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QUALCOMM®
CDMA Technologies

Modem Power Consumption Debugging Methods

80-N9858-1 Rev. A

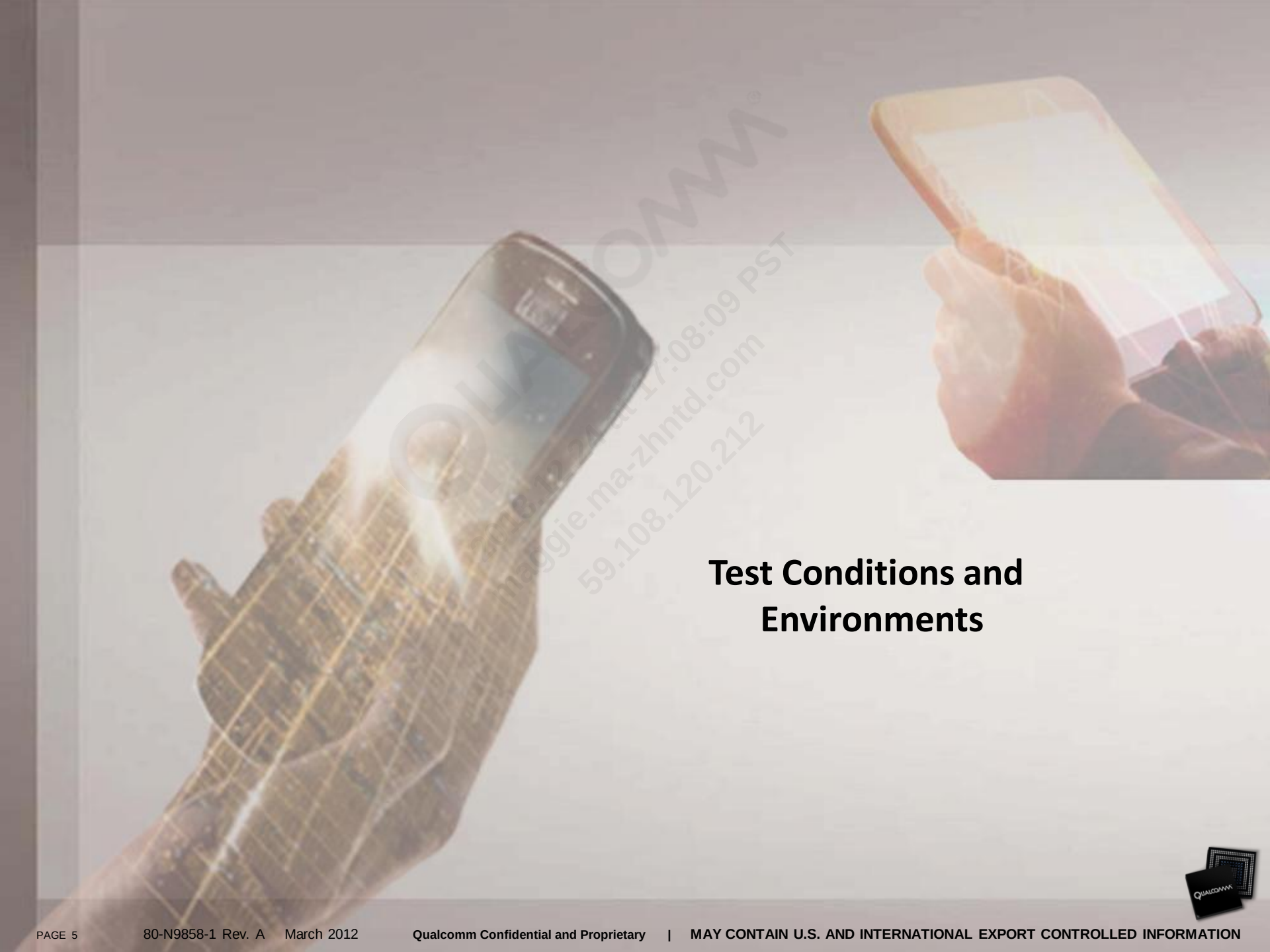
Qualcomm Confidential and Proprietary

QUALCOMM Incorporated
5775 Morehouse Drive
San Diego, CA 92121-1714
U.S.A.

Revision History

Revision	Date	Description
A	March 2012	Initial release

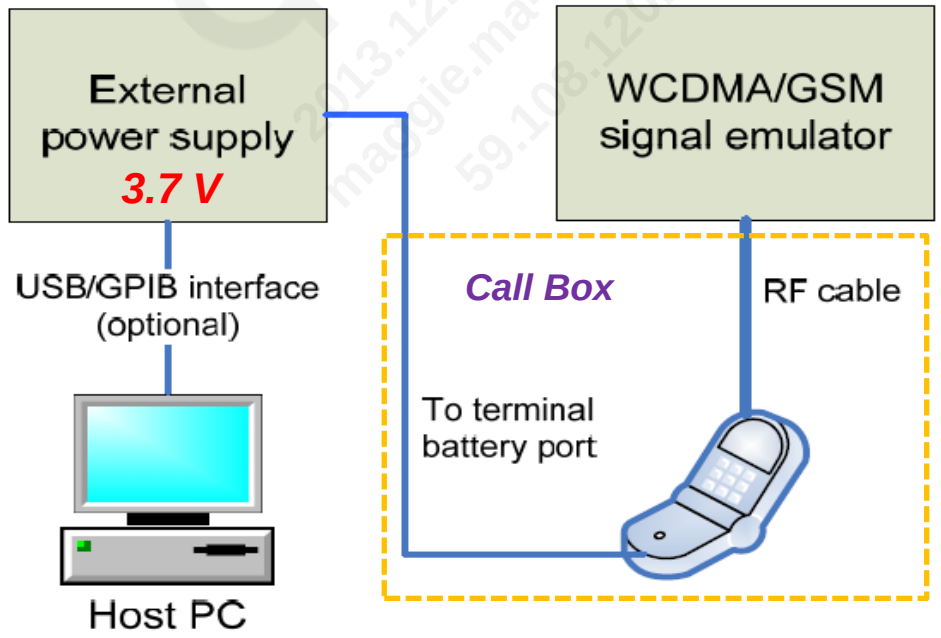
Contents



Test Conditions and Environments

Test Conditions – Test Setup

- Measurement
  - For additional information, see [Q2].
  - Some setting values of the test equipment can be different, according to standby/talk or CDMA/GSM/WCDMA/LTE mode.
  - To be compared/debugged properly, customers must measure the current in the same test conditions that are used by Qualcomm.
    - The standby/talk current numbers can be affected by some specific parameters.



