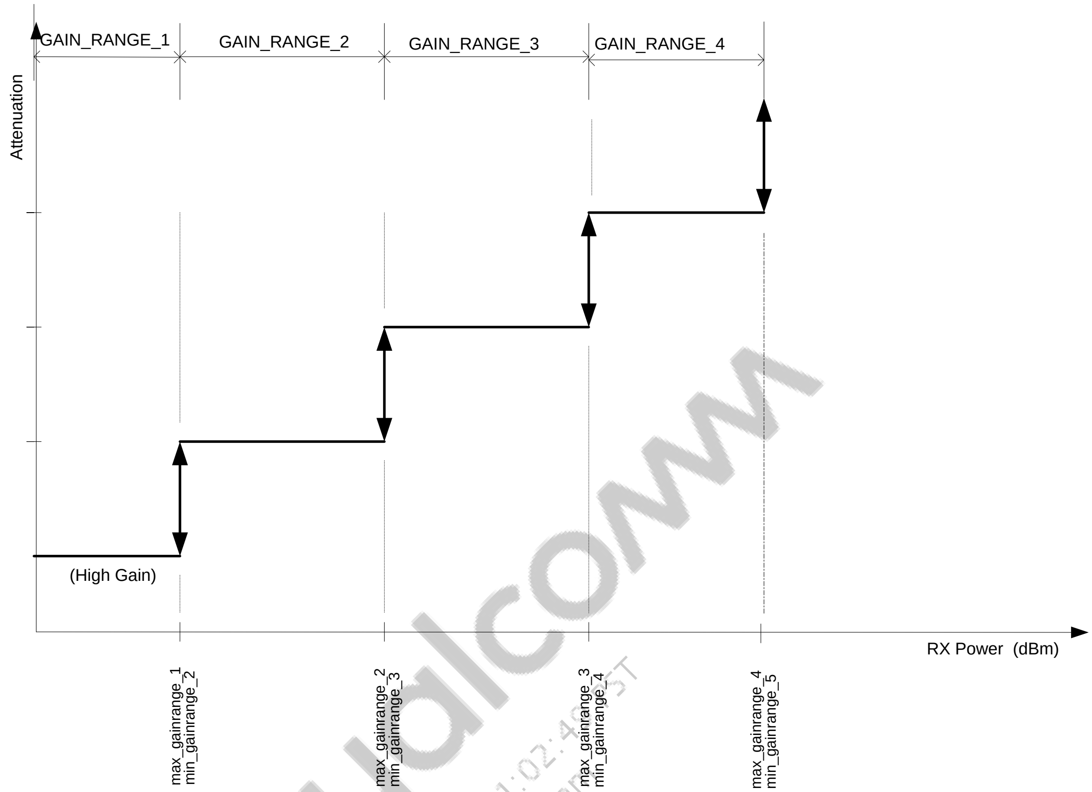


Figure 9-1 RFNV_GSM_Cx_GSM<band>_LNA_SWPT_I

NOTE: The conversion from dBm to dBFS is not available. The specified switch points should be applicable across a wide range of receiver designs.

Use the values in the static NV xml file included with the AMSS software.

9.2.1.2 RFNV_GSM_Cx_GSM<band>_COEX_RX_OFFSET_INFO_TBL

This NV stores the offset values between the filtered and unfiltered paths for the SGLTE CMCC RF card for 16 channels. (In some RF cards, only DCS is split-band in SGLTE. When using such RF cards, only the offset NV for the DCS band is used.)

The first 16 elements specify the ARFCN channels (16, uint16 elements). The second 16 elements specifiy the offsets for each ARFCN channel index (16, int16 elements).

Power offset values for each of the 16 channels is in dB×16 format (16 counts per dB). Each offset value is 2 bytes as shown in Table 9-2.

Table 9-2 RFNV_GSM_Cx_GSM<band>_COEX_RX_OFFSET_INFO_TBL format

Block	Data	Size
ARFCN	ARFCN[0]	Single, uint16 value
	ARFCN[1]	Single, uint16 value
	…	…
	ARFCN[15]	Single, uint16 value
Offset	Offset[0] (dB×16 units)	Single, int16 value
	Offset[1] (dB×16 units)	Single, int16 value
	…	…
	Offset[15] (dB×16 units)	Single, int16 value

Refer to *MPSS.DI.2.0 SGLTE RF Overview* (80-NJ017-13) for further information.

9.2.1.3 RFNV_GSM_<Cx>_<band>_HL_RX_LNA_SWPT_I

Data type: Eight int8 values, same type as Figure 9-1.

This NV items is similar to 9.2.1.1, RFNV_GSM_Cx_GSM<band>_LNA_SWPT_I but contains the LNA switch point on High Lin mode when it is used for SAWLess card. Refer to*:* *MSM8909+WTR4905 RF Calibration Software Overview* (80-NT093-2) for more details.

9.2.2 Calibrated, Rx RF NV items

9.2.2.1 RFNV_GSM_Cx_GSM<band>_RX_CAL_DATA_I

The format of this NV item is shown in Table 9-3.

.

Table 9-3 RFNV_GSM_Cx_GSM<band>_RX_CAL_DATA_I

Block	Data	Size
rx_cal_chan_size	Channel size	uint8 value
rx_cal_chan_list	Array of 16 Tx calibration channel list. The number of important elements in the array is determined by the rx_cal_chan_size. Each element contains an Absolute radio frequency channel number (ARFCN) used for calibration.	16 int16 values
RxState state 0 rx_freq_comp_data	16 frequency compensation values	16 int16 values
RxState state 1 rx_freq_comp_data	16 frequency compensation values	16 int16 values
RxState state 2 rx_freq_comp_data	16 frequency compensation values	16 int16 values
RxState state 3 rx_freq_comp_data	16 frequency compensation values	16 int16 values

To calibrate the rx_freq_comp_data elements, use these steps.

1. Set the Phone mode to the appropriate GSM band.
2. Set the phone to the appropriate RxState state.
3. Set the signal generator to inject a GMSK 3GPP specification waveform at an appropriate power level. (For the latest recommended power level, refer to the latest corresponding QSPR test tree.)
4. Set the channel to the appropriate ARFCN channel.
5. Record RSSI. Call this RSSI[i]
6. Repeat Steps 4 and 5 for all remaining ARFCN channels, and then repeat for all applicable RxState states (use the QSPR test tree for example guidance).

The value of the rx_freq_comp_data[i] element is then calculated using the following formula:

$$Rx\_freq\_comp\_data[i] = 16 \times (10 \times Log(RSSI[i]) - (-90\ dBm)).$$

9.2.2.2 RFNV_GSM_<Cx>_<band>_HL_RX_CAL_I

Data type: Same type as Table 9-3.

This NV item is similar to RFNV_GSM_Cx_GSM<band>_RX_CAL_DATA_I but contains the Rx Cal result on High Lin when it is calibrated for SAWLess card. High Lin could be enabled by XTT. Refer to *MSM8909+WTR4905 RF Calibration Software Overview* (80-NT093-2) for more details.

9.3 GSM Tx RF NV items

9.3.1 Static, Tx RF NV items

9.3.1.1 RFNV_GSM_Cx_GSM<band>_TX_TIMING_I

This NV item contains the GSM timing control adjustment values. Its format is described in Table 9-4.

Table 9-4 RFNV_GSM_Cx_GSM<band>_TX_TIMING_I format

Index	Element name	Data	Size
0	tx_burst_offset_adj	The time delta is needed to adjust the center of GSM Tx burst. Can be altered to adjust the center of GSM Tx burst (the transition from bit 13 to bit 14 of the midamble) to be three time slot periods (1731 μs) ± 1-bit period (± 3.69 μs) after the center of the corresponding Rx burst.	Single, int16 value
1	pa_en_start_off_adj	PA enable signal start time adjustment value. Its value can be altered to move the rising edge of the PA enable signal forward or backward to get the optimal configuration.	Single, int16 value
2	pa_en_stop_offset_adj	PA enable signal stop time adjustment value. Its value can be altered to move the falling edge of the PA enable signal forward or backward to get the optimal configuration.	Single, int16 value
3	pa_start_offset_adj	PA turn on time adjustment. Its value can be altered to adjust the rising edge of the TDMA Tx power burst.	Single, int16 value
4	pa_stop_offset_adj	PA turn off time. Its value can be altered to adjust the falling edge of the TDMA Tx power burst.	Single, int16 value
5	ant_timing_start_offset_adj	Antenna select control signal start time adjustment value. The value can be adjusted to move the rising edge of antenna select control signal forward or backward relative to PA enable signal rising edge to get the optimal configuration.	Single, int16 value
6	ant_timing_stop_offset_adj	Antenna select control signal stop time adjustment value. The value can be adjusted to move the falling edge of antenna select control signal forward or backward relative to PA enable signal falling edge to get the optimal configuration.	Single, int16 value

Use QRCT to adjust the tx_burst_offset_adj so the phone meets the power mask specification. In QRCT, a PA Start Delta button (see Figure 9-2) moves the leading edge of a TDMA burst backward and forward, depending on whether negative or positive values are entered.

To adjust tx_burst_offset_adj, peform the following in QRCT:

1. Enter 0 for Slot Number. If the leading edge of the power mask is not passing the specification, go to Step 2.
2. Enter a value of either 1 or -1.
3. Click **PA Start Delta**.
4. Check if power mask passes the specification.
5. Repeat Steps 1 to 4 until there is a passing leading edge power-vs-time mask.

tx_burst_offset_adj holds the time delta needed to adjust the center of GSM Tx burst (the transition from bit 13 to bit 14 of the mid-amble) to be 3 time slot periods (1731 µs) ± 1-bit period (±3.69 µs) after the center of the corresponding Rx burst.

Perform the following to calibrate this NV item using a call box:

1. Start a GSM call.
2. Measure the time alignment.
3. Ensure the error is within ±1 bit. If it is not, use the QXDM NV browser to adjust and write the new value of this NV item (NV_GSM_TX_BURST_OFFSET_ADJ_I) to the phone. QRCT NV tools may also be used.
4. Reset the phone and repeat Steps 1 through 3 until the error is within ±1 bit.

NOTE: Reset the phone power for the new value to take effect. 1 bit = 4 quarter symbols.

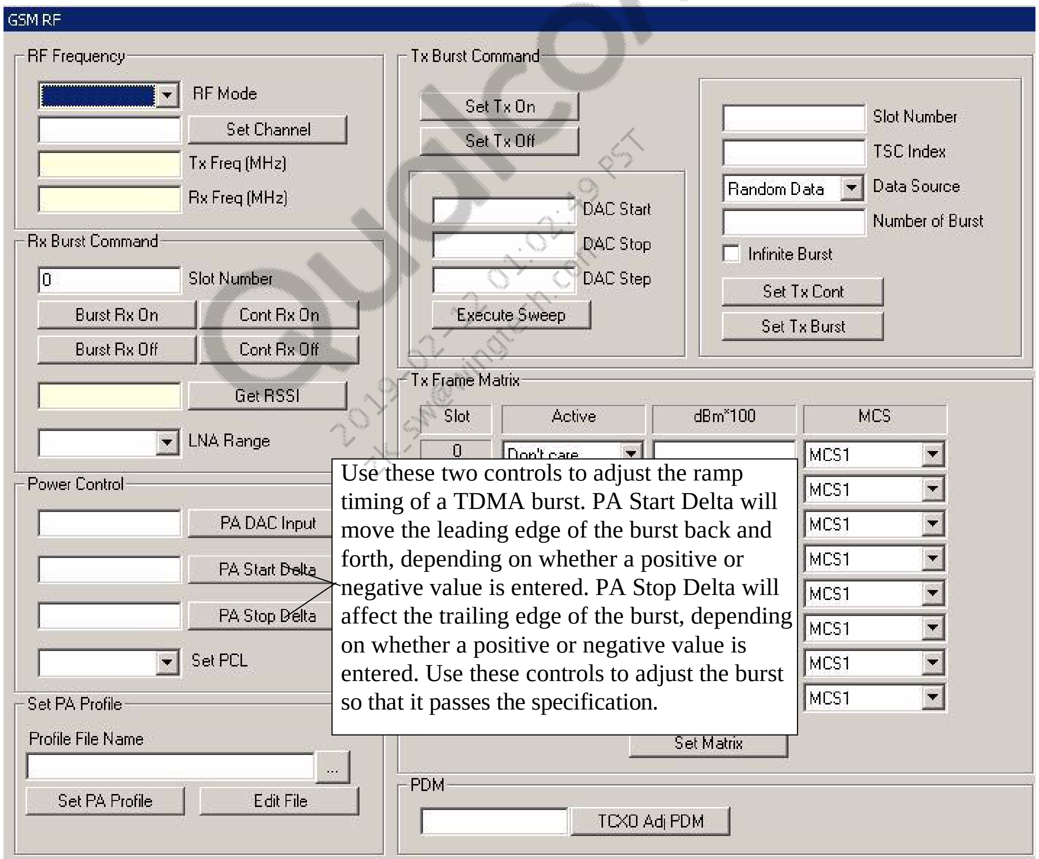


Figure 9-2 QRCT, PA Start/Stop delta characterization control

Other signals can also affect power mask specification performance, such as transmitter turn-on time and antenna switch timing. These can also be adjusted.
See Figure 9-3 and Figure 9-4 for details.

