

R&S®TLx9

Transmitter System

System Manual



2506506002

For information only!

This manual, dated July 9, 2018 reflects the technical status as of that date. There may have been technical changes since that time.

This manual describes the following R&S®TLx9 models:

- R&S®TLx9 (2506.5001.10), 1HU, 15/10/5 W
- R&S®TLx9 (2506.5001.20), 2HU, 200/100/50/25 W

The software contained in this product uses several valuable open source software packages. For information, see the "Open Source Acknowledgment" on the user documentation CD-ROM (included in delivery).

Rohde & Schwarz would like to thank the open source community for their valuable contribution to embedded computing.

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2506.5060.02 | Version 03 | R&S®TLx9

The following abbreviations are used throughout this manual: R&S®TLx9 is abbreviated as R&S TLx9.

Quality management and environmental management

Certified Quality System
ISO 9001

Certified Environmental System
ISO 14001

Sehr geehrter Kunde,

Sie haben sich für den Kauf eines Rohde&Schwarz Produktes entschieden. Sie erhalten damit ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unserer Qualitäts- und Umweltmanagementsysteme entwickelt, gefertigt und geprüft. Rohde&Schwarz ist unter anderem nach den Managementsystemen ISO 9001 und ISO 14001 zertifiziert.

Der Umwelt verpflichtet

- Energie-effiziente, RoHS-konforme Produkte
- Kontinuierliche Weiterentwicklung nachhaltiger Umweltkonzepte
- ISO 14001-zertifiziertes Umweltmanagementsystem

Dear customer,

You have decided to buy a Rohde&Schwarz product. This product has been manufactured using the most advanced methods. It was developed, manufactured and tested in compliance with our quality management and environmental management systems. Rohde&Schwarz has been certified, for example, according to the ISO 9001 and ISO 14001 management systems.

Environmental commitment

- Energy-efficient products
- Continuous improvement in environmental sustainability
- ISO 14001-certified environmental management system

Cher client,

Vous avez choisi d'acheter un produit Rohde&Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests de ce produit ont été effectués selon nos systèmes de management de qualité et de management environnemental. La société Rohde&Schwarz a été homologuée, entre autres, conformément aux systèmes de management ISO 9001 et ISO 14001.

Engagement écologique

- Produits à efficience énergétique
- Amélioration continue de la durabilité environnementale
- Système de management environnemental certifié selon ISO 14001



Customer Support

Technical support – where and when you need it

For quick, expert help with any Rohde & Schwarz equipment, contact one of our Customer Support Centers. A team of highly qualified engineers provides telephone support and will work with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz equipment.

Up-to-date information and upgrades

To keep your instrument up-to-date and to be informed about new application notes related to your instrument, please send an e-mail to the Customer Support Center stating your instrument and your wish. We will take care that you will get the right information.

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ROHDE & SCHWARZ

DECLARATION OF CONFORMITY in accordance with the Directive 2014/53/EU (RE Directive) Annex IV, certified by the Notified Body CTC advanced GmbH Germany, Identif. No. 0682.



This is to certify under our sole responsibility that the radio equipment

Equipment Type	Stock No.	Designation
TLU9	2506.5001K02	Broadcast Transmitter
TLU9-System	2507.1000K02	Broadcast Transmitter

Equipment class: 2.10 (Broadcast transmitter)

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to Directive (EC) No. 2014/53/EU Article 3 and the other relevant provisions [RED]
- relating to restriction of the use of hazardous substances in electrical and electronic equipment (2011/65/EC) [RoHS]

when used for its intended purpose

- Health and safety requirements pursuant to § 3 (1) 1, (Article 3(1) a))
- Protection requirements concerning electromagnetic compatibility § 3(1)(2), (Article 3(1)(b))
- Measures for the efficient use of the radio frequency spectrum § 3 (2), (Article 3(2))
- Air interface of the radio systems pursuant to § 3(3), (Article 3(3))

Harmonized standards applied: ETSI EN 302296-2 V1.2.1

Other means of proving conformity with the essential requirements (standards/specifications used):
EN 60950-1: 2006 + A1:2010 + A12:2011
ETSI EN 301489-1 V1.9.2
ETSI EN 301489-14 V1.2.1
EN50581:2012 (ROHS)
Rec.1999/519/EG; 26. BImSchV
Reg TP SSB RU005

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Munich, 2017-09-05


Central Quality Management GF-QP / Kemmet

3615.2880.02 02.00 CE

EN

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1 Information about this Manual

This manual is part of the documentation for the R&S TLx9 transmitter family from Rohde & Schwarz. The individual manuals for the transmitter family have a modular structure and complement each other.

Structure

The system manual, which is the central and overarching part of the overall documentation, describes all the steps involved in installing a transmitter.

Operation of the transmitter system after installation and the steps required to put the system into operation are described in the Tx9 operating manual.

The TLx9 service manual describes all maintenance, troubleshooting and service tasks that customers can carry out themselves. At certain points in the transmitter manual, the reader is referred to the appropriate operating manual or service manual.

Contents

The manuals for the transmitter family describe all activities required for installation, startup, operation, maintenance, troubleshooting and servicing of the transmitter and its component parts. The appendix contains the interface descriptions and the technical documentation.

Safety

All skilled personnel working with a transmitter or its components have a duty to read the associated manuals and to follow the safety measures described in the section "Safety" and given at appropriate points in the manual. It must be ensured that the transmitter and the individual components of the transmitter are used only for their intended use. All activities connected with the transmitter or individual transmitter components must be carried out by skilled personnel. If activities require additional skills and qualifications, this is indicated at the appropriate points in the manual.

Symbols and notation

The "warning triangle" symbol refers the reader to potential hazards. The degree of danger is indicated by different signal words next to the warning symbol.

Instructions are given in numbered steps. All other formatting options are intended to improve clarity and are self-explanatory.

2 Safety Instructions

2.1 Safety Instructions for Transmitter Systems and Equipment

NOTICE**Compliance with safety regulations**

The safety regulations specified in this manual must always be complied with.

The following points require special attention:

- Only qualified technicians are allowed to install and wire the electrical equipment.
- National and international safety rules and regulations must be observed when equipping operating facilities and during the assembly and operation of electrical systems.
These include, for example:
 - Protective measures to prevent accidents
 - Protection against overvoltage
 - Isolation of electrical systems
 - Grounding of electrical systems
 - Physical properties and laying of electrical lines and cables
 - Regulations that apply to factories, work areas and special systems
- When installing transmitter racks, it is important to observe national accident prevention regulations, for example, with regard to:
 - Crushing hazard when working beneath suspended loads
 - Fall hazards when working on ladders
 - Risk of injury when lifting heavy loads
- Personal protective equipment (PPE) must be used when installation or repair work is being carried out. Depending on the type of work, it may be necessary to wear protective clothing such as hard hats, safety gloves, eye protection, etc.
- Instruments and systems must not be operated unless their cabinets are closed. Observe the appropriate safety instructions when opening cabinets for maintenance or repair work.
- Isolate all poles when disconnecting instruments and systems from the AC supply. In addition, disconnect all external sources of power, i.e. all measuring cables, extension cables and multipoint connectors (except for special service connectors). Then wait approx. 5 minutes to ensure that the capacitors in the system are sufficiently discharged.
- Additional information on liquid-cooled transmitters: When installing the cooling system and filling it with coolant (pump and heat exchanger), the applicable regula-

tions on working with hazardous products (coolant) must be observed; see the section "Material Safety Data Sheets" under "EC Safety Data Sheet – Antifrogen".

2.2 General Safety Instructions

This section contains general safety instructions applying to all products manufactured or sold by Rohde & Schwarz.

In line with IEC215 or EN60215, transmitter systems and their add-on equipment must be operated under the responsibility of qualified technicians only. The minimum requirements for qualified electricians are also defined in the standard "Safety requirements for radio transmitting equipment".

Compliance with all legal and regulatory requirements is a precondition for operating radio equipment and systems. The operator and/or the operator's authorized representative is responsible for ensuring compliance with these requirements. They must additionally ensure that the training of the operating personnel satisfies the specific requirements of the respective country. This includes any periodic training that is necessary.

2.2.1 Basic Safety Instructions

It is essential to read and observe the following instructions and safety information.

All plants and locations of the Rohde & Schwarz group of companies make every effort to keep the safety standards of our products up to date and to offer our customers the highest possible degree of safety. Our products and the auxiliary equipment that they require are manufactured and tested in line with the applicable safety standards. Compliance with these standards is continuously monitored by our Quality Assurance department. The product described here has been manufactured and tested in accordance with the enclosed EC Certificate of Conformity and left the manufacturer's plant in a condition fully complying with the relevant safety standards. To maintain this condition and to ensure safe operation, you must observe all information, warnings and instructions provided in this manual. Please do not hesitate to contact the Rohde & Schwarz group of companies if you have any queries regarding these safety instructions.

Furthermore, it is your responsibility to use the product in an appropriate manner. This product is designed for use solely in industrial and laboratory environments or, if expressly permitted, also in the field and must not be used in any way that may cause personal injury or property damage. You are responsible if the product is used for any purpose other than its designated purpose or in disregard of the manufacturer's instructions. The manufacturer shall not be liable for any consequences resulting from the product being used for purposes other than those for which it is intended.

The product is used for its designated purpose if it is used in accordance with its product documentation and within its performance limits (see data sheet, documentation and the following safety instructions). Using the product requires technical skills and a

basic knowledge of English. It must therefore be ensured that only skilled and specialized staff or thoroughly trained personnel with the required skills are allowed to use the product. If personal protective equipment is required for using Rohde & Schwarz products, this will be indicated at the appropriate place in the product documentation. Keep the basic safety instructions and the product documentation in a safe place and pass them on to other users of the product.

Observance of the safety instructions is intended to prevent injury or damage resulting from hazards of all types. To this end, persons who are to use the product must carefully read and fully understand the following safety instructions prior to and during use of the product. It is also essential to observe all other safety instructions (e.g. relating to personnel protection) which are given at appropriate points in the product documentation. In these safety instructions, the term "product" refers to all articles sold and distributed by the Rohde & Schwarz group of companies; these include instruments, systems and all accessory items.

Signal words and their meaning

The following signal words are used in the product documentation to warn of risks and hazards.

DANGER

indicates an immediate high-risk hazard which will result in death or serious injury if it is not avoided.

WARNING

indicates a potential medium-risk hazard which can result in death or (serious) injury if it is not avoided.

CAUTION

indicates a low-risk hazard which could result in minor or moderate injury if it is not avoided.

