

Uppgjord (även faktaansvarig om annan) - Prepared (also subject responsible if other) BA/EML/AH/P A. J. Hoare (+44-1256-338181)		Nr - No. 1551 – KRC 118 12	
Dokansv/Godk - Doc respons/Approved BA/EML/AP/PC	Kontr - Checked	Datum - Date 1999-11-01	Rev pb1
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Technical Description of the R290_{Satellite} Dual Mode Globalstar/GSM User Terminal

Abstract

This document details the technical description of the R290 production unit.

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1 INTRODUCTION

1.1 SCOPE

This document details the systems' level information required by the Type Approvals' body for the R290 to obtain type approval.

Items such as the user guide and circuit diagrams are external to this document.

1.2 ABBREVIATIONS

A/D	Analogue - to - Digital Converter
AGC	Automatic Gain Control
ASIC	Application Specific Integrated Circuit
BB	Base band
CDMA	Code Division Multiple Access
CPU	Central processing Unit
DAC	Digital - to - Analogue Converter
DMUT	Dual Mode User Terminal
DSP	Digital Signal processor
DTMF	Dual-Mode Multiple-Tone
ECCP	Error Correction Co-Processor
ECLK	Electronic Clock
GHz	GigaHertz
GSM	Globalstar System for Mobile Communications
GMSK	Guassian Modulation Shift Keyed
GUM	Globalstar User Interface
GW	Gateway
H_DET	Power Detection
I and Q	In-phase and Quadrature
IF or I/F	Intermediate Frequency
LCD	Liquid Crystal Display
LED	Light Emitting Diode
LEO	Low Earth Orbit
LNA	Low Noise Amplifier
LO	Local Oscillator
mA	milliAmpere
mA.hr	milliAmpere hours
MHz	MegaHertz
MMI	Man Machine Interface
MSC	Mobile Switching Centre
N/A	Not Applicable

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O/P	Output
OQPSK	Off-shift Quadrature Phase Shift Keying
PA	Power Amplifier
PCB	Printed Circuit Board or Power Control Bit
PLL	Phase Locked Loop
PSTN	Public Service Telephone network
RAM	Random Access Memory
RF	Radio Frequency
RTC	Real Time Clock
Rx or RX	Receive
SIM	Subscriber Identity Module
SMPS	Switched Mode Power Supply
SPST	Single Pole Single Through
SRAM	Static Random Access Memory
TCXO	Temperature Controlled Crystal Oscillator
Tx or TX	Transmit
V _{BATT}	Battery Voltage
VCO	Voltage Control Oscillator

1.3 DEFINITIONS

BBii: Interface chip between Globalstar digital and IF signals

Gateway: The ground base station is the link between the phone (via satellite) and the terrestrial PSTN network.

GUM 2000: Globalstar Rake receiver

Foot print: Geographical area of land/water covered and serviced by a particular GW.

F_R Globalstar receive frequency range for a mobile station:

$$F_R = 2484.144 + 0.123 \cdot (N-1) \text{ MHz} \quad \text{where } 1 \leq N \leq 124$$

The DMUT shall support operations on channel numbers 1 through 124 inclusive. The preferred set of CDMA frequency assignments shall be channel number 63, 73, 53, 83, 43, 93, 33, 103, 23, 13, 123 and 3 in sequence.

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F_T Globalstar transmit frequency range for a mobile station:

$$F_T = 1610.64 + 0.03 \cdot (N-1) \text{ MHz} \quad \text{where } 4 \leq N \leq 509$$

The DMUT shall support operations on channel numbers 4 though 509 inclusive. (If $N = 1, 2$ or 3 , the DMUT may not meet the band emission requirements).

IC31: R290 modem chip.

Rx_ch: Receive frequency channels 1 to 123.

Tx_ch: Transmit frequency channels 4 to 496.

DMUT: R290 user terminal.

1.4

REFERENCES

Ref [1]	2/102 62 – 2/ROA 117 3861	Design Requirement for ROA 117 3861, R290 main Board.
Ref [2]	1911-2/ROA 117 3861	R290 Base band/GSM RF Board.
Ref [3]	1/1991-2/ROA 117 9620	Circuit diagram.
Ref [4]	BA/EML/AP/PC 99:0039	2 Cell Li-Ion Battery Management Specification for the R290 DMUT.

1.5

REVISION HISTIRY

Revision	Date	Comment
pA1	991020	First draft release.
pA2	991025	Second draft release after feedback from O/Ls
pA3	991101	Third draft release after review meeting.

