

## **EQUIPMENT DESCRIPTION**

**PCS 1900 BOOSTER**

**SINGLE FEED - SINGLE ANTENNA**

***SYSTEM PRODUCT SPECIFICATION***



The information contained in this document is furnished in commercial confidence and upon the condition that the individual and corporate rights originating in the information, whether patented or not, will be respected.

**Reference:**  
98DS0009

**Issue:** Issue 4.

**Date:** 13 April 1999

**Prepared by:**

**Authorized by Engineering:**

**Authorized by Quality:**

Ranjit S Manku & E. Yearby

# PRODUCT SPECIFICATION

98DS0009

Issue 4

April 99

## HISTORY

| DATE     | ISSUE   | AUTHOR                   | ISSUE NOTE | NOTES                                                                                                                                   |
|----------|---------|--------------------------|------------|-----------------------------------------------------------------------------------------------------------------------------------------|
| 03/02/98 | Issue A | R S Manku                | 5000-211   | Original                                                                                                                                |
| 16/03/98 | Issue 1 | R S Manku /<br>E. Yearby | 5000-260   | Changed Title. Technical Specification changed to apply to SF-SA type only.                                                             |
| 19Jan99  | Issue 2 | R S Manku /<br>E. Yearby | 5000-492   | Deleted 40 Watt Option. Updated section 2.5                                                                                             |
| 10Mar99  | Issue 3 | R S Manku /<br>E. Yearby | MI-0115?   | Added Transmit and Receive Path Output IP3                                                                                              |
| 13Apr99  | Issue 4 | R S Manku /<br>E. Yearby | MI-0179    | Called Product Specification. Updated Sections 2.5, 2.9, 3.4, 3.6 3.7. Re-introduced HPA bypass as an option. Interface drawings added. |
|          |         |                          |            |                                                                                                                                         |
|          |         |                          |            |                                                                                                                                         |
|          |         |                          |            |                                                                                                                                         |
|          |         |                          |            |                                                                                                                                         |
|          |         |                          |            |                                                                                                                                         |
|          |         |                          |            |                                                                                                                                         |
|          |         |                          |            |                                                                                                                                         |
|          |         |                          |            |                                                                                                                                         |
|          |         |                          |            |                                                                                                                                         |
|          |         |                          |            |                                                                                                                                         |
|          |         |                          |            |                                                                                                                                         |
|          |         |                          |            |                                                                                                                                         |
|          |         |                          |            |                                                                                                                                         |
|          |         |                          |            |                                                                                                                                         |
|          |         |                          |            |                                                                                                                                         |
|          |         |                          |            |                                                                                                                                         |

**CONTENTS**

|                                                                    |    |
|--------------------------------------------------------------------|----|
| 1. TECHNICAL SUMMARY .....                                         | 4  |
| 2. ELECTRICAL REQUIREMENTS.....                                    | 5  |
| 3. DC POWER .....                                                  | 8  |
| 4. APPROVALS AND REGULATORY ISSUES .....                           | 10 |
| 5. ENVIRONMENTAL REQUIREMENTS .....                                | 11 |
| 6. RELIABILITY, MAINTAINABILITY .....                              | 13 |
| 7. MECHANICAL REQUIREMENTS.....                                    | 13 |
| 8. INTERFACES.....                                                 | 13 |
| <br>Figure 1 - FUNCTIONAL BLOCK DIAGRAM – WITHOUT Tx BYPASS.....   | 14 |
| Figure 2 - FUNCTIONAL BLOCK DIAGRAM – WITH HPA BYPASS OPTION ..... | 15 |
| Figure 3 - INTERFACE CONTROL DRAWINGS.....                         | 16 |

**1. TECHNICAL SUMMARY**

This document defines the system requirements for a Single Feed Single Antenna PCS 1900 Booster. The system consists of a high power amplifier and a bandpass filter in the transmit path and bandpass / lowpass filters and a Low Noise Amplifier in the receive path. The system shall be designed to deliver single carrier Tx nominal gain of 12 dB with a maximum output of +43 dBm (20 W). The nominal gain of Rx shall be 22 dB. The system shall be housed in a compact low volume, lightweight IP68 enclosure. This product is designed to extend coverage, increase traffic and improve the quality of the signal within a network cell. The unit shall be convection cooled.

