

PAMS Technical Documentation

THF–10 Series Transceivers

Chapter 3

System Module

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Transceiver THF-10

Introduction

Functional Description

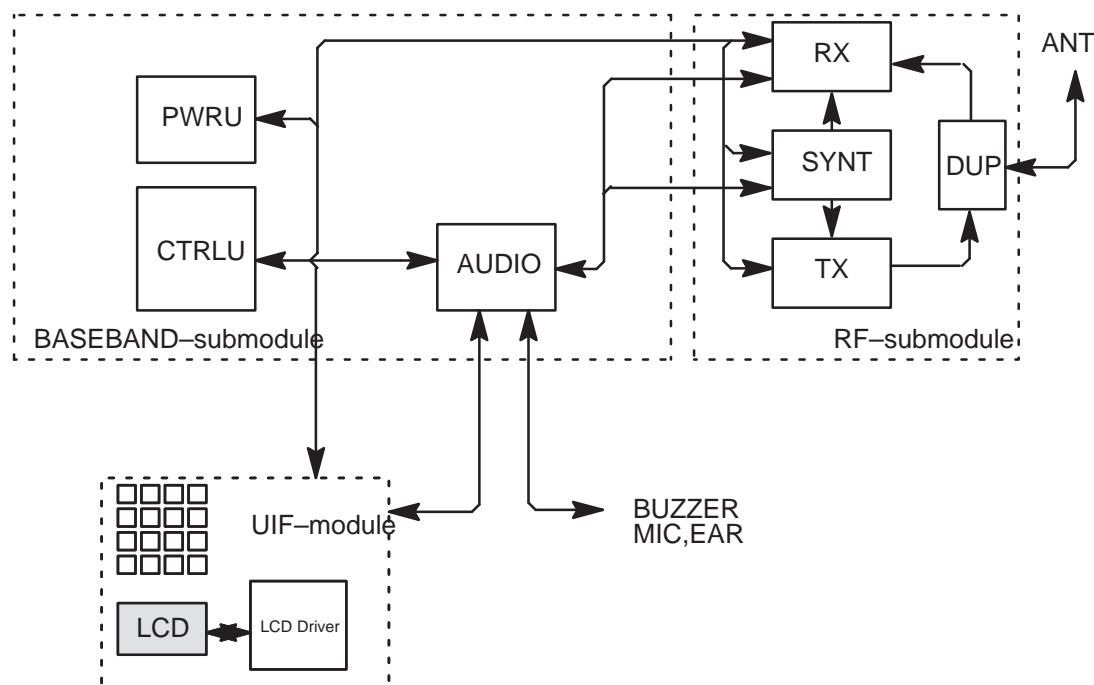
The transceiver electronics consist of UI module PCB and RF/system PCB. UI module is connected to system module with a connector. System and RF submodules are interconnected with PCB wiring. Unit can be connected to accessories with a bottom system connector, which includes charging and accessory control.

RF block is designed for a hand portable phone, which operates in NMT450 systems. Purpose of the RF module is to receive and demodulate radio frequency signal from the base station and to transmit a modulated RF signal to the base station.

The modulation method used in the phone is **F3E**.

Block Diagram

THF-10 consist of 2 PCB's, TA1 and GN4. TA1 consist of 2 submodules, BASEBAND and RF. BASEBAND consist of 3 functional blocks: PWRU, CTRLU and AUDIO; RF also consists of 3 modules: RX, SYNT, TX; while GN is the User Interface module (UIF-module).



Baseband

PWRU

The power block provides the supply voltages for the phone and includes also the charging electronics.

CTRLU

Main Features of the CTRLU block

- system control
- communication control
- authentication
- power up/down control
- accessory monitoring
- battery monitoring
- production testing
- RF-controls
- UIF-interface
- M2BUS interface

AUDIO

The block includes microphone and earpiece amplifier and all necessary audio functions.

RF

RX

The RX module receives and demodulates the radio frequency signal from the base station.

SYNT

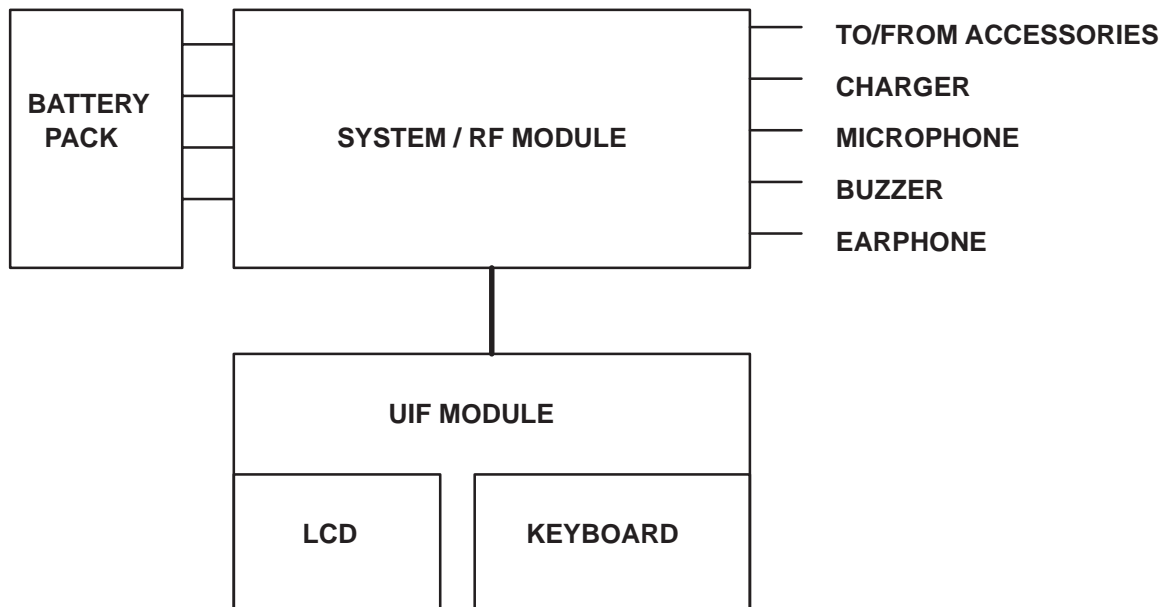
The transmitter synthesizer generates a frequency modulated RF signal for the transmitter section. The transmission frequency is generated by a phase-locked loop (PLL). The synthesizer circuit contains VCO, synthesizer logic and loop filter.

The receiver synthesizer generates the first injection frequency to the receiver module. The local frequency is generated by a phase-locked loop as in transmitter synthesizer. The synthesizer circuit contains VCO, synthesizer logic and loop filter.

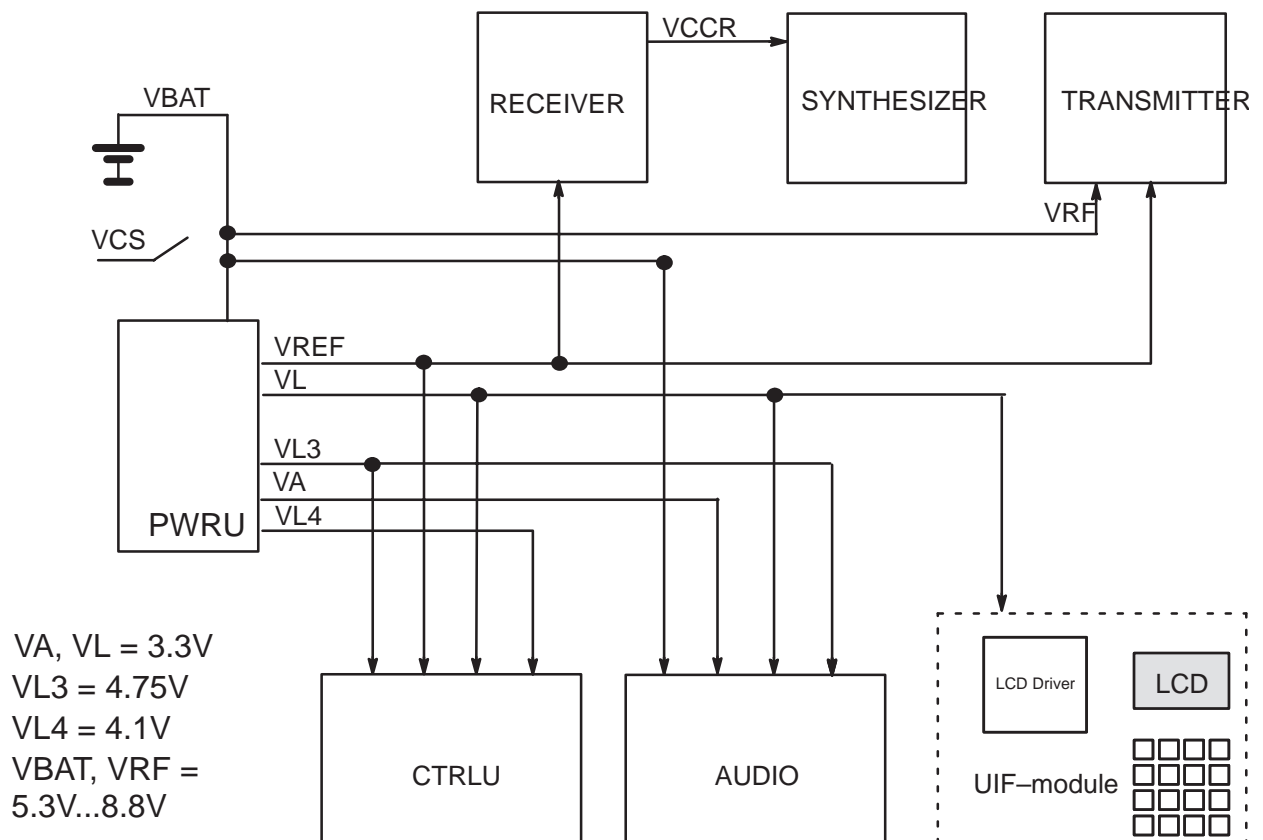
TX

The transmitter module generates and amplifies the RF signal to be transmitted to the base station.

Interconnection Diagram



Power Distribution Diagram



System Module TA1

Introduction

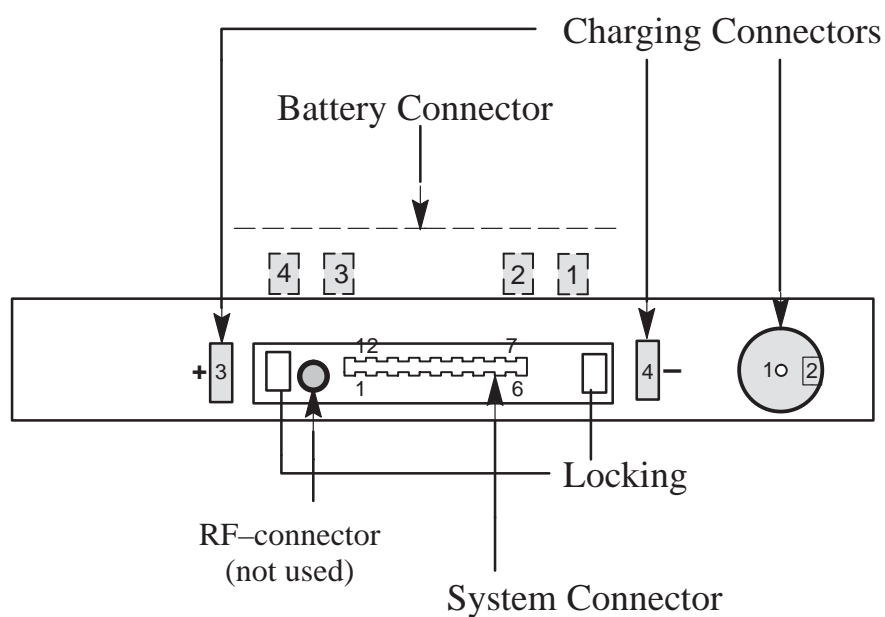
TA1 is the baseband/RF module of the THF-10 cellular transceiver. The TA1 module carries out all the system and RF functions of the transceiver. The system module TA1 is designed for a handportable phone, that operates in the NMT 450i system.

Technical Summary

External and Internal Connectors

The system module has two connectors, external bottom connector and internal UIF module connector.

