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nanoBTS Product Description

NGSM_GST_300   **1.0m0.1 CP**

nanoGSM®

REVISION HISTORY

Version	Change Summary	Date	Author
0.1	First draft	13 Jun 2008	AM4
0.2	Added details of 165 Series C/D, added the Safety and Regulatory chapter, and removed the Profile chapters.	20 Oct 2008	MB3
0.3	Updated with comments from review	13 Oct 2008	MB3
1.0	Released	21 Nov 2008	ZN1
1.0m0.1	Added 165E/F/G/H information – CP DRAFT	30 Apr 2009	ZN1

DOCUMENT APPROVAL

Approved by e-mail.

TABLE OF CONTENTS

1 INTRODUCTION

1.1 Overview

This product description gives the technical specification of the 165 and 139/140 series nanoBTSs from ip.access. It describes the basic properties and functionality of the hardware and software. It includes information on the management model supported by the BTS. It does not go into detail on GSM service support beyond the most basic. This is described in the range of Feature Description documents also available from ip.access.

1.2 Related Information

[GSM05.05]	3GPP TS05.05; Technical Specification Group GSM/EDGE; Radio Access Network; Radio transmission and reception (Release 1999)
[GSM05.08]	3GPP TS05.08; Technical Specification Group GSM/EDGE; Radio Access Network; Radio Subsystem Link Control (Release 1999)
[REF_110]	nanoGSM BSS MIB Definition (NGSM_REF_110)
[INST_300]	nanoBTS Installation Manual (NGSM_INST_300)
[NGSM_SOC]	nanoGSM Statements of Compliance, ip.access
[NGSM_APR]	nanoGSM Approvals, ip.access

1.3 Terminology

AMR	Adaptive Multi-Rate
ARFCN	Absolute Radio Frequency Channel Number
AWG	American Wire Gauge
BA list	Basestation Allocation
Backhaul processor	Synonym for PPC in this document
BHCA	Busy-Hour Call Attempts
BSC	Basestation Controller
BSIC	Basestation Identity Code
BTS	Base Transceiver Station
CA List	Channel Allocation
CBCH	Cell Broadcast Channel
CCCH	Common Control Channel
CEM	Contract Electronics Manufacturer
CGI	Cell Global Identity
Codec	Coder-Decoder

CRC	Cyclic Redundancy Check
DAC	Digital to Analog Converter
DHCP	Dynamic Host Configuration Protocol
DLP	Downlink Processor (baseband processor responsible for transmit processing)
Dongle	Hardware plug used to reset the BTS to factory default settings
EEPROM	Electrically Erasable Programmable Read Only Memory
EFR	Enhanced Full Rate (GSM Speech coding)
ESD	Electro-static Discharge
FCC	Federal Communications Commission
FEC	Fast Ethernet Controller, or Forward Error Correction
FER	Failure Event Report
FPGA	Field Programming Gate Array
FR	Full rate (GSM Speech coding)
GPIO	General Purpose Input-Output
GPRS	General Packet Radio Service
HR	Half Rate (GSM Speech Codec)
HTTP	Hypertext Transfer Protocol
IP	Internet Protocol
LED	Light Emitting Diode
MAC	Media Access Control. Signifies a particular layer in the ANSI standard protocol model for GPRS. Also used in this document in the phrase "MAC Address"
MAC Address	The physical (hardware) address of the Ethernet interface. Ip.access has its own MAC address range allocated by IEEE.
MS	Mobile Station (= handset + SIM)
NACK	Negative Acknowledge
NCELL	Neighbour Cell
NV	Non-volatile
NWL	Network Listen
OCXO	Oven Controlled Crystal Oscillator
OEMid	Original Equipment Manufacturer Identifier
OML	Operations and Maintenance Link
OOL	Out-of-lock
OPLL	Output PLL
PA	Power Amplifier (final internal amplification stage in the nanoBTS)
PCB	Printed Circuit Board
PCU	Packet Control Unit
PLL	Phase-Locked Loop
POST	Power-on Self Test
PPC	Power PC (particular device used for Ethernet interface processing)

RACH	Random Access Channel
RSL	Radio Signalling Link
SABM	Set Asynchronous Block Mode (a message indicating the establishment of the radio data link)
SACCH	Slow Associated Control Channel
SCH	Synchronisation Channel
SDP	Software Download Package (proprietary format for software download to the BTS)
SI	System Information
SMS-CB	Short-message service – cell-broadcast
SMS-PP	Short-message service – point-to-point
SNMP	Simple Network Management Protocol
SoLSA	Support of Local Service Area
TA	Type Approval (an obsolete term used to signify testing against the harmonised 3GPP compliance specifications for the purposes of CE marking)
TCU	Timing and Control Unit (a subsystem of the nanoBTS baseband processor)
TFTP	Trivial File Transfer Protocol
TIB	Timing Interface Bus
TRX	Transceiver
UL	Underwriters Laboratory
ULM	Uplink Master (baseband processor responsible for receive processing)
ULS	Uplink Slave (baseband processor – controlled by ULM – also performing receive processing)
VBS	Voice Broadcast Services
VGCS	Voice Group Call Services

2 SERIES MEMBERS

The 165 series consists of the following products for the GSM bands shown in brackets:

- 165A (DCS 1800)
- 165B (PCS 1900)
- 165C (EGSM 900)
- 165D (GSM 850)
- 165E (DCS 1800)
- 165F (PCS 1900)
- 165G (DCS 1800)
- 165H (PCS 1900)

The 139/40 series consists of the following products for the GSM bands shown in brackets:

- 139_ (DCS 1800)
- 140_ (PCS 1900)
- 177_ (GSM 850)
- 178_ (EGSM 900)

The band designator is as used in [GSM05.05].

3 HARDWARE SPECIFICATION

3.1 External

3.1.1 Appearance (Informative)

The 165 series nanoBTS are shown in Figure 1 and Figure 2.

Figure 1 - 165A/B (EDGE) nanoBTS (left) and 165C/D/G/H (right)
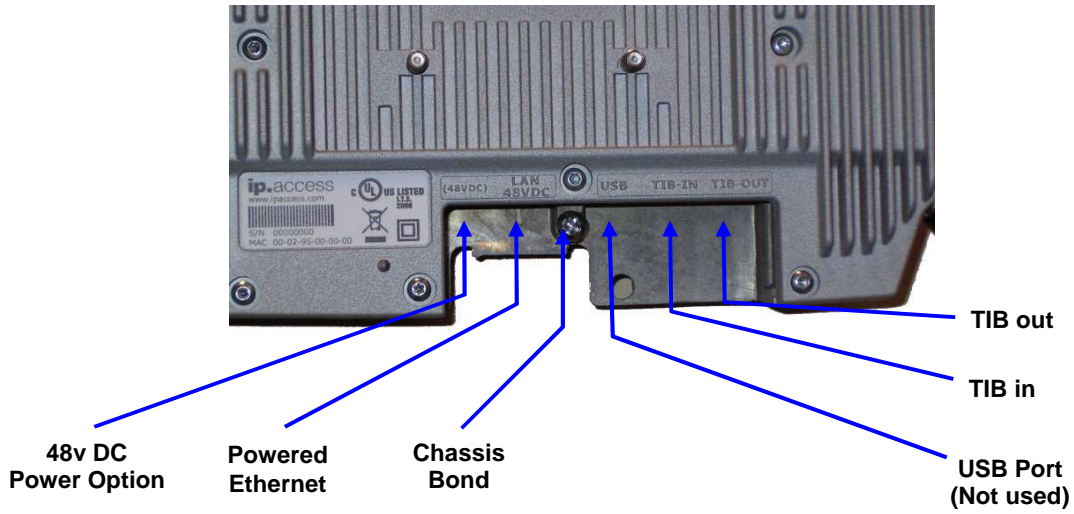
Figure 2 - 165 nanoBTS connectors

The 139/140 series nanoBTS is shown in Figure 3 and Figure 4.

Figure 3 - 139/140 nanoBTS
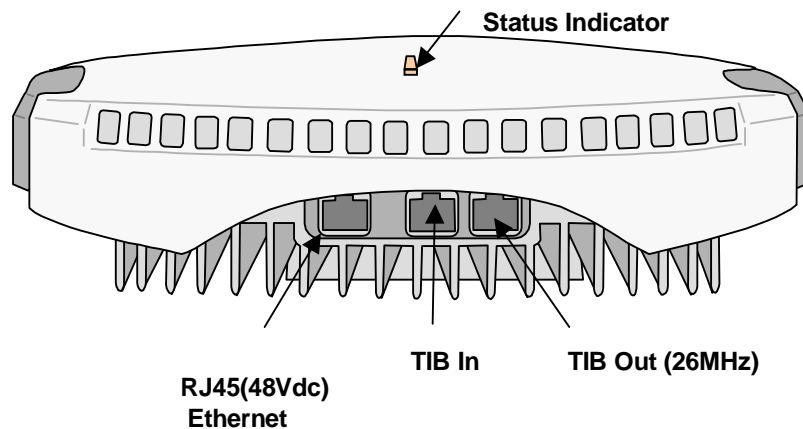
Figure 4 - 139/140 nanoBTS connectors

3.1.2   Size, Shape and Weight

The 165A/B series nanoBTS fits in an envelope approximately 276mm long, 208mm wide and 63mm deep. The plan shape is roughly rectangular. The 165C/D/G/H series nanoBTS fits in an envelope approximately 291mm long, 222mm wide and 63mm deep. The plan shape is roughly rectangular. These dimensions should not be used for space planning in installation. See [INST_300] for more information on space requirements of the 165 series. The unit weighs less than 2kg. When used in multi-TRX deployments, two 165 units may be mounted together in a "stacked" configuration (see [INST_300] for details).

The 139/140 series nanoBTS fits in an envelope approximately 275mm long, 210mm wide and 75mm deep. The plan shape is roughly elliptical. These dimensions should not be used for space planning in installation. See [INST_300] for more information on space requirements of the 139 series. The unit weighs less than 3kg.

Heavy finning on the back of the unit is provided for convective cooling when vertically mounted. When wall mounted, these fins are intended to be vertical.

Fins are also provided on the front of the unit, normally obscured by the plastic cosmetic cover. When ceiling mounted or in any other horizontal situation, the plastic cosmetic cover is intended to be removed to allow airflow across the front fins.

3.1.3   GSM Standards

Standards	Parts	Date
3GPP 11.21	Essential Compliance	v8.8.0
3GPP 05.05	EGSM, Power Class P1, as called up by 3GPP 11.21/Essential Compliance	v8.14.0
ETS 301 489	Part 8 – specific requirements for GSM basestations	v1.1.1

For a complete and normative statement of nanoGSM system approvals and standards compliance, see [NGSM_SOC].

3.1.4   Environmental

Operational:	Temperature Humidity	-5 ~+45C ambient 5-90% non-condensing
Storage:	Temperature Humidity	-20 ~ +80C ambient 5-90% non-condensing
Cold Start:	Warm-up period from cold	In-spec operation within 10 minutes
Hot Start:	System reset without loss of power supply	In-spec operation within 3 minutes
Standards:	ETS 300-019-1-1 ETS 300-019-1-2 ETS 300-019-1-3	Storage Class 1.1 Transport Class 2.3 Operation Class 3.1
	EN301-489-1 EN301-489-8 EN301-502	EMC general
	EN60950 / IEC 60950 /UL60950	Safety

Note that the 139/140 and 165 series are not hermetically sealed.

See [NGSM_APR] for complete approvals and standards compliance documentation.

3.1.5   Ethernet Interface

The Ethernet connector is 8-way RJ-45 female (screened on the 165 C/D/G/H).

The Ethernet physical layer is 10/100baseT, full-duplex, auto-negotiate.

3.1.6   DC Power

Power is expected by the unit on the Ethernet connector, according to IEEE802.3af option B or A. Option A is implemented with Or-ing diodes from the unused wires, and results in reduced supply margin and efficiency. Option B is preferred, therefore. See section 3.2.1 for more information.

The 139/140 series is designed to meet IEEE802.3af. Interoperability with 3rd party 802.3af supply equipment is not warranted. The unit is sold with its own mains power supply (Product 109), which inserts power onto the Ethernet cable. In addition, the 165 unit also has a separate connector for a 48V DC supply.

DC Power consumption is less than 13W.

3.1.7   TIB (Timing Interface Bus)

The TIB consists of two 10-way RJ45 connectors, a TIB-in and a TIB-out.

The TIB is required to synchronise the GSM frames between nanoBTS units acting together as a single multi-TRX BTS. TIB-in accepts GSM-frame timing from a preceding TRX and TIB-out generates it for the next TRX.

TIB-out	Current-mode LVDS drive, transformer coupled. Clock is divided system clock (26MHz/16).
TIB-in	LVDS, internal termination gives typically 300mV peak-to-peak when driven by TIB-out.
Reference Clock Input	External reference clock (10MHz), with detect circuit.
Frame Sync	Via removable link (for development / TA testing)
Security dongle	Support for detection of external dongle on TIB, connected to GPIO on PPC.
Maximum TIB cable length	1.5m
Drive control	Clock output to be enabled by software. This facilitates detecting position within a chain of BTS's.
Serial Interface	From PPC / ULM (via link on PCB).
FPGA Serial Output	For development logging output (via link on PCB).
TIB Spare 1 and 2	From FPGA (via link on PCB).
Connector	10 way RJ-45 with polarisation key to prevent insertion of standard Ethernet connector. Connectors and internal circuitry tolerant to hot insertion, removal and reversal of TIB in and TIB out cables.
Accessibility	Accessible in-situ. No protective cover.
ESD protection	Protected to Human Body / Equipment Level discharges and line induced surges. Protected against forced insertion of 48V Ethernet into TIB connectors, when debug links removed.