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2 DESCRIPTION OF GLOBALSTAR NETWORK

The Globalstar system is a Low-Earth-Orbit (LEO) satellite system designed to provide voice, fax, data, and other telecommunications services to users world-wide utilising Code Division Multiple Access (CDMA) technology for the satellite path.

3 R290 TECHNICAL DESCRIPTION

3.1 FUNCTIONAL OVERVIEW

The R290 is a hand held mobile terminal that can function in both GSM 900MHz and Globalstar mode.

The R290 is capable of supporting voice, fax and data transmissions.

The R290 is GSM 11.10 and phase 2 compliant.

The GSM antenna is located within the Globalstar antenna mounting.

The phone consists of three PCBs.

1. The key mat PCB
2. The Globalstar RF PCB
3. The GSM/Globalstar PCB (contains all the house keeping functionality and the GSM RF strip)

There are three sets of software within the DMUT.

1. GSM protocol, MMI and internal interface software (this software controls all the house keeping functionality within the DMUT, interfaces with the 386 software, controls the MMI and controls the GSM operation of the phone)
2. Globalstar mode software (this software is dedicated to the Globalstar operation of the DMUT and interfaces with the H8 software).
3. Calibration file (this is a small file down loaded in to the 386 side of the DMUT that is used to calibrate the power amplification, ear piece and volume control of the Globalstar side of the DMUT).

The DMUT is powered on with the 'pwr' button at the top of the keypad. The DMUT takes several seconds to initialise.

Once initialisation is complete (ICs are fully powered up), the DMUT will start "searching for networks" in the last mode of operation prior to power off. If the phone is not in the desired mode, the mode can be changed using the menu options. A satellite icon appears when the UT is in satellite mode.

With the DMUT in GSM mode, the Globalstar circuitry is switched off. With the DMUT in Globalstar mode, the GSM circuitry is drawing minimum current.

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Upon finding a network either satellite or terrestrial, the DMUT displays the signal strength and once registered the service provider's name. The DMUT LED, at the top, continually flashes green while in service.

If the DMUT is out of its home location, a walking person appears in the DMUT display. This is the roaming indication.

A call can now be placed or received, a SMS sent or received or a supplementary service set.

To power off the phone, the 'pwr' button is pressed until "powering off" is displayed, the power bars then disappear and the DMUT turns off after a time.

3.2 OPERATIONAL PARAMETERS

Given below are the physical, radio frequency, environmental and electrical characteristics of the R290.

3.2.1 Physical Characteristics

Height	162mm
Height (antenna stowed)	202mm
Height (antenna deployed)	335mm
Width	61mm
Depth	39mm
Mass	337g

3.2.2 RF Characteristics

3.2.2.1 GSM

Transmit Frequency	890 to 915MHz
Receive Frequency	935 to 960MHz
RF Power Output (max)	33dBm
RF Channel, Tx	1 to 124 inclusive
RF Channel, Rx	1 to 124 inclusive

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3.2.2.2 Globalstar

Transmit Frequency	1610.0 to 1626.5MHz
Receive Frequency	2483.5 to 2500.0MHz
RF Power Output (max)	26.0 +0.5 -0 dBm
RF Channels, Tx	4 to 505
RF Channels, Rx	1 to 124

3.2.2.3 Type of Emission

3.2.3 Environmental Characteristics

Operating Temperature Range	-20° to +55°C
Storage Temperature Range	-40° to +70°C
Humidity	95% relative
Rain and Dust	Ingress protection to EN 60529 IP52

3.2.4 Electrical Characteristics

3.2.4.1 Power Supply: Battery

Voltage	6.0 to 8.4V with the nominal at 7.2V
Capacity	1050mAh

3.2.4.2 Power Rails (Derived from Battery Supply)

Power Rail	Function
+4V Supply	Used in GSM/BB and GS_RF boards.
+3.3V Supply	Used in GSM/BB and GS_RF boards.
+6.5V Supply	Further regulated in to: +5V_RF, +5V_LNA, +5V_RF_TX and +5V_RF_VCO.
+3.0V Supply	GS_RF board and derived from +3.3V supply
+5.0V Supply	GS_RF board and derived from +6.5V supply

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3.2.4.3 DC Power Supply to Tx Stages (Derived from Battery Supply)

3.2.4.3.1 GSM

From the battery, the voltage goes to a switched mode power supply (SMPS). From the SMPS, various voltages are regulated before being applied to each stage.