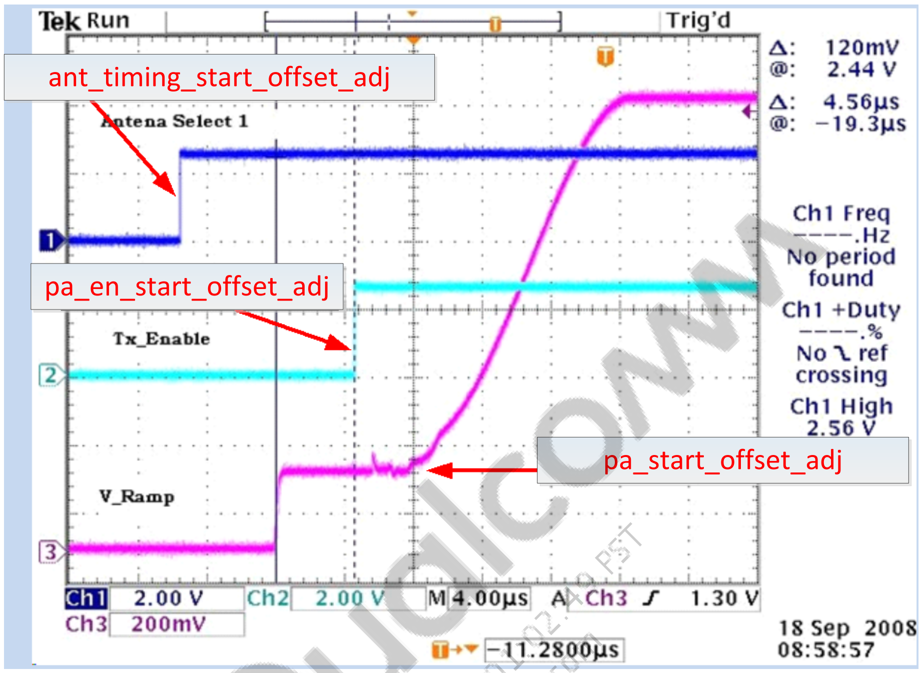


Figure 9-3 Control signals during PA ramp-up

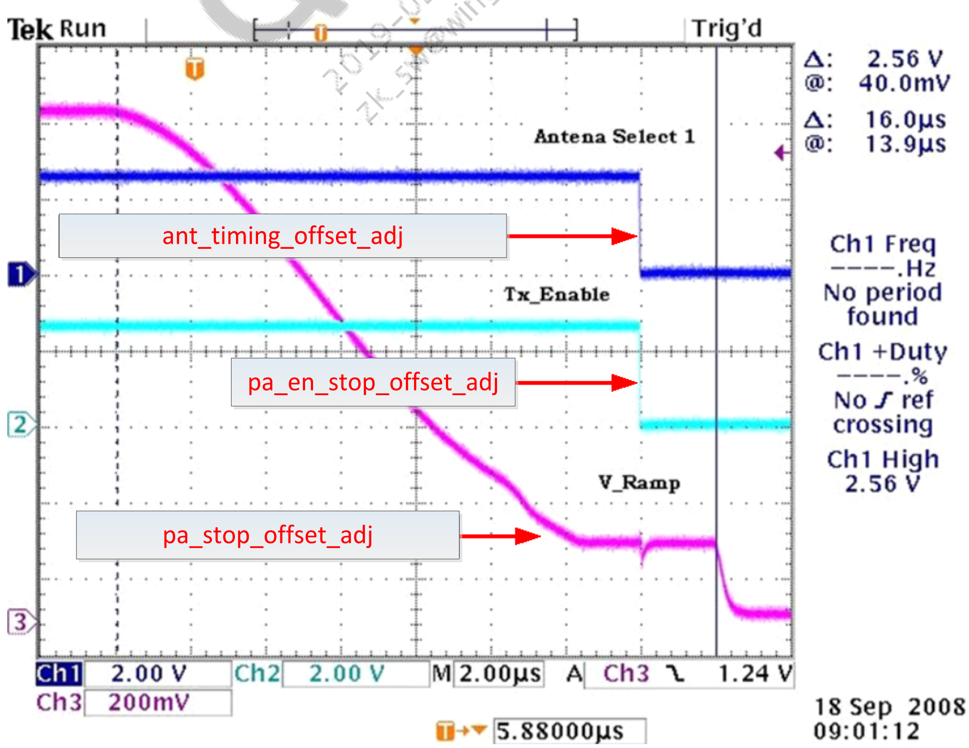


Figure 9-4 Control signals during PA ramp-down

9.3.1.2 RFNV_GSM_Cx_GSM<band>_POLAR_PATH_DELAY_I

Data type: Single int16 value. The format is the delay value directly returned from the FTM_SET_PATH_DELAY API command

The existence of two separate waveform paths through the chipset solution could lead to different signal delays on the phase path and the envelope path, affecting the EDGE waveform quality. Hence, the chipset solution allows for delays to be added to either path to make sure that the phase and envelope paths remain in sync.

Perform the following characterization procedure:

1. Set the band.
2. Set the phone to the reference channel.
3. Configure Tx to use random data using the QLIB_FTM_SET_TRANSMIT_BURST API. The TSC index and the number of bursts can be set to 0, and the infinite duration flag set to 1.
4. Use the FTM_SET_TX_FRAME_MATRIX API (ID 240) to configure the mobile for single timeslot operation at 8PSK maximum power (27 dBm for GSM/GSM_850, 26 dBm for DCS/GSM_1900) with MCS-5 channel coding.
5. Set the phone Tx on.
6. Sweep the delay values to find the value that yields the best output radio frequency spectrum (ORFS) due to modulation performance.
   a. Set the delay value using the FTM_SET_PATH_DELAY API (ID 237).
   b. Measure ORFS due to modulation.
   c. The best-case delay is determined by finding the delay value resulting in the lowest ORFS due to the modulation measurement at +400 kHz and -400 kHz.
   d. Each set delay call through the FTM_SET_PATH_DELAY returns the NV value that corresponds to the delay setting.
7. Write this value to NV item, NV_GSM_Cx_GSM<band>_POLAR_PATH_DELAY_I, to the phone.

NOTE: Depending on the specific chipset combination, the sweep produced in Steps 6 and 7 can produce noisy results. ORFS performance may vary significantly even between adjacent delay values. However, the noise characteristics are mostly repeatable from phone to phone. If characterizing the NV item value using multiple phones, do not average the optimal NV values across devices. Instead, pick an NV value that works acceptably well across all phones in the sample.

9.3.1.3 RFNV_GSM_Cx_GSM850_POWER_LEVELS_I, RFNV_GSM_Cx_GSM900_POWER_LEVELS_I, RFNV_GSM_Cx_GSM1800_POWER_LEVELS_I, RFNV_GSM_Cx_GSM1900_POWER_LEVELS_I

Data type: Array of 16, int16 values

These NV items hold the various GSM power levels for each Power control level (PCL) in dBm multiplied by 100. The format and the data stored in each item are shown in Table 9-5 and Table 9-6.

Table 9-5 RFNV_GSM_Cx_GSM850_POWER_LEVELS_I and RFNV_GSM_Cx_GSM900_POWER_LEVELS_I format

Block	Index	Data	Size
GSM low bands	0	450	Single int16 value
	1	650	Single int16 value
	2	850	Single int16 value
	3	1050	Single int16 value
	4	1250	Single int16 value
	5	1450	Single int16 value
	6	1650	Single int16 value
	7	1850	Single int16 value
	8	2050	Single int16 value
	9	2250	Single int16 value
	10	2450	Single int16 value
	11	2650	Single int16 value
	12	2850	Single int16 value
	13	3050	Single int16 value
	14	3250	Single int16 value
	15	3250	Single int16 value

Note: Since there are only 15 PCLs, data for index 15 is a repeat of data from index 14 in low bands.

Table 9-6 RFNV_GSM_Cx_GSM1800_POWER_LEVELS_I and RFNV_GSM_Cx_GSM1900_POWER_LEVELS_I format

Block	Index	Data	Size
GSM high bands	0	0	Single int16 value
	1	150	Single int16 value
	2	350	Single int16 value
	3	550	Single int16 value
	4	750	Single int16 value
	5	950	Single int16 value
	6	1150	Single int16 value
	7	1350	Single int16 value
	8	1550	Single int16 value
	9	1750	Single int16 value
	10	1950	Single int16 value
	11	2150	Single int16 value
	12	2350	Single int16 value
	13	2550	Single int16 value
	14	2750	Single int16 value
	15	2950	Single int16 value

9.3.1.4 RFNV_GSM_Cx_GSM<band>_POLAR_RAMP_PROFILE_I

This NV item contains the PA ramp-up and ramp-down profiles for each of the four GSM bands. The first array of the structure holds the ramp-up profile values, and the second array of the structure holds the ramp-down profile values. These values are typically numbers from 0 to 1 scaled by 4096.

Table 9-7 RFNV_GSM_Cx_GSM<band>_POLAR_RAMP_PROFILE_I format

Block	Data	Size
Ramp_up[0 – 29]	Array of 30 ramp-up values	30, uint16 values
Ramp_down[0 – 29]	Array of 30 ramp-down values	30, uint16 values

Note: Use values from the default static NV xml file released with the AMSS software.

9.3.1.5 RFNV_GSM_Cx_GSM<band>_MULTISLOT_MAX_TX_PWR_I

This NV item specifies the absolute power level in dBm after backoff for each multislot configuration in units of dB × 100, as shown in Table 9-8.

Table 9-8 RFNV_GSM_Cx_GSM<band>_MULTISLOT_MAX_TX_PWR_I format

Block	Data	Size
GSM (GMSK)	Specifies the absolute power level in dBm after backoff in GMSK for each 20 multislot configuration in the format of dBm × 100	Five, int16 values
EDGE (8PSK)	Specifies the absolute power level in dBm after backoff in 8PSK for each 20 multislot configuration in the format of dBm × 100	Five, int16 values

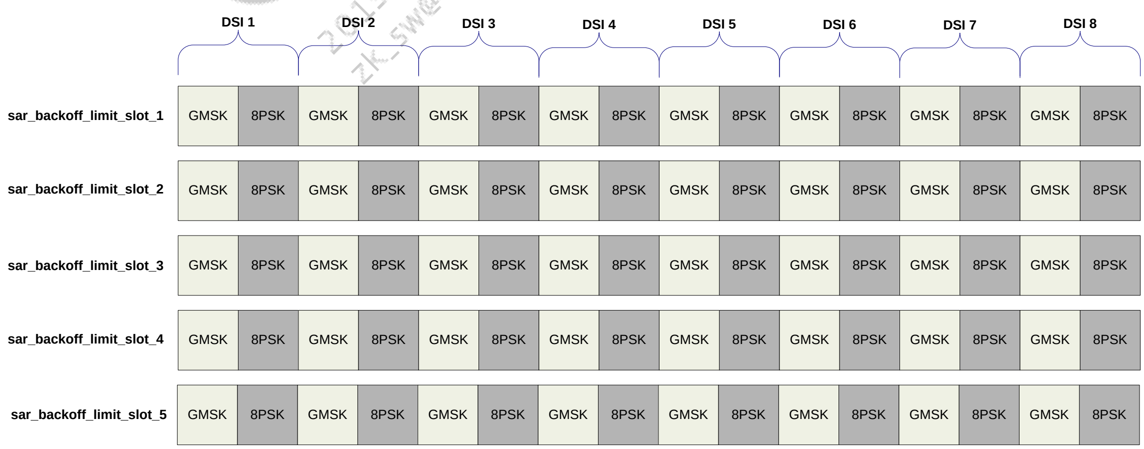
9.3.1.6 RFNV_GSM_Cx_GSM<band>_SAR_BACKOFF_I

Data type: Structure of five arrays: one array per slot. Each array contains 16, int16 values

This NV item allows specific absorption rate (SAR) backoff based on the GSM slot and the DSI index.

The NV item is divided into five arrays, one for each slot. The slot-specific arrays are 16-element arrays, where array elements 0, 2, 4,…, 14 specify the GMSK mode and elements 1, 3, 5, …, 15 specify the 8PSK-mode absolute Tx power limit in dBm (times 100).

Figure 9-5 shows the NV structure and Table 9-9 provides a detailed description of the format.



Note: The NV values for GMSK and 8PSK are in dB100

Figure 9-5 GSM SAR-related NV item structure

Table 9-9 RFNV_GSM_Cx_GSM<band>_SAR_BACKOFF_I format

Index	Slot	DSI	Element	Size
0	sar_backoff_limit_slot_1	DSI 1	GSM (GMSK)	Single int16
1			EDGE (8PSK)	Single int16
2		DSI 2	GSM (GMSK)	Single int16
3			EDGE (8PSK)	Single int16
…		…	…	…
12		DSI7	GSM (GMSK)	Single int16
13			EDGE (8PSK)	Single int16
14		DSI 8	GSM (GMSK)	Single int16
15			EDGE (8PSK)	Single int16
16	sar_backoff_limit_slot_2	DSI 1	GSM (GMSK)	Single int16
17			EDGE (8PSK)	Single int16
18		DSI 2	GSM (GMSK)	Single int16
19			EDGE (8PSK)	Single int16
…		…	…	…
28		DSI7	GSM (GMSK)	Single int16
29			EDGE (8PSK)	Single int16
30		DSI 8	GSM (GMSK)	Single int16
31			EDGE (8PSK)	Single int16
…	…	…	…	…
64	sar_backoff_limit_slot_5	DSI 1	GSM (GMSK)	Single int16
65			EDGE (8PSK)	Single int16
66		DSI 2	GSM (GMSK)	Single int16
67			EDGE (8PSK)	Single int16
…		…	…	…
76		DSI7	GSM (GMSK)	Single int16
77			EDGE (8PSK)	Single int16
78		DSI 8	GSM (GMSK)	Single int16
79			EDGE (8PSK)	Single int16

Example: For a maximum Tx power limit = +28.0 dBm, write the value 28/0.01 = 2800 for the associated DSI entry.

GSM can have one to five UL slots. Each band has an NV item for each of the five possible slot configurations. The NV item value limits the maximum Tx power in each of the slots.

Refer to *Dynamic Maximum Tx Power Limits* (80-VP146-8) for details.

9.3.1.7 RFNV_GSM_Cx_GSM<Band>_LINEAR_TX_GAIN_PARAM_I

These NV items hold the digital gain setting for the transmitter for GSM and EDGE type waveforms (see Table 9-10). This is not the same as the RGI gain setting, which is an RF gain setting. The level present at the device Tx output is a combination of the digital gain setting and the RGI gain setting.

A digital gain setting of 1 is equivalent to a setting of 128 in this NV item, and the maximum value is 511. This digital gain setting is used only during Tx DA calibration when there is a requirement to program various digital gains for the 8PSK steps (instead of a constant digital gain).

QTI has optimized these NV items. Customers should use the value provided in the appropriate static .xml file provided with the AMSS build.

Table 9-10 RFNV_GSM_Cx_GSM<band>_LINEAR_TX_GAIN_PARAM_I format

Block	Data	Size
GSM	GSM linear Tx gain value	Single, uint16 value
EDGE	EDGE linear Tx gain value	Single, uint16 value
Characteristic predistortion ENV_GAIN	Array of 16	16, unit8 values

9.3.1.8 RFNV_GSM_Cx_GSM<band>_ENV_GAIN_I

This NV item allows digital envelope gain slope (at baseband) adjustment separately for each RGI. This NV item applies to the top two power control levels (top two PCLs) of GSM. It does not apply to EDGE, since EDGE uses predistortion.

When transmitting GSM at high Tx power, power level errors can occur due to PA compression. The slope of (Δ output power)/(Δ input power) is not equal to 1 when the PA is in compression. RFNV_GSM_Cx_GSM<band>_ENV_GAIN_I can be used to compensate for this. Without compensation, the actual output power vs. desired output power is not a smooth curve. Compensation is stored separately for each the three frequency indexes. The format of the item is shown in Table 9-11.

