

2. Circuit Description

2-1 RF Part

2-1-1 Frequency Generator

The 13MHz reference clock (VCTCXO) drives the logic and RF part. The 13 MHz reference is controlled by the logic (10bits DAC minimum) and is kept to a frequency error less than ± 0.1 ppm after synchronization with the GSM network.

A 540 MHz oscillator is divided by 2 to generate a fixed 270 MHz VHF LO used in the TX I,Q modulator and mixed by 270 MHz. The UHF LO for the first RX down conversion and the TX offset mixing works in superheterodyne mode to reduce the relative bandwidth and to be able to work at a frequency greater than 1 GHz.

2-1-2 Transmitter

The baseband GSM chipset (Kernel5) generates I and Q baseband signals for the transmit vector modulator. The modulator provides more than 40dBc of carrier and unwanted side-band rejection and produces GMSK modulated signal, the 'reference' signal at 270 MHz which passes to the offset phase-locked loop block (OPLL). The OPLL consists of a down-converter, phase detector, loop filter and transmit VCO operating at the final RF output frequency. The down converter mixes the UHF LO (eg. 1172 MHz) with the transmit VCO signal to generate a 'feedback' signal at 270 MHz. The 'feedback' signal passes via a limiter to one port of the phase detector. The GMSK 'reference' signal from the vector modulator passes via a second limiter to the other input port of the phase detector. The phase detector generates an error current proportional to the phase difference between the 'feedback' signal from the down-converter and the 'reference' signal from the vector modulator. This error current is filtered by a second order low-pass filter to generate an output voltage which depends on the GMSK modulation and the desired channel frequency. This voltage controls the transmit VCO such that the VCO output signal, centered on the correct RF channel, is frequency modulated with the original GMSK data. The centre frequency of the transmit VCO is offset from the UHF LO frequency by 270 MHz. The OPLL acts as a tracking narrowband band pass filter tuned to the desired channel frequency. This reduces the wideband noise floor of the modulation and up-conversion process and provides significant filtering of spurious products. The OPLL architecture results in a low-noise GMSK modulated signal at 902 MHz with very low spurious content.

The RF GMSK output from the transmit VCO is fed via TX SAW filter to the RF power amplifier. The peak output power and the profile of the transmitted burst are controlled by means of a closed feedback loop. The RF output from the PA is sampled with a directional coupler. The sampled signal passes to an RF detector diode whose output voltage is dependent on the incident RF level. This 'feedback' voltage passes to the inverting input of the loop integrator. A 'reference' signal is generated within the baseband section under control of the layer 1 software. The loop maintains zero difference between the 'feedback' signal and the 'reference' signal. In this way, the amplitude and shape of the transmitted RF burst may be controlled by the baseband processor. In particular, the rise and fall profiles can be controlled to meet the stringent power/time templates and switching transient requirements of GSM 05.05.

