ANDREW

BRITECELL PLUS

User Manual

MN024-04

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1. Introducing Britecell Plus

1.1 The Features

Britecell Plus is an innovative platform designed in order to provide an effective and flexible coverage to a large variety of indoor scenarios.

Thanks to its high modularity, its low power consumption, and its full-transparency to protocols and modulation formats, Britecell Plus is the perfect plug&play solution to distribute any wireless standard (including GSM, GPRS, EDGE, CDMA, WCDMA, and WLAN IEEE 802.11b) to the in-building environments requiring reliable and interference-free communications, as well as high traffic capacity and maximum flexibility about future expansions.

These unique features make the Britecell Plus platform suitable also for applications to critical areas experiencing difficulties in establishing and keeping phone calls, while its compact design always guarantees a minimum aesthetic impact.

1.2 Britecell Plus brief Description

Britecell Plus is a Distributed Antenna System (DAS) based on the Radio-over-Fibre (RoF) technology, and capable of carrying wireless mobile signals through the 400 MHz- 2500 MHz frequency range regardless of their protocol and their modulation format.

The system has two basic components, a Master Unit and a Remote Unit. The Master Unit is made of one or more subracks typically connected to the BTS (Base Tranceiver Station) through either a repeater (RF interface) or a coaxial cable.

Each Remote Unit is connected with a dedicated pair of single-mode optical fibres (one for UL and one for DL) to the Master Unit. These optical fibres work on 1310 nm wavelenght and provide low losses and almost unlimited bandwidth, available for future system developments.

Britecell Plus is a modular system whose basic components are:

- one Master Unit made of one or more subracks, each providing 12 module slots. Each slot can host either an active or a RF passive device (chosen among the wide range of Britecell Plus options), in order to meet the planned design requirements;
- a variable number of Remote Units (TFAxxx), whose function is feeding the antenna passive network;
- a proper number of indoor antennas, suitable to provide radio coverage to the area. Britecell Plus is fully compatible with any type of indoor antennas;
- the optical cables required to connect the 19” subracks to the TFAxxx.

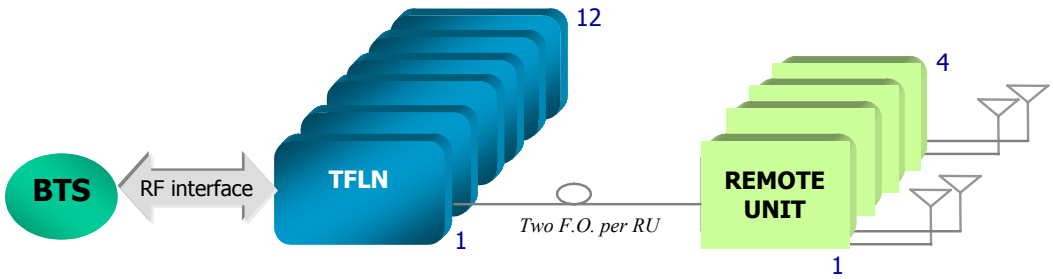


Fig. 1: Britecell Plus system block diagram.

1.3 Britecell Plus Features

The following lines report a brief summary of Britecell Plus main features:

- **multiband 2G, 2.5G and 3G – 802.11b WLAN compatible:** Britecell Plus is completely transparent to any transmission protocol and modulation format, and it can distribute any 2G, 2.5G, 3G wireless standard. In addition, a special option allows to carry also the WLAN (802.11b/g) service over the same infrastructure;
- **modular configuration for flexible design**: by properly setting some parameters like the amount of RUs and the antenna locations, the Britecell Plus architecture can follow the environment specific features in order to obtain the most effective radio-coverage of the indoor area. The modularity of the system allows easy modifications for future growth and increasing traffic;
- **easy to install**: the intelligent plug & play Britecell Plus system includes an Automatic Gain Control (AGC), that eliminates system gain variations regardless of optical loss. This avoids the need for field adjustments, thus reducing design, installation and optimization time.
- **low-power consumption**: establishing a "quasi line-of-sight propagation" towards all mobile phones inside the area, Britecell Plus works with extremely low power levels. Low power levels have two great advantages: 1) allow mobile phones to work at lower power levels, thus limiting the radiated emissions and increasing their battery life; 2) allow a better control of interference effects between adiacent cells.
- **central supervision functions**: all individual alarms of Britecell Plus system are stored in an internal flash memory, and available to both local and remote connections. Detailed alarm information is provided by special software (i.e. by Supervision or Maintenance software tools) running on a locally connected host, as well as any information about alarm status and alarm history is available to remote connections via TCP/IP protocols, SNMP agent, or HTTP servers. This alarm information is visible also by means of LEDs present on the front panels of both the MU and the RUs;
- **multiple-carriers system**: there are no restrictions on the number of carriers that the Britecell Plus can convey. Obviously, the more carriers per service, the less power per carrier;
- **remote power supply**: in case mains cannot be used for the Remote Units, Britecell Plus offers a centralised power supply option, which distributes both a DC low-voltage (- 48) power and the optical signals through a composite fibre optic/copper cable;
- **wide variety of RF passive devices**: the connections between the DAS and the local BTSs can be arranged so as to get the best fit for customers needs. Britecell Plus equipment provides RF splitters/combiners, multi-band duplexer/triplexer, attenuators, couplers for UL/DL paths, thus allowing the maximum design flexibility
- **high reliability**: the MTBF (Mean Time Between Failure) is estimated to be 300000 hours.

1.4 Britecell Plus typical Applications

Thanks to its unique features Britecell Plus is the ideal solution to set up radio coverage in may situations:

- **Multi operator shared infrastructure**: each mobile operator has its own carriers, which must be transported without affecting the others. Britecell Plus is capable of transmitting multiple carriers simultaneously, while providing an independent level adjustment for each of them, ensuring maximum performance and reducing infrastructure costs
- **High rise buildings**: RF signals from surrounding macrocells or external BTSs are usually quite strong inside high rise buildings, and cause so much interference that indoor mobile communications often become impossible. By strategically placing antennas along the exterior walls of the building, the signal to noise ratio can be optimised. This interference control solves many problems, such as the "ping pong" effect that sometimes is experienced when a mobile frequently changes from an indoor to an outdoor coverage.
- **Exhibition, conventions, and shopping centres**: the critical point of these environments is due to the high traffic loads, which are furthermore highly variable. Thus, the main goal to achieve is setting up a radio coverage which could effectively manage these variable traffic loads, with neither undervalued nor overvalued infrastructure expenses. A unique feature of Britecell Plus is that RF frequencies can be allocated quickly when and where they are needed, thus reducing the implementation cost. This makes Britecell Plus the proper solution also for temporary or last minute requests (such as conferences).
- **Airports**: they require modular and flexible radio coverage, in order to meet present needs while foreseeing future expansions. Britecell Plus can manage high traffic loads providing high quality with minimum environmental impact, while its modularity allows future extensibility.
- **Corporate Building**: inside a corporate building, difficult mobile communications may limit business transactions. These environments are often complex and densely populated with specific requirements to be fulfilled: high traffic capacity, maximum expectations on Quality of service, full compatibility with wireless standards and future expandability. Britecell Plus guarantees high quality radio coverage under all conditions, while maintaining maximum flexibility in managing any traffic condition.
- **Subways and Highly Dense Metropolitan Areas:** These areas are distinguished by large distances, and may require that RUs are placed far away from the BTSs. Britecell Plus guarantees the signal integrity at distances up to 3 km, and through the wideband interconnect link option distances of 20 km can be reached. Moreover, these environments need gradual investments, because initially operators provide radio coverage only in the busiest areas, and then extend it in order to reach complete coverage. The modularity of Britecell Plus helps operators to gradually expand the system. Some large cities often need to set up seamless and reliable radio systems for emergency services. The required RF infrastructure needs to be unobstrusive and environmental friendly; this can be achieved using a Britecell Plus DAS. When redundancy is required, two interleaved Britecell Plus systems can be used, management and supervision for these systems can be remotely established by means of an external modem and an open protocol such as SNMP.

1.5 Health and Safety Warnings

IMPORTANT NOTE: To comply with FCC RF exposure compliance requirements, the following antenna installation and device operating configurations must be satisfied: A separation distance of at least 35 cm must be maintained between the antenna of this device and all persons. RF exposure compliance may need to be addressed at the time of licensing, as required by the responsible FCC

Bureau(s), including antenna co-location requirements of 1.1307(b)(3). Maximum permissible antenna gain is:

Britecell Plus TFAM Remotes: 10dBi.

1.6 Britecell Plus Operation with Multiple RF Channels

The Manufacturer's rated output power of this equipment is for single carrier operation. For situations when multiple carrier signals are present, the rating would have to be reduced by 3.5 dB, especially where the output signal is re-radiated and can cause interference to adjacent band users. This power reduction is to be by means of input power or gain reduction and not by an attenuator at the output of the device.

2. Equipment Overview

2.1. The Remote Unit TFAxxx and relevant TKA installation kit

The TFAxxx is a device providing optical-to-electrical downlink conversion and electrical-to-optical uplink conversion, thus allowing a bidirectional transmission of signals between one TFLN and the remote antennas. It is available in 3 versions (low-power, medium-power, and high-power), each designed in order to support different output power levels on RF antenna ports.

Fig. 2: Different Remote Unit cases

In downlink each TFAxxx receives an optical signal from the TFLN, performs an optical-to-RF conversion, and transmits the resulting signal to the 2 antenna ports.

In uplink it receives a RF signal from remote antennas, provides a RF-to-optical conversion, and conveys the converted signal to the TFLN over the optical fibres.

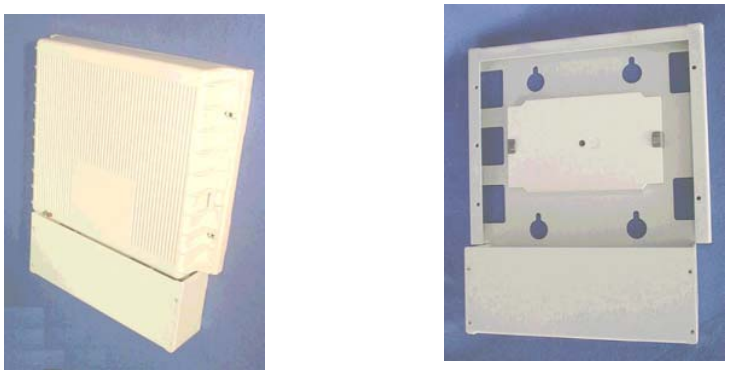


Fig. 3: TKA mounting kit for low and medium power remote units

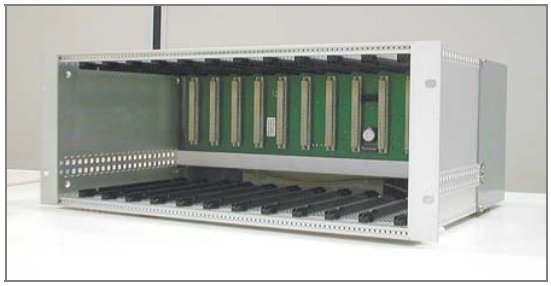
Each TFAxxx can be provided with an optional TKA installation kit, which contains a fibre optics splice holder and a compact case for an easy installation of the TFAxxx on walls or poles.

Moreover, the TKA compact cases are able to provide the TFAxxx with the different IP protection levels, depending on the specific environmental requirements.

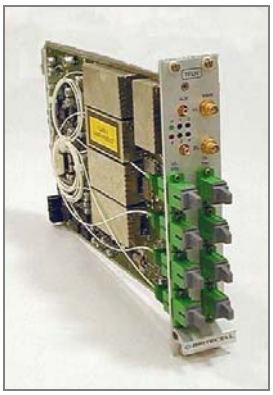
2.2. The Britecell Plus Master Unit

Below are listed the Britecell Plus modules. For further details about these components, refer to the next chapters of this manual.

The Sub-rack (TPRN) is a 19" subrack hosting the Britecell Plus modules; it accommodates 12 slots, whose sizes are 7 TE x 4 HE. As each Britecell Plus module takes up one or two slots, each Master Unit can sustain up to 12 modules, depending on design configuration and requirements.



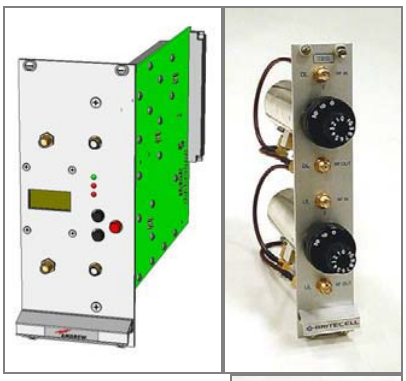
The Local Unit (TFLN): in downlink it provides an RF-to-optical conversion of the signal coming from the BTS, and transmits it to 4 optical outputs, so as to feed 4 TFAxxx. In uplink it provides optical-to-RF conversion for 4 optical signals coming from RUs, and it combines them into a single RF output, while providing automatic gain control in order to balance the fibre losses.
Module dimensions:
Width = 7TE, Height = 4HE (one slot in the Master Unit).



The duplexer (THYN): it combines the downlink (DL) and uplink (UL) paths into a single one, while maintaining the required isolation. The module dimensions are: Width = 7TE, Height = 4HE.

The variable RF attenuators (TBSI and TDI): they provide independent attenuations (adjustable from 0 to 30dB, with 1dB steps) on uplink and downlink RF paths, and allow the designer to optimize the signal level close to the BTSs. TBSI is an override attenuator, while TDI is a digital attenuator also providing 20dB gain on the UL path. Their dimensions are:

TBSI: Width = 7TE, Height = 4HE, i.e. a 1-slot space
TDI: Width =14TE, Height= 4HE, i.e. a 2-slot space



The RF diplexer (TLDN): in downlink it combines a low band RF signal (800 to 1000 MHz) and a high band RF signal (1700 to 2500 MHz) into a common RF port; in uplink it splits a composite signal between a low band RF port and a high band RF port. Module dimensions: Width = 7 TE, Height = 4 HE (one slot).

The RF triplexer (TLTN): in downlink it combines the low band signals (800 or 900MHz), the 1800MHz band signal and UMTS signal into a common one; in uplink it splits the triple band signal between three different RF single band paths. Module dimensions: Width = 7 TE, Height = 4 HE (one slot).

The RF splitters/combiners (TLCN2 and TLCN4): TLCN2 is a 2-way splitter/combiner. TLCN4 is a 4-way splitter/combiner. They can be used in a variety of different situations, such as:

- To connect a BTS with several LUs. In uplink the TLCN2 (or TLCN4) combines 2 (4) RF signals coming from different LUs onto a common RF signal, entering the BTS. In downlink the TLCN2 (or TLCN4) splits the downlink composite RF signal coming from the BTS onto 2 (4) RF ports, entering different Local Units;
- To connect several BTSs to a LU. In downlink the TLCN2 (TLCN4) combines the RF signals coming from different BTSs onto a common RF signal, entering the LU.

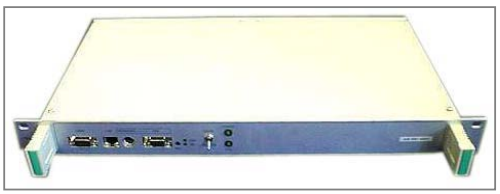
In uplink TLCN2 (TLCN4) splits the composite RF signal coming from a LU into 2 (4) RF signals entering different BTSs.

The WLAN interface board (TWLI):.it connects 3 WLAN Access Points to each TFLN, and it is necessary when 802.11b WLAN distribution through the DAS is required. Dimensions: Width = 14 TE, Height = 4HE (2 slots).

The wideband amplifier (TWANxx): it is an amplifier used to interface low power base stations to Britecell system. Its purpose is to amplify both DL and UL signals in order to compensate losses of passive combiners and splitters. Dimensions: Width = 7 TE, Height = 4HE.

The power limiters (TMPx-10): it monitors the DL power coming from the BTS, and attenuates it by 10 dB in case of overcoming of a programmable threshold level.
TMP2-10 Power Limiter is for 2G and 2.5G signals, working at 900 MHz and 1800 MHz.
TMP3-10 Power Limiter is for 3G signals.
Both modules are 7TE wide and 4HE high.

The SNMP agent (TSUNx): it is able to control up to 14 master units. It is available both as a plug-in module (Width = 14 TE, Height = 4HE, 2 slots) and as stand alone device (Width= 19", Height=1HE). It consists in a CPU, a flash memory and an Interface Board.



2.3. Block diagrams

To better understand the functions of the different units and modules, two block diagrams of the Britecell Plus system are reported here.

The first diagram (Fig. 4) refers to the case of duplexed BTSs, ie. BTS conveying both the downlink and uplink signals on a single RF port. In this case, a THYN module is required to combine the uplink and downlink paths on a single RF port. The second diagram (Fig. 5) refers to the case of not-duplexed BTSs, ie BTSs conveying the uplink and the downlink connections on separate RF ports.

Table 2.1 shows an overview of Britecell Plus equipment, including all the modules and the units stated above.

For more information about the single units and/or the single modules, please refer to the following sections.

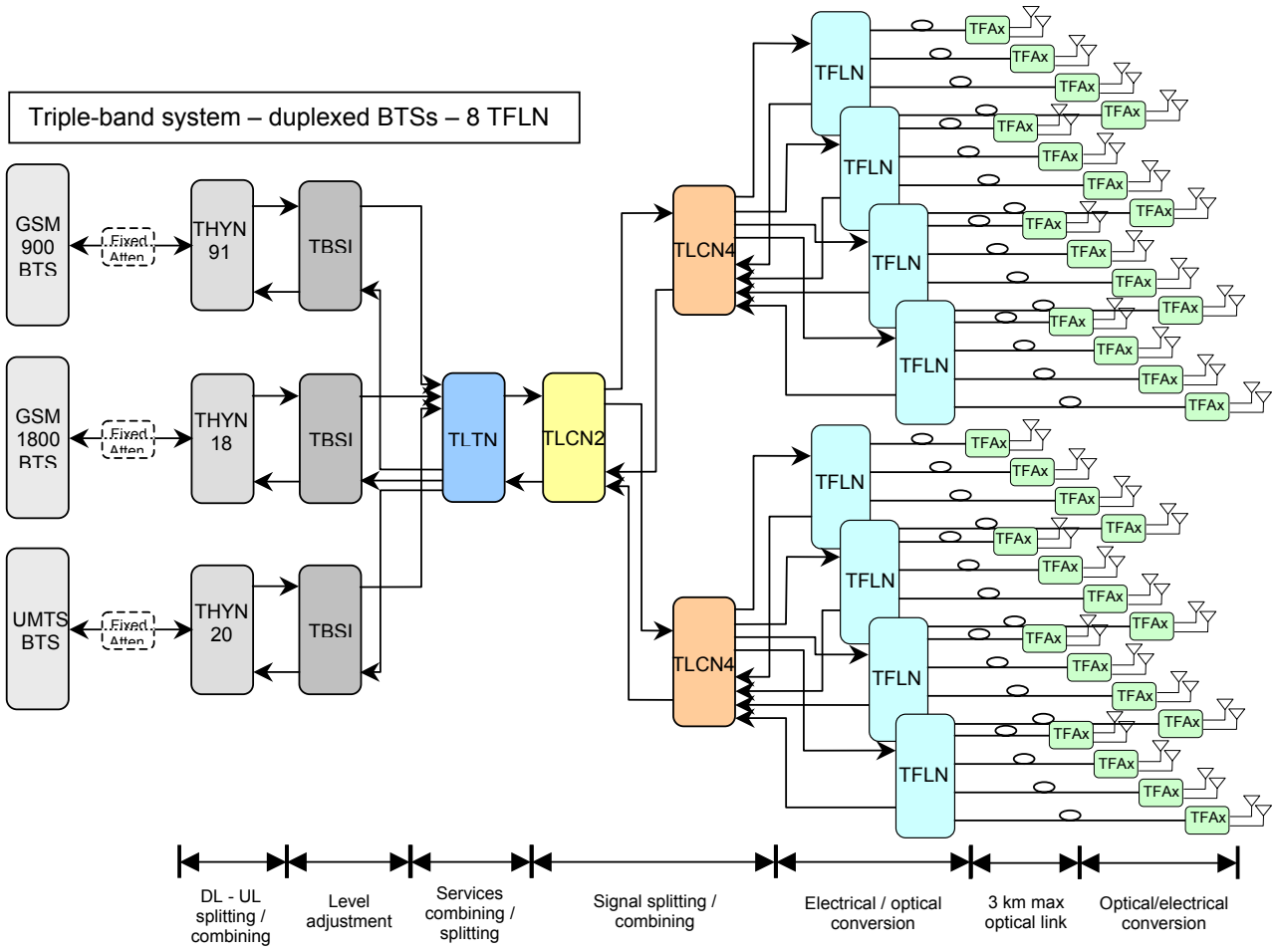


Fig. 4: Block diagram for a triple band system with 8 TFLN fully populated of TFAxxx, and duplexed base stations.

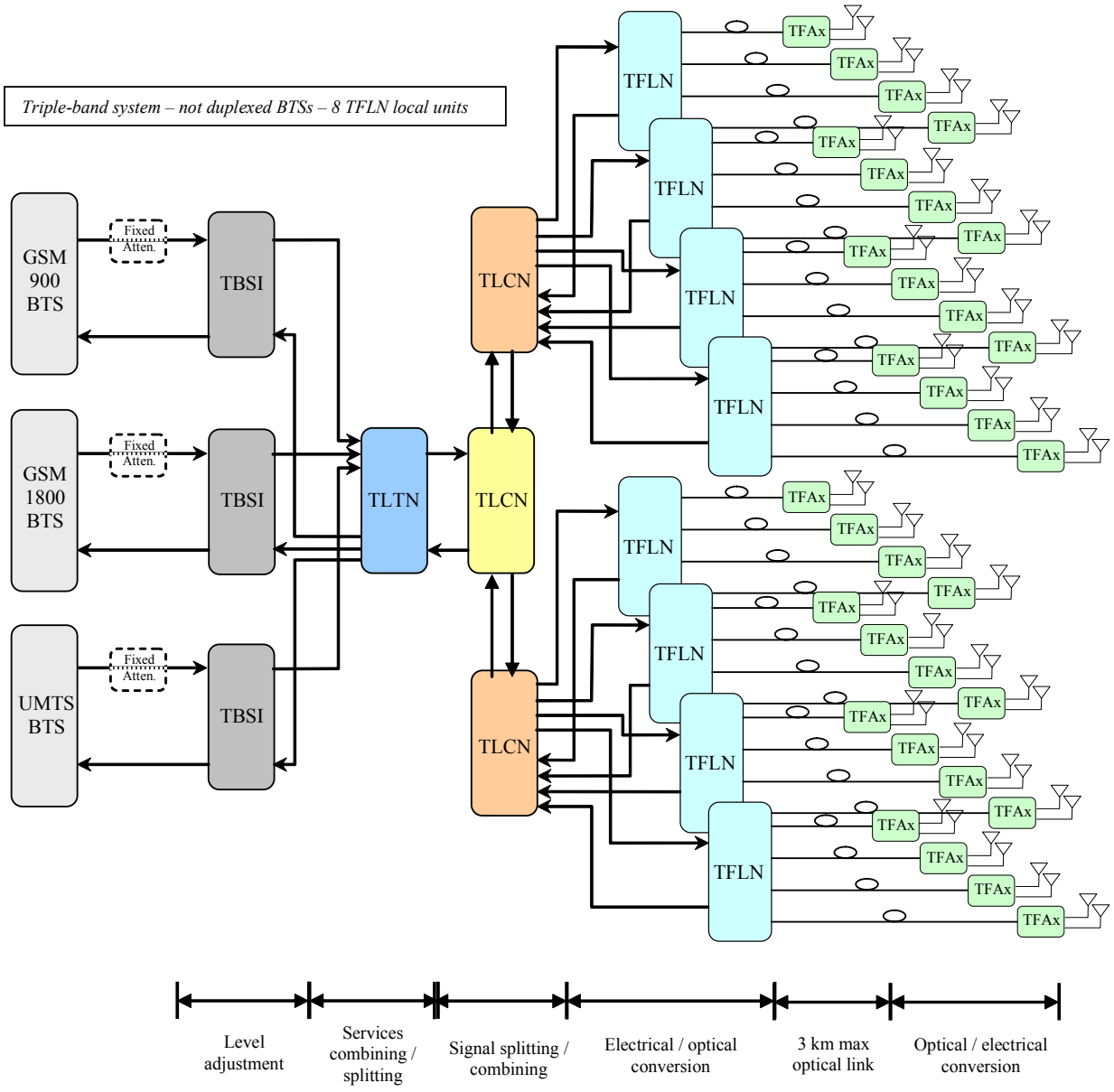


Fig. 5: block diagram for a triple band system with 8 TFLN fully populated, and non-duplexed base stations.