Bottom Connector X120



System Connector

| Signal Name | Pin | Notes |
|-------------|----------------|--|
| GND | 1, 8 | Power supply ground. |
| XMIC | 3 | External audio input from accessories or handsfree microphone. There is a pull-down resistor in accessory for identification |
| M2BUS | 6 | Serial bi-directional data and control between the handphone and accessories. A 10k pull-up resistor in HP. |
| HOOK | 10 | HOOK-indication. The phone has a 47k Ω pull-up resistor. |
| VOUT | 2 | Hands-free device power on/off. |
| BOOST0,1 | 5,11 | RF booster detect / power control |
| XEAR | 9 | External audio output to accessories or handsfree speaker. There is DC voltage control for HF unit mute. |
| BGND | BGND | Battery connector |
| BTEMP | BTEMP | Battery connector, Battery temperature |
| BSI | BSI | Battery connector |
| VBAT | B+ | Battery connector |
| VCS | 12,CH+, DC+ | Battery charging voltage |

| Signal Name | Pin | Notes |
|-------------|-------------|----------------------------------|
| VL | 1 | Logic supply voltage 3.3V |
| CALLLED | 2 | Call LED |
| BACKLIGHT | 3,4 | Backlights on/off |
| VNEG | 6 | Negative voltage for LCD module |
| ROW0,1,2 | 7-9 | Lines for keyboard read |
| LCDCLK | 10 | LCD Driver clock |
| XNWR | 11 | LCD Driver write selection input |
| XPWRON | 12 | Power on control from keyboard |
| GND | 13,14,15,16 | Ground |
| LD(0:7) | 17-24 | Parallel data for LCD driver |
| LCDREG | 25 | LCD Driver control/data select |

| Signal Name | Pin | Notes |
|-------------|-----|---------------------------------|
| LCDCS | 26 | LCD Driver chip select |
| LCDRESET | 27 | LCD Driver reset |
| XNRD | 28 | LCD Driver read selection input |

Control Signals

| Pin / Conn. | Line Symbol | Minimum | Typical / Nominal | Maximum | Notes | |
|-------------|-------------|---------|-------------------|---------|--------------------------------|---|
| 6/system | M2BUS | 0V | | 0.7V | Input low level | Isink<5mA Baud rate 9600 bits/s. |
| | | 2.3V | | 5.25V | Input high level | |
| | | 0V | 0.2V | 0.35V | Output low level | |
| | | 4.1V | 4.5V | 5.0V | Output high level | |
| 10/system | HOOK | 0V | | 0.5V | Input low level | Hook |
| | | 2.4V | | 3.2V | Input high level | |
| 5/system | BOOST0 | | 0V | | Booster detect / power control | RF booster detection / Booster power control. |
| | | | 3.3V | | Booster detect / power control | |
| 11/system | BOOST1 | | 0V | | Booster detect / power control | RF booster detection / Booster power control. |
| | | | 3.3V | | Booster detect / power control | |
| 2/system | VOUT | 0V | 0.2V | 0.4V | Output low, power off | HDA device power on/off |
| | | 4.1V | 4.5V | 5.0V | Output high, power on | |
| 12/system | VCS | 9.8V | | 16V | Isink < 730mA | |
| | | | | | | |
| 2/battery | BSI | | 1.95V | | 400mAh Li-ION | A 47kΩ pull-up resistor in HP. |
| | | | 0.45V | | 550mAh NiMH | |
| | | | 1.95V | | 1500mAh Li-ION | |

| Pin / Conn. | Line Symbol | Minimum | Typical / Nominal | Maximum | Notes | |
|-------------|-------------|---------|-------------------|---------|---|-------------------------|
| 3/battery | BTEMP | | 1.0V | | 47k Ω , B=4050 NTC between BTEMP and ground in battery pack. A 47k Ω pull-up resistor in HP. Vibrator control output (AC-controlled) | |
| 3,4/UIF | BACKLIGHT | | 0mA | | backlights off | Backlighting for keymat |
| | | | 40mA | | backlights on | |
| 17-24/UIF | LD(0:7) | 0V | | 0.7V | Output/Input low | LCD I/O, keypad output |
| | | 2.3V | | 3.3V | Output/Input high | |
| 7-9/UIF | ROW(0:2) | 0V | | 0.7V | Input low | Keypad input |
| | | 2.8V | | 3.3V | Input high | |
| 2/UIF | CALLLED | 0V | | 0.4V | Output low, call led off | |
| | | 2.8V | | 3.3V | Output high, call led on | |
| 25/UIF | LCDREG | 0V | | 0.7V | Output low | LCD data/control |
| | | 2.8V | | 3.3V | Output high | |
| 26/UIF | LCDCS | 0V | | 0.7V | Output low | LCD chipselect |
| | | 2.8V | | 3.3V | Output high | |
| 27/UIF | LCDRESET | 0V | | 0.7V | Output low | LCD reset |
| | | 2.8V | | 3.3V | Output high | |
| 11/UIF | XNWR | 0V | | 0.7V | Output low | LCD write |
| | | 2.8V | | 3.3V | Output high | |
| 28/UIF | XNRD | 0V | | 0.7V | Output low | LCD read |
| | | 2.8V | | 3.3V | Output high | |

Baseband Module

Introduction

The baseband module controls the internal operation of the phone. It controls the user interface, i.e. LCD driver, keyboard and audio interface functions. The module performs all signalling towards the system and carries out audio–frequency signal processing. In addition, it controls the operation of the transceiver and stores tuning data for the phone.

Technical Summary

All functional blocks of the baseband are mounted on a single multi layer printed circuit board. This board contains also RF–parts. The chassis of the radio unit contains separating walls for baseband and RF. All components of the baseband are surface mountable. They are soldered using reflow. The connections to accessories are fed through the CAP (Common Accessory Platform) bottom connector of the radio unit. The connections to User Interface –module (UIF) are fed through a board to board connector. There is no physical connector between RF and baseband.

List of submodules

| | |
|-------|----------------------------|
| CTRLU | Control Unit for the phone |
| PWRU | Power supply |
| AUDIO | Audio |
| RX | Receiver |
| TX | Transmitter |
| SYNT | Synthesizer |

These blocks are only functional blocks and therefore have no type nor material codes.

Technical Specifications

Modes of Operation

The module has three operating modes: stand–by ,listening and the conversation mode.

Standby mode:

CPU's clock is switched off, only NIPA timer is running to take care battery save timings.

If charger is connected CPU's clock doesn't go to standby mode.

Listening mode:

In the listening mode some blocks of the audio IC (NIPA) are in standby state.

Conversation mode:

In the conversation mode all ICs are active.

Maximum Ratings

| | |
|--------------------------------------|-----------------|
| Operating ambient temperature range: | −25 ... +55 °C. |
| Storage temperature range: | −40 ... +85 °C. |
| VBAT max. | 8.8 V (TX off) |
| | 7.5 V (TX on) |
| VCS max. | 16 V. |

Charging of the batteries is possible only in temperature range +5 ... +45 °C.

DC Characteristics

| Pin / Conn. | Line Symbol | Minimum | Typical / Nominal | Maximum | Unit / Notes |
|-------------|-------------|---------|-------------------|---------|--------------------------|
| | VCS | 11.0V | 12.0V | 16.0V | Slow charger |
| | | 9.8V | 10.3V | 10.8V | Fast charger |
| | VBAT | 5.3V | 6.0V | 8.8V | |
| | VRF | 5.3V | 6.0V | 8.8V | VBAT for RF module |
| | VA | 3.2V | 3.3V | 3.42V | I _{max} = 40mA |
| | VL | 3.2V | 3.3V | 3.42V | I _{max} = 40mA |
| | VL3 | 4.5V | 4.75V | 5.0V | I _{max} = 180mA |
| | VL4 | 3.8V | 4.1V | 4.6V | I _{max} = 40mA |
| | VREF | 3.2V | 3.3V | 3.42V | I _{max} = 5mA |

CTRLU

Introduction

The Control block controls all phones functions and it includes modem and SIS-processor too.

Technical Specifications

CTRLU Internal Signals, Inputs

| Signal Name | Notes | From |
|-------------|---|--------|
| VL | Logic supply voltage, 3.3V. | PWRU |
| VL3 | Logic supply voltage, 4.75V. | PWRU |
| VL4 | Supply voltage for SIS processor. | PWRU |
| VREF | Reference voltage 3.3V \pm 3%. Max. | PWRU |
| XRES | Reset line from MUUMI | PWRU |
| PWRON | Power on signal from MUUMI | PWRU |
| VCHARG | Charger voltage to A/D converter | PWRU |
| VBATSW | Battery voltage to A/D converter. | VCHARG |
| CLKMCU | Clock signal from NIPA. | AUDIO |
| NMI | Non maskable Interrupt request from NIPA | AUDIO |
| XINT | Interrupt request from NIPA. | AUDIO |
| BOOST0 | RF booster control | SYSTEM |
| BOOST1 | RF booster control | SYSTEM |
| HOOK | HOOK-indication | SYSTEM |
| BTEMP | Battery temperature | SYSTEM |
| BSI | Battery size indication | SYSTEM |
| M2BUS | Serial interface | SYSTEM |
| RFTEMP | RF temperature | SYNT |
| RSSI | Received signal strenght indication | RX |
| TXI | Transmitter output power level indication | TX |
| XPWRON | Power button from UIF. | UIF |
| ROW0 | Line for keyboard read. | UIF |
| ROW1 | Line for keyboard read. | UIF |
| ROW2 | Line for keyboard read. | UIF |
| ACCDDET | Accessory detection line | SYSTEM |

CTRLU Internal Signals, Outputs

| Signal Name | Notes | To |
|-------------|--|-----------|
| CSW | Charger control | PWRU |
| VOUT | Headset–adapter powersupply | SYSTEM |
| M2BUS | Common serial clock (nipa, sis) | SYSTEM |
| AGC | Gain control | RX |
| RXE | RX Circuit power on/off | RX |
| SCLK | Synchronous data clock for synthesizers | SYNT |
| SDAT | Synchronous data for synthesizers / TX duplex filter current control 2 (option) | SYNT, TX |
| SLE | Synthesizer data latch enable | SYNT |
| TXE | Transmitter control (on/off) | TX |
| TXC | Transmitter Power Control | TX |
| XNCS | NIPA chip select signal | AUDIO |
| XNWR | NIPA/LCD write control signal | AUDIO.UIF |
| XNRD | NIPA/LCD read control signal | AUDIO,UIF |
| NA0–3 | NIPA/LCD address bus | AUDIO,UIF |
| ND0–7 | NIPA/LCD data bus | AUDIO,UIF |
| EARENA | Ear amplifier enable | AUDIO |
| KBINT | Keyboard interrupt | AUDIO |
| MBUSINT | MBUS interrupt | AUDIO |
| MBUSOUT | MBUS out | PWRU |
| LIGHTS | Backlights on/off | UIF |
| LCDCS | LCD Driver chip select | UIF |
| LCDRESET | LCD Driver reset | UIF |
| CALL_LED | Call led control | UIF |
| XEARON | External ear amplifier enable | SYSTEM |
| XEARDC | External ear DC mute control enable | SYSTEM |

Block Description

CTRLU – PWRU

The MCU controls the watchdog timer in MUUMI. It sends a positive pulse at approximately 1 s intervals to XPWROFF pin of the MUUMI to keep the power on. If CTRLU fails to deliver this pulse, the MUUMI will remove power from the system. CTRLU controls also the charger on/off switching in the PWRU block. When power off is requested CTRLU leaves MUUMI watchdog without reset. After the watchdog has elapsed MUUMI cuts off the supply voltages from the phone. Battery charging is controlled by CSW line.

VBATSW, Battery voltage measurement

Battery voltage can be measured from 5.4 V to 10.3 V nominal with 3.3 V reference voltage. The absolute accuracy is low because of the reference 3 % accuracy and A/D-converter ± 8 LSB accuracy. This battery voltage measurement offset error must be calibrated with input voltage 6.0 V and 8.2 V. The A/D conversion result can be calculated from equation:

$$\text{A/D readout} = 1024 * (\text{VBATSW} * (47/147)) / \text{VREF}$$

VREF=3.3 V

For example:

| | | |
|-------|---------|------------|
| 8.2 V | results | 814 = 32EH |
| 6.0 V | results | 595 = 253H |

VCHARG, Charger voltage measurement

Charger voltage can be measured up to 18.3 V nominal. The A/D-conversion result can be calculated from equation :

$$\text{A/D readout} = 1024 * (\text{VCSW} * (22/115)) / \text{VREF} \quad \text{VREF=3.3 V}$$

For example:

| | | |
|--------|-------|------------|
| 12.0 V | gives | 671 = 29FH |
| 6.0 V | gives | 336 = 150H |

BSI, Battery size indication

Battery type can be defined with BSI resistor value. NiMH battery has different BSI resistor than Li-ION battery. Different size Li-ION batteries cannot be identified.

BTEMP, Battery temperature measurement

Battery temperature measurement is implemented with 47 kohm NTC with N value of 4050 and 47 kohm pullup resistor. The A/D conversion readout can be calculated from equation:

$$\text{A/D readout} = 1024 * (R_{\text{NTC}} / (R_{\text{NTC}} + 47k))$$

Battery voltage is measured over the VBATSW and charging voltage over the VCHARG. Battery temperature is measured over the BTEMP line. Battery size is determined by reading the BSI line. This is pulled to +3,3V by 47kohm. In the battery pack a "size" resistor is connected between BSI and GND. Battery charging is controlled by CSW line. Battery charging is controlled by CSW line.

Muumi watchdog is refreshed by controlling XPWROFF line.

– CTRLU – AUDIO

Interface between microcontroller and NIPA circuit is bidirectional 8-bit data bus with 4 address lines. Address, data and control lines are used in microcontroller as I/O-port pins. Data lines direction must be controlled with microcontroller data direction register. Interface includes address outputs NA0–3, data inputs (read) / outputs (write) ND0–7, chip select control output XCS, read control output XRD, write control output XWR and interrupt input XINT. When CPU is in sleep state, control signals XRD and XCS must be in '0' state and address output NA0–3 and NWR in '1' state and data lines ND0–7 must be in '0' state.

– CTRLU – UIF

Keyboard is connected directly to the controller. ND0–6 are output lines and ROW0–2 are input lines. Keyboard scanning is done by driving one ND line to 0 V at the time. If any key is pressed, then the corresponding ROW line goes to 0V and phone knows which key is pressed.

Data to LCD Driver is written and read by ND(0:7) lines. XNRD/XNWT are read / write selection lines and NA0 is instruction / data register selection line. LCDCS line enables the LCD driver.

ND(0:7) lines must be in 0 V state when phone is in sleep mode so that key pressing can be indicated.

Keyboards and LCD lights are controlled by LIGHTS signal.