TIB out	
1	TIB SPARE 1 (to FPGA via link on PCB)
2	TIB SPARE 2 (to FPGA via link on PCB)
3	26MHz OUT -
4	26MHz OUT +
5	GSM SYNC OUT +
6	GSM SYNC OUT -
7	PPC Serial interface OUT (via link on PCB)
8	PPC Serial interface IN (via link on PCB)
9	FPGA SERIAL OUT (via link on PCB)
10	Ground

TIB in	
1	10MHz IN-
2	10MHz IN+
3	26MHz IN-
4	26MHz IN+
5	GSM SYNC IN+
6	GSM SYNC IN-
7	TRX FRAME SYNC (via PCB link)
8	Not connected
9	Security
10	Ground

3.1.8 Antennas

165 nanoBTS units provide SMA connectors that are exposed when the antennas are unscrewed as illustrated in Figure 5. (The removable antennas for 165C, 165D, 165G and 165H are shown in Figure 5. The removable antennas for 165A and 165B are smaller. 165E and 165F have no removable antennas.)
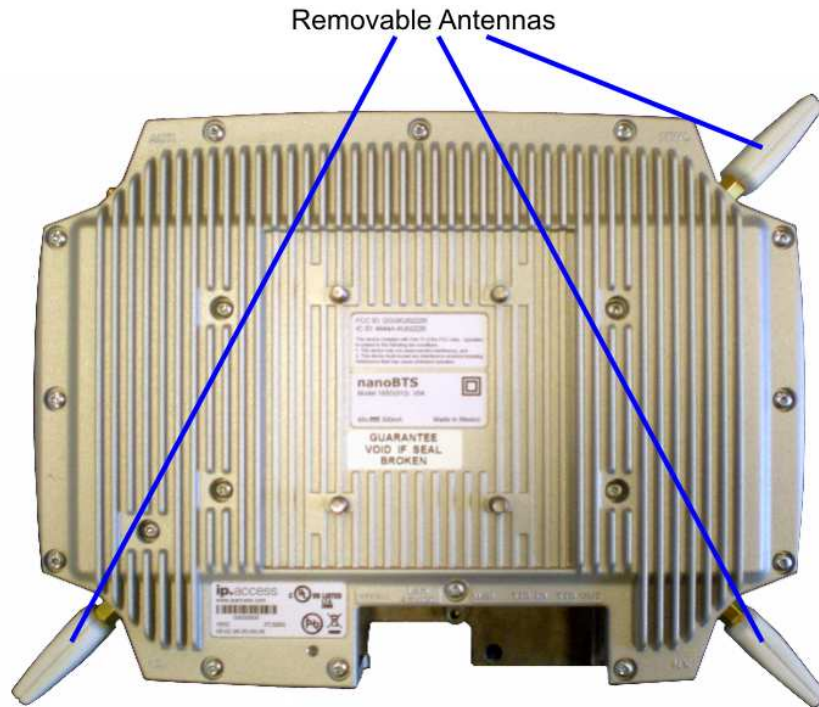
Figure 5 - Removable antennas – 165 hardware

The 139/140 series is normally used with its own internal antennas, of which there is one for transmit and one for receive. The units can be supplied with an optional external antenna kit, which allows the unit to be connected to an external duplexer, booster system, distributed antenna system or other external radio system (not supplied by ip.access). See [INST_300] for more details on the external antenna kit.

Figure 6 shows the 139/140 unit with external antenna kit fitted.

The external antenna kit introduces negligible loss, so the transmitter and receiver specifications given in sections 3.2.5, 3.2.6 and 3.2.7 apply equally at the external antenna ports.
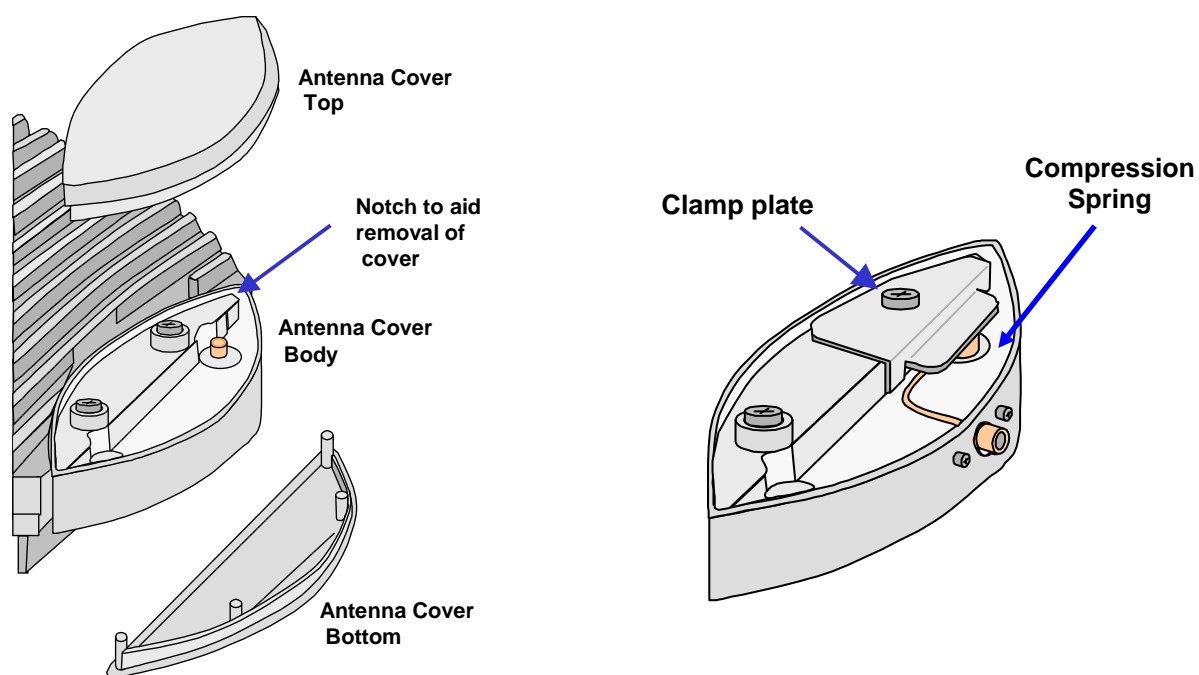
Figure 6 - External antenna kit

3.1.8.1   165 Antennas

Internal receive aerial	0 dBi nominal screw-on SMA omni-directional
Internal transmit aerial	0 dBi nominal screw-on SMA omni-directional
Internal NWL aerial	0 dBi nominal screw-on SMA omni-directional
Isolation (Tx to Rx)	30dB

3.1.8.2   139/140 Internal Antennas

Internal receive aerial	0 dBi nominal printed omni-directional
Internal transmit aerial	0 dBi nominal printed omni-directional
Isolation (Tx to Rx)	30dB

3.1.8.3   165 External Antenna Ports

Provision	Remove existing antennas to expose SMA connectors
Connectors	SMA female
ESD Protection	None – external cavity duplexer required

3.1.8.4   139/140 External Antenna Ports

Provision	Option kit – one connector each for transmit and receive
Connectors	SMA female
ESD Protection	None – external cavity duplexer required

3.1.9 LED Indicator

Two LEDS are provided on the PCB. These can provide three colours (red, green, orange) in various flash codes, as specified in section 5.8.2.

3.1.10 Labelling

TA/CE certification	Product 139 Product 165A Product 165E Product 165G	CE mark with associated devices. (FCC not appropriate for 1800MHz devices)
	Product 140 Product 165B Product 165F Product 165H	FCC mark with associated devices. UL mark with associated devices. (CE not appropriate for 1900MHz devices)
	Product 177 Product 165D	FCC mark with associated devices. UL mark with associated devices. (CE not appropriate for 850MHz devices)
	Product 178 Product 165C	CE mark with associated devices. (FCC not appropriate for 900MHz devices)
Product identification	Ip.access serial number in text and bar code, product code in text only	
MAC address	In text and bar code	
Positioning	Visible when mounted. Not positioned on front face.	
OEM label	Subject to separate specification and positioning	

3.1.11 Chassis Bond Point

139/140	Located on rear of BTS
165	Located on front of BTS
Multi-TRX operation	BTS's must be connected with 16AWG bonding cables when operated as a multi-TRX.
Cable length	Maximum cable length is 1.5m. Cable length must not exceed TIB cable length.

3.2   Internal

3.2.1   Power Supply

Input Voltage		36-57VDC (to cover power-over-ethernet range)
Input Current	max.	500mA from an input voltage of 37V. Input capacitor <180uf when operating (less during signature detect – see below)
Efficiency	min.	80%
Signature		Power input signature to comply with 802.3af rel 3 V_I slope (at 2.7 to 10.1V) 23.75K to26.25K ohms V offset <1.9V I offset <10uA Input capacitance 50 to 110nf Input inductance >100uH
IEEE802.3af wiring		Option B or A (B is preferred)
Isolation		1500V at 50-60Hz for 60S, resistance >2M ohms at 500V
Turn on Voltage		<44V
Turn off Voltage		>30V
48V DC Supply		165 units also have a direct DC power connector

3.2.2   OCXO

Frequency	26MHz
Accuracy (all causes)	$\pm 100 \times 10^{-9}$ per two years
Adjustment / calibration	Under processor DAC control or PLL locked to a TIB input with ability to calibrate free run frequency to a TIB input or NWL.
Adjustment DAC	12 bits +/- 0.5LSB differential non linearity
PLL Control Signals	LOCKED (PLL is in lock) XSENSE_1 (inverted PLL error analog value to ADC) XSENSE_2 (non inverted PLL error analog value to ADC) PLL_CE (tristates PLL to allow OCXO to free run at DAC value)

3.2.3   Backhaul Sub-System

Processor	139/140/178: MPC855T 165: MPC875	50MHz core and bus (32bit A&D)
Memory	Flash	8M
	SDRAM	8M
	EEPROM	64kbit

3.2.4 TRX Baseband Sub-System

Processors	Msp430 (3-off: ULM, ULS DLP)	139/140/178: ARM
		139/140/178: DSP
Memory	ULM	SRAM 256k x 16 bit (3 wait state)
	ULS	SRAM 256k x 16 bit (3 wait state)
	DLP	SRAM 256k x 16 bit (3 wait state)

3.2.5 Transmitter

	Frequency Range	**Maximum o/p power**
139_ (DCS 1800)	1805-1880MHz	+23dBm
140_ (PCS 1900)	1930-1990MHz	+23dBm
177_ (GSM 850)	869-894MHz	+20dBm
178_ (EGSM 900)	925-960MHz	+20dBm
165A (DCS 1800)	1805-1880MHz	+23dBm, +13dBm (8PSK)
165B (PCS 1900)	1930-1990MHz	+23dBm, +13dBm (8PSK)
165C (EGSM 900)	925-960MHz	+23dBm, +13dBm (8PSK)
165D (GSM 850)	869-894MHz	+23dBm, +13dBm (8PSK)
165E (DCS 1800)	1805-1880MHz	+23dBm, +13dBm (8PSK)
165F (PCS 1900)	1930-1990MHz	+23dBm, +13dBm (8PSK)
165G (DCS 1800)	1805-1880MHz	+23dBm, +13dBm (8PSK)
165H (PCS 1900)	1930-1990MHz	+23dBm, +13dBm (8PSK)

Channel spacing	200 kHz
Static power control	6 steps (2dB each)
Dynamic power control	6 steps (2dB each)
Power level error signal	Single bit – signals PA loop out of lock
OPLL unlock indicator	Single bit - s/w detects unlocked condition

Note that in static power applications (single TRX and C0 carrier) the dynamic power steps can be used statically to give a total static power control range of 12 steps of 2dB each.

3.2.6 Receiver - uplink

Frequency range	139_ (DCS 1800)	1710-1785MHz
	140_ (PCS 1900)	1850-1910MHz
	177_ (GSM 850)	824-849MHz
	178_ (EGSM 900)	880-915MHz
	165A (DCS 1800)	1710-1785MHz
	165B (PCS 1900)	1850-1910MHz
	165C (EGSM 900)	880-915MHz
	165D (GSM 850)	824-849MHz
	165E (DCS 1800)	1710-1785MHz
	165F (PCS 1900)	1850-1910MHz
	165G (DCS 1800)	1710-1785MHz
	165H (PCS 1900)	1850-1910MHz
Channel spacing	200 kHz	
Performance	Essential conformance to GSM 11.21 and GSM05.05	
Diversity	None	
AGC	Only baseband control	
Gain control steps	12, digitally controlled from ULS/ULM	
Gain settling time	5µs	

3.2.7 Receiver - downlink

Frequency range	139_ (DCS 1800)	1805-1880MHz
	140_ (PCS 1900)	1930-1990MHz
	177_ (GSM 850)	869-894MHz
	178_ (EGSM 900)	925-960MHz
	165A (DCS 1800)	1805-1880MHz
	165B (PCS 1900)	1930-1990MHz
	165C (EGSM 900)	925-960MHz
	165D (GSM 850)	869-894MHz
	165E (DCS 1800)	1805-1880MHz
	165F (PCS 1900)	1930-1990MHz
	165G (DCS 1800)	1805-1880MHz
	165H (PCS 1900)	1930-1990MHz
Channel spacing	200 kHz	
Performance	Normal MS specifications, derated by 10dB across the board	

4 MTBF

The 139/14- series has an MTBF greater than 120,000 hours. The 165 series has an MTBF of approximately 100,000 hours.

5   SOFTWARE SPECIFICATION

5.1   Top Level Feature Overview

The nanoBTS:

- supports DHCP for IP configuration

- supports 12.21 mechanism for software upgrades

- supports a single boot code storage bank

- supports two application code storage banks

- only supports a single "base-band transceiver" GSM 12.21 managed object instance

- supports configuration of the BTS via GSM 12.21 messages

- supports the ip.access "A-bis over IP Interface"

- supports "typical" GSM BTS operations such as

    - measurement pre-processing

    - handover

    - cell broadcast

    - transmission of system information

    - transmission and reception of "Full rate" or "Enhanced Full rate" speech traffic

    - transmission and reception of circuit switched data; A5/1 and/or A5/2 or "no encryption" algorithms over the air interface

- incorporates the GPRS Packet Control Unit (PCU) to deliver GPRS service to mobiles up to class 10 capability, with Coding Schemes 1-4. (165 with SR3 software also supports EGPRS MCS1-9)

- supports Advanced Multi-Rate speech codec (AMR) on 165 with SR3 software

- supports the ip.access "Network Listen" feature to monitor and decode other GSM base-stations

- performs regular monitoring of its operating conditions (e.g. temperature and voltage) and warn an operations and maintenance system if it exceeds its operating limits

- reports error conditions to the operations and maintenance system

- supports SNMP Gets and Traps for SNMPv2C

- controls an LED to provide feedback to the user as to the state the BTS is in

- interworks with the ip.access nanoBSC product

- stores non volatile parameters in EEPROM

These features are described in more detail in the following sections.

5.2   Explicitly Not Supported

- Multi-Slot Circuit Switched Data

- EDGE on 139 series BTS (supported by 165 with SR3 software)

- Half-rate speech codec (HR)

- Advanced Multi-Rate speech codec (AMR) on 139/140 series BTS (supported by 165 with SR3 software)

- IP Security

- IP Version 6

- HTTP server

- VGCS and VBS

- SOLSA

5.3   Standards

The base software support level is 3GPP Release 99 unless otherwise stated.

5.4   Reset Behaviour

5.4.1   Boot

On Power on, the bootstrap code changes the LED to state LED_SELF_TEST (note that this may actually mean that the LED is turned 'off' if the LED is disabled in EEPROM config – see section 5.8.2.

The bootstrap code performs Power-On-Self-Test (POST) on "cold" boot (if "Disable POST" flag is cleared in EEPROM). Warm boots do not perform POST.

The POST procedures check

- RAM on all processors

- Code Memory on all processors – checksum verification of code banks

- EEPROM Memory – checksum verification of attribute blocks

5.4.2   Software Code Banks and Software Bank Activation

nanoBTS software is stored in two banks, and the active bank is indicated by a EEPROM switch. If the active bank POST fails, then the inactive bank will be booted – with an associated Failure Event Report. If the inactive bank POST also fails, then the LED indicates LED_SELF_TEST_FAILURE.

nanoTRX software is downloaded to the inactive bank using the software download tool BtsInstaller (see [INST_300]). Software download proceeds without interrupting the operation of the BTS. The active bank flag is then altered. The next time the BTS restarts, the new software will be run.