NOTICE

indicates possible incorrect operation which could result in damage to the product.

These signal words correspond to the standard definitions for civil applications in the European Economic Area. Definitions that deviate from the standard definition may also exist in other economic areas or military applications. It is therefore essential to make sure that the signal words described here are always used only in connection with the related product documentation and the related product. The use of signal

words in connection with unrelated products or documentation can result in misinterpretation and in personal injury or material damage.

Operating conditions, operating positions and operating locations

The product may be operated only under the operating conditions, in the operation positions and at the operating locations specified by the manufacturer, without the product's ventilation being obstructed. If the manufacturer's specifications are not observed, this can result in electric shock, fire and/or serious personal injury or death. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed.

1. Unless otherwise specified, the following requirements apply to Rohde & Schwarz products:
 - a) Operating position: housing base at bottom
 - b) IP degree of protection: 2X
 - c) Degree of fouling: 2
 - d) Overvoltage category: 2
 - e) For indoor use only
 - f) Operation up to 2000 m above sea level
 - g) Transport up to 4500 m above sea level
 - h) Tolerance for nominal voltage: $\pm 10\%$
 - i) Tolerance for nominal frequency: $\pm 5\%$
2. Do not place the product on surfaces, vehicles, shelves or tables that for reasons of weight or stability are unsuitable for this purpose. Always follow the manufacturer's installation instructions when installing the product and fastening it to objects or structures (e.g. walls and shelves). Installing the product in a manner that does not comply with the product documentation could result in personal injury or even death.
3. Do not place the product on heat-generating devices (e.g. radiators or fan heaters). The ambient temperature must not exceed the maximum temperature specified in the product documentation or in the data sheet. Product overheating can cause electric shock, fire and/or serious personal injury or even death.

Electrical safety

If the information on electrical safety is not observed either at all or to the extent necessary, electric shock, fire and/or serious personal injury or even death may occur.

1. Prior to switching on the product, always ensure that the nominal voltage set on the product matches the nominal voltage of the mains supply. If a different voltage is to be set, the mains fuse of the product may have to be changed accordingly.
2. In the case of products with degree of protection I with movable power feed line and connector, operation is permitted only at sockets with protective conductor contact and connected protective conductor.

3. Intentional interruption of the protective conductor either along the feed line or in the product itself is not permitted. Doing so can result in the danger of an electric shock from the product. If extension cables or multipoint connectors are used, they must be checked on a regular basis to ensure that they are safe to use.
4. If the product does not have a mains switch for disconnecting the product from the power supply, the plug attached to the connecting cable must be used as a disconnect device. In such cases, it must be ensured that the power plug is within easy reach and accessible at all times (length of connecting cable approx. 2 m). Functional switches or electronic switches are not suitable for disconnecting the product from the power supply. If products without mains switches are integrated in racks or systems, a disconnect device must be provided at the system level.
5. Never use the product if the power cable is damaged. Check the power cable on a regular basis to ensure that it is in proper operating condition. Take appropriate safety measures and lay the power cable carefully to ensure that the cable will not be damaged and that no one can be hurt by, for example, suffering an electric shock or tripping over the cable.
6. Operation is only permitted in TN/TT supply networks which are fuse-protected with max. 16 A (higher fuse ratings should only be used after consultation with the Rohde & Schwarz group of companies).
7. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and completely into the socket provided. Disregard of these points can lead to sparks, fire and/or injury.
8. Do not overload the sockets, extension cables or multipoint connectors as this can cause fire or electric shocks.
9. For measurements in electric circuits with voltages $V_{rms} > 30$ V, suitable measures (e.g. appropriate measuring equipment, fusing, current limiting, electrical separation, insulation) must be taken to avoid any hazards.
10. In the case of connections to IT equipment (e.g. PCs or industrial computers), it must be ensured that such connections satisfy the IEC60950-1/EN60950-1 or IEC61010-1/EN61010-1 standards that apply in each case.
11. Unless expressly permitted, never remove the cover or any part of the housing while the product is in operation. Doing so would expose electrical lines and components and could lead to injuries, fire or damage to the product.
12. If a product is to be permanently installed, the connection between the protective conductor terminal on site and the product's protective conductor must be made first before any other connection is made. The product may be installed and connected only by a qualified electrician.
13. For permanently installed equipment without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused in such a way that anyone who has access to the product, as well as the product itself, is adequately protected from injury or damage.

14. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a bolt of lightning) can reach the product. Otherwise the person operating the product will be exposed to the danger of an electric shock.
15. Do not insert foreign objects into the housing openings. Doing so can cause short circuits inside the product and/or electric shocks, fire or injuries.
16. Unless otherwise specified, products are not protected against the penetration of fluids; see also the section "Operating conditions, operating positions and operating locations", item 1. The instruments must therefore be protected against the penetration of fluids. Failure to observe this point may result in the user suffering an electric shock or the product being damaged, which in turn can endanger personnel.
17. Never use the product under conditions in which condensation has formed or can form in or on the product, e.g. if the product has been moved from a cold to a warm environment. Penetration by water increases the risk of electric shock.
18. Prior to cleaning the product, disconnect it completely from the power supply (e.g. mains or battery). Clean instruments using a damp, soft, lint-free paper towel or cotton cloth. Warm water or a mild cleaner (good results have been achieved using glass cleaner (Mat. No. 0041.5336.00)) is recommended as a cleaning agent. If any other cleaning agent is to be used, it must be checked beforehand whether the cleaning agent is compatible with the surface to be cleaned.

Operation

1. Operating the product requires special training and intense concentration. It must be ensured that persons who operate the product are fit to do so from a physical, intellectual and mental viewpoint, otherwise there is a risk of injury or damage. It is the responsibility of the employer/operator to select suitable personnel for operating the product.
2. Before moving or transporting the product, read and observe the information in the section "[Transport](#)" on page 16.
3. As with all industrially manufactured goods, it is not possible to completely rule out the use of materials which cause allergies, i.e. "allergens" (e.g. nickel). If, when using Rohde & Schwarz products, allergic reactions occur (e.g. skin rash, frequent sneezing, red eyes or respiratory problems), consult a doctor immediately in order to determine the cause and to prevent health problems.
4. Before mechanically and/or thermally processing or dismantling the product, it is essential to refer to the section "[Disposal](#)" on page 16, item 1.
5. Depending on the function, certain products such as RF radio systems can produce an elevated level of electromagnetic radiation. In order to protect unborn life, pregnant women must be protected by means of suitable measures. Electromagnetic radiation also poses a risk to persons with pacemakers. The employer/operator is obliged to assess and identify workplaces where there is a particular risk of exposure to radiation, and to take precautions to prevent potential hazards.

6. In the event of fire, toxic substances (gases, fluids, etc.) can be discharged from the product and damage the health of personnel. If a fire occurs, appropriate measures must therefore be taken (e.g. breathing masks and protective clothing).
7. If a laser product is integrated in a Rohde & Schwarz product (e.g. CD/DVD drive), no settings or functions other than those described in the product documentation should be used in order to prevent injury (e.g. from the laser beam).

Repair and service

1. The product may be opened only by authorized, specially trained personnel. Before any work is performed on the product or before the product is opened, it must be disconnected from the supply voltage, otherwise there is a risk of electric shock.
2. Any adjustments, part replacements, maintenance or repairs may be performed only by authorized Rohde & Schwarz electricians. Only original parts may be used for replacing safety-relevant parts (e.g. mains switches, power transformers, fuses). A safety check must be performed after safety-relevant parts have been replaced (visual inspection, protective conductor test, insulation resistance measurement, leaking current measurement, functional test). This ensures that the product remains safe to use.

Batteries and accumulators/cells

If the instructions regarding batteries and accumulators/cells are not observed either at all or to the extent necessary, product users may be exposed to the risk of explosions, fire and/or serious personal injury and even death. Batteries and accumulators with alkaline electrolytes (e.g. lithium cells) must be handled in line with EN 62133.

1. Cells must not be disassembled, opened or crushed.
2. Cells and batteries must not be exposed to heat or fire. Storage in direct sunlight must be avoided. Keep cells and batteries clean and dry. Clean soiled terminals using a dry, clean cloth.
3. Cells and batteries must not be short-circuited. Cells or batteries must not be stored in a box or in a drawer where they can short-circuit each other, or where they can be short-circuited by other conductive materials. A cell or battery should only be taken out of its original packaging when it is to be used.
4. Keep cells and batteries out of the reach of children. If a cell or battery has been swallowed, seek medical assistance immediately.
5. Cells and batteries must not be subjected to severe mechanical jolts or impacts.
6. If a cell develops a leak, the fluid must not come into contact with the skin or eyes. If contact occurs, wash the affected area with plenty of water and seek medical assistance.
7. There is a risk of explosion if cells or batteries containing alkaline electrolyte (e.g. lithium cells) are replaced or charged incorrectly. To ensure that the product

remains safe to use, always replace cells or batteries with the appropriate Rohde & Schwarz type (see the replacement parts list).

8. Cells and batteries must be recycled and kept separate from residual waste. Accumulators and batteries that contain lead, mercury or cadmium must be disposed of as hazardous waste. Observe the national regulations regarding waste disposal and recycling.

Transport

1. The product may be extremely heavy. Therefore, the product must be handled with care. In some cases, the user may require a suitable means of lifting or moving the product (e.g. with a lift truck) to avoid back or other physical injuries.
2. Handles on the products are designed exclusively to enable personnel to transport the product. The handles are not to be used for securing the product to or on transport equipment (e.g. cranes, forklift trucks, carts, etc.). It is your responsibility to ensure that the products are attached securely to or on suitable transport or lifting equipment. Observe the safety regulations from the manufacturer of the used transport or lifting equipment in order to prevent injury to personnel and damage to the product.
3. If you use the product in a vehicle, it is the responsibility of the driver to drive the vehicle in a safe and appropriate manner. The manufacturer shall not accept liability for accidents or collisions. Never use the product in a moving vehicle if there is a risk that this could distract the vehicle driver. Make sure that the product is adequately secured in order to prevent injury or other damage in the event of an accident.

Disposal

1. If products or their components are processed mechanically and/or thermally beyond the scope of the operating conditions for which they were intended, hazardous materials (dust containing heavy metals such as lead, beryllium, nickel) can be released. For this reason, the product may only be disassembled by specially trained personnel. Improper disassembly may be hazardous to your health. National waste disposal regulations must be observed.
2. If, when handling the product, hazardous materials or operating fluids are encountered which must be disposed of separately (e.g. coolant or engine oils that have to be changed at regular intervals), the safety instructions from the manufacturer of these hazardous materials and operating fluids, and the applicable local disposal regulations must be observed. Also observe any additional relevant safety instructions in the product documentation. Incorrect disposal of hazardous materials or operating fluids can result in damage to health and the environment.