Table 9-11 RFNV_GSM_Cx_GSM<band>_ENV_GAIN_I format

Block	Data	Size
env_gain_freq_rgi_f1	Array of 32 envelope gain values for 32 RGIs, all applying to frequency index 0	32, uint16 values
env_gain_freq_rgi_f2	Array of 32 envelope gain values for 32 RGIs, all applying to frequency index 1	32, uint16 values
env_gain_freq_rgi_f3	Array of 32 envelope gain values for 32 RGIs, all applying to frequency index 2	32, uint16 values

Figure 9-6 shows the compensated vs. uncompensated Tx power comparison. Notice in the uncompensated plot that there are jumps (discontinuities). These jumps occur at RGI transitions. Between the RGI transitions, the slope of the curve is shallow due to PA compression.

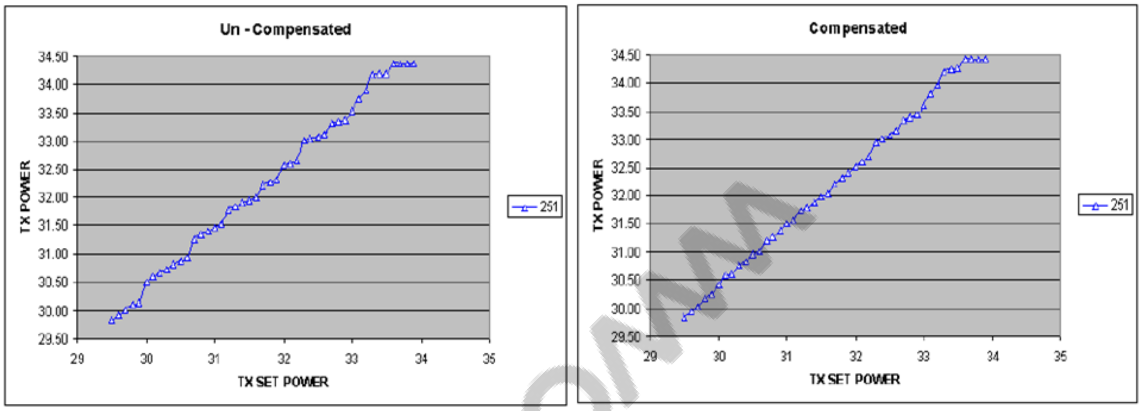


Figure 9-6 Effect of RFNV_GSM_Cx_GSM<band>_ENV_GAIN_I

For each band, there are three separate blocks; one for each calibration frequency index, 0, 1, and 2. Each NV item contains 32 values, one for each RGI (0 to 31). Each element corresponds to a digital baseband compensation slope, where 1024 is unity gain.

Characterization procedure

Perform the following steps:

1. Temporarily store a value of 83 in RFNV_GSM_Cx_GSM<band>_LINEAR_TX_GAIN_PARAM_I.gsm (see note).
2. Run normal GSM calibration with QSPR at the calibration frequency of interest to obtain the DA calibration data in the HTML logs (see note). It is not necessary to store the calibration data in NV.
3. Temporarily store a value of 74 (1 dB lower digital baseband gain) in RFNV_GSM_Cx_GSM<band>_LINEAR_TX_GAIN_PARAM_I.gsm (see note).
4. Run normal GSM calibration again with QSPR to obtain the DA calibration data in the HTML logs (see the note). It is not necessary to store the calibration data in NV.
5. Based on the DA calibration data in step 2, determine which RGIs are expected to be used in the top two PCLs (those RGIs with power level ≥ 29.5 dBm). Only the high gain PA state data need be considered.
6. For each RGI in the range found in step 5, record

   digBB_SlopeComp[RGI] = 1024 / (POUT83[RGI] – POUT74[RGI])

   where POUT83 is the DA calibration output power data when the RFNV_GSM_Cx_GSM<band>_LINEAR_TX_GAIN_PARAM_I.gsm was set to 83, and POUT74 is the output power data when RFNV_GSM_Cx_GSM<band>_LINEAR_TX_GAIN_PARAM_I.gsm was set to 74.
7. For each RGI below the range found in step 5, record

   digBB_SlopeComp[RGI] = 1024

8. Limit each element of digBB_SlopeComp to be realistic values between 0 and 4095. Following step 6 verbatim has the potential to sometimes produce very unrealistic values. Therefore, a step must be taken to limit the values to be within [0, 4095]. Narrowing the range further is also acceptable (to a maximum value somewhat less than 4096).
9. Store digBB_SlopeComp[] in RFNV_GSM_Cx_GSM<band>_ENV_GAIN_I in the appropriate frequency index block.
10. Repeat until all three calibration frequency channels are completed.

NOTE: Steps 2 and 4 involve calibrating the phone; however, the calibration results should not be stored in the phone NV memory. The only purpose of performing the calibration is to gather the data in the HTML logs.

NOTE: Steps 1 and 3 involve changing the value of an NV item. This change is only done for the purpose of this RFNV_GSM_<Band>_ENV_GAIN_F[1:3] characterization process. Once this characterization process is complete, the NV item's value can be restored to its normal value obtained from the default static NV xml file release with software.

Example

Example data from the QSPR test tree results, with RFNV_GSM_Cx_GSM<band>_LINEAR_TX_GAIN_PARAM_I.gsm set to 83, are shown in Figure 9-7. In this case, the closest power to > 29.5 is on RGI 15. Therefore, use the values from RGI 15 through RGI 31, and find the corresponding GSM PMEAS for RGI 15 through RGI 31 when digital gain NV = 74, to get the digBB_SlopeComp. Load digBB_SlopeComp indexes 0 to 14 with 1024. Repeat the process for the other calibration channels.

MEASUREMENTS: GSM/EDGE Tx DA Cal Sweep

Channel	PA Range	RGI	GSM PMEAS	EDGE PMEAS
37	0	...	...	...
37	0	12	27.7	24.5
37	0	13	28.5	25.7
37	0	14	29.3	26.3
37	0	15	30	27.3
37	0	16	30.5	28.1
37	0	17	31	29
37	0	18	31.4	29.6
37	0	19	31.9	29.9
37	0	20	32.3	30.2
37	0	21	32.6	30.6
37	0	22	32.7	31
37	0	23	32.9	31.6
37	0	24	33.1	31.9
37	0	25	33.3	32.3
37	0	26	33.3	32.6
37	0	27	33.5	32.8
37	0	28	33.5	33
37	0	29	33.6	33.2
37	0	30	33.7	33.3
37	0	31	33.7	33.4
37	1	0	3.9	3.9
37	1	1	6.2	6.3
37	...	...	...	...
124	0	1	7.3	6.5
...	...	...	...	...
...	...	...	...	...

Figure 9-7 Example DA calibration data

9.3.1.9 RFNV_GSM_Cx_GSM<band>_EXTENDED_PA_SWPT_I

This item contains all the PA switchpoints including those for GSM, EDGE, and switching into and out of Predistortion mode. The format of this NV item is shown in Table 9-12.

Table 9-12 RFNV_GSM_Cx_GSM<band>_EXTENDED_PA_SWPT_I format

Index	Block	Element name	Data	Size
0	GSM switchpoints	gmsk_pa_swpt_r0_to_r1	PA state (TxState) state 0 to 1 switchpoint	Single, uint16 value
1		gmsk_pa_swpt_r1_to_r2	PA state (TxState) state 1 to 2 switchpoint	Single, uint16 value

Index	Block	Element name	Data	Size
2		gmsk_pa_swpt_r2_to_r3	PA state (TxState) state 2 to 3 switchpoint	Single, uint16 value
3		gmsk_pa_swpt_r3_to_r4	PA state (TxState) state 3 to 4 switchpoint	Single, uint16 value
4		gmsk_pa_swpt_r4_to_r5	PA state (TxState) state 4 to 5 switchpoint	Single, uint16 value
5		gmsk_pa_swpt_r5_to_r6	PA state (TxState) state 5 to 6 switchpoint	Single, uint16 value
6		gmsk_pa_swpt_r6_to_r7	PA state (TxState) state 6 to 7 switchpoint	Single, uint16 value
7	EDGE switchpoints	edge_pa_swpt_r0_to_r1	PA state (TxState) state 0 to 1 switchpoint	Single, uint16 value
8		edge_pa_swpt_r1_to_r2	PA state (TxState) state 1 to 2 switchpoint	Single, uint16 value
9		edge_pa_swpt_r2_to_r3	PA state (TxState) state 2 to 3 switchpoint	Single, uint16 value
10		edge_pa_swpt_r3_to_r4	PA state (TxState) state 3 to 4 switchpoint	Single, uint16 value
11		edge_pa_swpt_r4_to_r5	PA state (TxState) state 4 to 5 switchpoint	Single, uint16 value
12		edge_pa_swpt_r5_to_r6	PA state (TxState) state 5 to 6 switchpoint	Single, uint16 value
13		edge_pa_swpt_r6_to_r7	PA state (TxState) state 6 to 7 switchpoint	Single, uint16 value
14	Predistortion switchpoints	pa_predist_swpt1	Non-predistortion to predistortion switchpoint for lower PA state (TxState) that supports predistortion	Single, uint16 value
15		pa_predist_swpt2	Non-predistortion to predistortion switchpoint for higher PA state (TxState) that supports predistortion (typically unused)	Single, uint16 value

The GSM switchpoints define the switching points of the different gain ranges of the linear PA for GSM only. They are defined in units of dBm × 100. The description in the Data column in Table 9-12 describes the different PA states (TxState states), varying from 0 to 7, consistent with the newer RFNV_GSM_Cx_GSM<band>_TX_CAL_DATA_I.

The EDGE switchpoints define the switching points of different gain ranges for linear PA for EDGE only. They are defined in units of dBm × 100.

The predistortion switchpoints define the power levels of going in and out of predistortion in units of dBm × 100. If a predistortion switchpoint falls within a PA state (TxState) then any power level within the same PA state that is greater than the value of the switchpoint given in these elements triggers predistortion. If the PA state is changed, however, the predistortion might not be used. There is a possibility of employing two predistortion switchpoints in two different PA states. Employing both predistortion switchpoints in one PA state is meaningless. To disable predistortion, set both of these elements to 0xFFFF. Predistortion is only used for a high-power EDGE transmission.

9.3.1.10 RFNV_GSM_Cx_GSM<band>_EXTENDED_SMPS_PDM_TBL_I

These items store the SMPS PDM value (also called the APT/GST value and/or PA bias value) that controls the supply voltage of the PA, during Tx power calibration. All GSM/EDGE RF calibration, such as DA calibration and predistortion calibration, uses this constant SMPS value for a given PA state (TxState). GSM/EDGE calibration procedures are unchanged whether this NV item is used.

These items also store the SMPS PDM value (also called the APT/GST value and/or PA bias value) that controls the supply voltage of the PA, during normal online mode operation. Each element corresponds to a PCL. Using these NV items allows a limited version of APT/GST functionality for 2G operation. Up to four distinct voltage settings are permitted, associated with PCLs. Store the voltage (in the format of a SMPS PDM value) for each PCL in the corresponding element.

For any PCL where the PDM value is specified as 0, the bypass pin of the SMPS is applied (if available).

The entire GSM/EDGE calibration takes place using a single, specific SMPS PDM value also stored in NV. That SMPS PDM value used in calibration is generally different than the SMPS PDM values used in online mode and stored in this NV item. As a consequence, a Tx power error may be introduced. The error in power that results from using a single voltage for calibration may be deemed tolerable, but should be considered when choosing values for this NV item.

If the NV item is unpopulated, all SMPS PDM values default to maximum.

Table 9-13 details the item's format.

Table 9-13 RFNV_GSM_Cx_GSM<band>_ EXTENDED_SMPS_PDM_TBL_I format

Block	Data	Size
RF calibration SMPS values	Array of up to eight values, each for a given PA state (TxState). Each element stores the SMPS PDM value that is used for that PA state during RF calibration.	Array of eight, uint16 values
GSM (GMSK) SMPS values	Array of 16 SMPS values, one for each PCL, for GSM. As a reference, the Tx power level per block index is the same as defined in RFNV_GSM_Cx_GSM<band>_POWER_LEVELS_I (see Section 9.3.1.3).	Array of 16 uint16 values

Block	Data	Size
EDGE (8PSK) SMPS values	Array of 16 SMPS values, one for each PCL, for GSM. As a reference, the Tx power level per block index is the same as defined in RFNV_GSM_Cx_GSM<band>_POWER_LEVELS_I (see Section 9.3.1.3).	Array of 16 uint16 values

Note:

1. These NV items are only applicable to phone designs implementing a variable voltage, DC-DC converter on the GSM/EDGE PA, controlled by the SMPS_PDM.
2. A maximum of four distinct voltages (in the format of a SMPS PDM values) are allowed per block.
3. Multislot operation: In normal online mode, when slots of a burst are at different PCLs, the SMPS voltage (PDM) is chosen as the largest of any slot of the burst. If SMPS bypass operation is needed for any slot, it is applied for the duration of the transmission.

9.3.1.11 RFNV_GSM_Cx_GSM<band>_VBATT_I

This NV item allows the maximum Tx power to be a function of battery voltage. It can also compensate for Tx power error (actual vs. desired Tx power) as a function of battery voltage, and is done individually for each PA state (TxState). The format and details of this NV item are described in Table 9-14.