– CTRLU – RX

RX circuit power is connected on/off by RXE signal.

Received signal strength is measured over the RSSI and intermediate frequency is measured over the IF.

– CTRLU – SYNT

RF temperature is measured over the RFTEMP. Frequency is controlled by AFC signal. Synthesizer is controlled via synchronous serial bus SDAT/SCLK. The data is latched to the synthesizer by the positive edge of SLE line. TX synthesizer power on/off (TXS/port P3) line is controlled via PLL circuit.

– CTRLU – TX

Transmitter output power level is measured over the TXI. TXE line activates power module. The power is controlled via TXC line which is PWM-controlled output port.

Main Components

Hitachi H8/3093

H8/3093 is a CMOS microcontroller. All memory needed (192 kB ROM, 4 kB RAM) except the EEPROM, is located in the controller.

MCU operating clock (7.3728 MHz) is generated on NIPA.

Controller Ports

| Pin No | Port | Signal | Description |
|--------|---------|---------|--|
| 1 | PB0 | SISCLK | Clock for SIS processor |
| 2 | PB1 | SISDATA | Serialdata to SIS processor |
| 3 | PB2 | EDATA | Serial data to EEPROM |
| 4 | PB3 | RXD | Serial interface (M2BUS) |
| 5 | PB4 | SCLK | Serial clock for synthesiz |
| 6 | PB5 | HOOK | Handset hook signal |
| 7 | PB6 | PWRON | Power button |
| 8 | PB7 | SLE | RX/TX synthesizer latch |
| 9 | P90 | TXD | Serial interface (M2BUS) |
| 10 | P92 | RXD | M2BUS net free timer input |
| 11 | P94 | ECLK | Clock to EEPROM |
| 12 | Vss | GND | Ground for processor. |
| 13–20 | P30–P37 | ND0–7 | Paraller data bus for NIPA,LCD & keys |
| 21 | Vcc | VL | Power supply for processor |
| 22 | P10 | NA0 | Address line for nipa and LCD register |
| 23 | P11 | NA1 | Address line for nipa |
| 24 | P12 | NA2 | Address line for nipa |
| 25 | P13 | NA3 | Address line for nipa |
| 26 | P14 | XNCS | NIPA chip select |
| 27 | P15 | XNWR | Read/write control to NIPA |
| 28 | P16 | XNRD | Read/write control to NIPA |
| 29 | P17 | LCDCD | LCD chip select |
| 30 | | GND | Ground for processor |
| 31 | P20 | LIGHTS | Backlight control |
| 32–35 | P21–P24 | ROW0–3 | Keypad inputs |
| 36–37 | P25–P26 | | |
| 38 | P27 | CALLCNT | Call continue during battery change |

| | | | |
|----|-------|----------|---------------------------------|
| 39 | P50 | XPWROFF | Muumi watchdog refresh |
| 40 | P51 | EARENA | EAR amplifier enable |
| 41 | P52 | CALL_LED | Call LED control |
| 42 | P53 | LCDRESET | Reset to LCD |
| 43 | P60 | | |
| 44 | MD0 | | |
| 45 | MD1 | | |
| 46 | | | |
| 47 | STBY | | |
| 48 | RES | XRES | Reset from MUUMI |
| 49 | NMI | NMI | Interrupt request from NIPA |
| 50 | Vss | GND | Ground |
| 51 | EXTAL | EXTAL | External system clock from NIPA |
| 52 | XTAL | | |
| 53 | Vcc | VL | |
| 54 | P63 | TXE | Transmitter on/off |
| 55 | P64 | AGC | Gain control |
| 56 | P65 | RXE | RX circuit power on/off |
| 57 | RESO | | |
| 58 | AVcc | | |
| 59 | P70 | VBATSW | Battery voltage |
| 60 | P71 | VCHARG | Charger voltage |
| 61 | P72 | RSSI | Received signal strength |
| 62 | P73 | TXI | Transmitter power monitor |
| 63 | P74 | BTEMP | Battery temperature |
| 64 | P75 | BSI | Battery size indication |
| 65 | P76 | RFTEMP | RF temperature |
| 66 | P77 | ACCDET | Accessory detection |
| 67 | Vref | Vref | Reference voltage for processor |
| 68 | AVcc | Vref | Reference voltage for processor |
| 69 | P80 | XINT | Interrupt request from NIPA |
| 70 | P81 | | |
| 71 | P82 | | |
| 72 | P83 | VIBRA | Vibra control |
| 73 | PA0 | BOOST0 | RF booster control |
| 74 | PA1 | BOOST1 | RF booster control |

| | | | |
|----|-----|--------|--------------------------------------|
| 75 | PA2 | XEARDC | DC to XEAR line control |
| 76 | PA3 | XEARON | XEAR amplifier ON |
| 77 | PA4 | CSW | Charging control |
| 78 | PA5 | SDAT | Serial data for synthesiz |
| 79 | PA6 | TXC | TX syntetisizer enable. Active high. |
| 80 | PA7 | VOUT | Power supply to HDA |

68HC11A8

68HC11A8 is a SIS (subscriber identification) circuit connected to the controller over serial bus IIC.

| Pin | Description |
|-------|-----------------------|
| EXTAL | Clock input from nipa |
| RESET | Reset input |
| PD0 | IIC bus data |
| PD1 | IIC bus clock |

EEPROM

There is two 8k EEPROMs in phone. EEPROM is a nonvolatile memory into which is stored the tuning data for the phone. In addition, it contains the short code memory locations to retain user selectable phone numbers.

| Pin | Description |
|-----|---------------|
| SDA | IIC bus data |
| SCL | IIC bus clock |

PWRU

Introduction

The power block provides the supply voltages for the baseband, and includes also the charging electronics.

Technical Specifications

PWRU Internal Signals, Inputs

| Signal | Description | From |
|---------|---|--------|
| CSW | Charger control | CTRLU |
| MBUSOUT | Serial interface | CTRLU |
| XPWRON | Power on control from keyboard | UIF |
| XPWROFF | Power off control from controller (watch dog) | CTRLU |
| VBAT | Battery voltage input | SYSTEM |
| VCS | Charging supply voltage from charger | SYSTEM |

PWRU Internal Signals, Outputs

| Signal Name | Signal description | To |
|-------------|--|------------------|
| XRES | Master reset | CTRLU |
| PWRON | Power on signal for microprocessor. | CTRLU |
| VL | Logic supply voltage, 3.3V | CTRLU,AU-DIO,UIF |
| VL3 | Logic supply voltage, 4.75V | CTRLU, AU-DIO |
| VL4 | SIS processor supply voltage, 4.1V | CTRLU |
| VA | Analog supply voltage. Max 40 mA. | SYNT,AU-DIO |
| VREF | Reference voltage 3.3V \pm 3%. Max. 5mA. | CTRLU, RF, TX |
| VBATSW | Battery voltage to A/D converter. | CTRLU |
| VCHARG | Charger voltage to A/D converter. | CTRLU |
| VRF | Battery voltage to RX-unit | RX |
| VBAT | Battery voltage to TX-unit | TX |
| M2BUS | Serial interface | SYSTEM |

Block Description

The baseband power supplying circuit includes:

– the supply voltages:

| | |
|------|---|
| VL | 40mA for digital circuits |
| VL3 | 20mA for RF |
| VL4 | 20mA for SIS-processor |
| VA | 20mA for analog circuits |
| VREF | 5mA reference voltage for A/D-converters and regulators |

- Regulator has been used before MUUMI
- switched output of battery (VBATSW) and charger voltage (VCHARG) measurements to MCU A/D-converter
- battery voltage detection and reset logic
- charger switch control output used to limit battery voltage $V_{BAT} < 8.8V$
- power on/off switch input (XPWRON), buffered output to MCU (PWRON)
- watchdog timer using oscillator in COFF pin , cleared by falling edge input in PWROFFX, elapsing time for watchdog timer is 3 ... 4 seconds
- M2BUS open drain output driver is not used.

The charge switch driving circuit is implemented with discrete components. This circuit includes transient voltage protection, soft charge switching, low voltage battery charging and battery disconnecting with charger connected protection. This circuit also limits battery voltage when charger is connected to protect MUUMI and TX transistors.

Power circuitry have three different operating modes: POWER OFF , RESET and POWER ON. In POWER OFF state MUUMI regulator outputs are disabled and reset control output signal (PURX) is active low. MUUMI internal oscillator at pin COFF is working in all operating modes. MUUMI goes through short RESET state (100ms) to POWER ON-state , if PWR-button is pressed or charger voltage input is connected to charging input VCS (charging voltage detection in MUUMI input VCHAR is level active). In RESET-state regulator outputs VL,VA and VREF are active and PURX-signal is active low. If battery voltage on MUUMIs pin is lower than 4.1 V (3.9V...4.3V) the circuit cannot go to POWER ON state. MUUMI goes also to RESET state, when battery voltage on MUUMIs pin is falling below 3.9 V (3.7V...4.1V). This situation is possible, when battery is fully discharged or battery is disconnected.

In POWER ON mode all regulator outputs are active and MUUMI reset signal output PURX is inactive high. Microcontroller XPWROFF-output signal clears at falling edge the watchdog inside MUUMI. If the watchdog is not cleared , MUUMI goes to POWER OFF state. When the charger is connected and battery voltage on MUUMIs pin is higher than 4.1V , module stays in POWER ON mode.

The microcontroller controls battery charging with CSW output (which is PWM-controlled output port) and MUUMI limits the maximum battery volt-

age to 8.8 V with CHRGSW-output.

No current flows from charger (VCHARG) to battery , if MCU output CSW is active low and XRES signal is inactive high. The battery is charged also, when charger is connected and XRES signal is active low. The charging circuit charges the battery during RESET to higher than 5.3 V.

The charging electronics is controlled by the CTRLU. When the charging voltage is applied to the phone while the phone is powered up, the CTRLU detects it and starts controlling the charging.

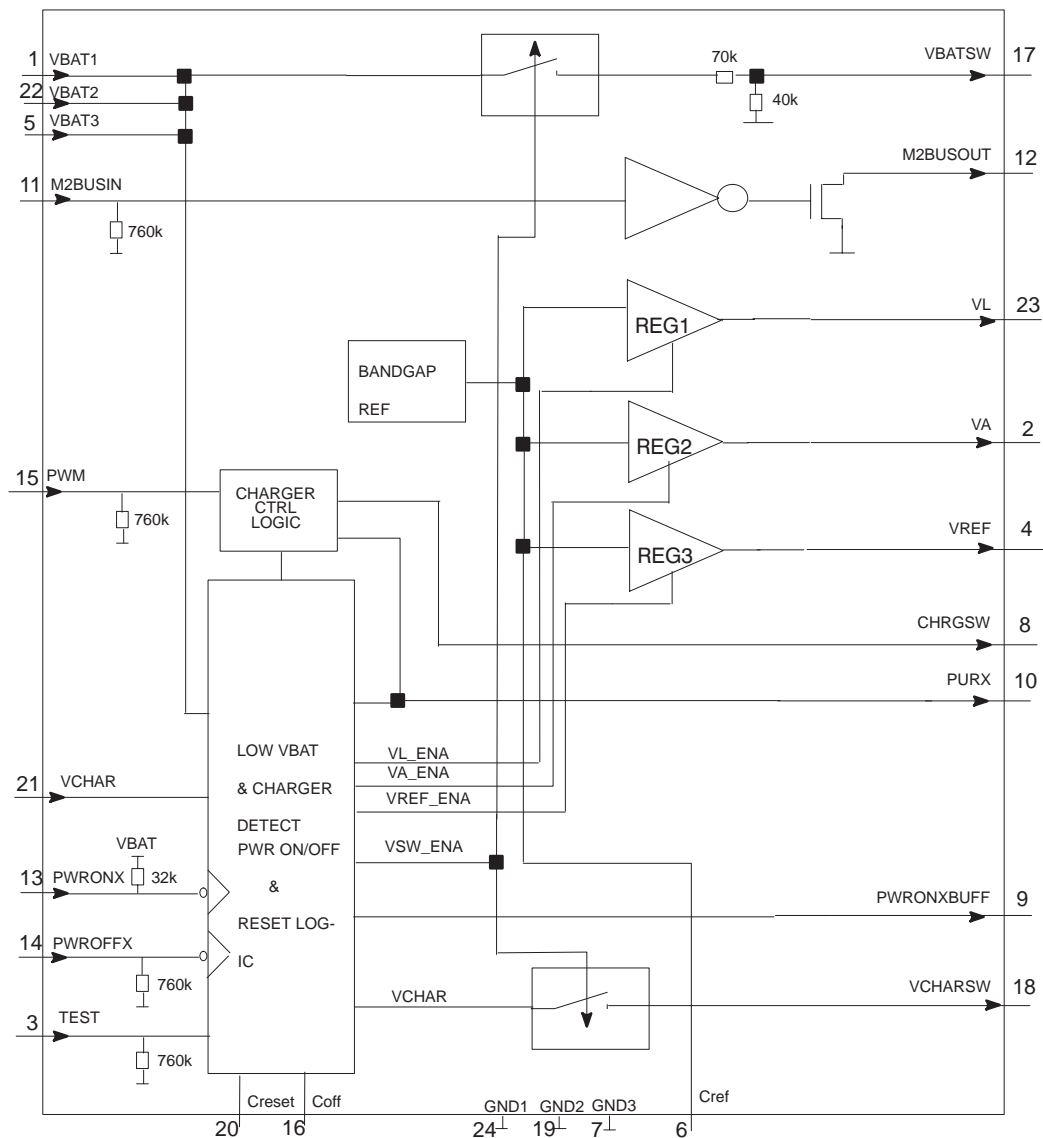
If the phone is in power-off, the MUUMI will detect the charging voltage . If the battery voltage is high enough the reset will be released and the CTRLU will start controlling the charging. If the battery voltage is too low the phone is in reset and charging control circuitry will pass the charging current to the battery. When the battery voltage on MUUMIs pin has reached 4.1V (3.9...4.3V) the reset will be removed and the CTRLU starts controlling the charging. This all is invisible to the user.