2.3 Special Hazard Information

2.3.1 Hazards from AC Supply Voltage

All voltages of $U_{rms} > 30 \text{ V AC}$ or $U > 60 \text{ V DC}$ must be regarded as constituting a shock hazard. When working with voltages that constitute a shock hazard, appropriate measures must be taken to prevent exposure to danger. Never work on live components. Work on live parts should only be performed in exceptional cases and only if special safety precautions are taken.

2.3.1.1 AC Power Supply

- Before connecting the AC power supply, it is important to ensure that the power supply specifications given for the system or instruments match the nominal specifications for the local power supply network. The power supply circuit must be protected by means of fuses in order to prevent overloads and short circuits.
- Miniature modules have neutral conductor fuses. As a result, the power supply may still be connected even after interruption of the circuit by a fuse.

2.3.1.2 Changing Fuses

- Fuses which are accessible to the operator should only be changed after the instruments have been disconnected from the power supply. They must always be replaced with fuses that have the same electrical rating, tripping characteristics and breaking capacity.
- Motor protection switches and automatic line fuses in those parts of a transmitter system that can be accessed by users must be tripped. If their response range is adjustable, the ex-factory setting must not be altered. If settings are changed inadvertently, the correct values specified in this documentation must be set.

2.3.2 Hazards from High-Energy Electric Circuits

The instruments contain low-voltage circuits that can be fed from a voltage source with an extremely low impedance (e.g. amplifier operating voltage). These circuits carry dangerously high levels of energy. At Rohde & Schwarz, we treat these circuits in the same way as circuits with hazardous contact voltages. Normally, these circuits are protected by covers to prevent unintentional contact. The cover has a warning label.

In practice it has been repeatedly shown that short circuits caused by small metallic tools result in severe burns. For safety reasons, any high-energy electric circuits in areas of the equipment that can be accessed by users are concealed by protective covers.

- Exercise the same amount of caution for measurements on low-impedance voltages (e.g. for repair purposes) that you would when performing measurements on operating voltages which constitute a shock hazard.

Wear suitable protective gear when necessary.

- Before opening any equipment or removing a particular cover, turn off the power supply and wait 5 minutes to ensure that capacitors have discharged sufficiently.
- Do not discharge capacitors by short-circuiting them.

2.3.3 Hazards from RF Radiation

2.3.3.1 Obligation to Instruct Personnel

- The operator must train all personnel in the operation of this transmitter or instrument in line with EN60215 and/or IEC215. It is essential that these regular training sessions emphasize the dangers related to high frequency that exist at the respective transmitter or instrument. Operating personnel are only authorized to adjust and operate the equipment after they have completed the respective training sessions and their participation has been documented.

High-energy RF circuits inside the transmitter or instrument are routed via conventional removable RF connectors (e.g. type N). Depending on the output power, the output ports of the transmitter and instrument are equipped with screw-type or plug-in RF lines or ducts.

If RF lines or modules carry high power, the connection point or the entire module is tagged with the general danger warning label (yellow triangle with a black exclamation mark).

2.3.3.2 RF Shielding

Transmitters and instruments from Rohde & Schwarz are shielded so that even in the immediate vicinity there is no danger from RF radiation when all RF lines are connected. This applies to statutory provisions in Germany, i.e. the regulation concerning electromagnetic fields:

Limits for electrical and magnetic field strengths of high-frequency installations are defined in the 26th ordinance of the German Federal Government's Emission Control Act of December 16, 1996 (26. BImSchV).

2.3.3.3 Rules When Operating an Amplifier

Disconnecting RF lines that are in operation can result in arcs. These can cause burns and eye injuries.

- Operation of the amplifier is only permitted if a main or dummy antenna is connected
- Never disconnect RF lines when the amplifier is in operation
- Never open the amplifier or modules when the amplifier is in operation
- Never operate the amplifier if RF lines are exposed

2.3.3.4 Rules When Working on an Open Amplifier

Operation with RF power is not permitted if the instrument has been opened or covers have been removed.

3 Transmitter System R&S TLx9

3.1 Design and Function – R&S TLx9

The TV transmitters of the TLx9 transmitter family cover the range between 470 MHz and 790 MHz (UHF band IV/V) and support the digital standards DVB-T, DVB-T2 and ISDB-T_(B). With the retransmitter option it is going to support DVB-T/T2 only. Analog TV standards are not supported.

The TLx9 series follows the concept of one product for all scenarios. The TLx9-platform is able to address the applications digital TV transmitter, digital radio transmitter for band III and GapFiller for many digital standards.

Regarding firmware and software, the TLx9 will apply the Tx9 platform which allows having a common software and firmware framework for all transmitter systems being part of the Tx9 generation.

Product features:

- Compliance with the digital modulation standards DVB-T, DVB-T2 (full R&S DVB-T2 feature set), ISDB-T_(B), ATSC and DTMB
- Output power level per transmitter 5 W up to 15 W in a 19" x 1 HU housing for UHF (before Bandpass filter)
- Output power level per transmitter 25 W up to 200 W in a 19" x 2 HU housing for UHF (before Bandpass filter)
- Equipped with adaptive non-linear pre-distortion and automatic linear pre-distortion
- Fully integrated redundancy components (ASI distribution, LAN switch board) for B transmitter
- For standard configurations there is no need to do customer specific adaptations in the factory
- State of the art GUI
- Cooling optimized for rack mounting (front – back)
- Highly flexible system configuration. One product for any application:
 - Transmitter
 - Retransmitter
 - Ready for GapFiller
- Optional fully integrated control for redundancy components (N+1, 1+1)
- Flexible configuration of redundancy systems:
 - Configuration as a N+1-system with $N \leq 8$
 - Operation of redundant (B-)transmitter in mixed configurations, e.g. DVB-T and DVB-T2
 - Support of a Backup TX system (1+1, no external Redundancy Control Board necessary)

- Common Remote Management over Web-Interface and SNMP. All transmitters of one redundancy system are:
 - visible over the management interfaces as one system
 - able to be controlled, monitored and managed by the operator of the TLx9 as one system
- Optionally integrated GPS receiver (fitting variant of the Exciter / GapFiller board)
- Optionally integrated OCXO to provide hold over mode stability in SFN networks for 24 h in case GPS or external 1 PPS signal fails (fitting variant of the Exciter / GapFiller board)
- For transmitter a transport stream feeding over ASI, IP over Gigabit Ethernet or satellite receiver is possible
- DVB-T/T2 receiver for retransmission or monitoring application to be optionally integrated into the TLx9 system
- DVB-S/S2 receiver module (with on-board CAM module and BTS recovery functionality) to be optionally integrated into the TLx9 system

3.1.1 Rack Design

The TLx9 is an all-in-one solution which means a complete transmitter system is integrated in a 19" x 1 or 2 HU housing (depending on the type) and minimal depth of maximum 600 mm in the power class of 5 W to 200 W.



Figure 3-1: TLx9 front view (1 HU)



Figure 3-2: TLx9 front view without air filter (2 HU)

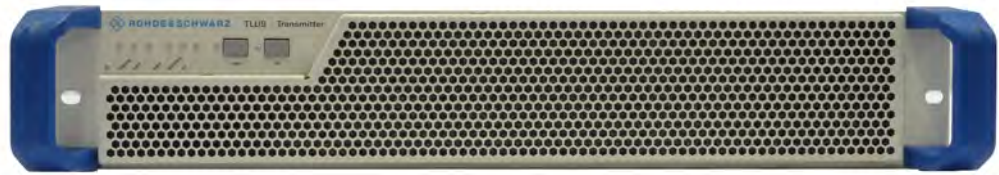


Figure 3-3: TLx9 front view with air filter (2 HU)

It allows inserting up to two hardware option modules (Re-TX, Sat RX, 1+1 control option etc.) to adjust the configuration for several different scenarios.



Figure 3-4: TLx9 back view, no options mounted (2 HU)

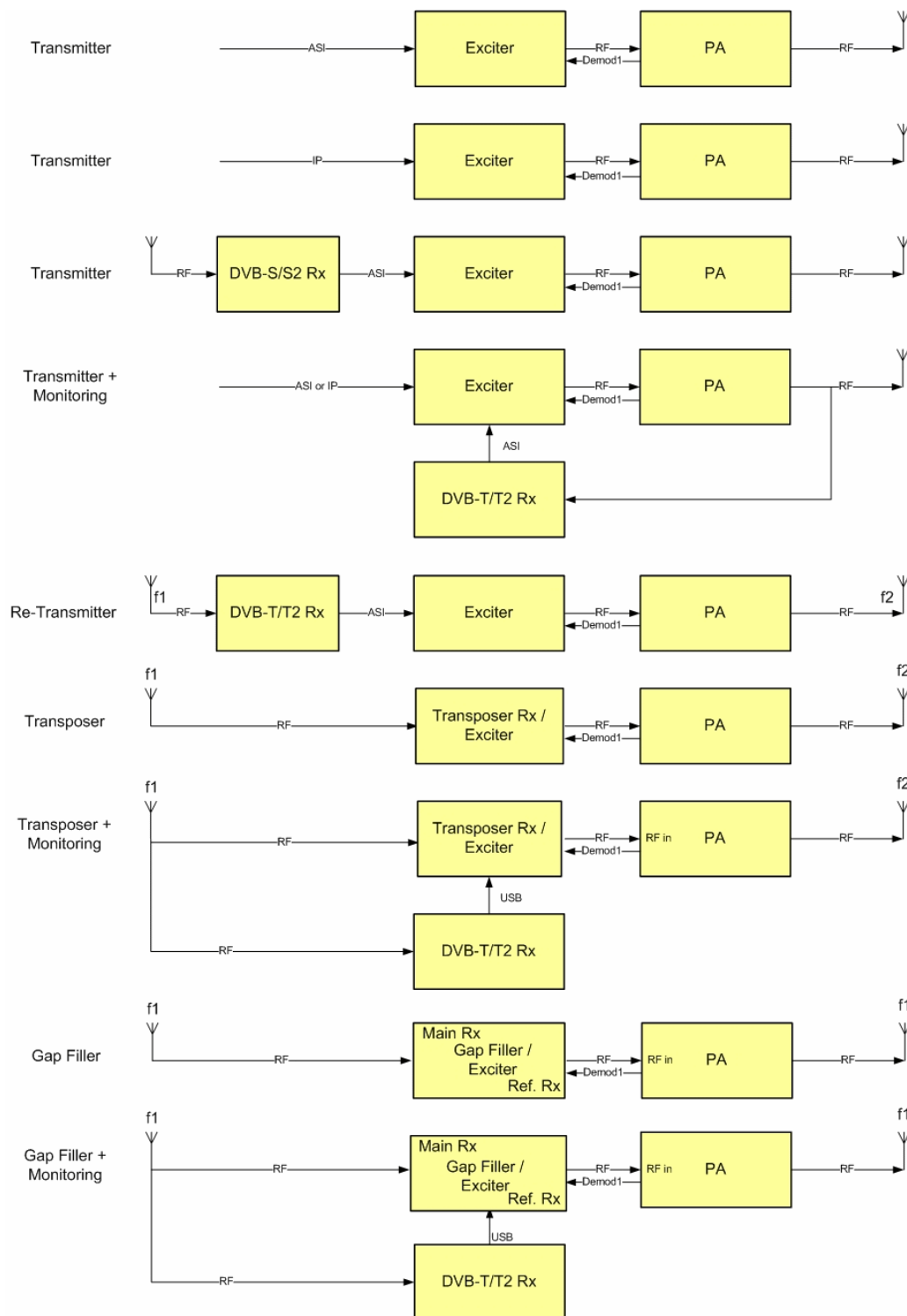
1 = Option slot A
2 = Option slot B



Figure 3-5: TLx9 back view with mounted option (2 HU)