Table 9-14 RFNV_GSM_Cx_GSM<band>_VBATT_I

Block	Element	Data	Size
Battery level	vbatt_levels[0]	Low-voltage value of interest. Format is volts × 100. (The resolution is 100 counts per volt.) Typically, a value of 3200 is stored here.	Single, uint16 value
	vbatt_levels[1]	Nominal voltage value of interest. Format is volts × 100. (The resolution is 100 counts per volt.) Typically, a value of 3700 is stored here.	Single, uint16 value
	vbatt_levels[2]	High-voltage value of interest. Format is volts × 100. (The resolution is 100 counts per volt.) Typically, a value of 4200 is stored here.	Single, uint16 value
VBATT_LO compensation	Maximum power backoff vs. voltage	Holds a fixed Tx maximum power backoff value corresponding to low-battery voltage level. When the battery voltage is below or equal to vbatt_levels[0], the backoff is specified by this element. When the battery voltage is between vbatt_levels[0] and vbatt_levels[1], the backoff is interpolated between this element and 0. (No backoff is applied at nominal voltage.) The format is dB × 100. (The resolution is 100 counts per dB.)	Single, int16 value
VBATT_LO compensation (cont.)	PA state (TxState) 0 power comp	Holds the low-voltage adjustment value for adjusting the actual Tx output power (relative to the desired Tx power) for TxState state 0. If the battery voltage is less than vbatt_levels[0], the adjustment is the value stored in this element. When the battery voltage is in between vbatt_levels[0] and vbatt_levels[1], the adjustment is interpolated between this element and 0. (No adjustment is applied at the nominal voltage.) The format is dB × 100. (The resolution is 100 counts per dB.) A negative value boosts actual power, while a positive value backs off power.	Single, int16 value

Block	Element	Data	Size
	PA state (TxState) 1 power comp	Holds the low-voltage adjustment value for adjusting the actual Tx output power (relative to the desired Tx power) for TxState state 1. If the battery voltage is less than vbatt_levels[0], the adjustment is the value stored in this element. When the battery voltage is in between vbatt_levels[0] and vbatt_levels[1], the adjustment is interpolated between this element and 0. (No adjustment is applied at the nominal voltage.) The format is dB × 100. (The resolution is 100 counts per dB.) A negative value boosts actual power, while a positive value backs off power.	Single, int16 value
	PA state (TxState) 2 power comp	Holds the low-voltage adjustment value for adjusting the actual Tx output power (relative to the desired Tx power) for TxState state 2. If the battery voltage is less than vbatt_levesl[0], the adjustment is the value stored in this element. When the battery voltage is in between vbatt_levels[0] and vbatt_levels[1], the adjustment is interpolated between this element and 0. (No adjustment is applied at nominal voltage.) The format is dB × 100. (The resolution is 100 counts per dB.) A negative value boosts actual power, while a positive value backs off power.	Single, int16 value
	PA state (TxState) 3 power comp	Holds the low-voltage adjustment value for adjusting the actual Tx output power (relative to the desired Tx power) for TxState state 3. If the battery voltage is less than vbatt_levels[0], the adjustment is the value stored in this element. When the battery voltage is in between vbatt_levels[0] and vbatt_levels[1], the adjustment is interpolated between this element and 0. (No adjustment is applied at nominal voltage.) The format is dB × 100. (The resolution is 100 counts per dB.) A negative value boosts actual power, while a positive value backs off power.	Single, int16 value
VBATT_HI compensation	Max power backoff vs. voltage	Holds a fixed Tx maximum power backoff value corresponding to high battery voltage level. When the battery voltage is between vbatt_levels[1] and vbatt_levels[2], the backoff is interpolated between 0 and this element. (No backoff is applied at nominal voltage.) When the battery voltage is above or equal to vbatt_levels[2], the backoff is specified by this element. The format is dB × 100. (The resolution is 100 counts per dB.)	Single, int16 value
VBATT_HI compensation (cont.)	PA state (TxState) 0 power comp	Holds the high-voltage adjustment value for adjusting the actual Tx output power (relative to the desired Tx power) for TxState state 0. When the battery voltage is in between vbatt_levels[1] and vbatt_levels[2], the adjustment is interpolated between 0 and this element. (No adjustment is applied at nominal voltage.) If the battery voltage is above or equal to vbatt_levels[2], the adjustment is the value stored in this element. The format is dB × 100. (The resolution is 100 counts per dB.) A negative value boosts actual power, while a positive value backs off power.	Single, int16 value

Block	Element	Data	Size
	PA state (TxState) 1 power comp	Holds the high-voltage adjustment value for adjusting the actual Tx output power (relative to the desired Tx power) for TxState state 1. When the battery voltage is in between vbatt_levels[1] and vbatt_levels[2], the adjustment is interpolated between 0 and this element. (No adjustment is applied at nominal voltage.) If the battery voltage is above or equal to vbatt_levels[2], the adjustment is the value stored in this element. The format is dB × 100. (The resolution is 100 counts per dB.) A negative value boosts actual power, while a positive value backs off power.	Single, int16 value
	PA state (TxState) 2 power comp	Holds the high-voltage adjustment value for adjusting the actual Tx output power (relative to the desired Tx power) for TxState state 2. When the battery voltage is in between vbatt_levels[1] and vbatt_levels[2], the adjustment is interpolated between 0 and this element. (No adjustment is applied at nominal voltage.) If the battery voltage is above or equal to vbatt_levels[2], the adjustment is the value stored in this element. The format is dB × 100. (The resolution is 100 counts per dB.) A negative value boosts actual power, while a positive value backs off power.	Single, int16 value
	PA state (TxState) 3 power comp	Holds the high-voltage adjustment value for adjusting the actual Tx output power (relative to the desired Tx power) for TxState state 3. When the battery voltage is in between vbatt_levels[1] and vbatt_levels[2], the adjustment is interpolated between 0 and this element. (No adjustment is applied at nominal voltage.) If the battery voltage is above or equal to vbatt_levels[2], the adjustment is the value stored in this element. The format is dB × 100. (The resolution is 100 counts per dB.) A negative value boosts actual power, while a positive value backs off power.	Single, int16 value

Note:

1. The implementation of the PA state power comp adjustments is different in the case of predistortion as opposed to no-predistortion. When predistortion is off, this is just applied as an offset to the set power. However, when predistortion is applied, changing the set power has the effect of changing the operating point on the predistortion curve. Instead, this offset is applied as a factor to the digital gain applied after predistortion.
2. Due to the introduction of GSM PAs using switched-mode power supplies, and the support of gain-state tracking (GST), the usefulness of this item is questionable.

9.3.1.12 RFNV_GSM_Cx_GSM<band>_TEMP_COMP_I

This item stores the standard temperature compensation data for GSM (and EDGE). The format is shown in Table 9-15.

Table 9-15 RFNV_GSM_Cx_GSM<band>_TEMP_COMP_I format

Block	Element name	Data	Size
Scaling data	temp_comp_pcl_pwr_scaling	Specifies the percentage of ΔHOT_NV and ΔCOLD_NV to be applied at each of the 16 thermistor ADC bins. The range (in units of percentage) of each element is from -100% to 100%.	16, int16 values
GSM (GMSK)	hot_temp_comp_pcl_pwr_offset_gmsk	Stores the magnitude (absolute value) of the power delta for each PCL at hot and cold temperatures (maximum and minimum temperatures of interest) relative to the room temperature, for GSM. Each element corresponds to a particular PCL. Units: absolute value (i.e., unsigned), |dB × 100|	16, uint16 values
	cold_temp_comp_pcl_pwr_offset_gmsk		16, uint16 values
EDGE (8PSK)	hot_temp_comp_pcl_pwr_offset_8psk	Stores the magnitude (absolute value) of the power delta for each PCL at hot and cold temperatures (maximum and minimum temperatures of interest) relative to the room temperature, for EDGE. Each element corresponds to a particular PCL. Units: absolute value (i.e., unsigned), |dB × 100|	16, uint16 values
	cold_temp_comp_pcl_pwr_offset_8psk		16, uint16 values

Note:

1. Refer to *Enhanced GSM Temperature Comp for MSM8960/MDM9x15 + RTR8600/WTR1605* (80-N5420-13) for details. There are also calculator spreadsheets *SCALING_NV Calculator for WTR1605 Enhanced GSM Temperature Compensation Spreadsheet* (80-N5420-15) useful in determining item values.
2. RFNV_GSM_Cx_GSM<band>_TEMP_COMP_I is the NV item for standard temperature compensation. It can be overridden by the enhanced temperature compensation feature using RFNV_GSM_ENH_TEMP_COMP_ENABLE_I and RFNV_GSM_Cx_GSM<band>_ENH_TEMP_COMP_I.

9.3.1.13 RFNV_GSM_Cx_GSM<band>_AMAM_TEMP_COMP_I

Data type: Array of 16, int8 values

This NV item holds 16 temperature compensation values corresponding to the 16 bins, with the first placeholder = HOT and the last placeholder = COLD. The maximum and minimum temperature ADC values are stored in NV item NV_ENH_THERM_I.

This NV item holds values for compensating the AMAM predistortion calibration slope across temperature. This is used to improve the EDGE ORFS due to switching or modulation performance over temperature and is not intended for GSM power temperature compensation.

During normal operation, AMSS reads the current temperature ADC value and determines the corresponding bin and temperature compensation value to apply.

Compensation values required depend on the PA chosen.

Data of these NVs were previously being passed through an obsolete NV named NV_<GSM band>_ PA_TEMP_COMP_INDEX_00_I. This name is not related to correct usage of the data and so the multichain NV name is changed.

9.3.1.14 RFNV_GSM_ENH_TEMP_COMP_ENABLE_I

Data type: uint8 value

Data range: 0 or 1

Units: None

Set this value = 1 to use the enhanced temperature compensation feature described in Section 9.3.1.15, using RFNV_GSM_Cx_GSM<band>_ENH_TEMP_COMP_I.

Clear (set to 0) this value to disable the enhanced algorithm and use the algorithm defined by the NV items RFNV_GSM_Cx_GSM<band>_ TEMP_COMP_I.

This NV item applies to all GSM bands.

9.3.1.15 RFNV_GSM_Cx_GSM<band>_ENH_TEMP_COMP_I

Data type: Structure of two arrays. Each is a 16 × 16, two-dimensional array of int16 elements, for a total of 256, int16 values per array. The first array is for GMSK, the second for EDGE. (Overall, this item contains 512, uint16 values.)

Units: 0.01 dB

These NV items contain the compensation values for each band/modulation mode combination, when using the GSM enhanced temperature compensation feature. The enhanced temperature compensation feature is enabled/disabled using RFNV_GSM_ENH_TEMP_COMP_ENABLE_I, described in Section 9.3.1.14.

The NV item contains two, 2-D arrays of 256 elements each, the first for GMSK, the second for EDGE, with each fundamental element containing the compensation value for a given temperature bin and PCL pair. Each 256 element item can be better described as a two-dimensional array of 16 arrays of 16 elements each.

The 256 elements in the array are grouped into blocks of 16 temperature indexes. Each block corresponds to a temperature bin. Temperature bin 0 corresponds to hot and bin 15 to cold. Table 9-16 summarizes the organization of elements in NV.

Table 9-16 RFNV_GSM_Cx_GSM<band>_ENH_TEMP_COMP_I item array format (first 256 elements for GMSK followed by 256 elements for EDGE)

Array index	Temperature bin index	PCL array index
0	0 (hot)	0
1		1
2		2
… …		… …
13		13
14		14
15		15
16	1	0
17		1
18		2
… …		… …
… …	… …	… …
… …	15 (cold)	… …
253		13
254		14
255		15

The mapping between actual power control level (PCL) and the PCL array index (as organized in NV) is different for low bands from high bands. Table 9-17 and Table 9-18 show the mapping, respectively.

Table 9-17 GSM enhanced temp comp PCL vs. array index mapping for low bands

Actual power control level (PCL)	19	18	17	16	15	14	13	12	11	10	9	8	7	6	5	X
PCL array index in NV	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

Low bands are GSM (850) and EGSM (900).

Table 9-18 GSM enhanced temp comp PCL vs. array index mapping for high bands

Actual power control level (PCL)	15	14	13	12	11	10	9	8	7	6	5	4	3	2	1	0
PCL array index in NV	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15

High bands are DCS (1800) and PCS (1900).

The value in each index represents how much to compensate the power relative to the desired target power. For example, suppose at a given temperature, the PCL = 5, uncompensated Tx power is 31.7 dBm, and the desired target power is 32.5 dBm. The power error is 32.5 - 31.7 = 0.8 dB. Input the value 80 for this NV item entry to instruct the enhanced temperature compensation algorithm to increase the output power by 0.8 dB.

Compensation values are linearly interpolated over temperature.

9.3.1.16 RFNV_GSM_Cx_GSM<band>_TX_GTR_THRESH_I

This item configures the Tx AGC threshold indicator values used when firmware needs to toggle a GRFC signal based on total Tx power, to perform camera flash power gating.

Table 9-19 shows the item format. The GRFC signal that controls the camera flash is referred to as the TXP2 pin in this description.

Table 9-19 NV_GSM_Cx_GSM<band>_TX_GTR_THRESH_I format

Block	Data	Size
Enabled (0 or 1)	0 – Disabled 1 – Enabled	Single, int8 value
Rise value	Format of dBm × 10	Single, int16 value
Fall value	Format of dBm × 10	Single, int16 value
Advance time	Units of ms	Single, int16 value

Use the enabled field to disable/enable the feature through NV memory.

Absolute rise and fall values are stored as signed int2 dBm10. To program a fall threshold of +12.0 dBm, the value input into RFNV would be 120. To program a rise point of +13.5 dBm, the value input into RFNV would be 135.

Advance time defines the delay between actual uplink (UL) subframe start and the instant when the TXP2 GRFC pin goes HIGH. TXP2 needs to be turned on around 0 to 200 µs in advance to reduce current to the flash in advance. For positive values, TXP2 is changed before the actual UL subframe. For negative values, TXP2 GRFC is changed after the start of the actual UL subframe.

9.3.1.17 RFNV_GSM_Cx_GSM<band>_ENH_APT_I

Data type: Structure of three values.

- Element 0 – Single, uint8 value called *pcl_threshold_val*.
- Element 1 – Single, uint16 value called *vbatt_threshold_low_pwr*.
- Element 2 – Single, uint16 value called *vbatt_threshold_high_power*.

The NV format is shown in Table 9-20.

Table 9-20 NV_GSM_Cx_GSM<band>_ENH_APT_I format

Index	Element name	Description	Size
0	pcl_threshold_val	Specifies the power level that makes the distiction between APT low power and APT high power modes. (See note)	Single, uint8 value
1	vbatt_threshold_low_pwr	Specifies the battery voltage threshold for low Tx power. Units are volts × 100.	Single, uint16 value
2	vbatt_threshold_high_power	Specifies the battery voltage threshold for high Tx power. Units are volts × 100.	Single, uint16 value

This NV item may be used for an enhanced version of GSM power tracking based on a threshold power control level (PCL), and voltage level interpolation.

NOTE: PCL is referenced indirectly. The value for “pcl_threshold_val” is not the direct PCL number but rather is the index corresponding to the power level stored in RFNV_GSM_Cx_GSM<band>_POWER_LEVELS_I.

To convert pcl_threshold_val to the actual PCL number, use the following formula for low bands:

ActualPCL = 19 - pcl_threshold_val,

and for high bands:

ActualPCL = 15 - pcl_threshold_val.

In normal operation, comparing the phone’s present Tx power to the power specified by pcl_threshold_val determines if the phone is in APT low-power mode, or APT high-power mode.