5.4.3 Reset Reason

If the BTS undergoes a fatal software reset of any sort, a byte indicating the "reset reason" is stored in memory before the reset is initiated. During the reset procedure, this "reset reason" byte is read out, and sent to the management system as a Failure Event Report.

5.5 Configuration

5.5.1 DHCP

The BTS supports the ip.access specific implementation of DHCP.

5.5.2 Fallback OML Link

The BTS supports a fallback link to its BSC, by configuring the "Primary OML Fallback Address" and "Port" and the associated "Fallback Timeout". If the fallback address and port are configured, then the BTS will behave as follows

- On startup, the primary, non-fallback address is repeatedly tried, until either connection succeeds or the fallback timer expires

- If the fallback timer expires, then the fallback address is repeatedly tried, until either connection succeeds or the fallback timer expires

- If the fallback timer expires, then the non-fallback address is tried again, and so on

If the fallback timer is zero (its default value) then the non-fallback and fallback addresses are tried alternately.

If the fallback address and port are unconfigured, then the non-fallback address is tried repeatedly for ever.

5.5.3 Management Model and Attributes

The management model is fully defined in [REF_110]. An example class tree for the 1800MHz EDGE/AMR BTS is given below.
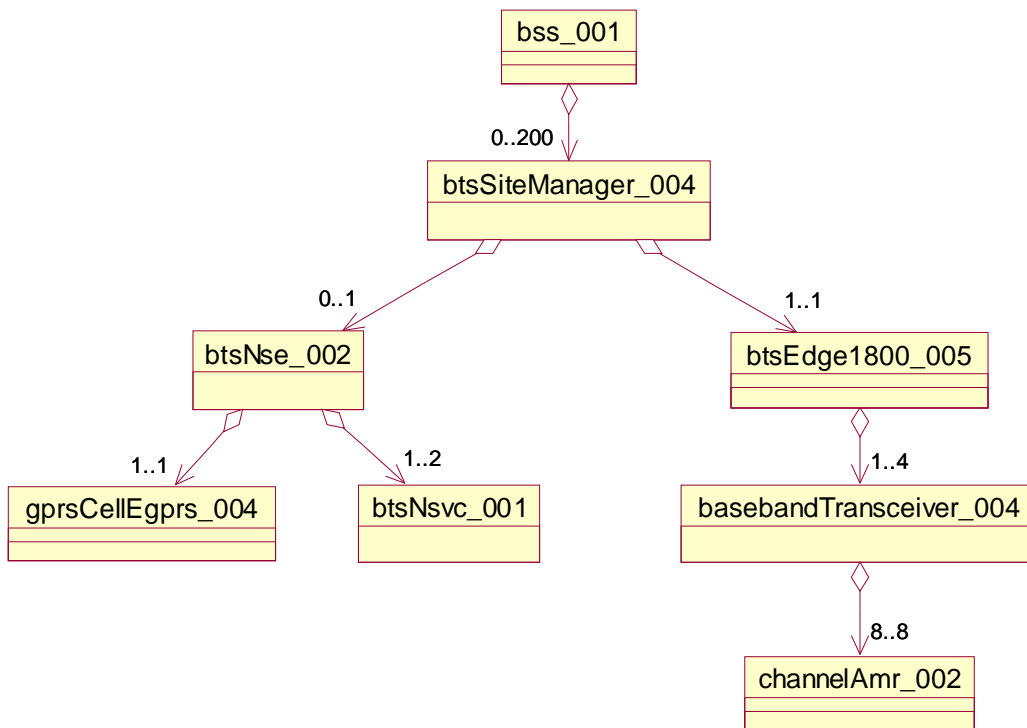
Figure 7 - 1800MHz, EDGE/AMR nanoBTS management model

5.5.4 Code Download

The BTS supports code download by using the software download function of the BtsInstaller tool (see [INST_300]).

The BTS examines the header of the downloaded file to determine if the BTS hardware is compatible with the SW. If any part of the code download is incompatible with the hardware, then the code download is NACK'd and the transfer is aborted, without affecting the running or the stored code.

For DHCP triggered TFTP, once the code has been successfully downloaded and the TFTP is complete, then the BTS shall set an internal flag (not set / get able from the outside world) to "disable DHCP triggered TFTP on reboot" in EEPROM. The BTS shall change the "Default" index to the index that it has just successfully downloaded. Then the BTS should reset itself. Once reset the BTS shall clear this flag (so that on the next reboot a DHCP triggered TFTP download is permitted) and begin executing this code.

If a code download fails or is aborted for any reason, then a Failure Event Report is sent to the management system.

5.6   Air Interface

5.6.1   Channel Combinations

The valid channel combinations on a "standalone" nanoBTS or on the Site Master TRX of a Multi-TRX configuration are:

Timeslot	Channel Types Allowed	Restrictions
TS0	Full BCCH	
	Combined BCCH	
	Combined BCCH with CBCH	
TS1	SDCCH/8	
	SDCCH/8 with CBCH	Only if TS0 is Full BCCH
	TCH/F, TCH/H	Requires 165 BTS with SR3 software
	Dynamic TCH/F, TCH/H	Requires 165 BTS with SR3 software
	Dynamic PDCH/TCH	
	PDCH	
TS2-7	TCH/F, TCH/H	TCH/H requires 165 BTS with SR3 software
	Dynamic PDCH/TCH	
	PDCH	

The valid channel combinations on a Slave TRX of a Multi-TRX configuration are:

Timeslot	Channel Types Allowed	Restrictions
TS0 and TS2-7	TCH/F, TCH/H Dynamic TCH/F, TCH/H	TCH/H and Dynamic TCH/H requires 165 BTS with SR3 software
TS1	SDCCH/8	Must be without CBCH
	TCH/F, TCH/H	TCH/H requires 165 BTS with SR3 software
	Dynamic TCH/F, TCH/H	Requires 165 BTS with SR3 software

The BTS supports different Training Sequence Codes (TSC) on each channel.

5.6.2   Power Control and Handover

The BTS supports MS Power Control algorithm according to [GSM05.08] annex A.

The BTS supports "Non Synchronised" handover.

The BTS does not support "Synchronised" handover of any variant.

The BTS performs Measurement Pre-processing to determine when a handover should occur and provides an ordered candidate list of Neighbour Cells to handover to (according to GSM 05.08 Annex A). The algorithm may be configured via "Measurement Pre-Process defaults" message (see section 5.14.2) in which case it is enabled. Configuration is BSC specific. Handovers can occur between different bands (e.g. 900MHz and 1800MHz).

The BTS sends RfResourceInds to monitor the background RF received power on unused timeslots.

The BTS supports the "Directed Retry" procedure on a particular MS to produce a list of candidate NCELLs that it can be handed over to.

5.6.3 Cell Broadcast

The BTS supports the "SMS-CB Default" message

The BTS supports the "SMS-CB Normal" message

The BTS does not support the "SMS-CB Scheduled" message

The BTS does not support the CBCH Flow control. The BTS sends an 08.58 ErrorInd upon receipt and throws a warning level FER (see section 5.7).

5.6.4 CCCH

The BTS supports Paging Re-organise and shall autonomously detect this by monitoring the System Information.

CCCH load management is supported via configurable Load Indication Period and Threshold attributes.

RACH load management is not supported.

Paging messages are repeated with configurable "Repeat Count" and "Repeat Period".

Paging repeats do not automatically terminate on receipt of the SABM.

5.6.5 System Information

The BTS transmits System Information (SI) messages as part of the BCCH channel (as defined in GSM 04.08 and 05.02).

The BTS supports SI 1, 2, 2bis, 2ter, 3, 4, 5, 5bis, 5ter, 6 (on SACCH), 7, 8, 13

The BTS does not support SI 9, 10, 16, 17.

All other System Information messages are not supported.

5.7 Error Handling

All software errors generate a "Failure Event Report" (FER) with manufacturer specific "Probable Cause". SW warnings include module and line number in the "Additional Text" IE's.

The BTS supports SNMP traps for all errors. Within the SNMP MIB there will be an entry of "last reported error".

There is a HW watchdog shall reset the system in case of unhandled errors.

Fatal Software errors store the error code in memory, and send a FER after reboot.

The BTS keeps a log of the last 10 SW and the last 10 HW errors in EEPROM including time and date of occurrence.

The BTS supports the GSM 12.21 (Version 5) "Request Outstanding Errors" procedure so that a BSC can list the state of all possible faults.

The BTS detects the loss of Ethernet connection by sending "keep-alive pings".

5.8   System Monitoring

The BTS monitors the Radio Synthesiser OPLL to ensure that it is transmitting on frequency. This will be done once per GSM frame. If an error is detected then the BTS will autonomously attempt to relock the OPLL. If the synthesiser does re-lock then a warning level FER shall be sent and immediately ceased. If the synthesiser fails to lock then a critical level FER on the radio carrier object is sent.

The BTS monitors the transmitter Power Amplifier OOL signal once per GSM Frame. If the BTS detects that the PA OOL signal is in error then the BTS shall send a major failure FER for the radio carrier object (the BTS does not reboot).

The BTS monitors its internal temperature. This is represented as a percentage of the nominal operating range. If the reading exceeds the "Temperature Alarm Thresholds" that are set in EEPROM then a FER shall be sent. It shall also send an SNMP trap. The default alarm thresholds are 0% and 100%. The percentages can go below 0% and are indicated as a signed number between –128% and +127%.

The BTS monitors its Input Voltage. If the result exceeds the "Voltage Alarm thresholds" then the BTS shall send an FER. It shall also send an SNMP trap. The default alarm thresholds are 0% and 100%.

5.8.1   SNMP Specific Features

The BTS supports SNMP v2C (Community-based) only.

The BTS supports the

- SMIv2 "Interfaces" MIB (see SMIv2 - Interfaces MIB - RFC 2233)
- SMIv2 "IP" MIB (see SMIv2 - IP MIB (IPv4) - RFC 2011)
- SMIv2 "TCP" MIB (see SMIv2 - TCP MIB - RFC 2012)
- SMIv2 "UDP" MIB (see SMIv2 - UDP MIB - RFC 2013)
- "Ethernet Interface MIB" – iso88023-csmacd group (see SNMP Ethernet Interface (EtherLike) MIB –   RFC 1643)
- SNMPv2 MIB. (see SMIv2 – SNMPv2 MIB – RFC 1907) with System group, SNMP group and MIB Objects group.

The BTS does not support SNMP "Sets". These shall be responded with the appropriate "SetResponse".

The BTS supports SNMP "Get", Get Next and "Get Bulk" on the supported MIBS

The BTS supports SNMP "Traps" on the supported MIBS.

The BTS supports SNMP enterprise "Traps" on all 12.21 failure event reports (except "Warning" or "Logged Warning" level failures) as the "last reported error" in the ip.access.v1 MIB. If the trap address is not NULL then a trap should be sent to the SNMP management agent.

The BTS supports setting of the SNMP "Community string" EEPROM parameter via 12.21 extensions only.

The BTS supports setting of the SNMP "Community string IP address" (that shall be used to limit SNMP gets by IP address) EEPROM parameter via 12.21 extensions only.

The BTS supports setting of the SNMP "SysContact" EEPROM parameter via 12.21 extensions only.

The BTS supports setting of the SNMP "trap address" EEPROM parameter via 12.21 extensions only.

The SNMP "SysLocation" shall be derived from 12.21 "location" string stored in EEPROM. Similarly the SNMP "SysName" shall be derived from the 12.21 "name" string stored in EEPROM.

The BTS supports the "ipaccess.v1" enterprise MIB that includes:

- description (of hardware)
- partNumber (hardware part number)
- partNumber (software part numbers and versions)
- serial number
- date and time of manufacture
- date and time of calibration
- input voltage (Volts)
- current draw (Amps)
- temperature (˚C) – signed number
- power (Watts)
- array of alarm states (for "input voltage", "current draw", "temperature" and "power")
- last reported error

5.8.2   LED States

It is possible to Disable the LED output (using 12.21 Set NV Attributes), however for some critical errors and for visual indication of on-site procedures (e.g. factory reset of database) the LED will still come on (see below).

In general, the LED states have a concept of precedence. Higher priority LED states take precedence over lower priority states.

With LED flag = ENABLED:

Table 1 - LED states when LED Enabled

State	Pattern	When	Precedence
LED_SELF_TEST_FAILURE	Red Steady	In boot or application code when a power on self test fails.	1 (High)
LED_UNSPECIFIED_FAILURE	Red Steady	On s/w fatal errors.	2
LED_NO_ETHERNET	Orange Slow Flash	Ethernet disconnected.	3

LED_DOWNLOADING_CODE	Orange Fast Flash	Code download procedure is in progress.	4
LED_ESTABLISHING_OML	Orange Slow Blink	OML not yet established (via primary or secondary OML port) but is needed in order for the BTS to become operational.	5
LED_FACTORY_RESET	Red Fast Blink	Dongle detected at start up and the factory defaults have been applied.	6
LED_SELF_TEST	Orange Steady	From power on until end of backhaul power on self-test	7
LED_NWL_TEST	Green Fast Flash	OML established, NWL test in progress	8
LED_LOCKED	Green Slow Flash	OML established, but an MO is locked that will prevent C0 being transmitted.	9
LED_OPERATIONAL	Green Steady	Default condition if none of the above apply.	10 (Low)

Note: When the nanoBTS is operational, it should continue to operate even if the OML connection is lost, and the LED should continue to show steady green.

With LED flag = DISABLED:

Table 2 - LED states when LED Disabled

State	Pattern	When	Precedence
LED_SELF_TEST_FAILURE	Red Steady	In boot or application code when a power on self test fails.	1 (High)
LED_UNSPECIFIED_FAILURE	Red Steady	On s/w fatal errors.	2
LED_NO_ETHERNET	Off	Ethernet disconnected.	3

LED_DOWNLOADING_CODE	Off	Code download procedure is in progress.	4
LED_ESTABLISHING_OML	Off	From power on until OML established.	5
LED_FACTORY_RESET	Red Fast Blink	Dongle detected at start up and the factory defaults have been applied.	6
LED_SELF_TEST	Off	From power on until end of backhaul power on self-test.	7
LED_NWL_TEST	Off	OML established, NWL test in progress.	8
LED_LOCKED	Off	OML established, but an MO is locked that will prevent C0 being transmitted.	9
LED_OPERATIONAL	Off	Default condition if none of the above apply.	10 (Low)

The non-steady LED states are defined as:

Table 3 - LED flash and blink timings

	Mark	Space
Slow Flash	1.0s	1.0s
Fast Flash	0.5s	0.5s
Slow Blink	1.9s	0.1s
Fast Blink	0.3s	0.1s

5.9   Traffic

5.9.1   Channel Types

The BTS supports the transport of

- Full Rate (FR)

- Enhanced Full Rate (EFR) GSM speech.

- AMR full- and half-rate speech (requires 165 BTS with SR3 software)

- BS20 (14.4k) single slot circuit switched data.

- BS21-26 (up to 9600) single slot circuit switched data

- BS61 and BS81 speech-then-data and alternate-speech-and-data.

The BTS does not perform any transcoding, but it does perform rate adaption for circuit switched calls to deliver all CSD bearers in V.110 frame format, for compatibility with the ip.access circuitBSC.