V116 is the charging switch; it is governed by the controller (CSW line) via voltage regulator V114 and V115. In fast charge mode CSW is "1" and in maintain charge mode there is controller controlled pulses. In charge off state CSW is "0". In maintain charge mode pulse ratio depends of charger and temperature.

There is three different ways to switch power on:

- Power key pressing grounds the XPWRON line. The MUUMI defects that and switches the power on.
- Charger detection on MUUMI detects that charger is connected and switches power on.
- MUUMI will switch power on when the battery is connected. If the battery is changed during the call, the power is kept on. If not the power is switched off.

Block Diagram of MUUMI



Main Components

- MUUMI asic

Makes the voltages, has power switch, charger and battery detection and watchdog.

- transistor V116 and diode V118

The charging current is passed through these components.

- regulators N130 and N140

N130 decreases battery voltage to 4.75 V which is suitable for MUUMI asic. N140 makes the supply voltage VL3 (4.75 V) to display and logic circuits.

Audio

Introduction

The block includes NIPA audio/signalling processor in a 64 TQFP package for NMT450 and NMT900 systems.

Main features

- Single chip FFSK modem and audio circuit
- Full duplex 1200 baud signalling
- DMS facility
- Low power consumption modes
- Programmable output clocks with clock stop for MCU and LCD
- 8 bit parallel interface with pull ups
- FSK indicator and level detector
- Speech volume indicator
- Programmable timer
- IF counter
- 8 bit DAC
- FII filter and gain control
- Low noise microphone amplifier
- Input for a handset microphone or an accessory
- Microphone sensitivity compensation +4.8/–4.2 dB range (4 bits)
- Compander
- RX and TX filters
- Tx hard limiter
- Tx AGC
- Internal reference compensation +1.00/–0.75 dB range(3 bits)
- Summing stage for voice/data, signalling and fii
- Transmitter compensation amplifier with +3.75/–3.75 dB range (4 bits)
- Receiver compensation amplifier with +3.75/–3.75 dB range (4 bits)
- Volume control amplifier with –20/+17.5 range (4 bits)
- Earphone amplifier with drive capability for ceramic earpiece
- Buffered output for a handset or an accessory
- Mute switches
- Dual and single tone multi–frequency generator
- Driver for buzzer amplifier
- Hands free functions

Technical Specifications

Audio Internal Signals, Inputs

| Signal Name | Notes | From |
|-------------|---|--------|
| VL | Logic supply voltage, 3.3V | PWRU |
| VA | Analog supply voltage, 3.3V | PWRU |
| VL3 | Logic supply voltage, 4.75V | PWRU |
| XRES | Reset line from MUUMI | PWRU |
| XNRD | Read control signal | CTRLU |
| XNCS | Chip select signal | CTRLU |
| XNWR | Write control signal | CTRLU |
| NA0...A3 | 4-bit address bus | CTRLU |
| ND0...D7 | 8-bit bidirectional data bus | CTRLU |
| EARENA | Earphone amplifier enable | CTRLU |
| XEARON | external earphone amplifier enable | CTRLU |
| XEARDC | External earphone DC enable | CTRLU |
| KBINT | Keyboard interrupt | CTRLU |
| MBUSINT | MBUS interrupt | CTRLU |
| DAF | Detected audio signal from receiver | RX |
| IF | (2nd) Intermediate frequency for AFC function | RX |
| XMIC | External audio input from accessories | SYSTEM |
| MICP | Microphone (positive node) | SYSTEM |
| MICN | Microphone (negative node) | SYSTEM |

Audio Internal Signals, Outputs

| Signal Name | Notes | To |
|-------------|--------------------------------------|--------|
| XEAR | External audio output to accessories | SYSTEM |
| ACCDDET | Accessory detection signal | SYSTEM |
| MOD | Audio output to synthesizer | SYNT |
| AFC | VCTCXO control | SYNT |
| BUZZER | Buzzer signal | SYSTEM |
| EARP | Earpiece (positive node) | UIF |
| EARN | Earpiece (negative node) | UIF |
| CLKMCU | Clock signal for MCU | CTRLU |
| XINT | Interrupt request to MCU | CTRLU |
| NMI | No maskable Interrupt request to MCU | CTRLU |

Pin list of NIPA

| Pin no | Symbol | Pin type | Notes |
|--------|-------------|----------|--|
| 1 | VDD1 | | + 3.3 V Supply voltage, digital |
| 2 | XRD | DIN/pd | Read control signal, active state LOW, pull-down > 50 k Ω |
| 3 | XCS | DIN/pd | Chip select signal, active state LOW, pull-down > 50 k Ω |
| 4 | A3 | DIN/pu | 4-bit address bus, MSB, pull-up > 50 k Ω |
| 5 | A2 | DIN/pu | 4-bit address bus, pull-up > 50 k Ω |
| 6 | A1 | DIN/pu | 4-bit address bus, pull-up > 50 k Ω |
| 7 | A0 | DIN/pu | 4-bit address bus, LSB, pull-up > 50 k Ω |
| 8 | D7 | DIO | 8-bit bidirectional data bus MSB |
| 9 | D6 | DIO | 8-bit bidirectional data bus |
| 10 | D5 | DIO | 8-bit bidirectional data bus |
| 11 | D4 | DIO | 8-bit bidirectional data bus |
| 12 | D3 | DIO | 8-bit bidirectional data bus |
| 13 | D2 | DIO | 8-bit bidirectional data bus |
| 14 | D1 | DIO | 8-bit bidirectional data bus |
| 15 | D0 | DIO | 8-bit bidirectional data bus LSB |
| 16 | VDD2 | | + 3.3 V Supply voltage, digital |
| 17 | NMI | DOUT | Non maskable Interrupt request |
| 18 | XCLR | DIN | HW reset input, active state LOW |
| 19 | TMODE | DIN/pd | Test mode selection, pull-down > 50 k Ω |
| 20 | TSEL | DIN/pd | Test select, pull-down > 50 k Ω |
| 21 | XINT | DOUT | Interrupt request to MCU, active state LOW |
| 22 | MBUSINT | DIN | MBUS interrupt request, falling edge active |
| 23 | KBINT | DIN | Keyboard interrupt request, falling edge active |
| 24 | IF | AIN | IF input |
| 25 | VSS2 | | 0 V Supply voltage, digital ground |
| 26 | VSA2 | | 0 V Supply voltage, analog ground |
| 27 | DAF | AIN | Signal input |
| 28 | FILO | AOUT | Rxfilter output |
| 29 | EXPI | AIN | Expander input |
| 30 | EAMPBO | AOUT | Expander Amplifier B output |
| 31 | EWCI | AIN | Expander Window Comparator input |
| 32 | EXPO | AOUT | Expander output |
| 33 | VDA2 | | + 3.3 V Supply voltage, analog |
| 34 | VOLI | AIN | Volume control ampl. input (Volume) |

| Pin no | Symbol | Pin type | Notes |
|--------|-------------|----------|--|
| 35 | EXTEAR | AOUT | Buffered output for handset or an accessory |
| 36 | EVGND | AIN | Earphone driver virtual ground |
| 37 | EARM | AOUT | Earphone driver output |
| 38 | EARP | AOUT | Earphone driver output |
| 39 | CWCI | AIN | Compressor window comparator input |
| 40 | DACO | AOUT | DA converter output |
| 41 | SIDEAR | AOUT | Sidetone output |
| 42 | REF | AIN | Internal analog signal ground 1.65 V |
| 43 | MIC | AIN | Microphone amplifier input |
| 44 | BIMIC | AOUT | Microphone bias current output |
| 45 | CMIC | AIN | Microphone current stabilization capacitor |
| 46 | EXTMIC | AIN | Audio input for a handset or an accessory |
| 47 | TXBPO | AOUT | Transmit bandpass filter output |
| 48 | VDA1 | | + 3.3 V Supply voltage, analog |
| 49 | COMI | AIN | Compressor input |
| 50 | COMO | AOUT | Compressor output |
| 51 | EMPI | AIN | Pre emphasis input |
| 52 | FIIOUT | AOUT | Received FII signal |
| 53 | TOUT | DOUT | Test output, digital |
| 54 | ATST | AOUT | Audio Filter Test output |
| 55 | MOD | AOUT | Transmit path output |
| 56 | VSA1 | | 0 V Supply voltage, analog ground |
| 57 | VSS1 | | 0 V Supply voltage, digital ground |
| 58 | BUZZ | DOUT | Buzzer output |
| 59 | ATOUT | AOUT | Test pin |
| 60 | CLKOUT | COUT | (7.3728 MHz) 3.6864 MHz crystal oscillator output |
| 61 | CLKIN | CIN | (7.3728 MHz) 3.6864 MHz crystal oscillator input or input for the external clock |
| 62 | CLKLCD | DOUT | Clock signal for LCD, 230.4 kHz or 57.6 kHz |
| 63 | CLKMCU | DOUT | Clock signal for MCU, 3.6864 MHz or 7.3728 MHz |
| 64 | XWR | DIN/pu | Write control signal, active state LOW, pull-up > 50 kΩ |

[illegible]

Transmit (TX) Audio Signal Path

The TX audio signal is processed in the NIPA circuit and fed via the MOD line to the TX synthesizer on SYNTHESIZER module.

NIPA ASIC contains the following stages for TX signal processing:

MICAM:

The signal from the microphone is fed to this stage and amplified up to 200 mVrms.

TXMUX + TXAAF:

TX source selection (exmic/mic/dmmf/muted). Txaafil prevents aliasing in TXBP filter.

TXATT:

TXATT is a hands free attenuator. Maximum attenuation is selectable from four levels: -30, -27, -24 or -21 dB.

MICTRI:

MICTRI is for different microphone (phone microphone, headset and handset etc.) sensitivity compensation. It is used also for dtmf level setting. Gain 16 levels, step 0.6 dB.

BANDPASS:

Tx bandpass filter takes out high freq noise and low freq hum.

COMPR:

It compresses speech dynamic area to avoid noise at tx and radio path. It is a amplitude compressor and ratio is 2:1 in dB scale. It can be bypassed for measurement or dtmf purposes.

PREEMP:

Pre-emphasis filter gives +6 dB/oct emphasis.

AGC:

Soft limiter is needed in order to suppress inter-modulation. Signal measuring circuitry measures peak-to-peak voltage. If signal on soft limiter input is not a sine signal (clipped in preceding stages), peak-to-peak signal level is increased in the post limiter filter.

LIM:

Hard limiter. It cuts the signal transients to 1131 mVpp levels.

TXLP:

The corner frequency of tx lowpass filter is 3400 Hz. Amplitude attenuation is 12 dB/oct after the corner point. Filter includes notch at 4 kHz.

TXTRI:

TXTRI is for nominal deviation tuning. Gain 8 levels, step 0.5 dB.

TXPOSTFIL:

Postfil eliminates filter clock.

SUM:

Speech, data and FII signals are summed together.

WTRFIL:

This block is a lowpass filter for FII and data. Transmitter Compensation Amplifier is these too. Gain 16 levels, step 0.5 dB.

WPOSFIL:

WPOSFIL filters out the replicates of the output spectrum around WTRFIL clock frequency and its harmonics.

Receive (RX) Audio Signal Path

NIPA contains the following stages for RX signal processing:

RXTRI:

RXTRI is for demodulation sensitivity compensation. Gain 16 levels, step 0.5 dB.

RXAAF:

RX aafilter filters out noise and other high frequency components from the incoming signal. It prevents aliasing in FIIFIL, RXFIL and MODRXFIL.

RXMUX+AAFIL:

Rxmux selects speech from DAF-pin or DTMF from generator or a loop from TXTRI or mute. Aafil prevents aliasing in RXFIL.

DEEMP+ RXFIL:

Rx filter filters out high freq noise and low freq hum. It has de-emphasis -6 dB/oct for the received speech signal. Design should include notch at 4kHz.

EXP:

It expands speech dynamic back to normal. It is a amplitude expander and ratio is 1:2 in dB scale. It can be bypassed for measurement or dtmf purposes.

VOL:

VOL is for earphone or accessory speaker/earphone volume control. Volume Control Amplifier. Gain 16 levels over -20 to +17.5 dB in 2.5 dB steps.

RXATT:

RXATT is a hands free attenuator. Maximum attenuation is selectable from four levels: -30, -27, -24 or -21 dB. Hands free controller (HF CONTR) measures peak-to-peak level of the received audio and controls gains of the transmit and receive attenuators as a function of measured signal level.

EAR:

The Earphone Amplifier is a single input, differential output amplifier for a ceramic earpiece.

ACC:

Buffer for accessory line is capable of driving high capacitive load. Gain and response of the buffer are fixed.

Transmitting data path

The data to be transmitted will be loaded into the transmitting register TRREG. From the TRREG register the 8 bit data is transformed to serial data which is sent to the FSK modulator (FSKMOD) and sine wave generator (SINGEN) and then to the summing block (SUM).

Receiving data path

The data from anti alias filter is connected through the modems RX filter (MODRXFIL) to the data comparator (DATACOMP) and then to FSK discriminator. Further from FSK discriminator data is connected to detecting filter (DETFIL) and from there to digital phase locked loop (DPLL).