Case 1: Tx power < power corresponding to pcl_threshold_val.

APT low-power mode.

If VBATT ≤ vbatt_threshold_low_pwr, PA voltage is placed in bypass mode.

If VBATT > vbatt_threshold_low_pwr, PA voltage is APT.

Case 2: Tx power ≥ power corresponding to pcl_threshold_val.

APT high-power mode.

If VBATT ≤ vbatt_threshold_high_pwr, PA voltage is placed in bypass mode.

If VBATT > vbatt_threshold_high_pwr, PA voltage is APT.

When the PA is in APT mode, the PA voltage it determined by the values stored in RFNV_GSM_Cx_GSM<band>_SMPS_PDM_TBL_I. when the PA is in bypass mode, the PA voltage is the battery voltage.

Example:

Consider NV item contents RFNV_GSM_C0_GSM850_POWER_LEVELS_I = {12, 3500, 3900}.

Also, for this example, suppose, RFNV_GSM_C0_GSM850_POWER_LEVELS_I = { 450,650,850,1050,1250,1450,1650,1850,2050,2250,2450,2650,2850,3050,3250,3250} (Note that index 12 of this item is 2850).

- If the Tx power level is < 28.5 dBm, and the VBATT is ≤ 3.5 volts, the PA is in bypass mode.
- If the Tx power level is < 28.5 dBm, and the VBATT is > 3.5 volts, the PA is in APT mode.
- If the Tx power level is ≥ 28.5 dBm, and the VBATT is ≤ 3.9 volts, the PA is in bypass mode.
- If the Tx power level is ≥ 28.5 dBm, and the VBATT is > 3.9 volts, the PA is in APT mode.

NOTE: It is highly recommended to use the values in the appropriate, default, static NV, xml file.

NOTE: It is essential that VBATT thresholds not exceed 3950 (corresponding to 3.95 V) when using the QFE2320 (QPA) device.

9.3.1.18 RFNV_GSM_Cx_GSM<band>_COEX_TX_OFFSET_INFO_TBL

This NV stores the offset values between the filtered and unfiltered path for the SGLTE CMCC RF card for 16 channels. (In some RF cards, only the DCS is split band in SGLTE. When using such RF cards, only the offset NV for the DCS band is used.)

The first 16 elements specify the ARFCN channels (16, uint16 elements). The second 16 elements specifiy the offsets, for each ARFCN channel index (16, int32 elements).

Power offset values for each of the 16 channels in dBx100 format (100 counts per dB). Each offset value is 2 bytes as shown in Table 9-21.

Table 9-21 RFNV_GSM_Cx_GSM<band>_COEX_TX_OFFSET_INFO_TBL format

Block	Data	Size
ARFCN	ARFCN[0]	Single, uint16 value
	ARFCN[1]	Single, uint16 value
	…	…
	ARFCN[15]	Single, uint16 value
Offset	Offset[0] (dB×10016 units)	Single, int32 value
	Offset[1] (dB×10016 units)	Single, int32 value
	…	…
	Offset[15] (dB×10016 units)	Single, int32 value

Refer to *MPSS.DI.2.0 SGLTE RF Overview* (80-NJ017-13) for further details.

9.3.1.19 RFNV_GSM_Cx_GSM<band>_PA_RANGE_MAP_I

Data type: single, uint32 value

The GSM driver has always used hardcoded GRFC signal logic (based on MIPI) for different PA gain ranges. These static NVs now replace the hardcoded logic to support more PA states.

The NV element is a 32-bit value with 4 bits for each PA range (each PA state). The least significant bit represents the logic for GRFC 0, and so on. The first 4-bit block corresponds to PA state 0, and so on (PA state 0 is the hightest gain PA state).

9.3.2 Calibrated, Tx RF NV items

9.3.2.1 RFNV_GSM_Cx_GSM<band>_TX_CAL_DATA_I

RFNV_GSM_Cx_GSM<band>_TX_CAL_DATA_I contains Tx calibration data that holds the frequency channel numbers used by external calibration, and the actual measured output and the corresponding value in dBm/100 per band per path. This NV is also used as the starting point for an index of values that are associated with the data stored in the AMAM and AMPM NV items.

These multichain NVs are extendable to accommodate any new NVs for any updates in calibration method, implementing a form of variant NV format. This document details the present NV item format, both for the most recent information and the more detailed calibration algorithms. Refer to *GSM Linear PA Calibration and Data Processing for NV Generation* (80-V9774-16) for more detail.

- Variant marker holds NV revision type and the number of custom datatype nodes, which follow the variant marker.
- For data nodes, type_id for GSM starts at 106; 106 is assigned for RGI list table data, 107 for PMEAS data, and 108/109 for AMAM/AMPM tables.
- Data type 110 is used for Cal V4 and contains the delta between characterized Tx power and real Tx power for different PCLs.

The general format of RFNV_GSM_Cx_GSM<band>_TX_CAL_DATA_I is shown in Table 9-22.

Table 9-22 RFNV_GSM_Cx_GSM<band>_TX_CAL_DATA_I general format

Block	Sub-block	What is stored	Size
General (fixed)	tx_cal_chan_size	Number of channels used for Tx calibration, typically three.	Single uint8 value
	tx_cal_chan	ARFCN channel numbers used for Tx calibration. The number of useful elements is specified by tx_cal_chan_size (typically three). The first ARFCN is mapped to channel index 0, and the third ARFCN is mapped to channel index 2.	Three unit16 values
	amam_max_dbm	AMAM necessary for maximum power output.	Single int16 value
	rgi_for_pred	RGI used for predistortion	Single uint8 value
Varient_Marker	Version	Version of the NV item	Single uint16 value
	Number of nodes	Number of nodes. This is the number N (See bottom left corner of this table.)	Single uint16 value
Node 1	datatype ID	106, 107, 108, 109 or 110. This value specifies the node type.	Single uint16 value
	Node data	<variable, depends on node type>	<variable, depends on node type>
Node 2	datatype ID	106, 107, 108, 109 or 110. This value specifies the node type.	Single uint16 value

Block	Sub-block	What is stored	Size
	Node data	<variable, depends on node type>	<variable, depends on node type>
…	…	…	…
Node N-1	datatype ID	106, 107, 108, 109 or 110. This value specifies the node type.	Single uint16 value
	Node data	<variable, depends on node type>	<variable, depends on node type>
Node N	datatype ID	106, 107, 108, 109 or 110. This value specifies the node type.	Single uint16 value
	Node data	<variable, depends on node type>	<variable, depends on node type>

The supported node types are shown in Table 9-23, and each node type is described individually in Table 9-24, Table 9-25, Table 9-26, Table 9-27, and Table 9-28.

Table 9-23 Supported node types

Node (stored in data type ID sub-block)	Type
106	RFNV_DATA_RGI_LIST_TYPE
107	RFNV_DATA_PMEAS_LIST_TYPE
108	RFNV_DATA_AMAM_LIST_TYPE
109	RFNV_DATA_AMPM_LIST_TYPE
110	RFNV_DATA_TX_PWR_ERROR_LIST_TYPE

Table 9-24 RFNV_DATA_RGI_LIST_TYPE (node type 106) element data format

Element	Data	Size
mod	0: GSM (GMSK) 1: EDGE (8PSK)	Single, uint8 value
pa_state	Specifies the PA state (TxState), ranging from 0 to 3	Single, uint8 value
valid_rgi_num	Number of valid RGIs in the list (up to 32) used for DA calibration	Single, uint8 value
rgi_list	List of RGIs used for DA calibration (see *GSM Linear PA Calibration and Data Processing for NV Generation* (80-V9774-16) for calibration procedure details)	32, uint8 value

Table 9-25 RFNV_DATA_PMEAS_LIST_TYPE (node type 107) element data format

Element	Data	Size
mod	0: GSM (GMSK) 1: EDGE (8PSK)	Single, uint8 value
channel_index	Specifies the channel index, 0, 1 or 2	Single, uint8 value
pa_state	Specifies the PA state (TxState), ranging from 0 to 3	Single, uint8 value
pmeas_list	List of Tx power levels in dBm100 units (units are absolute power in dBm, times 100). The number of actually valid power levels (up to 32) is given by the corresponding RFNV_DATA_RGI_LIST_TYPE in the valid rgi_num element. This list stores the DA calibration information (see *GSM Linear PA Calibration and Data Processing for NV Generation* (80-V9774-16) for calibration procedure details)	32, int16 values

Table 9-26 RFNV_DATA_AMAM_LIST_TYPE (node type 108) element data format

Element	Data	Size
amam_ampm_indentifier	0: AMAM (GMSK) 1: AMPM (8PSK) (Obviously, 0 is stored here for this AMAM type)	Single, uint8 value
channel_index	Specifies the channel index, 0, 1 or 2	Single, uint8 value
data_list	List of 128, measured, AMAM values. This table stores predistortion calibration information (refer to *GSM Linear PA Calibration and Data Processing for NV Generation* (80-V9774-16) for calibration procedure details)	128, uint16 values

Table 9-27 RFNV_DATA_AMPM_LIST_TYPE (node type 109) element data format

Element	Data	Size
amam_ampm_indentifier	0: AMAM 1: AMPM (Obviously, 1 is stored here for this AMPM type.)	Single, uint8 value
channel_index	Specifies the channel index, 0, 1 or 2	Single, uint8 value
data_list	List of 128, measured, AMPM values. This table stores predistortion calibration information (refer to *GSM Linear PA Calibration and Data Processing for NV Generation* (80-V9774-16) for calibration procedure details)	128, int16 values

Table 9-28 RFNV_DATA_TX_PWR_ERROR_LIST_TYPE (node type 110) element data format

Element	Data	Size
mod	0: GSM (GMSK) 1: EDGE (8PSK)	Single, uint8 value
channel_index	Specifies the channel index, 0, 1 or 2	Single, uint8 value
pwr_err_list	Used for Cal V4. It contains the delta between characterized Tx power and real Tx power for different PCLs (refer to *GSM Linear PA Calibration and Data Processing for NV Generation* (80-V9774-16) for calibration procedure details)	16, int16 values

9.3.3 GSM antenna tuner items

9.3.3.1 RFNV_GSM_Cx_GSM<band>_TX_RX_ANT_TUNER_I

These NV items store the antenna tuner control words for the particular radio path. The NV items support sending up to four distinct SPI words to one or more SPI slave devices to tune the antenna performance for the particular band. Each band can be broken into up to 16 different tuning ranges based on channel. This allows custom tuning of the antenna across the band.

Code words sent for the equivalent channel_list array index. If less than 32 bits are used, then least significant bits (LSBs) are used.

Table 9-29 shows the item format.

Table 9-29 RFNV_GSM_Cx_GSM<band>_TX_RX_ANT_TUNER_I format

Block		Data	Size
Rx	Device enable ▪ 0 – Disabled ▪ 1 – Enabled	Device 0	Single, uint8 value
		Device 1	Single, uint8 value
		Device 2	Single, uint8 value
		Device 3	Single, uint8 value
	Device chip select	If device 0 is enabled, uses chip select (0,1)	Single, uint8 value
		If device 1 is enabled, uses chip select (0,1)	Single, uint8 value
		If device 2 is enabled, uses chip select (0,1)	Single, uint8 value
		If device 3 is enabled, uses chip select (0,1)	Single, uint8 value
	Channel list	List of ARFCN Rx channels for valid frequencies. The list is ordered by the lowest values in MHz. A value of 0xFFFF is a terminator that implies that the remaining entries are invalid. The remaining entries above the terminator are eliminated in dynamic NV storage and do not take up space	Array of 16 uint16 values
	Code words	Array of 16 code words for device 0. Code words are sent for the equivalent channel_list array index. If less than 32 bits are used, LSB bits are used	16, uint32 values

Block		Data	Size
		Array of 16 code words for device 1. Code words are sent for the equivalent channel_list array index. If less than 32 bits are used, LSB bits are used	16, uint32 values
		Array of 16 code words for device 2. Code words are sent for the equivalent channel_list array index. If less than 32 bits are used, LSB bits are used	16, uint32 values
		Array of 16 code words for device 3. Code words are sent for the equivalent channel_list array index. If less than 32 bits are used, LSB bits are used	16, uint32 values
Tx	Device enable ▪ 0 – Disabled ▪ 1 – Enabled	Device 0	Single, uint8 value
		Device 1	Single, uint8 value
		Device 2	Single, uint8 value
		Device 3	Single, uint8 value
	Device chip select	If device 0 is enabled, uses chip select (0,1)	Single, uint8 value
		If device 1 is enabled, uses chip select (0,1)	Single, uint8 value
		If device 2 is enabled, uses chip select (0,1)	Single, uint8 value
		If device 3 is enabled, uses chip select (0,1)	Single, uint8 value
	Channel list	List of ARFCN Tx channels for valid frequencies. The list is ordered by the lowest values in MHz. A value of 0xFFFF is a terminator that implies that the remaining entries are invalid. The remaining entries above the terminator are eliminated in dynamic NV storage and do not take up space.	Array of 16 uint16 values
	Code words	Array of 16 code words for device 0. Code words are sent for the equivalent channel_list array index. If less than 32 bits are used, LSB bits are used.	16, uint32 values
		Array of 16 code words for device 1. Code words are sent for the equivalent channel_list array index. If less than 32 bits are used, LSB bits are used.	16, uint32 values
		Array of 16 code words for device 2. Code words are sent for the equivalent channel_list array index. If less than 32 bits are used, LSB bits are used.	16, uint32 values
		Array of 16 code words for device 3. Code words are sent for the equivalent channel_list array index. If less than 32 bits are used, LSB bits are used.	16, uint32 values

Refer to *SPI Control for Antenna Tuners in MDM9615/MSM8960* (80-N7536-1) and *Multifrequency Bin SPI Control for Third-Party Antenna Tuner* document (80-N7536-2) for details.

10 Antenna Tuner RF NV items

10.1 Third-party tuner RF NV items

The following tuner NV items are third-party:

- RFNV_CDMA_Cx_BCy_ANT_TUNER_I
- RFNV_WCDMA_<band>_ANT_TUNER_I
- RFNV_GSM_Cx_GSM<band>_TX_RX_ANT_TUNER_I (See Section 9.3.3.1)
- RFNV_LTE_<band>_ANT_TUNER_I
- RFNV_TDSCDMA_<band>_RX_ANT_TUNER_I
- RFNV_GPS_ANT_TUNER_I

These NV items store the antenna tuner control words for the particular radio path. The NV item supports sending up to four distinct SPI words to one or more SPI slave devices to tune the antenna performance for the particular band. Each band can be broken into 16 different tuning ranges based on channel. This allows custom tuning of the antenna across the band. Table 10-1 gives the format summary of the items.