Unit or Module name	Description	Dimensions
TFAxxx case-A TFAxxx case-B TFAxxx case-F	Remote unit Remote unit Remote unit	240 x 200 x 38 240 x 240 x 38 445 x 255 x 167
TKA01 TKA02 TKA04	RU installation kit RU installation kit RU installation kit	280 x 240 x 55 305 x 270 x 58 340 x 240 x 55
TPRN04 TPRNx4	passive subrack active subrack	19” x 4HE 19” x 4HE
TFLNx	Local unit	7TE x 4HE
TLCN2/4	2/4-way splitter	7TE x 4HE
TBSI2-30	adjustable attenuator	7TE x 4HE
TDI2-30	digital adjustable attenuator	14TEx4HE
THYNx	UL/DL duplexer	7TE x 4HE
TLDNx	diplexer	7TE x 4HE
TLTNx	triplexer	7TE x 4HE
TMPx-10	10 dB power limiter	7TE x 4HE
TWLI	WLAN interface	14TE x 4HE
TFBW	WLAN booster	240 x 200 x 38
TSUN1 or TSUN3 TSUN6	SNMP agent standalone SNMP agent plug in	19” x 1HE 14TE x 4HE

Tab. 1: Overview of all Britecell Plus available modules and units

3. Remote Unit TFAxxx

Module name:
Remote Unit
TFAxxx

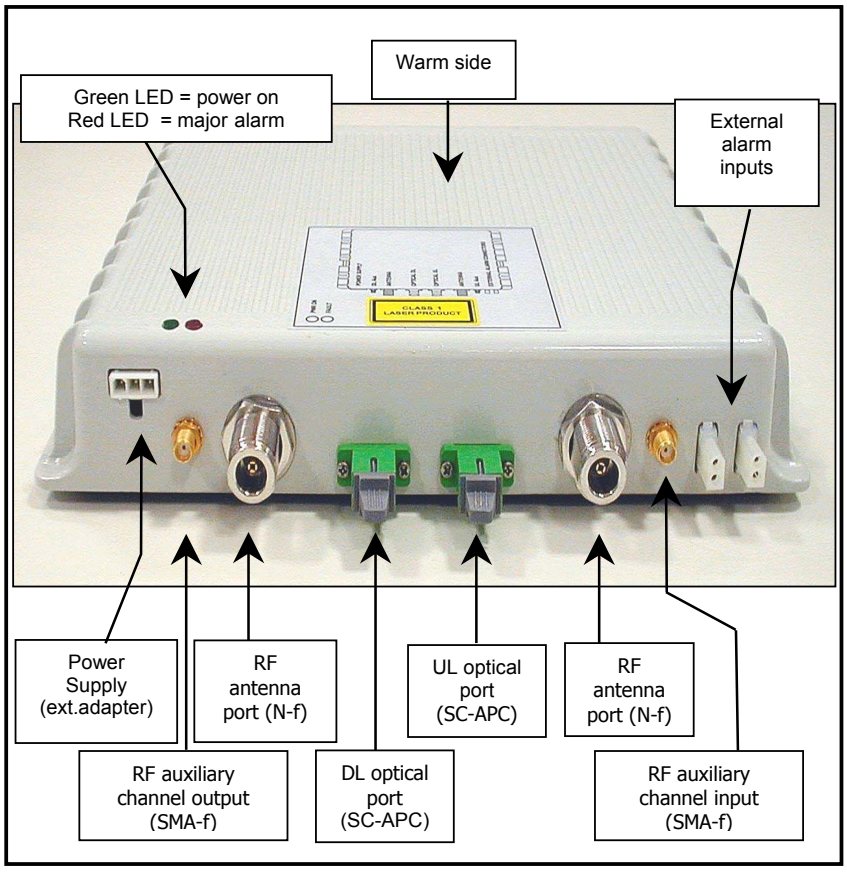
Case A

Main processes carried out by the TFAxxx:

- In Downlink (DL) operations:
  - Optical-to-RF conversion of the input optical signal
  - Automatic Gain Control (AGC) of each converted signal, in order to compensate optical losses (provided they are < 4dB);
  - RF amplification: the converted RF signal is boosted in order to maintain a good signal-to-noise ratio
  - RF filtering: a proper filter rejects the spurious emissions which lie out of the Downlink band
  - RF duplexing and splitting: the boosted RF signal is conveyed to 2 antenna ports
- In Uplink (UL) operations:
  - RF amplification: a low noise amplifier boosts the signal received from antennas so as to maintain a good signal-to-noise ratio
  - RF filtering: the boosted signal is cleaned from the spurious emissions which lie out of the Uplink band
  - Automatic Level Control (ALC): the RF signal level is adjusted according to the blocking requirements
  - RF-to-optical conversion of the signal, which is finally conveyed to the output optical port.

RF ports:

- 2 RF antenna ports, transmitting/receiving signals to/from distributed antennas. RF antenna ports are duplexed N-female connectors. These RF ports can be connected to distributed antennas either directly (i.e. through RF jumper cables) or through external TLCN passive splitters, thus allowing more antennas to be fed. **Unused RF ports are to be terminated with a 50 Ω load.**
- 1 RF auxiliary input and 1 auxiliary output (designed to receive and transmit additional signals like WLAN by means of proper booster TWBA). Auxiliary input and output ports are SMA-female connectors.



Optical ports:

- 1 optical output port, transmitting UL signals to TFLN local unit
- 1 optical input port, receiving DL signals from TFLN local unit

Module name:
Remote Unit TFAxxx

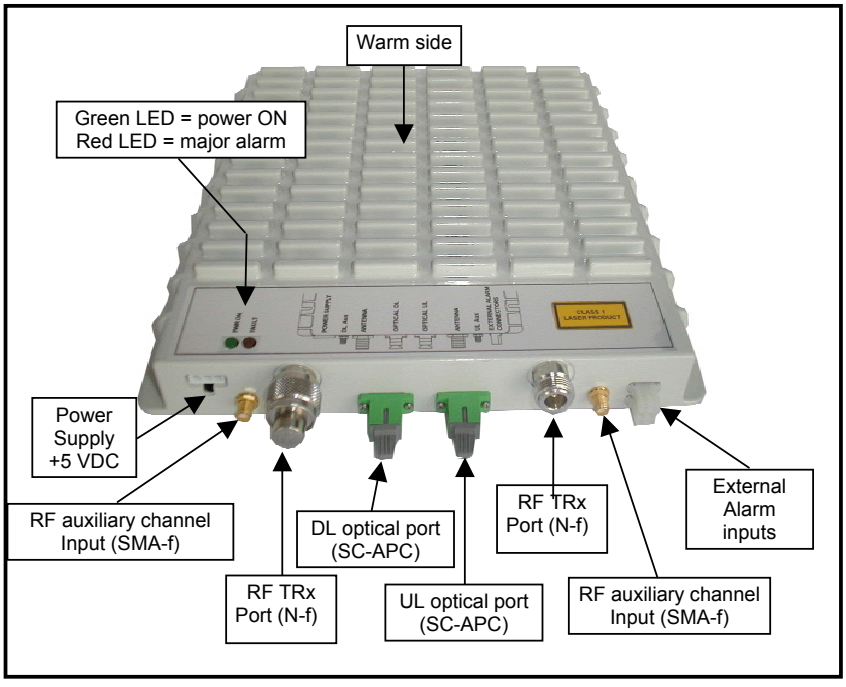
Case B

Main processes carried out by the TFAxxx:

- In Downlink (DL) operations:
  - Optical-to-RF conversion of the input optical signal
  - Automatic Gain Control (AGC) of each converted signal, in order to compensate optical losses (provided they are < 4dB);
  - RF amplification: the converted RF signal is boosted in order to maintain a good signal-to-noise ratio
  - RF filtering: a proper filter rejects the spurious emissions which lie out of the Downlink band
  - RF duplexing and splitting: the boosted RF signal is conveyed to 2 antenna ports
- In Uplink (UL) operations:
  - RF amplification: a low noise amplifier boosts the signal received from antennas so as to maintain a good signal-to-noise ratio
  - RF filtering: the boosted signal is cleaned from the spurious emissions which lie out of the Uplink band
  - Automatic Level Control (ALC): the RF signal level is adjusted according to the blocking requirements
  - RF-to-optical conversion of the signal, which is finally conveyed to the output optical port.

RF ports:

- 2 RF antenna ports,



means of proper booster TWBA). Auxiliary input and output ports are SMA-female connectors.

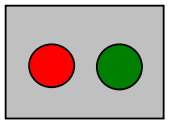
Optical ports:

- 1 optical output port, transmitting UL signals to TFLN local unit
- 1 optical input port, receiving DL signals from TFLN local unit

Visual alarms:

Two control LEDs are provided on the TFAxxx front side.
The green LED describes the power supply status, while the red LED describes the major Remote Unit failures.

TFAxxx LED

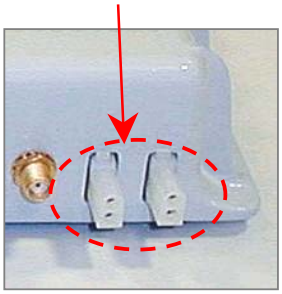


Led colour	*Meaning*
Red	Low optical power at DL input and/or RF amplifier failure
Green	Power supply status

Dry contact alarms:

TFAxxx is provided with two dry contacts inputs, which can be connected (through .062" MOLEX plugs) to any external device (ie. the TFBW stated above.

dry contacts



Dry contacts are open under non-alarm condition

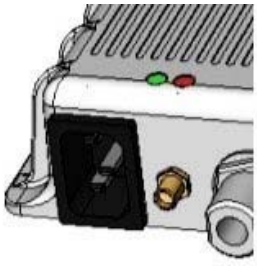
Power supply:

TFAxxx can be powered by universal mains (85/265 Vac) and by negative supply (-72/-36 Vdc).
Power supply adapter is included in the remote unit and can be external or internal according to the different models and part numbers:

- Case A: internal for all models with only exception of TFAN20 that has external adapter
- Case B: always external adapter for all models

Case A Remote Unit (except TFAN20)

These Remote Units are provided with internal power supply both for the 220VAC option and for the -48VDC option. As shown in the figure below different power supply connectors are provided for the two versions:

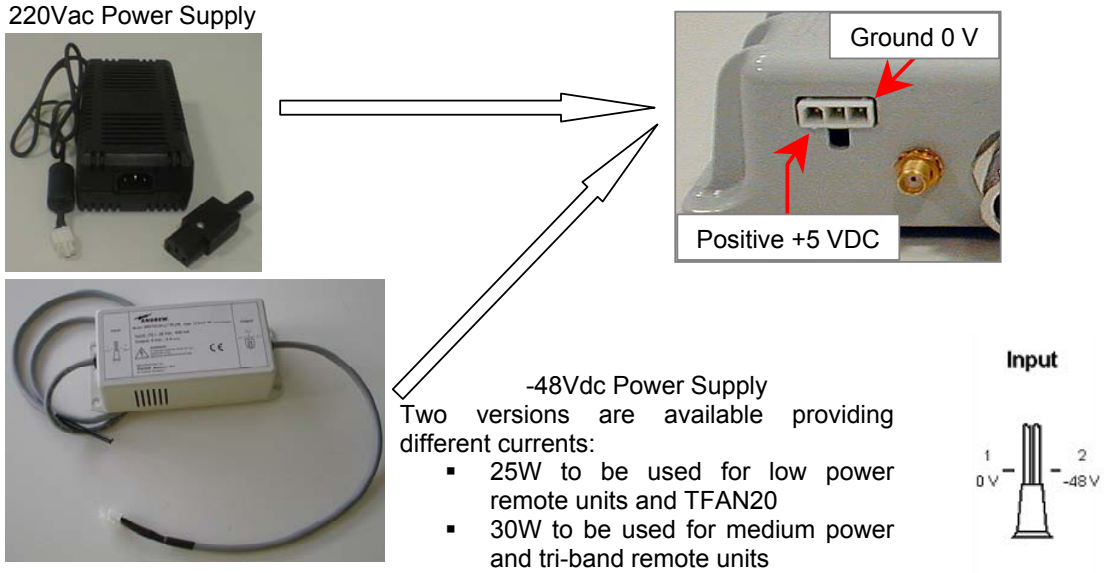


220VAC version
(IEC connector)

-48VDC version
(4 poles connector)

Case B Remote Unit and TFAN20

These Remote Units are provided with external power supply both for the 220VAC option and for the -48VDC option. As shown in the figure below different power supply are provided for the different versions each one providing to the remote units the +5VDC power supply through a 3 poles



-48Vdc Power Supply

Two versions are available providing different currents:

- 25W to be used for low power remote units and TFAN20
- 30W to be used for medium power and tri-band remote units

Warnings (to be read before remote units are installed)

Dealing with optical output ports

The TFAxxx remote unit contains semiconductor lasers. Invisible laser beams may be emitted from the optical output ports. Do not look towards the optical ports while equipment is switched on.

Choosing a proper installation site for the remote units

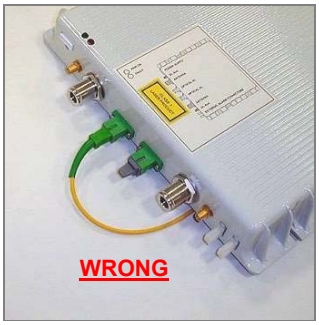
1. TFAxxx Remote Units are to be installed as close as possible to the radiating antennas, in order to minimize coaxial cable length, thus reducing the downlink power losses and the uplink noise figure.

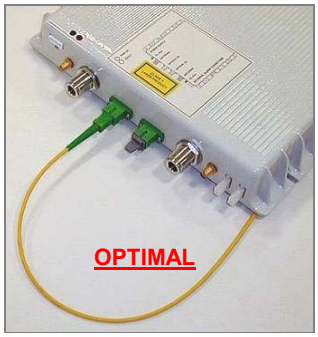
- When positioning the TFAxxx remote unit, consider that the placing of the relating antennas should be decided in order to minimize the Minimum Coupling Loss (MLC), so as to avoid blocking
- The TFAxxx remote unit is intended to be fixed on walls, false ceilings or other flat vertical surfaces (TKA installation kits are available, in order to provide a protective cover for TFAxxx Remote Unit, while making the TFAxxx installation easier and faster).

Handling optical connections

- When inserting an optical connector, take care to handle it so smoothly that the optical fibre is not damaged. Optical fibres are to be single-mode (SM) 9.5/125µm.
- Typically, Britecell Plus equipment is provided with SC-APC optical connectors (other connectors may be provided on request). Inserting any other connectors will result in severe damages.
- Do not force or stretch the fibre pigtail with radius of curvature less than 5 cm. See rightward figure for optimal fibre cabling.
- Remove the adapter caps only just before making connections. Do not leave any SC-APC adapter open, as they attract dirt. Unused optical connectors must always be covered with their caps.

- Do not touch the connector tip. Clean it with a proper tissue before inserting each connector into the sleeve. In case connector tips need to be cleaned, use pure ethyl alcohol.





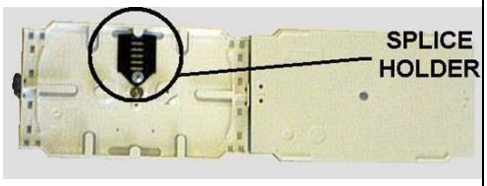
TFAxxx installation instructions

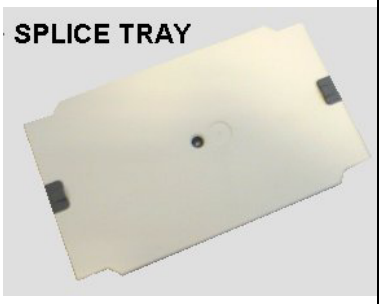
The TFAxxx kit includes:
A. 1 remote unit TFAxxx
B. a 50 Ω load
and according to the chosen model
C. an external power supply adapter (85-264 Vac or -48 V_{DC})
D. mains plug or -48 plug

First, drill into the wall so as to install four M4 screw anchors (not included) according to the dimensions indicated by the installation drawing in fig. 6, 7.
Fix the TFAxxx remote unit to the wall by firmly screwing the anchors.

In case you have purchased a TKA installation kit so as to preserve your TFAxxx remote unit, a splice holder is provided with the kit:

1. Fix the splice holder inside the splice tray.
2. Splice the optical fibres and close the splice tray.
3. Take care not to bend the fibres too much.
4. Fix the splice tray inside the splice box.





