Preliminary - Subjected to change without notice **Rev.pA0**

TOWER TOP POWER AMPLIFIER

PCS 1900MHZ / 20W

STANDALONE

TECHNICAL SPECIFICATION

1 INTRODUCTION

1.1 PURPOSE

This document describes the Technical specification for the Allgon Tower Top Power Amplifier for the PCS 1900 cellular band. The product number specified in the header has different variants available. These variants have different bandwidths, gain and options. A definition of the different available variants and a selection guide can be found in chapter 2.

1.2 SCOPE

The document details the total Technical performance of the TTPA, with respect to Electrical, Mechanical, Environmental, Safety and Reliability related parameters. Only the mast head mounted unit is described in this document. Other related products, such as APDU and Current Injectors, are described in other documents.

1.3 REVISION HISTORY

Rev. pA0	Draft	990518	M.Österberg
Rev.	Second draft		

1.4 RELATED DOCUMENTS

TIA, PS No 3389
Technical Specification for APDU 9209
Technical Specification for CI 9219

1.5 ABBREVIATIONS

TTPA	Tower Top Power Amplifier
PDU	Power Distribution Unit
APDU	Alarm And Power Distribution Unit
CI	Current Injector
PCN	Personal Cellular Network
AGC	Automatic Gain Control
ANT	Antenna
BTS	Base Transceiver Station
LED	Light Emitting Diode
MTBF	Mean Time Between Failures
MTTR	Mean Time To Replace
PA	Power Amplifier

1.6 DEFINITIONS

- **Normal operating conditions:**

The full operating performance specified in this document is guaranteed under conditions stated below:

Ambient temperature:	*Acc. to chapter 7 , after 30 min normal operation.*
Environment:	*Acc. to chapter 7 , after 30 min normal operation.*
DC power supply:	Acc. to chapter 4.
Return loss:	*> 18dB on all RF ports*.

Mounting: *Acc. to chapter 5.3*

The parameters specified are guaranteed over the warranty time.

- **Typical parameters:**
  All *typical* parameters are considered to be measured at an ambient temperature of 20 °C, and air pressure of 1013 mbar, after 30 min warm up, unless otherwise stated. The TTPA is designed for an operating life exceeding 10 years.

2 PRODUCT VARIANT DEFINITION

The TTPA are available with different frequency bands, together covering all PCS bands. A number of optional functions (listed in 2.2) are available depending on configuration. The existing, and preferred product configurations, are listen in 2.1.

2.1 DEFINITION OF THE AVAILABLE VARIANTS

Variant	Band / width	RX Freq.band	TX Freq.band	TX Gain	Options
9228.01	A+D / 20 MHz	1850-1870 MHz	1930-1950 MHz	7 dB	1,4,6
9228.02	B+E / 20 MHz	1870-1890 MHz	1950-1970 MHz	7 dB	1,4,6
*9228.03**	*C+F / 20 MHz*	*1890-1910 MHz*	*1970-1990 MHz*	*7 dB*	*1,4,6*

*Future Product

2.2 OPTIONAL FUNCTION SELECTION GUIDE

Option	See Section	Included in variant #
1. Fixed RX Gain 13dB	3.6.2	01,02,03
2. Separate DC connector	4.2.4	
3. Separate Alarm connector	4.2.5	01,02,03
4. Redundant DC/DC	3.8.4	
5. Antenna supervision	3.4.4	
6. RX bypass	3.6.6	
7. TX bypass	3.5.11	01,02,03