Figure 1 shows a block diagram of a Single Feed Single Antenna (SF-SA) PCS 1900 Booster.

This system is connected to the BTS via a common cable for receive and transmit signals, and to a common transmit / receive antenna.

As an option, the Booster shall provide a by-pass of the HPA in the transmit section as shown on figure 2, which shall be enabled if the HPA fails. By-pass of the LNA in the receive section shall be a standard configuration, which shall be enabled if the LNA fails

The Booster shall be designed to operate over the entire PCS band, but the filters optimized to pass only a 15 MHz band (e.g. A, B, C band). The unit shall be designed to mount on a mast (pole) or a wall and integrated with a customer provided sector antenna. A Solar Shield shall be included to provide protection against direct Sun Radiation.

A low pass filter and a variable attenuator at the output of the Low Noise Amplifier shall form an integral part of the LNA tile. The functional status of the LNA shall be monitored, e.g. current drawn by the LNA, and a low loss bypass switch shall be incorporated to provide failure mode operation.

An isolator, a VSWR monitoring circuit at the output and a variable attenuator at the input shall form an integral part of the HPA tile. Couplers at the input and the output of the HPA shall be used to monitor the input signal level and the level of the reflected signal at the output port. The Booster shall be designed to ensure good thermal stability.

The Booster unit shall also include voltage regulators to provide the required voltage to the amplifiers and to account for any voltage drop across the feeder cables which transmit DC power from the Power Distribution Unit (PDU) at the BTS to the Booster unit. The DC power shall be transmitted via the RF feeder cable using Bias Tees to couple the DC power onto the RF cables. The Bias Tees shall also provide protection against a lightning strike.

A serial data interface shall be used to monitor the status of the amplifiers, and display on the PDU at the base. The data interface system may also be used to transmit commands from the BTS to adjust the variable attenuators within the Booster Unit. The serial data signals shall be coupled onto the RF feeder cable via the Bias Tees used for coupling the DC power.

The Booster unit shall have 7/16 RF connectors for the antenna and the RF feeder cable connections. An earth stud shall be provided to connect earth strap between the unit and the mast (ground).

**2. ELECTRICAL REQUIREMENTS****2.1. Definitions**

|          |                                       |
|----------|---------------------------------------|
| BTS      | Base Transceiver Station              |
| ANT      | Antenna                               |
| Tx       | Transmit                              |
| Rx       | Receive                               |
| LNA      | Low Noise Amplifier                   |
| HPA      | High Power Amplifier                  |
| VSWR     | Voltage Standing Wave Ratio           |
| BTS Port | Base Station Connector on the Booster |
| ANT Port | Antenna Connector on the Booster      |
| LPF      | Low Pass Filter                       |
| PDU      | Power Distribution Unit               |

**2.2. Frequency Range**

|               |                 |
|---------------|-----------------|
| Transmit Band | 1930 - 1990 MHz |
| Receive Band  | 1850 - 1910 MHz |

**2.3. Operating Bandwidth**

|               |        |
|---------------|--------|
| Transmit Band | 15 MHz |
| Receive Band  | 15 MHz |

**2.4. Filter Isolation****Measured at ANT port:**

|                                            |         |
|--------------------------------------------|---------|
| Provided by Tx filter to Rx frequency band | > 85 dB |
| Provided by Rx filter to Tx frequency band | > 80 dB |

**Measured at BTS port:**

|                                            |         |
|--------------------------------------------|---------|
| Provided by Tx filter to Rx frequency band | > 45 dB |
| Provided by Rx filter to Tx frequency band | > 80 dB |

## 2.5. Spurious Output from High Power Amplifier Measured at ANT port

Spurious Emissions at the Antenna port with Booster operated at full rated power shall not exceed the following levels (ETSI 11.21) measured in the stated resolution bandwidth.

