Venus
Operation Description

1. Overview:

Venus works CDMA2000 1X EVDO dual bands (BC0 and BC1). And CPU dual core runs at 600MHz and 400MHz, with 4G bits NAND Flash Memory and 4G bits DDR.

1.1. The main IC include

Function module	Chipset manufacture part number	Remark
Base band	MSM7627	Qualcomm Platform
PMIC	PM7540	Qualcomm Platform
Memory	KA100O015E-BJTT	4G bit NAND+4G bit DDR, SAMSUNG
RF connector	ECT818000163	RF connector, 6 pins,,2.5*2.5*T1.5mm,ECT
RF Transceiver	RTR6500	Qualcomm platform
Quadplexer	ACFM7325	RF main switch, 6 pins, 4.1*7.1*T1.2mm, Avago
Diplexer	LFD18859MDP2B878	RF diversity switch, 6 pins, 1.6*0.8*T0.6mm; Murata
BC0 Isolator	CEG23832MDCB000	Isolator for BC0(815-849MHz), 2.0*2.0*T1.0mm, Murata
BC1 Isolator	CEG231G88DCB101	Isolator for BC1(1850-1915MHz),2.0*2.0*T1.0mm, Murata
BC0 PA	WS1105-BR1	Power Amplifier Module for CDMA BC0(817-849MHz), 3.0*3.0*T1.0mm, Avago
BC1 PA	WS1405-BR1	Power Amplifier Module for CDMA BC1(1850-1915MHz), 3.0*3.0*T1.0mm, Avago
Transistor	PEMD12	NPN/PNP resistor-equipped transistors, load for CDMA PA;1.7*1.7*T0.6mm,NXP
BC0 TX SAW	SAFEA833MAM0F00	Unbalanced SAW filter for CDMA BC0 TX (817-849MHz), 1.4*1.1*T0.6mm, Murata
BC1 TX SAW	ACPF-7005	Unbalanced SAW filter for CDMA BC1 TX (1850-1915MHz) 1.6*2.0*T1.1mm, Avago
BC0 DRX SAW	SAFEA878MAL0F00	Unbalanced SAW filter for CDMA BC0 diversity RX (862-894MHz), 1.4*1.1*T0.6mm, Murata
BC1 DRX SAW	SAFEB1G96AL2F00	Unbalanced SAW filter for CDMA BC1 diversity RX (1930-1995MHz), 1.4*1.1*T0.6mm, Murata
Diversity LNA	NJG1133MD7	LNA for CDMA diversity function. 1.6*1.6*T0.4mm, JRC

BC0 PRX SAW	SAFEA878MFL0F00	Balanced SAW filter for CDMA BC0 primary RX (862-894MHz), 1.4*1.1*T0.6mm, Murata
BC1 PRX SAW	SAFEB1G96FL2F00	Balanced SAW filter for CDMA BC1 primary RX (1930-1995MHz), 1.4*1.1*T0.6mm, Murata
GPS	RTR6500	GPS integrated, Qualcomm
GPS SAW	SAFEA1G57KJ0F00	SAW filter for GPS. 1.4*1.1*T0.6mm, Murata
GPS LNA	BGU7005	LNA for GPS, 1.0*1.45*T0.5mm, NXP
VC-TCXO 19.2MHz	KT3225R19200DCV28KUD	VC-TCXO 19.2MHz, ±2ppm,,3.2*2.5*T1.0mm, KYOCERA
Thermistor	NCP15XV103J03RC	NTC thermistor used for temperature sensor and temperature compensation, 1.0*0.5*T0.5mm, Murata
BT/Wi-Fi/FM	BCM4329Module	WM-BN-BM-01 WLAN +BT+FM 3-in-1 Module,USI
WLAN SAW	SAFEA2G45RA0F00	WLAN SAW Filter 50ohm,Murata
G_Sensor	BMA222	Acceleration sensor,2x2x1mm,tri-axial ±2g to ±16g,digital 8 bits, BOSCH
E-Compass	MMC3280MS	Ultra Small 3-axis Magnetic,Sensor, With I2C Interface,10pin LGA, 3.0x3.0x1.0mm,MMC3280MS,MEMSIC,
P_Sensor	TMD26711	PROXIMITY DETECTOR, FN-8,TAOS
MOSFET	NUS5531MTR2G	Main Switch Power MOSFET and Single Charging BJT,P-Channel,PNP,3*3mm WDFN8, ON SEMI
OVP	NCP349MNAE	Positive Overvoltage Controller with Internal Low RON NMOS FET, ON SEMI
Crystal, 32.768KHz	MS5V-T1R	Crystal,32.768KHz,±20ppm,7pF,1.15*1.15*4.7mm,, MS5V-T1R,MICRO crysatl

1.2. RECOMMENDABLE OPERATION CONDITION:

Normal Supply Voltage (V d.c.)	3.9V
Maximum Extreme Supply Voltage (V d.c.)	4.2V
Minimum Extreme Supply Voltage (V d.c.)	3.5V
Minimum Extreme Temperature**	-30 /60 degree
SIM/USIM Voltage	1.8 / 3v