5.9.2   Encryption

The BTS supports A5/1 and A5/2 encryption, as well as no-encryption. Some units may not be supplied with encryption in the software load, because of export restrictions or other reason. The BTS rejects attempts to set up channels with encryption scheme not supported in a particular software build.

5.9.3   Traffic Frame Formats

The BTS supports the carrying of raw 64kb/s payload for circuit switched data (as PCM may be carried by IETF standards).

The BTS supports the IETF standard frame format of RTP for Speech calls on (for AMR see RFC3267, and RFC3551 for FR/EFR).

The BTS supports a nanoGSM-proprietary RTP payload format for multiplexed payloads (to minimise bandwidth).

5.10   Performance

The BTS is rated to support a loading of 600 BHCA with <1% error rate of call set-up failures, directed retries, handovers and location updates due to internal performance constraints of the BTS.

5.11   Peripherals

5.11.1   Backhaul

5.11.1.1   Miscellaneous

The BTS contains a Fast Ethernet Controller IC (FEC) with 10/100 mbps auto-negotiation (auto-negotiation occurs without needing to reboot).

5.11.1.2   EEPROM Storage

The EEPROM structure is protected against bit error using a CRC check mechanism.

5.12   NV Configuration

5.12.1   Parameters

The NV management state model for each parameter is as shown in Figure 8. All attributes are initially in the "illegal" state. This means that the store is completely invalid. If the store is "illegal" when the software starts up then its structure is written and all attributes are "defaulted".

Type 1 attributes will be "initialised" and cannot be "modified", for example the MAC address. Type 2 attributes can be "modified", for example whether DHCP is enabled. To prevent changing read-only "initialised" values, if the OEMid value is non-null (has been "initialised") then write access to Type 1 attributes is denied. Given this model, the factory code requirements can be achieved using a single software image and a single defined use of the dongle.
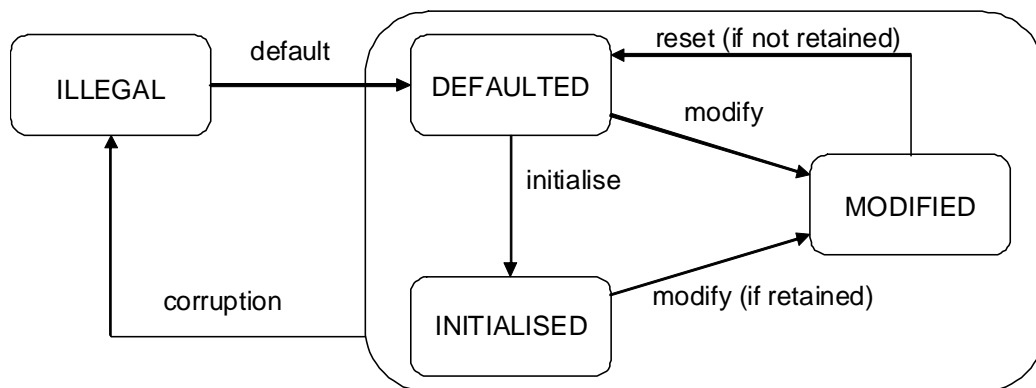
Figure 8 - NV configuration model

All attributes listed in Table 4 with "Initialised? == Y" are assumed to be type 1 attributes and cannot be overridden once OEMid has been set in the factory (except for the case of "OCXO DAC Value" which can be adjusted using the SetNVAttributes message or as a result of a frequency synchronisation test using NWL). For returned units in the factory, the OemID can be overridden with a special command (see FAT_017).

All other attributes are type 2. Those marked "Retained? == Y" are not reset to factory defaults by insertion of the dongle.

If the EEPROM is deemed to be corrupt then the BTS attempts to send a FER as soon as it connects (or is connected to) an OMC (see section 5.7). It shall also set the base-band transceiver managed objects to "Disabled, Failed". The LED state should also be set to "LED_FACTORY_RESET".

Note: Not all NV parameters are available for use by end-customers. Some are reserved for factory or other internal ip.access use.

Note: The presence of an NV flag does not indicate support of a feature of the same name.

Table 4 - NV Attributes

Attribute	Default Value	Initialised?	Retained?
MAC Address	00:02:95:00:00:00	Y	N/A
PCB Assembly Part Number	"108_029"	Y	N/A
PCB Assembly Issue	"X"	Y	N/A
HW/SW Compatibility	0x02	Y	N/A
CEM Id	0xFF	Y	N/A
CEM Serial Number	" "	Y	N/A
IPA Serial Number	" "	Y	N/A
OEM Id	0xFF	Y	N/A
Date and Time of Manufacture	01/01/1900 00:00:00	Y	N/A
Date and Time of Calibration	01/01/1900 00:00:00	Y	N/A
OCXO Slope	0x0000	Y	N/A
Max OCXO Current (mA)	1000	Y	N/A
Default Gateway	0.0.0.0	N	N
Subnet mask	0.0.0.0	N	N
IP Address	0.0.0.0	N	N
Primary OML Link IP Address	0.0.0.0	N	N
Primary OML Port	0	N	N

Secondary OML Link IP Address	0.0.0.0	N	N
Secondary OML Port	0	N	N
Flags 1 – Static Interface IP Config	FALSE	N	N
Flags 1 – Static IP Gateway Config	FALSE	N	N
Flags 1 – Static Primary OML Config	FALSE	N	N
Flags 1 – Dhcp	TRUE	N	N
Flags 1 – LED	TRUE	N	N
Flags 1 – Alarm Thresholds NV	TRUE	N	N
Flags 2 – Secondary OML Enable	TRUE	N	N
Flags 2 – Diagnostics Enable	FALSE	N	N
Flags 2 – CLI Enable	FALSE	N	N
Flags 2 – HTTP Enable	FALSE	N	N
Flags 2 – POST Enable	FALSE	N	N
Flags 2 – SNMP Enable	TRUE	N	N
OCXO DAC Value	0x0000	Y	Y
Input Supply Voltage Thresh Max Percent	100	N	N
Input Supply Voltage Thresh Min Percent	0	N	N
BTS internal Temperature Max Percent	100	N	N
BTS internal Temperature Min Percent	0	N	N
Input Supply Current Thresh Max Percent	100	N	N
Input Supply Current Thresh Min Percent	0	N	N
Input Supply Power Thresh Max Percent	100	N	N

Input Supply Power Thresh Min Percent	0	N	N
BTS Location	" "	N	N
BTS Name	" "	N	N
Site Id	0xFFFF	N	N
BTS Id	0xFF	N	N
TRX Id	0xFF	N	N
In Service Time	0	N	Y
Primary OML fallback address	0.0.0.0	N	N
Primary OML fallback port	0	N	N
SNMP community string	"public"	N	N
SNMP Trap Address	0.0.0.0	N	N
SNMP Trap Port	0	N	N
SNMP Manager Address	0.0.0.0	N	N
SNMP System Contact	"Not Known"	N	N

Note: "OEM Id" is defaulted with its null value 0xFF.

Note: "Date and Time of Calibration" is re-initialised whenever a full calibration is performed.

Note: "Subnet mask" is defaulted with its null value – if IP Address is configured and subnet mask is null then use a class mask appropriate for this address.

Note: "Primary OML Link IP Address" is initialised with its null value. The software must prevent attempts to use this address (NULL value) when connecting to servers.

Note: "Primary OML IP Port" is initialised with its null value. When booting with this null value, the software will choose an appropriate vendor specific value.

Note: "Flags 1 – Dhcp" is not directly settable. If any of the three static IP config flags (interface, gateway or OML) are false then this is true, otherwise it is false.

Note: "Flags 1 – Alarm Thresholds NV" is not directly settable. If any of the voltage, current, power or temperature thresholds are set, then this is true, otherwise it is false.

Note: "BTS Name" is defaulted with its null value. If the software detects this null value then it uses the value "nbts-" concatenated with the "-" separated MAC address.

5.12.2 TRX Controlled Parameters

Attribute	Default Value	Notes
TRX database schema		
TX Power ramps		13 levels, 32 x UInt16
TX Scale factors		13 levels, UInt16 for each level
TX Frequency compensation		12 ARFCN's, UInt16 for each ARFCN
TX DC Offsets	0x0, 0x0	2 x SInt16
RXGainControlNormal (i.e. uplink receiver)		26 AGC steps, UInt16 for each step
RXGainControNWL (i.e. downlink receiver)		26 AGC steps, UInt16 for each step
RxAccurateGainNormal (i.e. uplink receiver)		26 AGC steps, UInt16 for each step
RxAccurateGainNWL (i.e. downlink receiver)		26 AGC steps, UInt16 for each step
RxFreqCompNormal (i.e. uplink receiver)		12 ARFCN's, SInt16 for each ARFCN
RxFreqCompNWL (i.e. downlink receiver)		12 ARFCN's, SInt16 for each ARFCN
RxDC Offsets	0x0, 0x0	2 x SInt16

5.13 Operations

5.13.1 Network Listen

The BTS supports

- the "Channel Usage" test to determine received power on requested ARFCNs.

- the "BCCH Channel Usage" test to determine if the channel contains a FCH and SCH channel. It reports report the power level, BSIC, frame and sub-frame offset if a BCCH is detected.

- the "BCCH Info" test. It decodes SI1 to determine the CA list and SI3 to determine the CGI (Cell Global Identity). It captures SI2, SI2-bis, SI2-ter and sends them as entire SI messages in the result. The test may take up to 35 seconds to pick up all of the system information types off-air.

- the "Frequency Synchronisation" test to measure the frequency offset of other basestations with respect to its own OCXO setting. For each ARFCN it reports a frequency quality metric and the offset in ppb's. When the frequency error is such that the BTS can measure a coarse frequency offset from the FCH, but cannot decode the SCH (because the DSP equaliser cannot resolve the frequency offset) it reports an error with a frequency quality of "0".

- the "Beacon mode" test to enable other basestations to monitor it. This test is configurable to set the BSIC, ARFCN and transmit power to be used. The test continues until a "Stop Test" request is made. The transmitted BCCH information marks the cell as "barred" for all access types.

NWL tests will take the BTS out of service for the duration of the test. The BTS will restart service after the test is complete. A state change event report is generated at the beginning and end of the test.

5.13.2   Normal Operation

After boot-up and POST (if enabled), the BTS attempts to connect to Primary OML (as indicated in IP and Port number settings in database).

Once connection is established, it uses "heart-beat" connection message as defined in the ip.access Abis Over IP specification to detect if connection has gone down.

The BTS starts up a second OML server (if enabled in NV Config flag F9). It uses the second OML port specified in NV, or if this is NULL then assume a default of 3006. If the second oml IP address field is not NULL then it should reject connections from IP addresses that are not the same. SW activation can occur on either primary or secondary OML.

On loss of the second OML client the BTS does not reboot. Interrupted procedures are terminated and do not take effect.

Once the BTS has established any OML connection it performs a "SW Activation Request" for the Site Object.

Once the BTS has performed the "SW Activation" for the Site object it performs a "SW Activation Request" for the Baseband Transceiver Object.

Once the BTS has performed the "SW Activation" for the Baseband Transceiver object it will perform a "SW Activation Request" for the BTS object.

Once the BTS has performed the "SW Activation" for the BTS object it performs a "SW Activation Request" for the Radio Carrier Object.

The BTS shall send "State Change Event Report" messages at the appropriate times (as defined in GSM 12.21) whenever the managed object state changes.

5.13.2.1   SW Activation Procedure

The HW Configuration attribute in the SW Activate Request is the same for all objects, and is the same as would be obtained by sending a Get Attributes message to an object.

The SW Configuration attribute includes at least one SW Description for each type of image that it is dependent on, excluding boot code.

Note: The boot code has already finished executing by the time software activation occurs, so there is no need to activate it.

If, when an object sends a SW Activate Request, a version of an image that it depends on has already been activated, it only includes that version's SW Description, otherwise it includes a SW Description for each version of the image that is available for activation.

If the same software version is in both banks, then both banks shall be reported where applicable (see above).

Note that the value of the SW Configuration attribute in a SW Activate Request message sent by an object is therefore not the same as that of the SW Configuration attribute obtained by sending a Get Attributes message to the object. i.e. the SW Configuration Attribute reported as a response to the "GetAttributes" message includes the "Boot application"; the "Boot application" is not included in "SW Activate Request" messages.

Where a SW Activate Request contains more than one SW Description for a given image type, the first one is the "default" image. An image can be selected (eg. under user control) as the default image by sending a manufacturer-defined operations and maintenance message, "Set Default SW" to the nanoBTS.

Note: The term "Boot" in "Set Default SW" does not refer to the nanoBTS's boot code image, it refers to the (backhaul and TRX) software that the nanoBTS should run by default the next time it is rebooted.

The BTS expects to receive a SW Activate message in response to each SW Activate Request that it sends. The SW Activate message may contain 0, 1, or more SW Descriptions – and each of these must have been present in the corresponding SW Activate Request message. If it contains no SW Descriptions, the object to which it is sent will default to activating the most sensible default set of software. If it contains more than one SW Description, they should be such that they can all be activated (for example, there should not be more than one version for a given File Id).

Each managed object as defined in GSM 12.21 (Site Manager, BTS, Baseband Transceiver, Radio Carrier, and Channel) has a SW Configuration attribute, which is a list of one or more SW Description attributes. In the nanoBTS, each object's SW Configuration will contain a SW Description for each version of each of the images on which the object depends. (An object depends on a software image if the physical item that it represents requires the image to be executed before it can provide any service.)

Each 12.21 managed object has a HW Configuration attribute, which is a list of one or more HW Description attributes. In the case of the nanoBTS, each object's HW Configuration attribute will contain exactly one HW Description, which will have the same value for all objects. This HW Description relates to the PCB assembly inside the nanoBTS.

The BTS's Site Manager object sends a SW Activate Request containing a SW Description for each backhaul software image that is present. The first (and perhaps only) of these refers to the backhaul software that is currently running.

The BTS expects the BSC to send a SW Activate message containing either no SW Descriptions, or one SW Description. If there is no SW Description or there is one and it refers to the version of backhaul software that the BTS is currently executing, that is marked as having been activated, and the procedure continues. If there is one SW Description and it refers to the version of backhaul software in the other bank, the BTS marks that version as the default, and restarts itself. On restart, the BTS executes the version marked as the default, and repeats the software activation procedure. Note that it shall not send anything else to indicate that it had to reboot (such as a FER). This time, the Site Manager's SW Activate Request message will include the SW Description for the backhaul software that is now executing before the SW Description for the version that it was previously executing.

The BTS's Baseband Transceiver object sends a SW Activate Request containing a SW Description for the backhaul software image that was activated on the Site Manager object, plus a SW Description for each TRX software image that is present. The BTS expects the BSC to send a SW Activate message, which may contain no, one, or two, SW Descriptions. If there is no SW Description, the nanoBTS will activate the "default" TRX device software. If there is a SW Description for the backhaul, it must match that which was sent in the SW Activate Request. If there is a SW Description for the TRX software, the nanoBTS will load the specified version onto the TRX device and execute it.