Test Conditions – Sleep (Rock Bottom) Current

- Definition
  - The base current of low-power mode includes the leakage currents from every power source when the main clock (TCXO or XO) is turned off.
- Measurement
  - Sleep current can be measured when the main clock is turned off during standby mode or in airplane mode (the RF block is disabled).

Test Conditions – Standby Current

- Definition
  - Idle current – average current consumed during the total awake time
    - Total awake time – time interval between the TCXO warmup and the TCXO powerdown
    - PICH (PCH) awake time with RF chain active – time interval for PICH (PCH) searching
    - Average current during the total awake time
  - Standby current – average current during standby mode
    - Includes the rock-bottom current and idle current for PICH (PCH) searching, SIM polling, and BCCH update
    - Can be approximately calculated with the following equation when ignoring SIM polling/BCCH

$$\text{Standby current} = \frac{\text{rock-bottom current} + \text{idle current} * \text{total awake time}}{\text{DRX (MFRM) cycle}}$$

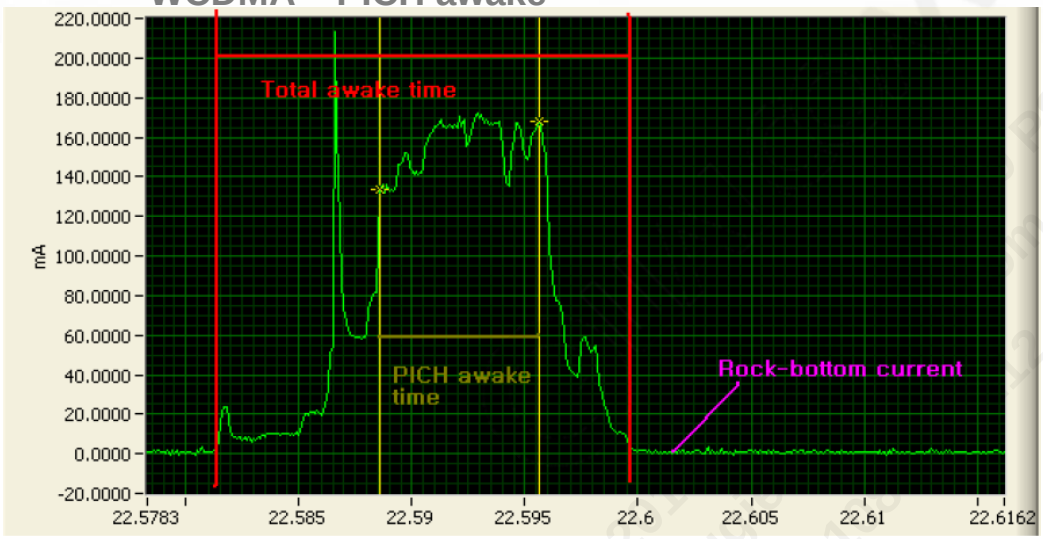
    - DRx cycle/MFRM-to time conversion table

WCDMA		GSM			
DRx	**Duration (ms)**	**MFRM**	**Duration (ms)**	**MFRM**	**Duration (ms)**
6	640	2	468	3	702
7	1280	4	936	**5**	**1170**
8	**2560**	6	1404	7	1638
9	5129	8	1872	9	2106

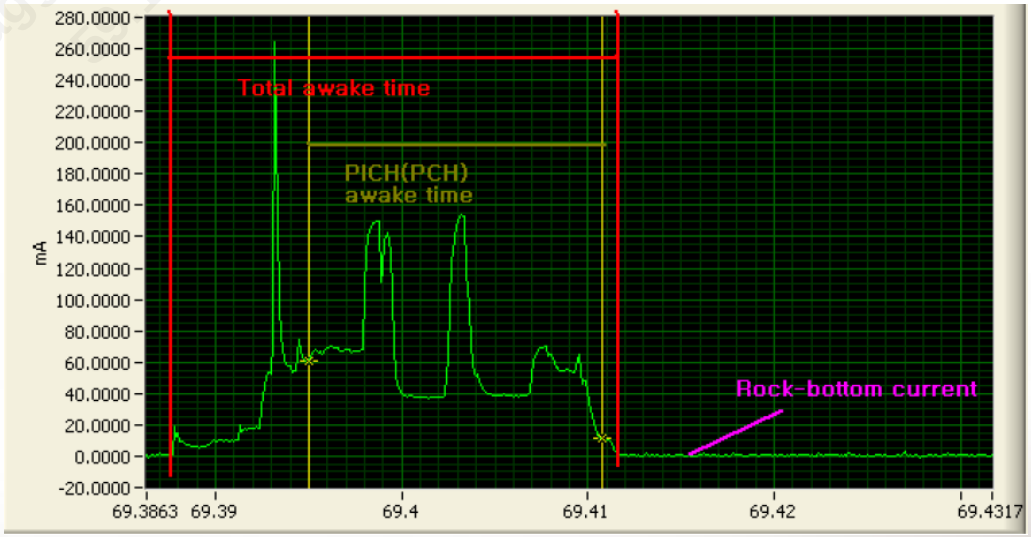
Test Conditions – Standby Current (cont.)