Note:
If you use your own splice box fix the splice box beside the TFAxxx

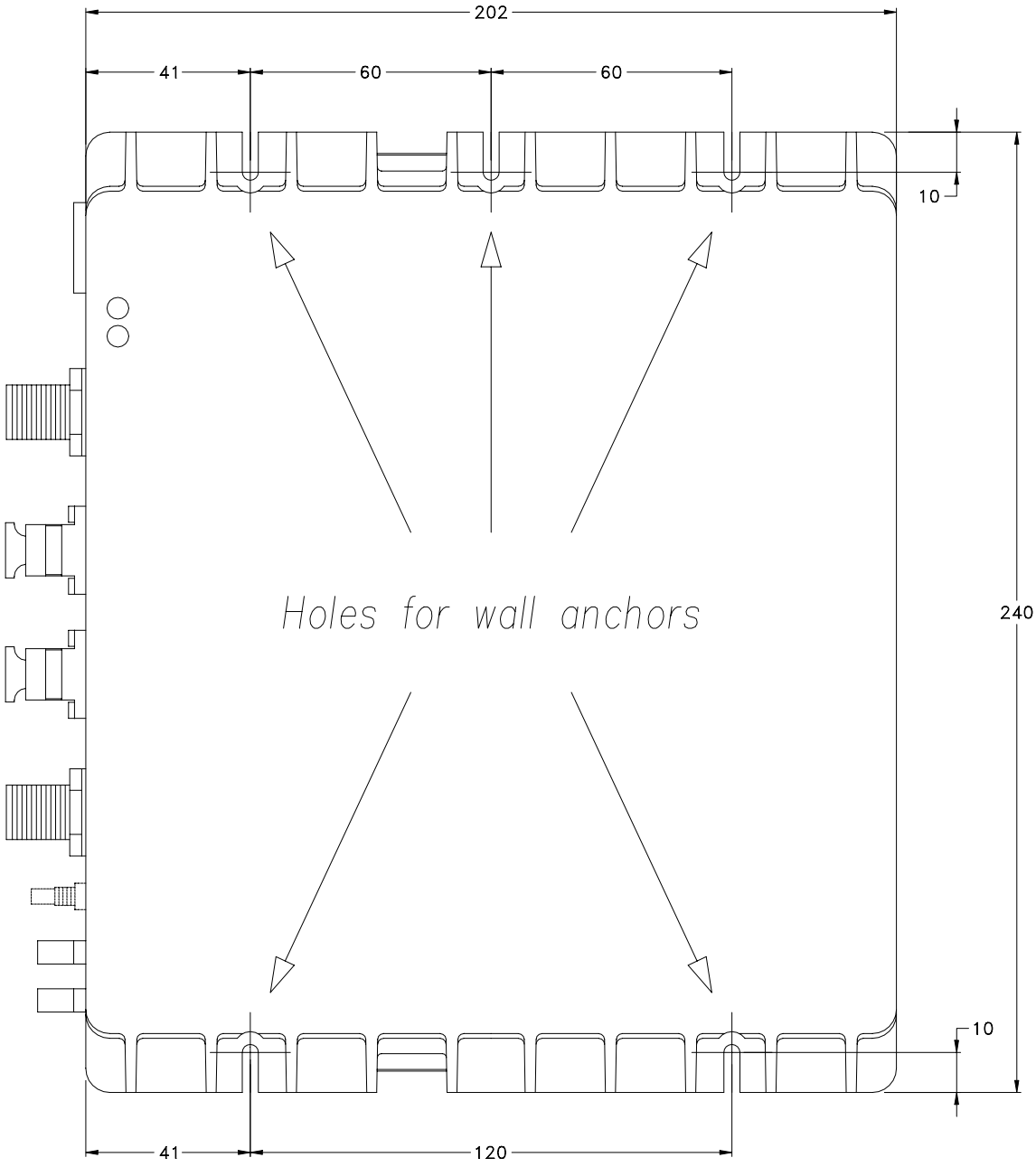


Fig. 6: CASE A layout with quote for wall anchors

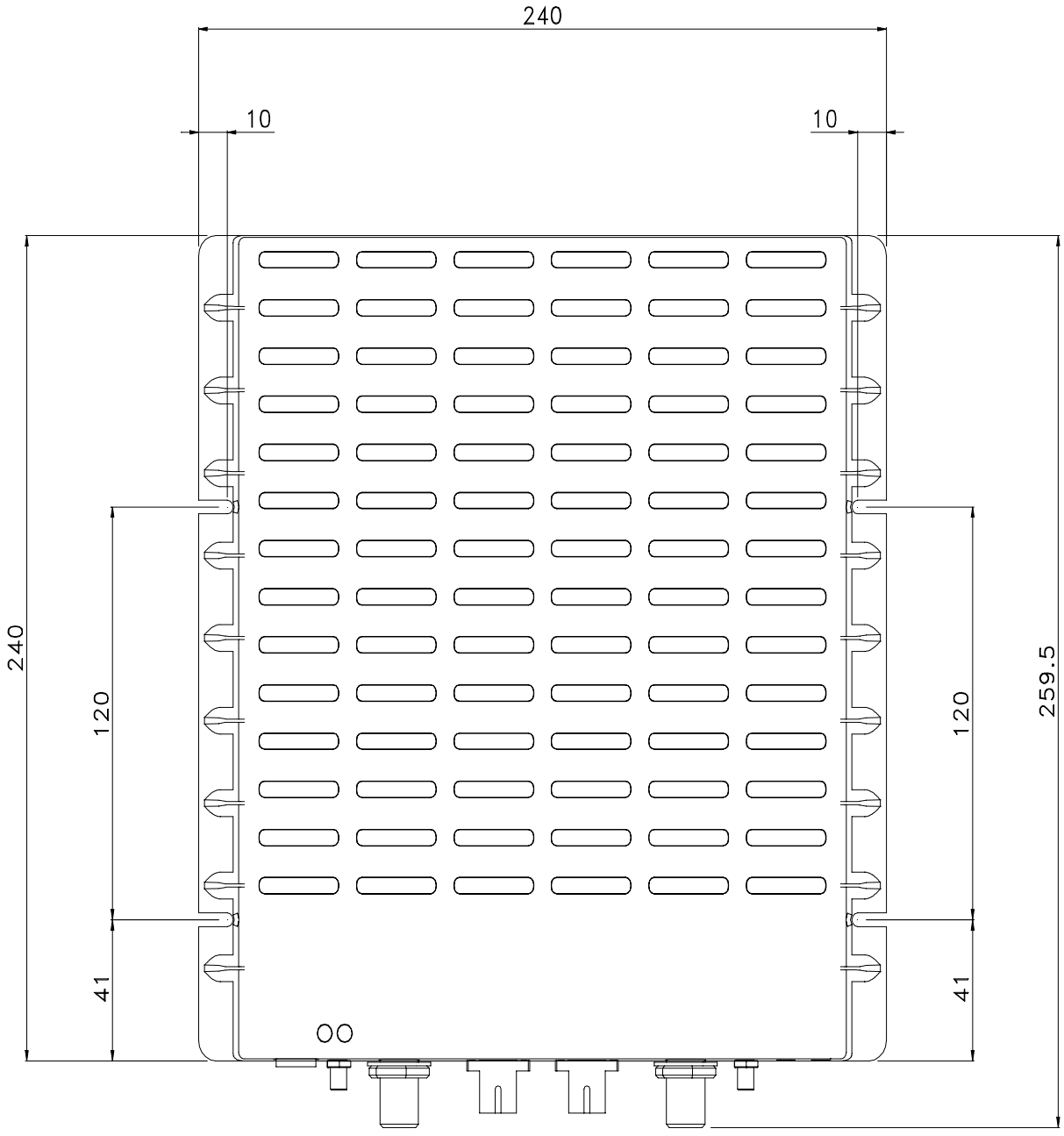


Fig. 7: CASE B layout with quote for wall anchors

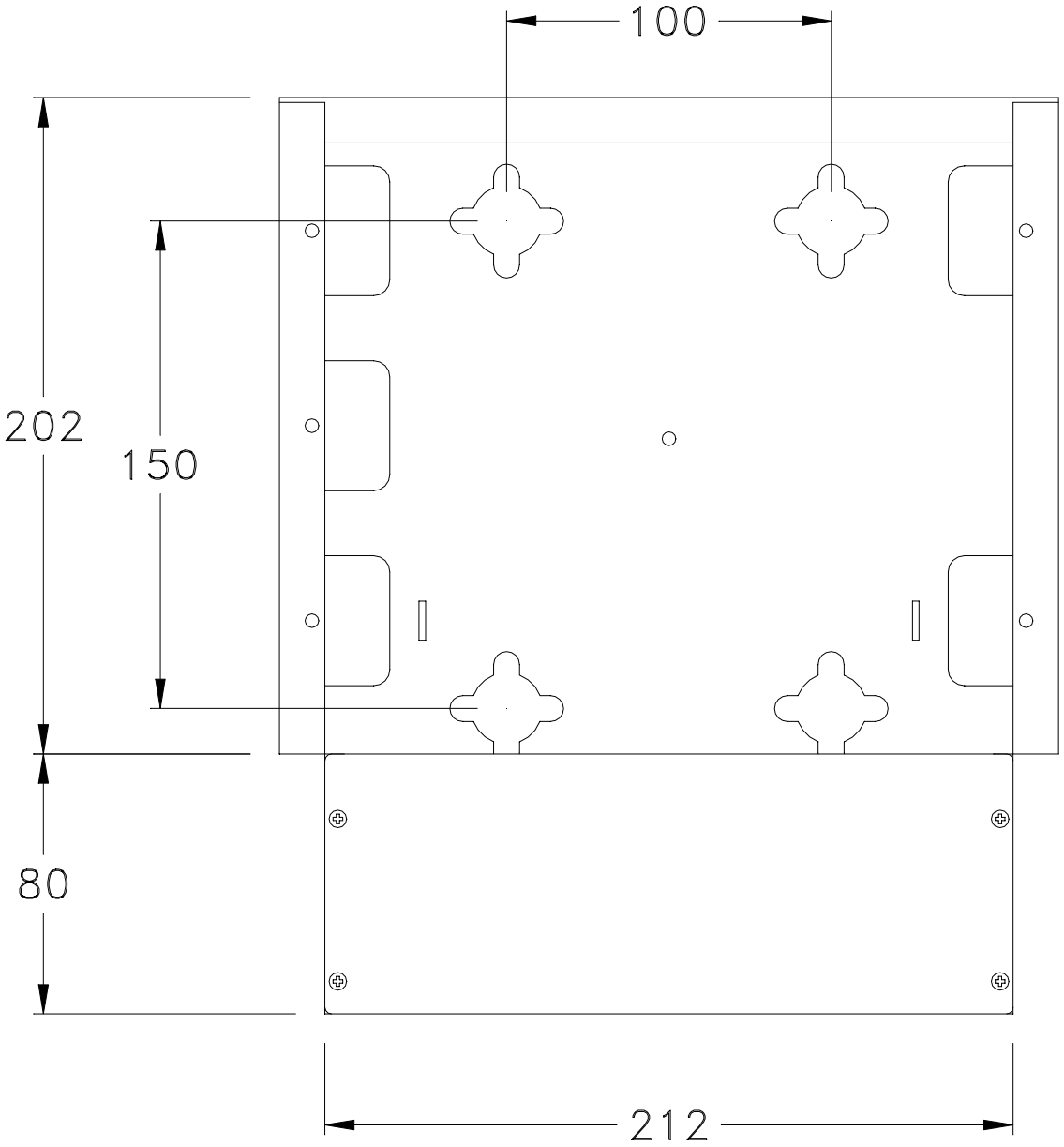


Fig. 8: TKA layout with quote for wall anchors

TFAxxx behaviour at system start-up

Before the TFAxxx remote unit is switched on, make sure that:

- the modules hosted by the Master unit have been connected each other with the RF jumpers, according to what has been planned in the system design
- every TFLN local unit has been connected to its remote units
- each remote unit has been connected to its coverage antennas

For a correct system start-up, all the remote units are to be switched on before the Master Unit.
For proper operations, the Master Unit can be turned on only when all the remote units are already on.

Once the TFAxxx has been switched on, its behaviour can be summarized in the following steps:

1. when the Remote Unit is turned on, both the LEDs upon the warm side turn on for a couple of seconds
2. After that, the unit green LED remains on (thus indicating proper power supply), while the red LED switches off as soon as the Master Unit is turned on (meaning that DL optical power is OK and no alarms are present).
3. Once the Master Unit has been switched on, the status of both LEDs have to be as reported in table 2. In case the red LED remains on, please refer to the troubleshooting section.

Led colour	*Status and Meaning*
Green	ON (when power supply is on)
Red	OFF (when no major failure affects TFAxxx operations)

Tab. 2: Status of TFAxxx LEDs in working conditions

4. After being switched on the remote unit starts working correctly. Anyway, in order to be recognized by the maintenance and supervision software, it is necessary for the corresponding TFLN local unit to carry out the discovery phase *(please refer to Supervision System Manual for more details)*. During this phase which can last at max. 4min, depending on the system complexity, the TFLN LED ┌┘ blinks. ***Do not connect/disconnect any cable or any piece of equipment during the discovery phase!*** This may result in failing the identification of the remote unit.

TFAxxx troubleshooting

Faults can be revealed by LEDS on the TFAxxx front panel as well as by LMT or supervision system (running on the agent)
Both LMT and supervision system provide full information about the device causing the alarm. As a consequence, troubleshooting procedure can be very immediate when failure detection is directly carried out through LMT or supervision system.
Britecell Plus modules are designed in order to exchange information so that each remote unit can receive failure notifications from its external equipment (e.g. a TFBW booster) through dry-contact connections. Moreover, the TFAxxx constantly monitors the optical signal received from its TFLN unit to control optical losses.
The following table reports a brief description of alarms related to each remote unit, together with a reference to the corresponding alerted LEDs on the triple band remote unit front. Single band and dual band units have similar alarms, where applicable.

Alarm description	*Red LED status*	*Priority*
Failure on external equipment connected to dry-contact 1	On	High
Failure on external equipment connected to dry-contact 2	On	High
Internal power supply failure	On	High
Breakdown in communications inside the TFAxxx board	On	High
The optical power received on DL port is too low (ie, the AGC can no more compensate the optical losses on DL input signal)	On	High
The optical power received on DL port is near to critical level, but the system still works (ie, AGC still compensates losses)	No detection	Low
GSM DL power amplifier failure	On	High
DCS DL power amplifier failure	On	High
UMTS DL power amplifier failure	On	High
Too high TFAxxx temperature	No detection[1]	Low

Tab. 3: Alarm Description

[1]This temperature alarm can be revealed by supervision or maintenance software if the TFAxxx board overheats. Keeping environmental conditions between +5°C and +40°.is an important key factor to get a proper TFAxxx temperature.

As the table shows minor alarms (low priority alarms) are revealed only by LMT or supervision system, but not by LEDs. Minor alarms detect critical situations which should be checked and tested in order to avoid future possible system faults.

Each remote unit is provided with an AGC system which comes in after the optical-to-RF conversion. This AGC can correctly compensate optical losses when these are estimated to be < 3 dB. In case optical losses are in the 3dB- 4dB range, the whole system still works, but AGC is near to its borderline levels. The red LED switches on when the estimated optical losses are > 4dB, the AGC not being able to compensate these losses any more.
As shows in the previous table, the same red LED switches on to reveal any major failure. Following the troubleshooting procedure reported hereinafter it is possible to better understand what the problem is.

Main troubleshooting procedure
(The following procedure is summarized by the flow-chart in fig. 8)
In case the red LED is ON, please follow these steps:

1. first of all, refer to dry-contact troubleshooting, so as to understand whether the alarm can depend on any external equipment failure (e.g. a TFBW booster failure) or not.
2. in case dry-contact troubleshooting has not revealed any failure, clean the optical adapter
3. if the problem still persists, refer to the fibre optic UL troubleshooting in order to check if optical cables or optical connections have any problem on UL path.
4. if previous action didn't make the LED switch off replace the unit with a new one or contact for assistance.

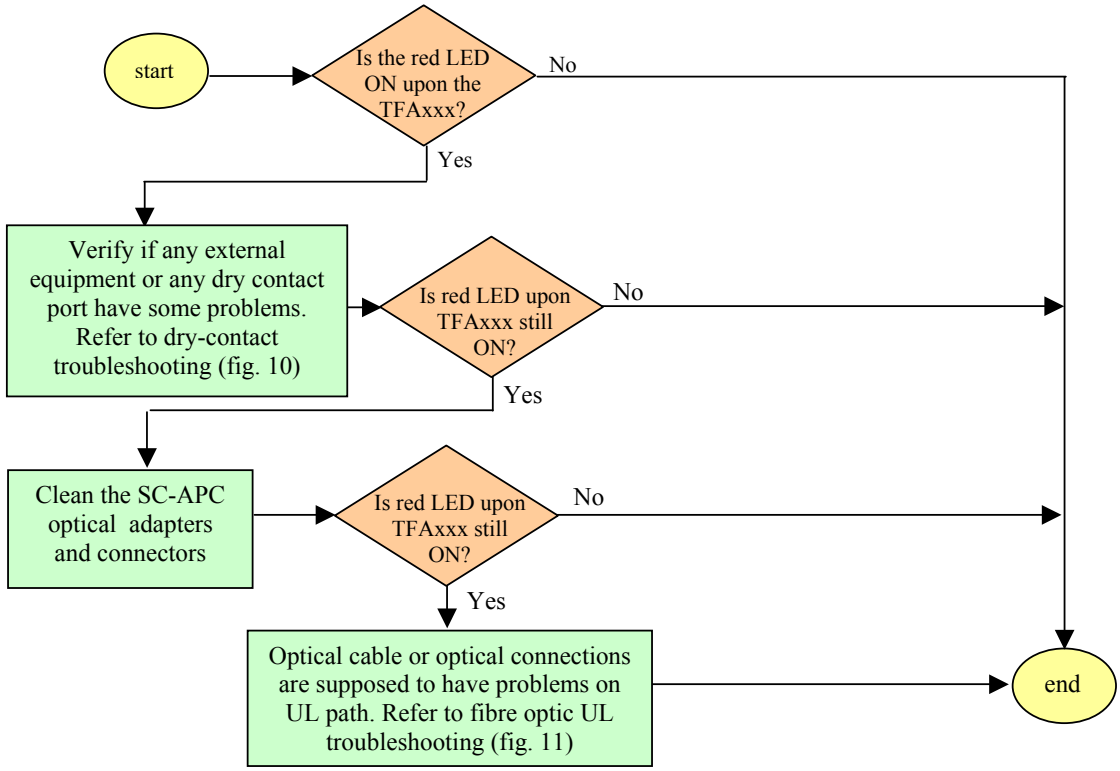


Fig. 9: Flow-chart describing the main troubleshooting procedure on TFAxxx

Dry contact troubleshooting

(The following procedure is summarized by the flow-chart in fig. 10)

This procedure needs to be considered if at least one TFAxxx dry-contact is connected to some external equipment. If not, return to main troubleshooting procedure.

Follow steps 1, 2 for each dry contact connected to any external equipment. These steps aim to detect any failure inside the external equipment or inside the dry-contact port. If dry-contacts don't reveal equipment malfunction or a port failure, return to the main troubleshooting procedure.

For any dry-contact connected to some external equipment, follow these steps:

1. Disconnect it, and check the TFAxxx LED status after the disconnection.
2. If the red LED has switched off, external equipment connected to the dry contact port should be faulty. Please test it.
3. If the TFAxxx red LED still remains on after the disconnection, measure voltage between the terminals of the dry contact port.
    a. If the terminals are electrically closed, the dry-contact port sis faulty. Contact the manufacturer for assistance.
    b. If the terminals are open, this means neither the analysis of the present dry contact nor the one of its external equipment has revealed failures. Re-connect the present dry contact port to its external equipment. In case the TFAxxx has another unchecked dry-contact connected to some external equipment, apply the whole procedure (ie steps 1-3) to this new port

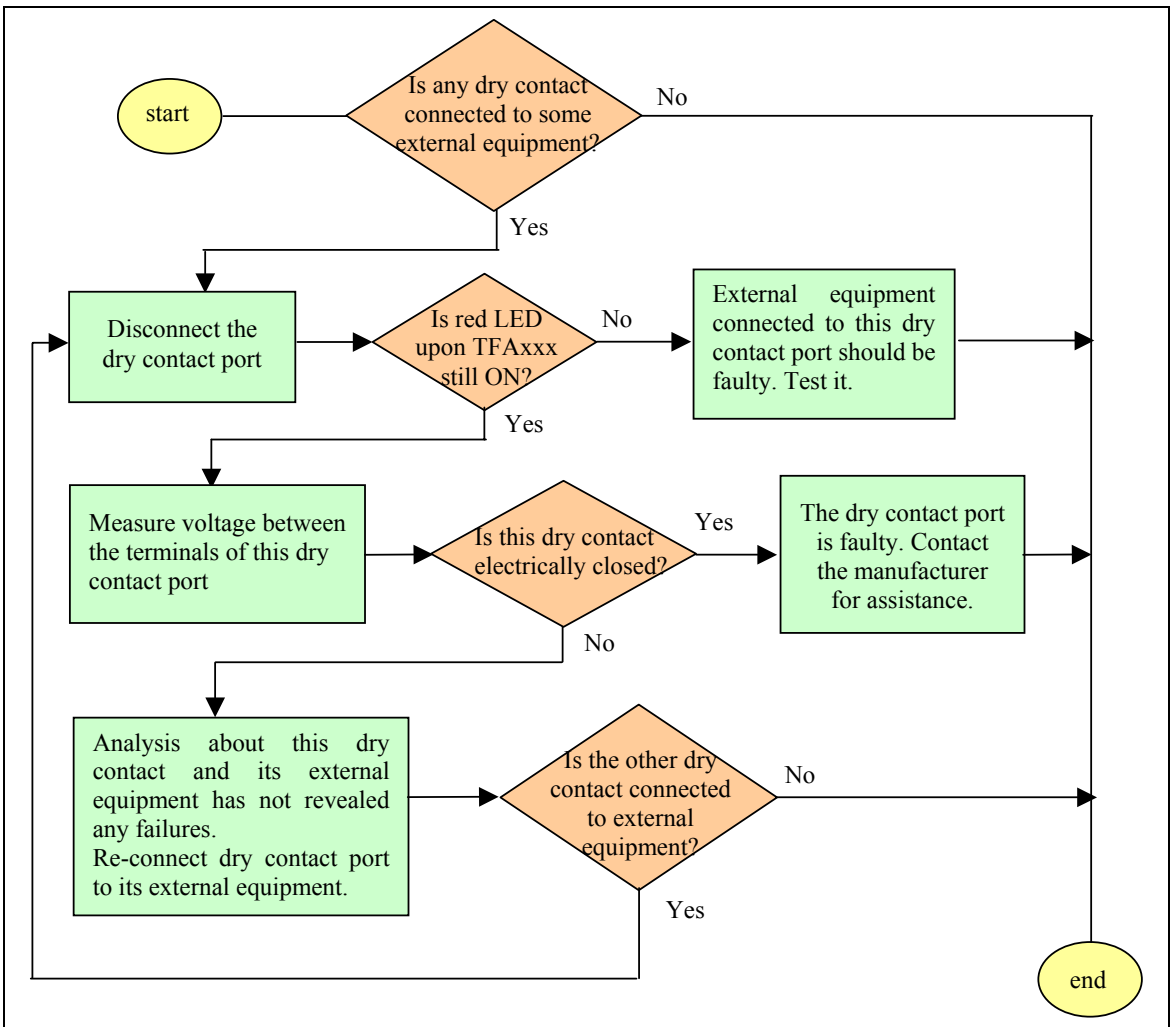


Fig. 10: Flow-chart describing the dry-contact troubleshooting.

Fibre optic UL troubleshooting

(The following procedure is summarized by the flow-chart in fig. 11)

- Check if there is any point where the fibre experiences a small radius of curvature. In this case, rearrange the optical path in order to avoid sharp bends (if necessary, replace the optical cable with a longer one). If this makes the TFLN red LED switch off, troubleshooting has been successful. Otherwise, follow next steps.
- Check if the SC-APC connectors are properly installed at both fibre ends (i.e. TFLN and TFAxxx ports). In case they are not, fix better SC-SPC connectors to relevant adapters. If this makes the TFLN red LED switch off, troubleshooting has been successful. Otherwise, follow next steps.
- Disconnect the optical fibre and clean it at both fibre ends (i.e. TFLN side and TFAxxx side) then reconnect the fibre to relevant ports. In case this makes the TFLN red LED switch off, troubleshooting has been successful. Otherwise, follow next steps.
- Disconnect the optical SC-APC connector from TFLN UL port, and measure the *output power* $P_{out(UL)}$ at corresponding fibre end (i.e. the power coming out of SC-APC UL connector). Then, go to the TFAxxx side, disconnect the optical SC-APC connector from TFAxxx UL port and measure the *input power* $P_{in(UL)}$ coming out of the TFAxxx UL port (i.e. the optical power entering the fibre).
- Calculate the UL fibre attenuation A_{UL} as: $A_{UL}\ [dB] = P_{in(UL)} - P_{out(UL)}$
  - If $A_{UL} > 4dB$, the fibre optic cable has some problems or cable path is too long. Replace it.
  - If $A_{UL} < 4dB$, then TFAxxx remote unit should be faulty. Before replacing it, check the TFAxxx status on supervision system and contact for assistance.