1.3. ABSOLUTE MAXIMUM RATING of CDMA PA:

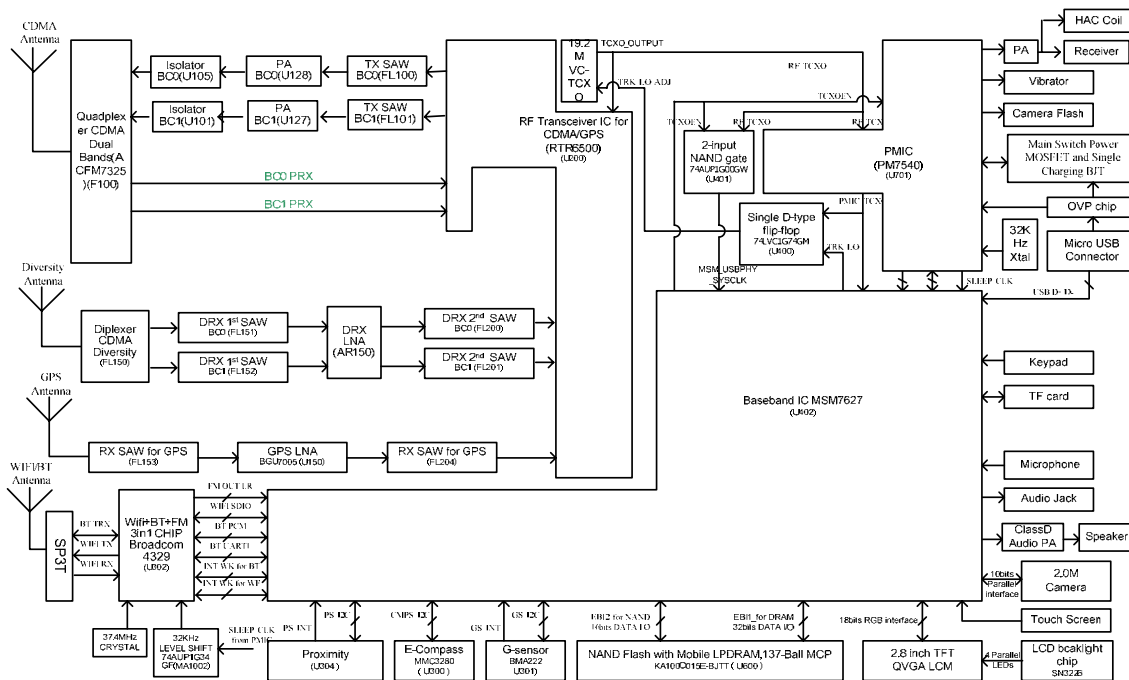| PA parameter	Specification		
	Min.	Type.	Max.
Power supply voltage	-	3.4v	5v
Power supply current	-	-	0.52A

2. System diagram Overview:

2.1. Overview

The MSM7627 platform supports high-performance applications, while providing world phone coverage on a single device:
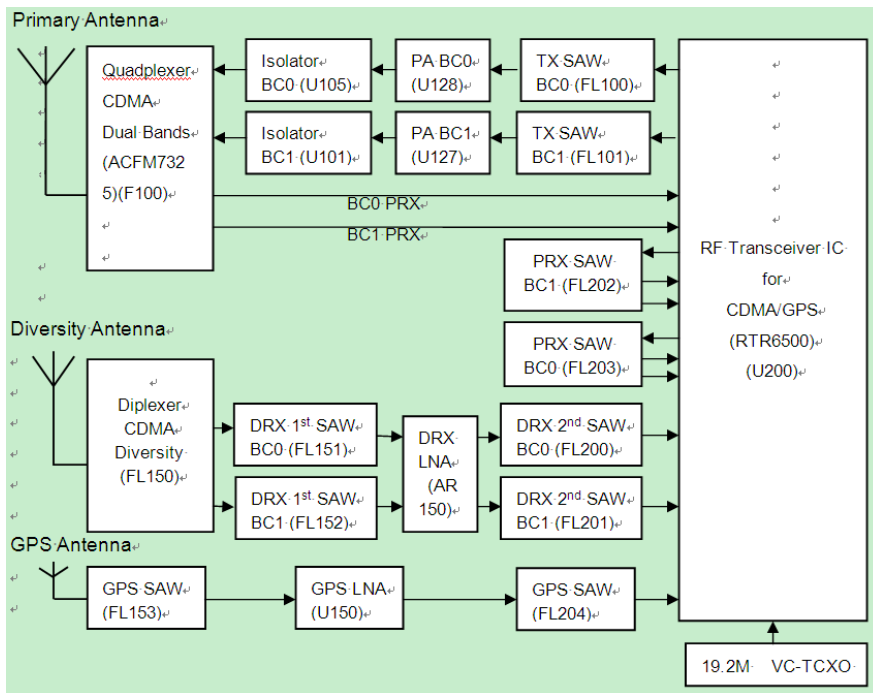
- CDMA 2000 1X RTT
- EVDO Rev.A

HW BLOCK DIAGRAM

CDMA Antenna — Quadplexer CDMA Dual Bands(ACFM7325)(F100) — Isolator BC0(U105) — PA BC0(U128) — TX SAW BC0(FL100); Isolator BC1(U101) — PA BC1(U127) — TX SAW BC1(FL101) — RF Transceiver IC for CDMA/GPS (RTR6500)(U600)

BC0 PRX / BC1 PRX

19.2M VC-TCXO — TCXO_OUTPUT — TRK-LO ADJ — RF TCXO

2-input NAND gate 74AUP1G00GW (U401)

Single D-type flip-flop 74LVC1G79GM (U800)

PMIC (PM7540)(U701)

MSM USB PHY SYSCLK / PMIC TCXO / TRK LO

Baseband IC MSM7627 (U402)

Diversity Antenna — Diplexer CDMA Diversity (FL150) — DRX 1st SAW BC0 (FL151) / DRX 1st SAW BC1 (FL152) — DRX LNA (AR150) — DRX 2nd SAW BC0 (FL200) / DRX 2nd SAW BC1 (FL201)

GPS Antenna — RX SAW for GPS (FL153) — GPS LNA BGU7005(U150) — RX SAW for GPS (FL204)

WIFI/BT Antenna — SP3T — Wifi+BT+FM 3in1 CHIP Broadcom 4329 (U802) — FM OUTL/R / WIFI SDIO / BT PCM / BT UART / INT WK for BT / INT WK for WF

BT PRX / WIFI TX / BT TX / WIFI RX

37.4MHz CRYSTAL; 32KHz LEVEL SHIFT 74AUP1G34 GF(MA1002); SLEEP CLK from PMIC; PS INT / PS I2C; CMPS I2C; GS INT / GS I2C; EBI2 for NAND 16bits DATA I/O; EBI1_for DRAM 32bits DATA I/O; 18bits RGB interface

Proximity (U304); E-Compass MMC3280 (U300); G-sensor BMA222 (U301); NAND Flash with Mobile LPDRAM,137-Ball MCP KA100C015E-BJTT (U600); 2.8 inch TFT QVGA LCM

HAC Coil; PA — Receiver; Vibrator; Camera Flash; Main Switch Power MOSFET and Single Charging BJT; OVP chip; 32K Hz Xtal; Micro USB Connector; USB D+ D-; Keypad; TF card; Microphone; Audio Jack; ClassD Audio PA — Speaker; 10bits Parallel Interface / 2.0M Camera; Touch Screen; Parallel LEDs; LCD backlight chip SN3226

2.2. RF

RF (Radio Frequency) section is in charge of the signal transmit and receiving, signal modulation and demodulation.