- Definition (cont.)

WCDMA – PICH awake



GSM – PCH awake



Test Conditions – Standby Current (cont.)

- For additional information, see [Q2].
  - Describes how to load the software build and QCN file, and also how to set the NV items and call box
  - The standby/talk test procedure is included for DMA/GSM/WCDMA/LTE
- General call-box setting parameters in GSM mode
  - Network mode setting – *GSM-only* through user-interface menu or NV setting
  - Paging multiframe rates (MFRM): 5 (=1.17 sec)
  - Neighbor cell searching parameter – no neighbor cell
  - BCH parameters
    - Cell power: -45 dBm/cell band; PGSM/broadcast channel: 50
  - TCH parameters
    - Traffic band – PGSM/traffic channel: 55
    - MS Tx level: 19 (5 dBm) for GSM PGSM talk current; 15 (5 dBm) for GSM DCS talk current

Test Conditions – Standby Current (cont.)

- General call-box setting parameters in WCDMA mode
  - Network mode setting – *WCDMA only*, not *Auto mode* through user interface menu or NV setting
    - *Periodic longer wakeup time at multiple DRX cycles, which was caused by Agilent 8960*
    - For additional details, see [Q6].
  - DRx cycle length: 256 frames (DRx = 8, 2.56 sec)
  - Cell parameters
    - Cell power: -45 dBm
    - Channel type: 12.2k + RMC for standby and talk
    - Paging service: AMR voice for standby and talk
    - UE target power: 0 dBm
    - RLC re-establish: off/call limit state; off/call drop timer – on
  - Security information/security parameters/security operations: none
  - AWGN power: off
  - Voice call/AMR setup
    - AMR radio access bearer: 12.2 k voice/AMR source – echo
    - Speech echo loopback delay: 500.0 ms
  - RF in/out amplitude offset setup for the calculated cable loss

Test Conditions – Standby Current (cont.)

- General call-box setting parameters in CDMA mode
  - Network mode setting: *CDMA only*
  - Slot cycle index: 2 (5.12 sec)
  - Cell info/registration parameters
    - Timer-based registration – off
    - Power UP registration state – on
  - Others
    - Cell 1 power: -45 dBm/1.23 MHz
    - Protocol Rev: 6 (IS-2000-0)
    - Radio configuration: FWD3, RVS3; SO33+F-SCH
    - UE target power: 0 dBm
    - RLC re-establish: off/call limit state; off/call drop timer – on
  - AWGN power – off
  - RF in/out amplitude offset setup for the calculated cable loss

Test Conditions – Standby Current (cont.)

- General call-box setting parameters in LTE mode
  - Network mode setting – *LTE only*
  - DRx cycle: 2.56 sec
  - No neighbor cell
    - By default, the phone assumes 255 neighbor cells and keeps searching.
    - To make sure no neighbors are present, add two blank hex files to \nv\item_files\modem\lte\ML1 through the EFS.
      - Two blank files can be created using any hex editor, or can be provided by request from Qualcomm.

Test Conditions – Talk Current

- Measurement
  - FFA is measured at the following Tx power level to exclude any external PA effect.
    - CDMA talk – at 0 dBm
    - GSM talk – at 5 dBm (PCL = 19 for PGSM/EGSM; PCL = 15 for DCS/PCS)
    - WCDMA talk – at 0 dBm as UE target power
    - LTE talk – Cat 3 / at 0 dBm / 10 MHz bandwidth
  - Need to check whether an actual Tx power level is correct as a desired value through ***The Measurement Selection*** button of the test equipment.
    - This is one of the key check points to ensure that RF calibration is correct, especially in GSM-mode Tx power.
    - RF calibration should be required, and RF cable loss should be calculated and reflected in the value.

Debugging and Optimization Methods

Qualcomm Key Debugging Strategy

- Customer provides the design differences from the schematic. Do a design review for power by filing a case in Salesforce.
  - Customer device design may not be the same as the FFA/MTP design.
  - Need to analyze additional power consumption from the extra components on the device.
  - Design review case – select case-record type (design review).
    - Fill out each item such as case information and problem description (like a normal case).
- Power debugging with reference to Qualcomm's power dashboard
  - For information on the MSM8960, see [Q7].
- Measure the current with the same measurement procedure/conditions as described in [Q2].
- Customer-specific test cases to be taken after standard dashboard case optimization and debugging.
- If the customer has any problem with power debugging, (i.e., test conditions, how to acquire clock/GPIO dump files, etc.), contact Qualcomm via Salesforce and file a case of type software or hardware using the following problem codes:
  - Software type case: problem area 1 (board-support-package) / problem area 2 (power management) / problem area 3 – select the appropriate item from the dropdown list.
  - Hardware type case: problem area1 (digital baseband) / problem area 2 (power consumption) / problem area 3 (not applicable)

Sleep Current – Summary

1. Check if the TCXO/XO clock is turned off properly during sleep.
   - Check why TCXO is not turned off via the RPM log or NPA dump analysis.
2. Measure the power rails and the breakdown numbers.
   - Check the turn-on power rails and voltage level on the basis of FFA/MTP.
   - Check which devices are consuming higher current: either MSM or external devices.
3. Deep debugging – from step 2
   - Step 3.1 – from MSM device
     - VDD_CORE (VREG_S3) voltage level/current consumption
       - VDD minimization
       - Higher current consumption – clock dump review
     - VDD_Mx (VREG_S1, VREG_L24, and VREG_L25) current consumption
       - Check/verify the current consumption data for the memory vendor during self-refresh mode.
     - VDD_PADx (VREG_S4) current consumption
       - GPIO configuration review during sleep
   - Step 3.2 – from external devices
     - Analyze additional leakage current for other power sources and external devices.
     - Check whether each power source for PMIC and separate LDOs is turned off properly during sleep.