Stage	Voltage (V)	Current (mA)
Pre-amp	3.0	50
PA	5.0	50
Power Amplifier Control Voltage	1.2 to 4.0	-

3.2.4.3.2 Globalstar

There are primary sets of voltage that run the Globalstar RF board.

a) 3.6V

This voltage is regulated and derived from the 4.0V supply (see section 3.2.4.2). This voltage is supplies the AGC, Tx IF amplifier and the RF driver amplifier.

b). 5.0V and –3.6V

These are two separate voltages but are used to drive the same part of the circuit. A regulated 5.0V supply goes to the Globalstar RF PA and a regulated –3.6V supply is used on the PA -ve bias.

3.3 R290 CIRCUIT DESCRIPTIONS

Given below are the descriptions of the three different circuit areas within the R290: Baseband, GSM-RF and Globalstar-RF.

3.3.1 Base Band

A description of the base band functionality can be found in Ref [1] with the layout of each circuit given in Ref [2]

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3.3.2 GSM - RF

The sheet number of each circuit area (e.g., sheet2 of 12) is given with respect to Ref [2].

Circuit Area	Function
Low Noise Amplifier (sheet 1 of 12)	Pre-amplification of Received signal before being filtered.
Rx Filter (sheet 1 of 12)	Provides out-of-band rejection. Signal passes through band pass filter (centre frequency 947.5MHz). The filtered signal goes into the W2020 transceiver.
IF SAW (sheet 1 of 12)	Provides channel filtering and adjacent channel rejection. The inputs to the SAW filter come from the W2020 transceiver. Signal is filtered and one of the outputs goes back in to the w2020 transceiver.
Antenna Switch (sheet 1 of 12)	Implemented using a ceramic duplexer. This functions between 902.5 and 947.5MHz and splits the Rx and Tx signal. Provides out of band filtering between the GSM frequency bands.
W2020B RF Transceiver (sheet 1 of 12)	Integrated RF transceiver. Provides modulation and demodulation of Tx and Rx signals. Rx I and Q signals are provided to base band by single IF down conversion followed by Quadrature demodulation. Tx I and Q signals are directly modulated to the transmit frequency from 2 LO input signals.
UHF VCO and Loop Filter (sheet 1 of 12)	Provides Rx and Tx frequency tuning using a 1006 - 1032MHz VCO. Loop filter provides filtering of UHF VCO control voltage.
Rx VCO Loop Filter and Resonator (sheet 1 of 12)	Provides control voltage filtering and lumped resonant elements for Rx LO.
Tx VCO Loop Filter and Resonator (sheet 1 of 12)	Provides control voltage filtering and lumped resonant elements for Tx LO.
13MHz System Clock (sheet 2 of 12)	This is a TCXO that runs at 13MHz with buffering and waveform conversion for use by the baseband station. This is also used to provide stable references for the VCO's using standard phase lock loop techniques.
RF PA and System Clock (sheet 2 of 12)	This is the RF amplification circuit with power control circuitry. The Tx signal is band filtered and pre-amplified before power amplification.

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3.3.3 Globalstar - RF

The sheet number of each circuit area (e.g., sheet 1 of 5) is given with respect to Ref [3].

Circuit Area	Function
Tx LO (sheet 1 of 5)	This part of the circuit contains a local oscillator (1488MHz) and frequency synthesiser that generates a signal for use in the Tx mixer. The output of the Tx LO is fed in to the Tx LO Amp.
Tx LO Amp (sheet 1 of 5)	Amplifies the synthesised signal and feeds the RF signal in to the Tx Mixer.
Rx LO (sheet 1 of 5)	This part of the circuit contains a local oscillator (2267MHz) and frequency synthesiser that generates a signal for use in the Rx mixer.
Temperature Sensor (sheet 1 of 5)	Used to monitor the temperature of the Globalstar RF board near the power amplifier.
TCXO (sheet 1 of 5)	This is the temperature controlled crystal oscillator that runs at 19.68MHz.
Battery Connections (sheet 1 of 5)	Battery connections.
Tx AGC and IF (sheet 2 of 5)	Tx IF signal comes in and goes through a variable gain control; the O/P is smoothed and filters at a centre frequency of 130.38MHz. The O/P of this stage is fed in to the Tx Mixer.
Tx Mixer (sheet 2 of 5)	The Tx Mixer up converts the Tx IF signal to a RF signal using the TX LO input. The frequency change is from 130.38MHz to 1.61 to 1.6265GHz. The Mixer O/P is filtered using a filter with a centre frequency of 1618.25MHz. The O/P is then fed to the Tx RF, stage two.
Tx RF Stage Two (sheet 2 of 5)	Stage two filters (at 1618.25MHz), amplifies and filters (at 1618.25MHz) before being passed to the power amplification stage.
Tx PA (sheet 2 of 5)	The RF signal is amplified up to +29dBm and passed through an isolator (1610 to 1626.5MHz). A digital potentiometer used for setting the bias of the power amp.
Rx RF (sheet 3 of 5)	Received signal is filtered (at 2491.75MHz) is amplified with a low noise amplifier and then filtered again (at 2491.75MHz). The filtered signal is passed to the Rx mixer.
Rx Mixer (sheet 3 of 5)	The mixer down converts from 2.4GHz to IF using the Rx LO signal. The IF signal is passed to the IF amp and SAW filter.