IF

Intermediate frequency counter (IFCTR) is on the modem to measure the frequency of IF signal.

AFC

AFC makes the synthesizer fine tuning. It can be used for channel side-step also.

AFC DA-converter output DC level tunes RF oscillator (VCXO) .

FII path

The FII signal is filtered and amplified with a 4 kHz bandpass filter (FIIF-IL). FIITRI is for FII sensitivity compensation. The filtered FII is then fed to summing block (SUM).

Buzzer driver

Buzzer driver is a PWM output, so volume of buzzer is controlled by length of the pulse.

Clock driver

Clock divider generates internal clock frequencies by dividing master clock frequency which is created by an internal crystal oscillator and an external 7.3728 MHz or 3.6864 MHz crystal. External clock signal can also be used. If the crystal is used the oscillator output CLKOUT must not be loaded. Buffered crystal frequency can be obtained at pin CLKMCU directly or divided by two. 230.4kHz / 57.6kHz clock can be obtained at pin CLKLCD. Frequency can be selected with control bit SELLCDC.

Earphone amplifier

NIPA can drive ceramic earphone only. Because of used dynamic earphone in THF-10, it need power amplifier for earphone. Main components of amplifier are transistors V751, V753, V754, V755 and diode V752.

RF Module

Introduction

The RF module is designed for handportable cellular phone which operates in the NMT-450i system. The purpose of the module is to receive and demodulate the radio frequency signal from base station and to transmit modulated RF signal to base station.

List of Functional Blocks

Receiver (RX)

Transmitter (TX)

Synthesizer module

Technical Specifications

Maximum ratings

The maximum battery voltage during transmission should not exceed 8.0 V. Higher battery voltages may destroy the power amplifier module.

| Parameter | Value |
|-----------------------------|-----------------|
| Battery voltage | 8.0 V |
| Regulated supply voltage | 4.75 V +/- 5 % |
| Operating temperature range | -25 ... +55 ° C |

DC Characteristics

Regulators

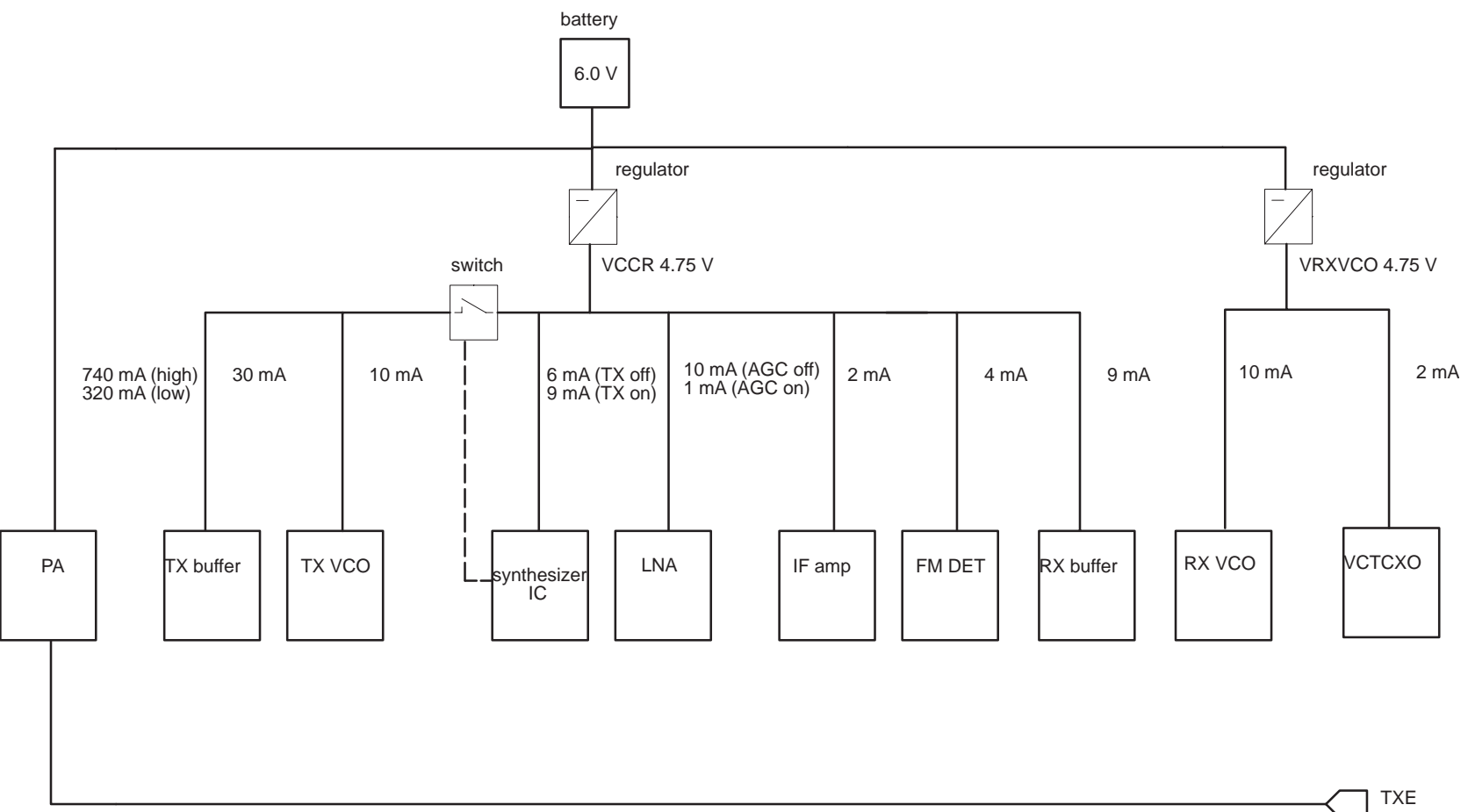
There are two regulators in the RF unit, and additional supply voltage, V_{ref} , which is regulated in the BB. The output voltage of the regulators is fixed, no external reference is needed.

Control Signals

In the following table the RF current consumption can be seen in different modes.

| control signals | | | current consumption (mA) | Notes |
|-----------------|---------------------------------|-----|--------------------------|-----------------------------------|
| RXE | TX synthesizer (P3-pin of N820) | TXE | | |
| H | L | H | 826 406 | power level 2 power level 0, 1 |
| H | L | L | 86 | RX on, TX-synthesizer on |
| H | H | L | 43 | RX on |
| L | H | L | 0.5 | all RF parts powered down |

RF Power Supply



Connections

Connections to Baseband module

| Signal Name | Type | Function |
|-------------|------------|--|
| AFC | Analog in | The reference oscillator frequency adjust. |
| AGC | Digital in | Automatic gain control for LNA |
| DAF | Analog out | Demodulated received signal (audio+data) |
| IF | Analog out | 2nd IF signal |
| MOD | Analog in | Modulation signal for transmitter (Audio + data) |
| RFTEMP | Analog out | RF temperature, which is determined by NTC resistor. |
| RSSI | Analog out | Received signal strength indicator. Voltage measurement. |
| RXE | Digital in | RX on/off –control |
| SCLK | Digital in | Serial clock for synthesizer. Active state: Rising edge |
| SDATA | Digital in | Serial data for synthesizer. Active state: High |
| SLE | Digital in | Synthesizer enable. Active state: Low |
| TXC | PWM in | Transmitter power control |
| TXE | Digital in | Transmitter regulator on/off. High when on. |
| TXI | Analog out | "TX power on" –indicator |
| VBAT | Power | Battery voltage |
| VREF | Power | Reference voltage |
| VRF | Power | Unregulated voltage from battery |

| Supply voltage | VDD | 3.3 V |
|----------------|-----|----------------------------------|
| Logical 1 | VOH | $VDD \cdot 0,7 \dots VDD + 0.3V$ |
| Logical 0 | VOL | $-0.3V \dots VDD \cdot 0,3$ |
| Logical 1 | IOH | $< 5\mu A$ |
| Logical 0 | IOL | $< 5\mu A$ |

| CLKIN | 14.85 MHz VCTCXO signal | |
|----------------|-------------------------|-----------------------------|
| Level | | 1 Vpp min |
| Load impedance | | 10 k Ω \10pF +/- 10% |
| Start time | | <60 mS after Vref rising |

| AFC | VCTCXO control voltage | |
|-------------------|------------------------|----------------------------|
| Type | | analog signal (DC–level) |
| Level | | 0.1...3,0 V DC |
| Load impedance | | $Z_L > 10 \text{ k}\Omega$ |
| Control step size | | < 12 mV |

| DAF | Demodulated audio and data signal | |
|------------------|-----------------------------------|-------------------------------|
| type | | analog signal |
| Nominal level | | 200 mVp-p @ 3.0 kHz deviation |
| Source impedance | | 360 Ω typical |

| IF | 450 kHz 2nd IF signal | |
|------------------|-----------------------|---|
| Level | | 300 mVp-p (typical) not specified by manufacturer |
| Source impedance | | < 1.0 k Ω |

| MOD | Modulation signal for transmitter (Audio + data) | |
|----------------|--|-------------------------------|
| Type | | Analog signal |
| Nominal level | | 500 mVp-p @ 3.0 kHz deviation |
| Load impedance | | $Z_L > 22 \text{ k}\Omega$ |

| RSSI | Received signal strength indicator | |
|------------------|------------------------------------|------------------------------|
| DC-level | | 0,5...1.6 V (–115...–45 dBm) |
| dynamic range | | 70 dB |
| Source impedance | | 56 k Ω |

| SCLK | Serial clock for synthesizer | |
|-------------|------------------------------|----------------|
| Type | | digital signal |
| Pulse width | | > 1 μ s |

| SDAT | Serial data for synthesizer | |
|------------------------------------|-----------------------------|---|
| Type | | digital signal |
| Pulse width | | > 1 μ s |
| VALUES | | |
| Control byte | | x010 011x x001 11xx (synte_initial_const A7,9C) |
| Reference divider | | 1188 (25 kHz channel) |
| Divider formulas for TX oscillator | | $N = 2 \cdot \text{ch} + 36238$ (TX_synte_base_const1 8D,8E) |
| Divider formulas for RX oscillator | | $N = 2 \cdot \text{ch} + 33438$ (RX_synte_base_const1 82,9E) |

| SLE | Synthesizer enable | |
|----------|--------------------|---|
| Type | | Digital signal |
| Function | | 0 = synthesizer enabled 1 = synthesizer disabled |

| RXE | Receiver enable | |
|------------------|------------------------|-------------------------------------|
| Type | | Digital signal |
| Function | | 0 = Receiver off 1 = Receiver on |
| On-state current | | < 100 uA |

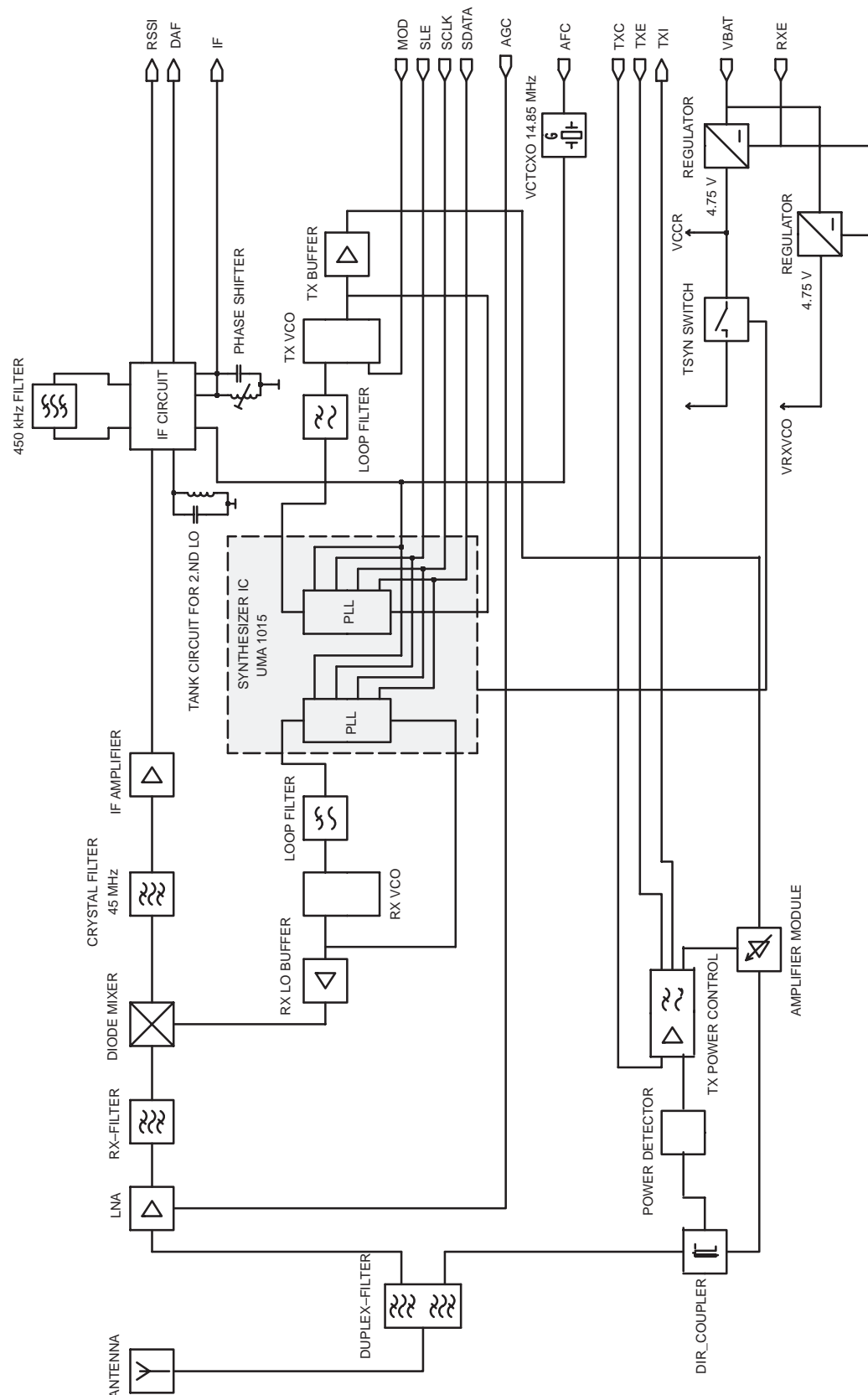
| TXC | Transmitter power control | |
|----------------------------|----------------------------------|--|
| Type | | PWM signal |
| Function | | Duty cycle of the TXC signal defines the TX power level. |
| PWM frequency | | 7.2 kHz |
| Level | | 0...3.3 V DC |
| Number of duty cycle steps | | 256 |
| Load impedance | | > 100 kohm |

