Logic Theory of Operation

Turn-On Sequence

There are two ways that the unit will turn on. Either the user presses and holds the turn on/off button for more than 1 second or a valid external power source is applied to the CE connector.

During power up U3000 (PM6650) will place PON_RESETB low and keep U1000 (MSM) in a reset state. During this time regulated voltages VREG_MSMA, VREG_MSMC, VREG_MSMP, and VERG_TCXO are allowed to come online and stabilize. Also when VREG_TCXO is brought online, U250 (TCXO) starts to oscillate at 19.2MHz and routes the signal to U3000 pin 4. After approximately 20mSEC, PON_RESETB will go high, TCXO_OUT is enabled (19.2MHz to MSM) and the MSM will start to run bootloader code and access U2000 (Flash) and U2100 (PSRAM). From this point going forward the MSM will must set PS_HOLD to a logic high within 200mSEC or U3000 will power down the unit.

Battery Charging

When external power is connected at the EMU connector, this power is applied to Pin2 of U3000 (PM) IC and to Q3803 as EMU_VBUS. If the EMU_VBUS is a valid voltage source and BATT_PLUS on pin 6 is greater than 2.9VDC, U3000 will set BAT_FET_N to a logic low which will turn on Q3801, and will adjust the charge current through Q3803 with control signal CHG_CNT_N.

EMU_VBUS must be between 3.3VDC and 5.6VDC for U3000 to enable battery charging mode. If the External voltage is less than 3.3VDC, U3000 will not switch to external power mode, but continue to draw power from the battery. If EMU_VBUS is between 5.6.VDC and 14VDC, U3000 will not enable the battery charging operation, but will regulate EMU_VBUS to B+ for phone operation.

At the same time U3000 (PM) starts the charge operation. The EMI_ID line (pin 2) is used to detect the accessory type attached to the EMU connector (J5000). A dual channel P channel FET (Q5100) is used to enable the ID_ADC line. U1000 will set the EMU_ID_ADC_EN line high as long as U1000 doesn't determine that a factory mode cable accessory is attached. A high state at EMU_ID_ADC_EN will bias Q5101 which will then bias Q5100. At this point the EMU_ID identification path will be enabled. U1000 (MSM) checks the ID_ADC line (Pin B4) to verify that there is a valid charger connected. If a valid charger is not connected, U1000 will stop the charging operation using the SBI to U3000 (PM).

During charging operation U1000 (MSM) communicates with the battery through the BATT_SER_DT line to determine the battery charge state. When the battery reports that it is fully charged, U1000 (MSM) will put U3000 (PM) into trickle charge. If U1000 (MSM) does not get a valid read on the BATT_SER_DT line the handset will display "Invalid Battery" during power up and U1000 (MSM) will keep U3000 (PM) from charging the battery. This is to protect the user from any potential damage from overcharging the Lithium-Ion battery.

If at any time the temperature of the battery drops below -10c or above +60c as monitored by control line BATT_THERM to U3000 (PM) and U1000 (MSM). U3000 (PM) will stop charging the battery and U1000 (MSM) handset display will show "Unable to Charge". This is to protect the battery, phone, and user as at extreme temperatures the battery ROM could be reporting inaccurate charge state information to U1000 (MSM) and could cause potential damage to the battery.

Table 1 is a quick guide to the requirements for U3000 (PM) to enter into charging mode.

	Normal Charge	Trickle Charge
Battery Voltage	2.9VDC - 4VDC	2.9VDC< or >4.1VDC
EXT_B+ Voltage	3.3VDC - 5.6VDC	3.3VDC - 5.6VDC
Battery Temp.	-10c to +60c	-10c to +60c
EMU_ID	200K or 440K	200K or 440K
BATT_SER_DT	Valid ROM	Valid ROM

Table 1

A valid external charger will have an internal resistor connected to EMU_ID line. For a mid-rate charger this is a 200K ohm resistor, for a high-rate charger this is an 440K ohm resistor. If EMU_ID line is shorted to EMU_VBUS, the unit will self power on. If the BATT_FDBK line has a resistance other than 200K or 440K, the unit will display "Unable to Charge".