The nanoBTS's BTS object sends a SW Activate Request containing a SW Description for the backhaul software image that was activated on the Site Manager object. The BSC should send a SW Activate message to the BTS object containing either no SW Descriptions, or the one SW Description that was in the SW Activate Request. In either case the procedure continues. If the BSC sends a SW Activate message in response that does not match any of its SW Descriptions then the BTS shall N'ACK the message.

The BTS's Radio Carrier object sends a SW Activate Request containing one SW Description for the backhaul software image that was activated on the Site Manager object and one for the TRX software that was activated on the Baseband Transceiver object. The BSC should send a SW Activate message to the BTS object containing either no SW Descriptions, or one or both of the SW Descriptions that were in the SW Activate Request. In either case, this is the end of the software activation procedure, and the other procedures associated with starting up the BTS can be carried out.

5.14   Abis Interface (ABIS)

The BTS conforms to the ip.access Abis Over IP specification.

5.14.1   Operations and Maintenance Signalling Messages

The BTS supports Abis messages according to the ip.access Abis Over IP specification and as clarified below on both primary and secondary OML links.

The BTS initiates the "Primary OML Establishment" procedure to the defined "primaryomlipport" parameter in EEPROM configuration. If this is set to the NULL value (see section 5.12) then the BTS shall use the vendor specific port number as defined in the software build (IPA BSC = 3002).

The BTS supports the "Connect IP Signalling" message according to the ip.access Abis Over IP specification.

The BTS supports the "Set Default SW" message according to the ip.access Abis Over IP specification. This has the effect of adjusting the EEPROM parameter so that on the next reboot the BTS will boot the specified Backhaul Index (see section 5.4.1). It will also use the "default" set indexes (for Backhaul and TRX) as its first preference offered to the BSC in the SW Activation procedures.

On receipt of new configuration the BTS will immediately use the configuration for the NVConfig Flags F7-F9. Note that in the case of F9 (Second OML Enable) that this does not disconnect current connections, but stops new connections.

The BTS will adjust the Frequency control immediately upon receipt of new configuration of the "Frequency Control" IE.

The BTS does not immediately use the new Primary OML or Secondary OML Configuration if a connection has already been established. It shall use the configuration for all new connections.

The BTS does not immediately action receipt of configuration of new IP Configuration (either from the "IP Interface Config" or "IP Gateway Config"). A reboot is always required.

The BTS immediately actions receipt of configuration of new BTS Location.

The BTS does not immediately use new Unit Id configuration (BTSid and TRXid). A reboot is always required. For single TRX configuration, the TrxId is always be 0.

The BTS supports setting of the "Name" field.

The BTS supports the extension to the "SetBTSAttribute" message for paging configuration. Note that the defaults are hard coded and cannot be adjusted in NV configuration.

The BTS supports the Set Alarm Thresholds with the behaviour as defined in the ip.access Abis Over IP specification. Note that the behaviour depends on the NVConfig flag F8 ("SetAlarmThresholds").

The BTS supports the "Perform test" message for starting NWL tests according to the ip.access Abis Over IP specification.

The BTS supports the "Get Attribute" message as defined in the ip.access Abis Over IP specification and not as per GSM 12.21 V5.0.0.

The BTS supports the "Reinitialise" message.

5.14.2   RSL Signalling Messages

The BTS uses the "Measurement Pre-processing Defaults" messages for configuration of the Measurement Pre-processing algorithm (according to the ip.access Abis Over IP specification). The BTS should accept this message at any time and apply new defaults for new dedicated connections. The BTS or any sub-object does not need to be locked for this to take effect.

5.14.3   User Traffic Messages

The BTS supports RTP Traffic format as defined in the ip.access Abis Over IP specification.

The BTS does not support the Traffic Frame Synchronisation Procedure.

5.14.4   Channel Control Messages

The BTS supports the "Heartbeat" procedure according to the ip.access Abis Over IP specification. The BTS requires the Identity Request Message over TCP or UDP. The BTS shall respond to a UDP message to the well-known "second omlipport" number (3006).

Upon heartbeat failure of OML, the BTS shall try to carry on if already operating, keep trying to reopen the connection. Messages should be discarded as required to avoid overflow (e.g. whenever connect returns a failure, discard any queue and immediately retry, if too many things queue whilst awaiting connection, discard as required).

Upon heartbeat failure of RSL, the BTS shall disable the relevant TRX, dropping calls and clearing up as required, (it should act as if locked and then immediately unlocked again).

Keep trying to connect, send an alarm to the operations and maintenance, resume normal operations as soon as link is restored.

5.15   GPRS Feature Support

The BTS supports

- Gb over IP, with NS frames being transported over UDP/IP.

- Mobiles up to multislot class 10.

- All coding schemes, CS1 through CS4, with link adaptation. MCS1 through MCS9 is also supported on the 165 BTS with SR3.0 or later software

- Air interface timeslots may be configured statically for GPRS or dynamically for GPRS. In the latter case the timeslots may be used as either TCH or GPRS according to traffic patterns

- NC mode 0.

- MAC dynamic uplink allocation

- Circuit mode paging during GPRS transfer

- MAC 2 phase access

6 SOFTWARE IMPLEMENTATION (INFORMATIVE)

6.1 139/140 Platform

The hardware platform for the BTS is shown in **Error! Reference source not found.**.
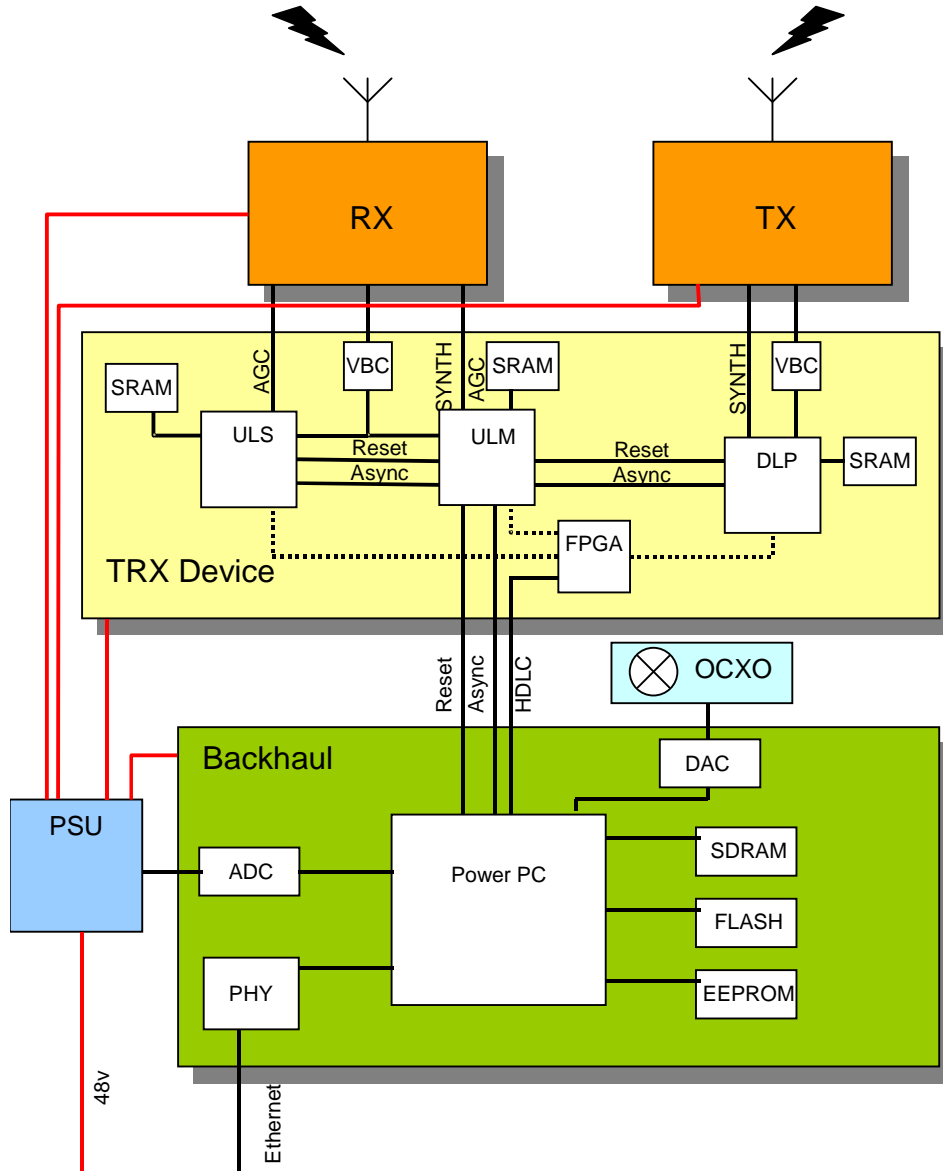
Figure 9 - Internal architecture of the 139/140 nanoBTS

It consists of three handset baseband devices (ADmsp430), a general purpose communications processor (MPC855T), and an FPGA based interprocessor communications buffer and synchronisation channel.

The ADmsp430 device consists of an ARM7 microcontroller, a Viterbi coprocessor, a ciphering engine, timing and control logic (the TCU), and an Analog Devices 21B series DSP device. The ARM7 runs AMX with application code written in ANSI C. The DSP runs native assembler.

The MPC855T device runs the Nucleus operating system which includes TCP, UDP, IP, ICMP, SNMP, and all MPC855T device drivers (as part of the Board Support Package). Other application code is developed internally by ip.access, written in ANSI C.

The FPGA is responsible for managing interprocessor communications buffers. An HDLC controller is implemented within it, which communicates directly to a similar sub-system in the MPC855T.

The FPGA also implements GSM frame level synchronisation between the three ADmsp430 devices.

6.2   Functional Partitioning

Broadly speaking, the GSM air interface functionality is managed by the three ADmsp430 devices, designated the ULM (uplink master), ULS (uplink slave) and DLP (downlink processor). These are collectively known as the TRX. The Ethernet interface is managed by the MPC855T, designed the BH (backhaul) processor.

The major functional elements within the nanoBTS are partitioned as follows

Function and sub-function		Processor
GSM L1 Receive, including soft-decision equalisation, de-interleave, channel decoding and deciphering	Even slots	ULM
	Odd slots	ULS
GSM L1 transmit, including ciphering, channel coding, interleave	All slots	DLP
GSM L2 processing, including BCCH scheduling		DLP
GPRS PCU	RLC/MAC	BH
GPRS L1		TRX
GPRS Gb	BSSGP and NS/IP	BH
Operations and Management Link (OML) Processing	Abis/IP messages terminate in the BH and generate device driver calls as required	BH
Radio Signalling Link (RSL) Processing	RSL (GSM8.58) messages	BH
	Embedded GSM4.08 messages	TRX (for onward transmission to MS)
Non-volatile storage		BH
Code download management		BH
IP stack and applications	DHCP, ICMP, TCP, RTP, RTCP, UDP	BH

6.3 Interprocessor Communications

Secure communications within the nanoBTS are implemented as follows

BH to TRX	HDLC framing including checksum generation and checking performed in MPC855T and FPGA
Intra-TRX (GSM L2)	Messages carried and routed through the FPGA
ARM7 to DSP	Dual-port memory interface
ARM7 to Synthesiser programming registers	DMA

6.4 Process Scheduling

For software tasks running on the ARM7 and MPC855T cores, software processes are scheduled either

- Asynchronously by the OS running on that processor, or
- Synchronously from interrupts generated by the underlying hardware devices or DSP

Software tasks running on the DSP are scheduled synchronously and deterministically using interrupts generated by the TCU. DSP tasks are divided into frame-based and block-based tasks. Frame based tasks have the highest priority, and include

- Burst data read and write
- Modulation and demodulation
- Equalisation, channel decode and deinterleave
- Receiver gain control
- Synthesiser programming
- Transmitter dynamic power control

Note that frame-based tasks occur every timeslot boundary.

Block based tasks execute every four frames, again, at the conclusion of each timeslot and include

- L2 block transfer from DLP

- Channel coding and interleaving

- Viterbi decoding of soft-decision results from equaliser

- L2 block transfer to ULM/ULS

Block based tasks run at lower priority than frame based tasks, and are usually interrupted by them.

6.5 Interprocess Communications and Synchronisation (139/140 units)

Software processes within the ARM7 and MPC855T processors communicate with each other exclusively using messages written to and read from OS maintained inter-process message queues. Other methods of interprocess communications (such as semaphores or shared memory) are not used.