Primary Antenna

Quadplexer CDMA Dual Bands (ACFM7325)(F100) → Isolator BC0 (U105) ← PA BC0 (U128) ← TX SAW BC0 (FL100) ← RF Transceiver IC for CDMA/GPS (RTR6500) (U200)

Isolator BC1 (U101) ← PA BC1 (U127) ← TX SAW BC1 (FL101) ←

BC0 PRX
BC1 PRX

PRX SAW BC1 (FL202)
PRX SAW BC0 (FL203)

Diversity Antenna

Diplexer CDMA Diversity (FL150) → DRX 1st SAW BC0 (FL151) → DRX LNA (AR 150) → DRX 2nd SAW BC0 (FL200)

DRX 1st SAW BC1 (FL152) → DRX 2nd SAW BC1 (FL201)

GPS Antenna

GPS SAW (FL153) → GPS LNA (U150) → GPS SAW (FL204)

19.2M VC-TCXO

Product technical parameters:

Items	BC0	BC1
Frequency allocation	TX(Uplink):824M-849MHZ RX(Downlink):869M-894MHZ	TX(Uplink):1850M-1910MHZ RX(Downlink):1930M-1990MHZ
Channel band width	1.25MHz	1.25MHz
Channel spacing	30KHz	50KHz
Channel	1013-1023,1024-1323,1-777	25-1175
Modulation	RC1,RC2:O-QPSK RC3:H-PSK	RC1,RC2:O-QPSK RC3:H-PSK
TX/RX channel space	45MHz	40MHz

	1023-1023: Fn=825.000+(N-1023) *0.03 1024-1323：Fn=815.040+(N-1024) *0.03 1-777：Fn=870.000+N*0.03 N: Channel No. Unit: MHz	Fn=1850+N *0.05 N: Channel No. Unit: MHz
(Fn)Freq. calculating formula		

2.3. BT and WIFI

The WM-BN-BM-01 module is designed based on Broadcom 4329 chipset solution. The 802.11b/g/n + BT + FM receiver Wireless SiP module WM-BN-BM-01 which refers as "SiP 3-in-1 module" is a small size module that provides full function of 802.11b/g/n(draft n) , Bluetooth 2.1+EDR/class 1 and FM Receiver.

2.3.1. Block diagram
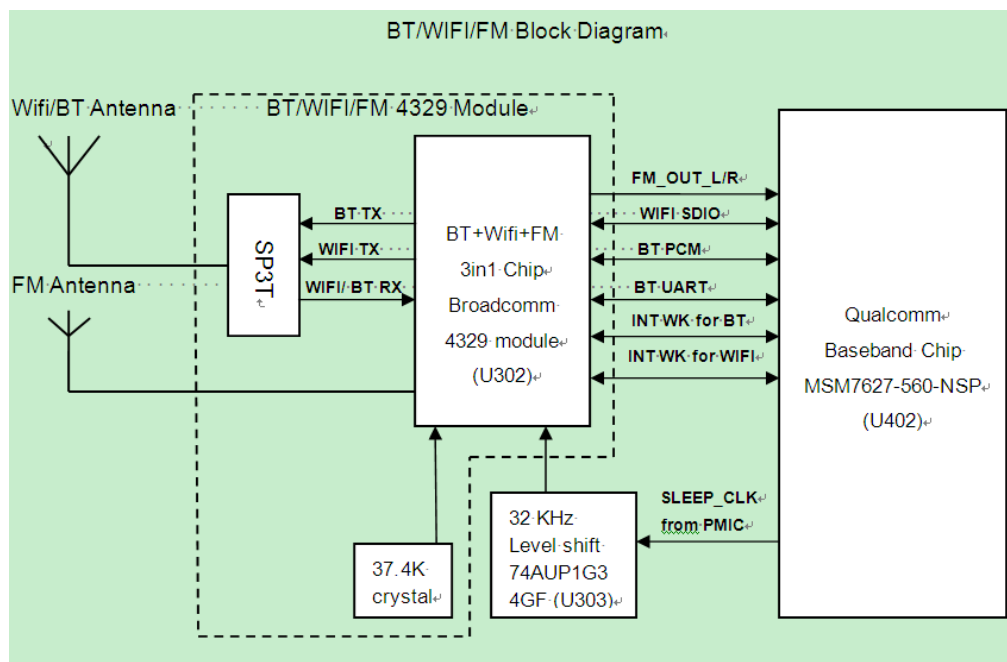
2.3.2. RADIO SPECIFICATIONS BLUETOOTH

Items	Values
Frequency Range	2400 MHz ~ 2483.5 MHz
RF Power Output	≤6dBm
Modulation	FHSS (Frequency Hopping Spread Spectrum) , GFSK,π/4 DQPSK and 8DPSK

Number or channels	79
Channel spacing	1MHz

2.3.3. RADIO SPECIFICATIONS WIFI

Items	Values
Frequency Range	2.4000 GHz – 2.462 GHz (2.4 GHz ISM Band)
RF Power Output	17 dBm +2.0/-2.0 dBm for 802.11b 15 dBm +2.0/-2.0 dBm for 802.11g 15 dBm +2.0/-2.0 dBm for 802.11n
Modulation	OFDM, DSSS (Direct Sequence Spread Spectrum), DBPSK, DQPSK, CCK , 16QAM, 64QAM
Number of selectable Sub channels	11
Channel spacing	5MHz