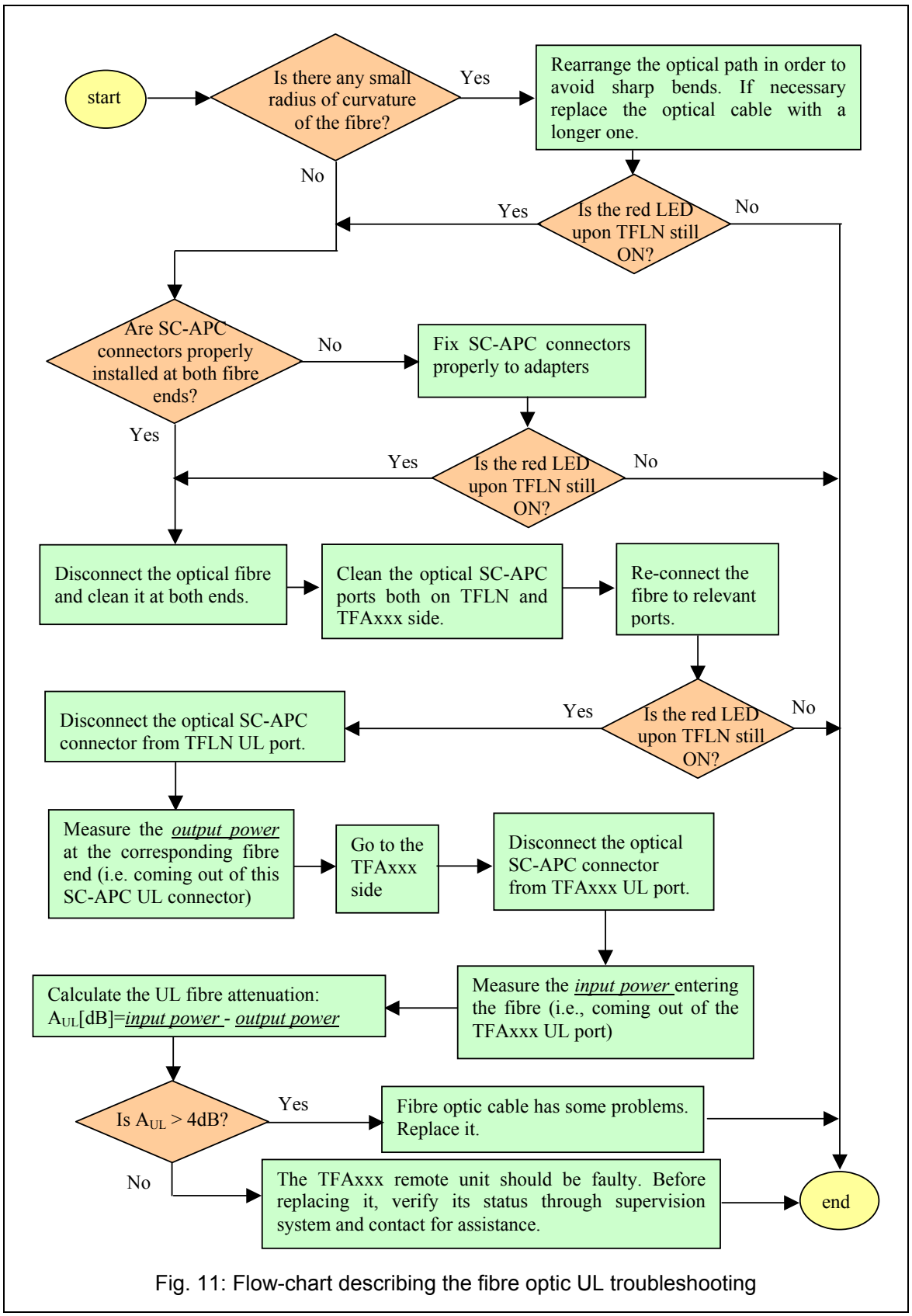
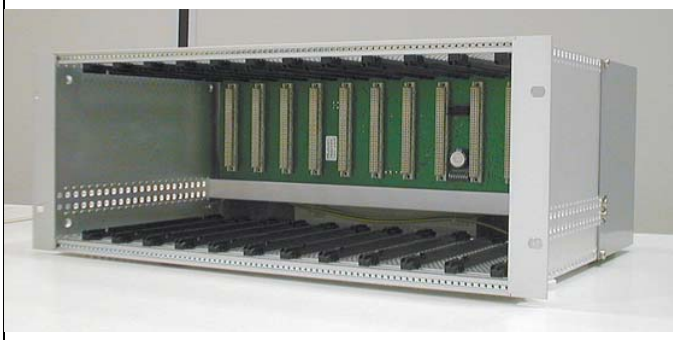


Fig. 11: Flow-chart describing the fibre optic UL troubleshooting

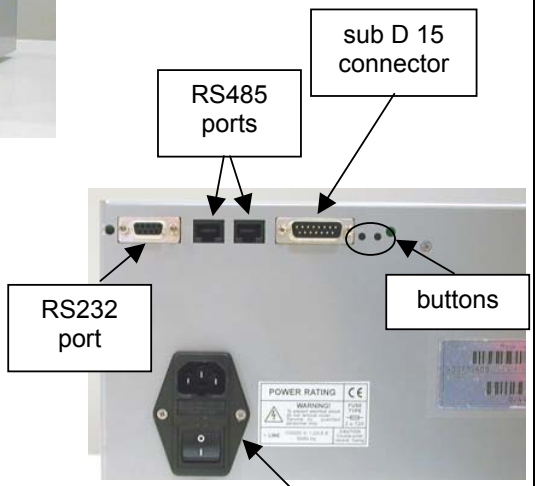
4. Master Unit

4.1. 19” Subrack TPRNxy

Name: **TPRN**	**Major TPRN features** The TPRNxy is a 19"subrack where all the Britecell Plus plug-in modules can be inserted. Britecell Plus equipment provides a wide variety of these subrack models, differentiated by power supply and by communication ports placing. Each one is provided with: • 12 free slots, each with Height=4HE, Width=1HE • Power supply 220 Vac or -48 Vdc • Locally or remotely connectible through: ➢ RS232 serial port ➢ RS485 two-wire bus ➢ sub-D 15 pin male-connector • Internal microcontroller for I2CBUS alarm collection • Manual reset button, able to re-initialize both the inserted modules and the TPRN microcontroller • Manual stand-by button, able to re-initialize the inserted modules, while keeping the TPRN microcontroller working.



Back view of the TPRN sub-rack with power supply and communication ports on the back



Front view of the TPRN sub-rack with power supply and/or communication ports on the front through TFM board

TFM board allowing communication ports and power supply (according to relevant versions) on the front of the subrack.

TPRN models

A brief description of all the available TPRN master units is reported hereinafter.

Passive subrack (TPRN04)

- TPRN04 is a passive subrack. It does not provide power supply to any inserted module, and therefore it is designed to host passive modules only. It can be useful in a multi-subrack system, in case the customer decides to put all the active modules in an active subrack, to be chosen among the following ones.

220 Vac powered TPRNs (TPRN14 / TPRN24 / TPRN14F / TPRN24F)

- TPRN14 is an active subrack designed to be fed through 220 Vac universal mains. Both the connector for 220Vac power supply and the communication ports are placed on the subrack rear. The 220 Vac power supply is not redundant (ie, no spare adapter is provided).
- TPRN24 is an active subrack designed to be fed through 220 Vac universal mains. Both the connector for 220Vac power and the communication ports are placed on the subrack rear, and the 220 Vac power supply is redundant: i.e., a spare adapter guarantees the correct system operations even in case the main 220Vac adapter has a breakdown.
- TPRN14F is an active subrack designed to be fed through 220 Vac universal mains. The connector for 220Vac power supply is on the subrack rear, while the communication ports are on a TFM module, inserted in the 12th master unit slot. The 220 Vac power supply is not redundant (i.e. no spare adapter is provided).
- TPRN24F is an active subrack designed to be fed through 220 Vac universal mains. The connector for 220Vac power supply is on the subrack rear, while the communication ports are on a TFM module, inserted in the 12th master unit slot. The 220 Vac power supply is redundant: i.e., a spare adapter guarantees the correct system operations even in case the main 220Vac adapter has a breakdown.

-48Vdc powered TPRNs (TPRN34 / TPRN34F)

- TPRN34 is an active subrack designed to be fed through –48 Vdc negative supply. Both the connector for -48Vdc power supply and the communication ports are placed on the subrack rear.
- TPRN34F is an active subrack designed to be fed through –48 Vdc negative supply. Both the connector for –48 Vdc power supply and the communication ports are on a TFM module, occupying the 12th master unit slot. This allows an easier maintenance, in case the -48 Vdc power supply has a breakdown.

TPRN power supply

All the TPRN models refer to one of the following power supplies.

Universal mains

(85 ÷ 264Vac, 50/60Hz).

This connector is mounted on the TPRN back panel either for the redundant version or the simple one. A ground terminal and a couple of fuses are also included. Fuses have to be replaced in case they fail (when it happens both the green LED on TPRN panel and the supervision system detect the failure).

Fig. 12: 85÷264Vac connector

Fig. 13: -72÷-36Vdc connector

Fig. 14: ground terminal on the rear

The external power supply (220Vac or -48Vdc) is converted into a +12Vdc voltage allowing feeding the active modules inserted into the TPRN.

TPRN ports

The TPRN subrack is provided with a set of I/0 ports which allow the connection to any external device. All these ports (RS232, RS485, sub-D 15 pin male connector) can be placed both on TPRN back and on TPRN front, depending on chosen version.

RS232 serial port

The RS232 serial port can be used to connect the TPRN subrack to the agent.

The connection baud rate can be set to 9600 bps or 19200 bps, by properly setting the dip-switch 5 standing on the interior TPRN backplane (see fig. 15). The baud-rate setting through dip-switch 5 is shown in table 4.

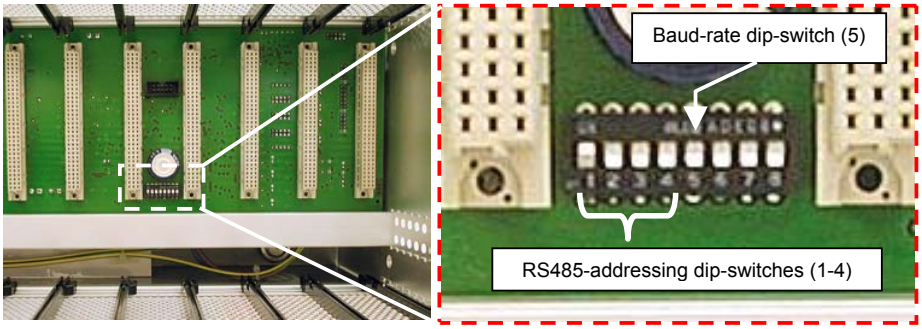


Fig. 15: Dip-switches on TPRN backplane.

Baud rate [bps]	Dip-switch 5
9600	OFF
19200	ON

Tab. 4: Setting RS232 baud-rate through dip-switch 5

Whichever baud rate you choose through dip-switch 5, remember that:

- the same RS232 connection speed must be set up on the agent
- the baud-rate which is selected through the dip-switch 5 sets the connection speed for both the RS232 port and the RS485 port as the TPRN uses both ports with the same rate.

RS485 port

The RS485 port consists of two RJ-45 connectors, which work as input and output ports towards a RS485 bus.

This RS485 bus has to be used in order to connect a multi-subrack system to the agent. In this case:

- the TPRN subracks have to be connected one another via RS485 bus;
- In order to monitor the whole system, the agent has to be connected to one of the TPRN subracks through RS232 port.

Before connecting one another the TPRN subracks belonging to a multi-subrack system, remember to assign an exclusive binary address to each one. This is essential in order to let the supervision system recognize the different master units.

The binary address assignment can be done through dip-switches 1,2,3,4, which stand on interior TPRN backplane (see figure 15). A list of the correspondences between the addresses and the dip-switches is provided by table 5: simply note that dip-switch 1 is the least significant binary digit, while dip-switch 4 is the most significant one.

Address	Dip-switch 1	Dip-switch 2	Dip-switch 3	Dip-switch 4
0001	ON	OFF	OFF	OFF
0010	OFF	ON	OFF	OFF
0011	ON	ON	OFF	OFF
0100	OFF	OFF	ON	OFF
0101	ON	OFF	ON	OFF
0110	OFF	ON	ON	OFF
0111	ON	ON	ON	OFF
1000	OFF	OFF	OFF	ON
1001	ON	OFF	OFF	ON
1010	OFF	ON	OFF	ON
1011	ON	ON	OFF	ON
1100	OFF	OFF	ON	ON
1101	ON	OFF	ON	ON
1110	OFF	ON	ON	ON

Tab. 5: Dip-switches address settings

The baud rate of the RS485 ports is the same of the RS232 port as per the setting of dip-switch 5 (see before)

Whichever baud rate you choose, remember that:

- the same RS485 connection speed has to be set up on all the connected device (TPRN subracks or TSUN);
- the baud-rate which is selected through the dip-switch 5 sets the connection speed for both the RS485 port and the RS232 port.

Sub-D 15 pins male connector

The TPRN subrack provides a sub-D 15 pins male connector, shown in fig. 4.17.

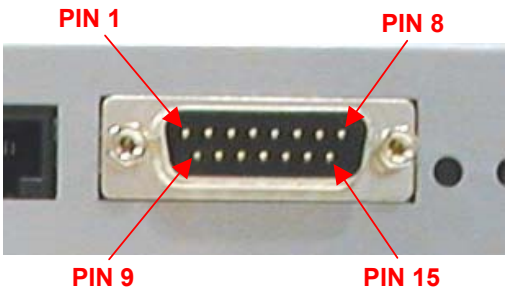


Fig. 16: sub-D 15 pin male connector

This connector provides:

- 4 optoisolated input ports which can be used to reveal any failure on remote equipment. The default status of these input ports can be defined through the supervision system. After that, any change from default status will be revealed as a failure signal and cause the corresponding Auxiliary Input LED to switch on upon the TFM board (on TPRN front panel)
- a summary of major and minor alarms related to failures detected not only on the TPRN subrack, but also on any active module hosted by the TPRN itself.
- 2 relay output ports, which be can used to drive any external device connected to subD-15 pins adapter. By using the supervision system each of these output ports can set up on "open" or "close" conditions.

A more detailed description of the meaning and functionality of each pin is reported in table 6. The pins are numbered from left to right, and from top to bottom (refer to fig. 16).

PIN	***Name***	***Meaning***
1	Ground	It is a ground terminal for digital inputs, i.e. for pin 2, 3, 9, 10.
2	Digital input n°1 (SW assignable)	This port can be used to monitor external equipment status. Once a default working status has been assigned (through supervision system) to this input port, any change is detected as a failure signal causes the Auxiliary Input LED 1 to switch on upon the TFM board.
3	Digital input n°2 (SW assignable)	This port can be used to monitor external equipment status. Once a default working status has been assigned (through supervision system) to this input port, any change is detected as a failure signal causes the Auxiliary Input LED 2 to switch on upon the TFM board.
4	Disconnected pin	No meaning
5,6	Summary of major alarms	These pins present an open circuit if a major alarm is active on the TPRN subrack or on any module hosted by it.
7,8	Summary of minor alarms	These pins present an open circuit if a minor alarm is active on the TPRN subrack or on any module hosted by it.
9	Digital input n°3 (SW assignable)	This port can be used to monitor external equipment status. Once a default working status has been assigned (through supervision system) to this input port, any change is detected as a failure signal causes the Auxiliary Input LED 3 to switch on upon the TFM board
10	Digital input n°4 (SW assignable)	This port can be used to monitor external equipment status. Once a default working status has been assigned (through supervision system) to this input port, any change is detected as a failure signal causes the Auxiliary Input LED 4 to switch on upon the TFM board
11	Disconnected pin	No meaning
12,13	Digital output n°1 (SW assignable)	These pins are terminals of an output port (output relay 1), which can be driven through the supervision system. The output port can be set to "open" or "close" condition. These 2 statuses can be used to pilot any external device connected to subD-15 connector.
14,15	Digital output n°2 (SW assignable)	These pins are terminals of an output port (output relay 2), which can be driven through the supervision system. The output port can be set to "open" or "close" condition. These 2 statuses can be used to pilot any external device connected to subD-15 connector.

Tab. 6: Functional description of pins provided by sub D male connector.

Note: The TPRN subrack uses I2Cbus standard protocol to collect status and alarm information from hosted modules. Thanks to that, the alarm summaries (provided through pins 5-6 and 7-8) report major and minor failures related not only to TPRN subrack but also to any hosted module.

TPRN visual alarms (where available)

A full description of all TPRN alarms is provided by the Supervision system. All TPRN subracks including a TFM board (i.e. TPRN14F, TPRN24F, TPRN34F models) also provide alarm monitoring through the LED front panel (see fig. 17).

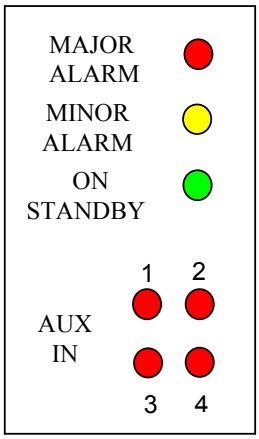


Fig. 17: LED panel on TFM board

Label	*LED colour*	*Meaning*
MAJOR ALARM	Red	ON when a major alarm is detected on TPRN
MINOR ALARM	Yellow	ON when a minor alarm is detected on TPRN
ON STANDY	Green	ON when TPRN is on
1	Red	ON if any external alarm is detected through the input port 1 of sub D connector.
2	Red	ON if any external alarm is detected through the input port 2 of sub D connector.
3	Red	ON if any external alarm is detected through the input port 3 of sub D connector.
4	Red	ON if any external alarm is detected through the input port 4 of sub D connector.

Tab. 7: alarm description

Major and minor LED alarms upon TFM board refer only to major and minor failures on the TPRN itself and do not detect any fault on the hosted modules.

Note: Being able to collect module status through I2Cbusl, the TPRN also knows any alarm information about the hosted modules. However, as each active module controls its internal failures through its own LEDs panel, the LEDs upon TPRN subrack only refer o its circuitry.

Auxiliary input LEDs reveal an alert condition when corresponding pins recognize any alarm on the external device connected through sub D 15 connector.

Warning (recommended for system designing and installing)

Providing a correct heat dissipation

For a correct use of the TPRN subrack, it is important to verify that:

- the system is designed in order to put no more than 8 active modules inside a TPRN subrack. This guarantees a proper heating dissipation for the system. In case you want to install more than 8 active modules inside a TPRN subrack, it is important to provide the subrack with a proper ventilation system;
- active and passive modules should be alternated as much as possible inside the TPRN subrack avoiding too many active cards being inserted close together;
- in case the system consists of more than one TPRN subrack, a minimum distance of 1 HE has to be kept between nearby TPRN subracks to ensure proper heat dissipation. The rack containing the TPRN subracks has to be large enough to guarantee this correct distance between master units.

Minimizing equipment costs

In order to reduce the cost of Britecell Plus equipment, a multi-subrack system should be designed according to the following guidelines:

- a passive subrack (TPRN04) may be used to house only passive modules;
- an active subrack (TPRN14, TPRN14F, TPRN24, TPRN 24F, TPRN34) may be used to sustain all the active modules, and some of the passive ones (as stated above, it is advisable to alternate active and passive cards into an active subrack).

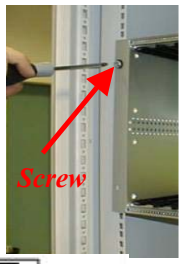
Setting the dip-switches in a multi-subrack system

If you are installing a multi-subrack system, remember to assign each subrack an exclusive binary address, by properly setting dip-switches 1,2,3,4 on the interior TPRN backplane (see fig. 15 and tab.5). Dip-switch 5 has to be set on each TPRN subrack in order to fix the baud rate for RS485 and RS232 port. Connecting TPRNs through RS485 port is necessary when supervising the whole multi-subrack system through the SNMP agent which has also to be set at the same baud rate.

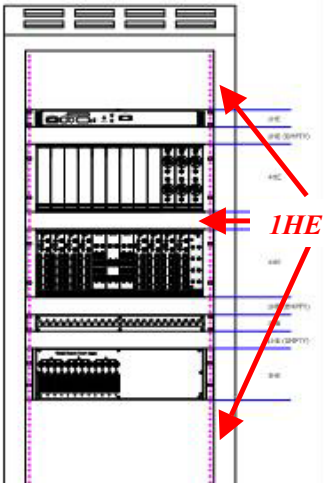
TPRN Installation

The TPRN kit provides:

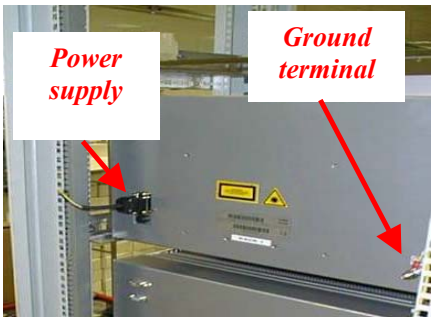
- 1 Sub rack TPRN



Leave at least 1HE distance between two subracks in order to facilitate the air circulation.
Leave at least a 1HE free space between the bottom or the top of the cabinet and the TPRNs.



Connect the ground to the safety ground terminal.
Then, connect the power supply connector to the mains.



TPRN behaviour at system Start-up

Before switching on the TPRN subrack, make sure that:

- all expected modules have been inserted
- the modules have been connected each other by RF jumpers, according to what has been planned during system design
- every TFLN contained in the Master Unit has been connected to its TFAxxx remote units
- each TFAxxx remote unit has been connected to its coverage antennas
- the agent (if present) has been connected/housed to/into the Master Unit
- different subracks have been connected each other via bus RS485 and each of them should have different addresses
- the rack housing the TPRN is large enough to leave a minimum distance of 1HE between contiguous TPRN subracks

Remember that TFAxxx remote units have to be switched on before relevant Master Unit. Only when all the TFAxxx remote units are on, the Master Unit can be turned on.

Once the TPRN subrack has been switched on, the system behaviour can be summarized as per the following steps:

1. when TPRN subrack is turned on, all seven LEDs upon the TPRN front panel (provided that TPRN is equipped with a TFM board) go on for a couple of seconds
2. After that, the green LED remains ON (indicating proper power supply), while the other LEDs indicate the remote units status, according to the following table 8

Note: Some of the AUX IN LEDs 1, 2, 3, 4 can remain ON if the corresponding input statuses are wrongly associated to external equipment working condition. In this case, once the step 4 has finished, remember to properly set the default status by the supervision system.

3. About 10sec after the TPRN subrack has been switched on, all TFLN modules housed in the TPRN itself begin a "discovery" phase in order to identify and collect status of the connected TFAxxx remote units. While the discovery phase is working (at max. 4min. depending on the system complexity) each TFLN general alarm (i.e., LED " ⌐┘ ") blinks, whereas the other TFLN LEDs go on showing the detected status.

   Do not connect/disconnect any cable or piece of equipment until all the TFLN modules have finished the discovery phase. This may result in failing the identification of TFAxxx. Anyway during the discovery phase, the whole system can still work correctly as discovery process aims to collect information about TFAxxx but doesn't affect the basic working of the system.

Label	*LED colour*	*Status*
ON STANDY	Green	ON (when power supply is on)
MAJOR ALARM	Red	OFF (if no major alarm is detected on TPRN subrack)
MINOR ALARM	Yellow	OFF (if no minor alarm is detected on TPRN subrack)
1	Red	OFF (if no external alarm is detected through the input port 1 of the sub D 15 pin connector)
2	Red	OFF (if no external alarm is detected through the input port 2 of the sub D 15 pin connector.
3	Red	OFF (if no external alarm is detected through the input port 3 of the sub D 15 pin connector)
4	Red	OFF (if no external alarm is detected through the input port 4 of the sub D 15 pin connector)

Tab. 8: subrack LED status in full-working condition.

4. Once the discovery has finished, the general alarm (i.e. the LED "⌐┘") on each TFLN panel stops blinking, and switches OFF (provided that the TFLN local unit is not affected by a general failure).

TPRN troubleshooting

In case a TPRN subrack shows any problem, this will be revealed through LEDs upon TPRN front panel. A more detailed status and alarm description could be provided through the SNMP agent.

It should be noted that TPRN minor and major alarm LEDs just refer to TPRN subrack itself and detect errors on TPRN circuitry, but do not signal alert situations on the hosted active modules Active modules are monitored by their own LED panels.

A complete overview of TPRN alarms is reported in the following table.

Alarm description	*LED*	*LED colour*
Redundant power supply active	Minor alarm LED	Yellow
+12V degradation	Major alarm LED	Red
I^2Cbus error	Minor alarm LED	Yellow
Temperature out of range	Minor alarm LED	Yellow
Alarm revealed on auxiliary input port 1	AUX IN LED 1	Red
Alarm revealed on auxiliary input port 2	AUX IN LED 2	Red
Alarm revealed on auxiliary input port 3	AUX IN LED 3	Red
Alarm revealed on auxiliary input port 4	AUX IN LED 4	Red

Tab. 9: Brief description of alarms detected through TPRN LED panels.

Red major alarm LED refers to power supply degradation and switches on in case the +12Vdc power falls below a threshold level in factory set. In this case, TPRN automatically turns to standby mode so that alarm LED remains on while no over-current gets through the circuitry of hosted modules, thus preserving the system integrity. Once power supply has been repaired, the

TPRN needs to be rebooted. In case the TPRN subrack is equipped with a redundant power supply (TPRN24, TPRN24F), a degradation of the +12 Vdc power results in an automatic switching from main to spare converter and yellow minor alarm LED switches on to highlight that the redundant power supply is active. In case also redundant power supply degrade the TPRN automatically turns to stand-by mode and major alarm red LED switches on to signal no-working situation. Once the power supply has been repaired the TPRN needs to be rebooted.