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Rx IF Amp and SAW Filter (sheet 3 of 5)	The IF signal is amplified and filtered using a band pass filter centred at 224.88MHz.
Rx Variable gain Amplifier (sheet 3 of 5)	The filtered signal is split and amplified before being passed to the BBii.
BB2 (sheet 4 of 5)	Interfaces between the Tx and Rx IF signals and the GUM ASIC on the base band board.
Tx and Rx Regulator (sheet 5 of 5)	Ensures that the Tx and Rx sides of the Globalstar RF board receive a smooth 3.6V supply.
3V3 Regulator (sheet 5 of 5)	Ensures that the BBii and the associated circuitry receive a smooth 3.3V supply.
TCXO Regulator (sheet 5 of 5)	Ensures that the BBii and the associated circuitry receive a smooth 3.3V supply. Regulator for TCXO 3V3.
PA Negative Regulator (sheet 5 of 5)	Ensures that the PA receives a smooth –ve supply for the PA gate bias.

3.4 R290 PORTS

Given below are all the ports that can be physically connected to on the UTM.

Port	Classification
SIM Card	Signal/Control
Battery	Power
Battery Charger	Power
System Connector	Signal/Control
Globalstar RF Tx Car Kit	Power
Globalstar RF Rx Car Kit	Power
Globalstar RF Tx Test	Power
GSM RF Car Kit	Power

3.5 R290 ANCILLARY EQUIPMENT

Given below are the accessories that connect to the DMUT.

- Portable hands free
- Travel charger
- Car charger

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- d) Car kit
- e) Mobile Office (that includes a data cable)

3.6 USER CONTROL FUNCTIONS

Given below are the control functions on the DMUT including the volume control buttons on the left-hand side of the DMUT.

Key Name	Function
pwr	This powers on and off the R290.
clr	This clears a character or a string of characters from the phone display that has been incorrectly entered.
mem	This gains the user access to the memory store either in the phone or on the SIM card.
send	This is the 'initiate/answer a call' key or the 'yes' key for option selection.
end	This is the 'terminate a call' key or the 'no' key.
Menu keys	These two up/down arrows allow the user to navigate the menu structure and select different option.
Volume keys	Located on the left-hand side of the phone, these keys are used to control the volume of the ringer, DTMF tone and the audio in a call.
Alphanumeric keys	Allow the user to enter a phone number, enter word strings and scroll through written text.

3.7 POWER LEVELS

Given below are the power levels that the DMUT operates at in the two different modes.

3.7.1 GSM

As defined by GSM 11.10.

3.7.2 Globalstar

The power ranges from +10dBm to +26 –0, +0.5dBm in increments of 0.5±0.5dB.

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3.8 DESCRIPTION OF MODULATION TECHNIQUES USED

Given below are the modulation technique used in the GSM and Globalstar sides of the DMUT.

3.8.1 GSM

The modulation type is GMSK with a modulation index of 0.5, BT= 0.3 and a data rate of 270.833 kb/s (=13MHz/48kb/s), this leads to a maximum frequency deviation of ± 67 kHz. The data stream is passed through a linear filter before transmission that has a response set by the GSM BT factor.

BT is the product of B, the 3dB bandwidth of the linear filter, and T, the bit duration. The linear filter is contained in the IC22 (This is the GSM signal processor).

3.8.2 Globalstar

The Globalstar waveform is a CDMA, direct sequence, spread spectrum with OQPSK modulation.

Digital pulse shaping (filtering) is provided prior to the BBii. The filter characteristic is a root-raised cosine.

Special filtering is provided within the BBii. The BBii is an I and Q modulator and filters out the clock.