2.4. BB

BB (Base-Band) section is the control & management center of the mobile where OS (Operate System) running and provides the MMI for the mobile.
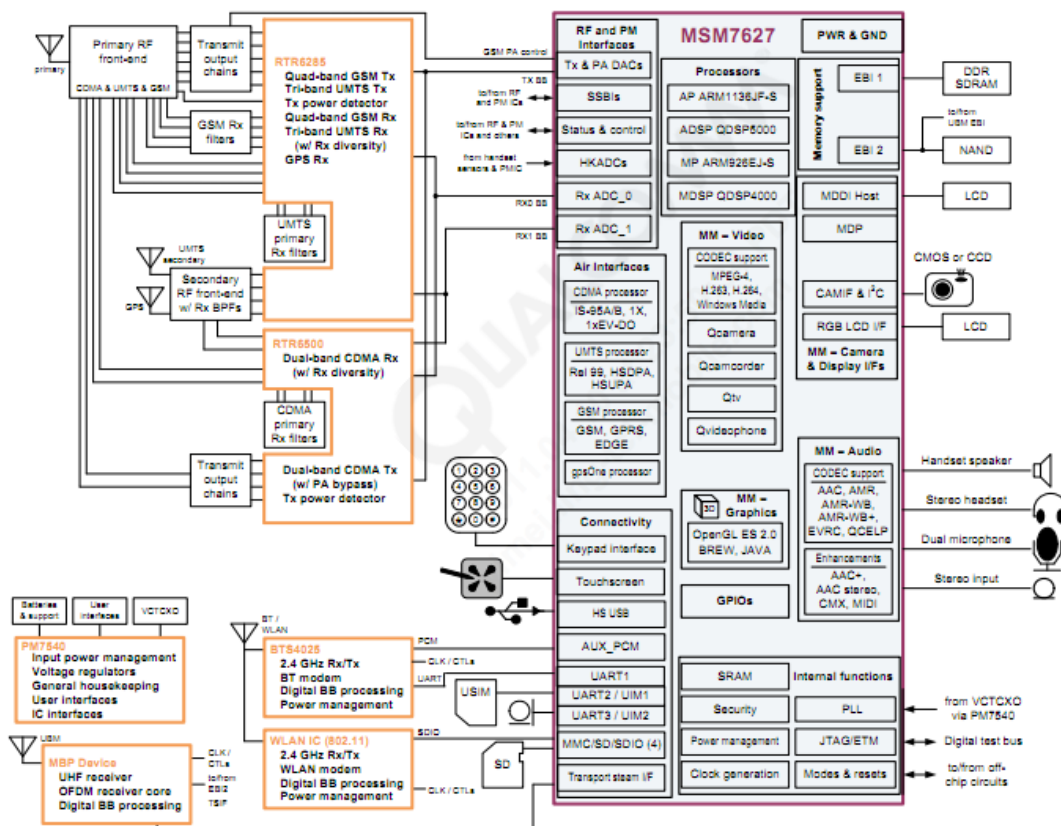
Main Features:

The basic MSM7627 family system solution consists of the MSM7627 family, RTR6285™, RTR6500™, and PM7540™ ICs, plus the AMSS™ system software with the SURF7627™ platform available for development. General features include:

- CDMA 1X and 1xEV-DO Rev. A
- WCDMA Rel '99 plus HSDPA and HSUPA
- GSM/GPRS/EDGE
- High-performance ARM1136JF-S™ application processor at up to 600 MHz; QDSP5000™ a 320 MHz
- High-performance ARM926EJ-S™ modem processor at up to 400 MHz; QDSP4000™ at 122.88 MHz
- Java® hardware acceleration for faster Java-based games and other applets
- Support for Bluetooth® 2.1 EDR via an external Bluetooth System-on-Chip (SoC)
- High-speed, serial mobile display digital interface (MDDI) that optimizes the interconnection cost between the MSM device and the LCD panel
- Receive diversity support for CDMA and WCDMA modes, thereby providing improved capacity and data throughput
- USB 2.0 compliant high-speed USB core with limited OTG capabilities
- Integrated high-speed USB PHY
- Integrated wideband stereo codec for digital audio applications
- Direct interface to digital camera module with video front-end (VFE) image processing
- GPS position location capabilities
- Vocoder support (EVRC, 13k QCELP®, 4GV™, GSM-HR, FR, EFR, AMR, and AMR-WB/+)
- Advanced 12 × 12 ×1.05 mm, 0.4 mm pitch, 560 NSP

Architecture and base band processing features

- High-performance ARM1136JF-S 600 MHz application processor:
  - ARM® architecture v6
  - 32 kB instruction and 32 kB data cache
  - 256 kB ARM11™ L2 cache
  - 4 kB level-one tightly-coupled memory (TCM)
  - 8-stage pipeline, branch prediction with return stack
  - Supports the ARM and Thumb instruction sets, and Jazelle™ technology to enable direct execution of Java byte-codes
  - Low-interrupt latency
- Industry standard ARM926EJ-S 400 MHz embedded microprocessor subsystem
  - 16 kB instruction and 16 kB data cache
  - ARM version 5TEJ instructions
  - Higher performance five-stage pipeline, Harvard cached architecture
  - Higher internal CPU clock rate with on-chip cache
  - Internal watchdog and sleep timers
- QDSP5000 320 MHz application digital signal processing (ADSP)
  - 512 kB L2 cache
- QDSP4000 122.88 MHz modem digital signal processing (MDSP)

Memory support features

- 256 kB internal memory (IMEM) for graphics, internal functions, DSP, etc.
- Dual-memory buses separating the high-speed memory subsystem (EBI1) from low-speed peripherals (EBI2) such as LCD panels
- Enhanced EBI1 memory support: 200 MHz bus clock for DDR SDRAM
- EBI2 support:
  - 1.8 or 2.6 V memory interface support
  - NAND/OneNAND™ flash memory interface
  - Boot from NAND/OneNAND
  - LCD and Universal Broadcast Modem™ (UBM™) support

3. Signal Flow

Brief of the mobile signal flow as below:

3.1. Receiver principle

RX signal flow chart:
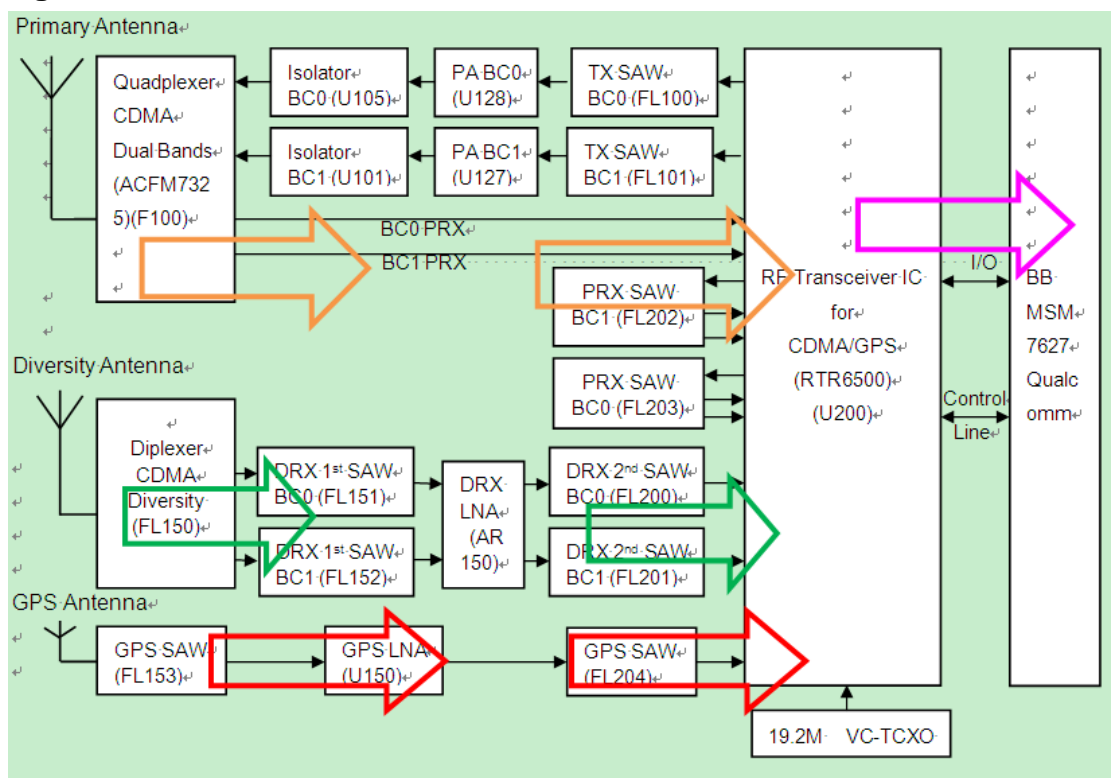
The aerial signal mobile received go to RF Connector, and then transmit to transceiver via the selected band in RF switcher & SAW filter. Four IQ signals input to CPU, Go through A/D, DSP, and D/A section in CPU, then output to receiver.