Refer to *SPI Control for Antenna Tuners in MDM9615/MSM8960* (80-N7536-1) and *Multifrequency Bin SPI Control for Third-Party Antenna Tuner* (80-N7536-2) for details.

NOTE: QTI no longer supports third-party antenna tuners in MSM8909/89x7. Customers must implement their own driver to read the NVs.

Table 10-1 Format of ANT_TUNER items

Name	Comment	Type
device0_enable	Device 0 in use (1), not used (0)	uint8
device1_enable	Device 1 in use (1), not used (0)	uint8
device2_enable	Device 2 in use (1), not used (0)	uint8
device3_enable	Device 3 in use (1), not used (0)	uint8
device0_cs	Device 0, if enabled, uses chip select (0,1)	uint8
device1_cs	Device 1, if enabled, uses chip select (0,1)	uint8
device2_cs	Device 2, if enabled, uses chip select (0,1)	uint8
device3_cs	Device 3, if enabled, uses chip select (0,1)	uint8
channel_list[16]	In the ARFCN or Rx channel index for valid frequencies, the list is ordered by the lowest values in MHz. A value of 0xFFFF is a terminator that implies that the remaining entries are invalid. The remaining entries above the terminator are eliminated in dynamic NV storage and do not take up space.	uint16
device0_code_words[16]	Code words are sent for the equivalent channel_list array index. If less than 32 bits are used, LSB bits are used.	uint32

Name	Comment	Type
device1_code_words[16]	Code words are sent for the equivalent channel_list array index. If less than 32 bits are used, LSB bits are used.	uint32
device2_code_words[16]	Code words are sent for the equivalent channel_list array index. If less than 32 bits are used, LSB bits are used.	uint32
device3_code_words[16]	Code words are sent for the equivalent channel_list array index. If less than 32 bits are used, LSB bits are used.	uint32

10.2 RFNV_ATUNER_ALGO_TYPE

Data type: uint8

This NV specifes Antenna Tuner Operation Mode for QFE25x0.

- 0 – Advanced open loop (AOL) only, static NV default
- 2 – Open loop (OL) only.
- 4 – Closed loop (FBRx-based) + AOL (static NV default). Not used in MSM8909/89x7 at this time
- 5 – Closed loop L (FBRx-based) + OL. Not used in MSM8909/89x7 at this time

10.3 RFNV_RFC_DISABLE_FAILURE_FOR_NONFATAL_DEVICES_I

Data type: uint8

- 0 – Disable failure for nonfatal device defined in the RFC.
- 1 – Enable failure for nonfatal device defined in the RFC.

In some designs, the QTuner may not be mounted during RF bring up. Setting this NV item to 1 by default bypasses the QTuner software device check. Otherwise, it fails at RF initialization during bootup and cannot perform further testing.

10.4 RFNV_ANT_TUNER<instance number>_NVG_DETUNE_I

Data type: See Table 10-2.

This NV item is for the negative voltage generator (NVG) feature. NVG is in the tuner chip which improves linearity. NVG is used in a system containing multiple antennas with one or more antenna tuners. Supported on QTuner only, there is no NVG support for third-party tuners. If NVG NV item is not set, NVG by default is turned on and no detune code written.

Each tuner has its own NV that enables/disables the NVG framework to turn on NVG when Txchain is active, to program the detune tune code.

Detune tune code is used to program the inactive tuners to detune them away from the active Txfrequency. There are three sets of detune tune codes:

- Detune_code1 – Used when the active Txchain is in LB, the resonant frequency is tuned away from LB
- Detune_code2 – Used when the active Txchain is in MB, the resonant frequency is tuned away from MB
- Detune_code3 – Used when the active Txchain is in HB, the resonant frequency is tuned away from HB

Two Txfrequency boundaries define HB, MB, and LB.

- Active Txfrequency ≤ Tx_freq_boundary_1: Detune the inactive tuner to detune_code1.
- Tx_freq_boundary_1 < Active Txfrequency ≤ Tx_freq_boundary_2: Detune the inactive tuner to detune_code2.
- Tx_freq_boundary_2 < Active Txfrequency: Detune the inactive tuner to detune_code3.

Table 10-2 RFNV_ANT_TUNER<instance number>_NVG_DETUNE_I

Name	Description	Example	Data type
Version	Version ID	0xA	uint8
nvg_framework_enable	0 – Disable detune and NVG programming of the tuner <instancenumber> 1 – Enable detune and NVG programming of the tuner <instancenumber>	1	unit8
detune_code_size_in_bytes	Size of the tune code in bytes	2	unit8
detune_code1	Tune code that must be programmed when Txfrequency ≤tx_freq_boundary1_khz	63,192	unit8 x 8
tx_freq_boundary1_khz	Txfrequency upper boundary of the first bin, i.e., the upper boundary of the Txfrequency for which detune_code1 must be programmed	800000	unit32
detune_code2	Tune code that must be programmed when Txfrequency > tx_freq_boundary1_khz and ≤tx_freq_boundary2_khz	63,176	unit8 x 8
tx_freq_boundary2_khz	Txfrequency upper boundary of the second bin, i.e., the upper boundary of the Txfrequency for which detune_code2 must be programmed	900000	unit32
detune_code3	Tune code that must be programmed when Txfrequency > tx_freq_boundary2_khz	63,176	unit8 x 8

11 Antenna-Switching Diversity (ASDiv) feature NVs

An Antenna Switching Diversity (ASDiv) feature is enabled in some MSM8909 PLs. This chapter describes all NVs required to support the ASDiv feature. For more information about ASDiv, refer to *Antenna Switching Diversity (ASDiv)* (80-NJ705-1).

ASDiv NVs are not normal RF NVs. They are not defined in Nvdefinition and can only be modfied with QXDM.

11.1 LTE NVs

11.1.1 NV70248 LTE ML1 Antenna Switch Diversity Config

Data type: See Table 11-1.

NV 70248 was created for the ASDiv feature in QxDM Professional™ (QxDM Pro) as shown. Usage of each field is self-explanatory.

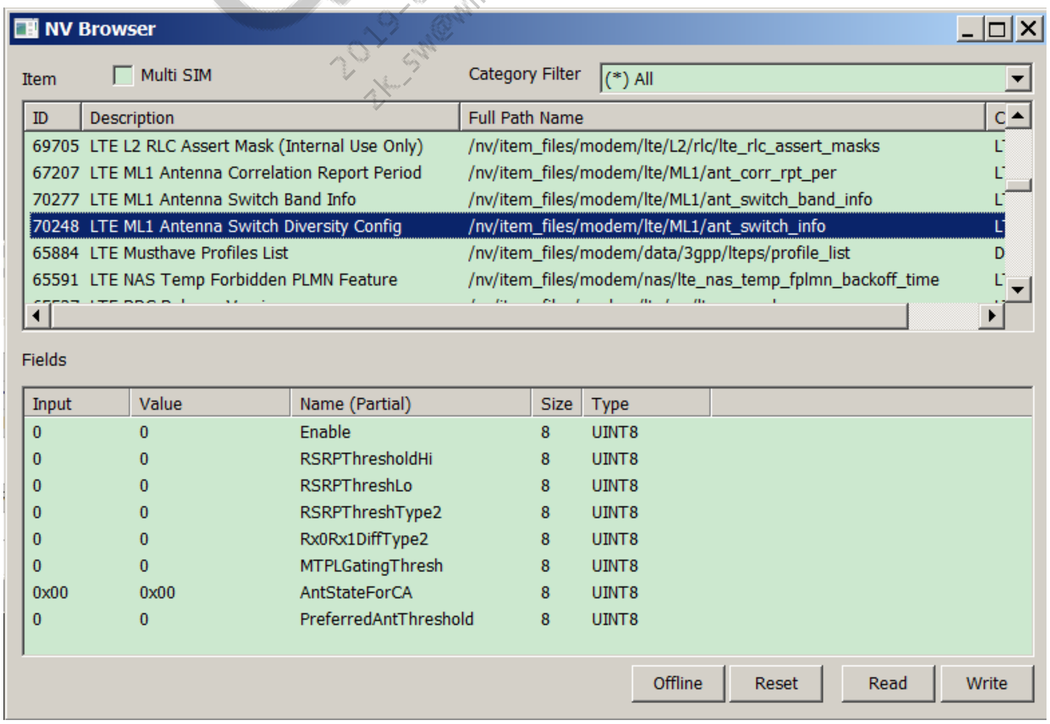


Table 11-1 NV 70248 structure

NV field	Length (bytes)	Usage
Enable	1	▪ 1 – Enable LTE ASDiv feature ▪ 0 – Disable LTE ASDiv feature
RSRPThresholdHi	1	Unsigned 8-bit value ▪ Value is decided by OEM based on performance test results ▪ Unit is dB ▪ Recommended value is 8
RSRPThreshLo	1	Unsigned 8-bit value ▪ Value is decided by OEM based on performance test results ▪ Unit is dB ▪ Recommended value is 5
RSRPThreshType2	1	Unsigned 8-bit value, although it represents negative value ▪ Value is decided by OEM based on performance test results ▪ Unit is dBm ▪ Recommended value is 100, which means -100 dBm
Rx0Rx1DiffType2	1	Unsigned 8-bit value ▪ Value is decided by OEM based on performance test results ▪ Unit is dB ▪ Recommended value is 8
MTPLGatingThresh	1	Unsigned 8-bit value, although it represents negative value ▪ Value is decided by OEM based on performance test results ▪ Unit is dBm ▪ Recommended value is 80, which means -80 dBm
AntStateForCA	1	Unsigned 8-bit value ▪ Value is decided by the OEM based on the RF configuration for CA ASDiv RF cards ▪ Can be 0 or 1 for default/crossed antenna connection, respectively ▪ If set to 1, when LTE CA mode is enabled, ASDiv moves to antenna configuration 1 and then disables the ASDiv algorithm; ASDiv is enabled again after exiting LTE CA mode ▪ If set to 0, when LTE CA mode is enabled, ASDiv moves to antenna configuration 0 and then disables the ASDiv algorithm; ASDiv is enabled again after exiting LTE CA mode ▪ Recommended value is 0xFF, which is NA for most OEMs
PreferredAntThreshold	1	Unsigned 8-bit value ▪ Value is decided by the OEM based on performance test results ▪ If primary RSRP < PreferredAntThreshold while going to sleep in DSDS mode, the opposite antenna configuration is registered to TRM for the wake-up antenna configuration ▪ If primary RSRP > PreferredAntThreshold while going to sleep in DSDS mode, the same antenna configuration is registered to TRM for the wake-up antenna configuration ▪ Unit is dBm ▪ Recommended value is 100, which means -100 dBm

NV field	Length (bytes)	Usage
SafeConditionThreshold	1	Unsigned 32-bit value ▪ Value is decided by OEM to ask control or release control of antenna configuration in multi-SIM mode ▪ If primary RSRP is below this threshold, LTE requests control of the antenna for switching purposes from TRM

11.1.2 NV 70277 LTE ML1 Antenna switch band information

Data type: See Table 11-2.

NV 70277 was created to select the switching algorithm of a specific band. There are two fields in this NV. Table 11-2 describes field usage.

Table 11-2 NV 70277 structure

NV field	Length (bytes)	Usage
type_1_bands_mask	8	▪ If NV 70248 enable field is set to 1, this field indicates bands for which the LTE modem uses the type1 antenna switching algorithm. Note that if both type1 and type2 masks contain the same band, the modem uses type2. ▪ Each bit number corresponds to a band + 1, for example, LTE band 1 is bit 0, LTE band 2 is bit 1, etc.
type_2_bands_mask	8	▪ If NV 70248 enable field is set to 1, this field indicates bands for which the LTE modem uses the type2 antenna switching algorithm. Note that if both type1 and type2 masks contain the same band, the modem uses type2. ▪ Each bit number corresponds to a band + 1, for example, LTE band 1 is bit 0, LTE band 2 is bit 1, etc.

For example, if the user decides to select type1 for Band 13 and type2 for Bands 4 and 25:

- type1_bands_mask = 0x800
- type2_bands_mask = 0x1000008

The type_1_bands_mask/ type_2_bands_mask is not used to disable ASDiv for a specific band. After a band enables ASDiv, the entire system (LTE/WCDMA/GSM/1X/TDS) must enable ASDiv.

11.2 WCDMA NVs

11.2.1 NV70240 WCDMA WL1 antenna swtich NV

Data type: See Table 11-3.

Table 11-3 NV70240 Structure

Subfield	Explanation
Power_delta (unsigned 16-bit int)	Baseline threshold used to derive oneProbe, twoProbes, threeProbes thresholds Recommended value – 3 dB
Rscp_trigger (unsigned 16-bit int)	Step 1 trigger threshold; setting to X means using –X dBm threshold Recommended value – 90, meaning -90 dBm
Ant_switch_enable (unsigned 16-bit int)	Set to 0 to disable switch on WCDMA side; 1 to enable
Type2_RSCP_switch_ threshold (unsigned 8-bit int)	Absolute RSCP threshold to trigger switch for type2 algorithm. Setting to X means type2 algorithm switches to the hypothesis antenna when the average RSCP level is less than –X dBm Recommended value – 100, meaning -100 dBm
Type2_MTPL_ threshold (unsigned 8-bit int)	MTPL threshold to trigger switch for type2 algorithm; divide by 50 to get the percentage threshold; e.g., set to 25 means MTPL percentage threshold to trigger switch is 50% Recommended value – 25, meaning 50%

11.2.2 NV70219 MCS TRM antenna diversity switch initial setting

Data type: See Table 11-4.

Table 11-4 NV 70219 structure

Subfield	Explanation
DPDT_switch_default	Used to set initial default position of DPDT switch ▪ 0 – (TRM_TX_DIV_SWITCH_CONFIG_0) is default connection ▪ 1 – (TRM_TX_DIV_SWITCH_CONFIG_1) is cross-connection (Tx chain connected to Antenna 1)
AntSwitch TestModeControl	Used to force switching or algorithm on/off for testing/verification purposes ▪ 0 – Typical (normal mode) ▪ 1 – AlternateOnOff (turning on and off switch diversity algorithm periodically) ▪ 2 – AlternatingOffForcedSwitch (forces switching between two antennas periodically) ▪ 3 – AlternatingOnOffForcedSwitch (forces switch diversity algorithm on and off, and forces switching between two antennas periodically)
AntSwitchDiv_DwellingTime	Duty cycle to switch between two antennas and switch algorithm on/off (as defined by the AntSwitchTestModeControl above), in units of 10 ms
DPDT_switch_SV_default	Not used

11.2.3 NV70276 wl1_ant_switch_band_nv

Data type: See Table 11-5.