3.9 TX FREQUENCY GENERATION (OSCILLATOR FREQUENCY STABILISATION)

Given below are the methods used to generate the transmit frequency in the GSM and Globalstar sides of the DMUT.

3.9.1 GSM

For the GSM RF side of the R290, the TCXO (X1) is used to achieve oscillator frequency stabilisation. The frequency (13MHz) of each TCXO is checked at to factory as part of the quality control procedures.

3.9.2 Globalstar

For the Globalstar RF side of the R290, the TCXO (IC29) is used to achieve frequency stabilisation. The frequency (19.68MHz) of each TCXO is checked at the factory as part of the quality control procedures.

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3.10 METHOD OF FREQUENCY STABILISATION

Given below are the method used to stabilise the frequency that the Tx strip has been tuned to.

3.10.1 GSM

The actual GSM frequency (both Tx and Rx) is synthesised using an UHF synthesiser controlled by a PLL. The 13MHz TCXO is used as a reference frequency. A 200kHz signal is derived from the 13MHz clock to use as a reference for the tuneable UHF synthesiser, 200kHz also provides the channel spacing required for GSM. In order to meet the frequency error specification on transmit of $\pm 0.1\text{ppm}$, a frequency offset is calculated from the error between the handset and base station time bases. An offset parameter is then loaded in to a register on the IC22 that then introduces a phase offset on to the transmit I & Q signals to compensate for any time base error.

3.10.2 Globalstar

The instruction as to which Globalstar frequency is generated by the i386 transmitted as a digital signal. The IF signal is generated within the BBii. The BBii has its own VCO with an external PLL.

The Tx RF frequency is further stabilised using the Tx LO and PLL with VCO. The TCXO (19.68MHz) is used as a reference oscillator.

Lock signals are generated from all the RF and IF synthesisers. These signals are fed to a comparator; this comparator outputs one signal line stating.

3.11 TX POWER TUNING (TUNE-UP PROCEDURE)

Given below is the method of tuning the Tx strip for the GSM and Globalstar sections of the DMUT.

3.11.1 GSM

A power control voltage held in the register in the CSP1089 determines the transmit power level. Coupling and detecting a small portion of the output power and comparing the detected voltage with a reference voltage determined during transmission calibration provides power control. The output of this comparator is the PA control voltage. This provides closed loop control that continuously corrects the output power throughout the Tx burst.

3.11.2 Globalstar

There are three areas that are involved with the Tx power tuning; these are calibration, AGC and power detection (H_DET).

a). Calibration

Each Globalstar RF board is calibrated at the factory. It is this calibration table that allows the RF output power, of the DMUT, to be determined.

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b). AGC

The AGC is given a figure, at which the RF output power is to be set, this is converted in to a voltage and is used to drive the amplification stage, including the PA.

c). H_DET

This is the power detector used in the feedback circuit to correct any RF output power drift (tells the DMUT RF system to go higher or lower) locked or not locked.

3.12 FUNCTIONAL DESCRIPTION OF EACH IC

Given below is the functional description of each IC in the DMUT along with the part and identification number.

3.12.1 GS_RF Board (2/ROA 117 9620)

For location of each individual IC, refer to the circuit diagrams of Ref [3].

3.12.1.1 TxLO

IC Number	Part Number	Function
2	LMX2330A	Frequency synthesiser 1.4 to 1.5GHz.

3.12.1.2 RxLO

IC Number	Part Number	Function
5	LMX2330A	Frequency synthesiser 2.2 to 2.3GHz.

3.12.1.3 Temperature Sensor

IC Number	Part Number	Function
7 a to c	LMC6482I	Operational Amplifier

3.12.1.4 TCXO

IC Number	Part Number	Function
29	RTL 203 651/01	19.68MHz clock

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3.12.1.5 Tx AGC

IC Number	Part Number	Function
27	Q5505	Variable gain control

3.12.1.6 Tx Mixer

IC Number	Part Number	Function
16	MD54 - 0006	Mixer. Up converts from IF to 1.6GHz.

3.12.1.7 Tx RF

IC Number	Part Number	Function
15	1610 – 1626.5MHz	Isolator
11	CMM2306	Pre-amplifier

3.12.1.8 Tx PA

IC Number	Part Number	Function
14	CMM1335	Power amplifier up to +29dBm.
8	10K	Digital potentiometer used for setting the bias of the power amp.