1) Marked by red color is GPS path.
2) Marked by original color is BC0 or BC1 primary RX path.
3) Marked by green color is BC0 or BC1 diversity RX path.

4) Marked by pink color is a common path between transceiver and BB.

3.2. Transmitter principle

TX signal flow chart:
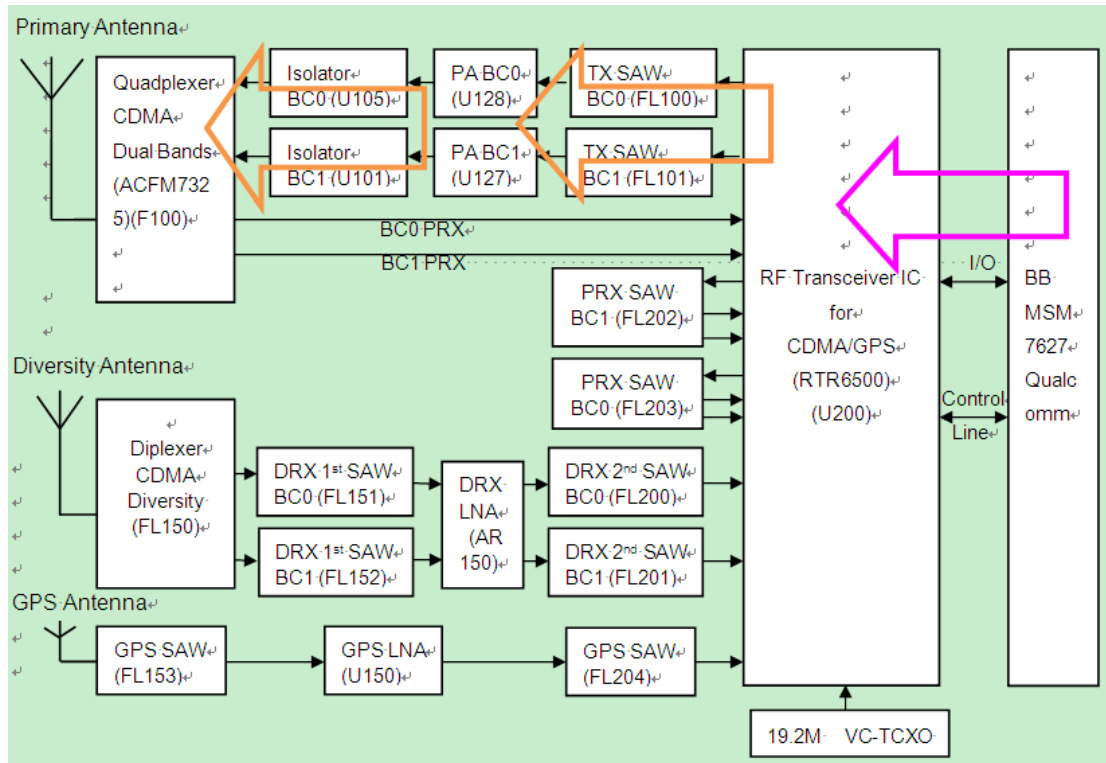
Audio signal input from Microphone. Microphone convert the voice signal to analog signal and input to CPU (MSM7627). Go through A/D, DSP, and D/A section, output to transceiver by IQ signals, These analog input signals are buffered, filtered by low-pass filters, amplified, and then applied to the quadrature upconverter mixers …in transceiver(RTR6500). Then output to TX SAW, PA, go through Isolator, Quadplexer to antenna.

1) Marked by original color is BC0 and BC1 TX path.
2) Marked by pink color is a common path between transceiver and BB.

4. Tx Power Limit Strategy for CDMA-1xEVDO

The Tx Power Limit function on Venus OneTouch 909B product use the power detector circuit named HDET to read every 1.25ms the ADC value (named HDET_ADC in this document), which represent the real-time Tx Power level, and two internal registers named TX_GAIN_LIMIT and TX_GAIN_CTL. The former register is used to limit the Tx

Power, while the latter is used to represent and control the Tx Power.   If the real-time Tx Power intends to be larger than Tx Power Limit defined in the TX_GAIN_LIMIT register, the internal DSP circuit will change the TX_GAIN_CTL register value to the one defined in the TX_GAIN_LIMIT register.
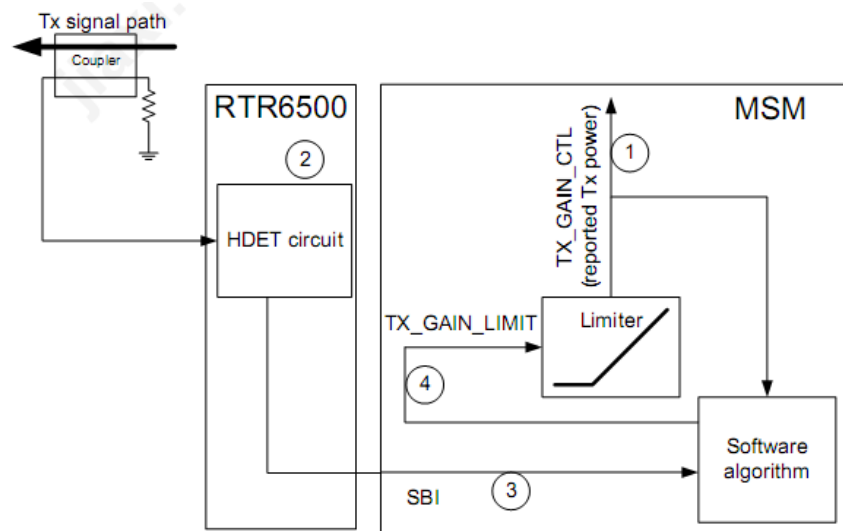

Figure 1: Tx Power Limit feedback loop.