The one exception to this rule is the communication between DSP and ARM. Software running on the DSP core reads its data on interrupt generated by the TCU from dual-port memory shared with the ARM.
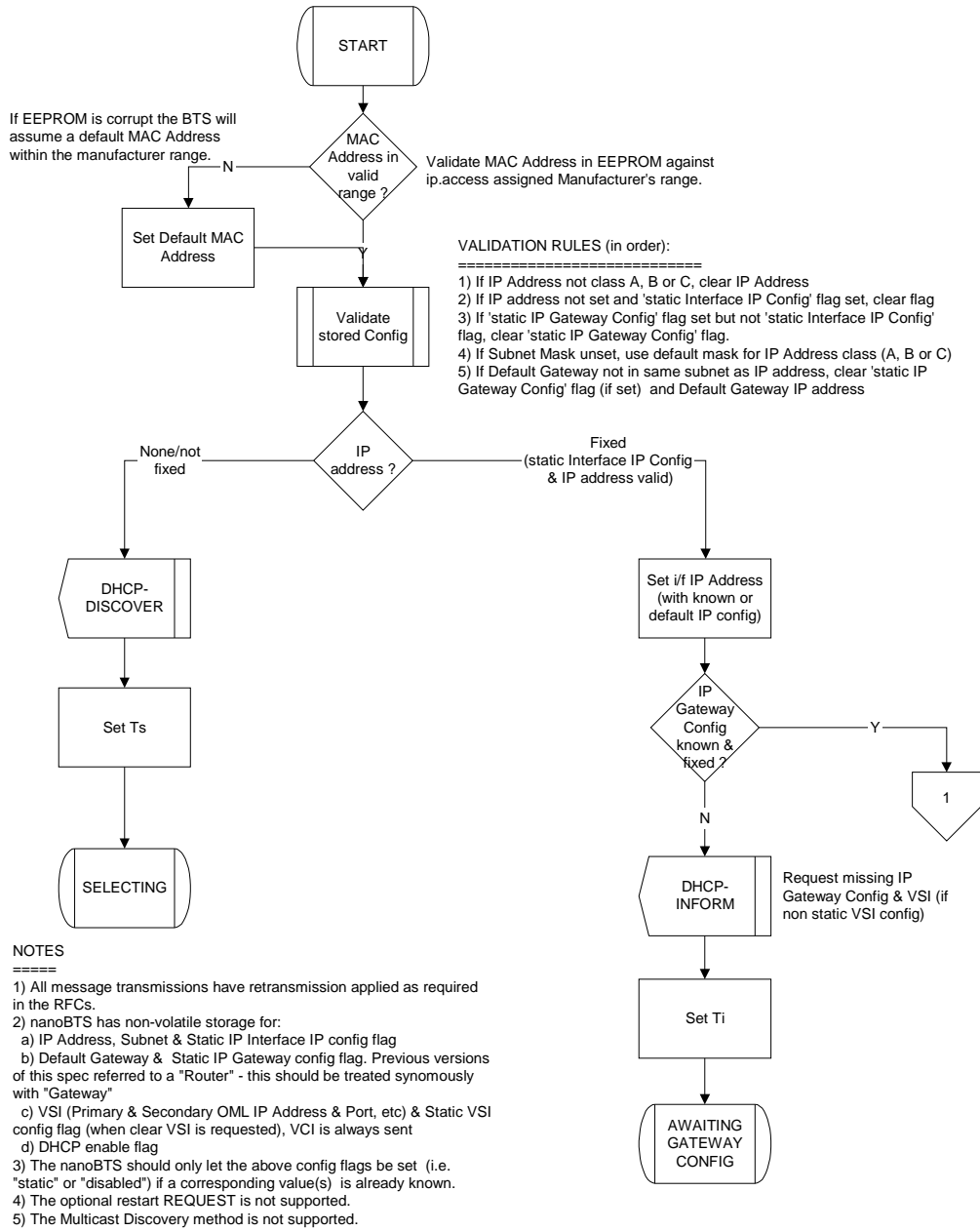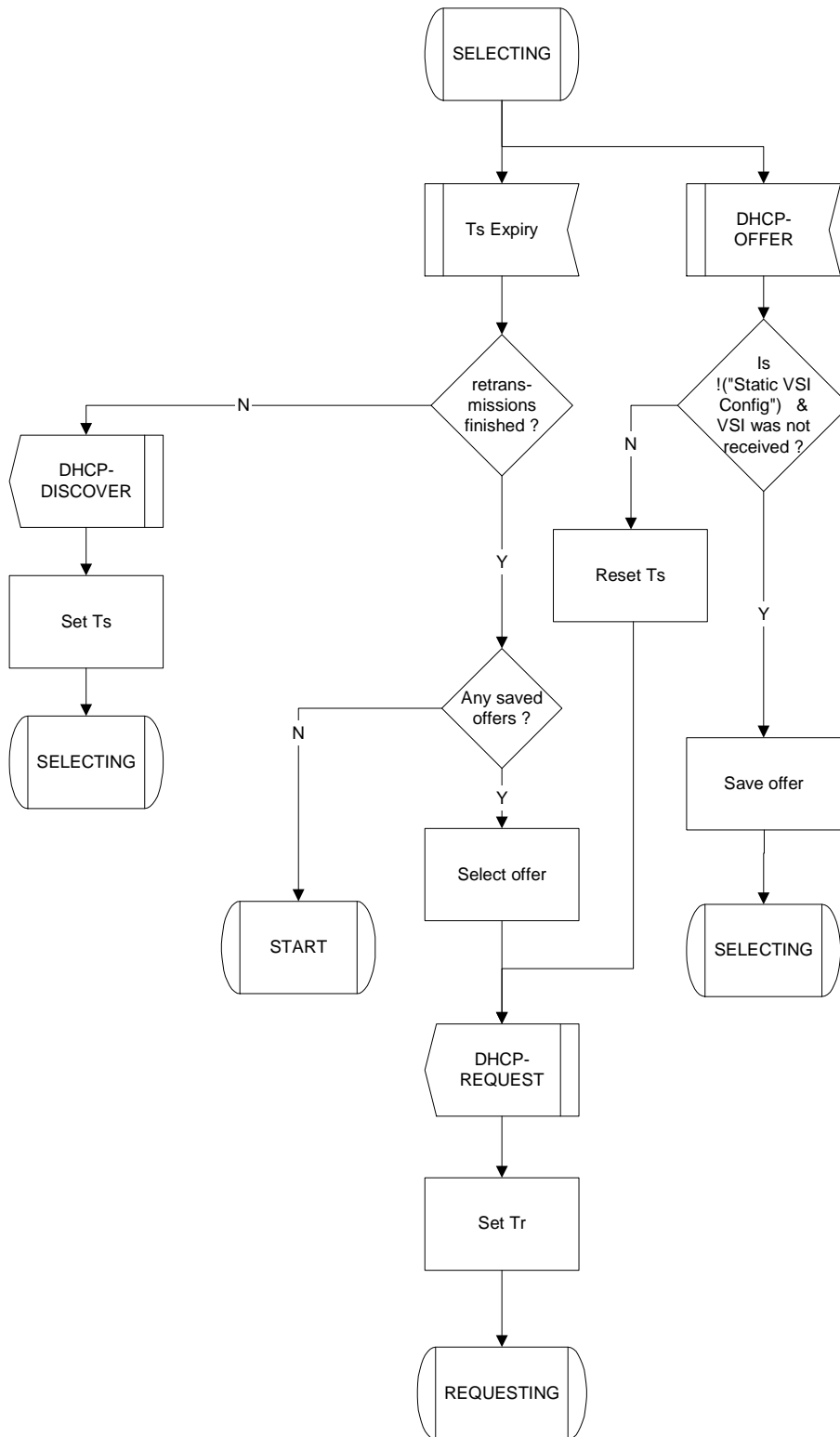
7   DHCP

START

If EEPROM is corrupt the BTS will assume a default MAC Address within the manufacturer range.

MAC Address in valid range ?

Validate MAC Address in EEPROM against ip.access assigned Manufacturer's range.

N → Set Default MAC Address

Y

Validate stored Config

VALIDATION RULES (in order):
============================
1) If IP Address not class A, B or C, clear IP Address
2) If IP address not set and 'static Interface IP Config' flag set, clear flag
3) If 'static IP Gateway Config' flag set but not 'static Interface IP Config' flag, clear 'static IP Gateway Config' flag.
4) If Subnet Mask unset, use default mask for IP Address class (A, B or C)
5) If Default Gateway not in same subnet as IP address, clear 'static IP Gateway Config' flag (if set) and Default Gateway IP address

IP address ?

None/not fixed

Fixed (static Interface IP Config & IP address valid)

DHCP-DISCOVER

Set i/f IP Address (with known or default IP config)

Set Ts

IP Gateway Config known & fixed ?

Y → 1

SELECTING

N

DHCP-INFORM

Request missing IP Gateway Config & VSI (if non static VSI config)

NOTES
=====
1) All message transmissions have retransmission applied as required in the RFCs.
2) nanoBTS has non-volatile storage for:
 a) IP Address, Subnet & Static IP Interface IP config flag
 b) Default Gateway & Static IP Gateway config flag. Previous versions of this spec referred to a "Router" - this should be treated synomously with "Gateway"
 c) VSI (Primary & Secondary OML IP Address & Port, etc) & Static VSI config flag (when clear VSI is requested), VCI is always sent
 d) DHCP enable flag
3) The nanoBTS should only let the above config flags be set (i.e. "static" or "disabled") if a corresponding value(s) is already known.
4) The optional restart REQUEST is not supported.
5) The Multicast Discovery method is not supported.

Set Ti

AWAITING GATEWAY CONFIG

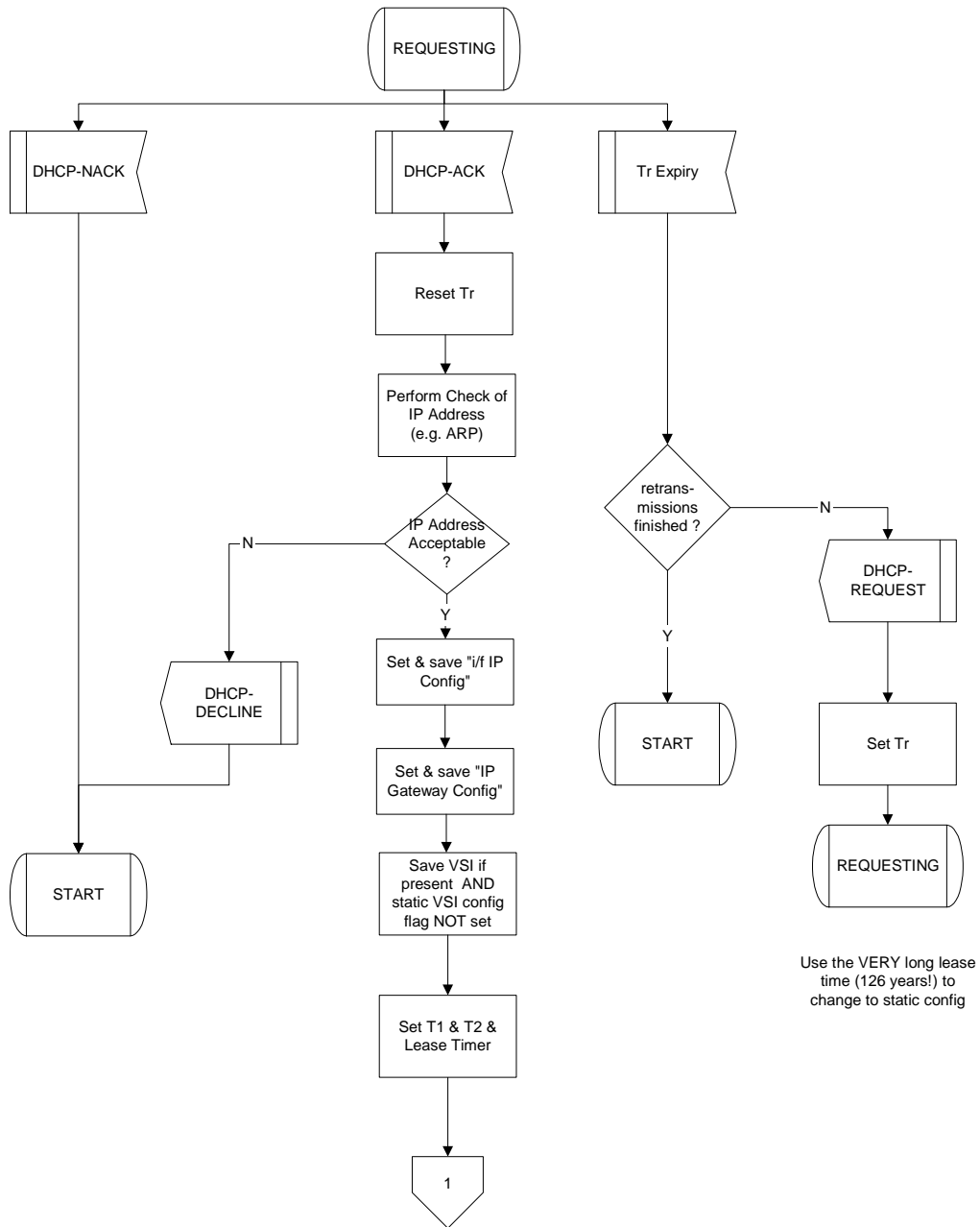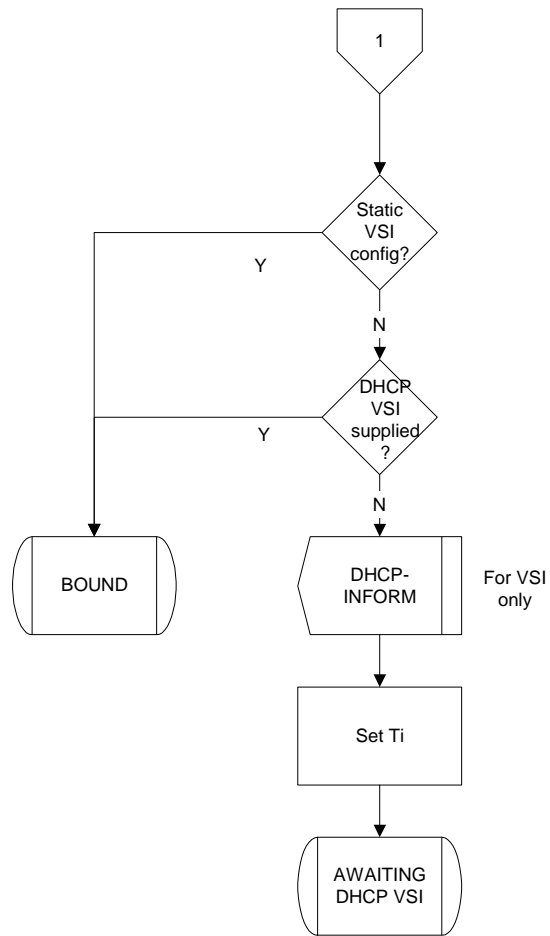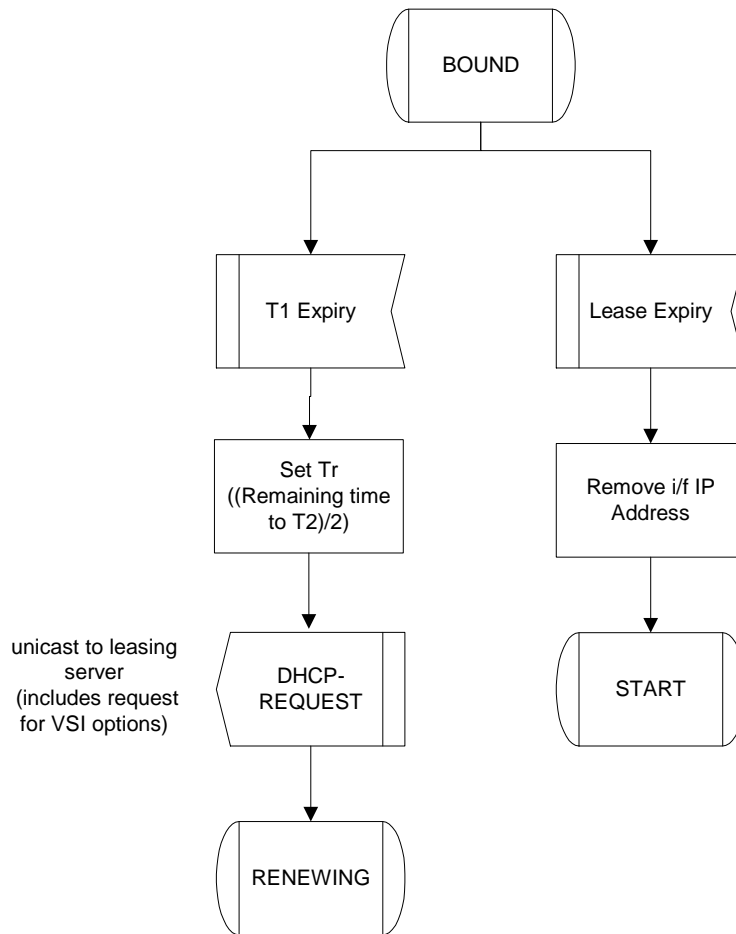**Figure 10 - START state**

Figure 11 - SELECTING state

Figure 12 - REQUESTING state

Figure 13 - Connector '1'

NOTES

1) T1, T2 & Lease Timer are not running if using a fixed
IP Address

Design assumes that
   T1 expiry time < T2 expiry timer < Lease expiry time

2) If the VSI is known, it should be used to attempt to
contact the BSC (even if it is known from a previous
config).