| Frequency Band                            | Level                                       | Offset                                                                    | Resolution BW                                  |
|-------------------------------------------|---------------------------------------------|---------------------------------------------------------------------------|------------------------------------------------|
| Up to 1000 MHz                            | -36 dBm                                     |                                                                           | 100 kHz                                        |
| 880 – 960 MHz                             | -98 dBm                                     |                                                                           | 100 kHz                                        |
| 925 – 960 MHz                             | -57 dBm                                     |                                                                           | 100 kHz                                        |
| 1850 – 1910 MHz                           | -120 dBm                                    |                                                                           | 100 kHz                                        |
| 1930 - 1990 MHz                           | -36 dBm                                     | >1.8 – 6.0 MHz from carrier                                               | 100 kHz                                        |
| 1000 MHz – 12.75 GHz<br>(outside Tx band) | -30 dBm                                     | ( from TX band edge)<br>≥2 MHz<br>≥5 MHz<br>≥10 MHz<br>≥20 MHz<br>≥30 MHz | 30 kHz<br>100 kHz<br>300 kHz<br>1 MHz<br>3 MHz |
| Broadband Noise                           | -70 dBc or –36 dBm which ever is the higher | >6 MHz to Tx band edge                                                    | 100 kHz                                        |

## 2.6. Out of band Gain Reduction

Measured from ANT port to BTS port.

100 kHz - 1825 MHz

> 15 dBc

1935 MHz - 12.75 GHz

> 15 dBc

## 2.7. Bypass Condition Insertion Loss

Rx band

<2.4 dB

Tx band

<2.3 dB

## 2.8. Noise Figure

Rx Band over temperature range -40 to +55 °C

2.0 dB (at maximum gain setting)

Typical Value at +25 °C

1.8 dB (at maximum gain setting)

## 2.9. Transmit Path Gain

**BTS to ANT port, any 15 MHz band in range 1930 - 1990 MHz**

Nominal Gain

12 dB ± 1 dB

Variation with temperature -40 to +55°C

± 1.5 dB (at maximum output power)

## 2.10. Receive Path Gain

**ANT to BTS port, any 15 MHz band in range 1850 - 1910 MHz**

Nominal Gain

22 dB ± 0.5 dB

Variation with temperature -40 to +55°C  $\pm 1.5$  dB

**2.11. Variable Gain Adjustment**

Transmit path 2 - 12 dB in 1 $\pm$ 0.5 dB steps  
Receive path 7 - 22 dB in 1 $\pm$ 0.5 dB steps

**2.12. Output 1 dB Compression Point**

Transmit Output 1 dB Compression  $\geq +44$  dBm  
Receive Output 1 dB Compression  $\geq +10$  dBm

**2.13. Output IP3**

Transmit Output IP3  $\geq +54$  dBm  
Receive Output IP3  $\geq +20$  dBm

**2.14. Tx Dynamic Range**

Dynamic Range of HPA  $\geq 35$  dB

**2.15. Stability Under Different Load Conditions**

Both the Tx and Rx paths shall remain stable under the worst case match condition of 10:1

**2.16. Maximum Input No Oscillation**

The maximum signal that can be tolerated by the LNA in the Rx band at the ANT port without causing the LNA to oscillate shall be +10 dBm.

The maximum signal that can be tolerated by the HPA in the Tx band at the BTS port without causing the HPA to oscillate shall be +38 dBm.

**2.17. Maximum Survivable Input**

The maximum signal that can be tolerated by the LNA in the Rx band at the ANT port without causing damage to the LNA shall be +20 dBm.

The maximum signal that can be tolerated by the HPA in the Tx band at the BTS port without causing damage to the HPA shall be +42 dBm single carrier input .