The Tx Power value will be changed to its limited value only if the TX_GAIN_CTL value exceeds the one of TX_GAIN_LIMIT. The Power Limit feedback loop represented in the Figure 1, is used to achieve this change and the timing interval of one cycle is 20ms (hardcoded in software). The Software algorithm will do the following steps to control the Tx Power Limit:

Step 1: The mobile station intends to output a Tx Power at a level defined by TX_GAIN_CTL, the Tx Power will change accordingly.

Step 2: The HDET circuit reads the ADC value every 1.25ms and record the HDET_ADC value.

Step 3: Through SBI interface, the HDET_ADC value will be passed to baseband side (MSM).

Step 4: Determination of the proper Tx Power Limit value that will be assigned to TX_GAIN_LIMIT register. Here are the prerequisites required to understand how it's done:

(1) Because the Tx Power dynamic range is large (from -60.4dBm to 42dBm), the limitation of the Tx Power concern only the higher Tx Power range. Thus, only the upper 1/4 of Tx Power dynamic range is used and breaks up into 16 segments, which is associated with EXP_HDET_VS_AGC table index from 0 to 15. These segments are [16.4: 18], [18: 19.6]… [40.4: 42] (all values in dBm).

During calibration steps (in factory), we build up this table that represent the relationship between HDET_ADC values and the corresponding Expected Tx Power Gain level (AGC). For this, we vary the Tx Power such as 18dBm by adjusting the TX_GAIN_CTL value so that the Tx Power corresponds to a proper power level for each index. Then, we read the value of the HDET_ADC register for each index and store them in the table.

After calibration, the EXP_HDET_VS_AGC table will look like this:
{57, **67**, 80, 96, 113, 135, **160**, 185, 210, 235, 255, 255, 255, 255, 255, 255}.

Two specific HDET_ADC values, 67 and 160, are read and recorded during calibration steps. 67 and 160 are respectively the lowest and highest HDET_ADC values used by the feedback algorithm for power limiting. Typically, 67 is the HDET_ADC reading that corresponds to the Max Output Power Limit minus 6dB and 160 is the HDET_ADC reading that corresponds to the Max Output Power Limit plus 2dB. For example, if the Max Output Power Limit is 24dBm, then 67 and 160 values correspond to a Tx Power of 24 - 6 = 18dBm and 24 + 2 = 26dBm respectively.

Based on those two specific values, it's hardcoded in software that the previously cited 16 segments table are divided into another 3 scopes, which represent the lower power, middle power, and higher power ranges, so-called A, B and C scopes:
A [HDET_ADC<67], B [67≤HDET_ADC≤160] and C [HDET_ADC>160].

(2) In scope B, HDET circuit is highly accurate; it's possible to adjust the Tx Power Limit depending on frequency, temperature variations and Power Limit feedback loop. The software will read (all the time and every 1.25ms) the TX_GAIN_CTL value through internal register, to get the real-time Tx Power level.
Besides this, based on the previously cited EXP_HDET_VS_AGC table, another new table (EXP_AGC_VS_HDET) which indexed with HDET_ADC value ranged from 0 to 255, will be established by interpolation algorithm in software side. This new table can map the HDET_ADC value to the corresponding expected TX_GAIN_CTL value. Thus, through the read value of HDET_ADC as indexed by SBI interface, it's easy to find the related correct (expected) TX_GAIN_CTL, then compare it to the real-time TX_GAIN_CTL value and determine a delta value. Tx Power Limit is adjusted by that delta value.

(3) If the detected HDET_ADC value stays in A scope, that's mean the Tx Power level is in the lower range, so the software will rise the Tx Power Limit of 5dB to allow the Tx Power to rise up at the next cycle.

(4) If HDET_ADC stays in C scope, which means the Tx Power level is higher than the Max Output Power Limit (24dBm), the Tx Power Limit value will be

decreased by 2dB. In such case, it will be necessary to wait one cycle to go out of C scope.

All the upper 4 steps are under the condition that the Hotspot function is closed. Otherwise, the software will set one flag named hotspot_enabled to TRUE after activating the Hotspot function by marking the check box of Portable Wi-Fi hotspot in the Tethering & portable hotspot setting. This is the only way to activate the Hotspot function and can be deactivated only by enduser (following the User Manual description) or by a power off of the mobile. In every Power Limit feedback loop cycles, this flag will be checked and if it's TRUE, based on the 4 steps previously explained, the Max Output Power Limit value will be decreased (Power Limit Backoff) by 1.5dB for US Cellular band (800MHz) and 3dB for US PCS band (1900MHz). Thus, limits the Tx Power to lower level. Note that the adjustment (-1.5dB or -3dB) will reflect the Tx Power Limit in all scopes (A/B/C), but not the real-time Tx Power.

The control of the Power Limit Backoff permit to complies with SAR certification limit and because this limitation only affect the higher range of Tx Power (around 24dBm), there is no real impact for enduser in most use case (no change on the sensitivity of the mobile).