| TXE | Transmitter on/off control | |
|------------|-----------------------------------|-------------------------|
| Type | | Digital signal |
| Function | | 0 = TX off 1 = TX on |

| TXI | "TX power on" –indicator | |
|------------------|---------------------------------|--------------------------------|
| Type | | Analog signal |
| Source impedance | | 47 kΩ (Typical) |
| Level | | > 1 V = TX on < 1V = TX off |

| VBAT | Battery voltage | |
|------------------|------------------------|--------|
| Nominal value | | 6.5 V |
| Minimum value | | 5.8 V |
| Absolute maximum | | 8.0 V |
| Max. current | | 850 mA |

| VREF | Reference voltage | |
|-------------|--------------------------|-----------|
| Level | | 3.3 V ±4% |



Functional Description

Receiver

The receiver is a dual-conversion superheterodyne using two intermediate frequencies, 45 MHz and 450 kHz.

The RF signal from the duplexer RX port is applied to the low noise RF amplifier. The amplifier is realized with transistor V320. Amplifier stage input matching is accomplished by C320 and L320. R320 and R326 are used for biasing. Output matching is carried out by L321, C327 and C322.

AGC circuit is realized by V330 and V331. AGC-off current is determined by R335 and R331. AGC-on current is determined by R335.

Next the signal is filtered with Z320. The filter is followed by a single balanced diode mixer, realized with Z340, Z341, Z342 and V340.

After the mixer the 45 MHz IF signal is filtered with crystal filter Z360. The matching between mixer and the filter is realized with L342, R346, C347 and C348. Next the IF signal is amplified by V360. Input matching is realized with R360. The biasing is realized with R361 and R362 through R364. Capacitors C360 and C361 are used for RF bypassing.

The second mixer, IF amplifier and quadrature detector are all integrated in the circuit N370. The second LO frequency, 44.55 MHz, is third harmonic of the VCTCXO frequency. LO signal is realized with tank circuit C372 and L371. After the mixer the 450kHz IF signal is filtered with ceramic filter Z370. The IF amplifier output signal is phase shifted by resonance circuit C377, R371 and L370. After this the signal is fed to a quadrature detector.

The DAF, RSSI and 2nd IF signal (450 kHz) are fed to the audio/logic unit.

RX Synthesizer

The first injection frequency is generated by a digital phase locked loop (PLL). The PLL consists of VCO, loop filter and PLL IC which includes reference and main dividers. The output frequency of the loop (LO) is obtained from a voltage-controlled oscillator (VCO) G520. Output level of VCO is 1 dBm \pm 2 dB. The VCO output signal is amplified by transistor V532 and fed to the receiver mixer via Z342. A portion of output signal is fed back to the synthesizer.

The overall divisor of the chain is selected according to the desired channel.

The internal dividers of N820 are programmed with 17 bits, which are transferred serially on the SDATA (synthesizer data) line from the processor into an internal shift register also located in N820. Data transfer is timed with SCLK clock pulses.

The divided frequency is compared with a highly stable reference frequency from VCTCXO by a phase comparator in the PLL circuit (N820). The phase comparator controls the VCO frequency by means of a DC voltage through the loop filter so as to keep the divided frequency applied to the phase comparator equal to the fixed reference frequency.

The reference frequency is 12.5 kHz. This reference frequency is obtained from voltage controlled temperature compensated crystal oscillator (VCTCXO). Oscillator frequency is 14.85 MHz. The VCTCXO frequency is divided by 1188.

RX loop filter

Phase comparator output is pin 3. If the VCO frequency is too high, the output goes low and discharge integrator capacitor C522. After this, the DC control voltage and the VCO frequency will decrease.

If the VCO frequency is too low, the output goes high and charge the integrator capacitor C522. Thereafter the DC control voltage and the VCO frequency will go up.

Output pulses from the phase detector have to be supplied to the loop filter. The function of the integrator is to convert positive and negative pulses to DC voltage. The remaining ripple and AC components are filtered in the three stage lowpass filter.

TX Synthesizer

The transmitter synthesizer generates a frequency modulated transmitter signal to the transmitter section. The injection frequency for transmitter is generated by a digital phase locked loop (PLL). The modulated TX frequency is generated in TX-VCO (G420). Output level of VCO is 1 dBm \pm 2 dB. After VCO TX signal is amplified in TX buffer V430 before power amplifier module. Gain in TX buffer is about 12 dB.

TX Loop Filter

Output pulses from the phase detector N820 pin 17 are supplied to the loop filter. The integrator, which is constituted of R426, C428 and C424, converts positive and negative pulses to DC voltage. The remaining ripple is filtered in the three stage low-pass filter.

Transmitter

The transmitter is realized with power amplifier module (N620). The modulated RF signal from the TX synthesizer is applied to the 50 ohm input of the transmitter module. The power level is controlled by the voltage which is supplied to pin 2 of PA module. A voltage proportional to the output power is rectified from a directional coupler L640 by DC-biased Schottky diode V634. This rectified voltage is fed to a differential amplifier which consists of transistors V611, V630, V631, and V632.

The reference voltage to control PA module is filtered from the PWM signal TXC to DC voltage by three stage lowpass filter. The differential amplifier adjusts the collector voltage of the transistor V630 so that the reference voltage and the voltage proportional to the output power are equal. The transmitter is switched on when TXE goes high (logic 1), which enables the transmitter power control circuit by transistor V611. When the transmitter is inactive (TXE low) the RF level from the transmitter is reduced below -57 dBm.

The rectified voltage, which is proportional to the power output signal, is fed along TXI line through R636 to the BB-unit. This TXI line (TX power on Indicator) is used to avoid false transmission.

Regulators

Voltages (4.75 V) for RF parts are provided by two regulator-components (N310, N311). Voltage from N311 is used for receiver VCO and VCTCXO. Voltage from N310 is used for other RF-parts excluding PA module. TX synthesizer and transmitter VCO get supply voltage via switch (V411). It is controlled by PLL circuit. Regulators are controlled by RXE-line.

RF Characteristics

Temperature range

| Line Symbol | Minimum | Typ / Nom | Maximum | Unit / Notes |
|-----------------------|---------|-----------|---------|--------------|
| Operating temperature | -25 | | +55 | °C |

RX submodule

| N=Normal E=Extreme conditions | | Unit / Notes | |
|-------------------------------------|--|--------------------------|--------------------------------------|
| | Frequency range | (See variant appendices) | |
| | Type | FM receiver, 2 IFs | |
| | Intermediate Frequencies | 45 MHz, 450 kHz | |
| N / E | RSSI dynamic range | > 65 dB | |
| N / E | AGC attenuation | 10 dB | |
| | | NMT requirements | ETSI requirements |
| N | RF-sensitivity | < -113 dBm (SINAD 20 dB) | < -107 dBm (SINAD 20 dB) |
| E | RF-sensitivity | < -110 dBm (SINAD 20 dB) | < -101 dBm (SINAD 20 dB) |
| N | Adjacent channel selectivity | > 67 dB | > 70 dB |
| E | Adjacent channel selectivity | > 60 dB | > 60 dB |
| N | Spurious response rejection | > 67 dB | > 70 dB (no TX) > 67 dB (with TX) |
| N | Intermodulation rejection | > 67 dB | > 65 dB |
| N | Blocking at freq. RX ± 1 to ± 10 MHz except at freq. where spur. resp. are found | > -80dB | > -84dB |
| N | Spurious emissions | | |
| N | 100 kHz ... 1000 MHz | < -57 dBm | < -57 dBm |
| N | 1000 MHz ... 4000 MHz | < -47 dBm | < -47 dBm |
| N / E | Audio harmonic distortion | < 5% | |
| N / E | Noise & hum | < -20 ... -40 dB | |

TX submodule

| N=Normal E=Extreme conditions | | Unit / Notes | |
|-------------------------------------|--|---------------------------|----------------------------------|
| | | NMT requirements | ETSI requirements |
| | Frequency range | (See variant appendices) | |
| N | Frequency deviation | (See variant appendices) | |
| N / E | Carrier switching time from – 40 dB to its steady state power and frequency within ± 1 kHz final frequency | < 6 ms | |
| | | NMT requirements | ETSI requirements |
| N / E | Frequency error | ± 2.5 kHz | ± 2.0 kHz |
| N / E | Output power (after duplex filter) at all channels | | |
| N / E | PL 0,1 | 21.76 ($\pm 2 / 3$) dBm | 21.76 ($\pm 1.5 / +2, -3$) dBm |
| N / E | PL 2,3 | 31.76 ($\pm 2 / 3$) dBm | 30.0 ($\pm 1.5 / +2,-3$) dBm |
| | Spurious emissions | | |
| N | 100 kHz ... 1000 MHz (tx operating) | < –36 dBm | < –36 dBm |
| N | 100 kHz ... 1000 MHz (standby) | < –57 dBm | < –57 dBm |
| N | 1000 MHz ... 4000 MHz (tx operating) | < –30 dBm | < –30 dBm |
| N | 1000 MHz ... 4000 MHz (standby) | < –47 dBm | < –47 dBm |
| N | Adjacent channel power | > 67 dB | > 70 dB |
| N / E | Limiting characteristics of modulator | $\pm 3.7 \dots 4.7$ KHz | |
| N / E | Harmonic distortion | < 5 % | |
| N | Residual modulation (CCITT on) | < –40 dB | |
| N | Residual modulation (CCITT off) | < –20 dB | |

Parts list of TA1 (EDMS Issue 1.8)

Code: 0200960

| ITEM | CODE | DESCRIPTION | VALUE | TYPE |
|---|---------|---------------|-------|------------------|
| TA1 SMD VARIATION MODULE – See variant appendix | | | | |
| 0201052 TA1 BASIC MODULE (EDMS Issue: 2.11) | | | | |
| R101 | 1430804 | Chip resistor | 100 k | 5 % 0.063 W 0402 |
| R102 | 1430796 | Chip resistor | 47 k | 5 % 0.063 W 0402 |
| R111 | 1430804 | Chip resistor | 100 k | 5 % 0.063 W 0402 |
| R112 | 1430788 | Chip resistor | 22 k | 5 % 0.063 W 0402 |
| R113 | 1430796 | Chip resistor | 47 k | 5 % 0.063 W 0402 |
| R114 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R115 | 1430734 | Chip resistor | 220 | 5 % 0.063 W 0402 |
| R116 | 1430804 | Chip resistor | 100 k | 5 % 0.063 W 0402 |
| R117 | 1430788 | Chip resistor | 22 k | 5 % 0.063 W 0402 |
| R118 | 1430770 | Chip resistor | 4.7 k | 5 % 0.063 W 0402 |
| R119 | 1430740 | Chip resistor | 330 | 5 % 0.063 W 0402 |
| R120 | 1430764 | Chip resistor | 3.3 k | 5 % 0.063 W 0402 |
| R121 | 1430786 | Chip resistor | 18 k | 5 % 0.063 W 0402 |
| R122 | 1430786 | Chip resistor | 18 k | 5 % 0.063 W 0402 |
| R123 | 1430786 | Chip resistor | 18 k | 5 % 0.063 W 0402 |
| R124 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R125 | 1430740 | Chip resistor | 330 | 5 % 0.063 W 0402 |
| R130 | 1430804 | Chip resistor | 100 k | 5 % 0.063 W 0402 |
| R140 | 1430804 | Chip resistor | 100 k | 5 % 0.063 W 0402 |
| R152 | 1430740 | Chip resistor | 330 | 5 % 0.063 W 0402 |
| R153 | 1430726 | Chip resistor | 100 | 5 % 0.063 W 0402 |
| R155 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R156 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R157 | 1430770 | Chip resistor | 4.7 k | 5 % 0.063 W 0402 |
| R158 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R160 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R161 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R162 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R163 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R164 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R165 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R166 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R167 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R168 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R169 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R170 | 1430700 | Chip resistor | 10 | 5 % 0.063 W 0402 |
| R171 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R172 | 1430796 | Chip resistor | 47 k | 5 % 0.063 W 0402 |
| R173 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R190 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |

System Module

Technical Documentation

| | | | | |
|------|---------|---------------|-------|------------------|
| R191 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R202 | 1430796 | Chip resistor | 47 k | 5 % 0.063 W 0402 |
| R203 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R204 | 1430792 | Chip resistor | 33 k | 5 % 0.063 W 0402 |
| R205 | 1430792 | Chip resistor | 33 k | 5 % 0.063 W 0402 |
| R206 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R208 | 1430770 | Chip resistor | 4.7 k | 5 % 0.063 W 0402 |
| R210 | 1430770 | Chip resistor | 4.7 k | 5 % 0.063 W 0402 |
| R214 | 1430804 | Chip resistor | 100 k | 5 % 0.063 W 0402 |
| R215 | 1430796 | Chip resistor | 47 k | 5 % 0.063 W 0402 |
| R217 | 1430788 | Chip resistor | 22 k | 5 % 0.063 W 0402 |
| R218 | 1430804 | Chip resistor | 100 k | 5 % 0.063 W 0402 |
| R219 | 1430804 | Chip resistor | 100 k | 5 % 0.063 W 0402 |
| R221 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R222 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R223 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R224 | 1430792 | Chip resistor | 33 k | 5 % 0.063 W 0402 |
| R225 | 1430792 | Chip resistor | 33 k | 5 % 0.063 W 0402 |
| R226 | 1430792 | Chip resistor | 33 k | 5 % 0.063 W 0402 |
| R230 | 1430796 | Chip resistor | 47 k | 5 % 0.063 W 0402 |
| R231 | 1430830 | Chip resistor | 1.0 M | 5 % 0.063 W 0402 |
| R232 | 1430814 | Chip resistor | 270 k | 5 % 0.063 W 0402 |
| R233 | 1430804 | Chip resistor | 100 k | 5 % 0.063 W 0402 |
| R234 | 1430792 | Chip resistor | 33 k | 5 % 0.063 W 0402 |
| R235 | 1430802 | Chip resistor | 82 k | 5 % 0.063 W 0402 |
| R241 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R243 | 1430792 | Chip resistor | 33 k | 5 % 0.063 W 0402 |
| R244 | 1430792 | Chip resistor | 33 k | 5 % 0.063 W 0402 |
| R245 | 1430770 | Chip resistor | 4.7 k | 5 % 0.063 W 0402 |
| R246 | 1430804 | Chip resistor | 100 k | 5 % 0.063 W 0402 |
| R251 | 1430792 | Chip resistor | 33 k | 5 % 0.063 W 0402 |
| R252 | 1430792 | Chip resistor | 33 k | 5 % 0.063 W 0402 |
| R270 | 1430804 | Chip resistor | 100 k | 5 % 0.063 W 0402 |
| R271 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R272 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R310 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R311 | 1430710 | Chip resistor | 22 | 5 % 0.063 W 0402 |
| R320 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R321 | 1430786 | Chip resistor | 18 k | 5 % 0.063 W 0402 |
| R322 | 1430740 | Chip resistor | 330 | 5 % 0.063 W 0402 |
| R324 | 1430700 | Chip resistor | 10 | 5 % 0.063 W 0402 |
| R325 | 1430724 | Chip resistor | 82 | 5 % 0.063 W 0402 |
| R330 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R331 | 1430812 | Chip resistor | 220 k | 5 % 0.063 W 0402 |
| R332 | 1430756 | Chip resistor | 1.2 k | 5 % 0.063 W 0402 |
| R335 | 1430764 | Chip resistor | 3.3 k | 5 % 0.063 W 0402 |
| R341 | 1430690 | Chip jumper | | 0402 |

| | | | | |
|------|---------|---------------|-------|------------------|
| R342 | 1430766 | Chip resistor | 3.9 k | 5 % 0.063 W 0402 |
| R343 | 1430776 | Chip resistor | 8.2 k | 5 % 0.063 W 0402 |
| R344 | 1430734 | Chip resistor | 220 | 5 % 0.063 W 0402 |
| R345 | 1430760 | Chip resistor | 1.8 k | 5 % 0.063 W 0402 |
| R346 | 1430690 | Chip jumper | | 0402 |
| R360 | 1430690 | Chip jumper | | 0402 |
| R361 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R362 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R363 | 1430762 | Chip resistor | 2.2 k | 5 % 0.063 W 0402 |
| R364 | 1430714 | Chip resistor | 33 | 5 % 0.063 W 0402 |
| R370 | 1430758 | Chip resistor | 1.5 k | 5 % 0.063 W 0402 |
| R371 | 1430770 | Chip resistor | 4.7 k | 5 % 0.063 W 0402 |
| R373 | 1430714 | Chip resistor | 33 | 5 % 0.063 W 0402 |
| R374 | 1430804 | Chip resistor | 100 k | 5 % 0.063 W 0402 |
| R381 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R411 | 1430770 | Chip resistor | 4.7 k | 5 % 0.063 W 0402 |
| R412 | 1430700 | Chip resistor | 10 | 5 % 0.063 W 0402 |
| R414 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R421 | 1430700 | Chip resistor | 10 | 5 % 0.063 W 0402 |
| R422 | 1430774 | Chip resistor | 6.8 k | 5 % 0.063 W 0402 |
| R423 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R424 | 1430770 | Chip resistor | 4.7 k | 5 % 0.063 W 0402 |
| R425 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R426 | 1430760 | Chip resistor | 1.8 k | 5 % 0.063 W 0402 |
| R427 | 1430734 | Chip resistor | 220 | 5 % 0.063 W 0402 |
| R428 | 1430718 | Chip resistor | 47 | 5 % 0.063 W 0402 |
| R430 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R431 | 1430690 | Chip jumper | | 0402 |
| R432 | 1430774 | Chip resistor | 6.8 k | 5 % 0.063 W 0402 |
| R433 | 1430690 | Chip jumper | | 0402 |
| R434 | 1430700 | Chip resistor | 10 | 5 % 0.063 W 0402 |
| R521 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R522 | 1430770 | Chip resistor | 4.7 k | 5 % 0.063 W 0402 |
| R523 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R524 | 1430764 | Chip resistor | 3.3 k | 5 % 0.063 W 0402 |
| R525 | 1430726 | Chip resistor | 100 | 5 % 0.063 W 0402 |
| R526 | 1430710 | Chip resistor | 22 | 5 % 0.063 W 0402 |
| R613 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R615 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R621 | 1430748 | Chip resistor | 680 | 5 % 0.063 W 0402 |
| R631 | 1430804 | Chip resistor | 100 k | 5 % 0.063 W 0402 |
| R632 | 1430804 | Chip resistor | 100 k | 5 % 0.063 W 0402 |
| R633 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R634 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R635 | 1430762 | Chip resistor | 2.2 k | 5 % 0.063 W 0402 |
| R636 | 1430796 | Chip resistor | 47 k | 5 % 0.063 W 0402 |
| R637 | 1430772 | Chip resistor | 5.6 k | 5 % 0.063 W 0402 |

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|------|---------|---------------|-------|------------------|
| R638 | 1430796 | Chip resistor | 47 k | 5 % 0.063 W 0402 |
| R639 | 1430784 | Chip resistor | 15 k | 5 % 0.063 W 0402 |
| R640 | 1430726 | Chip resistor | 100 | 5 % 0.063 W 0402 |
| R641 | 1430726 | Chip resistor | 100 | 5 % 0.063 W 0402 |
| R642 | 1430690 | Chip jumper | | 0402 |
| R711 | 1430796 | Chip resistor | 47 k | 5 % 0.063 W 0402 |
| R712 | 1430796 | Chip resistor | 47 k | 5 % 0.063 W 0402 |
| R721 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R722 | 1430788 | Chip resistor | 22 k | 5 % 0.063 W 0402 |
| R723 | 1430700 | Chip resistor | 10 | 5 % 0.063 W 0402 |
| R724 | 1430812 | Chip resistor | 220 k | 5 % 0.063 W 0402 |
| R725 | 1430812 | Chip resistor | 220 k | 5 % 0.063 W 0402 |
| R731 | 1430762 | Chip resistor | 2.2 k | 5 % 0.063 W 0402 |
| R732 | 1430792 | Chip resistor | 33 k | 5 % 0.063 W 0402 |
| R733 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R740 | 1430700 | Chip resistor | 10 | 5 % 0.063 W 0402 |
| R741 | 1430762 | Chip resistor | 2.2 k | 5 % 0.063 W 0402 |
| R742 | 1430804 | Chip resistor | 100 k | 5 % 0.063 W 0402 |
| R743 | 1430718 | Chip resistor | 47 | 5 % 0.063 W 0402 |
| R744 | 1430718 | Chip resistor | 47 | 5 % 0.063 W 0402 |
| R751 | 1430796 | Chip resistor | 47 k | 5 % 0.063 W 0402 |
| R752 | 1430796 | Chip resistor | 47 k | 5 % 0.063 W 0402 |
| R753 | 1430700 | Chip resistor | 10 | 5 % 0.063 W 0402 |
| R767 | 1430788 | Chip resistor | 22 k | 5 % 0.063 W 0402 |
| R768 | 1430788 | Chip resistor | 22 k | 5 % 0.063 W 0402 |
| R769 | 1430700 | Chip resistor | 10 | 5 % 0.063 W 0402 |
| R770 | 1430700 | Chip resistor | 10 | 5 % 0.063 W 0402 |
| R779 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R780 | 1430788 | Chip resistor | 22 k | 5 % 0.063 W 0402 |
| R782 | 1430784 | Chip resistor | 15 k | 5 % 0.063 W 0402 |
| R783 | 1430772 | Chip resistor | 5.6 k | 5 % 0.063 W 0402 |
| R785 | 1430796 | Chip resistor | 47 k | 5 % 0.063 W 0402 |
| R786 | 1430700 | Chip resistor | 10 | 5 % 0.063 W 0402 |
| R789 | 1430770 | Chip resistor | 4.7 k | 5 % 0.063 W 0402 |
| R790 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R791 | 1430764 | Chip resistor | 3.3 k | 5 % 0.063 W 0402 |
| R793 | 1430778 | Chip resistor | 10 k | 5 % 0.063 W 0402 |
| R800 | 1800673 | NTC resistor | 15 k | 10 % 0.12 W 0805 |
| R811 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R814 | 1430754 | Chip resistor | 1.0 k | 5 % 0.063 W 0402 |
| R819 | 1430752 | Chip resistor | 820 | 5 % 0.063 W 0402 |
| R820 | 1430786 | Chip resistor | 18 k | 5 % 0.063 W 0402 |
| R825 | 1430726 | Chip resistor | 100 | 5 % 0.063 W 0402 |
| R826 | 1430786 | Chip resistor | 18 k | 5 % 0.063 W 0402 |
| R827 | 1430714 | Chip resistor | 33 | 5 % 0.063 W 0402 |
| R828 | 1430714 | Chip resistor | 33 | 5 % 0.063 W 0402 |
| R829 | 1430710 | Chip resistor | 22 | 5 % 0.063 W 0402 |

| | | | | |
|------|---------|---------------|-------|-----------------------|
| C101 | 2611668 | Tantalum cap. | 4.7 u | 20 % 10 V 3.2x1.6x1.6 |
| C102 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C103 | 2310791 | Ceramic cap. | 33 n | 20 % 50 V 0805 |
| C104 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C105 | 2610024 | Tantalum cap. | 2.2 u | 20 % 16 V 3.2x1.6x1.6 |
| C106 | 2610024 | Tantalum cap. | 2.2 u | 20 % 16 V 3.2x1.6x1.6 |
| C107 | 2611668 | Tantalum cap. | 4.7 u | 20 % 10 V 3.2x1.6x1.6 |
| C108 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C109 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C111 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C112 | 2604209 | Tantalum cap. | 1.0 u | 20 % 16 V 3.2x1.6x1.6 |
| C113 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C114 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C130 | 2604209 | Tantalum cap. | 1.0 u | 20 % 16 V 3.2x1.6x1.6 |
| C131 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C132 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C140 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C141 | 2611668 | Tantalum cap. | 4.7 u | 20 % 10 V 3.2x1.6x1.6 |
| C142 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C144 | 2604209 | Tantalum cap. | 1.0 u | 20 % 16 V 3.2x1.6x1.6 |
| C151 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C152 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C153 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C156 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C157 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C158 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C160 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C162 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C163 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C164 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C167 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C168 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C169 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C170 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C171 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C172 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C173 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C174 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C175 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C176 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C177 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C178 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C180 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C181 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C182 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C183 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C184 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |

| | | | | |
|------|---------|---------------|-------|-----------------------|
| C185 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C186 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C187 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C188 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C189 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C190 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C191 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C192 | 2320546 | Ceramic cap. | 27 p | 5 % 50 V 0402 |
| C193 | 2320546 | Ceramic cap. | 27 p | 5 % 50 V 0402 |
| C201 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C202 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C203 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C205 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C206 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C207 | 2320781 | Ceramic cap. | 47 n | 20 % 16 V 0603 |
| C208 | 2320546 | Ceramic cap. | 27 p | 5 % 50 V 0402 |
| C228 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C229 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C230 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C231 | 2312296 | Ceramic cap. | | Y5 V 1210 |
| C241 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C242 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C251 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C252 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C301 | 2604209 | Tantalum cap. | 1.0 u | 20 % 16 V 3.2x1.6x1.6 |
| C302 | 2312296 | Ceramic cap. | | Y5 V 1210 |
| C310 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C311 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C312 | 2312296 | Ceramic cap. | | Y5 V 1210 |
| C313 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C314 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C315 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C316 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C317 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C319 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C320 | 2320536 | Ceramic cap. | 10 p | 5 % 50 V 0402 |
| C322 | 2320552 | Ceramic cap. | 47 p | 5 % 50 V 0402 |
| C323 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C324 | 2611668 | Tantalum cap. | 4.7 u | 20 % 10 V 3.2x1.6x1.6 |
| C325 | 2320548 | Ceramic cap. | 33 p | 5 % 50 V 0402 |
| C327 | 2320522 | Ceramic cap. | 2.7 p | 0.25 % 50 V 0402 |
| C332 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C333 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C341 | 2320536 | Ceramic cap. | 10 p | 5 % 50 V 0402 |
| C342 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C344 | 2320532 | Ceramic cap. | 6.8 p | 0.25 % 50 V 0402 |
| C347 | 2320532 | Ceramic cap. | 6.8 p | 0.25 % 50 V 0402 |