Table 11-5 NV 70276 structure

Subfield	Explanation
type_1_bands_mask	64-bit unsigned, set corresponding bit to 0 to disable type1 algorithm for specific band, 1 to enable. When type1 is enabled, WCDMA RxD Control NV 3851 shall enable RxD by setting to 3 or 5 Each bit number corresponds to a band + 1, e.g., UMTS band 1 is bit 0, UMTS band 2 is bit 1, etc.
type_2_bands_mask	64-bit unsigned, set corresponding bit to 0 to disable type2 algorithm for a specific band, 1 to enable; type2 can be chosen independent of the NV 3851 setting Each bit number corresponds to a band + 1, e.g., UMTS band 1 is bit 0, UMTS band 2 is bit 1, etc.
Type2_RSCP_drop_thre	Type2 RSCP drop threshold used to trigger switch in lookback condition; default is 10 dB
Type2_post_switchBack_ suspension_time	Suspension time for type2 algorithm when a switchback occurs; default is 300 frames
Type2_post_switch_eval_base_ thre	Baseline threshold for type2 switch protection; assume the value is x, then a switchback occurs when UL+DL degradation is larger than [x+13, x+11, x+9, x+7, x+5, x+3, x+2, x+1, x] dB for the first 10, 15, 20, ...45, 50 frames after a switch, respectively. Default is 2 dB

11.3 GSM NVs

Table 11-6 summarizes the applicable GSM NVs.

Table 11-6 GSM NV items for antenna-switching algorithm

NV item	Name	Description	Recommended value
70245	GSM_ASDiv_Enable (8-bit boolean)	Enables and disables the GSM antenna switch diversity algorithm	—
70221	GSM_ASDiv_PWR_Delta (16-bit int)	Power imbalance in dB for fast antenna switching	3 dB
70220	GSM_ASDiv_Thresh (16-bit int)	Power in dBm, below which the algorithm starts running	-80 dBm
70338	GSM_TYPE_2_EN (8-bit boolean)	Enables GSM type2 antenna switch	1 for SGLTE
70339	GSM_TRAF_MDM_TH (16-bit int)	GSM traffic power to allow LTE/WCDMA/TDS to switch the antenna	-69 dBm
70340	GSM_IDLE_MDM_TH (16-bit int)	GSM idle power to allow LTE/WCDMA/TDS to switch the antenna	-79 dBm

NV item	Name	Description	Recommended value
70341	GSM_TRAF_SENS (16-bit int)	Threshold that triggers an antenna switch in Traffic mode	-90 dBm
70342	GSM_IDLE_SENS (16-bit int)	Threshold that triggers an antenna switch in Idle mode	-100 dBm
70343	GSM_Large_Delta (16-bit int)	Large delta in comparison to pre- and postswitch Rx levels to determine switchback	3 dB
70344	GSM_Small_Delta (16-bit int)	Small delta in comparison of pre- and postswitch Rx levels to determine switchback	1 dB
70345	GSM_HYST_TIME (16-bit int)	Number in SACCH periods, used to provide time hysteresis after a switch or switchback	3

11.4 CDMA NVs

11.4.1 1X NVs

11.4.1.1 NV 70298 1X antenna switch diversity (1X AsDiv)

Data type: See Table 11-7.

Table 11-7 NV70298 structure

NV 70298	Description	Default
Version	Version of the NV item	—
Access_Traffic_Enable	Enable Access/Traffic ASDiv	0 (disabled)
Init_Idle_Disable_Override	To disable Init and Idle ASDiv (1 to disable, 0 to enable); this is checked only if Init or Idle ASDiv is separately enabled.	1 (disabled)
Access_Disable_Override	To disable access ASDiv (1 to disable, 0 to enable); this is checked only if the Access_Traffic_Enable flag is set.	1 (disabled)
Acq_RxAGC_switch_Thresh	Rx AGC threshold in dbm for antenna switch in ACQ	-95
Acq_RxAGC_switchback_ Thresh	Rx AGC threshold in dbm for antenna switchback in ACQ	5
type1_Band	Band-specific type1 algorithm enable field (bit 0 is BC0, bit 1 is BC1, etc.); if a bit is set, it means the type1 algorithm needs to be run for that band class. To enable type1 bands, set to 0xFFFF. To disable type1 bands, set to 0.	0
type2_Band	Same as type1_Band, but this is to enable type2. For a band class bit, if both type1 and type2 bits are set, the algorithm defaults to type1. If both are not set, the algorithm is not run for that band class. To enable type1 bands, set to 0xFFFF. To disable type1 bands, set to 0.	0

NV 70298	Description	Default
traffic_AbsoluteRatchetThresh	Absolute ratchet threshold in percentage for both type1 and type2	10
traffic_RelativeRatchetThresh	Relative ratchet threshold in percentage for both type1 and type2	5
traffic_HoldPeriod	Number of frames in hold period for both type1 and type2	100 (2 sec)
type1_IIR_FilterConstant	IIR filter constant for type1 algorithm	10
type1_DecisionInterval	Number of periods after which a check is done to do switching for type1	10
type1_SwitchThreshold_dBm	Threshold in difference between primary and secondary RxAGC to do the switch (in dBm) for type1	10
type2_FramesToCheckSwitch	Number of frames after which a switch decision is made in type2	4
type2_FERThresh	FER threshold in percentage for type2	3
type2_RxAGCThresh_dBm	Rx AGC threshold in dBm for type2	-95
type2_RxAGCThresh2_dBm	Rx AGC threshold in dBm for type2 only design 1X switch back threshold	-95
Following items are for Ver 4		
honor_data_traffic_crisis_mode	Honor Crisis mode switching of data traffic if not in safe condition in IDLE	0
Idle_pingpong_mitigation_thresh	Threshold to limit the ping-pong ASDiv switches on idle wakeup	3
Idle_switch_suspension_thresh	Threshold to suspend ASDiv switches in idle wakeup after hitting ping-pong threshold	6
Traffic_crisis_mode_thresh	Threshold for setting Crisis mode in traffic	0 (disabled)

MSM8909/MSM89x7 uses NV 70298 Ver 4, which is different to some older targets which employ Ver 3.

To program the NV item:

1. Use EFS Explorer and delete the existing .conf file, /nv/item_files/conf/onex_srch.conf.
2. Refresh to ensure the file is deleted. Reset the phone from within EFS Explorer. This is important, otherwise the delete is not flashed to EFS.
3. Shut down the QxDM Pro/QPST server. This is also important, as QPST caches a copy.
4. After the phone powers up, check that the .conf file is recreated and has a new timestamp. If not, repeat from Step 1.

After the above steps, NV 70298 is writeable.

NOTE: With the new NV 70298, bit 3 of 1018 and 70262 are no longer valid (deprecated) for the ASDiv algorithm.

11.4.1.2 NV 66042 CDMA 1X ZZ2_2 Selection Param

Data type: See Table 11-8.

Table 11-8 NV 66042 structure

NV 66042	Description	Default
agc_sens	AGC sensitivity	0
ecio_sens	E_c/I_0 sensitivity	0
ecio_max_diff	E_c/I_0 max difference	8
weight	AGC vs E_c/I_0 weight	30
Conditions Mask	Bit 23 must be set for enabling ASDiv in IDLE (0xFFFFFFFF)	0x0 (disable ASDiv in IDLE)

11.4.1.3 NV 66043 CDMA 1X ZZ2_2 threshold

Data type: See Table 11-9.

Table 11-9 NV 66043 structure

NV 66043	Description	Default
chan_est_thresh_mod	QPCH channel estimator modifier	0
agc_bad_thresh	Bad AGC threshold	-100
ecio_bad_thresh	Bad E_c/I_0 threshold	-128
agc_good_thresh	Good AGC threshold	-95
ecio_good_thresh	Good E_c/I_0 threshold	-120
Reserved	—	—

11.4.2 EV-DO NVs

11.4.2.1 NV 70297 HDR sTxD configurable parameters

Data type: See Table 11-10.

To program the NV item:

1. Use EFS Explorer and delete the existing .conf file, /nv/item_files/conf/hdrsrch_config_info.conf.
2. Refresh to ensure the file is deleted. Reset the phone from within EFS Explorer. This is important, otherwise the delete is not flashed to EFS.
3. Shut down the QxDM Pro/QPST server. This is also important because QPST caches a copy.
4. After the phone powers up, check that the .conf file was recreated and has a new timestamp. If not, repeat from Step 1.

After the above steps, NV 70297 is writeable.

Table 11-10 NV 70297 structure

NV 70297	Description	Default
Version	NV item version	1
Enabled	If ASDiv feature is enabled for DO	1
Type1 Band Mask	Bitmask for bands where type1 algorithm should be used	For DSDA, 0; otherwise: 0xFFFFFFFFFFFFFFFF
Type2 Band Mask	Bitmask for bands where type2 algorithm should be used	For DSDA, 0xFFFFFFFFFFFFFFFF; otherwise: 0
Type1 Decision Period	Decision period in ms for type1; HDR checks every decision period to evaluate switching	2000
Type2 Decision Period	Decision period in ms for type2; HDR checks every decision period to evaluate switching	500
Revert Period	Revert period in ms after switching antenna; HDR may revert to its preswitch configuration if it is better; note that it must be greater than 80 ms (sampling period)	81
Hold Period	After switching (after reverting decision is made), wait Hold Period in ms before reevaluating RF for switching	2000
AGC IIR Coefficient A	IIR coefficient in filter: y(n) = (IIRCoefA/100)*y(n-1)+(100- IIRCoefA)/100*x(n)	90 (0.9)
Antenna AGC Threshold	AGC difference across primary and diversity antenna that may lead to an antenna switch	6400 (1 dB = 640)
Absolute SINR threshold	Threshold used to compare against current SINR; in raw firmware, SINR format ($SINR_{dB} = 10*log_{10}$ (SINR/512)	64 (-9 dB)
Relative SINR threshold	Threshold used in comparing current/previous SINR readings; in raw firmware, SINR format ($SINR_{dB}$ = $10*log_{10}$ (SINR/512)	5120 (10 dB)
Antenna SINR threshold	Threshold used in comparing current/preswitch SINR readings; in raw firmware, SINR format ($SINR_{dB}$ = $10*log_{10}$(SINR/512)	1024 (3 dB)

NV 70297	Description	Default
Absolute Ratchet Threshold	Threshold used in comparing current ratcheting with set number; percentage of half slots where ratcheting occurred	10 (10%)
Relative Ratchet Threshold	Threshold used in comparing previous/current ratcheting; percentage of half slots where ratcheting occurred	5 (5%)
Antenna Ratchet Threshold	Threshold used in comparing current/preswitch ratcheting; percentage of half slots where ratcheting occurred	5 (5%)

11.4.3 SVLTE NVs

11.4.3.1 NV 70219 MCS TRM antenna diversity switch initial settings

Data type: See Table 11-11.

Table 11-11 NV item 70219 structure

NV 70219	Description
DPDT_Switch	▪ 0 – Passthrough ▪ 1 – Swap
AntSwitchTestModeControl	▪ 0 – Normal mode ▪ 1 – AlternateOnOff (alternates between ASDiv enabled and disabled) ▪ 2 – AlternatingOffForcedSwitch (ASDiv disabled, DPDT_switch alternates between 0 and 1) ▪ 3 – AlternationOnOffForcedSwitch (alternates between ASDiv enabled, disabled, DPDT_switch=0, and DPDT_switch=1)
AntSwitchDiv_DwellingTime	Time in 10 ms spent in each alternating state for AntSwitchTestModeControl = 1~3
DPDT_switch_SV_Default	Default switch configuration for SV (this NV is for traffic-traffic mode in SVLTE only)
SV_Behavior	Used to select between Keep and NV default ▪ 0 – SV Traffic-Traffic Keep (when UE enters traffic-traffic from some other modes, the antenna configuration remains unchanged), Idle-Idle Default (when the UE enters idle-idle from some other modes, it shall start from the idle-idle default configuration, as defined by DPDT_Switch) ▪ 1 – SV Traffic-Traffic Default (when the UE enters traffic-traffic from some other modes, it shall start from the traffic-traffic default configuration, as defined by DPDT_switch_SV_Default), Idle-Idle Default ▪ 2 – SV Traffic-Traffic Keep, Idle-Idle Keep (for testing only; not viewed in dropdown) ▪ 3 – SV Traffic-Traffic Default, Idle-Idle Keep (for testing only; not viewed in dropdown)

11.5 TD-SCDMA NVs

11.5.1 NV 70289 TDS antenna switch parameter control

Data type: See Table 11-12.

Table 11-12 NV 70289 structure

NV 70289	Description	Recommended
tdssrch_rscp_antenna_switch_enable	▪ 0 – Disable TDS ASDiv feature ▪ 1 – Enable TDS ASDiv feature	1 (enable)
tdssrch_rscp_antenna_switch_threshold_db_x256	DL_RSCP threshold in dBm*256	-90 * 256
tdssrch_rscp_antenna_switch_back_threshold_db_x256_high	obsolete	—
tdssrch_rscp_antenna_switch_back_threshold_db_x256_low	obsolete	—
Hysteresis_Timer_Short	obsolete	—
Hysteresis_Timer_Medium	obsolete	—
Hysteresis_Timer_Long	obsolete	—
Look_Back_Threshold_dB	Threshhold used to detect RSCP persistent drop	5
T1_probe_time	Probing length on each antenna (ms)	500
Num_probe_cycles	Number of probings on each antenna during the probing stage.	1
Base_waiting_time	Base waiting time used to calculate T2 length.	1000
MTPL_ratio_threshold	Unit – % (percentage)	50
Look_back_time	How long to look back to compare the power level of current time and previous time (ms)	3000

12 EFS device autocalibration storage

12.1 Chipset autocalibration requirements and design

RF analog chipset devices have varying self-calibration configuration needs that include spanning from no self-calibration required, continuous runtime self-calibration, and one-time persistent self-calibration. This chapter focuses on the needs of persistent self-calibration data—data that must be determined once in the factory under specific conditions and then saved for reuse throughout the phone's life. Self-calibration data are:

- Specific to the physical hardware device
- Independent of the way in which the device will be used or the chipset that it will be combined with
- Generally independent of any external signal requirements, i.e., things that can be measured without presenting a specific reference signal or configuring the chip in a specific mode

RF software is required to work with heterogeneous and rapidly evolving hardware platforms. This presents a unique set of challenges to correctly save and retrieve autocalibration data when the software does not have a prior knowledge of what combination of chips it will be expected to control before factory calibration.