5. Codes for Tx Power Limit algrithm

```
LOCAL void rf_adjust_cdma_pwr_limit
(
   int4 ms_interval           /* time interval since last call */
)
{
   int2 agc_error;            /* Tx AGC error   */
   ... ...
   ... ...
   /* - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - - */
   /* If Tx is on, then perform power adjustment.
   */
   if ( rf_tx_status == RF_TX_IS_ON )
      {
         ... ...
         ... ...
      /* ------------------------------------------------------------
      ** If the HDET value is above the HDET offset, we are either in the
      ** HDET adjust range(B scope), or above it(C scope).   If in-range(B scope), adjust Tx AGC.   If
      ** above the range(C scope), bring the limit down.
      ** ------------------------------------------------------------ */
      if ( (rf_hdet_data >= rf_hdet_off_adj )      // >=67
```

```c
          || (rf_hdet_was_disabled == TRUE ))


   /*========================================//
   //   ((rf_hdet_data - rf_hdet_off_adj) <= rf_hdet_spn_adj )
   //      B Scope
   //========================================*/
 {
   /* --------------------------------------------------------------
   ** If within ~-6,+2dB of the Tx power limit (~+18,+26dBm), adjust the
   ** Tx limit.   HDET is only highly accurate in this range, so we only
   ** adjust the limit when operating in this range.
   ** -------------------------------------------------------------- */


   if ((rf_hdet_data <=rf_hdet_spn_adj+rf_hdet_off_adj)||(rf_hdet_was_disabled == TRUE))
   {
      /* ----------------------------------------------------
      ** Calculate new power limit =
      **       AGC error based on measured power (HDET)
      **       + Correction based on temperature,
      **       + Correction based on frequency
      **
      ** AGC error based on measured power (HDET) =
      **       Tx AGC value - Tx AGC Offset - Expected Tx AGC
      ** ---------------------------------------------------- */

      /*
           When reverting to a channel configuration that doesn't
           require inhibiting the max power correction, wait until
           the next frame before modifying the tx limit.
      */
      if( (rf_hdet_was_disabled == TRUE) && (rf_disable_hdet == FALSE) )
      {
        rf_hdet_was_disabled = FALSE ;

        /*lint -save -e717 */
        clk_reg( &rf_pwr_call_back,            /* pointer to call back structure     */
                  rf_enable_125_ms_isr,         /* address of function to call back */
                  RF_TX_LIM_ADJ_FRAME_DELAY, /* time to wait till call back        */
                  (int4)0,                      /* delay between repeat call backs   */
                  RF_CALL_BACK_ONCE );          /* do only one call back             */
        /*lint -restore */
        return ;

      }
      else if( rf_disable_hdet == TRUE )
```

```c
        {
          agc_error = 0 ;
        }
      else {


          /* ------------------------------------------------------------
          ** Compare what HDET is telling us to the gain limit reading
          ** ------------------------------------------------------ */


          /* ------------------------------------------------
          ** Calculate Tx AGC error based on HDET (measured power)
          ** Got agc_pdm value from new table EXP_AGC_VS_HDET[256]
          ** established from EXP_HDET_VS_AGC[16] table.
          ** Tx AGC value - Tx AGC Offset - Expected Tx AGC
          ** -------------------------------------------- */


           agc_error = (rf_tx_agc_adj - RF_TX_AGC_OFF) - \
                        *(rf_exp_agc_table_ptr+rf_hdet_data);


          /* ------------------------------------------------------------
          ** Add in the frequency compensation
          ** ------------------------------------------------------------ */
          agc_error +=rf_freq_comp.i_tx_lim_vs_freq;


          /* ------------------------------------------------------------
          ** Add in the temperature compensated base value for rf_tx_pwr_limit
          ** ------------------------------------------------------------ */
          agc_error += rf_cdma_tx_lim_vs_temp_now;
          ... ...
          ... ...
      }
          /* ------------------------------------------------------
          ** Sum the filtered error with the current CDMA Tx power limit,
          ** and set the new Tx power limit
          ** ------------------------------------------------------ */
            /* update the TX power limit */
          rf_set_tx_pwr_limit(agc_error + rf_tx_pwr_limit );
          ... ...
          ... ...
        }
        else {
        /*==========================================//
        //    ! ((rf_hdet_data - rf_hdet_off_adj) <= rf_hdet_spn_adj )
```

```
//      C Scope
//==========================================*/

  /* ----------------------------------------------------------------
  ** Else, if the Tx power is above the limit, move the limit down 2 dB
  ** to bring the power below the limit.   If the HDET value is above the
  ** HDET correction range, the power is above the desired power limit.
  ** ------------------------------------------------------------ */

  /* Lower the power limit by 2 dB */

  if ( rf_get_cagc_linearizer_range() == RF_HAS_102DB_CDMA_DYNAMIC_RANGE )
  {
      ... ...
      ... ...
  /* update the TX power limit */
    rf_set_tx_pwr_limit( rf_tx_pwr_limit - (2 * RF_TX_LIM_CNT_PER_DB_102) );
  }
  else    /* 85 dB dynamic range */
  {
   ... ...
    ... ...
  }
 }
}
else
{
  /*==========================================//
  //   (rf_hdet_data < rf_hdet_off_adj )
  //      A Scope
  //==========================================*/

  if ( rf_get_cagc_linearizer_range() == RF_HAS_85DB_CDMA_DYNAMIC_RANGE )
  {
     ... ...
     ... ...
  }
  else /* 102 dB dynamic range */
  {
    if ( (rf_tx_pwr_limit - RF_TX_LIM_CNT_PER_DB_102) < rf_tx_agc_adj )
    {
      /* ----------------------------------------------------------------
      ** Else, if the power is below the limit and the power is limiting,
      ** move the limit up by 5 dB to let the power come up to a reasonable
```

```c
            ** limit.   If the power is limiting, and the HDET value is below the
            ** HDET correction range, the power is below the desired power limit.
            **
            ** Allow a 1 dB tolerance on "limiting", so that power control can
            ** dither at the limit.
            ** ---------------------------------------------------------------- */


            /* Raise the limit by 5 dB
             */
             /* update the TX power limit */


            if (rf_hdet_data != 0)
            {
        rf_set_tx_pwr_limit( rf_tx_pwr_limit + (5 * RF_TX_LIM_CNT_PER_DB_102) );
         ... ...
         ... ...
            }
        }
      }
    ... ...
    ... ...
     /* -------------------------------------------------------------
     ** If hit/exceeded the lower/upper limit, something is probably broken.
     ** ---------------------------------------------------------------- */

     if ( rf_tx_pwr_limit <= RF_TX_PWR_CALC_MIN ) {
        ERR("RF Tx Power Limit min'd (%d)", rf_tx_pwr_limit, 0, 0);
     }
     if ( rf_tx_pwr_limit >= RF_TX_PWR_CALC_MAX ) {
        ERR("RF Tx Power Limit max'd (%d)", rf_tx_pwr_limit, 0, 0);
     }


     /* -------------------------------------------------------------
     ** Computation done, get data again after RF_TX_LIM_ADJ_REPEAT_TIME ms
     ** ---------------------------------------------------------------- */

     clk_reg( &rf_pwr_call_back,           /* pointer to call back structure   */
             rf_enable_125_ms_isr,        /* address of function to call back */
             RF_TX_LIM_ADJ_REPEAT_TIME_20M, /* time to wait till call back      */
             (int4)0,                      /* delay between repeat call backs  */
             RF_CALL_BACK_ONCE );          /* do only one call back            */
    } // end of if TX_ON
}
```

```c
void rf_set_tx_pwr_limit
(
  int2 set_level          /* 10 bit limit value to load */
)
{
  int2 temp_level;        /* temp for rf_tx_pwr_limit format conversion */

  /* limit to 10 bit control range 0..1023 */
  rf_tx_pwr_limit = RF_SATURATE( set_level,
                                 RF_TX_PWR_CALC_MIN,
                                 RF_TX_PWR_CALC_MAX );
  temp_level = rf_tx_pwr_limit;

  /* convert 0..1023 control range to +511..-512 hardware range */
   temp_level = RF_TX_PWR_REG_MAX - temp_level;

  /* check if the hotspot function is activated.*/
  if(HotspotIsEnabled)
  {
     switch (rf_chain_ptr->rf_curr_cdma_band)
     {
         case RF_BC0_BAND:
             temp_level += 15;      // sub 1.5db for band 0
             break;
         case RF_BC1_BAND:
             temp_level += 30;      // sub 3.0db for band 1
             break;
         default:
             break;
     }
     temp_level = RF_SATURATE( temp_level,
                               RF_TX_PWR_REG_MIN,
                               RF_TX_PWR_REG_MAX);
  }
  /* else, go on normal operation for limit cal.*/

  /* Write 10 bits to CAGC TX_GAIN_LIMIT hardware port.
  ** Writing to this register will cause the hardware to pick up the new
  ** value (all 10 bits).
  */
   HWIO_OUTM( TX_GAIN_LIMIT_WR, HWIO_RMSK(TX_GAIN_LIMIT_WR),(word) temp_level);
}
```
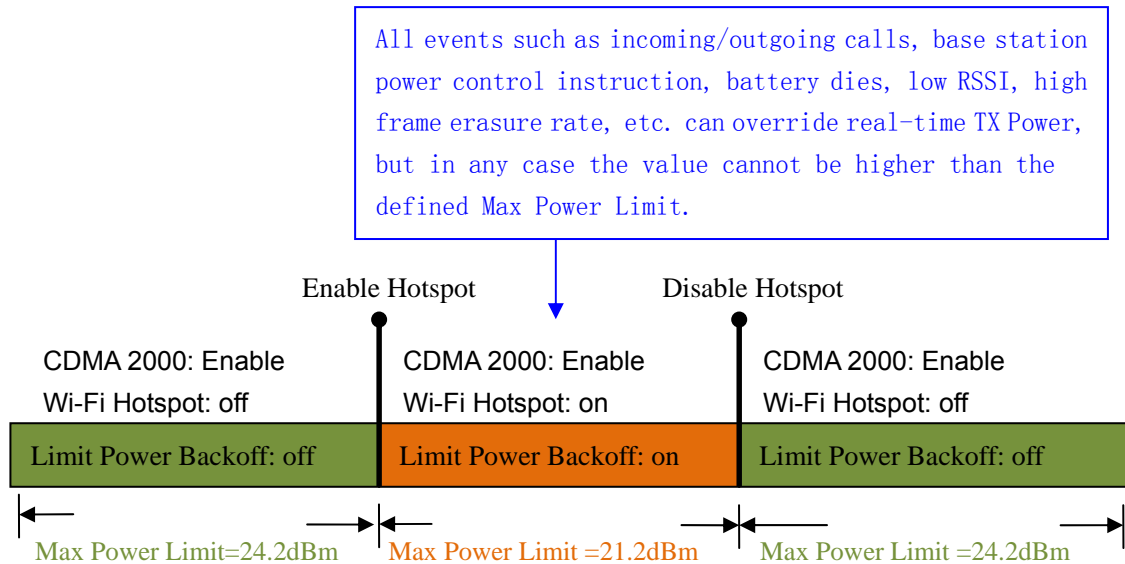
6. Power Limit Backoff when Hotspot on

