MOTOROLA

Personal Communications Sector

GSM Service Support Level 3 Authorized

GSM Service Support

Training - Documentation - Engineering

A668

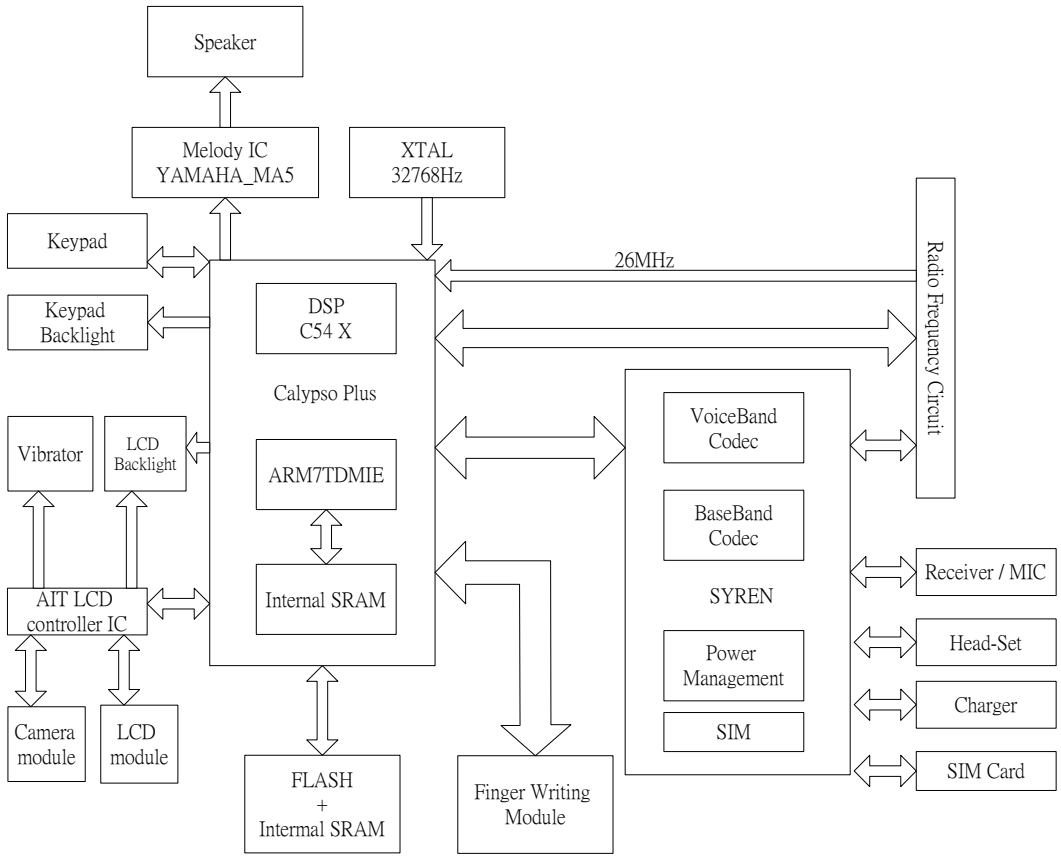
Level 3
Circuit Description
08 / 20 / 04
V1.0

Index

1 Circuit Description

Generally, the circuit is divided into 2 parts: Baseband(BB) circuits and Radio Frequency (RF) circuits.

1.1 Baseband circuits



The Base-band circuits mainly consist of 5 chips: CALYPSO+ (Calypso Plus), SYREN (PTWL3016), Flash memory add external SRAM(Intel RD38F3350LLZDQ0), Melody IC（YAMAHA MA-5）, and AIT800G (LCD controller IC).

1.1.1 Digital Processor Chip – Calypso +

CALYPSO+ (U201) is a chip implementing the digital Base-band processes of a GSM/GPRS mobile phone. This chip combines a DSP sub-chip (C54x, LEAD2 CPU) with its program and data memories, a Micro-Controller core with emulation facilities (ARM7TDMIE), internal 48Kb of Boot ROM memory, 5.5M bit SRAM memory, a clock squarer cell, several compiled single-port or 2-ports RAM and CMOS gates.

The application of CALYPSO+ is the management of the GSM/GPRS Base-band processes through the GSM layer 1, 2 and 3 protocols as described in the ETSI standard with a specific attention to the power consumption in both GSM dedicated and idle modes, and GPRS (class 12) capability.

1.1.1.1 Melody IC

The YAMAHA MA-5 (U101) is a synthesizer LSI for mobile phone that realizes advanced game sounds designed for driving the speaker of the mobile through SPOUT1(pin17 of MA-5), SPOUT2(pin18 of MA-5).