12.1.1 High-level summary of requirements

The software must be capable of permanently storing self-calibration data for every physical chip that is present in the system.

The set of chips in the system is defined by one of the following mechanisms:

- The RF_HW_ID identifying a specific RF card and associated card AG data structures compiled in the code
- An RF configuration described by a binary file in EFS and no AG data structures compiled in the code
- Other future mechanisms that are yet to be defined

The self-calibration data computed for a specific chip must be reloaded into that specific chip at every boot.

The software must support a varying amount of self-calibration data from each chip. The format of the data for any chip need not have any commonality with any other chip.

The software must efficiently support chips that require no self-calibration with no permanent storage allocated if a chip needs no persistent self-calibration data.

The software must support chipset self-calibration data changing format between different hardware versions of the same chip.

New devices may need to incrementally write self-calibration data as they discover their capabilities after the initial factory self-calibration routine has run.

12.1.2 RF NV restrictions

RF NV is a fixed-format, predefined, published interface for configuration data that is intended to be configured by the user. Examples include static software parameters and calibration data that can be computed and written to the mobile during factory testing.

RF NV is not designed to store variable and flexible amounts of data that can dynamically change based on the needs of the software. RF NV is designed to statically define the configuration parameters that the software is expressly written to understand and utilize.

A portion of the RF NV namespace (item numbers) must be statically allocated to a specific function. Under-allocation of the namespace for the worst possible case results in maintenance issues and software faults when the configuration exceeds the static namespace allocation. Over-allocation wastes RF NV namespace, and always runs the risk of becoming under-allocated in the future.

Aggregating multiple entities into a single RF NV namespace entry presents challenges in defining the partition mechanism and insuring that the single item is correctly committed to permanent storage whenever self-calibration data is updated. Aggregating into a single entry requires implementing difficult read-modify-write semantics in all devices and runs the risk of unintentional and undesired data loss. Implementing a robust aggregation storage method effectively requires re-implementing a filesystem on top of RF NV.

The RF NV format must be published. RF NV could be defined as an opaque array of bytes, but the RF NV tools require the maximum size of the item to be defined. An aggregate or variable-sized item would need to have an arbitrary maximum size limit placed on it. Future chipsets that violate this size limitation would require the RF NV items to be discarded, and an entirely new set of RF NV items defined. Over-allocation of the maximum RF NV size places an unnecessary burden on the RF NV tools to be able to hold the maximum amount of data. Over-allocation again runs the risk of becoming under-allocation in the future.

Providing user-visible RF NV for self-calibration data gives an implicit suggestion that the data is of interest to the customer. The data is generally irrelevant to the customer and publishing it places an unnecessary documentation burden on the software team for all devices. There is no mechanism in RF NV to limit the scope of information sharing to key customers.

12.1.3 RFC-EFS oriented self-calibration storage

The general storage capability of EFS allows device self-calibration to meet the needs of:

- Cards that can have any combination of devices
- Devices that can have wildly different self-calibration requirements
- Self-calibration requirements that can change between chip revisions

The RFC-EFS structure has already defined a filesystem namespace schema for card-specific data. There is nothing more fundamentally card-specific than the list of devices present on the card. Therefore device self-calibration naturally lends itself to storage in the namespace that is already associated with the RFC. The RFC framework will be responsible for providing the namespace root for device self-calibration, and for insuring that each device consistently receives the same filesystem root path.

Each device is provided a unique filesystem root for creating a file or files. Devices are free to implement read-modify-write or append semantics as needed without risking the data for any other devices in the system. Only devices that require self-calibration will create files; devices that require no persistent self-calibration data will not consume EFS or memory resources.

Devices are responsible for formatting their self-calibration data. This allows devices to optimize the memory and storage requirements for the device, independent of any other devices in the system. It supports devices evolving their self cal needs over the course of ES, FC, and CS development and detecting when self-calibration data was taken with older software that is no longer compatible with newer software.

Devices that need to incrementally self-calibrate after the generic self-calibration command can choose to create new files or append data to existing calibration data. EFS resource consumption can be optimized by intelligently allocating self-calibration data between multiple small files or a single large file as necessary.

12.1.4 Device limitations

The device’s self-calibration EFS storage is only supported for chips that conform to the rfdevice_physical_device class interface.

12.2 Configuration backup

12.2.1 General AMSS configuration backup

AMSS functional areas define their own configuration files since the NV subsystem was deprecated. Since there is no centralized database of configuration in AMSS anymore, a protocol was devised to allow PC tools to back up the arbitrary configuration files that subsystems were free to define.

Configuration backup tools are required to access the UE /nv/item_files/conf/ directory for files ending in .conf. AMSS software modules are responsible for writing a configuration file in this directory at bootup, enumerating the list of files that the backup tool must save for a complete backup. The backup tool is expected to save the configuration files and the contents pointed to by the configuration files by using the Diag EFS subsystem access commands.

RF NV quickly expanded beyond the ability of the RF.conf file to enumerate all RF items without generating unnecessarily large text files on the modem EFS. RF NV advertises the directories that are to be backed up in entirety through .bl files in the /nv/item_store/rfnv directory. The RF subsystem creates the following two .bl files:

- /nv/item_store/rfnv/rfnv.bl
  - Contains a reference to itself: /nv/item_store/rfnv
  - Backs up all files created through the RF NV facility
- /nv/item_store/rfnv/rfc.bl
  - Refers to /rfc
  - Ensures EFS-RFC based cards are correctly backed up and restored, including self-calibration data

If this protocol is not followed, configuration backup may miss critical configuration data from any subsystem.

12.2.2 Filename conventions

For RF NV specifically, we have two files that list the directories that are to be backed up:

- /nv/item_store/rfnv/rfnv.bl
- /nv/item_store/rfnv/rfc.bl

rfnv.bl contains a single path: /nv/item_files/rfnv/

rfc.bl contains a single path: /rfc/

Non-RF NV item number RF configuration items consist of:

- New DC calibration data
  - Store as an EFS file (selfcal/modem/adc.dat).
  - This is part of internal device calibration to remove the DC generated in the WTR and the ADC within the MSM
- Tuner characterization files
  - Stored under “/rfc/%d/ATuner/”
  - %d is replaced with the RF hardware ID of the RF card
  - Common tuner configuration is stored in “common/info.dat” under this path
  - Tech-specific tuner configuration is stored in “<tech>/b<band#>_device<device#>_ant_tuner_char.dat” under this path
- Chipset self-calibration data, including Internal Device Calibration (IDC) results
  - Stored under /rfc/%04d/selfcal/dev%d
  - The first %d is replaced by the 0-padded 4-digit RF HW ID, and the second %d replaced by the index of the device as it is listed in the RFC common device table for the given RFC

Figure 12-1 shows the screenshot of EFS explore, where self-calibration data folder is highlighted.

- IP2 cal data for Sawless card is stored under /rfc/ip2_cal (Figure 12-2)

Devices may store data in a file specified by the above path or treat the path as the root directory for one or more files stored at their discretion. If this protocol is not followed, the configuration backup may miss critical configuration data from any subsystem.

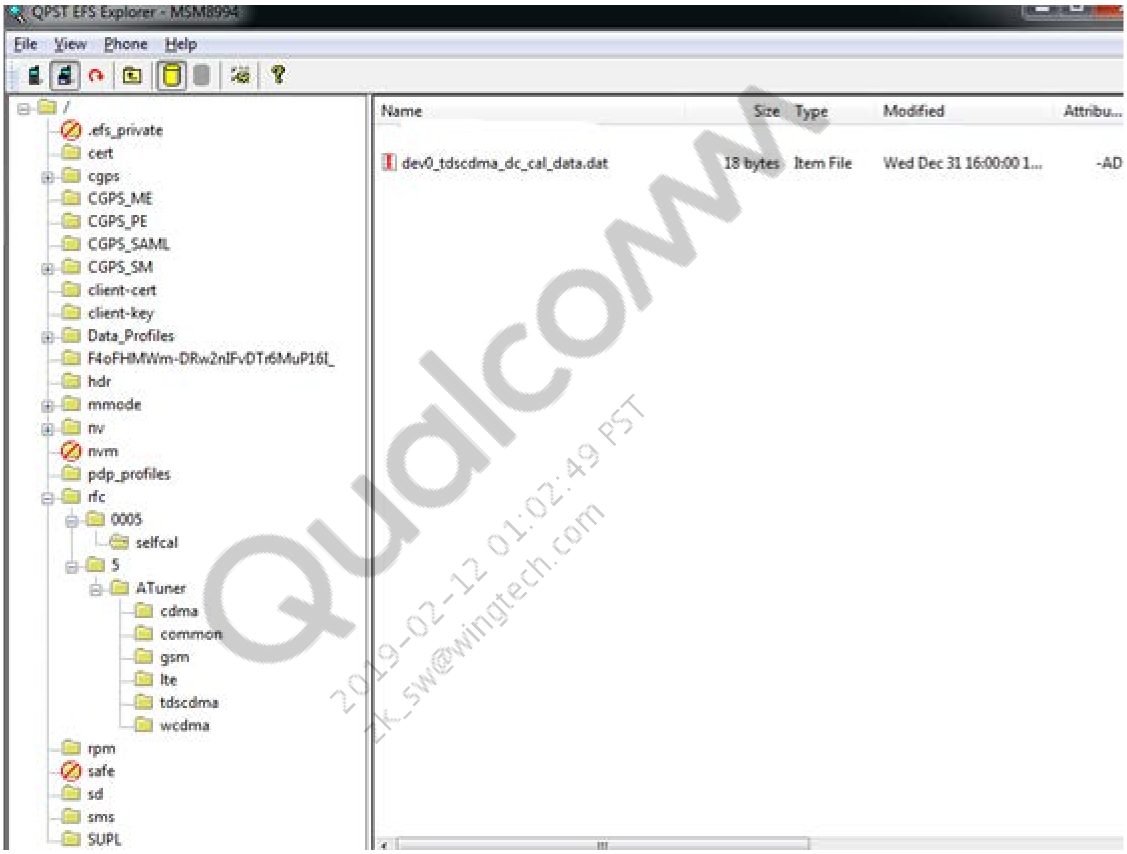


Figure 12-1 EFS files of RF configuration items

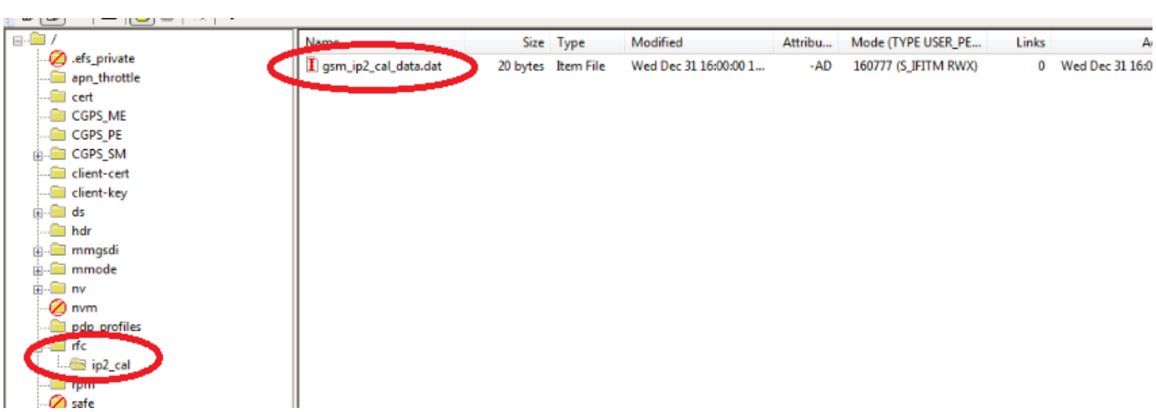


Figure 12-2 EFS file for IP2 cal

A References

A.1 Related documents

Title	Number
Qualcomm Technologies, Inc.	
FTM Common API Commands	80-VA888-1
Factory Test Mode CDMA 1X RF Test Commands	CL93-V5419-1
Factory Test Mode GSM RF Test Commands	CL93-V5370-1
Factory Test Mode WCDMA Test Commands	CL93-V5368-1
Description of Interpolated Frequency Compensation Feature	80-V7936-8
IZAT Gen 8 Engine Family RF Development Test Procedures	80-VM522-2
XO Calibration Manual Test Procedure	80-VR839-1
Using a Linear PA for GSM Applications	80-VF846-14
XO Training Topics	80-VP447-7
UMTS and LTE Protocol NV Items	80-VF299-1
LTE RF NV Items	80-VP146-14
Factory Test Mode LTE Commands	80-VR832-1
Dynamic Maximum Tx Power Limits	80-VP146-8
SPI Control for Antenna Tuners in MDM9615/MSM8960	80-N7536-1
Multifrequency Bin SPI Control for Third-Party Antenna Tuner	80-N7536-2
MSM8909 QFE25x0 Antenna Tuner Software Guide	80-NT093-7
QFE1100 xPT Software Design Guide	80-NG201-2
GSM Linear PA Calibration and Data Processing for NV Generation	80-V9774-16
Enhanced GSM Temperature Comp for MSM8960/MDM9x15 + RTR8600/WTR1605	80-N5420-13
SCALING_NV Calculator for WTR1605 Enhanced GSM Temperature Compensation Spreadsheet	80-N5420-15
MPSS.DI.2.0 SGLTE RF Overview	80-NJ017-13
MPSS.JO.x RF Factory TD-SCDMA Calibration Overview	80-NT112-1
MPSS.JO.x LTE Factory RF Calibration Overview	80-NT112-2
MPSS.JO GSM Factory RF Calibration Design Guide	80-NT112-25
MPSS.JO.x WCDMA Factory RF Calibration Overview	80-NT112-3
MPSS.JO.x CDMA Factory RF Calibration Overview	80-NT112-4
MSM8909 GSM Factory RF Calibration Software Training	80-NT112-5
MPSS.JO.x XO Factory Calibration Software Overview	80-NT112-7
Antenna Switching Diversity (ASDiv)	80-NJ705-1
MSM8909+WTR4905 RF Calibration Software/XTT/DLL Revision Guide	80-NT093-10
MSM8909+WTR4905 RF Calibration Software Overview	80-NT093-2

Title	Number
GSM Linear PA Calibration and Data Processing for NV Generation	80-V9774-16

A.2 Acronyms and terms

Acronym or term	Definition
FBRX	Feedback Receive
RRI	Reverse Rate Indicator
SV	Simultaneous Voice