Sleep Current

- Check whether the TCXO/XO clock is turned off properly during sleep.
  - When viewing the VDD_AP_CORE (VDD_K0/K1) voltage, check if the AP blocks enter power collapse properly.
    - If not turned off, one or more major subsystems on the MSM are failing to go into their lowest power mode, and this is preventing XO shutdown:
      - Low-power audio subsystem (LPASS) is not going into power collapse.
      - Applications subsystem (APSS) is not going into power collapse.
      - Modem subsystem (Q6 software – MSS) is not going into sleep.
      - RIVA subsystem is not going into sleep.
      - DSPS – Sensor subsystem is not going to sleep.
      - Modem subsystem (Q6 firmware – MSS) is not going into sleep.
  - Check which subsystem is preventing XO shutdown through RPM external logs, gpRPMFWMaster data structure, etc.

Sleep Current (cont.)

- The breakdown current and voltage level for each power source
  - VDD_CORE (VREG_S3), VDD_K0/K1 (VREG_S5/S6), VDD_PAD (VREG_S4), RF-related power sources, etc.
  - Measure target UE's breakdown numbers/voltage level
- VDD_CORE (VREG_S3) – higher current consumption
  - Check whether VDD minimization is operating properly (e.g., 0.65 V for MSM8960)
  - Review the clock dump
    - Can view the operating clock frequency, and which clocks are turned on/off
    - Unused clocks should be turned off properly
    - Breakpoint – for MSM8960, right before XO shut down at the clk_regime_swfi(); in RPM
- Higher current consumption on VDD_PADx (VREG_S4)
  - GPIO configuration review during sleep mode
    - Background and guidance – see [Q5]
    - How to debug and optimize – solution: 15542
    - Same as VDD_CORE above: breakpoint

Sleep Current (cont.)

- Other debugging items
  - To analyze additional leakage current for other power sources and external devices:
    - Need to remove them one by one
      - LCD, camera, and third-party WiFi/Bluetooth/FM devices
      - Audio AMP, backlight IC
      - RF components (PAM/FEM module, etc.)
  - Check whether each power source for PMIC and separate LDOs is turned off properly during sleep
    - Unused power sources should be turned off.
  - Measure/subtract the charging current of the external coin-cell part.

Sleep Current – Case Study

- MSM8255-0 project based on Android platform
  - Rock-bottom current
    - Measurement – for each power source in PM8058

First measured current		Voltage during sleep	Measurement	Final measurement
Breakdown numbers	VBAT	3.7 V	**11.6 mA**	**1.6 mA**
	SMPS0 – MSMC1	0.75 V	1.5 mA	1.4 mA
	SMPS1 – MSMC2	0	0	0
	SMPS2 – MSMA1	0	0	0
	SMPS3 – MSME	1.8 V	**8.8 mA** (**4.7 mA at VBAT**)	250 µA
	SMPS4 – MSMA2	0	0	0

Sleep Current – Case Study (cont.)

- MSM8255-0 project based on Android Platform (cont.)
  - Rock-bottom current (cont.)
    - Debugging results

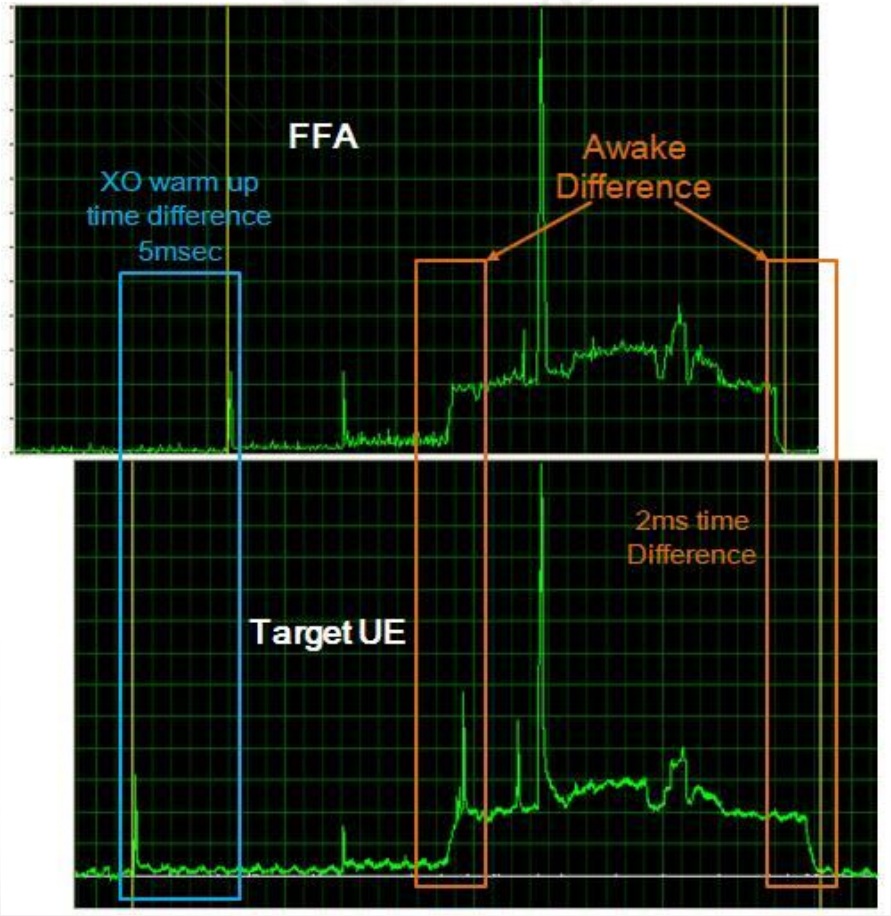
Items	VBAT	Reduction	Remarks
Initial current number	11.6 mA	—	
Bluetooth/WiFi device (third-party) – removal	3.9 mA	7.7 mA	VBAT – 6.6 mA MSME – 1.1 mA
Analog switch device – removal	3.2 mA	0.7 mA	0.7 mA at LDO8
Unused LDOs in PM8058 – off	2.9 mA	0.3 mA	Total 10 LDOs
GPIO configuration	**1.6 mA**	1.3 mA	