3.12.1.9 Rx RF

IC Number	Part Number	Function
18	MGA - 85563	Low noise amplifier

3.12.1.10 Rx Mixer Section

IC Number	Part Number	Function
19	IAM - 91563	Mixer that down converts from 2.4GHz to IF

3.12.1.11 Rx IF Amp and SAW Filter

IC Number	Part Number	Function
20	MMIC	IF amplifier

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3.12.1.12 Rx Variable Gain Amplifier

IC Number	Part Number	Function
21	Q5500	Variable gain amplifier

3.12.1.13 BB2

IC Number	Part Number	Function
22	CD90 – 21884 – 5	CDMA to FM receive (BBii)
23	4W53	Multiplexer that feeds into BBii.
26	LMX2315	Rx IF synthesiser
25	TC7W14FU	Schmitt trigger
24 A to E	LMV339MT	Comparitor circuit for synthesiser lock

3.12.1.14 Tx Regulation

IC Number	Part Number	Function
3	MAX8860EUA28	3.6V regulator for Tx strip.

3.12.1.15 Rx Regulation

IC Number	Part Number	Function
10	MAX8877EUK36-T	3.6V regulator for Rx strip.

3.12.1.16 3V3 Regulation

IC Number	Part Number	Function
1	3V3	3.3V regulator for BBii and the associated circuitry.

3.12.1.17 TCXO Regulation

IC Number	Part Number	Function
9	LP2980-3V3	Regulator for TCXO 3V3.

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3.12.1.18 PA Negative Regulation

IC Number	Part Number	Function
6	843	-Ve regulator for PA gate bias.

3.12.2 GSM/BB Board (2/ROA 117 3861)

For location of each individual IC, refer to the circuit diagrams of Ref [2].

3.12.2.1 Low Noise Amp

IC Number	Part Number	Function
13	INA-12063	Pre-amplification of Rx signals

3.12.2.2 Antenna Switch

IC Number	Part Number	Function
1	RTN 501 57/01	902.5 – 947.5MHz. Splits Rx and Tx signal. Provides out of band filtering.

3.12.2.3 W2020B RF Transceiver

IC Number	Part Number	Function
3	W2020	Integrated RF transceiver. Provides modulation and demodulation of Tx and RX signals.

3.12.2.4 UHF VCO and Loop Filter

IC Number	Part Number	Function
3	RTL 402 715/01	1019MHz. Provides Rx and Tx frequency tuning.

3.12.2.5 13MHz System Clock

IC Number	Part Number	Function
4	7SLU04	Clock buffer
5	7SL02F	Clock that converts signal to square wave.
X1	RTL 203 652/01	TCXO clock that runs at 13MHz

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		±2.5ppm.
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3.12.2.6 RF PA and System Clock

IC Number	Part Number	Function
48	AD8519	Buffering of power control voltage
8 A and B	MC33202	Power comparitor detector bias supply
6	TA4003	Transmit buffer amplifier
7	PF01411A	Tx power amplifier

3.12.2.7 5V Supply

IC Number	Part Number	Function
51 a to g	74LVC14	Hex trigger inverter
9	MAX660	Voltage doubler
25	LP2981-5V0	Voltage regulator

3.12.2.8 3V RF Supply

IC Number	Part Number	Function
12	3V3	Low drop out voltage regulator

3.12.2.9 Charging Li-Ion

IC Number	Part Number	Function
17	MAX846A	Battery charging supervisor

3.12.2.10 Main Board Signal Processors

IC Number	Part Number	Function
22	CSP1089	Integrates timing and control functions within GSM phone with A/D and D/A I/Fs to both audio and RF sections of phone. Timing control for burst transmission.
18	DSP1628	ECCP. Memory mapped in to H8.

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3.12.2.11 GSM and Main Board Processing

IC Number	Part Number	Function
60	H8/HD6433044	Microprocessor control functions of GSM baseband, provides all MMI I/Fs, for both GSM and Globalstar and control power supply's and battery management.
24	GT28F160B3-TA120	Flash 1M x 16
27	KM68V2000ALFI-10L	SRAM 256k x 8. System working memory.
29	28LV256	EEPROM 32k x 8. Parameter storage.