I2Cbus alarm is a minor alarm which turns on when TPRN subrack cannot communicate with one or more hosted module. Each TPRN slot is provided with 2 pins, which automatically detect the presence of a module inside the slot. If the module is detected but TPRN is not able to communicate with it through I2Cbus the minor alarm LED switches on.

Note: at commissioning remember to mask the unused slots through LMT software (please refer to the relevant manual for more information) to avoid not significant alarm being switched on.

In case one of TPRN LED alarms switches on please refer to the troubleshooting procedure reported hereinafter to recognize the failure. This procedure is valid in case the TPRN includes the TFM module showing LEDs on the front panel otherwise please check LMT or supervision system handbooks.

TPRN main troubleshooting procedure

(The following troubleshooting procedure is summarized by the flow-chart in fig. 18)

- When the TPRN is correctly supplied, the green LED on TFM board is switched on. In case the TPRN does not switch on, check the fuse upon the power supply connector. If it is burned, just replace it with a new one, and restart the TPRN. If it is not, the power supply system may be faulty, contact the manufacturer for assistance.
- In case the major alarm LED (red LED) is on, the system experiences power supply degradation. In this case, the TPRN automatically has turned to stand-by mode, in order to preserve the internal circuitry from over-current. Contact the manufacturer for assistance.
- In case the minor alarm LED (yellow LED) is on, please refer to Minor Alarm Troubleshooting reported in the following.
- In case any AUX IN LED (red LED) is on, an alarm condition is revealed through the corresponding input port of sub D 15 pin connector, if any external device has been connected to the TPRN master unit through sub D port, it may have some problems. Test it. If you do not detect any failure on external device, the input port of subD-15 connector shouldn't have been set to the correct default status through the supervision system.

Minor alarm troubleshooting

(The following troubleshooting procedure is summarized by the flow-chart in fig. 19)

- In case the TPRN is provided with a redundant power supply, the main power supply may have failed. Check the fuse, and replace it if burned.
- If the minor alarm LED is still on, disconnect one module at a time from the TPRN backplane. After having disconnected each module, check if the minor alarm LED is still one.
    - In case the yellow LED switches off after disconnecting any card, the disconnected module may be faulty. Test it or contact the manufacturer for assistance.
    - If the minor alarm LED remains still on, the TPRN may have problems either in internal I2Cbus communications or in overheating. Contact manufacturer for assistance.

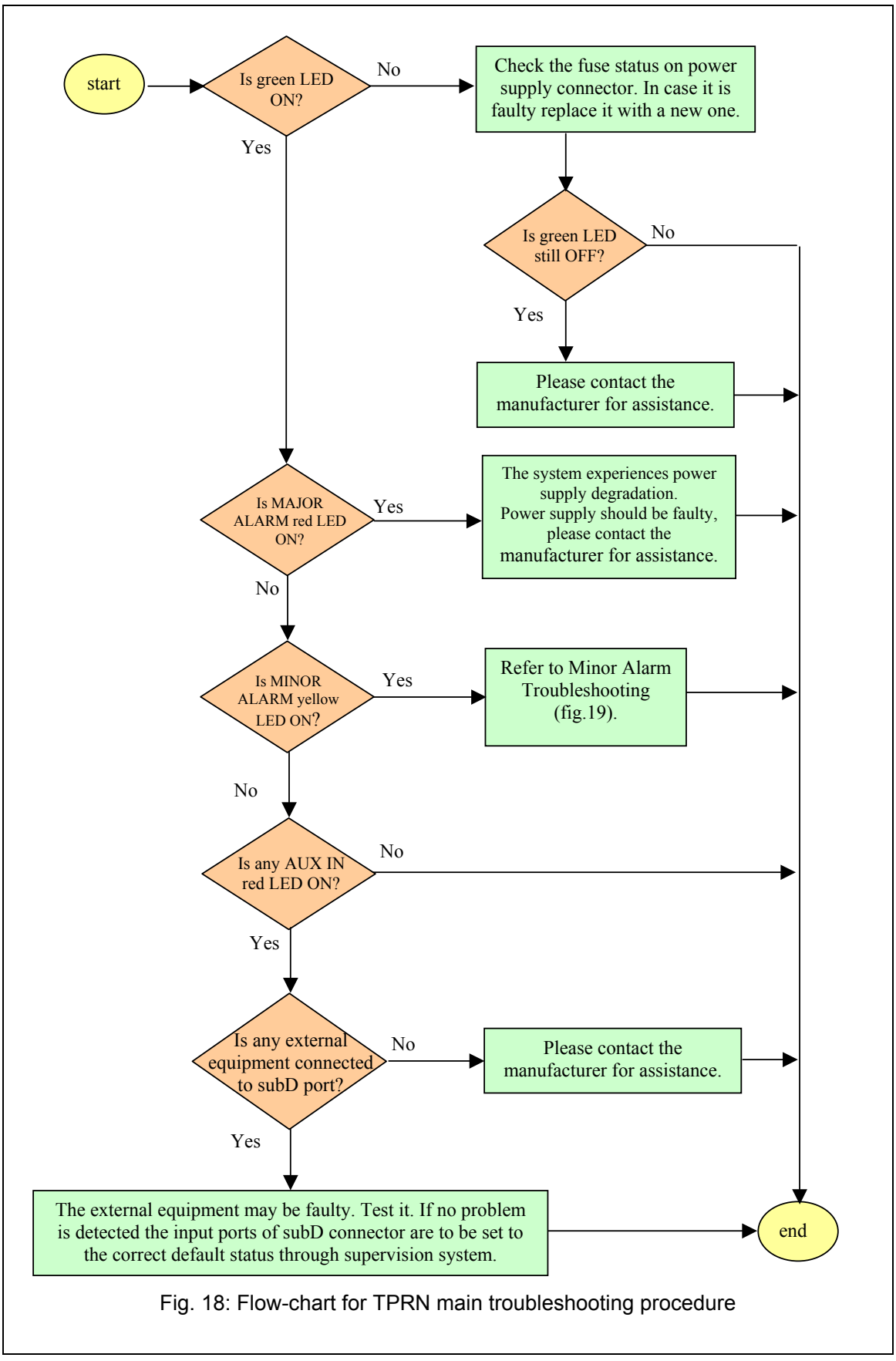


Fig. 18: Flow-chart for TPRN main troubleshooting procedure

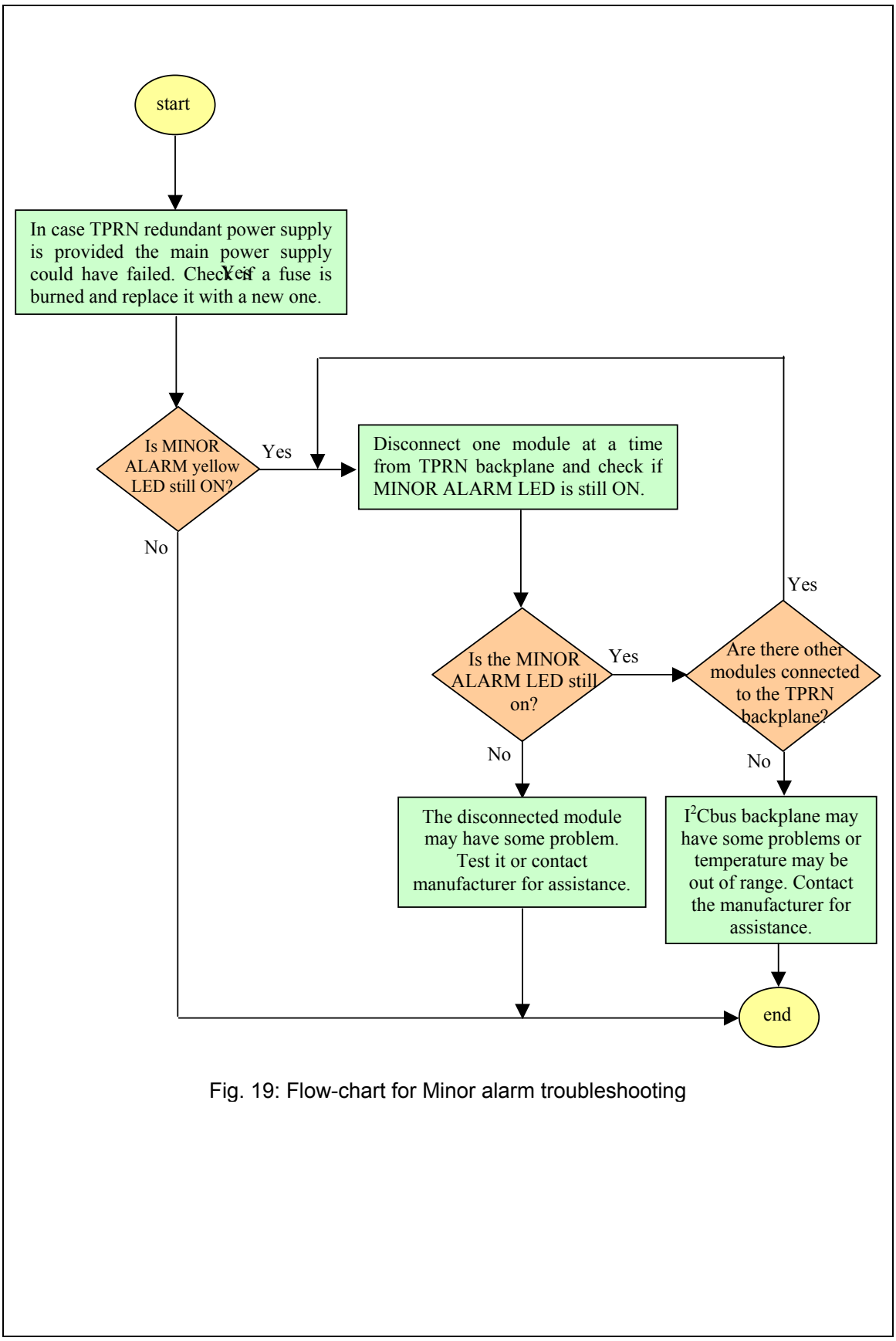


Fig. 19: Flow-chart for Minor alarm troubleshooting

4.2. Local Unit TFLN

Module name:
TFLN

Main processes carried out by the TFLN module

- In Downlink (DL) operations:
  - RF-to-optical conversion of the input RF signal
  - Optical splitting: input RF signal is split onto 4 optical outputs
- In Uplink (UL) operations:
  - Optical-to-RF conversion of the 4 input optical signals
  - Automatic Gain Control (AGC) of each converted signal to compensate optical losses (provided they are < 4dB);
  - RF combining of the 4 adjusted signals into a single RF output

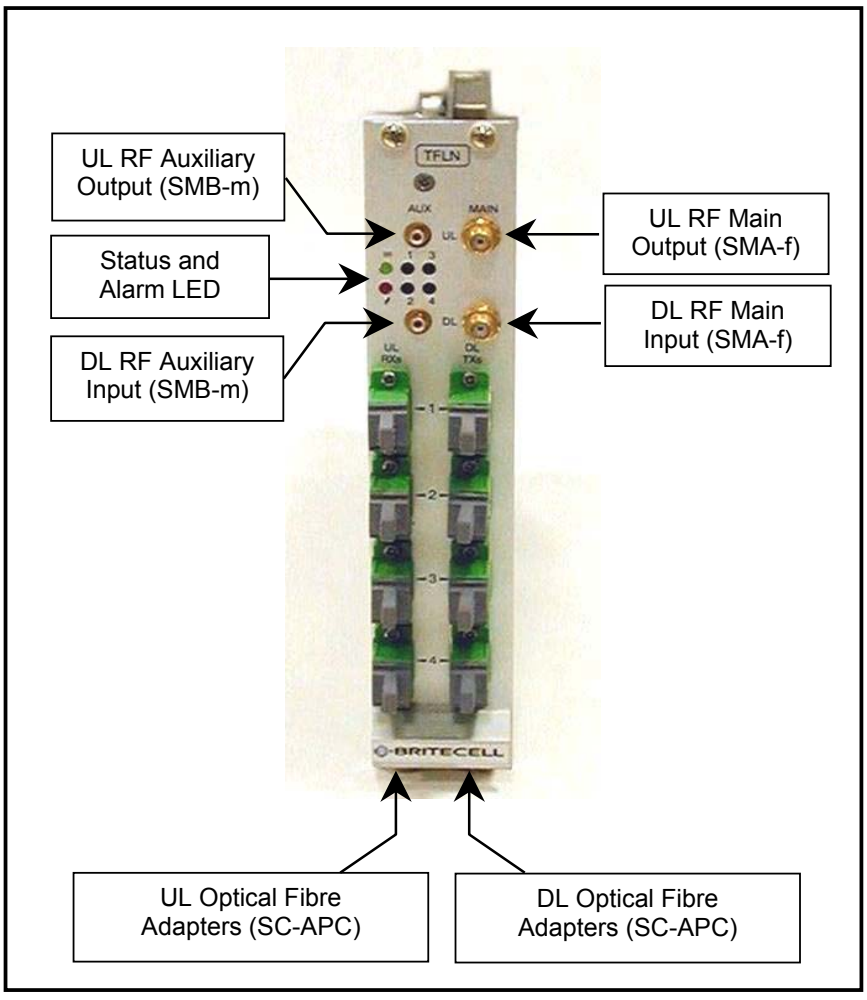
RF ports

- 1 DL RF input port
- 1 auxiliary DL RF input port, dedicated to WLAN services
- 1 UL RF output port
- 1 auxiliary UL RF output port, dedicated to WLAN services

Note: nominal input levels at RF port require a maximum input RF power. of 3dBm (please refer to datasheet for further information), as well as RF outputs may require a power adjustment to fill within the BTS receiving range.
In order to fulfil these requirements, external UL and DL attenuations may be required (see TBSI module).

Optical ports

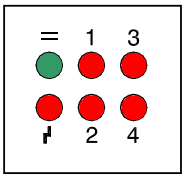
- 4 DL optical output ports (SC/APC)
- 4 UL optical input ports (SC/APC)



TFLN visual alarms

The TFLN front panel is provided with 6 LEDs (see on the right), showing status and alarm information.
LED meaning is reported on the rightward table.
Further information about alarm status is delivered by Britecell Plus supervision system.

Note: In case the four TFLN optical output ports are not all connected to Remote Units, the unused ports must be properly masked at commissioning in order to avoid spurious alarms (please refer to LMT manual).



Label	*LED colour*	*Meaning*
=	Green	Power supply status OK
⌐┘	Red	General TFLN failure, it can be: - TFLN laser failure - UL or DL amplifier failure - TFLN short circuit
1	Red	Low UL optical power received from Remote Unit 1 (fault in optical link 1 or Remote Unit 1 failure)
2	Red	Low UL optical power received from Remote Unit 2 (fault in optical link 2 or Remote Unit 2 failure)
3	Red	Low UL optical power received from Remote Unit 3 (fault in optical link 3 or Remote Unit 3 failure)
4	Red	Low UL optical power received from Remote Unit 4 (fault in optical link 4 or Remote Unit 4 failure)

Tab. 10: summary of TFLN LED meanings.

TFLN power supply

Each TFLN local unit is supplied by the subrack back-plane (12V).
The power consumption of each TFLN local unit is 9W.

Warnings (to be read before the TFLN installation)

Dealing with optical output ports

- The TFLN local unit contains semiconductor lasers. Invisible laser beams may be emitted from the optical output ports. Do not look towards the optical ports while equipment is switched on.

Handling optical connections

- When inserting an optical connector, take care to handle it so smoothly that the optical fibre is not damaged. Optical fibres have to be single-mode (SM) 9.5/125µm.
- Typically, Britecell Plus equipment is provided with SC-APC optical connectors. As an alternative, FC-APC connectors may be provided. Inserting any other connectors will result in severe damages.
- Do not force or stretch the fibre pigtail with radius of curvature less than 5 cm. See fig. 20 for optimal fibre cabling.
- Remove adapter caps only just before making connections. Do not leave SC-APC adapters open, as they attract dust. Unused SC-APC adapters must always be covered with their caps.
- Do not touch the adapter tip. Clean it with a proper tissue before inserting each connector into the sleeve. In case adapter tips need to be better cleaned, use pure ethyl alcohol

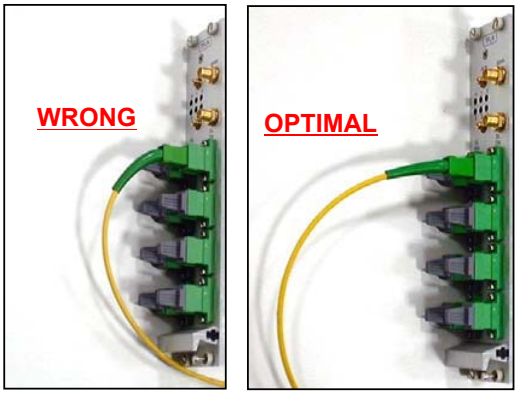


Fig. 20: Fibre Optic bending

Inserting or removing TFLN modules

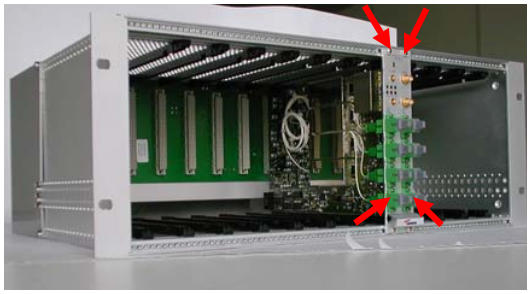
- Do not remove or insert any TFLN module into TPRN subrack before having switched off main power supply.
- The TFLN modules must be handled with care, in order to avoid damage to electrostatic sensitive devices.
- When installing TFLN modules in the subrack, take care to alternate active and passive cards in order to ensure proper heat dissipation.
- In a multi-subrack system, remember to assign to each subrack a proper RS485 bus address before installing the modules (please refer to TPRN section for further details).

TFLN positioning in system design

- In case no ventilation system is installed, do not insert more than 8 active modules into a subrack.
- In case more than 8 active cards have to be housed into the TPRN subrack, it's advisable to install the TPRN subrack inside a rack with forced ventilation.
- Take care to meet expected requirements on RF ports. An adjustable attenuator could be necessary when the power coming from the BTS exceeds the required levels to avoid causing damages in Britecell Plus circuitry or increase of spurious emissions.

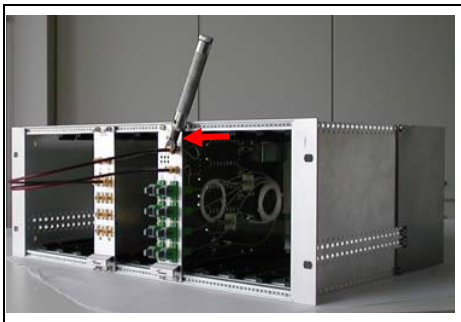
TFLN installation

The TFLN local unit is housed in a TPRN subrack and its dimensions are 19" width and 4HE height. A TFLN module can be accommodated in any of these 12 slots.

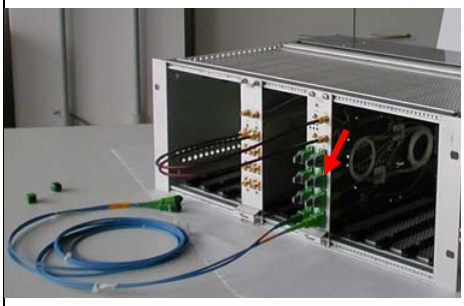


Note: In case a new TFLN module has to be installed in a still working Master Unit, switch off the subrack before inserting the plug-in TFLN module

Firstly, gently insert the TFLN in one of the 12 available slots, and lock the 4 screws on the front corners.



Then connect the UL and the DL RF cable *(which come from a TBSI or a TLCN module, depending on how the system has been designed)* to the TFLN UL and DL ports, respectively.
Use a specific torque wrench to fix these RF cables to DL and UL ports.



Remove the caps from TFLN optical ports and connect the SC-APC fibre optic cables to the ports.
UL and DL cables coming from the same remote unit have to be connected to UL and DL ports marked by the same number on the TFLN front panel.

As you switch on the system, carefully refer to the TFLN Start-Up section.
Remember that remote units should be switched on before than the Master Unit in order to follow a correct Start-Up procedure.

TFLN behaviour at system start-up

Before the Master Unit is switched on, make sure that:

- all expected modules have been inserted into the Master Unit
- the modules have been connected each other by RF jumpers, according to what planned in the system design
- every TFLN local unit has been connected to relevant remote units
- each remote unit has been connected to its coverage antennas
- the supervision agent, if present, has been connected to the Master Unit
- different Master Units are connected each other via bus RS485

After that, remember that only when all the remote units are already on, the Master Unit itself can be turned on.
Once the Master Unit has been switched on, the TFLN behaviour at system start-up can be summarized as per the following steps:

1. When Master Unit is turned on all the six LEDs upon the TFLN front panel go on for a couple of seconds. After that, the green LED remains on (indicating proper power supply) while the other LEDs indicate the local unit status, according to the following table.
   Note: In case unused optical ports of the TFLN have not been masked through LMT yet, corresponding LEDs will be on. If so, wait for the end of step 3 (discovery phase) then use LMT to mask them (please refer to relevant Application Note)

Label	*LED colour*	*Status*
=	Green	ON (power supply is on)
⌐┘	Red	OFF (no major failure affects TFLN operations)
1	Red	OFF (no major failure affects corresponding remote unit or UL connection)
2	Red	OFF (no major failure affects corresponding remote unit or UL connection)
3	Red	OFF (no major failure affects corresponding remote unit or UL connection)
4	Red	OFF (no major failure affects corresponding remote unit or UL connection)

Tab. 11: Status of the TFLN LEDs in full-working conditions

2. About 10 seconds after the system has been switched on, TFLN module begins a "discovery" phase to identify connected remote units. This operation is necessary to collect all the information to be provided to the supervision system.
   While the discovery phase is working, the TFLN general alarm (LED ⌐┘) blinks while the other LEDs go on showing previously detected status. Time dedicated to discovery phase can be at maximum 4min and depends on system complexity. ***Do not connect/disconnect any cable or any piece of equipment during the discovery phase!*** This may result in failing the identification of remote units.
   Please note that, while the discovery phase is running, the whole system is working correctly. Discovery operations aim to collect information about remote units but they don't affect the system functionality.

3. Once the discovery is finished, the TFLN general alarm (LED ⌐┘) stops blinking and switches OFF. The power supply LED (green LED) remains on while LEDs 1,2,3,4 show either the status of the remote units or the quality of the UL connections. In case some of these LEDs remain on, check if they refer to unused optical ports or not. In case of unused TFLN ports use LMT to mask it otherwise if LED referring to a connected remote unit remains on, please refer to Troubleshooting procedure.