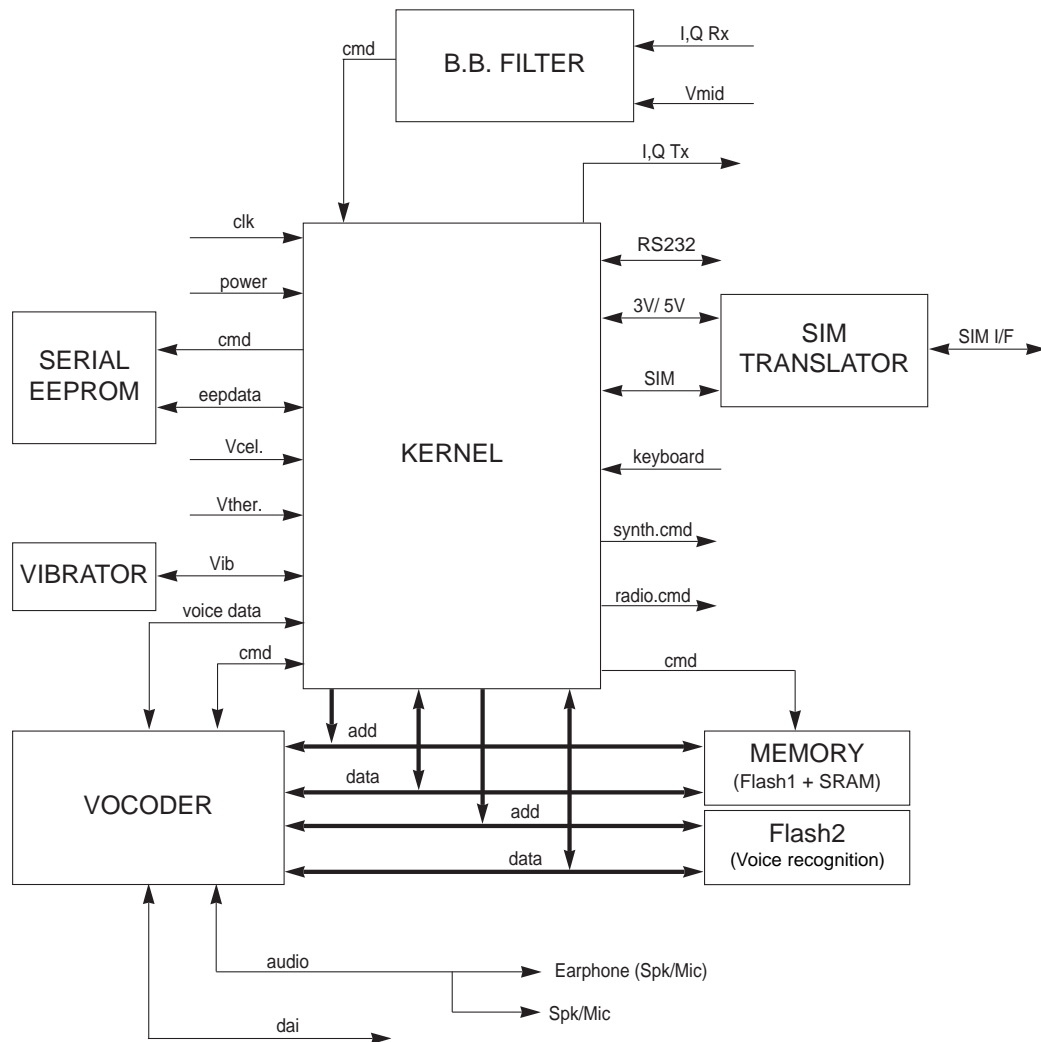
The RF output passes to the antenna connector via an integrated TX/RX switch and lowpass filter to attenuate the harmonics generated by the power amplifier.

2-1-3 Receiver

The incoming RF signal passes through the integrated lowpass filter and TX/RX switch. This is followed by a 947 MHz SAW Band Pass Filter and a bipolar low-noise amplifier (LNA). The HD155101BF includes an active bias circuit which stabilizes the DC operating point of the LNA. The RF signal passes via a second RF SAW filter to the first receive mixer. This mixer is implemented as a Gilbert cell within the HD155101BF. The incoming signal at 947 MHz mixes with the UHF LO at 1172 MHz to generate a 225 MHz IF signal. The IF signal passes from the mixer output via a 225 MHz IF SAW filter to the first IF amplifier. A further internal Gilbert cell mixes the 225 MHz IF signal down to the 45 MHz second IF. The 45 MHz output from the second mixer is filtered and passes to the AGC amplifier. The gain of the AGC amplifier is set by a DC control voltage supplied by the baseband. The usable control range is in excess of 80dB. Finally, the AGC output signal at 45 MHz passes to the demodulator and is mixed down to DC to generate I and Q baseband signals. The baseband signals pass via baseband filter to the baseband A/D converters. The remainder of the channel filtering is performed by the baseband chipset.