Standby Current – Summary

1. Measure the awake time and average current.
   - Measure the waveform during awake.
   - Analyze the awake duration to check whether abnormal awake is happening.
2. Deep debugging – from the waveform analysis
   - Step 2.1 – longer W-PICH (G-PCH, C-QPCH, L-PCCH) awake time
     - NV items
     - F3 log analysis
     - RAM dump analysis
   - Step 2.2 – higher awake average current
     - Measure the voltage level, especially VDD_CORE (VREG_S3)
     - Clock dump review/comparison

Standby Current

- Measure the awake time and average current.
  - Confirm the setting parameters of the test equipment.
  - Monitor the awake waveforms for a few minutes through the software tool.
    - Need to check abnormal awake waveform on customer target.



Standby Current (cont.)

- Longer PICH (PCH) awake time
  - NV items check
    - Four NV Items – 1027, 1892, 1895, and 1962 = 0x0 (disabled)
    - NV_DIAG_DEBUG_DETAIL_I and NV_DIAG_DEBUG_DETAIL_I for saving F3 log
      - These should be set to 0x00.
  - F3 log analysis
    - Use the QXDM tool to acquire F3 log for around 5 min on each CDMA/GSM/WCDMA/LTE mode.
    - Example:
      - Longer awake time happened every 5 sec on both 2G and 3G.
      - Using the F3 log analysis, determined that the ADC block is working every 5 sec.

```
03–03–50.780  sec_drv_task.c  202 H   =====Voltage [4002]mV, Current [358]mA
03–03–50.780  sec_drv_task.c  203 H   =====SOC = [68], State = [3], res = [1]
03–03–55.813  sec_drv_task.c  202 H   =====Voltage [4001]mV, Current [359]mA
03–03–55.813  sec_drv_task.c  203 H   =====SOC = [68], State = [3], res = [1]
03–04–00.846  sec_drv_task.c  202 H   =====Voltage [4002]mV, Current [358]mA
03–04–00.846  sec_drv_task.c  203 H   =====SOC = [68], State = [3], res = [1]
03–04–05.879  sec_drv_task.c  202 H   =====Voltage [4001]mV, Current [359]mA
03–04–05.879  sec_drv_task.c  203 H   =====SOC = [68], State = [3], res = [1]
```

  - RAM dump analysis
    - Can acquire various details from RAM dump analysis such as sleep-controller timelines

Standby Current (cont.)

- Higher PICH (PCH) awake average current
  - Measure the voltage level for each power source during idle.
    - VDD_CORE, VDD_K0/K1, etc.
  - VDD_CORE – higher voltage level
    - Call stack analysis (or NPA dump analysis)
      - Check which clock voting affects the VDD_CORE voltage during awake.
      - Assume that VDD_CORE voltage is a specific number, such as 1.20 V (vs. MTP = 1.10 V).
      - Breakpoint – refer to *Power Consumption Measurement Procedure for Android-based Devices* (80-N6837-1).
      - Qualcomm will provide this breakpoint information for each device.
      - Examples:
        - By MDP clock frequency
        - By GRP (graphic) clock frequency
  - Clock dump analysis
    - To optimize the awake average current for internal blocks, unused clocks should be properly turned off.
    - Breakpoint – refer to [Q2].
    - Qualcomm will provide this breakpoint information for each device.

Standby Current – Case Study

- Standby current

MSM8255-0 VBAT = 3.7 V			Initial values	NV item [1]	WCDMA only [2]
GSM standby (MRFS = 5)	Total standby current		**3.78 mA**	**3.05 mA**	–
	Rock-bottom current		1.65 mA		–
	PCH awake	Avg. current	–	42 mA	–
		Avg. time	–	37 ms	–
WCDMA standby (**DRx = 7**)	Total standby current		**3.5 mA**	3.3 mA	**3.1 mA**
	Rock-bottom current		1.65 mA		
	PICH awake	Avg. current	–	54 mA	–
		Avg. time	–	36 ms	–

Notes:

1. Abnormal awake events happen every 9.4 sec → NV items change
2. *WCDMA mode only* – longer wakeup time by only Agilent 8960
   MSMC1 voltage – MDP clock fix through clock-dump file analysis

Talk Current – Summary

1. Measure the talk current between target UE.
   - Confirm the setting parameters of the Tx power level.
2. Compare the voltage level of VDD_CORE (VREG_S3).
   - Call stack analysis (or NPA dump analysis)
3. Higher talk current
   - F3 log analysis
   - Clock-dump review/comparison

Talk Current

- Measure the talk current on target UE
  - Refer to the Current Consumption Application Note (e.g., 80-N1622-11 for MSM8960) for the current consumption data for each device.
  - Confirm the setting parameters of the test equipment.
    - GSM
      - PGSM, Tx = +5 dBm (PCL = 19)
      - DCS, Tx = +5 dBm (PCL = 15)
    - CDMA/WCDMA/LTE: Tx = 0 dBm

Talk Current (cont.)