Removing a TFLN module

Switch off the Master Unit power supply, remove the SC-APC optical connectors, and insert the protection caps into TFLN optical ports. Then

- unscrew the 4 screws and slowly remove the card.
- put the removed TFLN card in its safety box.
- switch on again the Master Unit power supply, and refer to Start Up section.

TFLN troubleshooting

In case a TFLN local unit has any problem, this will be easily revealed through LEDs on TFLN front panels.
Troubleshooting procedure can be easy when failure detection is directly carried out through LMT or supervision system, as an alternative, a manual troubleshooting procedure can be carried out.
LEDs panel on TFLN front detect not only failures inside the TFLN, but they also reveals malfunctions located on related remote unit.
The following table reports a brief description of the TFLN alarms, together with a reference to the corresponding alerted LEDs:

Alarm description	***Alerted LED***	***Alarm priority level***
The optical power received on UL port 1 is too low and the AGC can no more compensate the optical losses on UL port 1	**1**	High
The optical power received on UL port 2 is too low and the AGC can no more compensate the optical losses on UL port 2	**2**	High
The optical power received on UL port 3 is too low and the AGC can no more compensate the optical losses on UL port 3	**3**	High
The optical power received on UL port 4 is too low and the AGC can no more compensate the optical losses on UL port 4	**4**	High
The optical power received on UL port 1,2,3, or 4 is near to critical level but AGC still works	**none**	Low
High priority alarm on Remote Unit 1	**1**	High
High priority alarm on Remote Unit 2	**2**	High
High priority alarm on Remote Unit 3	**3**	High
High priority alarm on Remote Unit 4	**4**	High
Low priority alarm on Remote Units 1, 2, 3 or 4	**none**	Low
TFLN laser failure	⌐	High
UL RF amplifier failure	⌐	High
DL RF amplifier failure	⌐	High
Short circuit on TFLN module	⌐	High
Overtemperature on TFLN board[1]	**none**	Low

Tab. 12: TFLN LEDs description

As the table shows, LEDs on the TFLN front panel signal all high priority alarms while minor alarms, which detect critical situations which should be checked and tested in order to avoid future possible system faults, are only revealed by LMT or supervision system.
Each TFLN is provided with an AGC system which compensates optical losses < 3 dB. TFLN LED alarms switch on when the estimated optical losses are > 4dB, the AGC not being able to compensate these losses any more.
One of LEDs 1,2,3,4 might turn on not only to indicate a high optical loss detected by TFLN, but also to reveal a remote unit failure. Understanding the reason why one of LEDs 1,2,3 or 4 is on (a remote unit failure, an optical cable fault or an external equipment malfunction) can be done following the troubleshooting procedure reported hereinafter.

[1] Remember that proper TFLN environmental temperature is between +5°C and +40°C

Main troubleshooting procedure

(The following procedure is summarized by the flow-chart in fig. 21)

- In case the TFLN general alarm (LED ⌐┘) is on replace the faulty TFLN local unit with a new one and contact the manufacturer for assistance.
- In case one of the LEDs 1,2,3,4 is on the corresponding TFLN adapter might be dirty. Try cleaning it using pure ethyl alcohol. If the LED is still on go to the corresponding remote unit side and check the red LED upon TFAxxx warm side:
  - If it is off, the optical cables or the optical connections are supposed to have some problem on DL path. Refer to fibre optic DL troubleshooting for more information (fig. 22).
  - If it is on, refer to dry-contact troubleshooting (fig. 10) to understand whether the alarm can depend on external equipment failure or not. In case dry-contact troubleshooting does not reveal any failure, clean the remote unit optical adapters.
    If the problem still persists the UL optical cable or optical connections is supposed to have some problems. Please refer to the fibre optic UL troubleshooting (fig. 11) for more information.

Fibre optic DL troubleshooting

(The following procedure is summarized by the flow-chart in fig. 22)

- Check if there is any point where fibre experiences a short radius of curvature. In this case, rearrange the optical path in order to avoid sharp bends (if necessary, replace the optical cable with a longer one). If TFLN red LED switches off, troubleshooting has been successfully carried out. Otherwise, follow next steps.
- Check if SC-APC connectors are properly installed at both fibre ends. In case they are not, fix better SC-SPC connectors to adapters. If TFLN red LED switches off, troubleshooting has been successful. Otherwise, follow next steps.
- Disconnect the optical fibre and clean it better at both ends then clean the SC-APC ports on both the TFLN and the remote unit. Re-connect the fibre to relevant ports after cleaning. If it doesn't made TFLN red LED switch off, follow next steps.
- Disconnect the optical SC-APC connector from remote unit DL port, and measure the *output power* $P_{out(DL)}$ at the corresponding fibre end. Then, go to the TFLN side, disconnect the optical SC-APC connector from TFLN DL port and measure the *input power* $P_{in(DL)}$ coming out of the TFLN DL port. Calculate the DL fibre attenuation A_{DL} as $A_{DL}\ [dB] = P_{in(DL)} - P_{out(DL)}$
  - If $A_{DL} > 4dB$, then the fibre optic cable has some problems. Replace it with a new one.
  - If $A_{DL} < 4dB$ troubleshooting procedure has not identified the problem. Refer to supervision system or contact assistance.

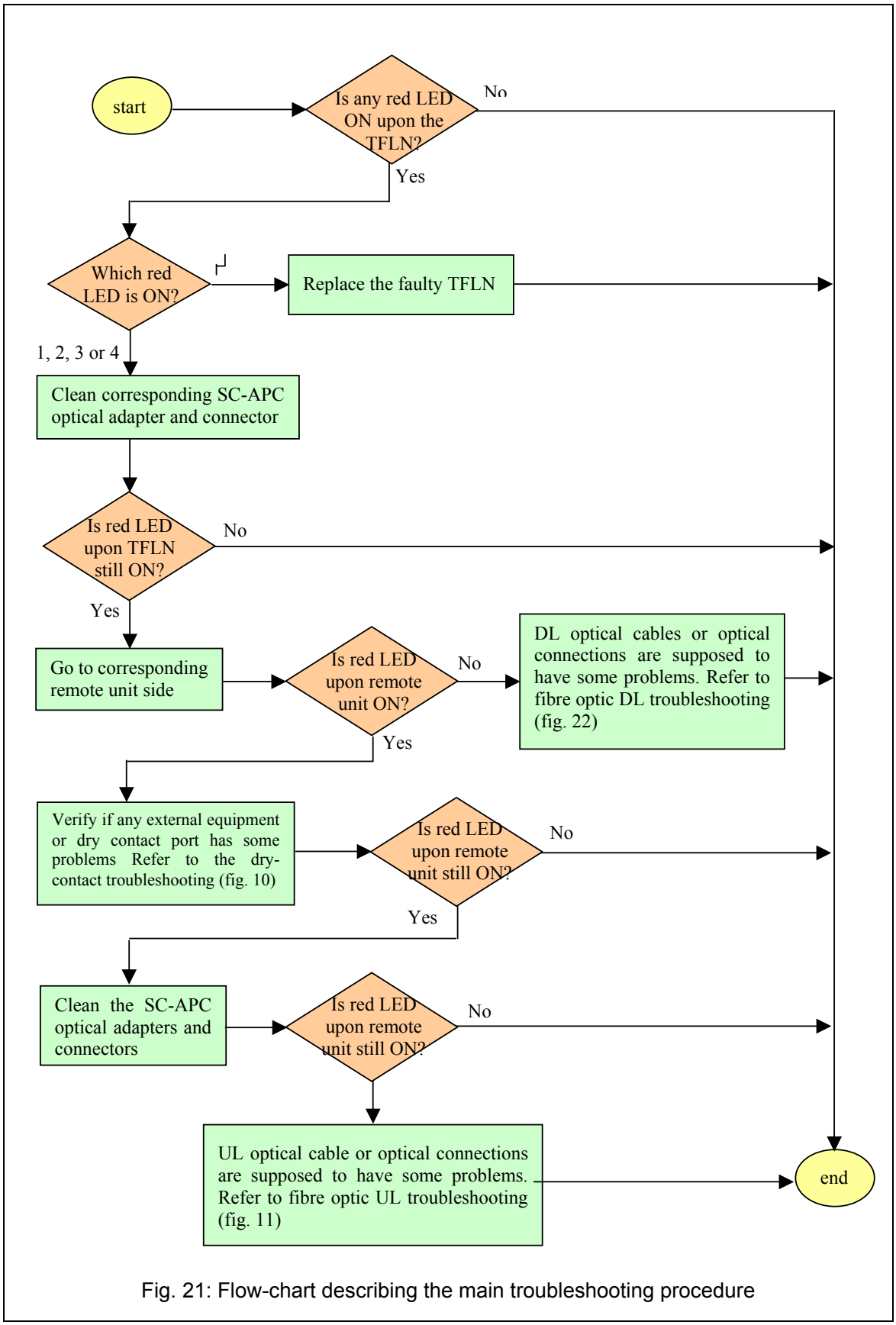


Fig. 21: Flow-chart describing the main troubleshooting procedure

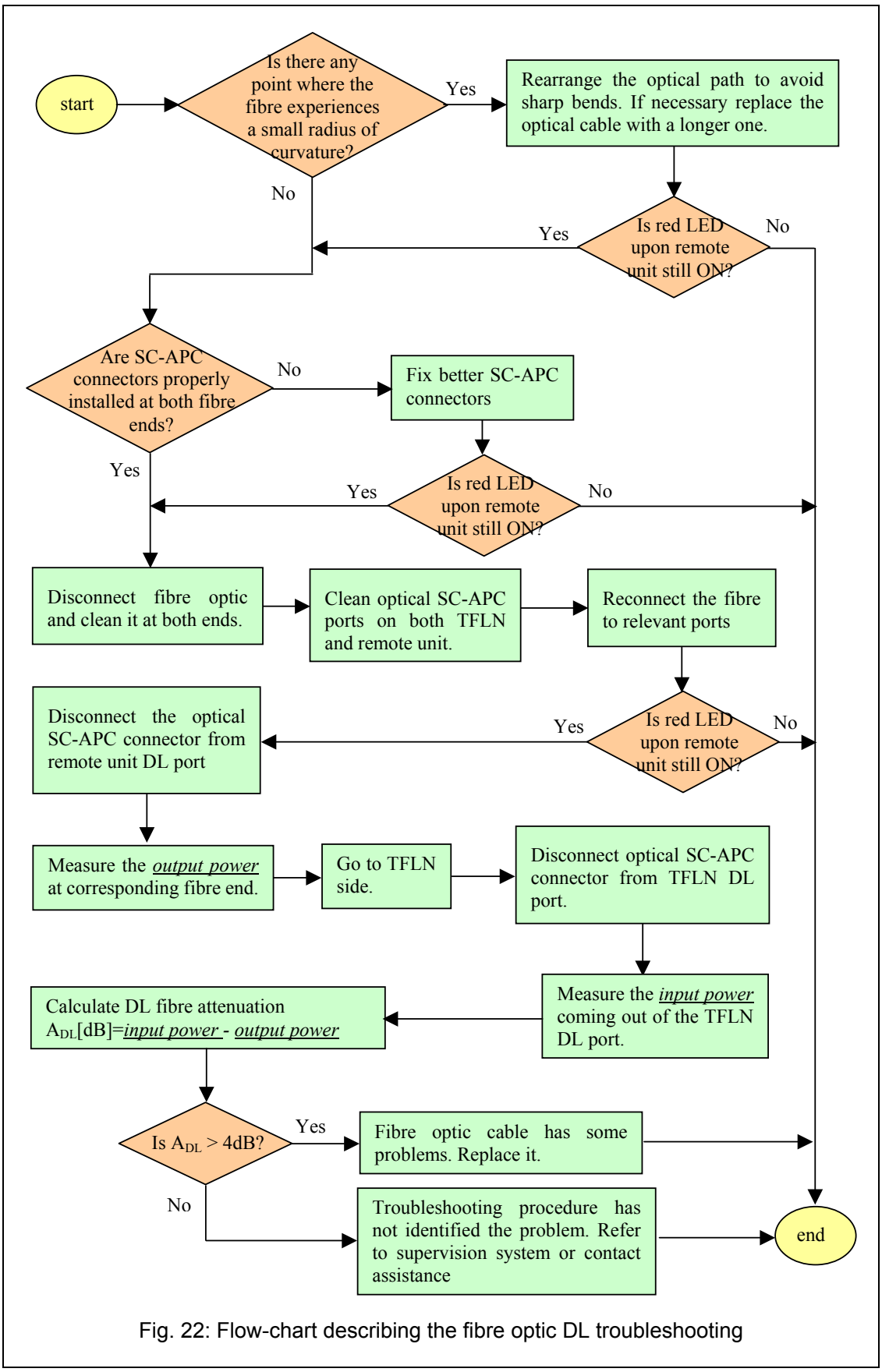
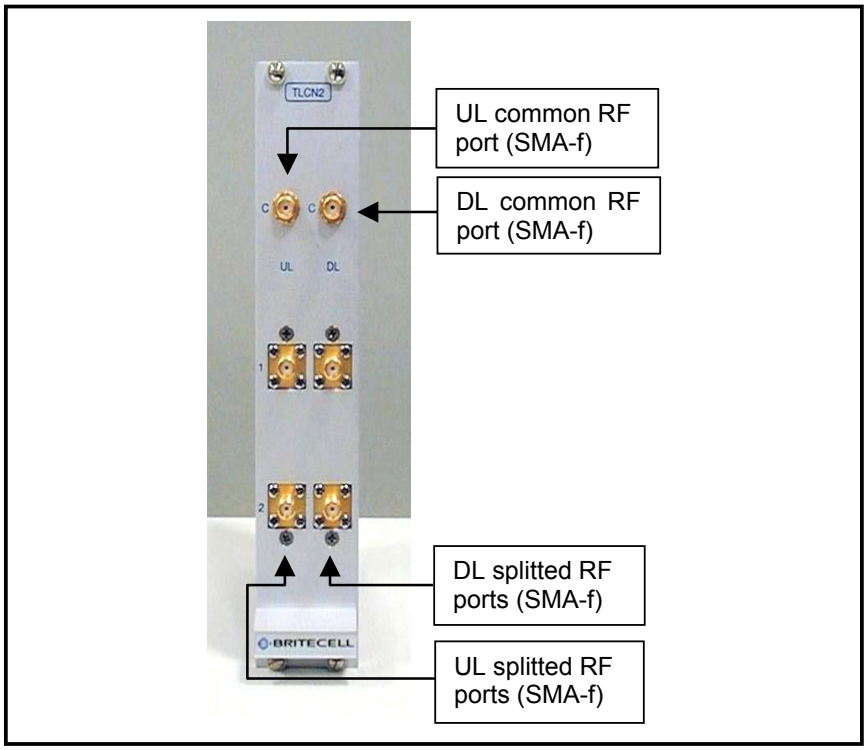


Fig. 22: Flow-chart describing the fibre optic DL troubleshooting

4.3. 2-way splitter TLCN2

Module name: **TLCN2**	**Description:** The TLCN2, bidirectional 2-way splitter/combiner, can be used to: ➢ combine 2 RF signals into a common RF output ➢ split an RF input into 2 RF output signals It is a passive device which doesn't require power supply. In case of splitting "C" works as an input port while "1" and "2" ports are the outputs. In case of combining "1"and "2" work as input ports while "C" is the output one.
RF ports: ➢ 1 DL common RF port ("C") ➢ 2 DL splitted RF ports ("1","2") ➢ 1 UL common RF port ("C") ➢ 2 UL splitted RF ports ("1","2") Note: each port is bidirectional.	

TLCN2 main applications

Main applications of the TLCN2 module are:

- Connecting a BTS to more than one TFLN local unit, so that:
  - ➢ TLCN2 splits the DL input coming from a BTS into 2 output signals entering 2 different TFLN local units
  - ➢ TLCN2 combines the UL inputs coming from 2 TFLN local units into 1 common signal, entering the BTS
- Connecting a TFLN local unit to more than one BTS, so that:
  - ➢ TLCN2 combines the two DL inputs coming from 2 BTSs into 1 output signal entering the TFLN local unit
  - ➢ TLCN2 splits the UL inputs coming from TFLN local unit into 2 different output signals entering 2 different BTSs

More TLCN2 modules can be used in cascade connections.

TLCN2 insertion loss

The TLCN2 insertion loss varies slightly with the frequency bands:

	700-1400MHz	***1400-2200MHz***	***2200-2500MHz***
TLCN2 insertion loss	3.7 ± 0.4dB	4.1 ± 0.5dB	4.6 ± 0.4dB

When designing the system, remember to take into account the insertion loss of the TLCN2.

Warnings

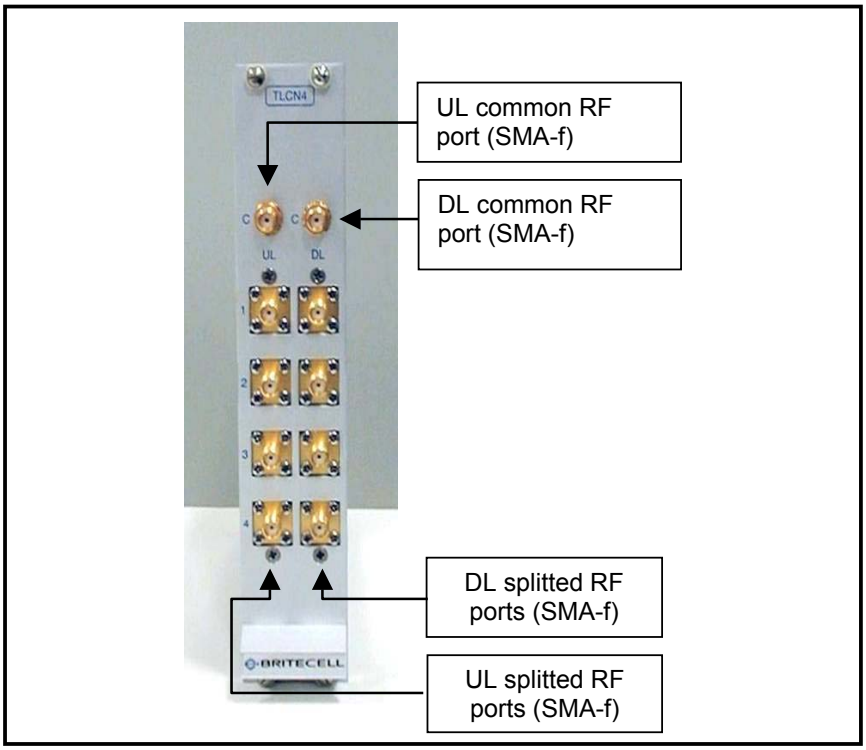
The overall input power must not exceed +24dBm

TLCN2 Installation

Since the TLCN2 module requires no power supply it can be housed either in an active or a passive TPRN subrack.

1. Unpack the kit which include
   - 1 TLCN2
   - 4 RF jumpers
2. Carefully insert the TLCN2 module in any of the TPRN subrack slots and lock the 4 screws on the front corners.
3. Connect RF cables to UL and DL ports, according to what planned by designer. Use a specific torque wrench to fix each cable to relevant ports.
4. In case some ports remain unused remember to connect them to a 50 Ω load (not included)

4.4. 4-way splitter TLCN4

Module name: **TLCN4**	**Description:** The TLCN4, bidirectional 4-way splitter/combiner, can be used to: ➢ combine 4 RF signals into a common RF output ➢ split an RF input into 4 RF output signals It is a passive device which doesn't require power supply. In case of splitting "C" works as an input port while "1", "2", "3" and "4" ports are the outputs. In case of combining "1", "2", "3" and "4" work as input ports while "C" is the output one.
RF ports: ➢ 1 DL common RF port ("C") ➢ 4 DL splitted RF ports ("1","2","3","4") ➢ 1 UL common RF port ("C") ➢ 4 UL splitted RF ports ("1","2","3","4") Note: each port is bidirectional.	

TLCN4 main applications

Main applications of the TLCN4 module are:

- Connecting a BTS to more than one TFLN local unit, so that:
  - ➢ TLCN4 splits the DL input coming from a BTS into 4 output signals entering 4 different TFLN local units
  - ➢ TLCN4 combines the UL inputs coming from 4 TFLN local units into 1 common signal, entering the BTS
- Connecting a TFLN local unit to more than one BTS, so that:
  - ➢ TLCN4 combines the two DL inputs coming from 4 BTSs into 1 output signal entering the TFLN local unit
  - ➢ TLCN4 splits the UL inputs coming from TFLN local unit into 4 different output signals entering 4 different BTSs

More TLCN4 modules can be used in cascade connections.

TLCN4 insertion loss

The TLCN4 insertion loss varies slightly with the frequency bands:

	700-1400MHz	***1400-2200MHz***	***2200-2500MHz***
TLCN4 insertion loss	7.4 ± 0.4dB	8.0 ± 0.5dB	8.4 ± 0.4dB

When designing the system, remember to take into account the insertion loss of the TLCN2.

Warnings

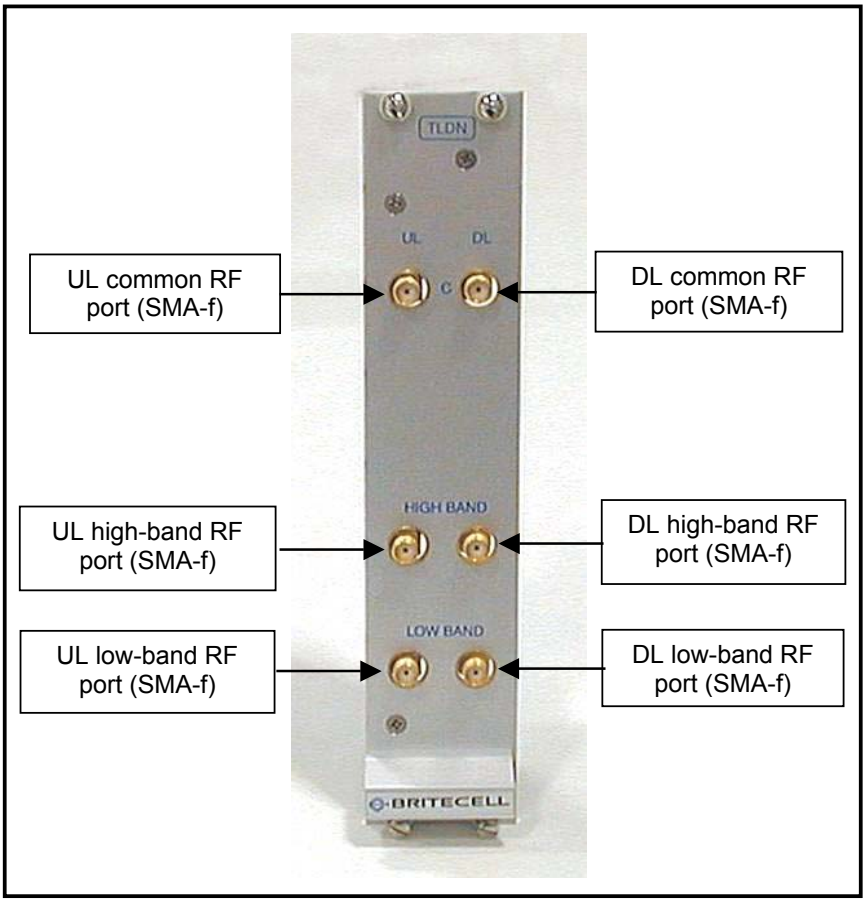
The overall input power must not exceed +24dBm

TLCN4 Installation

Since the TLCN4 module requires no power supply it can be housed either in an active or a passive TPRN subrack.