2-2 Baseband Part

2-2-1 General Block Diagram



< Fig. 3 Baseband Block Diagram >

2-2-2 ROM1 & SRAM

8M (X16) Flash ROM and 2M (X8) bit SRAM are used. Two devices are merged in one package. This device is a combination memory organized as 524, 288 x 16 bit flash memory and 262, 144 x 8 bit static RAM in one package.

2-2-3 ROM2

A 8M (X16) bit Flash Memory is used for the voice recognition and voice memory. This device is an 8, 388, 608 bit flash memory with batch chip erasing, sector erasing, and byte and word writing using a single 3V power supply.

2-2-4 EEPROM

The kernel requires some external non-volatile memory to store various system parameters, such as RF control calibrations, extra dial stores etc. A 64 K (65, 536) bit device is used. This device is internally organized 8192 x 8. This device features a serial interface and software protocol allowing, operation on a simple, two wire bus.

2-3 SIM

2-3-1 SIM Interface

An interface is provided to a serial port controlling the SIM interface. It can support 5V and 3V SIM interface. The hardware interface consists of SIMVCC, SIMdata I/O, SIMclk output, SIMRST output, and SIMPRES input. The interface is controlled through TX Data, RX Data, control, and status registers. Transmit and receive data may use a 256 byte buffer or be exchanged through single byte registers. SIMVCC may be used to control the power supply to the SIM card.