3) If no VSI is known, the BTS should passively await
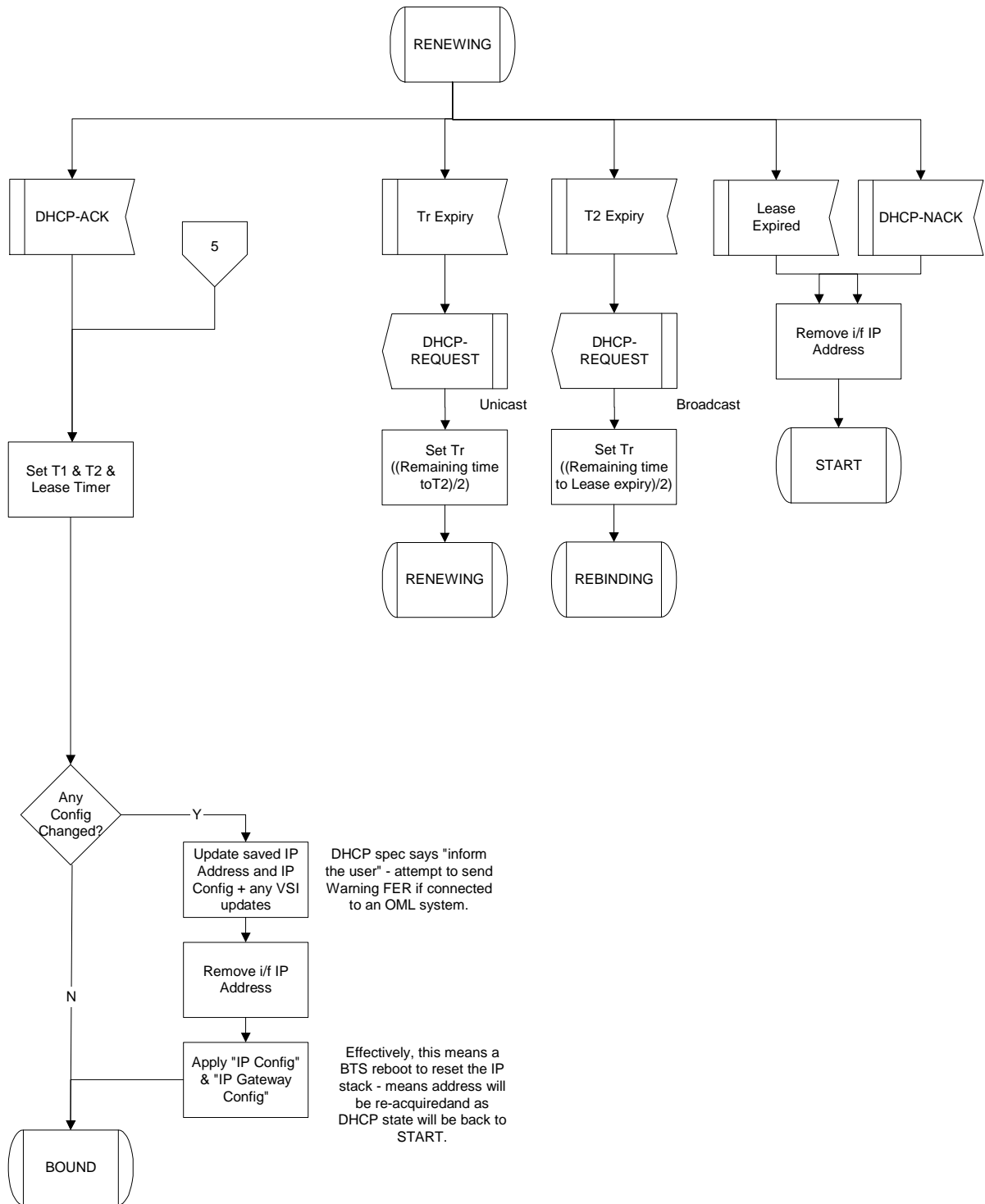configuration through the BTS A-bis port.

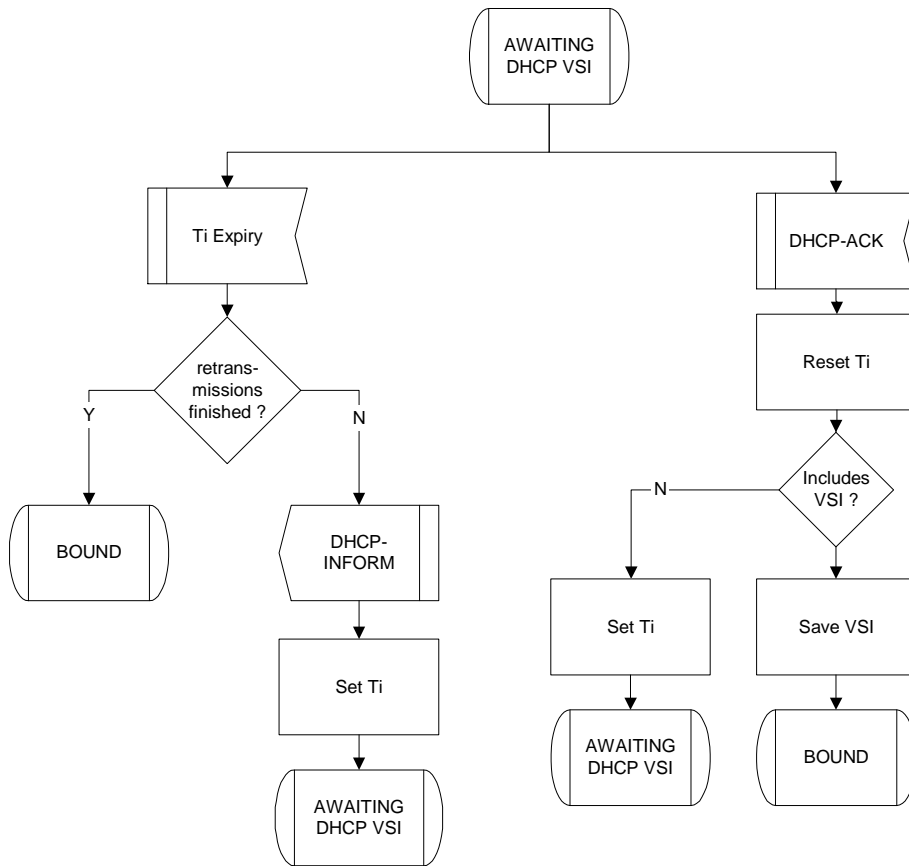**Figure 14 - BOUND state**

Figure 15 - RENEWING state
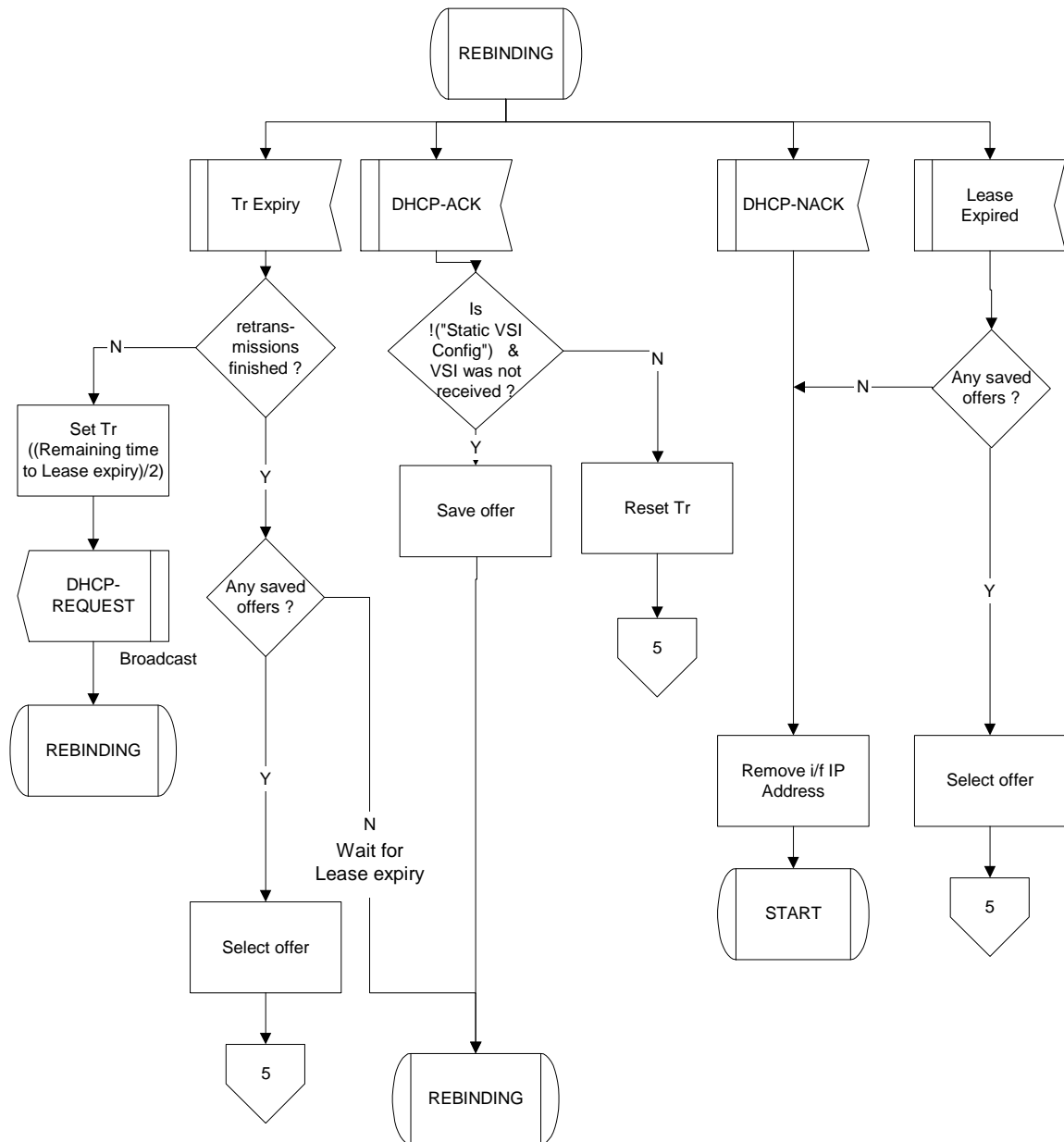
Figure 16 - REBINDING state
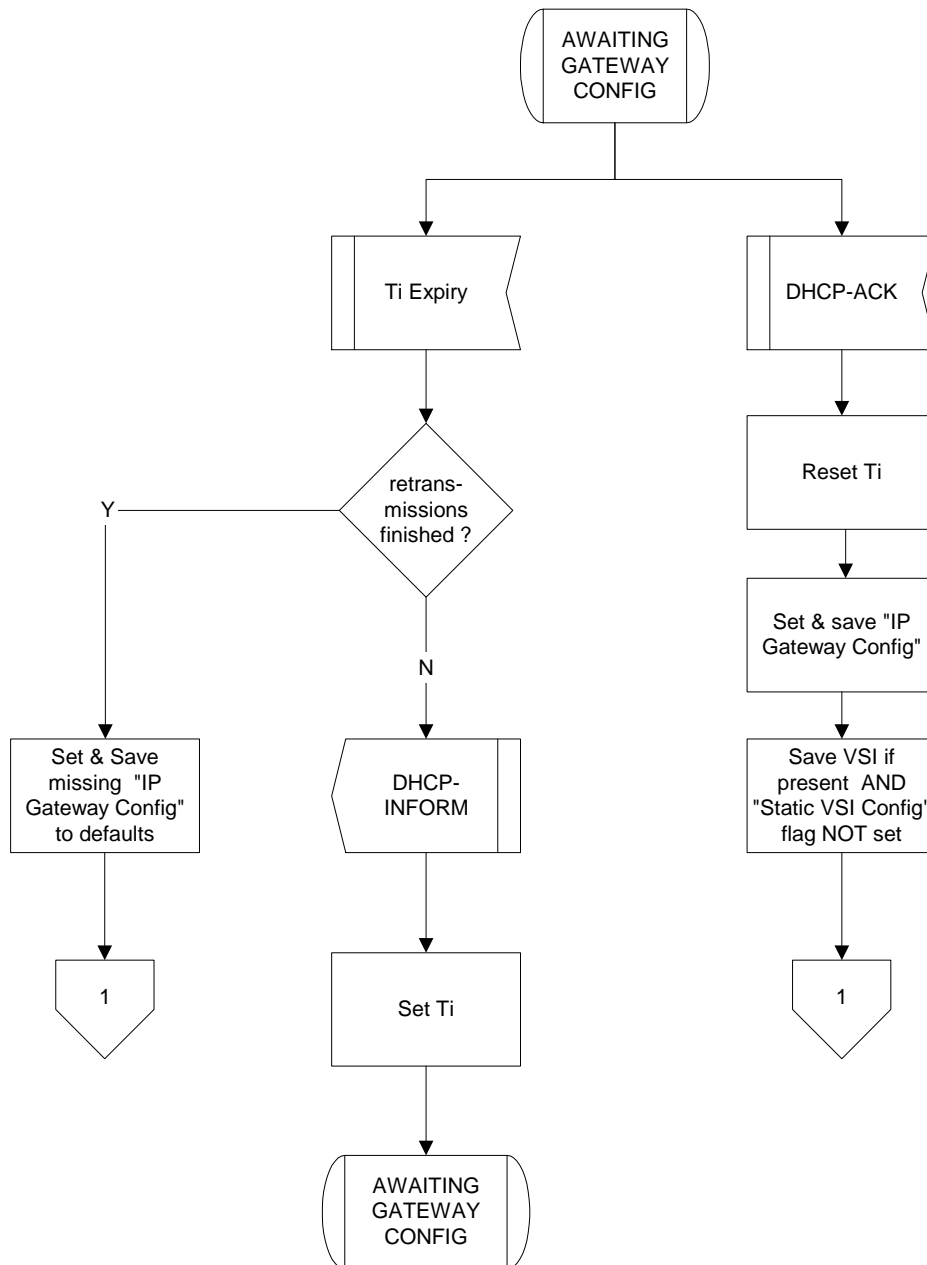
Figure 17 - AWAITING GATEWAY CONFIG state

Figure 18 - AWAITING DHCP VSI state

8 CUSTOMER SAFETY AND REGULATORY INFORMATION

8.1 Introduction

8.1.1 Purpose and Scope

This section provides the customer with safety and regulatory warnings, cautions and information.

Products covered are the model 108, 110, 139, 140, 165 and 178 range of nanoBTSs, model 109 and 126 power supplies.

8.1.2 Terminology

UL   Underwriters Laboratories

FCC   Federal Communications Commission

IC   Industry Canada

CE   European Union

8.2 Model 109 Power Supply

8.2.1 109 - Handbook - Warnings and Cautions

This document is written in English.
Please request a copy in your local language if required.

This product is only intended to power products approved by IP Access.
Ensure that only IP Access products are connected to an Ethernet circuit enabled for 48V operation. This also applies to outlets remote from the unit.

For indoor use only, output cabling is SELV / LAN for indoor routing only.

Do not cover casing or otherwise impede cooling.

Do not apply power to unit if there is any evidence of condensation.

Do not open casing as mains voltages may be present within the unit.

90 to 264VAC input is via a 2 pin IEC C7 (figure 8) connector. Inlet cable assembly must carry a suitable local approval (e.g. UL marked for US and Canadian markets).