- Higher talk current
  - Compare the voltage level for each power source during idle.
    - VDD_CORE (VREG_S3), VDD_K0/K1 (VREG_S5/S6, usually turn-off), etc.
  - VDD_CORE (VREG_S3) – higher voltage level
    - Call stack analysis (or NPA dump analysis)
  - F3 log analysis
    - Use the QXDM to acquire F3 log for around 5 min on CDMA/GSM/WCDMA/LTE for further debugging.
  - Clock dump analysis
    - Breakpoint – any points during the talk state

Talk Current – Case Study

- Talk current

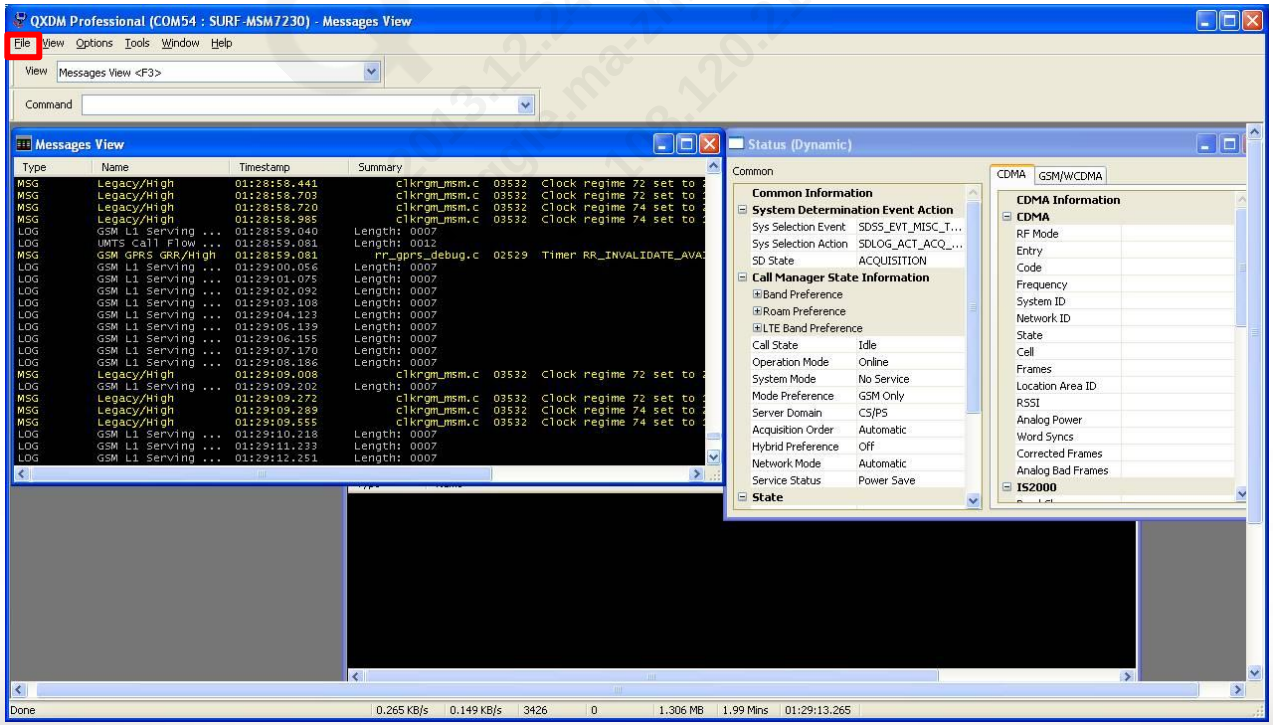
Talk current	Test conditions	Initial values	Clocks-off (intermediate)	Final values
GSM	PGSM, Tx = +5 dBm	99.7 mA	91.2 mA	88.2 mA
WCDMA	Tx = 0 dBm	146.5 mA	144.2 mA	130.8 mA

  - Debugging results
    - Through the clock dump review, these talk numbers were optimized after turning off the unused clocks.
      - Global/DDR performance level
      - I2C, MDP, UART1DM, USB, VPE, etc.

How to Acquire F3 Log/Dump Files

How to Acquire F3 Log Using QXDM

- Acquiring F3 log files using QXDM
  1. Open the *QXDM Professional* tool.
  2. Check whether the target UE enters the proper test scenario.
  3. Menu option – File/Load Configuration → Select the *.dmc file.
     - All the proper viewers are being displayed. Automatically, logging begins.
  4. Wait for the logging time.
  5. Menu option – File/Save Item → Save the log file (*.isf) with a specific filename.