The power supply for YAMAHA (U101) is listed below:

Digital power supply for internal core -- VDD (pin7 of MA-5) : 2.8V
Digital power supply for I/O interface – IOVDD (pin32 of MA-5) : 2.8V
Analog power supply for speaker amplifier – SPVDD (pin15 of MA-5) : 3.6V

The Control / Communication signals are summarized as follows:

/RD – **R**ead signal
/CS1 -- signal CPU select
/WE -- Write signal
A1 – Address lines
Data 0-7 – Data lines
13M_OUT – Clock input complies with TCXO
/MELODY_RST -- Hardware reset input

1.1.1.2 LCD Controller IC

The AIT LCD controller IC ***AIT800G*** (U108 in the upper board) is an LCDC solution designed with support for the digital video revolution in mobile products. The ***AIT800G*** contains an integrated single port camera interface and dual port LCD interface. It controls the LCD module, Camera module, LCD back-light, Indicator Flashlight and Vibrator in the upper board.

1.1.1.2.1 Main LCD

The LCD module is a 128 (x3: RGB) x 160 dots LCD module with LCD driver while TFT (65k colors) display mode.

The interface is listed in the following:

LCM_BL1~3 – LED backlight power supply: anode
RSTB – LCM reset
LD[0..17] – Data bus
LRD -- Read signal
LWR -- Write signal
LAD1 – Register select signal
M_LCD – Main panel select
2V8D – power supply
BIT_SEL – 16 or 18 bit select

1.1.1.2.2 LCD Backlight Driver

The U210 in Upper PCB , AAT3113, is a charge pump DC/DC converters that use fractional (1.5X) conversion to increase efficiency in White LED applications. It can be used to produce current levels up to 20mA for each output from a 3.3~4.2V input. The outputs are connected to LCM_BL1~3 of LCD module so that the LCD backlight can be turned on. There are two external flying capacitors , C208 and C209 , required for this converter.

A serial digital input , BL_EN from U108 (AIT LCD controller IC), is provided to enable, disable and set the LED drive current for a 32 level logarithmic scale LED brightness control.

1.1.1.2.3 Camera Module

This is a color VGA CMOS sensor (1280 X 960) camera module with 2.8V digital power supply. The Control / Communication signals are summarized as follows:

CD[0..9] – digital video output data
CVREF – vertical synchronization signal
CHREF – horizontal effective pixel synchronization signal
CCLKOUT – crystal clock input
CCLKIN – pixel clock output
2V8A – Analog power supply
2V8D – Digital power supply
1V8 – core power supply
CRESET – device reset signal
CPDWN – power down signal input
CSDA – I2C data
CSCL – I2C clock

1.1.1.3 Vibrator

The Vibrator Motor is activated via turning on a transistor T201 with control signal , VIB, from U201 Calypso+.

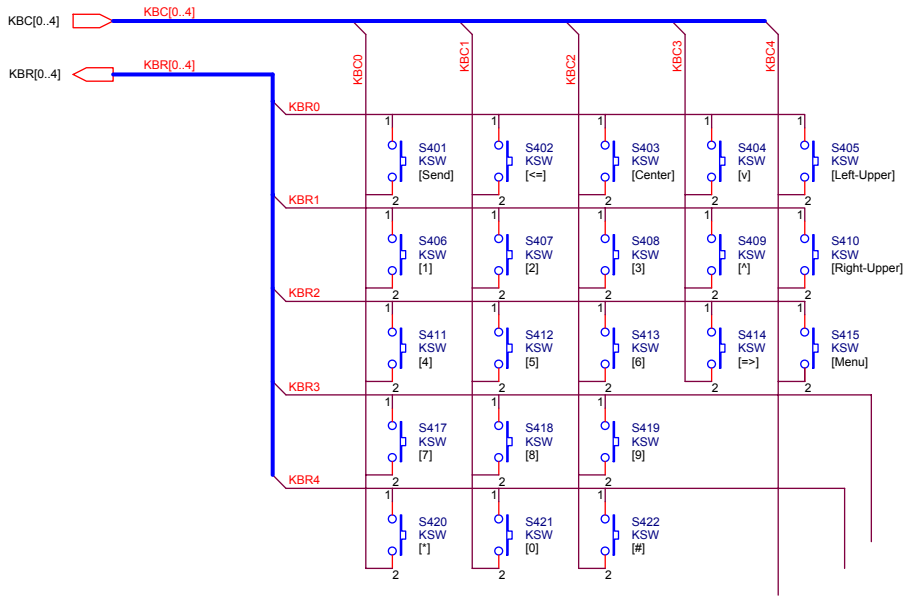
1.1.1.4 Keypad

The keypad keyboard is connected to the U201 Calypso+ using:

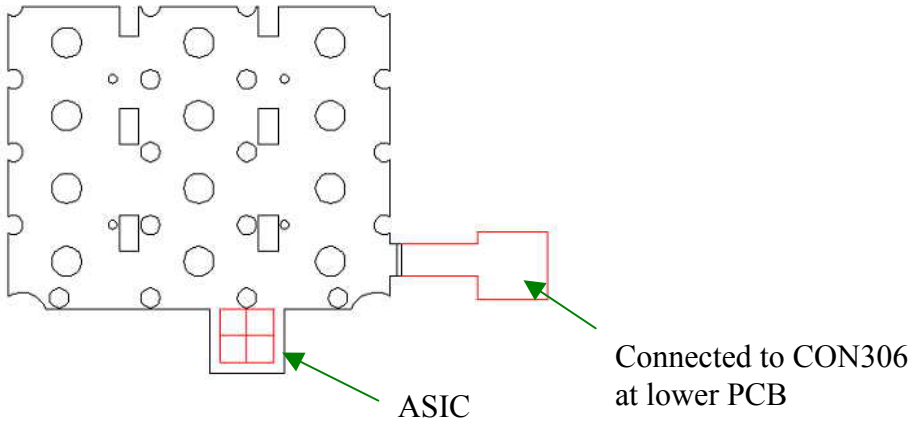
- KBR (4:0) input pins for row lines
- KBC (4:0) output pins for column lines

If a key button of the keybord matrix is pressed, the corresponding row and column lines are shorted together. To allow key press detection, all input pins (KBR) are pulled up to VCC and all output pins (KBC) are driving a low level . Any action on a button will generate an interrupt to the micro-controller which will scan the column lines with sequence.

The Keypad Matrix is described as follws:



1.1.1.5 Finger Writing



The module -- Finger Writing is one of capacitive sensing trackpads, and provides cursor control by detecting finger or thumb movement in using a technique known as field distortion sensing. It requires to be connected to system with SPI(MOSI, MISO and SCK) interface. CON306 is the connector for this operation. The module is powered by V-SRAM.

1.1.1.6 Keypad Backlight

The Keypad Backlight, LED401~413 , are controlled by U201 Calypso+ through switching NMOS U402 with two current limiter resistors, R404 and R405.

1.1.1.7 XTAL 32.768KHz

The oscillator is based on a CMOS inverter (in U201 Calypso+), crystal X201 and phasing capacitors (C201 and C205) are connected between input and output of the oscillator to provide the additional phase lag necessary to satisfy the oscillation criteria.

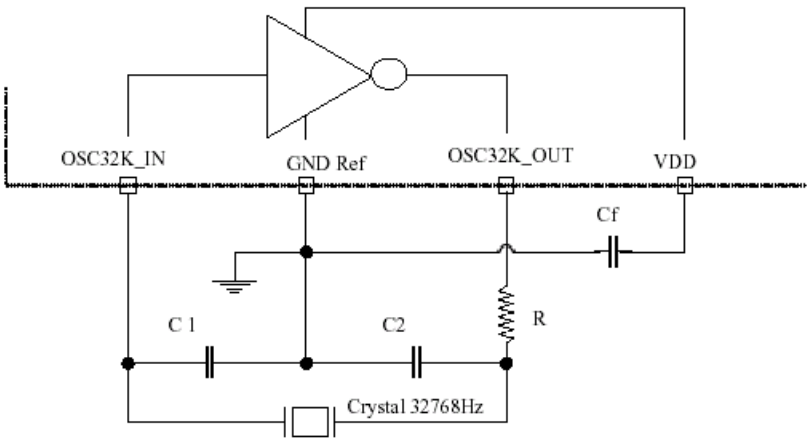


Figure (1) typical 32KHz oscillator

1.1.1.8 26MHz

The 26MHz is firstly provided by U603 VCTCXO and then connected to U601 RF transceiver for reference clock. The output 26MHz signal be fed to U201 Calypso+ through C626.

1.1.2 Analog Baseband Device – Syren

The SYREN-TWL3016 (U202), includes a complete set of Base-band functions that perform the interface and processing of the following voice signals, the Base-band in-phase (I) signal and quadrature (Q) signals, which support single-slot and multi-slot modes. The SYREN also includes associated auxiliary RF control features, supply voltage regulation, battery charging controls, and switch ON/OFF system analysis.