**2.18. Intermodulation Products at ANT Port**

Two carriers in the band 1930 - 1990 MHz, the forward wanted signal at a maximum rated output power and the interfering signal at a power level 30 dB below the wanted signal output power into the ANT port. The frequency of the interfering signal to be chosen such that the 5<sup>th</sup> order intermodulation product with the wanted forward signal falls in the 15 MHz receive band corresponding to the 15 MHz transmit band.

| <b>Intermodulation Band</b>                 | <b>Intermodulation Level</b> | <b>Measurement BW</b> |
|---------------------------------------------|------------------------------|-----------------------|
| 15 MHz operating band<br>in 1850 - 1910 MHz | -120 dBm                     | 300 kHz               |

**2.19. Intermodulation Products at BTS Port**

Two Signals in the band 1850 - 1910 MHz at a power level of -49 dBm into ANT Port. The frequency of the interfering signal to be chosen such that the 3<sup>rd</sup> order intermodulation product with the main receive signal falls in the 15 MHz receive band.

| <b>Intermodulation Band</b>                 | <b>Intermodulation Level</b> | <b>Measurement BW</b> |
|---------------------------------------------|------------------------------|-----------------------|
| 15 MHz operating band<br>in 1850 - 1910 MHz | -120 dBm                     | 300 kHz               |

**2.20. Return Loss**

| <b>ANT and BTS Ports</b>                 | <b>Return Loss*</b> |
|------------------------------------------|---------------------|
| Rx Operating Band                        | ≥ 18 dB             |
| Tx Operating Band                        | ≥ 18 dB             |
| Bypass mode Tx band (option) and Rx band | ≥ 16 dB             |

- Reference to 50 Ω

**3. DC POWER****3.1. Booster input supply voltage**

+28V to 30.25 V DC

**3.2. Power Consumption**

182 watts max. made up of:

6 A @ 30.25VDC

**3.3. Power Supply Interface**

Coupled via Bias Tee

**3.4. Booster Power Supply Distribution Unit (PDU)**

The DC to the Booster shall be provided from Airtech Power Distribution Unit is enclosed in a weatherproofed enclosure. The PDU also monitors alarms and provides gain controls. The PDU is specified in the PDU Specification No. 98DS0004.

As an option the PDU can supply DC power to six Boosters.

**3.5. Lightning Protection**

The lightning protection is implemented on the Bias Tee circuit board at the BTS port and by direct tap on the filter at the Antenna port. It is based on IEC 801-5, embodied by BS EN6100-4-5.

The Booster is designed to withstand a lightning pulse of 20 kA, pulse shape 8/20  $\mu$ s.

**3.6. Alarms**

Alarms from the Booster shall be provided on the PDU via a Bias Tee using serial data interface.

These alarms cover the following :

LNA current out of range (partial failure indicated)

LNA current out of range (bypass activated)

HPA temperature out of range – Transmit gain reduced and alarm raised

HPA current out of range - alarm raised and bypass activated (option)

Transmit path over-gain – Transmit gain reduced and alarm raised

Reverse power out of limit - alarm raised

Alarms on the PDU can be classified to provide 'fatal / non-fatal' signals at the BTS.

**3.7. Alarm Limits**

HPA heatsink temperature limit

as required for the HPA

Reverse power

> +36 dBm ( $\pm 1$ dB)

Excess Gain in Tx path

Output power >+44 dBm ( $\pm 0.5$ dB)**4. APPROVALS AND REGULATORY ISSUES****4.1. Electromagnetic Compatibility**

The equipment is fully compliant with the following European Community requirements.

European EMC directives 89/336/EEC and 92/31/EEC for both spurious emissions and immunity.

European Telecommunications Standard ETS 300 342-2 (-3)

**4.2. Environmental Specifications**

The equipment is fully compliant with the following specifications of the European Telecommunications Standards.