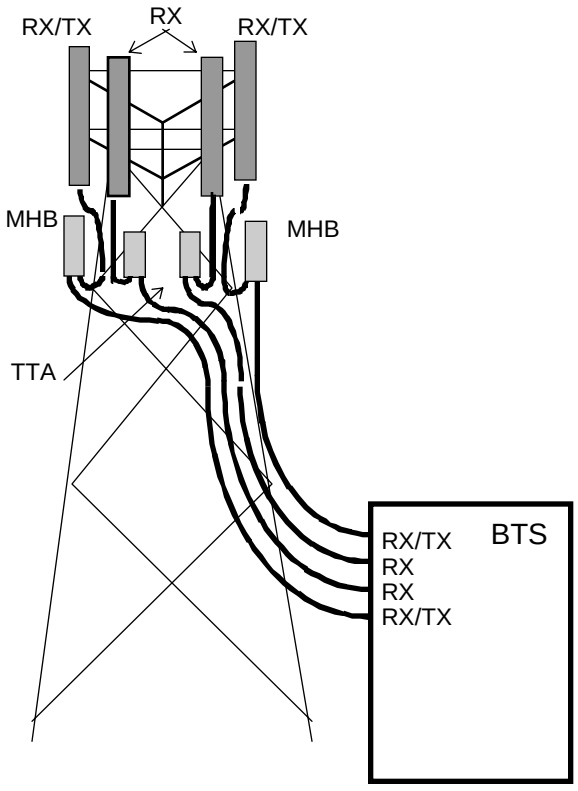
3 SYSTEM OVERVIEW

3.1 GENERAL

The PCS Tower Top Power Amplifier (TTPA) is intended for use at sites where it is necessary to improve the coverage area. The TTPA boosts both the receive-path signal and the transmit power from one TRx in order to preserve site link balance. TX and RX signal paths are separated by means of duplexers. The TX Power Amplifier (PA), as well as the RX Low Noise Amplifier (LNA), utilizes balanced architectures to add redundancy.

The TTPA can also be used together with a micro or mini BTS to reach coverage equivalent with a far more expensive Macro BTS installation.

The TTPA has a small and lightweight design, which enables it to be mounted in the antenna tower, near the antenna. This means that less costly feeders can be used since the attenuation becomes of less concern when the PA and the LNA is situated near the antenna. DC power to the TTPA is supplied , via the antenna feeder. The TTPA incorporates an advanced self-supervision system that automatically switches the unit into bypass mode in the event of malfunction or power failure.



KEY PARAMETERS

TX Gain: 7 dB

TX Power: +43 dBm (20W)

RX Gain: 13dB

Figure 1. Typical site configuration with Tower Top Amplifiers.

3.2 PRINCIPLE OF OPERATION

3.2.1 General

The TTPA has the RX and the TX signal paths separated by means of duplex filter or isolators. All circuitry for power supply and supervision are included inside the unit.
The TTPA has two ports designated BTS and ANT. The BTS port carries the signals to/from the BTS rack (e.g. TX-in, RX-out, DC-power). The ANT port will be connected to the antenna. See figure 2 Basic TTPA Block Diagram.

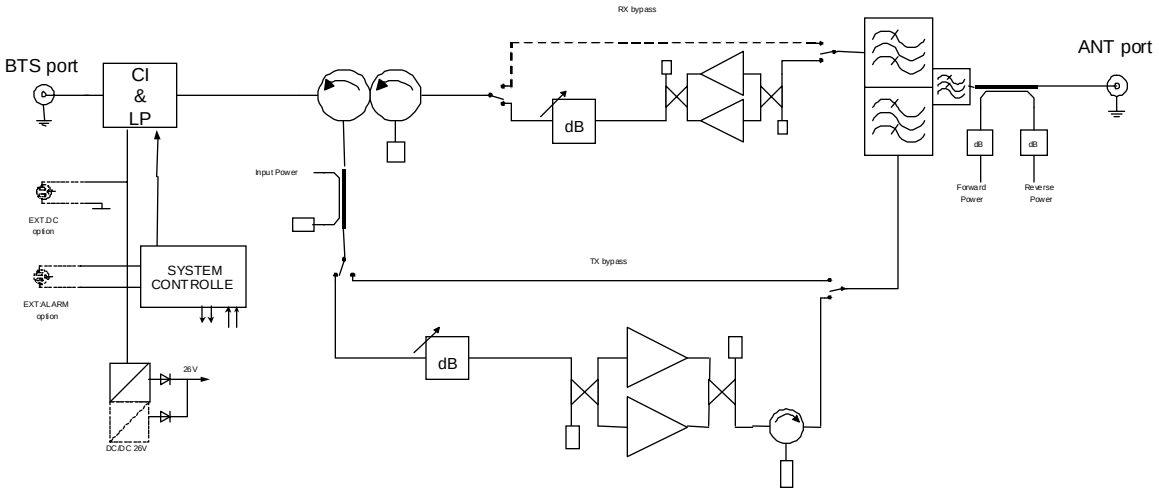


Figure 2. Block diagram of the Tower Top Power Amplifier.

3.2.2 Transmit Path

The Transmit path incorporates a balanced power amplifier with high linearity. An Automatic Gain Control circuit (AGC) keeps the gain at a constant level from input to ANT output. TX-path Bypass is optional.