The SYREN interfaces with the digital Base-band device, Calypso+, through a digital Base-band serial port (BSP) and a voice-band serial port (VSP). The signal ports communicate with a DSP core (C54x). A micro-controller serial port (USP) communicates with the micro-controller core and a time serial port (TSP) communicates with the time processing unit (TPU) for real time control.

A specific module is dedicated to support the 3V/1.8V Sim card interface. The module includes the generation of the Sim card supply voltage as well as level shifters to adapt the SIM card signal levels to the micro-controller I/O signal levels.

The SYREN also includes an on-chip voltage reference; under-voltage detection and power-on reset circuits.

1.1.2.1 SIM card

The SIM Card digital interface in U202 SYREN insures the translation of logic levels between U201 Calypso+ and SIM card.

The SIM card inerface can be programmed to drive a 1.8V or 3V SIM card. The interfaces between SIM holder CON301 and U202 SYREN are summarized in the follwing:

SIMCLK – SIM card reference clock
SIMRST – SIM card reset
SIMIO – SIM card bidirectional data line
VRSIM – power supply for SIM card

1.1.2.2 Charger

The U704 is an Overvoltage Protection IC from USB charger whose OUT pin controls the U701 dual P-channel MOSFET ON/OFF. The truth table of U704 is listed below:

TRUTH TABLE

IN	CNTRL	OUT
$<V_{th}$	L	GND
$<V_{th}$	H	V_{CC}
$>V_{th}$	L	V_{CC}
$>V_{th}$	H	V_{CC}

The normal operational voltage of VUSB is 5V <Vth(5.5v), EXT_PW_EN keeps at low logic level so that the VABT can be charged.

The VCHG is a 5V input that will connect to U202 to let mobile know the charger is plugged in.

1.1.2.3 Receiver / MIC

The receiver signals come from U202 and then go through L201 in UpperPCB for noise reducing. The MIC signals also come from U202 and are biased by MICBIAS from U202.

1.1.2.4 Light Sensor

The U401 is a photo IC which detects the illuminance and output a voltage signal, Light_Sensor. Accordingly, the mobile will decide whether keypad backlight should be turned on or not by detecting the U401 output voltage.

1.1.2.5 Hall Sensor

The U102 is an Omnipolar Hall Switch. The output, Hall_Sensor, will go back to U201 and help mobile to know the Flip status (open or close).

1.1.2.6 Headset

The CON102 is the Headset Jack. The Headset MIC is biased by 2V8_HF and goes back to U202 through AUXI. The U103 is a SPDT switch which selects VOICE (HSOL from U202) or MELODY (HPOUT from U101) for the EAR signal to Headset.

The U105 is a voltage detector whose output signal, HOOK_SW, will indicate if the button in Headset is pressed and help mobile to connect or disconnect a call.

1.1.3 Memory

The Flash memory and Internal SRAM (U501) is used to store code and other parameters. It contains 128M-bit *2 Flash memory and 64M-bit SRAM

The Flash memory uses 3V I/O and 1.8V core voltages. The Control / Communication signals are listed below:

/RD –**R**ead signal to Flash and SRAM
/CS3 - signal is used as PSRAM select
F1_CE - signal is used as Flash die #1 memory select
F2_CE - signal is used as Flash die #2 memory select
/WE - Write signal to Flash and SRAM
A[1..23] – Address lines
Data 0-15 – Data lines
FDP - **R**eset
/BHE- RAM upper enables
/BLE - RAM lower enables

1.2 Radio frequency circuits

The RF circuits consist of the transceiver (U601), Power amplifier (U602), T/R switch (U604), RF SAW Filter(F601, F602, F603), TCXO (U603), Antenna switch (U206), and some other components.

The TCXO (U603) is used to generate 26MHz signal. It's the fundamental frequency source of the Rossini circuits.