PSU109 – Environmental Specification

- −10 °C to +45 °C ambient operating temperature.

- This product has been listed by UL for use in a 25 °C ambient.

- −20 to +80 °C ambient storage temperature.

- 5 to 95% RH non-condensing humidity.

8.2.2 109 - Handbook - FCC Text

WARNING
This is a class B product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

Federal Communications Commission
Note: This equipment has been tested and found to comply with the limits for a class B digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

8.2.3 109 - Handbook - Industry Canada text

This Class B digital apparatus complies with Canadian ICES-003.

Cet appareil numériqué de la classe B est conformé à la norme NMB-003 du Canada.

8.2.4 109 - Handbook - Regulatory Compliance Statement

EMC Standards

- EN 55022 and EN55024 (CE marked)

- FCC Part 15 class B

- ICES-003

Safety Standards

- EN60950 (CE marked)

- UL60950 Listed (File number E231617) (USA and Canada)

This product is intended for use in all Member States of the European Union

"Hereby, ip.access declares that this Ethernet Power Inserter is in compliance with the essential requirements and other relevant provisions of Directives 73/23/EEC and 89/336/EEC."

The PSU109 is supplied by Poly-Products Industries, model number ILA1711112.

A copy of regulatory compliance documentation may be obtained in writing from:

"IP access Ltd, Building 2020, Cambourne Business Park, Cambourne, Cambridge, CB23 6DW, UK".

8.3   Model 126 Ethernet Switch and Power Inserter

8.3.1   126 - Handbook - Warnings and Cautions

This document is written in English.
Please request a copy in your local language if required.

This product is only intended to power products approved by IP Access.

Ensure that only IP Access approved products are connected to an Ethernet circuit enabled for 48V operation, this also applies to outlets remote from the unit.

To be located in a restricted access location only (accessible to maintenance personnel only).

For indoor use only, output cabling is SELV / LAN for indoor routing only.

Do not block ventilation holes or otherwise impede cooling.

Refer to National Engineering Code (USA). Wiring methods must be in accordance with NEC Article 300.

When rack mounting, secure via front panel plate with 4 bolts and ensure that no additional load is placed upon the caseworks (e.g. heavy objects on top).

When rack mounting, ensure that the internal rack temperature does not exceed the rating of this product.

Do not apply power to unit if there is any evidence of condensation.

Do not open casing as mains voltages may be present within the unit.

AC inlet cable must carry suitable local approval (e.g. UL marking for US and Canadian markets).

126 - Input Power Source Specification

- Unit may be powered via AC or DC (not both).

- 90 to 132 and 180 to 264VAC (auto-ranging) via an IEC C13 connector. 135W, 2A rating.

- 47 to 57V DC via screw terminals on the front panel. 115W 3A rating. The installer must ensure that this supply connection is fused externally at 5A and provision is made for an external disconnection device.

- Appliance must be earthed, either via the mains connector (mains operation) or screw terminal on the front panel (DC operation).

126 – Environmental Specification

- $-5\ ^\circ$C to +45 $^\circ$C ambient operating temperature.

- -20 to +80 $^\circ$C ambient storage temperature.

- 5 to 95% RH non-condensing humidity.

8.3.2   126 - Handbook - FCC Text

WARNING This is a class A product. In a domestic environment this product may cause radio interference, in which case the user may be required to take adequate measures.

Federal Communications Commission Note: This equipment has been tested and found to comply with the limits for a class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

8.3.3   126 - Handbook - Industry Canada text

This Class A digital apparatus complies with Canadian ICES-003.

Cet appareil numériqué de la classe A est conformé à la norme NMB-003 du Canada.

8.3.4 126 - Handbook - Regulatory Compliance Statement

The nanoBTS conforms to the following regulatory standards.

EMC Standards

- EN 55022 and EN55024 (CE marked)
- FCC Part 15 class A
- ICES-003

Safety Standards

- EN60950 (CE marked)
- IEC 60950
- UL60950 Listed (File number E230296) (USA and Canada)
- CB certificate (DK-7033)

> This product is intended for use in all
> Member States of the European Union

"Hereby, ip.access declares that this Ethernet Switch / Power Inserter is in compliance with the essential requirements and other relevant provisions of Directives 73/23/EEC and 89/336/EEC."

A copy of regulatory compliance documentation may be obtained in writing from:

"IP access Ltd, Building 2020, Cambourne Business Park, Cambourne, Cambridge, CB23 6DW, UK".

8.4 nanoBTS Products

8.4.1 nanoBTS - Handbook - Warnings and Cautions

This system is designed to be operated indoors as a fixed system device and must be located either on or near the ceiling away from the user. It must be mounted in a manner to ensure that all users and bystanders are kept a minimum of 20cm away from the integral antennas at all times.

Do not touch or move the antenna(s) while the unit is transmitting or receiving.

Do not hold any component containing a radio such that the antenna is very close to or touching any exposed parts of the body, especially the face or eyes while transmitting.

In most parts of the world, regulatory approval(s) are needed before the nanoBTS is operated.

Do not connect any device other than the nanoBTS to any RJ45 socket that has been enabled for nanoBTS connection (i.e. 48Vdc operation).

The nanoBTS is intended for dry indoor applications only. If evidence of condensation is present do not apply power to the nanoBTS.

The nanoBTS must only be powered using an ip.access model 109 PSU (PPI part number ILA1711112) or ip.access model 126 Ethernet switch and power inserter (unless prior written approval is obtained from IP Access). Model 165 BTS's may also be powered by a direct 48V connection using a PSU specified in writing by IP Access Ltd.

PSUs supplied by ip.access must not be used for powering any other equipment (unless carried out in a manner having prior written approval from IP Access).

TIB ports on the NanoBTS may only be connected with ip.access supplied cables with part numbers 139-040, 139-041, 139-042, 139-043 or 165-076.

Fitting external antenna or antenna cabling to the BTS invalidates the type approval, CE marking and UL listing referred to herein (unless carried out in a manner having prior written approval from IP Access).

Maximum cable length from the Ethernet Hub, Switch or PSU is limited to 100m.

### 8.4.2 nanoBTS - Handbook - Parts required for each nanoBTS

- WALL FIXINGS: These are not normally provided as part of the NanoBTS but should be suitable for the wall material and weight of the NanoBTS (2.7kg). Suggested materials are 4 x 30mm no.10 woodscrews or M5 bolts and wall plugs (if required).

- PSU.

- nanoBTS complete with mounting bracket.

- RJ45-RJ45 connecting leads.

8.4.3 nanoBTS - Handbook - Provision of Power to the nanoBTS

Power for the nanoBTS may be inserted at either the RJ45 outlet or at the output of the last Ethernet switch/hub/router etc. see figure below.

θ PSU located at the switch
**φ PSU located at nanoBTS**
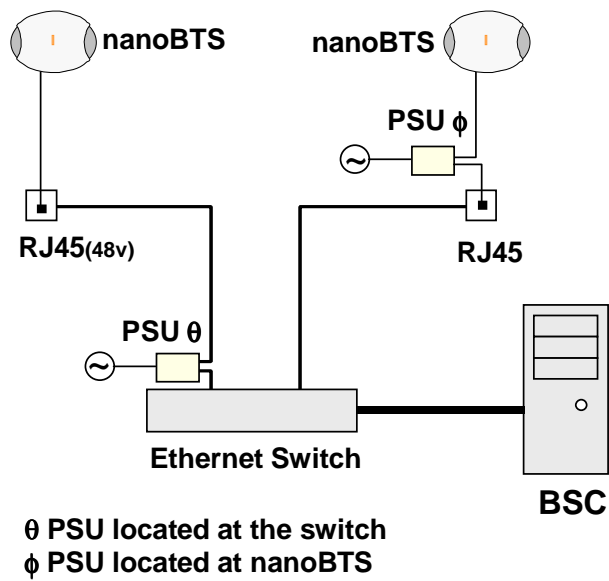
When using the ip.access model 126A Ethernet Switch and Power Inserter, external PSU's are not required, the nanoBTS is connected locally or via site cabling to the powered ports of the 126.
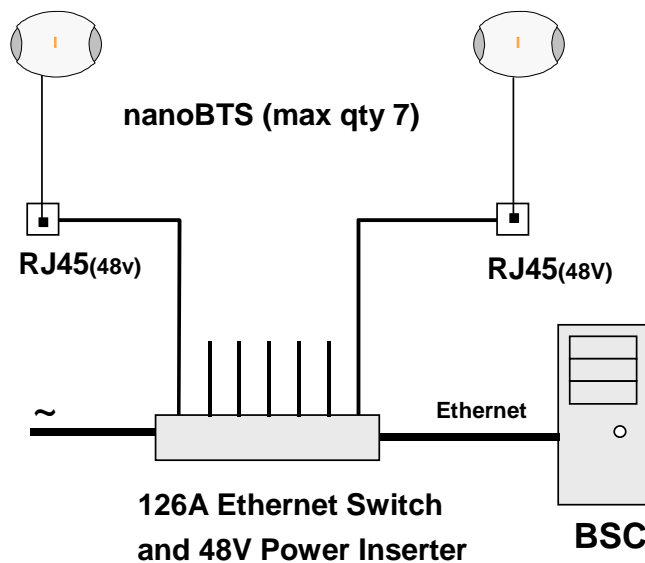

8.4.3.1 nanoBTS - Handbook - Installing the PSU at the Ethernet switch

If the 109 PSU is located at the patch panel /output port of the Ethernet switch, it is important that the 109 PSU is connected exactly as illustrated below (failure to do so may cause damage to the switch). Ensure that the 109 PSU is placed in a location that is ventilated and that the connection leads provide no safety hazard.

Cable to nanoBTS

110-230Vac

Connection to nanoBTS

PSU

48Vdc

48Vdc

Connection to LAN

RJ45

Ethernet Switch
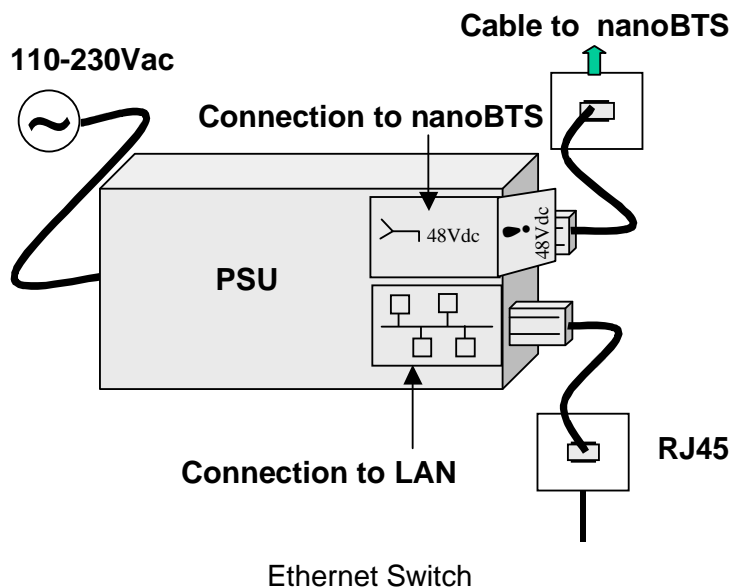
8.4.3.2 nanoBTS - Handbook - Installing the PSU at the nanoBTS

Ensure that the 109 PSU is placed in a location that is ventilated and that the connection leads provide no safety hazard.

110-230Vac

Connection to nanoBTS

PSU

48Vdc

48Vdc

Connection to LAN

RJ45
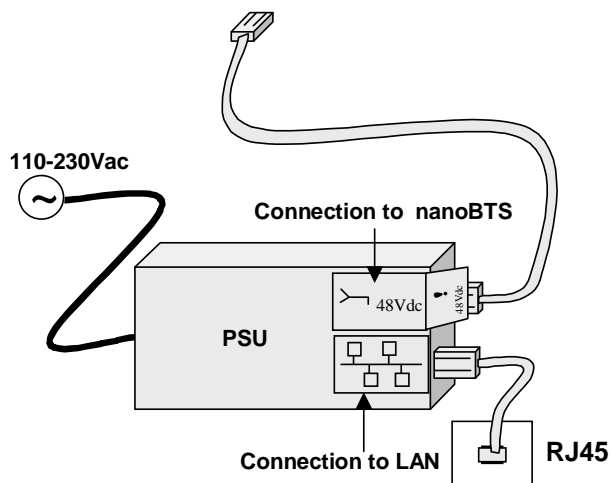
8.4.4 nanoBTS - Handbook - FCC Text

Standards

- FCC Rule 47 Parts 2, 15, 24

Note: Changes or modifications not expressly approved by the party responsible for compliance may void the user's authority to operate this equipment.

Model 110 nanoBTS has FCC ID QGGM180TVX

Model 140 nanoBTS has FCC ID QGGKU02ZZT

Model 165B nanoBTS has FCC ID QGGKU02ZZP

Model 165D nanoBTS has FCC ID QGGKU02ZZR

Model 165F nanoBTS has FCC ID QGGKU02ZZP

Model 165H nanoBTS has FCC ID QGGKU02ZZS

Federal Communications Commission

Note: This equipment has been tested and found to comply with the limits for a class A digital device, pursuant to part 15 of the FCC rules. These limits are designed to provide reasonable protection against harmful interference when the equipment is operated in a commercial environment. This equipment generates, uses, and can radiate radio frequency energy and, if not installed and used in accordance with the instruction manual, may cause harmful interference to radio communications. Operation of this equipment in a residential area is likely to cause harmful interference in which case the user will be required to correct the interference at his own expense.

8.4.5 nanoBTS - Handbook - IC Text

Standards

- RSS133 issue 2

Note: Changes or modifications not expressly approved by the party responsible for compliance may void the user's authority to operate this equipment.

Model 110 nanoBTS has IC (Industry Canada) ID 4644A-M180TVX

Model 140 nanoBTS has IC (Industry Canada) ID 4644A-KU02ZZT

Model 165B nanoBTS has IC (Industry Canada) ID 4644A-KU02ZZP

Model 165D nanoBTS has IC (Industry Canada) ID 4644A-KU02ZZR

Model 165F nanoBTS has IC (Industry Canada) ID 4644A-KU02ZZP

8.4.6 nanoBTS - Handbook - Regulatory Compliance Statement

The nanoBTS conforms to the following regulatory standards:

Type Approvals

- GSM essential requirements under article 3.2 of the R&TTE directive ETSI EN 301 502. CE Marking (CE0168).
- FCC - see above.
- IC – see above.

EMC Standards

- ETSI EN 301 489-1 and –8, ETSI EN 301 502.
- FCC - see above.
- IC – see above.

Environmental Standards

- ETS 300 019.

Safety Standards

- EN60950 (CE Marking)

- IEC 60950

- UL60950 Listed (file number E230296, USA and Canada)

- CB Certificate

This product is intended for use in all
Member States of the European Union

"Hereby, ip.access declares that this NanoBTS is in compliance with the essential requirements and other relevant provisions of Directive 1999/5/EC."

A copy of regulatory compliance documentation may be obtained in writing from:

"IP access Ltd, Building 2020, Cambourne Business Park, Cambourne, Cambridge, CB23 6DW, UK".