3.2.3 Receive Path

The Receive path consists of a balanced LNA with very low noise factor. The LNA has a gain change capability in order to compensate for different feeder losses and optimize the link budget on each site. RX bypass, which will cut in at power failure or LNA failure, is an optional function.

3.2.4 Power Supply

The Power Supply filters and regulates the input DC power to suit the amplifiers. DC power fed into the unit on the BTS input connector through the feeder is standard. Separate DC connector and redundant DC/DC is optional.

3.2.5 Supervision

A number of parameters are constantly supervised.

TX Power Amplifier:
Output power, VSWR (when input power within specified limits), transistor currents, voltages, temperature and power supply. VSWR supervision optional.

RX LNA:
Transistor currents and power supply.

Control unit:
The system controller at startup and at certain intervals makes a system self-test.

3.2.6 Alarming

The TTPA has an alarm connector with two independent relay contacts and an auxillary input.
The Relays are assigned to different alarms depending on whether it is a Major or Minor alarm (Relay 1=Major, Relay 2=Minor).
This facilitates differentiation of minor alarms (not interrupting transmission) from major alarms that indicates loss of transmission. All alarms can be gated to one by simply connecting the contacts in parallel.

ALARM	Cause	Action in TTPA	Relay #
Overtemp	Cooling flange above 80°C**	RX_bypass****/TX Bypass****	1
DC-Minor	One DC/DC-converter failed	none	2
*DC-Major****	*No DC power to TTPA **	*TX Bypass*	*1*
TX-Minor	One PA Transistor failed	None	2
TX-Major	PA Failure, No Gain	PA shutdown & TX Bypass	1
RX-Minor	One LNA Transistor failed	None	2
RX-Major	LNA Failure	none	1
*VSWR Alarm****	*VSWR > 2.5:1****	*none*	*2*
OP-Alarm	Output Power over Limit	none	2
IP-Alarm	Input Power over Limit	none	2
*RP-Alarm****	*Reflected Power over Limit*	*none*	*2*
AGC-Alarm	Gain control failed	Gain accuracy reduced	2
*AUX-Alarm****	*Auxillary input shorted*	*none1*	*2*
*TTA_Minor****	*Diversity TTA minor failure*	*none*	*2*
*TTA_Major****	*Diversity TTA major failure*	*none*	*2*
SYS_Minor	CPU System test failed	none	2
SYS_Major	CPU System test failed	TX Bypass****	1

* Either due to failure of both DC/DC converters, or no DC power applied to the unit.
** restart at +60°C
*** Default value. Software changeable level 2:1 to 5:1 is optional

**** Optional function, not supported in all variant.

ELECTRICAL SPECIFICATION

3.3 ABSOLUTE MAXIMUM RATINGS

The Absolute Maximum Rating is defined as the value of applied signal/power etc. that is guaranteed not to damage the unit permanently. This applies over the full operating temperature range of the unit.

Parameter	MAX	MIN	Unit
3.1.1 Input DC Voltage (low imp. Source)	-	-70	V
3.1.2 Reverse Input DC Voltage	75	-	V
3.1.3 Input Power on BTS port (TX-band)	40	-	dBm
3.1.4 Input Power on ANT port (TX-band)	43	-	dBm
3.1.5 Input Power on BTS port (RX-band)	20	-	dBm
3.1.6 Input Power on ANT port (RX-band)	20	-	dBm
3.1.7 Input Power on ANT port (other bands)	43	-	dBm
3.1.8 Input Power on BTS port (other bands)	40	-	dBm

3.4 GENERAL PARAMETERS

3.4.1 Nominal Impedance

Nominal impedance of all ports: 50Ω

3.4.2 Return Loss

Measured over the tuned Rx and Tx band.

Normal operation:		Bypass:	
BTS port:	> 18 dB	BTS port	> 12 dB
ANT port:	> 18 dB	Ant port:	> 12 dB

3.4.3 Power Consumption

Max:	130W	(2.5A @48V)
Primary Fuse:	4 A Slow	

3.4.4 Antenna Supervision (VSWR) (option 5)

This optionally feature monitors the Forward and Reflected power at the ANT port. If calculated VSWR exceeds the VSWR LIMIT, a VSWR-alarm is issued. The VSWR value below is the default value and is optionally software changeable from 2:1 to 5:1.

	VSWR	Return Loss
VSWR LIMIT:	2.5:1	~7.4 dB

The VSWR-alarm is active down to an average output signal power > 20 dBm.