3.1.2 TLx9 system applications

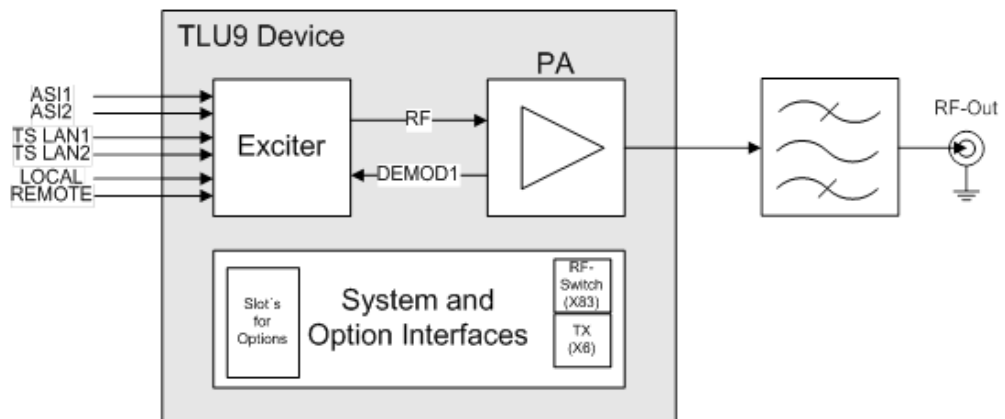
The logical units are arranged according to the following rules:



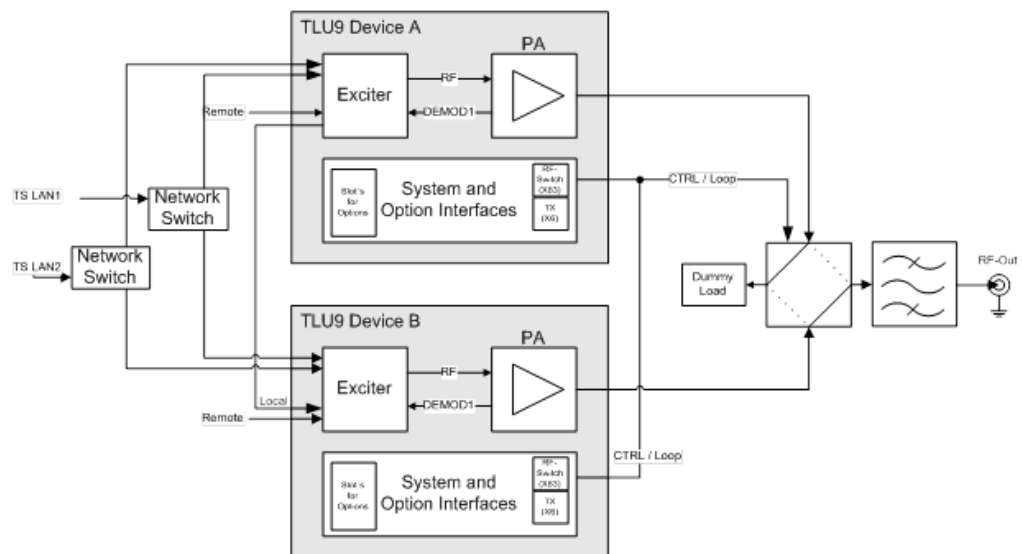
3.1.3 TLx9 redundancy systems

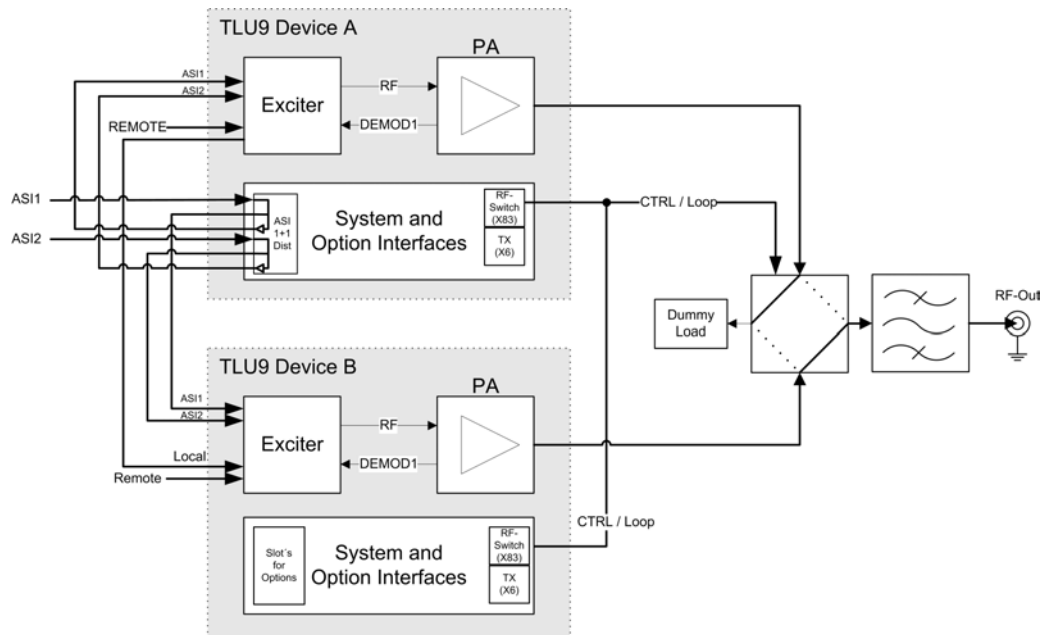
The TLx9 will support a maximum of up to 8 active transmitters in an N+1 system (8+1). For system configurations (e.g. N+1) no additional external control devices are necessary. The complete system control is placed inside the reserve B-Transmitter.

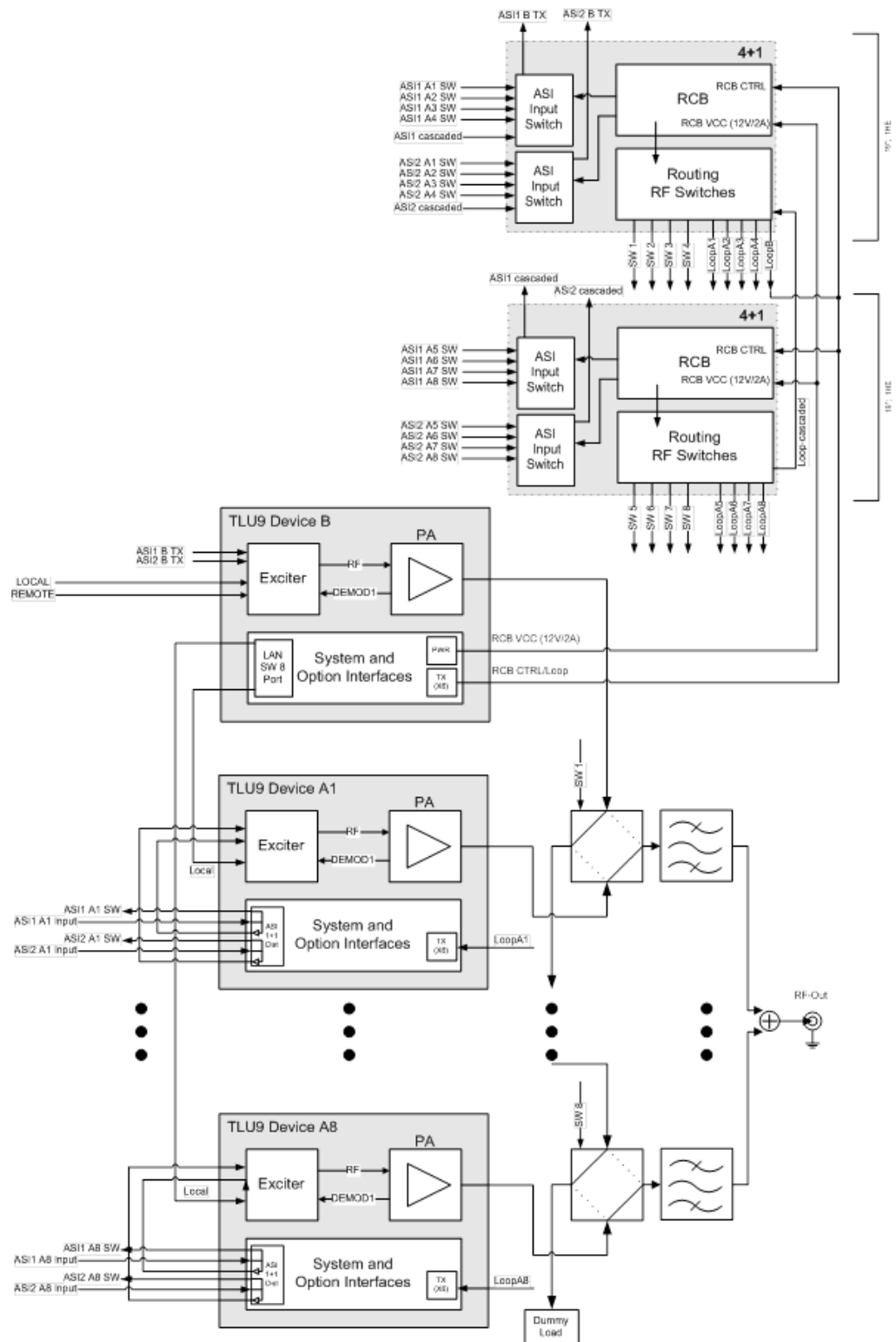
Single TX configuration:

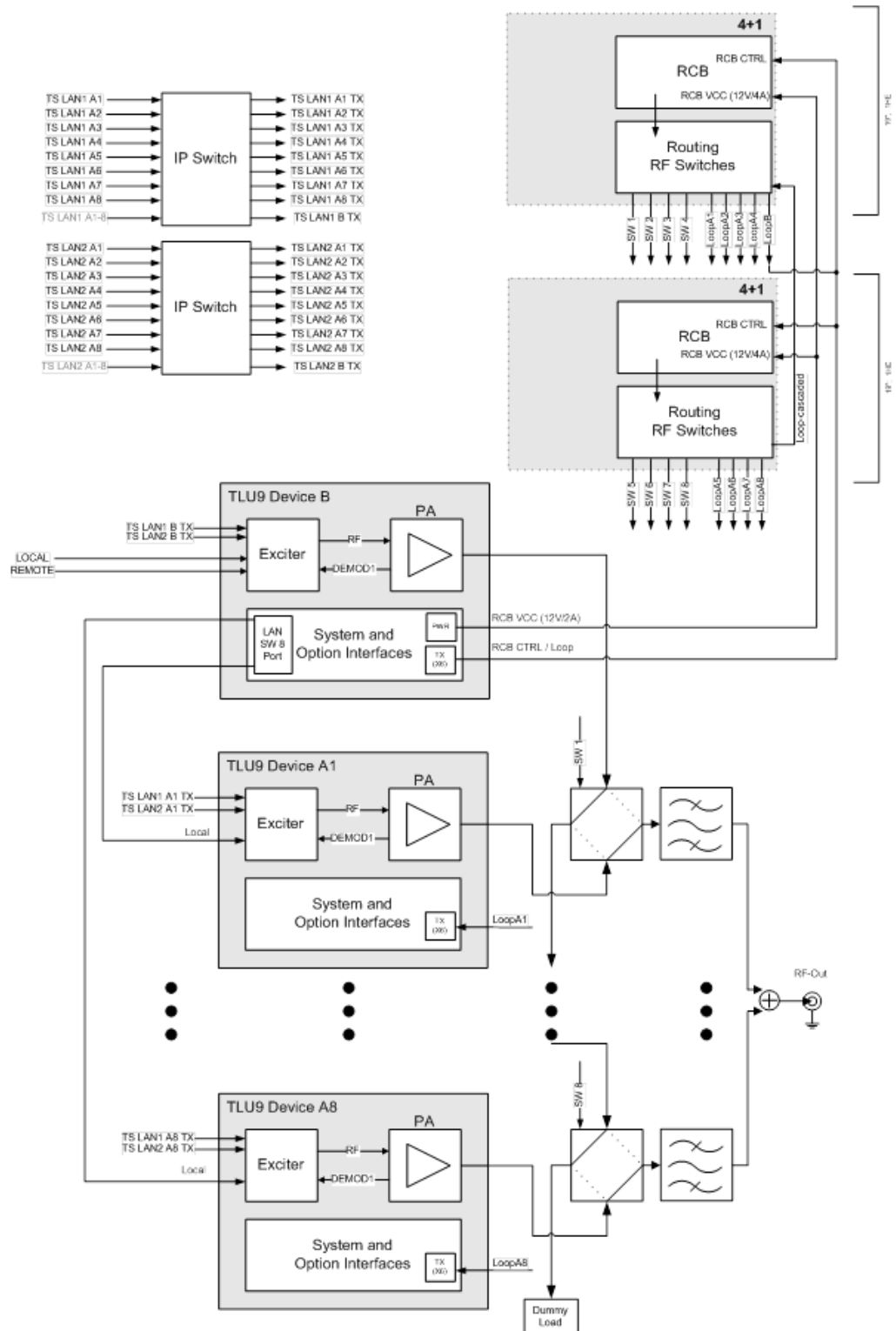


Backup TX with LAN feeding:



Backup TX wit ASI feeding:

N+1 with ASI feeding (max. 8+1):

N+1 with LAN feeding (max. 8+1):

3.1.4 Modules and devices

3.1.4.1 Overview

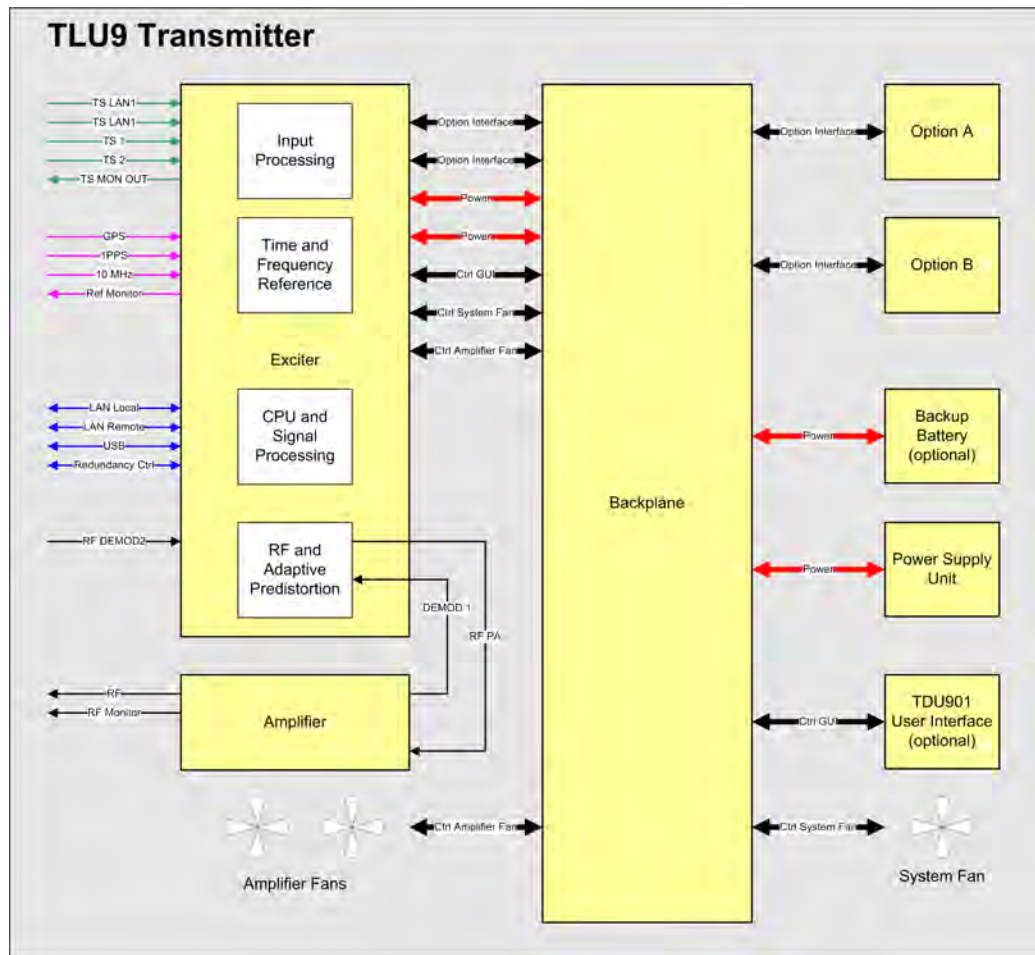


Figure 3-6: Block diagram

3.1.4.2 Inside View (1HU)

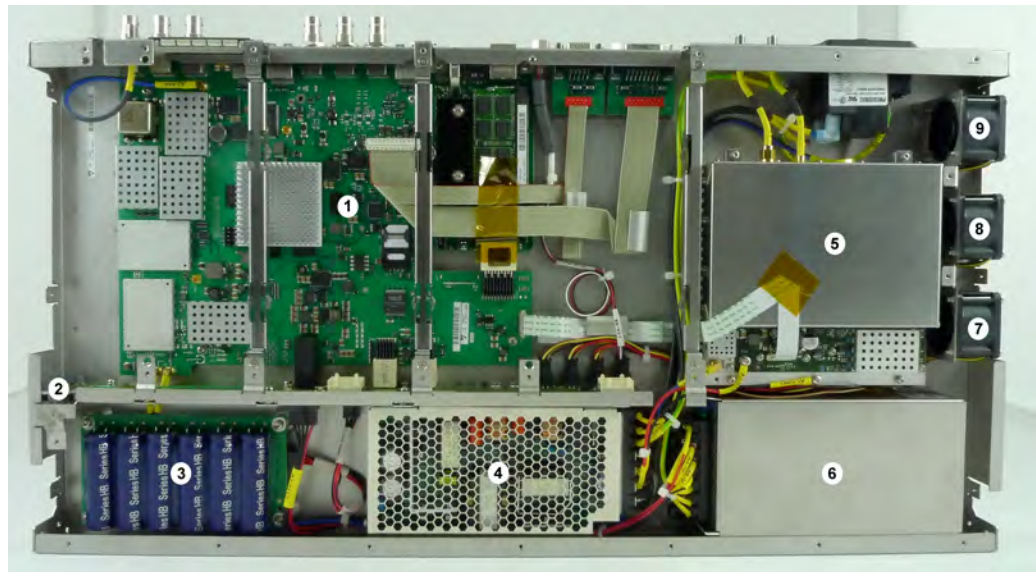


Figure 3-7: Inside View (1HU)

- 1 = Exciter / GapFiller board
- 2 = Backplane
- 3 = Capacitor backup battery
- 4 = System power supply
- 5 = Power Amplifier module
- 6 = Power Amplifier power supply
- 7 = Fan E1
- 8 = Fan E2
- 9 = Fan E3