Internal Audio Routing

The microphone is a press fit and is connected to MK4100. The microphone audio is routed through C4100 to U1000 (MSM) as MIC1. U1000 (MSM) buffers the audio and routes it to the Mic_Amp2 network as MIOCOUT_P and MICOUT_N. The Mic_Amp2 network is used for filtering and bias control of the amplifier in U1000 (MSM). The output of Mic_Amp2 is MICFB_P and MICFB_N which is routed to U1000 (MSM).

The earpiece audio is routed from U1000 (MSM) to speaker limiters, R4000 and R4001, as EAR10_P and EAR10_N. From the speaker limiters the audio is routed to J6500 as SPKR_P and SPKR_N. This audio is routed from J6500 via the hinge flex to the earpiece located in the flip assembly.

Speakerphone Audio Routing

Speakerphone transmit audio uses the microphone connected to MK4100. The microphone audio is routed through C4100 to U1000 (MSM) as MIC1. U1000 (MSM) buffers the audio and routes it to the Mic_Amp2 network as MIOCOUT_P and MICOUT_N. The Mic_Amp2 network is used for filtering and bias control of the amplifier in U1000 (MSM). The output of Mic_Amp2 is MICFB_P and MICFB_N which is routed to U1000 (MSM).

Speakerphone receive audio is routed from U1000 (MSM) to U3000 (PM6650) as AUXO_N. When speakerphone mode is selected by the user the MSM configures the PM6650 to use its internal audio amplifier for the AUXO_N input. The amplified audio is routed to the speaker through L5001 and L5000 as POLY_SPKR_N and POLYSPKR_P, respectfully.

Headset Audio

When a headset is attached to the EMU port (J5000) a 102k ohm pull down resistor is placed on the EMU_ID line. U1000 (MSM) will identify the accessory through the ID_ADC line. U1000 (MSM) will then attempt to switch the headset into stereo mode by adding a 100k ohm pullup resistor (R5107) on the ID_ADC line. This is done setting EMU_STEREO_EN in a high state. The stereo headset will respond by switching out the 100k ohm pull-up resistor placed on the EMU_D_P line (pin 3). This will cause EMU_D_P to go into a low state, thus identifying a stereo

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headset. If the EMU_D_P didn't change state, the headset would be identified as a mono headset.

When a headset is attached to the EMU bus, EMU_D_P and EMU_D_M USB drivers are disabled and the lines are used for audio. EMU_D_P is used as audio out (speaker) and EMU_D_M is used as audio in (mic). If a stereo headset is used, EMU_D_P is audio out right and EMU_ID_M is audio out left. When the headset is attached an interrupt on EMU_SEND_END_DET will be enabled. A rising end on this interrupt will indicate a key press on the send/end key of the headset.

Headset microphone audio comes in on EMU_D_M (Pin 4) and is routed to U3000 (PM). U3000 will then route the audio to U1000(MSM) using line AUXI_P (AE19).

U1000 (MSM)

The MSM is the microprocessor for the radio. U1000 (MSM) provides for all interface operations between the baseband, RF, display, keyboard, audio, and camera.

Audio interface

Microphone audio comes in on MIC1_P (Pin AF20) and MIC1_N (Pin AF20). This audio is routed back out as MICOUT_P (Pin AA19) and MICOUT_N (Pin W18) to a filter network. The filtered audio comes in as MICFB_P (Pin AC20), MICFB_N (Pin AC21), MICIN_P (Pin AF22) and MICIN_N (Pin AE22). MICBIAS (Pin AE23) is used to provide DC bias to the microphone

The earpiece audio is routed from U1000 (MSM) to speaker limiters, R4000 and R4001, as EAR10_P and EAR10_N.

Speakerphone audio is routed from the MSM as AUXO_N (Pin AC18). The speakerphone is also used for the alert.

EMU_SEND_END_DET (Pin L23) is used when the user has a headset with the built in send/end button and can answer and end a call with this signal.