3.4.5 Reflected Output Power Supervision

If the reflected power from the antenna exceeds +38 dBm, the reflected power supervision function will decrease the TX gain in order to limit the reflected power to a level less than +38dBm. An *RP_Alarm* alarm will be issued in this condition .

3.4.6 Total Feeder DC Resistance and Maximum Feeder Length

Maximum length: 250 m (833 ft)
Maximum feeder DC resistance: 2Ω
Measured between the inner and outer connector with the other feeder end short circuited.
**Note: Only valid when using feeder cable for DC-feed.

3.4.7 Intermodulation Distorsion

The measurements are made on both ports with the TTPA operating at its nominal rated output power and with:

Two interfering signals in the PCS-RX band at a power level of -40 dBm at ANT port.
One interfering signals in the PCS-TX band at a power level of +13 dBm at ANT port.

Maximum IMD level:

Band	ANT port	BTS port	Meas BW
RX	-128 dBm	-114 dBm	100 kHz
TX	-70 dBc	-70 dBc	100 kHz

3.5 TRANSMIT PATH PARAMETERS

3.5.1 TX Operating Frequency

-**See section 2.1**

3.5.2 TX Nominal Output Power

Measured at the ANT port, within the tuned TX band.

Min: +43 dBm (20W)

3.5.3 TX Overload Supervision

When the average Output Power exceeds 43 dBm with:

≥ 1.0 dB an TX-OP Minor Alarm (TX Over Power) alarm is issued
≥ 2.0 dB the TX power is soft limited by the AGC circuitry not to exceed this value. and a TX-OP Major Alarm is issued.

3.5.4 TX Two Tone Linearity

Measured with two CW signals of 37dBm each (43dBm Peak Power) out from the unit in TX band, giving 40dBm total average output power. Max 1MHz spacing between tones.

Level of IM-tones Max: -30dBc

3.5.5 TX Nominal Gain

Nominal Gain is defined as [MaxGain(inband) + MinGain(inband)] / 2

7dB

3.5.6 TX Gain Tolerance

Measured with AGC in operation.
Nominal gain ± 0.5 dB

3.5.7 TX Gain Ripple

Ripple is defined as [MaxGain(inband) - MinGain(inband)]

Max: 1 dB

3.5.8 TX AGC Operation

The AGC system continuously holds the TX-gain at nominal value.
If the system fails to regulate the power a PA-fail alarm is generated.
The AGC time constant is chosen to compensate for thermal and other long term drift.

Minimum average input power level for AGC operation: +20 dBm.
TX gain tolerance with AGC not operating: ±1.5dB.

3.5.9 TX Stability

The TX-amplifier is unconditionally stable for all passive loads at input and output.

3.5.10 TX Spurious Emissions and Broadband Noise

Measured at ANT port, with the TTPA operating at nominal output power.
Peak power and measurement bandwidth as listed in table.

Outside TX band:

Frequency band	Max peak power / Bandwidth
RX band	- 128 dBm / 100 kHz
1850-1910 MHz	- 98 dBm / 100 kHz
824 - 849 MHz	- 98 dBm / 100 kHz
100 kHz - 50 MHz	- 36 dBm / 10 kHz
50-1000 MHz	- 36 dBm / 100 kHz
1 – 12.75 GHz, outside TX band >± 2 MHz	- 30 dBm / 30 kHz
" >± 5 MHz	- 30 dBm / 100 kHz
" >± 10 MHz	- 30 dBm / 300 kHz
" >± 20 MHz	- 30 dBm / 1 MHz
" >± 30 MHz	- 30 dBm / 3 MHz

Inside TX band:

Frequency band	Max peak power / Bandwidth
Carrier offset > ± 1.8 MHz	- 36 dBm / 30 kHz
Carrier offset > ± 6 MHz	- 36 dBm / 100 kHz

3.5.11 TX Bypass Loss (option 7)

TX bypass function is optional.
Measured from ANT to BTS port
Typ. 2.0 dB
Max: 2.6 dB

3.5.12 TX Redundancy & Bypass Operation

In the event of failure of one of the transistors in the power amplifier the gain will drop by approx. 6dB. In this condition a TX-minor alarm will be generated. If both transistors fail and the TX Bypass option is installed, the TX-path will be switched to bypass mode and a TX-major alarm will be issued. Bypass mode will automatically be initiated if DC power to the PA fails.