3.12.2.12 RTC

IC Number	Part Number	Function
10	RS5C62	Real time clock
21	LP2980-3V0	Voltage regulator to derive 3.0V

3.12.2.13 SIM Interface

IC Number	Part Number	Function
33	ROP 1011 097-c	VIC SIM interface ASIC

3.12.2.14 PA Supplies

IC Number	Part Number	Function
19	LTC1435	Switched mode supply controller

3.12.2.15 Reset Generator and LCD ECLK Generator

IC Number	Part Number	Function
34	MAX809	Power on reset generator
37	74LVC14	Hex Schmitt trigger inverter
35	7SL02F	NOR gate
36 E	74LVC32	QUAD OR gate

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3.12.2.16 Decode Login

IC Number	Part Number	Function
40	74LVC138	3 to 8 decoder
51 D	74LVC14	Hex Schmitt trigger inverter
26 A to E	74LVC32	QUAD OR gate

3.12.2.17 Globalstar MMI I/F

IC Number	Part Number	Function
14	71V321	2k x 8 dual port RAM between H8 and i386.

3.12.2.18 Keyboard I/F

IC Number	Part Number	Function
38	LVC374	Octal latch
39	LVC245	Octal line driver

3.12.2.19 Globalstar Audio I/F

IC Number	Part Number	Function
42	LV4066	QUAD SPST analogue switch

3.12.2.20 Globalstar General I/F

IC Number	Part Number	Function
43	LVC374	Octal latch

3.12.2.21 Vocoder

IC Number	Part Number	Function
61	ADSP-2185	Single chip microprocessor optimised for digital signal processing and used in vocoder application.
46 A, B and E	74LVC32	QUAD OR gate
62 a, b and g	74LVC14	Hex Schmitt trigger inverter

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3.12.2.22 386 Memory

IC Number	Part Number	Function
20	KM616V4010CLZI-L	SRAM 256k x 16. System working memory
15	GT28F160B3-TA120	Flash 1M x 16. Memory for i386.

3.12.2.23 Globalstar Audio

IC Number	Part Number	Function
30 D and E	74LVC08	2 parts of a QUAD 2 input AND gate
50	TLV320AC36	CODEX
67	RYT 101 6124/3C	Audio buffer amplifier

3.12.2.24 Globalstar Processing

IC Number	Part Number	Function
55	GUM2 ASIC	Integrates 3 major function blocks: RF I/F, BBii I/F and auxiliary I/F with i386EX
46 C and D	74LVC32	QUAD OR gate
62 C	74LVC14	Hex Schmitt trigger inverter
58	49.152MHz	i386 processor clock
57	FA80386EX	Intel i386EX 32-bit architecture microprocessor that functions on Globalstar side of phone and operates at 3.3V and a clock speed of 24.576MHz.
51 b and f	74LVC14	Hex Schmitt trigger inverter
26 D	74LVC32	QUAD OR gate

3.12.2.25 Globalstar Power Supply Logic

IC Number	Part Number	Function
62 e and f	74LVC14	Hex Schmitt trigger inverter
30 B and C	74LVC08	QUAD 2 input AND gate
69 B and E	74LVC08	QUAD 2 input AND gate

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3.12.2.26 Globalstar +4V supply

IC Number	Part Number	Function
66	LTC1147L	Switched mode supply controller

3.12.2.27 Main 3V3 Supply

IC Number	Part Number	Function
11	LTC1147L	Switched mode supply controller

3.12.2.28 Globalstar Reset Circuit

IC Number	Part Number	Function
62 d	74LVC08	QUAD 2 input AND gate
30 D	74LVC14	Hex Schmitt trigger inverter
28	MAX825	Power reset supervisor

3.12.2.29 Modem

IC Number	Part Number	Function
31		CPU of this chip is ARM7TMDI THUMB processor. Used to: transfer data between IRENE and H8, connection to bottom system connector.
26 B	74LVC32	QUAD OR gate
44 A to E	74LVC125	QUAD tri state buffer
51 e	74LVC14	Hex Schmitt trigger inverter
32	IDT71V30L55TF	1k x 8 Dual Port SRAM between IRENE and GSM DSP
41	KM616V4010CLZI-L	SRAM 256k x 16. Working IRENE memory.

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3.12.2.30 Data Port

IC Number	Part Number	Function
69 C	74LVC08	QUAD 2 input AND gate
26 C	74LVC32	QUAD OR gate
45	MAX3243	RS232 Transceiver
51 C	74LVC14	Hex Schmitt trigger inverter

3.13 OPERATIONAL DESCRIPTION OF SYSTEM CRITICAL COMPONENTS

Given below are the components that are critical to the system operation of the GSM and Globalstar Tx sides of the DMUT.