Operational Conditions

Class 4.1, ETS 300 019-1-4

Transportation Conditions

Class 2.3, ETS 300 019-1-2

Storage Conditions

Class 1.2, ETS 300 019-1-1

**5. ENVIRONMENTAL REQUIREMENTS****5.1. Operating Conditions**

The Booster operates satisfactorily under the following external climatic conditions:

| Environmental Condition       | Value                    |
|-------------------------------|--------------------------|
| Air Temperature               | -40 °C to +55 °C         |
| Relative Humidity             | 5 to 95 %                |
| Absolute Humidity             | 1 to 29 g/m <sup>3</sup> |
| Rate of Change of temperature | 0.5°C / min.             |
| Air Pressure                  | 70 to 106 KPa            |
| Solar Radiation               | 1120 W/m <sup>2</sup>    |

**5.2. Storage and Transportation Conditions**

| Environmental Condition       | Value                       |
|-------------------------------|-----------------------------|
| Air Temperature               | -40 °C to +70 °C            |
| Relative Humidity             | 8 to 100 %                  |
| Absolute Humidity             | 0.03 to 60 g/m <sup>3</sup> |
| Rate of Change of temperature | 0.5°C / min.                |
| Air Pressure                  | 70 to 106 KPa               |
| Solar Radiation               | 1120 W/m <sup>2</sup>       |

**5.3. Vibration**

The Booster conforms to BS2011 part 2.1, sections Ea, Eb and Fc - Corresponding IEC publication.

**5.3.1. Operational Conditions**

Vibration Test:

| Parameter  | Frequency Range | Severity (3 Axes)                       | Duration           |
|------------|-----------------|-----------------------------------------|--------------------|
|            | (Hz)            | (Disp) (mm) (Accel) (m/s <sup>2</sup> ) | (ms)               |
| Sinusoidal | 5 - 9           | 3.5                                     | 3 x 5 sweep cycles |
| Sinusoidal | 9 - 200         | 10                                      | 3 x 5 sweep cycles |

Shock Test:

| Parameter | Shock Spectrum | Severity                       |                               | Duration |
|-----------|----------------|--------------------------------|-------------------------------|----------|
|           | (Hz)           | (Accel)<br>(m/s <sup>2</sup> ) | (No)                          | (ms)     |
| Shock     | Half Sine      | 100                            | 500 (in each of 6 directions) | 6        |

**5.3.2. Transportation Conditions**

Vibration Test:

| Parameter  | Frequency Range | Severity (3 Axes)                          |                        | Duration    |
|------------|-----------------|--------------------------------------------|------------------------|-------------|
|            | (Hz)            | (ASD)<br>(m <sup>2</sup> /s <sup>3</sup> ) | (Roll Off)<br>(dB/oct) |             |
| Random     | 5 - 20          | 0.96                                       |                        | 3 x 10 mins |
| Sinusoidal | 9 - 200         |                                            | -3                     | 3 x 10 mins |

Shock Test:

| Parameter           | Shock Spectrum | Severity                       |                                                                     | Duration |
|---------------------|----------------|--------------------------------|---------------------------------------------------------------------|----------|
|                     | (Hz)           | (Accel)<br>(m/s <sup>2</sup> ) | (No)                                                                | (ms)     |
| Shock<br>(m≤100 Kg) | Half Sine      | 400                            | 500 (in each of 6 directions)<br><b>OR:</b> 1000 in normal attitude | 6        |

Drop Test:

| Parameter | Mass     | Drop Height | No of Drops                            |
|-----------|----------|-------------|----------------------------------------|
|           | (Kg)     | (m)         |                                        |
| Free Fall | 50 - 100 | 0.3         | 1 on each face or 2 in normal attitude |
| Toppling  | -        | -           | None                                   |

**5.3.3. Enclosure Weatherproofing**

The unit is weatherproofed ( including connectors) to IP68 of the European Standard IEC 529.

**6. RELIABILITY, MAINTAINABILITY****6.1. Reliability**

The MTBF for the Booster, calculated using MIL HDBK 217F for Ground Benign Conditions at +25 °C, is 125,000 Hours. Reliability data from the manufactures was used for the power devices in the HPA and FETs in the LNA. The calculations took account of the fact that the electronics in the HPA section will operate at temperatures approximately 20°C higher than ambient.

**6.2. Maintainability**

The Mean Time To Replace (MTTR) the Booster is < 60 minutes.