3.1.4.3 Replaceable Modules (1HU)

Module	Comment	Ref. des.	Part number
EMI Filter D-SUB 9/15 Pole	Filter Circuit Boards		2507.2264.02
TDK Lambda HWS150A-12	12 V system power supply	A4	2506.7604.00
TDK Lambda HWS100A-24/A	PSU 108 W power supply	A9	3592.0364.00
Capacitor Backup Battery	TLx9-B69	A10	2506.8698.02
4GByte Micro SD card	for initial installation of TLx9 Exciter / GapFiller software a device test system (2509.4812.10) is needed		2507.3054.00
Chip Card	via chip card service kit		1201.5610.23
1+1 ASI Distribution Board	TLx9-B60 (Option slot A/B)		2506.8600.02
DVB-T / T2 Receiver	TLx9-B61 (Option slot A/B)		2506.8617.02
DVB-S / S2 Receiver	TCE900-M10 (Option slot A/B)		2109.3193.02

Module	Comment	Ref. des.	Part number
Mini LAN Switch Board	TLx9-M6 (Option slot B)		2109.2380.03
LAN Switch Board	TCE900-M6 (Option slot B)		2109.2897.02
1+1 RF Switch Board	TLx9-B59 (Option slot A/B)		2506.8598.02
PA / System Fan	Fan 1 / 2 / 3 12 V 40X40X28 LC	E1 E2 E3	3622.9805.00
Lithium battery	CR 2032		0858.2049.00
Fuse	10 A	F1, F2	0606.3136.00
Mains filter	5/15 W	X1	1201.8184.00
Air Filter Mat 1 HU			2506.4205.00
DX 12 V Ext. Cable	Terminal Supply	W17	2506.7056.00
X60 RF Cable RF OUT	RF output	W60	2506.7410.00
X61 RF Cable RF MON	RF monitor output	W13	2506.7391.00
X66 GPS ANT Cable	GPS antenna input	W66	2506.7491.00
Insulation Film	Insulation film for cover power supply		2509.4293.00
Cover Power Supply complet	Cover with insulation film		2509.4529.00

3.1.4.4 Inside View (2HU)



Figure 3-8: Inside View, example 200 W (2HU)

- 1 = Fan E2
- 2 = Fan E1
- 3 = Fan E3
- 4 = Capacitor backup battery
- 5 = System power supply
- 6 = Power Amplifier power supply
- 7 = Backplane
- 8 = Power Amplifier module
- 9 = Exciter / GapFiller board

3.1.4.5 Replaceable Modules (2HU)

Module	Comment	Ref. des.	Part number
EMI Filter D-SUB 9/15 Pole	Filter Circuit Boards		2507.2264.02
TDK Lambda HWS150A-12	12 V system power supply	A4	2506.7604.00
TSP901	Transmitter Status Panel	A5	2507.2935.02
TDK Lambda HFE1600-48	200 W PA related power supply	A6	3589.9506.00
TDK Lambda GWS500-36	100 W PA related power supply	A8	2506.7804.00
Emerson/Artesyn LCM300Q-T 24 V / 300 W	25 W and 50 W PA related power supply	A9	2506.7704.00
Capacitor Backup Battery	TLx9-B69	A10	2506.8698.02
4GByte Micro SD card	for initial installation of TLx9 Exciter / GappFiller software a device test system (2509.4812.10) is needed		2507.3054.00
Chip Card	via chip card service kit		1201.5610.23
1+1 ASI Distribution Board	TLx9-B60 (Option slot A/B)		2506.8600.02
DVB-T / T2 Receiver	TLx9-B61 (Option slot A/B)		2506.8617.02
DVB-S / S2 Receiver	TCE900-M10 (Option slot A/B)		2109.3193.02
Mini LAN Switch Board	TLx9-M6 (Option slot A)		2109.2380.03
LAN Switch Board	TCE900-M6 (Option slot A)		2109.2897.02
1+1 RF Switch Board	TLx9-B59 (Option slot A/B)		2506.8598.02
LAN Local Backup TX	TLx9-B58 (Option slot A)		2506.8581.02
PA Fan	Fan 1 (25 W and 50 W)	E1	3593.0951.00
PA Fan	Fan 1 (100/200 W)	E1	3593.0945.00
PA Fan	Fan 2 (200 W)	E2	3593.0945.00
System Fan	Fan 3 (25/50/100/200 W)	E3	3593.0945.00
Lithium battery	CR 2032		0858.2049.00
Fuse	10 A	F1, F2	0606.3136.00
Mains Filter	25/50/100 W	X1	1201.8184.00
Mains Filter	200 W	X1	3622.7631.00
Air Filter Mat 2 HU			2506.6143.00
Fan Sealing Pad			2506.6243.00
X66 GPS ANT Cable	GPS antenna input	W66	2506.7210.00

3.1.4.6 Option Keys

Option	Part number	Comment
Service-K0		Service Key
TLX9-FACTORY		TLx9-Factory
TIME-CONTROL		Reset time monitoring data
K00		TLx9K0 Demo key
TLX9-K02	2506.9020.02	Option key SNMP
TLX9-K06	2506.9065.02	Option key DTMB (Transmitter only)
TLX9-K08	2506.9088.02	Option key ISDB-T(B) (Transmitter only)
TLX9-K12	2506.9120.02	Option key DVB-T (Transmitter only)
TLX9-K25	2506.9259.02	Option key DVB-T2 RF MONITORING
TLX9-K31	2506.9313.02	Option key TS OVER IP (Transmitter only)
TLX9-K35	2506.9359.02	Option key MPLP (Transmitter only)
TLX9-K37	2506.9371.02	Option key GPS (Transmitter only)
TLX9-K41	2506.9213.02	Option key ATSC (Transmitter only)
TLX9-K43	2506.9436.02	Option key SIGNAL ANALYSIS (Transmitter only)
TLX9-K44	2506.9442.02	Option key DVB-T2 (Transmitter only)
TLX9-K47	2506.9471.02	Option key DVB-T2 MISO (Transmitter only)
TLX9-K49	2506.9494.02	Option key DVB-T2 LITE (Transmitter only)
TLX9-K50	2506.9507.02	Option key DVB-T2 TONE RESERVATION (Transmitter only)
TLX9-K55	2506.9559.02	Option key DVB-S/S2 RX IP OUTPUT (Transmitter only)
TLX9-K56	2506.9565.02	Option key DVB-S/S2 RX DECRYPTION (Transmitter only)
TLX9-K59	2506.9594.02	Option key NIT RESTAMPING (Transmitter only)
TLX9-K60	2506.9607.02	Option key BTS DECOMPRESSION (Transmitter only)
TLX9-K62	2506.9620.02	Option key WINDOW SIZE 14US (GapFiller only)
TLX9-K63	2506.9636.02	Option key WINDOW SIZE 17US (GapFiller only)
TLX9-K64	2506.9642.02	Option key R&S SMART EC (GapFiller only)
TLX9-K65	2506.9659.02	Option key HTML5 GUI
TLX9-K71	2506.9713.02	Option key REDUNDANT FEEDING (Transmitter only)
TLX9-K73	2506.9736.02	Option key GLONASS (Transmitter only)
TLX9-K74	2506.9742.02	Option key DVB-S/S2 Multistream (Transmitter only)

Option	Part number	Comment
TLX9-K80	2506.9807.02	Option key SYSTEM CONTROL
TLX9-K83	2506.9836.02	Option key 10 W
TLX9-K84	2506.9842.02	Option key 15 W
TLX9-K85	2506.9859.02	Option key 50 W

3.1.4.7 Material Number Assignment

Material No. of article	Name	Comment	Corresponding Board Material No. in SW
2506.5001K02	TLX9	TLx9 System KMAT (Transmitter)	2506.5001.02
2506.5001K03	TLX9-GF	TLx9 System KMAT (GapFiller)	2506.5001.02
		Keycard	2506.9907.02
2506.8023.02	TLX9-B02	Advanced Transmitter Exciter Board	2506.8023.02
2506.8023.02	TLX9-B02	Advanced Transmitter Exciter Board	2507.2229.05
2506.8030.06	TLX9-B03	GapFiller Board 6 MHz	2507.2006.03
2506.8030.08	TLX9-B03	GapFiller Board 8 MHz	2507.2006.02
2506.5001.10	In TLX9 1HE	5/10/15 W Amplifier	2507.2629.02
2506.5001.30	In TLX9-GF 1HE	5/10/15 W Amplifier	2507.2629.02
2506.8223.02	TLX9-B22	Air Filter 2 HU *	
2506.8423.02	TLX9-B42	25 W Amplifier	2507.2729.02
2506.8430.02	TLX9-B43	50 W Amplifier	2507.2729.02
2506.8446.02	TLX9-B44	100 W Amplifier	2507.2829.02
2506.8452.02	TLX9-B45	200 W Amplifier	2507.2829.02
2109.2380.03	TLX9-M6	Mini LAN Switch, Variant for TLx9 with mechanical components	2509.4735.02
2109.2897.02	TCE900-M6	LAN Switch (big version)	2109.2900.02
2506.8581.02	TLX9-B58	Local LAN2 Board Backup TX (only 2HU devices)	No EEPROM
2506.8598.02	TLX9-B59	1+1 RF Switch Board	2507.2135.02
2109.3193.02	TCE900-M10	DVB-S/S2 Receiver (Transmitter only)	5303.7500.02
2506.8600.02	TLX9-B60	1+1 ASI Distribution card	2507.2429.02
2506.8617.02	TLX9-B61	DVB-T/T2 Receiver	2113.9986.02
2506.8698.02	TLX9-B69	Exciter Backup Battery	
2506.5101.04		TLX9 CD-ROM Doku	

* The air filter for 1 HU TLU9 is directly installed at the device frame.

3.1.4.8 Option Boards

The following table shows all possible combinations for the plug-in of option boards:

Device	Option A	Option B
DVB-T/T2 RX	Yes	Yes
DVB-S/S2 RX	Yes	Yes
ASI Distribution 1+1	Yes	Yes
Antenna Switch	Yes	Yes
LAN Switch (1HU) *	No	Yes
LAN Switch (2HU) *	Yes	No

* Wide (200 x 150 mm) and small (200 x 90 mm) options can be mounted.



Figure 3-9: Option board positions in 1 HU device

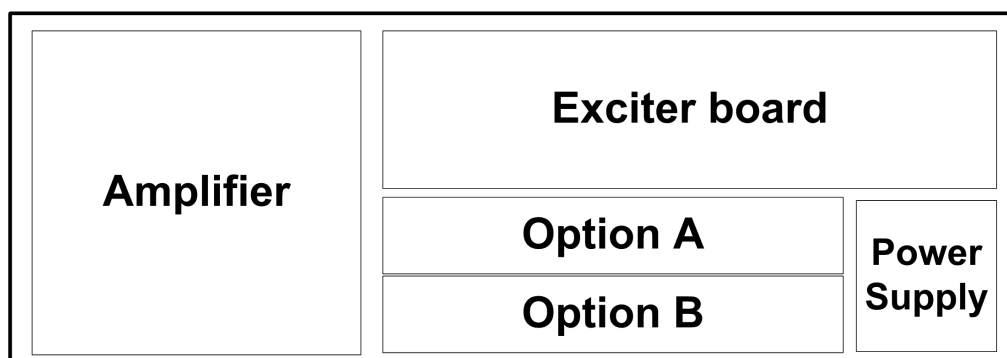


Figure 3-10: Option board positions in 2 HU device

3.1.4.9 Backplane

This module is the base for the inter-board communication.