1. Unpack the kit which include
   - 1 TLCN4
   - 8 RF jumpers
2. Carefully insert the TLCN4 module in any of the TPRN subrack slots and lock the 4 screws on the front corners.
3. Connect RF cables to UL and DL ports, according to what planned by designer. Use a specific torque wrench to fix each cable to relevant ports.
4. In case some ports remain unused remember to connect them to a 50 Ω load (not included)

4.5. RF diplexer TLDN

Module name: **TLDN**	**Description:** The TLDN is a passive RF diplexer which combine/split low-band (800-1000MHz) and high-band (1700-2200MHz) signals in a multi-band system. Main operations carried out are: ➢ In Downlink it combines a low band RF signal (800MHz to 1000MHz) and a high band RF signal (1700MHz to 2200MHz) into a common RF path ➢ In UpLink it splits a composite signal into a low-band (800MHz to 1000MHz) and a high-band (1700MHz to 2200MHz) one. As it is a passive device it doesn't need power supply.
RF ports ➢ 1 DL common RF port ("C"), which sends out the combined DL signal ➢ 1 DL high-band RF input port, which receives the high-band signal ➢ 1 DL low-band RF input port, which receives the low-band signal ➢ 1 UL common RF port ("C"), which receives the combined UL signal ➢ 1 UL high-band RF output port, which sends out the high-band signal ➢ 1 UL low-band RF output port, which sends out the low-band signal	

TLDN main applications

Main applications of the TLDN module are:

- Connecting 2 BTSs with different services to one TFLN local unit in a dual band system, so that:
  - ➢ TLDN combines the DL inputs coming from 2 different BTSs (carrying different services) into an output signal entering a TFLN local unit
  - ➢ TLDN divides the UL input coming from a TFLN local unit into 2 UL outputs entering 2 different BTSs (carrying different services)

TLDN insertion loss

The TLDN insertion loss is as follows:

TLDN insertion loss	<1.5dB

When designing the system, remember to take into account the insertion loss of the TLDN.

Warnings

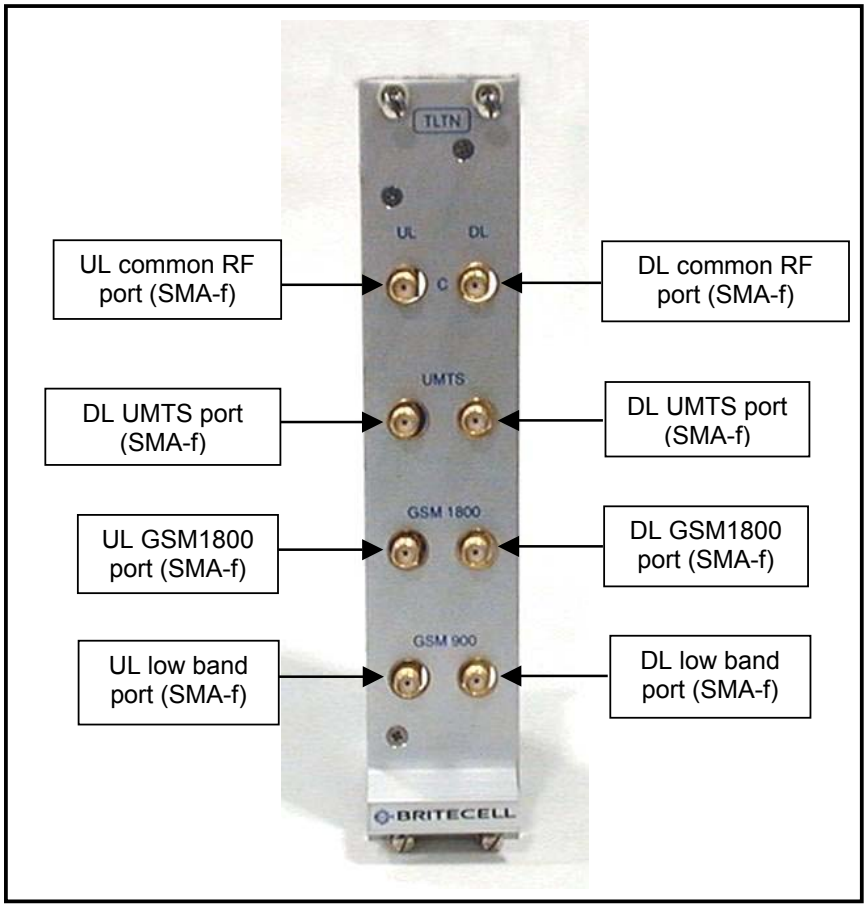
The overall input power must not exceed +27dBm

TLDN Installation

Since the TLDN module requires no power supply it can be housed either in an active or a passive TPRN subrack.

1. Unpack the kit which include
   - 1 TLDN
   - 4 RF jumpers
2. Carefully insert the TLDN module in any of the TPRN subrack slots and lock the 4 screws on the front corners.
3. Connect RF cables to UL and DL ports, according to what planned by designer. Use a specific torque wrench to fix each cable to relevant ports.

4.6. RF triplexer TLTN

Module name: **TLTN**	**Description:** The TLTN is a passive RF triplexer which combine/split low-band (800-1000MHz), GSM1800 and UMTS signals in a multi-band system. Main operations carried out are: ➢ In Downlink it combines a low band RF signal (800MHz to 1000MHz) a GSM1800 signal and an UMTS signal into a common RF path ➢ In UpLink it splits a composite signal into a low-band (800MHz to 1000MHz) a GSM1800 and an UMTS one. As it is a passive device it doesn't need power supply.
RF ports ➢ 1 DL common RF port ("C"), which sends out the combined DL signal ➢ 1 DL UMTS RF input port, which receives the UMTS band signal ➢ 1 DL GSM1800 RF input port, which receives the GSM1800 signal ➢ 1 DL low band RF input port, which receives the low band signal ➢ 1 UL common port ("C"), which receives the combined UL signal ➢ 1 UL UMTS RF output port, which sends out the UMTS signal ➢ 1 UL GSM1800 RF output port. which sends out the GSM 1800 signal ➢ 1 UL low band RF output port, which sends out the low band signal	

TLTN main applications

Main applications of the TLTN module are:

- Connecting 3 BTSs with different services to one TFLN local unit in a tri-band system, so that:
  - ➢ TLTN combines the DL inputs coming from 3 different BTSs (carrying different services: low band, GSM1800 and UMTS) into an output signal entering a TFLN local unit
  - ➢ TLTN divides the UL input coming from a TFLN local unit into 3 UL outputs entering 3 different BTSs (carrying different services: low band, GSM1800 and UMTS)

TLTN insertion loss

The TLTN insertion loss is as follows:

TLTN insertion loss	<3.5dB

When designing the system, remember to take into account the insertion loss of the TLDN.

Warnings

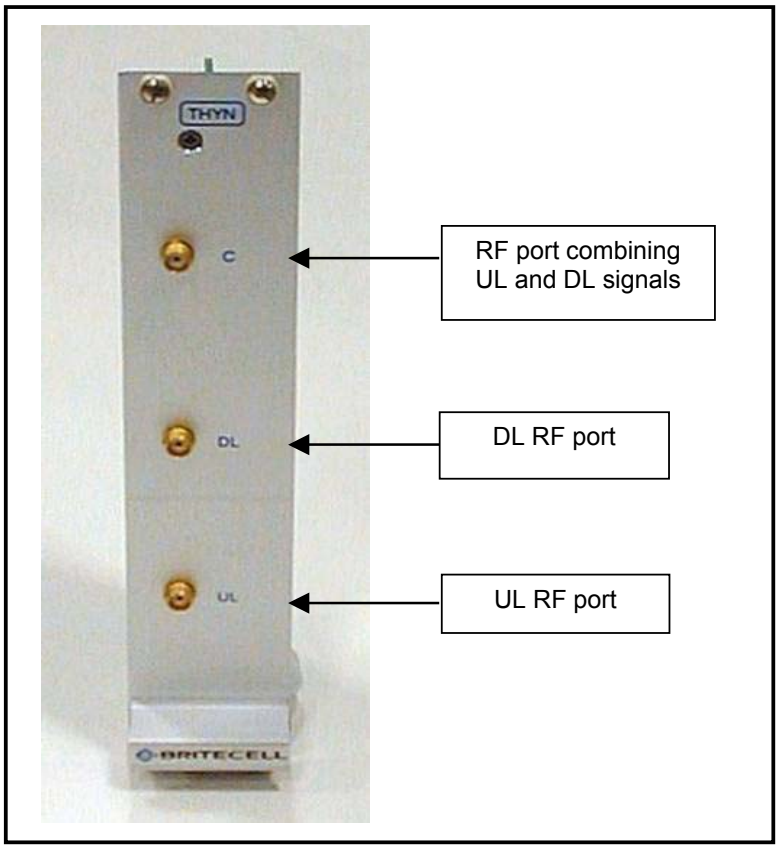
The overall input power must not exceed +27dBm

TLTN Installation

Since the TLTN module requires no power supply it can be housed either in an active or a passive TPRN subrack.

1. Unpack the kit which include
   - 1 TLTN
   - 6 RF jumpers
2. Carefully insert the TLTN module in any of the TPRN subrack slots and lock the 4 screws on the front corners.
3. Connect RF cables to UL and DL ports, according to what planned by designer. Use a specific torque wrench to fix each cable to relevant ports.

4.7. RF duplexer THYN

Module name: **THYN**	**Description:** THYN is a family of duplexers which combines/splits the downlink and uplink paths into a single one while maintaining the required isolation. As this device is band dependent be sure to choose the right single band version.
RF ports ➢ 1 DL port, which receives DL signal ➢ 1 UL port, which sends out the UL signal ➢ 1 common port ("C"), which provides an UL and DL combined signal	

THYN main applications

Main applications of the THYN module are:

- Connecting a BTSs with duplexed antenna port to a Britecell Plus system, so that:
  - THYN combines/splits the DL and UL signals coming from a single port of the BTS into two separated ports

THYN insertion loss

The THYN insertion loss is as follows:

	Frequencies < 1GHz	***Frequencies > 1 GHz***	***UMTS***
THYN UL insertion loss	7.0 ± 1dB	7.0 ± 1.5dB	2.0 ± 0.5dB
THYN DL insertion loss	3.3 ± 0.5dB		

When designing the system, remember to take into account the insertion loss of the TLDN.

Warnings

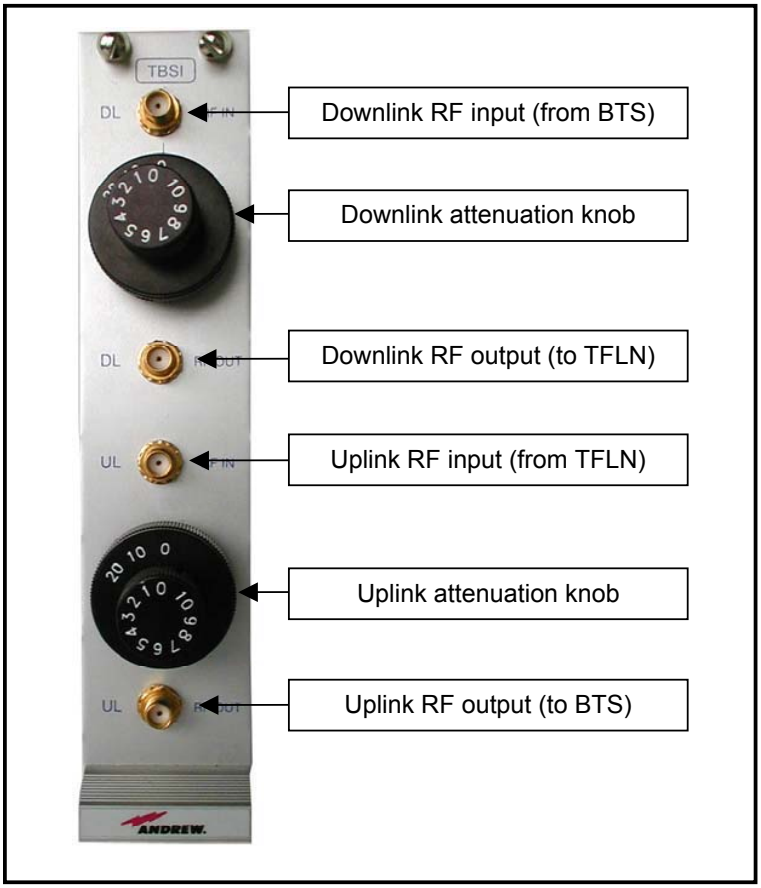
The overall input power must not exceed +30dBm

THYN Installation

Since the THYN module requires no power supply it can be housed either in an active or a passive TPRN subrack.

1. Unpack the kit which include
   - 1 THYN
   - 2 RF jumpers
2. Carefully insert the THYN module in any of the TPRN subrack slots and lock the 4 screws on the front corners.
3. Connect RF cables to common, UL and DL ports, according to what planned by designer. Use a specific torque wrench to fix each cable to relevant ports.

4.8. RF attenuator TBSI

Module name: **TBSI**	**Description** The TBSI module is an adjustable RF attenuator, necessary in order to: ➢ set the correct power level for the RF downlink signal entering the DL input port of the TFLN local unit; ➢ set the correct power level for the RF uplink signal entering the BTS, in order to meet desired requirements about BTS blocking level and BTS receiver sensitivity In order to set these different attenuations TBSI provides 2 separate knobs to regulate UL and DL attenuations independently (please refer to BriteTool manual to understand how to calculate the right value of attenuation trough BriteTool)
RF ports ➢ 1 DL RF input port receiving the DL signal to be attenuated ➢ 1 DL RF output port sending out the attenuated DL signal ➢ 1 UL RF input port receiving the UL signal to be attenuated ➢ 1 UL RF output port sending out the attenuated UL signal The attenuation required both on DL and UL can be properly set through relevant knob (30dB range, 1dB step).	

TBSI main applications

Main applications of the TBSI module are:

- adjusting RF levels coming to/from a BTSs:
  - ➢ TBSI adjusts the DL signal to meet the required power level at TFLN DL input
  - ➢ TBSI adjusts the UL signal coming from TFLN to provide the required blocking level and receiver sensitivity to the BTS

TBSI insertion loss

The TBSI insertion loss is as follows:

	DC to 2GHz	*2GHz to 2.17GHz*
TBSI insertion loss	< 1dB	< 1.3dB

When designing the system, remember to take into account the insertion loss of the TBSI.

Warnings

The overall input power must not exceed +30dBm

TBSI Installation

Since the TBSI module requires no power supply it can be housed either in an active or a passive TPRN subrack.

1. Unpack the kit which include
   - 1 TBSI
   - 2 RF jumpers
2. Carefully insert the TBSI module in any of the TPRN subrack slots and lock the 4 screws on the front corners.
3. Connect RF cables according to what planned by designer. Use a specific torque wrench to fix each cable to relevant ports.
4. Set proper attenuation values.

4.9. Digital RF attenuator TDI

Module name:

TDI

Description

The TDI module is a digital adjustable RF attenuator, necessary in order to:

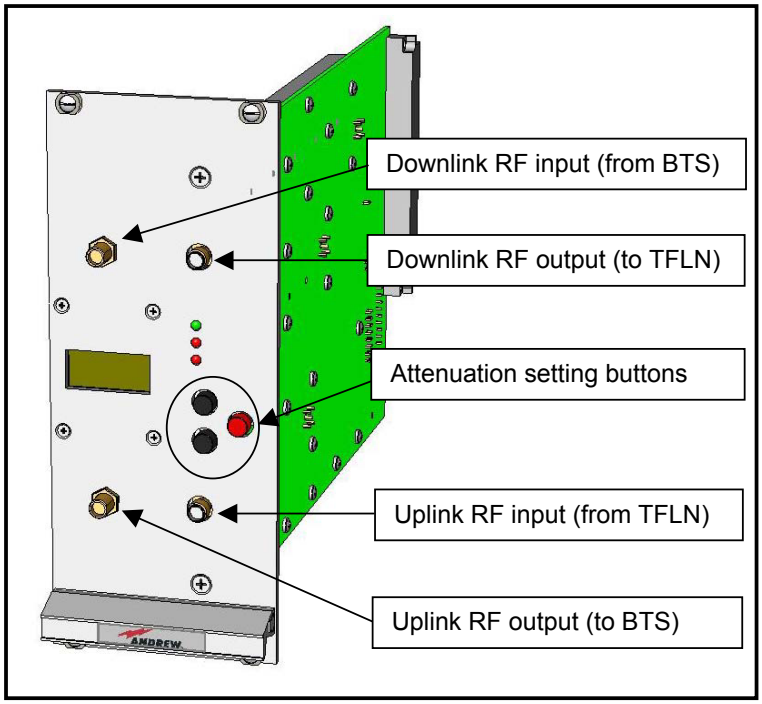
- set the correct power level for the RF downlink signal entering the DL input port of the TFLN local unit;
- set the correct power level for the RF uplink signal entering the BTS, in order to meet desired requirements about BTS blocking level and BTS receiver sensitivity. In UL apart from the 30dB attenuation range, it is provided with a gain allowing increasing dynamic available for the optimisation of the performances at BTS side.

Being digital, the TDI is provided with a LCD panel and buttons allowing setting the different attenuations on UL and DL independently (please refer to BriteTool manual to understand how to calculate the right value of attenuation trough BriteTool). The attenuation settings can also be done remotely through the supervision system.

RF ports

- 1 DL RF input port receiving the DL signal to be attenuated
- 1 DL RF output port sending out the attenuated DL signal
- 1 UL RF input port receiving the UL signal to be attenuated
- 1 UL RF output port sending out the attenuated UL signal

The attenuation required both on DL and UL can be properly set through LCD display or supervision system (30dB range, 1dB step).



TDI main applications

Main applications of the TDI module are:

- adjusting RF levels coming to/from a BTSs:
  - TBSI adjusts the DL signal to meet the required power level at TFLN DL input
  - TBSI adjusts the UL signal coming from TFLN to provide the required blocking level and receiver sensitivity to the BTS

It is advisable to use this module when an increase of the dynamic available on the UL path is needed.

TDI visual alarms

The TDI front panel is provided with 2 LEDs showing status and alarm information.
LED meaning is reported on the rightward table.
Further information about alarm status is delivered by Britecell Plus supervision system.

Label	*LED colour*	*Meaning*
Power	Green	Power supply status OK
UL Alarm	Red	UL amplifier failure

Tab. 13: Summary of TDI LEDs meaning

The Temperature alarm is considered a minor alarm and as the policy is to show through LED signalling only the major alarm, it will be provided only by the supervision system.
In case of power supply degradation the green LED switch off and the problem is signalled through the supervision system.

TDI power supply

Each TDI digital attenuator is supplied by the subrack back-plane (+12V).
The power consumption of each TDI is 3W max.

Warnings

The overall input power must not exceed +30dBm

Inserting or removing TDI modules

- Do not remove or insert any TDI module into TPRN subrack before having switched off main power supply.
- The TDI modules must be handled with care, in order to avoid damage to electrostatic sensitive devices.

TDI Installation

The TDI digital attenuator is housed in a TPRN subrack and its dimensions are 19" width and 4HE height. A TDI module can be accommodated in any of these 12 slots.

Note: In case a new TDI module has to be installed in a still working Master Unit, switch off the subrack before inserting the plug-in TDI module

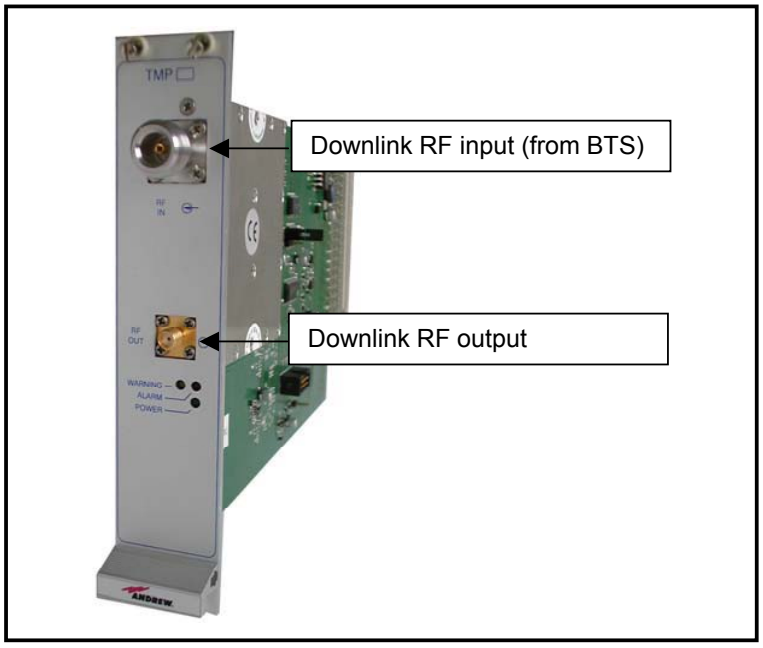
1. Unpack the kit which include
   - 1 TDI
   - 2 RF jumpers
2. Carefully insert the TDI module in any of the TPRN subrack slots and lock the 4 screws on the front corners.
3. Connect RF cables according to what planned by designer. Use a specific torque wrench to fix each cable to relevant ports.
4. Switch on the subrack and set proper attenuation values.

Removing a TDI module

Switch off the Master Unit power supply and remove RF jumpers. Then

- unscrew the 4 screws and slowly remove the card.
- put the removed TDI card in its safety box.
- switch on again the Master Unit power supply.

4.10. Power limiter TMPx-10

Module name: **TMPx-10**	**Description**
	TMPx-10 power limiter is available in two versions, one suitable for 2G services and the other for 3G. This module monitors the DL input power and when Operator's BTS power increases above a set threshold, it ensures the signal path being attenuated by 10dB to avoid subsequent circuits being overdriven. TMPx-10 threshold is programmable through the supervision system.
RF ports ➢ 1 DL RF input port receiving the DL signal to be checked from the BTS ➢ 1 DL RF output port sending out the DL signal	

TMP main applications

Main applications of the TMP module are:

- Check DL RF level coming from a BTS in order to protect the system if the level exceed a programmed threshold

TMP visual alarms

The TMP front panel is provided with 3 LEDs showing status and alarm information.
LED meaning is reported on the rightward table.
Further information about alarm status is delivered by Britecell Plus supervision system.

Label	*LED colour*	*Meaning*
Power	Green	Power supply status OK
Warning	Amber	It signals a general warning which can be due to: - over temperature - no RF signal at input port
Alarm	Red	General TMP failure, it can be: - power supply degradation - switched mode active (10dB att.)