3.6 RECEIVE PATH PARAMETERS

3.6.1 RX Operating Frequency

-See section 2.1

3.6.2 RX Gain

Nominal Gain is defined as [MaxGain(inband) + MinGain(inband)] / 2

13 dB

Optionally reduced in 1 dB steps from 13 to 7 dB.

3.6.3 RX Gain Tolerance

±0.6 dB

3.6.4 RX Gain Ripple

Ripple is defined as [MaxGain(inband) - MinGain(inband)]

±0.5 dB

3.6.5 RX Noise Figure

Measured at Nominal RX gain.
Typ: 1.9 dB
Max: 2.9 dB

3.6.6 RX Bypass Loss (option 6)

RX bypass function is optional.
Measured from ANT to BTS port
Typ. 2.2 dB
Max 2.9 dB

3.6.7 RX Input Intercept Point IIP3

Min: +6dBm

3.6.8 RX Stability

The RX-amplifier is unconditionally stable for all loads at input and output of the TTPA.

3.6.9 RX Redundancy

In the event of failure of one of the transistors in the balanced LNA the gain will drop by approx. 6dB. An *RX-minor alarm* will be generated. If both transistors fail, an *RX-major* alarm will be generated.

3.7 FILTER PARAMETERS

Rx and Tx bands according to paragraph 2.1

Isolation ANT to LNA input

DC – 1000	90 dB
1000 – {35 MHz below Rx Band}	30 dB
1910 – 1990	50 dB
Tx Band (20 MHz wide)	85 dB
1990 – 5970	40 dB
5970 – 12750	20 dB

3.8 POWER SUPPLY PARAMETERS

3.8.1 Supply Voltage

- 48 Volts DC

3.8.2 Supply Voltage Tolerance

Measured at BTS port.
Max: -60V
Min: -40 V

3.8.3 Supply Voltage Noise Tolerance

- Ripple and noise 10Hz to 100 MHz: 100 mV p-p
- Wideband noise 4kHz to 20 MHz, any 3kHz band: 1V p-p

3.8.4 DC/DC Redundancy (option 4)

The power supply consists of two DC/DC converters in parallel, sharing the current. In the case off one converter failing, the remaining converter will power the unit to full operation. An alarm (DC-minor) will be signaled to the PDU. If both DC/DC converters fails, or no power is applied to the unit, the APDU detects this automatically and raises an alarm.

3.8.5 DC Input Protection

- Reverse Voltage Protection
- Over voltage Protection (see lightning spec.)
- Over current protection

3.8.6 Inrush Current

Measured at power on with nominal supply voltage.
Max peak: 15A
Max after 10ms: 3A

4 MECHANICAL SPECIFICATION

4.1 PHYSICAL PARAMETERS

4.1.1 Height

350 mm (±20mm)

4.1.2 Width

220 mm (±20mm)

4.1.3 Depth

230 mm (±20mm)

4.1.4 Volume

17 dm^3

4.1.5 Weight - Clamping Unit

3 kg

4.1.6 Weight - Amplifier Unit

12 kg (26.5 lb)

4.1.7 Color

RAL 7035 and Nature Anodized Aluminum, non reflective.

4.1.8 Wind Load

~155 N @ 150 km/h (41.67 m/s)

4.1.9 Materials

All plastic materials are characterized according to ISO 1043.

4.1.10 Weatherproofing

UL50/IP 65

4.2 INTERFACES

The TTPA has total of two (2) ports designated BTS and ANT. The BTS Connector carries the signals to/from the BTS rack (e.g. TX-in, RX-out, DC-power and Alarm signaling). The ANT connector should be connected to the antenna.

4.2.1 BTS Connector

7/16 Female

4.2.2 ANT Connector

7/16 Female

4.2.3 Earthing

Earthing stud: M8 x 15mm

4.2.4 DC Connector (option 2)

Optional DC connector for separate DC, *see 2.2*
Type: Binder series 623 , 6 poles, male

4.2.5 Alarm Connector (option 3)

Optional alarm connector*, see 2.2*
Type: Binder series 623 , 12 poles, male

4.2.6 Power ON LED

Optional LED, indicating POWER ON
Color: Green

4.3 MOUNTING

NOTE: DC power must be connected to the TTPA within one day after mounting to prevent damage due to moisture.