2-4 POWER MANAGEMENT

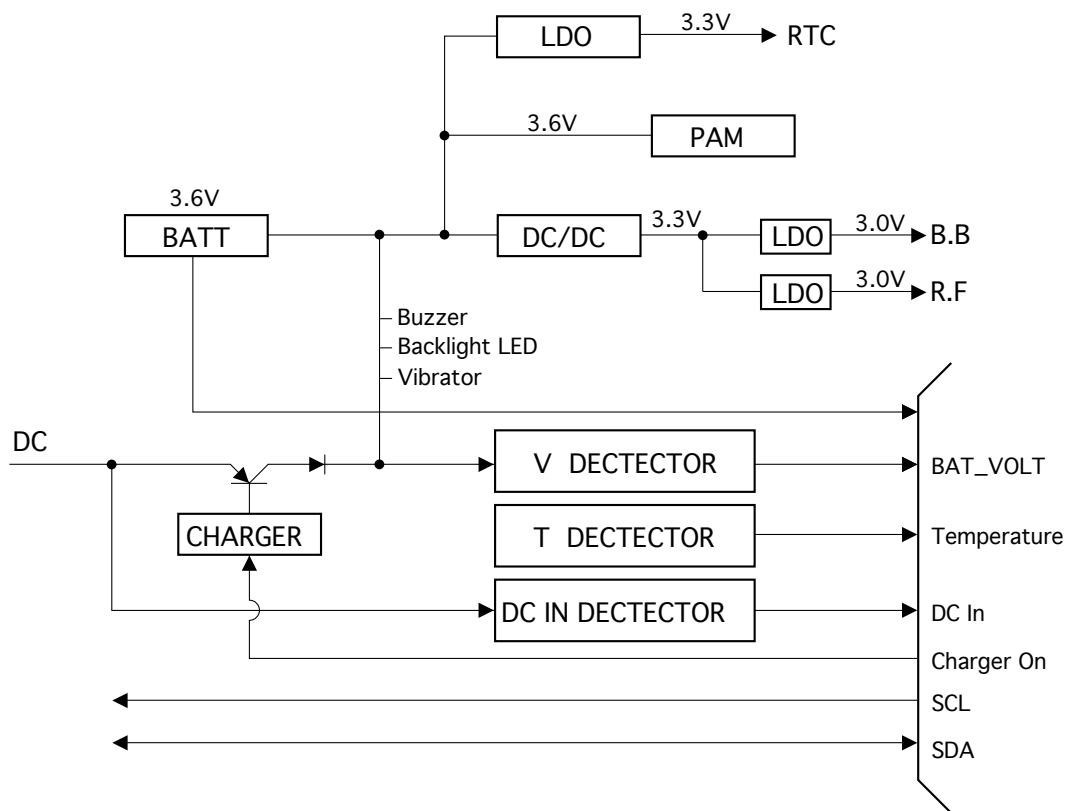
2-4-1 DC/DC Converter

Our 1 cell Li-ion battery solution requires a up-converting DC/DC conversion circuit for efficiency improvement. The device is a PWM Step-up DC/DC converter IC. Specification is as below;

- V_{in} : 2.75 V ~ 4.2 V
- V_{out} : 3.3 V ~ 4.1 V
- Ripple: less than 50 mVpp
- Efficiency: typ. 85 % (up to 96%)

2-4-2 Charger Circuitry

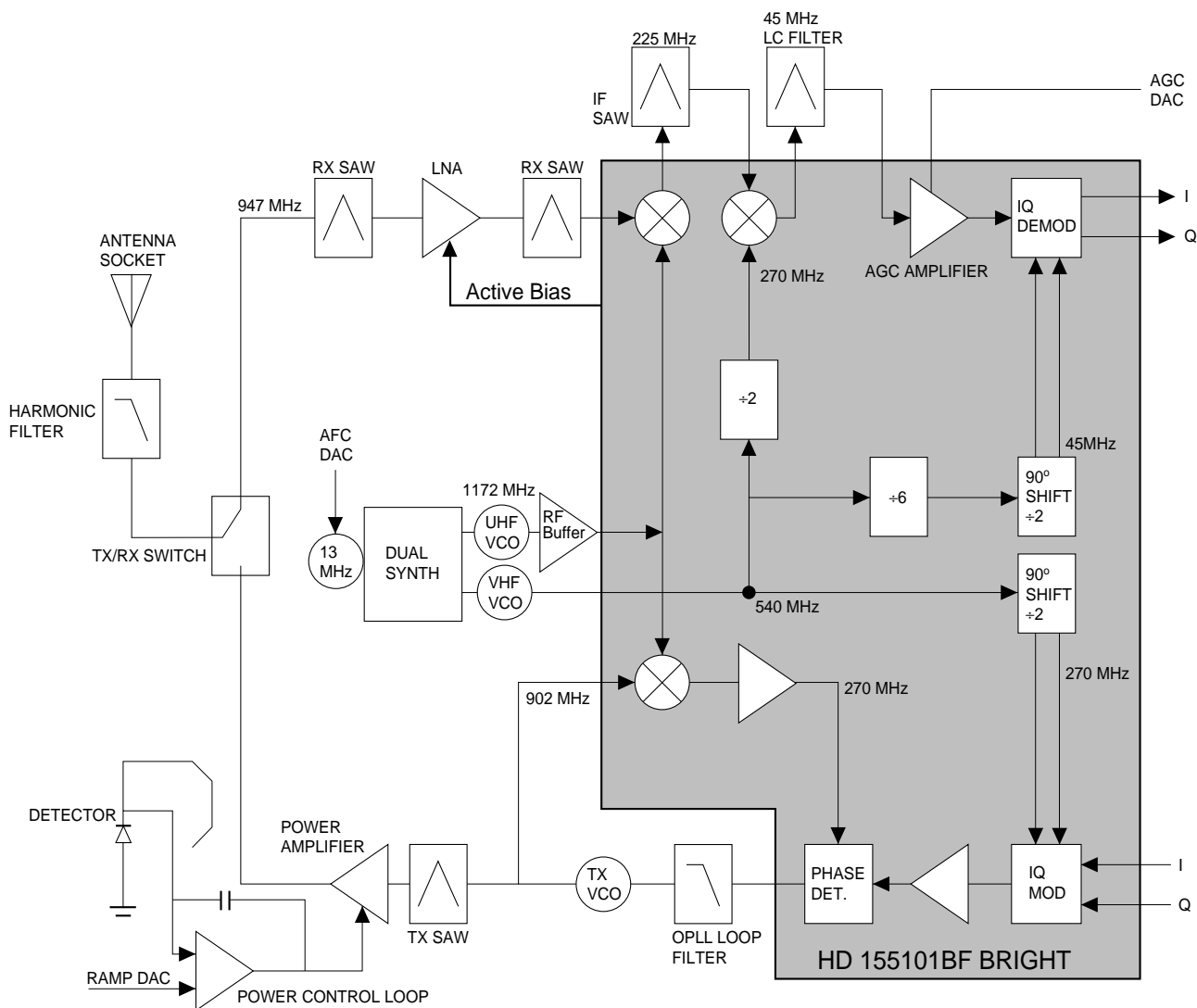
The simplified built-in charger circuit diagram is as below ;