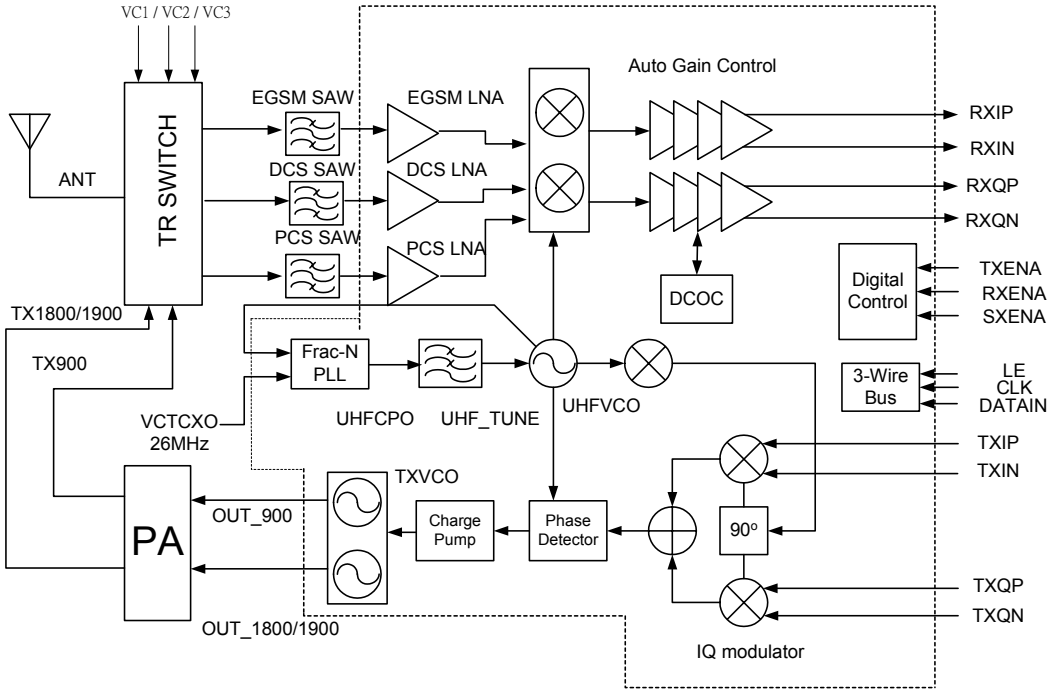
The transceiver (U601) is a complete RF front end for triple-band GSM and GPRS wireless communications. The transmit section interfaces between the baseband processor and the power amplifier. The receive section interfaces between the RF SAW filters and the baseband processor.

The T/R switch (U604) is used to switch the signal path to the direction of Transmit/Receive, GSM900/DCS1800/PCS1900 bands so that the signal goes to the correct path.

The RF SAW Filter (F601, F602, F603) is used to filter out-of band noise.

The PA (U602) is used to amplify uplink signal to the required signal strength.

1.3 Functional Description



The transceiver U601 (Skyworks, SKY74117) is a complete RF for multi-band GSM and GPRS wireless communications.

The receive section uses a direct-down conversion architecture.

The transmit section is a complete translation loop from the baseband subsystem to the power amplifier, and uses an fractional-N phase locked loop with a fully integrated transmit VCO. The frequency synthesizer includes integrated UHF VCO, varactors and loop filters.

1.3.1 Receive section

Includes four integrated LNAs, quadrature demodulator circuitry that performs direct down-conversion, baseband amplifier circuitry with I/Q outputs, baseband filter with programmable bandwidths, five stages of DC offset correction, and IP2 calibration circuitry.

The baseband section provides eight programmable bandwidth settings ranging between 90 kHz and 160 kHz to allow for added flexibility when interfacing to any mixed signal baseband device. All baseband filtering is provided on-chip using no external capacitors. The filter chain consists of two fixed real poles, two fixed conjugate pole pairs, and one programmable conjugate pole pair. The result is a flat passband with minimal group delay distortion at any bandwidth setting.

1.3.2 Transmit section

To minimize the post-PA filtering requirements and any additional post-power amp losses, the transmit path consists of a vector modulator and a frequency translation loop. The loop functions as a PLL with a mixer in the feedback path and a modulator in the reference path. The loop provides a PFD and charge pump, integrated loop filters, two transmit VCOs, down-conversion mixer in the feedback path, a frequency divider for frequency plan flexibility, and the modulator. The mixers in the feedback path provide either high side or low side injection to provide flexibility in the frequency plan. The modulator in the reference path uses a vector summing technique to reject the unwanted image and to also sufficiently attenuate the 3rd and 5th harmonics. Therefore, no external IF filters are required.

1.3.3 Frequency synthesizer

The SKY74117 includes a fully integrated UHF VCO with an onchip 3rd order loop filter. A single sigma-delta fractional-N synthesizer phase-locks the Local Oscillator (LO) used in both transmit and receive paths to a precision frequency reference input. Fractional-N operation offers low phase noise and fast settling times, allowing for multiple slot applications such as GPRS. The SKY74117 frequency stepping function with a 3 Hz resolution allows quad band operation in both transmit and receive bands using a fully integrated on-chip UHF VCO. The fine synthesizer resolution allows direct compensation or adjustment for reference frequency errors.

The SKY74117 re-centers the UHF VCO frequency range each time the synthesizer is programmed. This proprietary Skyworks' technique, called Digital Frequency Centering (DFC) extends the VCO frequency coverage, speeds up settling time, and ensures robust performance since the VCO is always operated at the center of its tuning range.