EMU Bus audio has AUXI_P (Pin AE19) and AUXI_N (Pin AF19) for incoming audio and AUXO_P (Pin AA17) for outgoing audio. SW_B_PLUS_EN (Pin L21) is used to provide B+ to external devices on the EMU connector.

Camera interface

When the user selects camera mode, CAM_SW_EN (Pin N23) will go high to turn on the camera. When the camera is on data is continuously transferred to the MSM on data lines CAMIF_DATA0 – CAMIF_DATA7 (Pins D22, B23, A23, F20, B22, D21, A22, D20).

CAMIF_VSYNC (Pin A24), CAMIF_HSYNC (Pin E23), and CAMIF_PCLK (Pin D25) provide the MSM with sync clocks.

Display interface

The MSM sends data to the Main and CLI display on data line. LCD_CS_N (Pin AF14) is used to select the main display and CLI_CS_N (Pin AA14) is used to select the CLI display. WE2_N is used to enable write time to both displays and DISPLAY_RS (Pin AC13) provides the clock to both the main and CLI display. RESOUT_N (Pin F12) is the reset for both displays.

Keyboard interface

The MSM scans the keyboard and volume buttons with KEYBD_C0 – KEYBD_C6 and detects which keypad or volume is activated with input lines KEYDB_R0 – KEYBD_R4. Table 2 shows the grid layout for easy identification of a stuck signal. Flip detection is done by input signal FLIP_OPEN_DET (Pin AC15). The input signal LIGHT_SENS_ADC (Pin AB25) is used by the MSM to keep the backlights off when the background light detection switch detects strong ambient light.

	KEYBD_ R0	KEYBD_ R1	KEYBD_ R2	KEYBD_ R3	KEYBD_ R4
KEYBD _C0	SW_UP	SW_2		SW_ CSFT	Volume UP (S6000)
KEYBD _C1	SW_DN	SW_8	SW_CLR	SW_ RSFT	Volume Down (S6001)
KEYBD _C2	SW_ LEFT	SW_4	SW_ CARRIER	SW_ LSFT	Smart Switch (S6002)
KEYBD _C3	SW_RT	SW_6	SW_SND		Smart Voice (S6003)
KEYBD _C4	SW_9		SW_7	SW_3	
KEYBD _C5	SW_0	SW_ MENU	SW_5		
KEYBD _C6	SW_ POUND (#)		SW_ STAR (*)	SW_1	

Table 2

Memory interface

Address and Data lines are used to transfer the program information to and from the U2000 (Stacked Flash and SDRAM). SDRAM_CS_N (Pin D5) is used to select Low Power SDRAM. SDRAM_WE_N (Pin D6) is the write enable for Low Power SDRAM. SDRAM_CLK (Pin C7) is the clock for the Low Power SDRAM. NAND_CE_N (Pin G3) is the chip enable for the Flash ROM. NAND_RE_N (Pin F3) is the read enable and NAND_WE_N (Pin M3) is the write enable for the Flash ROM. If the code runs properly then MSM will set PS_HOLD (Pin F10) to keep U3000 (PM) running.

External Memory interface (V3m Only)

The MMC interface is used to access external Trans-flash memory cards. Trans-flash card interfaces to the MSM through a 3-wire serial bus. The serial bus consists of MMC_DAT_SRC1 (pin 7), MMC_CLK_OUT1 (pin 5), and MMC_CMD (pin 3). Trans-flash cards have a total of 8 pins. Four of those pins are data lines, but the MSM is designed to only use one of the data lines (MMC_DAT_SRC1).

The MMC_DETECT (pin 2) signal is used to detect the presence of a Trans-flash card. The MSM reads the signal to determine presence of the Trans-flash card. MMC_DETECT line is normally pulled low by R7002. When no Trans-flash card is attached, the MMC_DETECT line is at low state, indicating to the MSM that no memory card is present. The Trans-flash card has an integrated pull-up resistor on the MMC_DETECT pin. When the memory card is attached, the MMC_DETECT line will be pulled high. This will signal the MSM that a memory card is present. Although the mechanical design of the memory card connector doesn't permit hot-swap function, software will have the MSM constantly monitor the MMC_DETECT line.