3.13.1 GSM

Component	IC number	Reference [1]	Function
TCXO	X1	Sheet 2 of 12	For frequency stabilisation and channel tuning.
W2020	IC3	Sheet 1 of 12	Modulation
Tx Transmit SAW and Duplexer	F3 902.5MHz + (W2020)	Sheet 1 of 12	Limits transmit spurious radiation.
Rx Duplexer and Rx SAW	F1 947.5MHz + (W2020)	Sheet 1 of 12	Out of band rejection.
IF SAW Filter	F2 at 71MHz	Sheet 1 of 12	In band rejection (adjacent channels).
Tx PA	IC7	Sheet 2 of 12	Amplification of the GSM signal prior to transmission to the GSM antenna.

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3.13.2 Globalstar

Component	IC number	Ref [1]	Function
TCXO	IC29	Sheet 1 of 5	For frequency stabilisation and channel tuning.
Tx Synth	IC2	Sheet 1 of 5	Accurate Tx frequency generation.
Rx Synth	IC5	Sheet 1 of 5	Accurate Rx frequency generation.
Tx IF Filter	F1 at 130.38MHz	Sheet 2 of 5	Tx IF out of band frequency filtering.
Tx Mixer Filter	F7 at 1618.25MHz	Sheet 2 of 5	Tx RF out of band frequency filtering.
Tx Stage 2 Filter	F6 at 1618.25MHz	Sheet 2 of 5	Tx RF out of band frequency filtering.
Tx Stage 2 Filter	XR2 at 1618.25MHz	Sheet 2 of 5	Tx RF out of band frequency filtering.
Tx RF Filter	IC15 at 1610 to 1626.5MHz	Sheet 2 of 5	Tx isolation for the DMUT Tx frequency band.
Rx RF Filter	F3 at 2491.75MHz	Sheet 3 of 5	Rx RF out of band frequency filtering.
Rx RF Filter	F4 at 2491.75MHz	Sheet 3 of 5	Rx RF out of band frequency filtering.
Rx SAW Filter	F5 at 224.88MHz	Sheet 3 of 5	Rx IF out of band frequency filtering.
BBi	CD90-21884-5	Sheet 4 of 5	I and Q modulation.

3.14 PROCESSOR MONITORING FUNCTION (FAULT DETECTION MECHANISM)

Given below are the fault detection mechanisms within the DMUT.

3.14.1 GSM

The GSM RF side of the R290 does not have any fault detection mechanisms.

3.14.2 Globalstar

There is a lock detect mechanism on each of the PLL that detect if the frequency goes in to misalignment. If this condition arises, the DMUT will not enable the PA.

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3.15 VOLTAGE SHUTDOWN MECHANISM

For more detail, on the battery, other than that given below, refer to Ref [4].

4V and 3.3V supplies have a short circuit mechanism that comes in to operation at 900mA.

The 3.0V and 5.0V supplies have a short circuit mechanism that comes in to operation at 150mA.

6.5V max supply with no short circuit mechanism as it feeds in to the 5.0V supplies.

3.15.1 Battery Voltage Management

See also section 6.4 of Ref [4].

$V_{BATT} < 3.0V$	No discharging or charging allowed by battery protection circuit.
$3.0V < V_{BATT} < 6.0V$	Charging only allowed. Further discharge is prohibited. Power on is not allowed unless the DMUT is attached to a charger and charging.
$V_{BATT} > 8.4V$	Can be caused by poor tolerance of A/D conversion. Will be ignored and normal operation will ensue.

3.15.2 Battery Thermal Management

See also section 6.5 of Ref [4].

Temperature	Operation Condition
$X < -20^{\circ}C$	No operation allowed (Discharging or charging).
$-20^{\circ}C < X < 0^{\circ}C$	Discharging allowed (DMUT can make calls). No charging permitted.
$0^{\circ}C < X < 45^{\circ}C$	Normal operation (discharging and charging allowed).
$45^{\circ}C < X < 60^{\circ}C$	Discharging allowed (DMUT can make calls). No charging permitted.
$X > 60^{\circ}C$	No operation allowed (Discharging or charging).

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3.16 RADIO SERVICES PROTECTION (RADIO SHUTDOWN MECHANISM, FAULT CONDITIONS)

Given below are the protection/shutdown mechanisms of the DMUT in GSM and Globalstar mode.

3.16.1 GSM

The GSM RF side of the R290 does not have any shut down mechanism under fault conditions.

3.16.2 Globalstar

Each Globalstar RF board is calibrated to +26dBm, if the RF power output (power control loop) goes unstable, the DMUT will go in to ratchet mode. Ratchet mode causes the DMUT to limit the output power (the DMUT pulls the power down by 2dB).