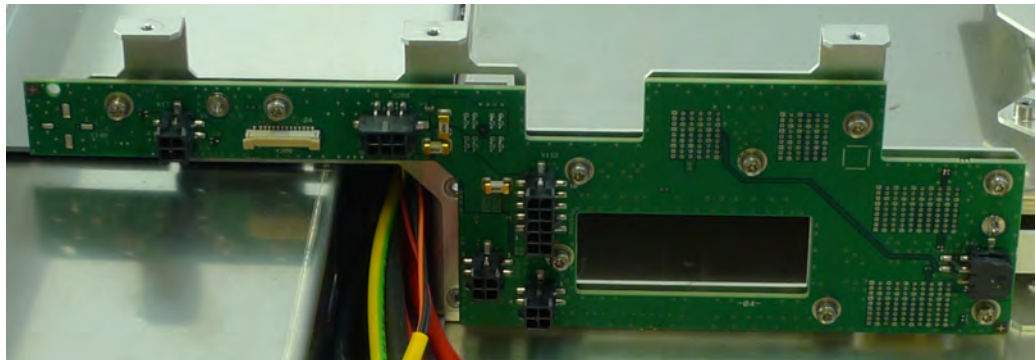


Figure 3-11: Backplane, example 2HU

3.1.4.10 Exciter Board

This board provides the TLx9 Exciter functions, depending on the HW fitting variant:

- External (customer) interfaces
- Video input signal handling
- Channel coding
- Generation of modulated OFDM signal
- RF signal generation.
- Reference and sync input signal handling
- Regulation of PA output power
- Digital linear precorrection and non-linear PA precorrection
- Control of power supplies
- Control of redundancy switching
- Different HW fitting variants:
 - Advanced (2 x ASI input, 2 x TSolP input, GPS and OCXO reference oscillator)
 - GapFiller (1 x RF input and OCXO reference oscillator)
- TCE901 (GPS and OCXO, dual inputs, TS monitoring, local LAN2, measurement couplers, RF mon, PCIe SW, COFDM out, +13 dBm amp)

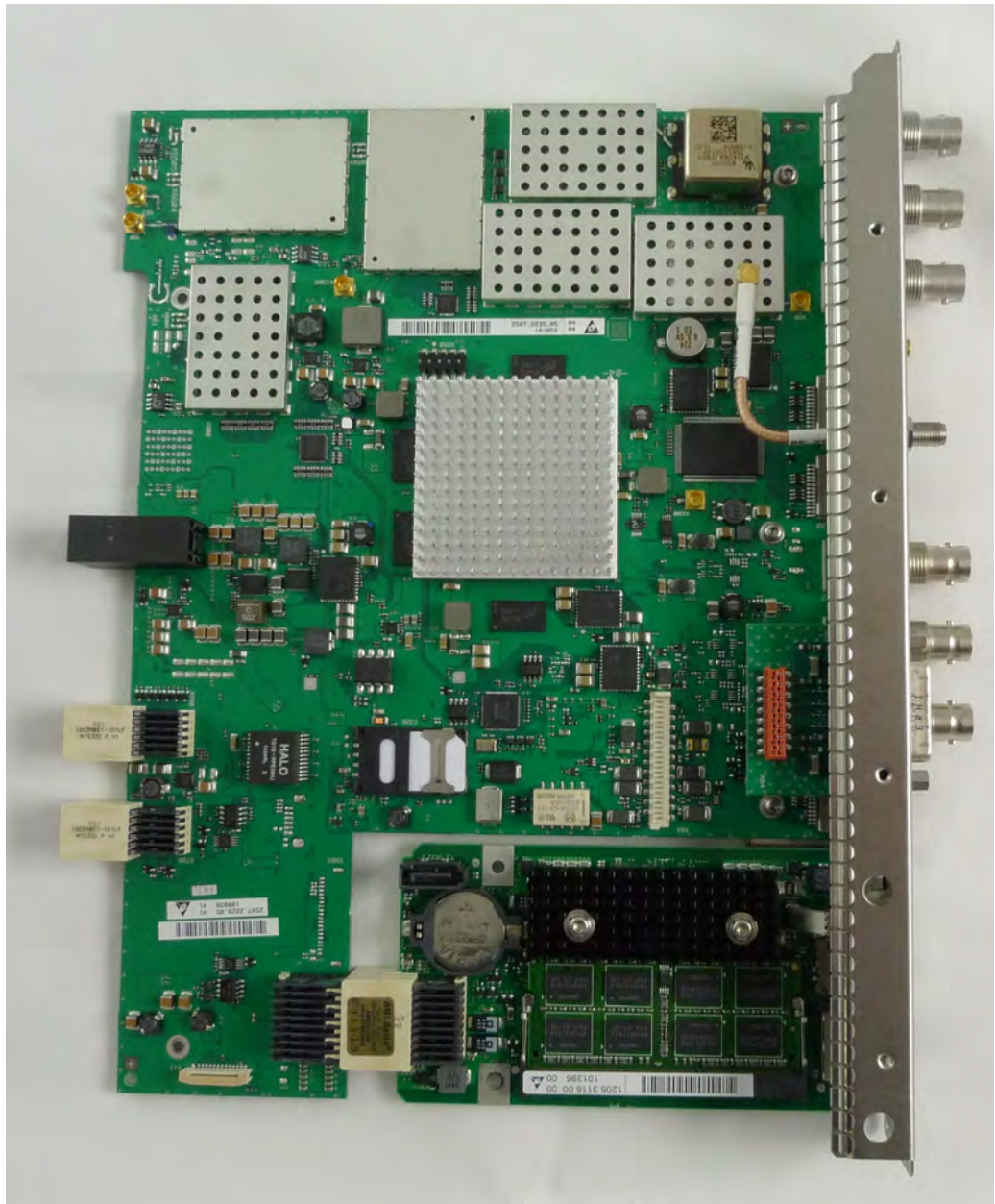


Figure 3-12: Exciter Board, example type Advanced

3.1.4.11 GapFiller Board

The GapFiller board replaces the Exciter board for GapFiller functions.

The GapFiller is integrated in the x9 transmitter family and supports all commercially available broadcast standards; such as DVB-T, DVB-T2 (full R&S DVB-T2 feature set), ISDB-T_(B), ATSC and DTMB.

GapFiller Receiver:

- High performance echo cancellation algorithm: at least -25 dB echo cancellation gain
- The echo cancellation settings are automatically adapted to the specific echo situation at the installation site
- The signal quality at the output is better compared to the R&S XLX8000

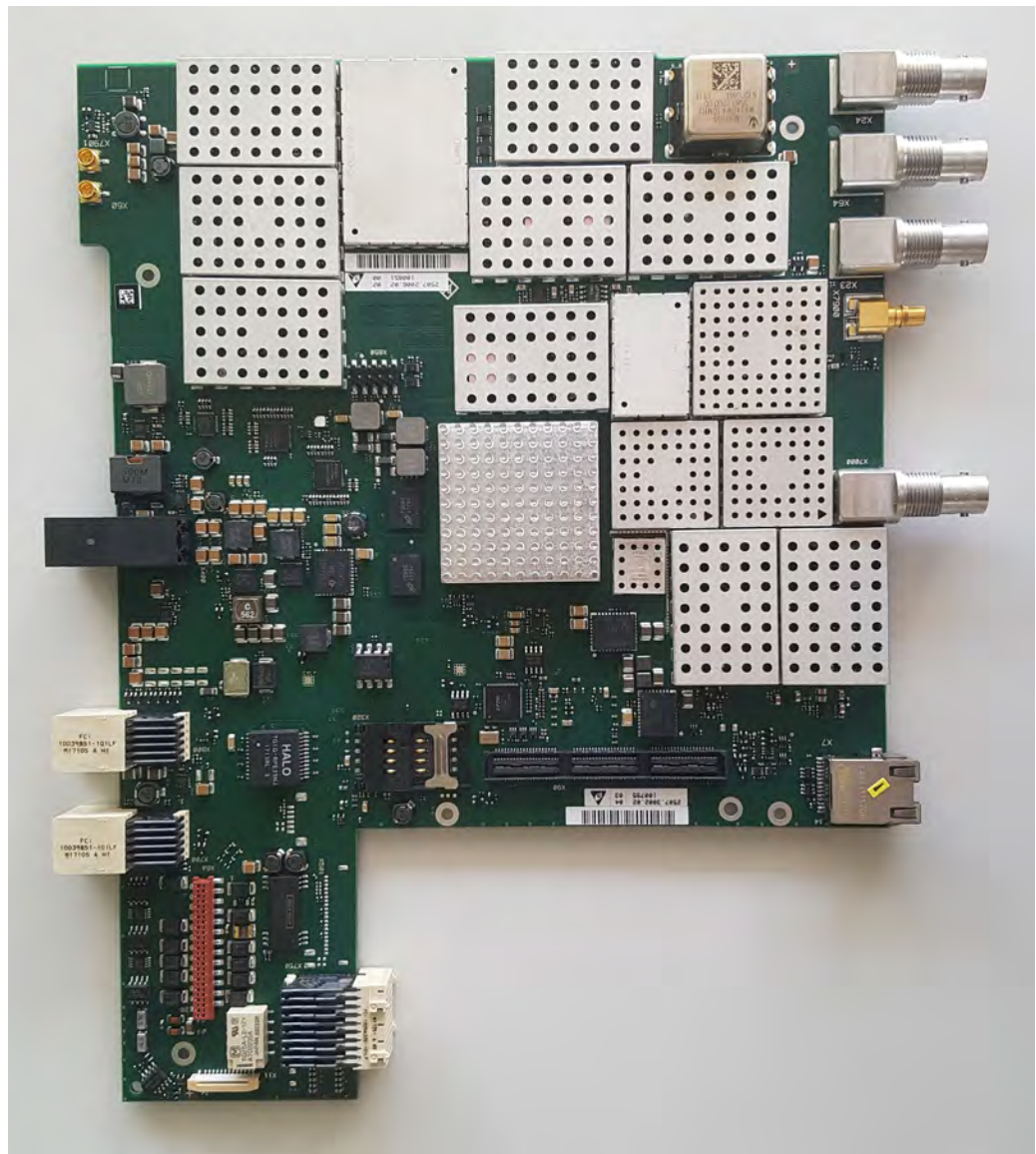


Figure 3-13: GapFiller Board

3.1.4.12 TSP901 (Transmitter Status Panel) of 1HU device

The functionality is identical with the TSP901 of the 2HU device (see [Chapter 3.1.4.13, "TSP901 \(Transmitter Status Panel\) of 2HU device"](#), on page 40) but the LEDs and buttons are arranged in a different way.