4.3.1 Mounting method

The TTPA is equipped with a pole clamping unit. This enables the installation personnel to first install the relatively light mast clamp, and then easily hook on the actual amplifier. This feature reduces the risk of accidents during installation.

- Pole mounting with clamps. Pole diameter: 50 - 120 mm
- Wall mounting by means of mounting plate.

4.3.2 Mounting Time

The unit is designed to be easily mounted by normally skilled installation personnel in less than 20 minutes. (Not including commissioning)

4.3.3 Mounting Requirements

- The unit must have non obstructed free air to a distance of 0.5m from TOP and BOTTOM sides, and 0.2 m from all other sides, except BACK side.
- Mounting angle: Vertically ±10° (Applies to completed mounting, TTPA in operation)

4.3.4 MTTR

Less than 15 min (excluding commissioning)

5 ENVIRONMENTAL SPECIFICATION

5.1 OPERATING CONDITIONS

(Conditions: The unit mounted in free air, DC power applied at all times.)

5.1.1 Ambient Air Temperature Full Performance

Max: + 50 °C
Min: - 35 °C

5.1.2 Survival Operational Temperature

Max: + 80 °C
Min: - 40 °C
When the internal temperature exceeds +80°C the power is reduced and the transmission path goes into bypass mode. Resets automatically when the temperature decreases.

5.1.3 Relative Humidity

Max: 100 %
Min: 8 %

5.1.4 Absolute Humidity

Max: 30 g/m^3
Min: 0.26 g/m^3

5.1.5 Rate of Temperature Change

Max: 1°C/min (ambient)

5.1.6 Air Pressure

Max: 106 kPa
Min: 70 kPa

5.1.7 Solar Radiation

Max: 1125 W/m^2 (with solar cover)

5.1.8 Vibration

According to: ETS 300 019-2-4

5.1.9 Applicable Test Standards

ETS 300 019-2-4 class T4.1
80 / 85 environmental test

5.2 STORAGE AND TRANSPORTATION

(Conditions: 6 months storage of unit in original shipping container with intact sealing)

5.2.1 Ambient Air Temperature

Max: + 85 °C
Min: - 45 °C

5.2.2 Relative Humidity

Max: 100 %
Min: 8 %

5.2.3 Absolute Humidity

Max: 30 g/m^3
Min: 0.26 g/m^3

5.2.4 Rate of Temperature Change

Max: 2°C/min (ambient)

5.2.5 Air Pressure

Max: 106 kPa
Min: 50 kPa

5.2.6 Vibration

According to: ETS 300 019-2-1
ETS 300 019-2-2
IEC 68-2-6
IEC 68-2-36
IEC 68-2-29
IEC 68-2-32

5.2.7 Applicable Test Standards

Transport: ETS 300 019-2-2 class T2.3
Storage: ETS 300 019-2-1 class T1.2

5.3 ELECTROMAGNETIC COMPATIBILITY (EMC)

Complies to: ETS 3000 342-2
IEC 1000-4-5
FCC Part 24
FCC Part 15

5.4 LIGHTNING PROTECTION

According to IEC 1000-4-5 extended to 10 kA short circuit current.

ANT port DC grounded

6 RELIABILTIY SPECIFICATION

6.1 OPERATING LIFE

The TTPA is designed for an operating life exceeding 10 years.

6.2 THEORETICAL MTBF

Theoretical MTBF is calculated according to MIL-HDBK-217F, part stress method, ground fixed, uncontrolled environment, 40°C ambient temperature. If available, practically derived reliability data is used in place of statistical in the calculation. This calculation yields an MTBF of > 25000 hours.

Note: the calculated MTBF gives a very conservative value. Especially when the components MTBF is based on the default data specified in MIL-HDBK-217F and not from an accelerated life time test. If such data was available on every component then a result close to the field proven MTBF could be calculated.

6.3 FIELD PROVEN MTBF

The TTPA is designed to demonstrate a field proven MTBF of over 200000 hours, calculated over a period exceeding one (1) year.

7 SAFETY SPECIFICATION

7.1 TOXIC MATERIALS

No toxic materials is used within the unit.

7.2 SAFETY CLASSIFICATIONS

CE-Recognition: EN 60950
UL-Classification: UL 1950

8 SERVICE AND MAINTENANCE

8.1 SERVICE

No field serviceable parts inside. Failed unit must be returned to Allgon.
Service only by qualified personnel authorized by Allgon.

8.2 MAINTENANCE

No periodic maintenance necessary.