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RF interface

When the RF IC's are lock onto the band and channel set by the MSM, SYNTH_LOCK (Pin C26) will be a logic high. Intelligence data is sent to U210 (RFT) as TXI (Pin W21), TXQ (Pin Y26), TXI_N (Pin V21) and TXQ_N (Y25). Power control is maintained by monitoring RF_DETECT and changing control line TX_AGC_ADJ (Pin L14). In analog mode the RF is also monitored by input signal DAC_REF (Pin F13). TX_ON (Pin H12) enables U210 (RFT) to transmit. PA_R1 (Pin A20), PA_ON0 (Pin B19) and PA_ON1 (Pin A19) are used to select and enable the appropriate PA for transmit.

RF_CONN_DET (Pin T23) is used to detect if an external antenna is connected to the phone.

TRK_LO_ADJ (Pin H14) is used to adjust the TCXO to accommodate for any frequency drift of the RF circuit.

U3000 (PM)

The U3000(PM) regulates the voltages, charges the battery, and provides the clocks to the U1000(MSM).

When a logic low is detected on Pin 24 (KBDPWR_N) or when EMU_VBUS is applied to pin 2, U3000 starts the power up sequence. Initially PON_RESETB (pin 9) is held low to keep all other IC held in a reset condition so that the regulated voltages and system clocks can come up and stabilize. Regulated voltages VREG_MSMA (Pin 56), VREG_MSMC (Pin 31), VREG_MSMP (Pin 50), and VREG_TCXO (Pin 84) automatically power up during the turn on sequence. Regulated voltages VREG_SYNTH (Pin 81), VREG_RF_TX (Pin 73), and VREG_RF_RX (Pin 69) are programmable regulators and are controlled by U1000 (MSM).

After 20mSEC PON_RESETB (Pin 9) will go high and buffered TCXO will be sent to U1000 (MSM) on Pin a53. The U1000 (MSM) has 200mSEC to set PS_HOLD (Pin 57) high. If U1000 (MSM) ever fails to keep this line high, U3000 will time out after 200mSEC and shut down. This is used so that if ever U1000 (MSM) freezes or if U1000 (MSM) never initializes, U3000 (PM) does not continue to drain the battery. This is also used to prevent the user from getting a false indication from the display that the unit is working (The display maintains the last loaded image in display memory).

The external sleep clock is connected to Pin 44 (Clock In) and Pin 46 (Clock Out). This external clock is buffered by U3000 (PM) and sent to U1000 (MSM) on Pin 45 (SLEEP_CLK) and is used only during digital sleep time when the TCXO clock is powered down to save current.

When EXT_B+ is connected to the radio and is detected by Pin 2, CHG_CNTB (Pin 4) will be a variable DC output to control the current flow through Q3803. ISNS_P (Pin 3) and ISNS_M (Pin 5) provide a DC feedback to U3000 (PM) to monitor for over current conditions. If U3000 (PM) ever detects a voltage drop across R3802, U3000 (PM) will shut down preventing damage to the radio. When charging BAT_FET_N (Pin 7) is a logic low enabling Q3801 to allow current flow to the battery. When the unit is operating from the battery BAT_FET_N will also be a logic low to allow current to flow from the battery to the radio as B+. VBAT (Pin 6) is used to monitor the battery voltage to ensure that U3000 (PM) shuts down during low voltage conditions. Also U3000 (PM) provides an ADC count to U1000 (PM) which will update the battery icon on the display.

PHONE_THERM (Pin 72) is an input to U3000 (PM) which will provide an ADC count to U1000 (MSM) to monitor the temperature of the Phone. BATT_THERM is an input to U1000 (MSM) to monitor the temperature of the battery.

VIB_DRV_N (Pin 25) provides a logic high to enable the vibrator. D3000 is used to help filter the DC while the vibrator is active to prevent noise from feeding back into the U3000 (PM) and causing noise on the regulated power lines.

KPD_DRV_N (Pin 23) is used to control the backlights on the keyboard. This will be a logic high when the keyboard backlights are on.