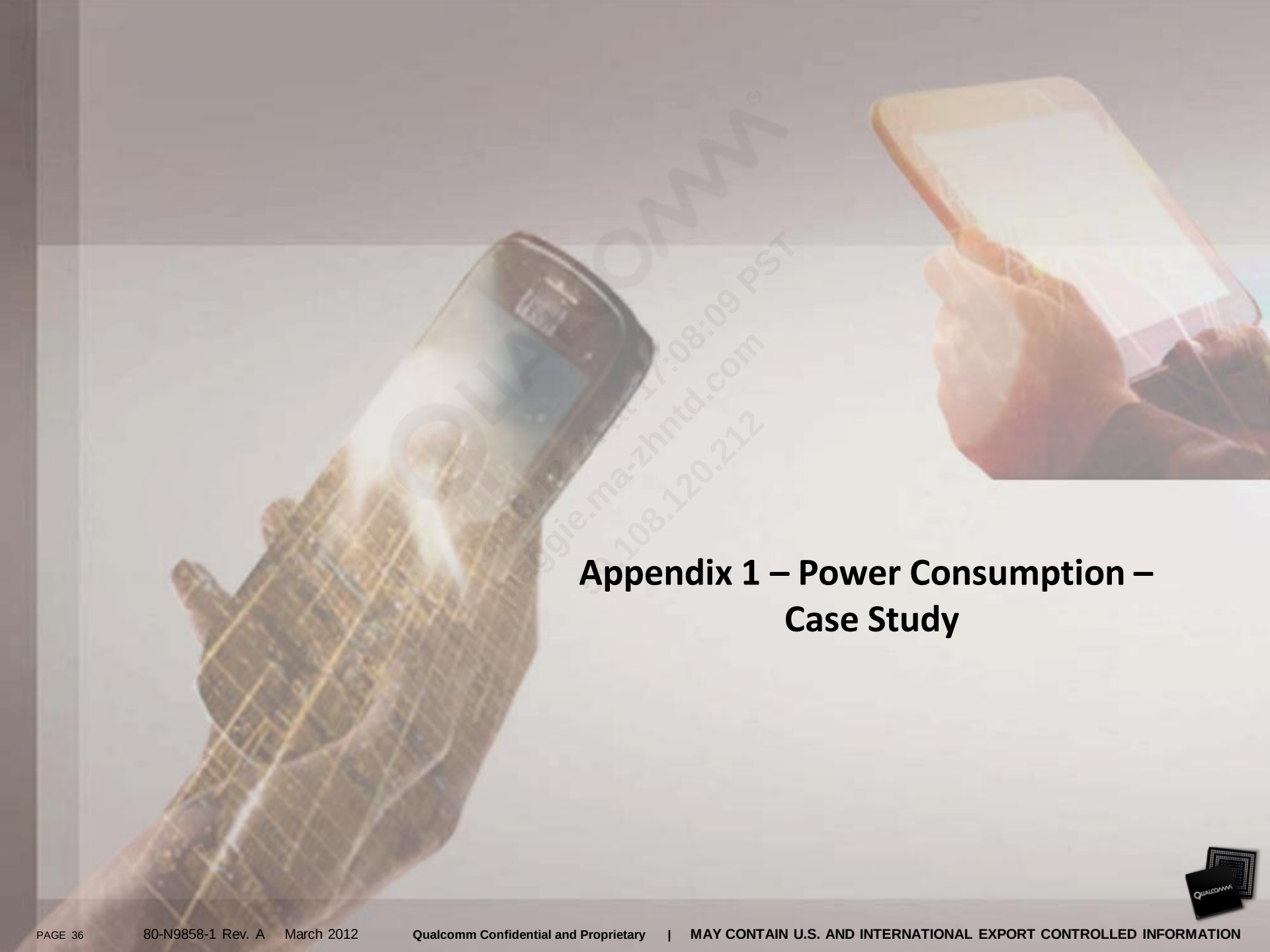
How to Acquire Clock Dump

- Test environment
  - Hardware – MSM8960 Customer Development Platform (CDP)
  - Main meta-build software– M8960AAAAANLYDxxxxxx
    - Dynamic_Krait_c0_usb shortcut @ <meta-build>\common\t32\t32_standalone
  - MPSS software – M8960AAAAANAAMxxxxxx
    - testclock.cmm @ <modem build>\modem_proc\core\systemdrivers\hal\clk\chipset\msm8960\tools
- Run clockdump in TRACE32 (T32):
  1. Connect JTAG to target device.
  2. Run test scenario.
  3. Launch Dynamic_Krait_c0_usb shortcut T32 shortcut.
  4. Clear *EnReset* of Option @SYSTEM.VIEW dialog box.
  5. Run *Up* of Mode @SYSTEM.VIEW dialog box. The application stops.
  6. cd \\<modem build>\modem_proc\core\systemdrivers\hal\clk\chipset\msm8960\tools.
  7. Run testclock.cmm.
  8. Type *all* and press the [Enter] key when the window for taking clock dumps appears.

```
Type ? for help
<supported modules>
top_all (system clocks) // lpass_all (low power audio clocks) //
mmss_all (multimedia clocks) // apcs_all (Apps clocks)
```

How to Acquire GPIO Dump

- Test environment
  - Hardware – MSM8960 CDP
  - Main meta-build software – M8960AAAAANLYDxxxxxx
    - Dynamic_Krait_c0_usb shortcut @ <meta-build>\common\t32\t32_standalone
  - MPSS software – M8960AAAAANAAMxxxxxx
    - tlmm_gpio_8x60.cmm @ <modem build>\ modem_proc\core\systemdrivers\tlmm\t32
- Run tlmm_gpio_8x60.cmm in T32:
  1. Connect JTAG to the target device.
  2. Run the test scenario.
  3. Launch Dynamic_Krait_c0_usb shortcut T32 shortcut.
  4. Clear *EnReset* of Option @SYSTEM.VIEW dialog box.
  5. Run *Up* of Mode @SYSTEM.VIEW dialog box. The application stops.
  6. cd \\<modem build>\modem_proc\core\systemdrivers\tlmm\t32.
  7. Run tlmm_gpio_8x60.cmm.



Appendix 1 – Power Consumption – Case Study

Case Study 1

- MSM8255-0 (512 MB LPDDR2) + QTR8200 with Android Platform
  - Rock-bottom current
    - Measurement – for each power source in PM8058

First measured current		Voltage during sleep	Measurement	Final measurement
Breakdown numbers	VBAT	3.7 V	**11.6 mA**	**1.6 mA**
	SMPS0 – MSMC1	0.75 V	1.5 mA	1.4 mA
	SMPS1 – MSMC2	0	0	0
	SMPS2 – MSMA1	0	0	0
	SMPS3 – MSME	1.8 V	**8.8 mA** (**4.7 mA at VBAT**)	250 µA
	SMPS4 – MSMA2	0	0	0

Case Study 1 (cont.)

- MSM8255-0 (512 MB LPDDR2) + QTR8200 with Android Platform (cont.)
  - Rock bottom current (cont.)
    - Debugging results

Item	VBAT (mA)	Reduction (mA)	Remarks
The initial current number	11.6 mA	–	
Bluetooth/WiFi device (3rd party) – removal [1]	3.9 mA	7.7 mA	VBAT – 6.6 mA MSME – 1.1 mA
Analog switch device – removal [2]	3.2 mA	0.7 mA	0.7 mA at LDO8
Unused LDOs in PM8058 – off	2.9 mA	0.3 mA	Total 10 LDOs
GPIO configuration [3]	**1.6 mA**	1.3 mA	

Note:

1. Finally, optimized the power-down mode of the Bluetooth/WiFi device.
2. Finally, its power source was turned off and GPIO was configured properly for non-operating mode.
3. Finally, optimized through GPIO configuration review during sleep mode.

Case Study 1 (cont.)