< Fig. 4 Built-in Charger Circuitry >

2-5 RADIO INTERFACE

2-5-1 RF Block Diagram



< Fig. 5 RF Block Diagram >

2-5-2 Baseband Filter

To control the spectral splatter and thus the intersymbol interference (ISI), filtering is applied to the baseband pulses. The required filtering is achieved very simply using a small, low cost discrete LC structure, which has the great advantage of not consuming current.

2-6 AUDIO

2-6-1 Audio Inputs

The Handset provides two audio inputs:

- Built in microphone
- Connection for external microphone

A microphone biasing amplifier reduces component count in the overall system design:

- Supply: 2.2 V regulated to $\pm 20\%$
- Different output to eliminate possible coupling noise problems, MICBIASP and MICBIASN
- Maximum current: 500 μ A
- Maximum load: 200 pF

2-7 EXTERNAL INTERFACE

A 18 pin connector is mounted on the bottom corner of the PCB. The antenna external connection is on the right hand side of this connector.

2-8 KERNEL SPECIFICATION

2-8-1 FEATURES

- Complete Layer 1 support
- TDMA burst building (ETSI Rec.5-02)
- Coding and interleaving (Rec. 5-03)
- GMSK with differential coding (Rec. 5-04)
- Programmable power template for Tx burst control
- AGC in Receive mode
- I,Q inputs or single intermediate frequency (IF) input
- Detection of FCCH, SCH, Normal and Dummy Bursts
- Flash ROM programming abilities
- Auxiliary ADC for battery voltage and temperature monitoring

2-8-2 Equalizer

MAJOR FEATURES

- Frequency Correction Burst Correction
- Frequency Correction Burst Frequency Measurement
- Synchronization Burst Long Preamble Correlation
- Normal Burst Short Preamble Correlation
- Channel Impulse Response Generation
- Possible Received Value Generation
- Data Equalization
- Carrier Power Measurement
- Doppler Shift Measurement and Correction
- Scaled 7-Bit Soft Decision
- I and Q component recovered from Received Data

2-9 VOCODER SPECIFICATION

2-9-1 FEATURE

- Complete GSM voice encoding and decoding functions
- DTX function
- Voice Activity Detection (VAD) output
- Fully asynchronous coding and decoding
- A-law PCM conversion
- DTMF generation
- Sidetone level control
- Programmable microphone amplifier with two differential input ports
- Two programmable audio output amplifiers
- 13 MHz master clock

2-10 Desk Top Charger

2-10-1 Charging

The desk-top charger contains switching regulator to charge a lithium battery from an DC/DC adaptor. The battery type is detected at pin 15 (MPU) through U5 (front port) and U26 (rear port). Battery charging current is turned into V_i . V_i is measured at pin 12 (MPU) after R32 and C23 to cancel the noise. When the battery voltage is too low, the charging circuit turns to trickle mode using Q9 and Q11.