Below is the description of Power Limit Backoff operation for BC1 CDMA 2000 used as a base case:

All events such as incoming/outgoing calls, base station power control instruction, battery dies, low RSSI, high frame erasure rate, etc. can override real-time TX Power, but in any case the value cannot be higher than the defined Max Power Limit.

Enable Hotspot   Disable Hotspot

CDMA 2000: Enable	CDMA 2000: Enable	CDMA 2000: Enable
Wi-Fi Hotspot: off	Wi-Fi Hotspot: on	Wi-Fi Hotspot: off
Limit Power Backoff: off	Limit Power Backoff: on	Limit Power Backoff: off

Max Power Limit=24.2dBm   Max Power Limit =21.2dBm   Max Power Limit =24.2dBm

Example:

1) real-time TX Power=23dBm   real-time TX Power=21.2dBm   real-time TX Power=23dBm*

2) real-time TX Power=20dBm   real-time TX Power=20dBm*   real-time TX Power=20dBm*

*: If no change in the environment.

When Wi-Fi Hotspot mode is activated, whatever the cellular data connection (1xRTT/EVDO) is active or not, the Max Output Power Limit is redefined, please refer to below table for detailed information.

Modes of Operation	BC0 (CDMA 800)			BC1 (CDMA 1900)		
Test Channel	1013	384	777	25	600	1175
Channel Ranges	1013 - 777			25 - 1175		
Max Output Power Limit Setting (dBm)	24.5			24.2		
Output Power Range (dBm)	23.5~25			23.2~25		
Power Limit Backoff (dB)	1.5			3.0		
Max Output Power Limit after Power Backoff (dBm)	23.0			21.2		
Measured Max Output Power (dBm)	24.5	24.88	24.75	24.24	24.20	24.22
Measured Max Output Power after Power Limit Backoff (dBm)	22.93	23.36	23.13	21.14	21.03	21.10
Measured Power Limit Backoff (dB)	1.57	1.52	1.62	3.1	3.17	3.12

The Max Output Power Limit is the maximum power allowed by the mobile phone to transmit. There is no way for the mobile phone to transmit higher power than this one. The Max Output Power Limit applies for both voice and data modes.

Only the Max Output Power Limit is affected by the modification. The real-time TX Power is not affected in any other situation.

When Wi-Fi Hotspot mode is activated, and cellular data connection (1xRTT/EVDO) is active, if there are incoming or outgoing voice calls, the data connection (1xRTT/EVDO) will stop, but Wi-Fi Hotspot mode will still be on, and the Power Limit Backoff will still be activated.

When Wi-Fi Hotspot mode is deactivated, the Power Limit Backoff is also deactivated.

End of this file