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|------|---------|---------------|-------|-----------------------|
| C348 | 2320604 | Ceramic cap. | 18 p | 5 % 50 V 0402 |
| C360 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C361 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C362 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C363 | 2320532 | Ceramic cap. | 6.8 p | 0.25 % 50 V 0402 |
| C370 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C371 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C372 | 2320546 | Ceramic cap. | 27 p | 5 % 50 V 0402 |
| C373 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C374 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C375 | 2312296 | Ceramic cap. | | Y5 V 1210 |
| C376 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C377 | 2310490 | Ceramic cap. | 360 p | 2 % 50 V 0805 |
| C378 | 2320556 | Ceramic cap. | 68 p | 5 % 50 V 0402 |
| C379 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C380 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C381 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C382 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C410 | 2611668 | Tantalum cap. | 4.7 u | 20 % 10 V 3.2x1.6x1.6 |
| C411 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C420 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C421 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C422 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C424 | 2610024 | Tantalum cap. | 2.2 u | 20 % 16 V 3.2x1.6x1.6 |
| C425 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C426 | 2310777 | Ceramic cap. | 22 n | 20 % 50 V 0805 |
| C427 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C428 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C429 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C430 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C432 | 2320536 | Ceramic cap. | 10 p | 5 % 50 V 0402 |
| C434 | 2320548 | Ceramic cap. | 33 p | 5 % 50 V 0402 |
| C435 | 2320508 | Ceramic cap. | 1.0 p | 0.25 % 50 V 0402 |
| C439 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C520 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C522 | 2604209 | Tantalum cap. | 1.0 u | 20 % 16 V 3.2x1.6x1.6 |
| C523 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C524 | 2310777 | Ceramic cap. | 22 n | 20 % 50 V 0805 |
| C525 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C526 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C527 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C528 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C611 | 2312296 | Ceramic cap. | | Y5 V 1210 |
| C612 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C613 | 2320546 | Ceramic cap. | 27 p | 5 % 50 V 0402 |
| C623 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C625 | 2320546 | Ceramic cap. | 27 p | 5 % 50 V 0402 |

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| C628 | 2604209 | Tantalum cap. | 1.0 u | 20 % 16 V 3.2x1.6x1.6 |
| C631 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C632 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C634 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C637 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C641 | 2320520 | Ceramic cap. | 2.2 p | 0.25 % 50 V 0402 |
| C646 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C700 | 2320530 | Ceramic cap. | 5.6 p | 0.25 % 50 V 0402 |
| C701 | 2320552 | Ceramic cap. | 47 p | 5 % 50 V 0402 |
| C702 | 2320556 | Ceramic cap. | 68 p | 5 % 50 V 0402 |
| C703 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C704 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C711 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C712 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C713 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C714 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C715 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C716 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C717 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C721 | 2310777 | Ceramic cap. | 22 n | 20 % 50 V 0805 |
| C723 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C724 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C731 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C732 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C733 | 2604209 | Tantalum cap. | 1.0 u | 20 % 16 V 3.2x1.6x1.6 |
| C734 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C740 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C741 | 2320546 | Ceramic cap. | 27 p | 5 % 50 V 0402 |
| C742 | 2312296 | Ceramic cap. | | Y5 V 1210 |
| C750 | 2320584 | Ceramic cap. | 1.0 n | 5 % 50 V 0402 |
| C762 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C763 | 2604209 | Tantalum cap. | 1.0 u | 20 % 16 V 3.2x1.6x1.6 |
| C766 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C767 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C768 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C778 | 2312296 | Ceramic cap. | | Y5 V 1210 |
| C779 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C780 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C782 | 2310777 | Ceramic cap. | 22 n | 20 % 50 V 0805 |
| C783 | 2604209 | Tantalum cap. | 1.0 u | 20 % 16 V 3.2x1.6x1.6 |
| C785 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |
| C790 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C791 | 2320560 | Ceramic cap. | 100 p | 5 % 50 V 0402 |
| C792 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C793 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C794 | 2307816 | Ceramic cap. | 47 n | 20 % 25 V 0805 |
| C795 | 2320107 | Ceramic cap. | 10 n | 5 % 50 V 0603 |

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| C814 | 2312401 | Ceramic cap. | 1.0 u | 10 % 10 V 0805 |
| C815 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C818 | 2320534 | Ceramic cap. | 8.2 p | 0.25 % 50 V 0402 |
| C820 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C821 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C826 | 2611668 | Tantalum cap. | 4.7 u | 20 % 10 V 3.2x1.6x1.6 |
| C827 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| C838 | 2611668 | Tantalum cap. | 4.7 u | 20 % 10 V 3.2x1.6x1.6 |
| C839 | 2320778 | Ceramic cap. | 10 n | 10 % 16 V 0402 |
| L101 | 3641262 | Ferrite bead | 30r/100mhz 2a | 1206 |
| L102 | 3641262 | Ferrite bead | 30r/100mhz 2a | 1206 |
| L103 | 3641262 | Ferrite bead | 30r/100mhz 2a | 1206 |
| L151 | 3640035 | Filt z>450r/100m | 0r7max 0.2a | 0603 |
| L154 | 3640035 | Filt z>450r/100m | 0r7max 0.2a | 0603 |
| L155 | 3640035 | Filt z>450r/100m | 0r7max 0.2a | 0603 |
| L320 | 3643003 | Chip coil 12 n | 5 % Q=30/250 MHz | 0805 |
| L321 | 3643003 | Chip coil 12 n | 5 % Q=30/250 MHz | 0805 |
| L341 | 3641572 | Chip coil 22 n | 5 % Q=45/250 MHz | 0805 |
| L342 | 3645027 | Chip coil 470 n | 10 % Q=25/25 MHz | 0805 |
| L347 | 3643003 | Chip coil 12 n | 5 % Q=30/250 MHz | 0805 |
| L370 | 3640103 | Chip coil 320 u | 2 % Q=40/796 kHz | 1812 |
| L371 | 3645027 | Chip coil 470 n | 10 % Q=25/25 MHz | 0805 |
| L430 | 3641548 | Chip coil 100 n | 10 % Q=40/150 MHz | 0805 |
| L431 | 3641572 | Chip coil 22 n | 5 % Q=45/250 MHz | 0805 |
| L611 | 3641262 | Ferrite bead | 30r/100mhz 2a | 1206 |
| L621 | 3641548 | Chip coil 100 n | 10 % Q=40/150 MHz | 0805 |
| L640 | 3640065 | Passive dir. coupler | 403-520m SMD | |
| B701 | 4510012 | Crystal | 7.3728 M +--50PPM | 11x4x2mm |
| G810 | 4510043 | SM, VCTCXO112cb | 14.85mhz+--2ppm | 3.3v |
| F101 | 5119011 | SM, fuse | f2a 63v | 1206 |
| Z360 | 4510085 | XTAL filter | 45 M +--7.5KHZ | 4POLE |
| Z370 | 4510061 | Cer.filt 450+--6khz | 11.8x7.5 | |
| V110 | 4113828 | Trans. supr. | SMBJ28ADO214AA | |
| V111 | 4219904 | Transistor x 2 | UMX1 npn 40 V | SOT363 |
| V113 | 4210102 | Transistor | BC858W pnp 30 V 100 mA | 200MWSOT323 |
| V114 | 4200226 | Darl. transistor | BCV27 npn 30 V 300 mA | SOT23 |
| V115 | 4200226 | Darl. transistor | BCV27 npn 30 V 300 mA | SOT23 |
| V116 | 4210020 | Transistor | BCP69-25 pnp 20 V 1 A | SOT223 |
| V117 | 4210100 | Transistor | BC848W npn 30 V | SOT323 |
| V118 | 4110074 | Schottky diode | STPS340U 40 V 3 A | SOD6 |
| V140 | 4100285 | Diode x 2 BAV99 | 70 V 200 mA | SER.SOT23 |
| V151 | 4200811 | Transistor | BC849C npn 30 V 0.1 A | SOT23 |
| V170 | 4210102 | Transistor | BC858W pnp 30 V 100 mA | 200MWSOT323 |
| V171 | 4210102 | Transistor | BC858W pnp 30 V 100 mA | 200MWSOT323 |
| V172 | 4210100 | Transistor | BC848W npn 30 V | SOT323 |
| V210 | 4210102 | Transistor | BC858W pnp 30 V 100 mA | 200MWSOT323 |
| V231 | 4210102 | Transistor | BC858W pnp 30 V 100 mA | 200MWSOT323 |

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| V263 | 4119902 | Diode x 4 IMP11 | 80 V 0.3 A IMD |
| V271 | 4210102 | Transistor | BC858W pnp 30 V 100 mA 200MWSOT323 |
| V320 | 4210010 | Transistor | BFP183 npn 12 V 65 mA SOT143 |
| V330 | 4210102 | Transistor | BC858W pnp 30 V 100 mA 200MWSOT323 |
| V331 | 4219922 | Transistor x 2 | UM6 |
| V340 | 4100567 | Sch. diode x 2 | BAS70-04 70V15 mA SERSOT23 |
| V360 | 4210066 | Transistor | BFR93AW npn 12V 35mA SOT323 |
| V411 | 4210102 | Transistor | BC858W pnp 30V 100mA 200MWSOT323 |
| V430 | 4210090 | Transistor | BFG540/X npn 15V 129mA SOT143 |
| V532 | 4210066 | Transistor | BFR93AW npn 12V 35mA SOT323 |
| V611 | 4210100 | Transistor | BC848W npn 30V SOT323 |
| V630 | 4210102 | Transistor | BC858W pnp 30V 100mA 200MWSOT323 |
| V631 | 4210100 | Transistor | BC848W npn 30 V SOT323 |
| V632 | 4210100 | Transistor | BC848W npn 30 V SOT323 |
| V634 | 4100567 | Sch. diode x 2 | BAS70-04 70V15 mA SERSOT23 |
| V635 | 4116536 | Zener diode | BZX84 5 % 2.4 V 0.3 W SOT23 |
| V637 | 4110117 | Zener diode | BZX84 5 % 3.9 V 0.3 W SOT23 |
| V723 | 4100285 | Diode x 2 | BAV99 70 V 200 mA SER.SOT23 |
| V741 | 4200226 | Darl. transistor | BCV27 npn 30 V 300 mA SOT23 |
| V742 | 4111824 | Diode | BAS16 75 V 250 mA 6 ns SOT23 |
| V772 | 4100285 | Diode x 2 | BAV99 70 V 200 mA SER.SOT23 |
| V790 | 4100567 | Sch. diode x 2 | BAS70-04 70V15 mA SERSOT23 |
| V791 | 4100567 | Sch. diode x 2 | BAS70-04 70V15 mA SERSOT23 |
| V792 | 4100285 | Diode x 2 BAV99 | 70 V 200 mA SER.SOT23 |
| D241 | 4370029 | IC, ASIC | PQFP64 |
| D251 | 4342264 | IC, EEPROM | SO8S |
| D252 | 4342264 | IC, EEPROM | SO8S |
| D790 | 4341611 | IC, 2xbn.counter | 4bit so14 74HC393 SO14S |
| N101 | 4370084 | IC, mas1013s-t | muumi NMP70084 SSOP24 |
| N130 | 4340164 | IC, regulator | TK11247 4.75 V 180 mA SSO6 |
| N140 | 4340164 | IC, regulator | TK11247 4.75 V 180 mA SSO6 |
| N310 | 4340164 | IC, regulator | TK11247 4.75 V 180 mA SSO6 |
| N311 | 4340164 | IC, regulator | TK11247 4.75 V 180 mA SSO6 |
| N370 | 4349694 | IC, if amp+fm detector | TA31136 SSO16 |
| N701 | 4370137 | IC, Nipa3 nmt audio/signalling t | TQFP64 |
| N761 | 4340331 | IC, Power amp. | LM4862 P W SO8S |
| N762 | 4340331 | IC, Power amp. | LM4862 P W SO8S |
| N820 | 4349616 | IC, 2xsynth 1.1ghz 3v sso | UMA1015M SSO20 |
| S100 | 5219005 | IC, SWsp-no 30vdc 50ma | sm SW TACTSMD |
| S101 | 5219005 | IC, SWsp-no 30vdc 50ma | sm SW TACTSMD |
| X001 | 5469031 | SM, conn c | hp2502-0101 1x2 m P1.25 |
| X002 | 5469031 | SM, conn | chp2502-0101 1x2 m P1.25 |
| X003 | 5469031 | SM, conn | chp2502-0101 1x2 m P1.25 |
| X120 | 5469007 | Syst.conn | 12af+jack+dc dct2 SMD |
| X130 | 5460021 | SM, conn | 2x14m spring p1.0 PCB/PCB |
| X600 | 5429007 | SM, coax conn | m sw 50r 0.4-2ghz |
| | 9854210 | PCB TA1 131.0X43.0X1.0 M4 2/PA | |