- MSM8255-0 (512 MB LPDDR2) + QTR8200 with Android Platform (cont.)
  - Standby current
    - Measurement

VBAT = 3.7 V			Initial values	NV Item *	WCDMA only **
GSM standby (MRFS = 5)	Total standby current		**3.78 mA**	**3.05 mA**	–
	Rock-bottom current		1.65 mA		–
	PCH awake	Avg. current	–	42 mA	–
		Avg. time	–	37 ms	–
WCDMA standby (**DRx = 7**)	Total standby current		**3.5 mA**	3.3 mA	**3.1 mA**
	Rock-bottom current		1.65 mA		
	PICH awake	Avg. current	–	54 mA	–
		Avg. time	–	36 ms	–

Note:
For details on * and ** – see the next slide.

Case Study 1 (cont.)

- MSM8255-0 (512 MB LPDDR2) + QTR8200 with Android Platform (cont.)
  - Standby current (cont.)
    - Debugging results
      - * NV items change

NV item		Description	Setting values
1027	Enable MDSP logging	MDSP memory dump enable	0
1892	Enable logging	Diag debug control	0
1895	Enable logging	Diag debug detail	0
1962	Enable logging	Trace files saved EFS	0

        - Abnormal awake events (longer awake time and higher average current) can happen every 9.4 sec.
        - After changing these NV items, the standby current was improved.
      - ** WCDMA-only mode – longer wakeup time by only Agilent 8960
        - Unlike other test equipment, the UE will show the periodic longer wakeup time at every specific cycle only on Agilent 8960.
        - The UE should be set to *WCDMA mode only*, or other test equipment should be used.
        - Around 0.2 mA can be improved.

Case Study 1 (cont.)

- Final rock-bottom/standby current values

VBAT = 3.7 V			MSM8255-0 project	
			Initial number	**Final number**
GSM standby (MRFS = 5)	Total standby current		3.78 mA	**2.45 mA**
	Rock-bottom current		1.65 mA	**1.28 mA**
	PCH awake	Avg. current	–	34 mA
		Avg. time	–	37 ms
WCDMA standby (**DRx = 7**)	Total standby current		3.5 mA	**2.65 mA**
	Rock-bottom current		1.65 mA	**1.25 mA**
	PICH awake	Avg. current	–	44 mA
		Avg. time	–	40 ms

Case Study 2

- MSM8255-0 (512 MB LPDDR2) + QTR9215
  - Rock-bottom current
    - Measurement – for each power source in PM8058

First measured current		Voltage during sleep	Measurement	Final measurement
Breakdown numbers	VBAT	3.7 V	**2 mA**	**1.4 mA**
	SMPS0 – MSMC1	0.75 V	1.5 mA	1.5 mA
	SMPS1 – MSMC2	0	0	0
	SMPS2 – MSMA1	0	0	0
	SMPS3 – MSME	1.8 V	**1.4 mA**	300 µA
	SMPS4 – MSMA2	0	0	0

    - Debugging result
      - GPIO configuration review during sleep
      - Rock-bottom number is approximately 1.4 mA

Case Study 2 (cont.)

- Standby current
  - Measurement

VBAT = 3.7 V (Software – 1035)			Initial values [1]	MSMC1 (1.1 V) and others [2]	Final
GSM standby (MRFS = 5)	Total standby current		5.42 mA	2.93 mA	**2.71 mA** [3]
	Rock-bottom current		1.47 mA	1.58 mA	1.28 mA
	PCH awake	Avg. current	60 mA	44 mA	42 mA
		Avg. time	38 ms	31 ms	31 ms
WCDMA standby (DRx = 8)	Total standby current		8.06 mA	2.51 mA	2.12 mA
	Rock-bottom current		1.47 mA	1.54 mA	1.28 mA
	PICH awake	Avg. current	65 mA	55 mA	50 mA
		Avg. time	36 ms	35 ms	35 ms

Notes:

1. These values were provided by the customer.
2. See the next slide.
3. Had two kinds of abnormal longer PCH awake every 30 sec.

Case Study 2 (cont.)

- Standby current (cont.)
  - Debugging results
    - MSMC1 voltage = 1.2 V vs. FFA = 1.1 V
      - Through call-stack review, determined that CLKRGM_MSMC_CLIENT_GRP sets MSMC1 to 1.2 V.
        - GPU core clock – 245 MHz in operation → 0 MHz when there is no operation (during awake)
      - It affects other power-consumption reduction for LCD on state, MP3 playback, etc.
    - Some unused clocks – on
      - Through clock-dump review/comparison, some unused blocks (USB, UART, etc.) were turned on during awake.
    - Abnormal awake
      - UE showed longer awake time every 5 sec.
      - Through F3 log review, determined that the battery ADC block was operating.

Case Study 2 (cont.)

- Talk current
  - Measurement

Talk current	Test conditions	Initial values	Clocks-off (intermediate)	Final values
GSM	PGSM, Tx = +5 dBm	99.7 mA	91.2 mA	88.2 mA
WCDMA	Tx = 0 dBm	146.5 mA	144.2 mA	130.8 mA

  - Debugging results
    - Through the clock-dump review, these talk numbers were optimized after turning off the unused clocks.

References

Ref.	Document	
Qualcomm		
Q1	*Application Note: Software Glossary for Customers*	CL93-V3077-1
Q2	*Power Consumption Measurement Procedure for Android-Based Devices*	80-N6837-1
Q3	*Power Consumption Optimization and Debugging Guide for MSM8660 Devices*	80-N6923-1
Q4	*Presentation: MSM8960 Power Management and Optimization Guide*	80-N5232-1
Q5	*Configuration of Input Pins During Device Sleep*	80-VN499-7
Q6	*Standby Current Optimization on the MSM6K/7K Mobile Station Modem Series Troubleshooting Guide*	80-VE263-8
Q7	*AMSS 8960 Current Consumption Data for Linux Android*	80-N1622-11

Questions?

https://support.cdmatech.com