2-10-2 Control Part

This circuit contains 4-bit micro controller (U21), including an I/O port, timer, A/D converter to control battery charging. This circuit uses a 4 MHz main clock and +5V power.

BATTERY VOLTAGE DETECTION

Battery voltage from the front port is detected at R20, R18 and measured at pin 13 (MPU).
Battery voltage from the rear port is detected at R14, R13 and measured at pin 14 (MPU).

BATTERY TEMPERATURE DETECTION

The charger always detects the battery temperature via NTC thermistor to prevent battery thermal problems. This circuit is composed of parallel resistors because NTC thermistor has log-scale thermal characteristics. If the battery temperature exceeds 55 degrees C, charging stops.

AUTONOMOUS TIMER

If MPU has stopped charging and the timer goes to the 'on' state by an external shock, overcharging may occur. A timer (U7-4) prevents the battery from being overcharged by any unexpected external influence.

2-11 Cigar Lighter Adaptor (CLA)

2-11-1 General Description

The CLA is a regulated switched-mode power supply designed for use with a portable HHP. The power supply is connected directly to the phone and provides a voltage path for charging a battery installed in the hand-held portable phone.

2-11-2 Circuit Description

The input voltage range of CLA is from 12 Vdc to 30 Vdc, and the nominal voltage is 13.7 Vdc. The output current is 600 mA. The ripple and noise amplitude is less than 50 mV at the input (12 V ~ 30 Vdc). And the limit settings are shown below;

- Current limit : 600 mA \pm 50 mA at nominal input 13.7 V
- Output voltage : 9.0 V (+/- 0.8 V) Vdc at no load.

In addition, the temperature limit is -20 upto +85 °C for storage, and 0 to +40 °C for operating. The CLA size of SGH-600 is 89.3 x 43 x 27 mm, and the weight is 110 g.

2-12 Travel Adaptor (TA)

2-12-1 General Description

This adaptor is designed for use with a portable hand held phone (HHP). It is a switching-mode power supply connected directly to the phone with a cable, and it provides a voltage for charging a battery installed in the hand held portable phone.

2-12-2 Circuit Description

The input voltage range is 85 ~ 264 Vac, and input frequency is 47 ~ 63 Hz. At an input voltage of 230 Vac (standard input voltage), AC input current is 0.1 A(rms). The output voltage range is 9.0 V \pm 10% and the unit maintains current 600 mA \pm 30 mA. The operating temperature is 0 ~ 55 °C, and for storage -20 ~ 85°C. Power ON/OFF cycle is 1.0sec min. The overall size is 74.1 x 28.4 x 79.8 mm and the weight is 65 g without the output DC cable. The charger is an AC/DC switch mode flyback converter featuring constant current and voltage limit. Output cable is two-way DC cable. Maximum output power is 6.4 W.

2-13 Hands Free Car kit

2-13-1 General Description

Many states and countries are considering legislation requiring mobile phone users to operate in Hands-Free mode while driving.

Feature of the hands free kit are:

- Power adaptor (600 mA) from vehicle battery to GSM battery pack.
- Ignition sensor for automatic power ON/OFF.
- Car stereo mute function in Hands-Free mode, with programmable output level.
- External microphone input.
- Loudspeaker output.
- Hands-Free operation.

2-13-2 Circuit Description

The input voltage range is from 12V dc to 28V dc, (battery) and input current is 10mA(stanby). The operating temperature is -10 ~ 60 °C, and for storage temperature is - 30 ~ 85 °C(± 5 °C). The charging voltage is DC9V and charging current is MAX 600mA.

2-13-3 Audio Features

- Microphone Sensitivity: -60 dB ± 3 dB
- Speaker S/N: -45 dB ± 3 dB (1W Output)
- Speaker Distortion: 20% below (3W Output)
- Speaker Feature: Impedance 4Ω, Max 5W Output
- Echo Cancellation: 50 dB (Min)
- Noise Suppression: 15 dB (Min)