Tab. 14: Summary of TMP LEDs meaning

TMP power supply

Each TMPx-10 power limiter is supplied by the subrack back-plane (+12V).
The power consumption of each TMPx-10 is 2W max.

TMP insertion loss

The TMP insertion loss is as follows:

TMP insertion loss	< 1.5dB

When designing the system, remember to take into account the insertion loss of the TMP.

Warnings

The overall input power must not exceed +35dBm

Inserting or removing TMP modules

- Do not remove or insert any TMP module into TPRN subrack before having switched off main power supply.
- The TMP modules must be handled with care, in order to avoid damage to electrostatic sensitive devices.

TMP installation

The TMP power limiter is housed in a TPRN subrack and its dimensions are 19" width and 4HE height. A TMP module can be accommodated in any of these 12 slots.
Note: In case a new TMP module has to be installed in a still working Master Unit, switch off the subrack before inserting the plug-in TMP module

1. Unpack the kit which include
   - 1 TMP
   - 1 RF jumper
2. Carefully insert the TMP module in any of the TPRN subrack slots and lock the 4 screws on the front corners.
3. Connect RF cables according to what planned by designer. Use a specific torque wrench to fix each cable to relevant ports.
4. Switch on the subrack

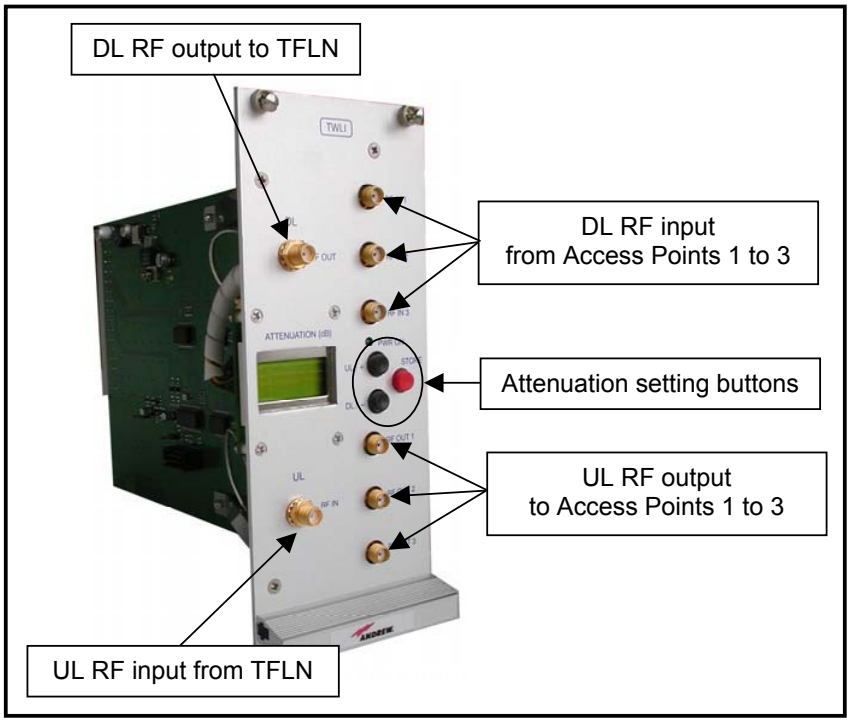
Removing a TMP module

Switch off the Master Unit power supply and remove RF jumpers. Then

- unscrew the 4 screws and slowly remove the card.
- put the removed TMP card in its safety box.
- switch on again the Master Unit power supply.

5. Optional equipment and accessories

5.1. WLAN interface TWLI

Module name: **TWLI**	**Description** Britecell Plus system allows distributing WLAN service (802.11b) through an auxiliary channel while concentrating all the Access Points together with the central equipment. The TWLI module allows connecting up to 3 Access Points to one TFLN and setting up to 4dB attenuation, if needed, on the DL path.
RF ports ➢ 3 DL RF input ports receiving the DL signals from up to 3 different Access Points ➢ 1 DL RF output port sending out the DL signal to the TFLN auxiliary port ➢ 1 UL RF input port receiving the UL signal from the TFLN auxiliary port ➢ 3 UL RF output ports sending out the UL signals to up to 3 different Access Points A 4dB attenuation range is available on the DL path in order to adjust levels coming from the Access Points.	

TWLI main applications

Main applications of the TWLI module are:

- provide to the TFLN the WLAN signals coming from up to 3 Access Points concentrated on the same room.

TWLI power supply

Each TWLI WLAN interface module is supplied by the subrack back-plane (+12V).
The power consumption of each TWLI is 2W max.

Warnings

The overall input power must not exceed +19dBm

Inserting or removing TWLI modules

- Do not remove or insert any TWLI module into TPRN subrack before having switched off main power supply.
- The TWLI modules must be handled with care, in order to avoid damage to electrostatic sensitive devices.

TWLI installation

The TWLI WLAN interface is housed in a TPRN subrack and its dimensions are 19" width and 4HE height. A TWLI module can be accommodated in any of these 12 slots.

Note: In case a new TWLI module has to be installed in a still working Master Unit, switch off the subrack before inserting the plug-in TWLI module

1. Unpack the kit which include
   - 1 TWLI
   - 2 RF jumpers
2. Carefully insert the TWLI module in any of the TPRN subrack slots and lock the 4 screws on the front corners.
3. Connect RF cables according to what planned by designer. Use a specific torque wrench to fix each cable to relevant ports.
4. Switch on the subrack

Removing a TWLI module

Switch off the Master Unit power supply and remove RF jumpers. Then

- unscrew the 4 screws and slowly remove the card.
- put the removed TWLI card in its safety box.
- switch on again the Master Unit power supply.

5.2. Amplifier TWANx

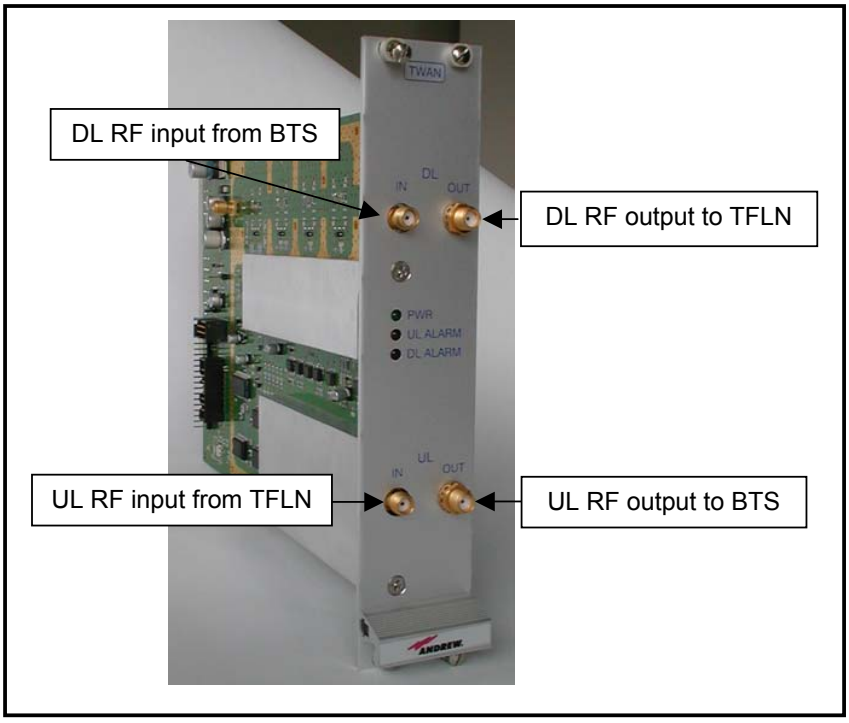
Module name:
TWAN

Description

The purpose of the TWAN module is to amplify DL and UL signals when Britecell Plus is interfaced with a low power BTS.
The gain allows also compensating for losses in splitting/combining network. As this device is band dependent be sure to choose the right single band version.

RF ports

- 1 DL RF input port receiving the DL signal from BTS
- 1 DL RF output port sending out the amplified DL signal to the TFLN
- 1 UL RF input port receiving the UL signal from TFLN
- 1 UL RF output port sending out the amplified UL signal to the BTS



TWAN main applications

Main applications of the TWAN module are:
- amplifying the levels to/from a low power BTS:
- compensate for splitting/combining network losses

TWAN visual alarms

The TWAN front panel is provided with 3 LEDs showing status and alarm information.
LED meaning is reported on the rightward table.
Further information about alarm status is delivered by Britecell Plus supervision system.

Label	*LED colour*	*Meaning*
Power	Green	Power supply status OK
UL Alarm	Red	UL amplifier failure
DL Alarm	Red	DL amplifier failure

Tab. 15: Summary of TWAN LEDs meaning

The Temperature alarm is considered a minor alarm and as the policy is to show through LED signalling only the major alarm, it will be provided only by the supervision system.
In case of power supply degradation the green LED switch off and the problem is signalled through the supervision system.

TWAN power supply

Each TWAN digital attenuator is supplied by the subrack back-plane (+12V).
The power consumption of each TWAN module is 3W max.

Warnings

The overall input power must not exceed 0dBm

Inserting or removing TWAN modules

- Do not remove or insert any TWAN module into TPRN subrack before having switched off main power supply.
- The TWAN modules must be handled with care, in order to avoid damage to electrostatic sensitive devices.

TWAN Installation

The TWAN digital attenuator is housed in a TPRN subrack and its dimensions are 19" width and 4HE height. A TWAN module can be accommodated in any of these 12 slots.

Note: In case a new TWAN module has to be installed in a still working Master Unit, switch off the subrack before inserting the plug-in TWAN module

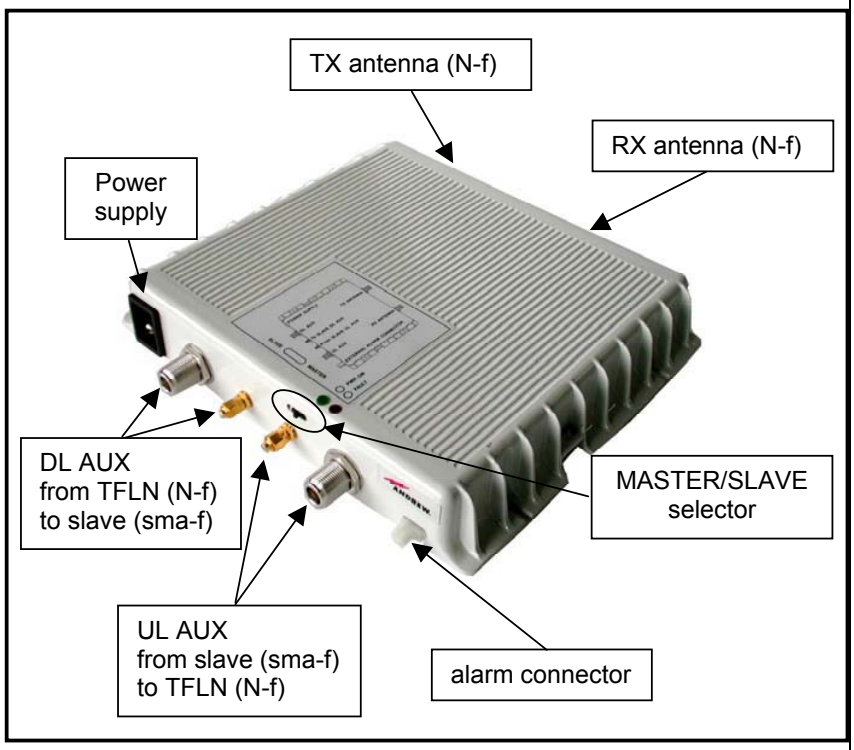
1. Unpack the kit which include
   - 1 TWAN
   - 2 RF jumpers
2. Carefully insert the TWAN module in any of the TPRN subrack slots and lock the 4 screws on the front corners.
3. Connect RF cables according to what planned by designer. Use a specific torque wrench to fix each cable to relevant ports.
4. Switch on the subrack.

Removing a TWAN module

Switch off the Master Unit power supply and remove RF jumpers. Then

- unscrew the 4 screws and slowly remove the card.
- put the removed TWAN card in its safety box.
- switch on again the Master Unit power supply.

5.3. WLAN booster TFBWx

Module name: **TFBW**	**Description** Britecell Plus system allows distributing WLAN service (802.11b) through an auxiliary channel while concentrating all the Access Points together with the central equipment. The TFBW radio front end is connected to the remote unit in order to provide the radio coverage through the antennas (one for TX and the other for RX, required isolation between these antennas is 50dB). Up to 2 TFBW boosters can be cascaded to provide two coverage points.
RF ports ➢ 1 DL RF AUX input port receiving the DL signal from TFLN ➢ 1 DL RF AUX output port sending out the DL signal to another TFBW slave ➢ 1 TX antenna port ➢ 1 UL RF AUX input port receiving the UL signal from another TFBW slave ➢ 1 UL RF AUX output port sending out the UL signal to the TFLN ➢ 1 RX antenna port A MASTER/SLAVE selector is provided allowing connecting two cascaded boosters	

TFBW main applications

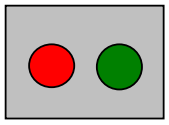
Main applications of the TFBW module are:

- amplify UL and DL WLAN signals coming to/from the auxiliary channel of a TFLN
- provide WLAN coverage through a TX and a RX antenna

Visual alarms:

Two control LEDs are provided on the TFBW front side.
The green LED describes the power supply status, while the red LED describes the major booster failures.

TFBW LED panel

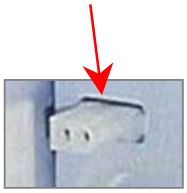


Led colour	*Meaning*
Red	DL amplifier failure
Green	Power supply status OK

Dry contact alarms:

TFBW is provided with a dry contact output, which can be connected to any of the dry contacts available on the remote unit. In such a way, the alarm information about this external device can be signalled through the red LED of remote unit.

dry contact



Dry contacts are open under non-alarm condition

Power supply:

TFBW WLAN booster can be powered by universal mains (85/265 Vac) or by negative supply (-72/-36 Vdc).
The power consumption of each TFWB module is 16W max.

Warnings

Choosing a proper installation site for the WLAN booster

- WLAN boosters are to be installed as close as possible to the radiating antennas, in order to minimize coaxial cable length.
- When positioning the TFBW booster, consider that the placing of the relating antennas should guaranteed an isolation between antennas of at least 50dB
- The TFBW booster is intended to be fixed on walls, false ceilings or other flat vertical surfaces

TFBW installation

The kit includes:

- 1 TFBW booster
- 2 50 Ω sma loads
- 2 RF jumpers
- 1 alarm cable

and according to the chosen model mains plug or -48 plug

To install the TFBW WLAN booster follow next steps:

1. drill into the wall so as to install four M4 screw anchors (not included) according to the dimensions indicated by the installation drawing in fig. 6.
2. fix the TFBW booster to the wall by firmly screwing the anchors.
3. connect RF cables according to what planned by designer. Use a specific torque wrench to fix each cable to relevant ports.
4. connect the TFBW to the power supply.

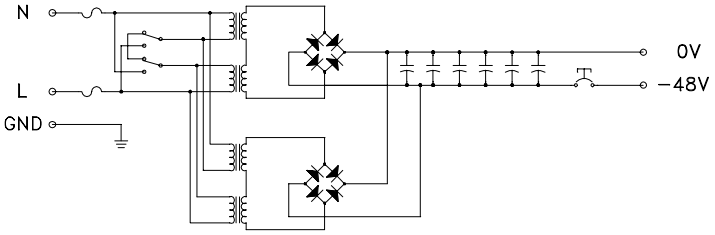
5.4. Remote power supply TRS/TRSN

Module name:
TRS/TRSN

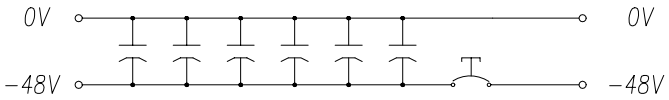
Description

TRS/TRSN provides centralised supply to all remote units through individual outputs with short circuit protection switches.
Main supply (230Vac or 115Vac) is converted into a -48Vdc.
TRS/TRSN supply unit has been designed to provide DC supply with standard AWG14/16 copper line to the remote units. Maximum allowed distance depends on copper section, remote unit current consumption and voltage range.
A passive option is available if -48Vdc is already provided.

Active distribution



Passive distribution



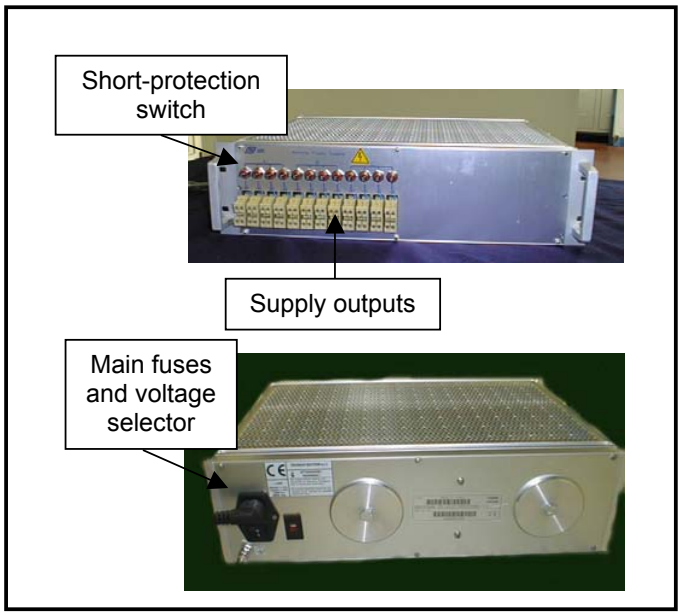
Ports

TRS version is applicable to all low power remote units and TFAN20. It is available with

- 24 supply outputs
- 12 supply outputs

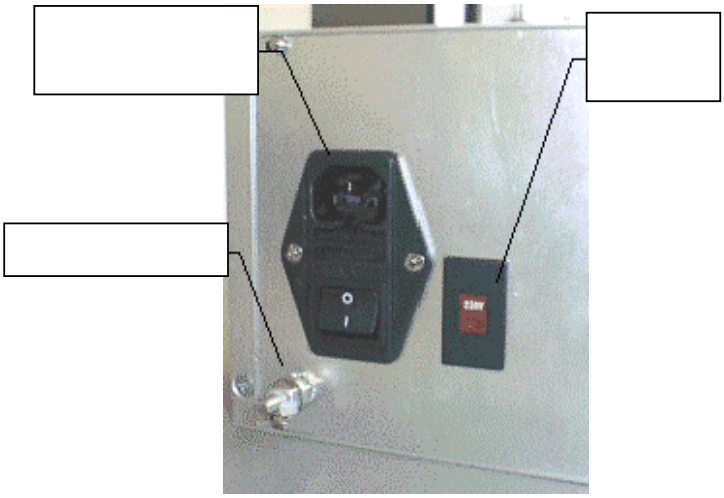
TRSN version is applicable to tri-band and medium power remote units. It is available with

- 12 supply outputs



Power supply:

Two types of mains (115/230VAC, 50/60Hz) can be applied to the TRS/TRSNx2 versions which have been designed for active distribution of nominal -48VDC. Mains connector and voltage selector are placed on the back panel.



A TRS/TRSNx1 passive version is available in which a direct current (–72 to –36 VDC) can be applied to the system. Power supply cabling is provided: the blue cable support –48 VDC, the black one 0 VDC.

Ground terminals are part of supply connectors. An external grounding terminal (screw) is also available.

Mains connector and switch houses also the fuses:

- 250V, 4A delayed type for the active version
- -48V, 15A delayed type for the passive version

Warnings

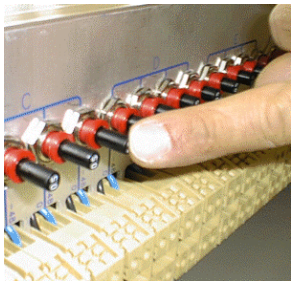
- Caution: do not open the unit before disconnecting the mains. Internal assemblies can be accessed by qualified personnel only
- Do not connect supply outputs to remote units before switching off the unit or disconnecting the mains
- Being a DC supply provided, a wrong connection can damage the remote unit. Verify the proper polarity before switching on the equipment.

TFBW installation

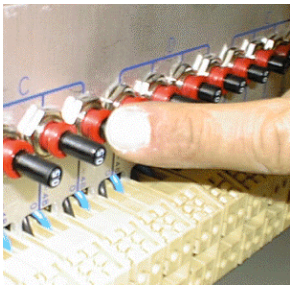
The TRS/TRSN subrack should be placed as near as possible to the TPRN to allow an easy cabling in case of mixed fibre-copper cables. If the subrack mounting location is not provided with a good air circulation, leave at least one unit free between subracks.
The kit includes a TRS/TRSN and a power cable.

1. Fix the TRS/TRSN subrack to the cabine with 4 screws
2. During the installation phase don't connect the power cable to the main power line and don't switch on the TRS/TRSN
3. Set the switch in accordance with your main power line (115 Vac or 230 Vac) for universal mains option. In case of negative supply option (-48 VDC), no switch is provided. Then connect the ground screw.
4. Before connecting the wires from TRS/TRSN to the remote units, open all the fuses pulling the red circle then connect electrical wires for the remote units
5. When all electrical wires have been connected and the system is ready to start, connect the power cable, switch on the TRS/TRSN. Push one fuse at a time.

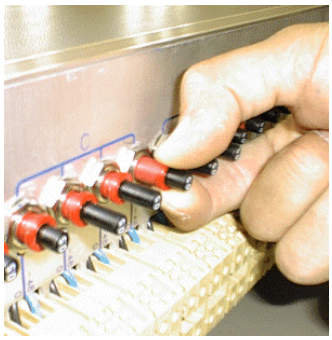
Each remote unit can be switched on-off by the relevant switch. The pictures below show how to do it.



OFF position



ON position: push down the black button



To switch off pull out the red collar.

If a surge or an overloading condition occurred the switch automatically jump into an OFF position.

TRS/TRSN startup

- Check that power supply voltage selector is in the correct position (115 or 230 VAC). In passive distribution version this selector is not present.
- Have all the switches in OFF position
- Check the connection polarity is not wrong
- Power on the TRS/TRSN unit through the back general switch
- Power on each remote unit through the front panel switches
- Check if the remote units shows the proper green supply led ON

TRS/TRSN Troubleshooting

If the remote unit doesn't appear to be properly supplied

- Check the fuses on the rear panel
- Check the voltage at the front panel screw connectors: nominal value without load is -59VDC, nominal value with full load is -48VDC. If Those values are exceeded by 10% check the if the mains are within the allowed limits. In passive distribution version, the output voltage depends on the supply source.
- Check the voltage at the remote side it should be in the range -36 to -72 VDC that is the maximum allowed range admitted by the remote units.

If the protection switch jump always in OFF position

- Check if any short on the line
- Check if the remote unit shows the nominal current power consumption.
- Check if any long period overshooting related to the mains supply.

If the fuses blow up after a power-on with all the front switches ON, there should be a too high initial peak current transient: check the proper fuse (delayed type) or substitute with an higher current fuse (i.e. 6A or 10 A). If the problem still persists check the proper ground /mains connection.