**7. MECHANICAL REQUIREMENTS****7.1. Volume**

| Parameter       | Value         |
|-----------------|---------------|
| Output RF power | 20 W          |
| Volume          | < 14.3 Liters |

**7.2 Dimensions (Including Heatsink)**

| Parameter       | Value  |
|-----------------|--------|
| Output RF power | 20 W   |
| Length          | 300 mm |
| Width           | 253 mm |
| Depth           | 190 mm |

(figures in brackets include fixings, brackets, handles etc)

**7.3. Weight**

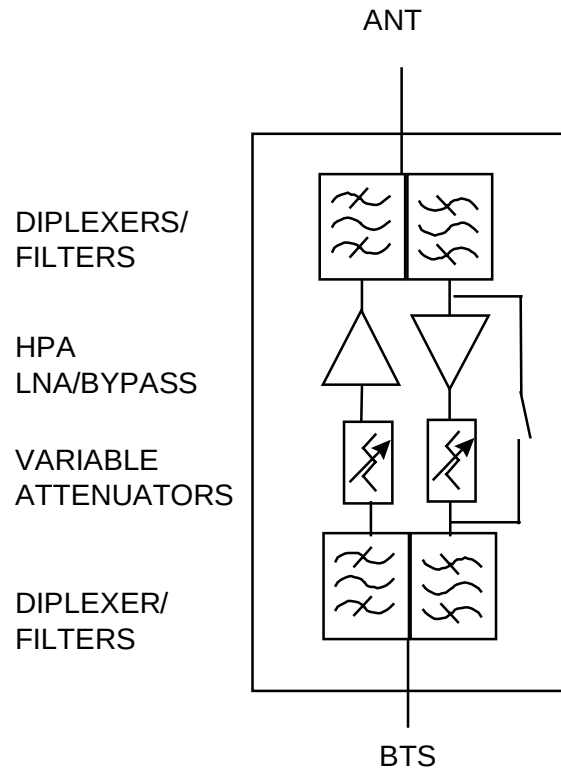
| Parameter       | Value |
|-----------------|-------|
| Output RF power | 20 W  |
| Weight          | 15 kg |

**8. INTERFACES**

Connectors:

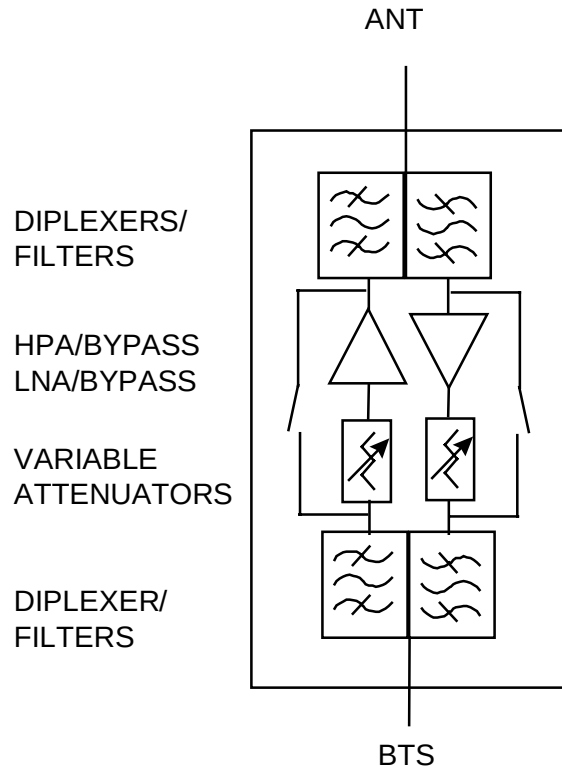
| Parameter                       | Connector Type |
|---------------------------------|----------------|
| RF Connectors ANT and BTS ports | 7/16 Female    |

Figure 1 - FUNCTIONAL BLOCK DIAGRAM – WITHOUT Tx BYPASS



Single Feeds - Single Antenna  
SF - SA

Figure 2 - FUNCTIONAL BLOCK DIAGRAM – WITH HPA BYPASS OPTION



Single Feeds - Single Antenna  
SF - SA

Figure 3 - INTERFACE CONTROL DRAWINGS