Figure 3-14: Local operation for 1HU device

3.1.4.13 TSP901 (Transmitter Status Panel) of 2HU device

The TSP901 allows local operation of a transmitter and shows basic informations.

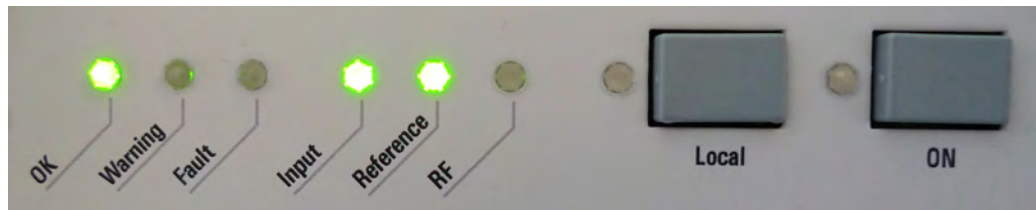


Figure 3-15: TSP901 (Transmitter Status Panel)

For N+1 and MultiTX transmitters, each individual transmitter has a separate TSP901, which allows local operation of the single transmitters.

Meaning of LEDs

LED		Message
OK (green)		Transmitter, everything OK
Warning (orange) ^[1]		Warning for transmitter
Fault (red)		Fault for transmitter
Input	OK	Sum input status of the Exciter / GapFiller is OK
	W	Sum input status of the Exciter / GapFiller has a Warning
	F	Sum input status of the Exciter / GapFiller has a Fail
Reference	OK	Sum reference of the Exciter / GapFiller is OK
	W	Sum reference of the Exciter / GapFiller has a Warning
	F	Sum reference of the Exciter / GapFiller has a Fail

	Off	Reference signal (10 MHz/ PPS/GPS...) is not present and is not required, since frequency regulation source is set to "Manual"
RF	OK	Transmitter RF OK
	W	Transmitter RF Warning
	F	Transmitter RF Fail ^[2]
	Off	Transmitter program off
Local		Transmitter Local/Remote LED shows the Local status (yellow)
On		Transmitter On (ON/OFF command accepted by the transmitter)

^[1] During an update of the FPGA firmware (e.g. after installing a new software version) the Warning LED is flashing.

^[2] Special case: Saved RF Fail for (switched over and) switched off transmitter.

3.1.4.14 TDU901 (Transmitter Display Unit)

The R&S TDU901 is a display unit with a touchscreen function and a graphical user interface for configuring Tx9 transmitter systems.



Figure 3-16: TDU901 (Transmitter display unit)

The display has a touchscreen function for operating all of the transmitter functions.



Using sharp-edged objects can damage or destroy the surface. Therefore only use your finger to operate the touchscreen.

1. A light touch on a button is enough to trigger a user action.
2. A button lights up orange for as long as your finger remains there. The action is not carried out until you remove your finger from the button.

Tip: To cancel an inadvertently selected action, slide your finger to the side away from the button highlighted orange and then lift your finger off the touchscreen.

The TDU901 Touch-Screen is existing in two variants. The Var. 02 is the standard configuration with mechanical holder and coated front plate. The Var. 03 is extended with a front LOCAL LAN connection for more convenient LAN cabling (local operation with Laptop).

If the USB Display Var. 03 is ordered together with a 2HU TLx9 Backup TX System it is mandatory to order also the option LOCAL LAN2 for the system control device, otherwise the local LAN control at the front is not possible.

3.1.4.15 Power Amplifier Module

The amplifier-pallet operates from 470 MHz to 790 MHz. The whole amplifier stage is designed as a fixed gain amplifier without any compensation of gain and temperature and frequency response. There is no internal power or gain control. The entire FPGA-based power control is done on the Exciter / GapFiller board by a variable gain amplifier (VGA) and a voltage variable attenuator (VVA). The detection of the output power is done on the TLx9 PA module.

Fitting variants:

- PA Pallet and 200 W heat sink and 2 fans
- PA Pallet and 100 W heat sink and 1 fan
- PA Pallet and 50 W heat sink and 1 fan

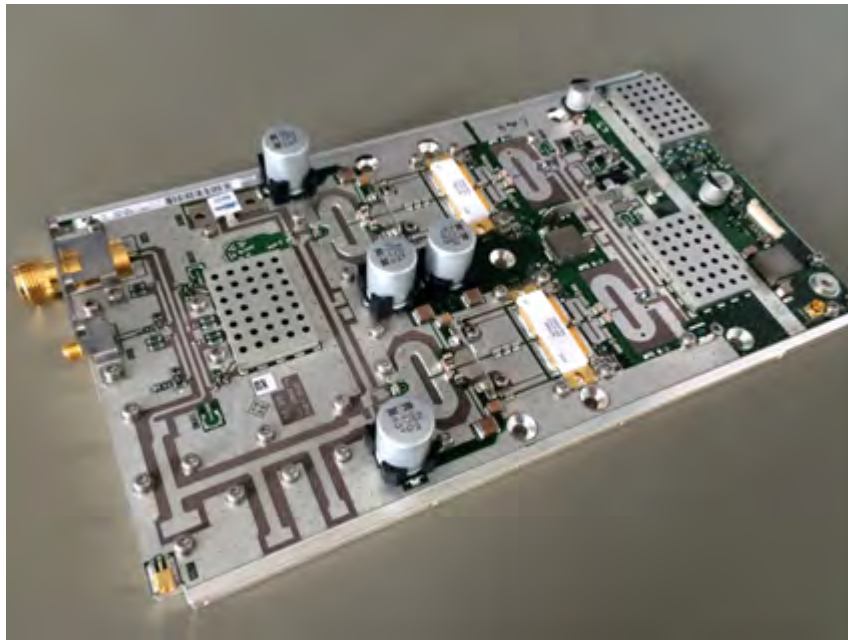


Figure 3-17: Power Amplifier Module (example)

3.1.4.16 Power Supplies

Fitting variants:

- 200 W PA: 12 V PS and 48 V PS and adapter card and EC11 AC connector
- 100 W PA: 12 V PS and 36 V PS and Euro AC connector
- 50 W PA: 12 V PS and 24 V PS and Euro AC connector

Used Power Supplies:

Voltage	Power	Material Number	Type
12 V	150 W	2506.7604.00	TDK Lambda HWS150A-12
24 V	300 W	2506.7704.00	Emerson LCM300Q-T 24V/300W
36 V	500 W	2506.7804.00	TDK Lambda GWS500-36
48 V	1800 W	3589.9506.00	TDK Lambda HFE1600 - 48

3.1.4.17 Capacitor Backup Battery

Delivers 12 V backup power to the Exciter / GapFiller Board to avoid reboots during power glitches.



Figure 3-18: Capacitor Backup Battery

3.1.4.18 IPM2/4 Processor Board

For inter-board and interface controlling.



Figure 3-19: IPM2/4 Processor Board

3.1.4.19 ASI Distribution Board

For distribution of ASI inputs between active and reserve TLx9 transmitter. Installed in one of the TLx9 option slots for 1+1 or N+1 configuration.

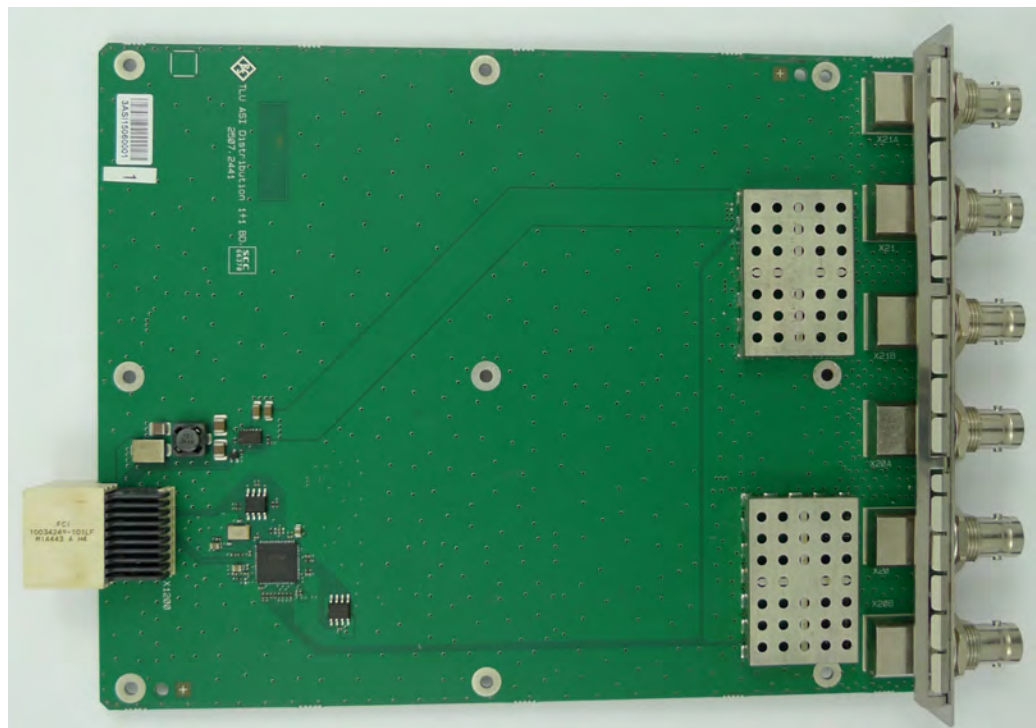


Figure 3-20: ASI Distribution Board

3.1.4.20 DVB-T/T2 Receiver

This module is a complete receiver for DVB-T and DVB-T2. Output of the module is a MPEG transport stream (ASI) and a set of measurement values (RF power, MER, BER, packet error,...). The control is done by USB. The receiver can handle the complete VHF and UHF frequency range. To operate the board a reference frequency is mandatory.

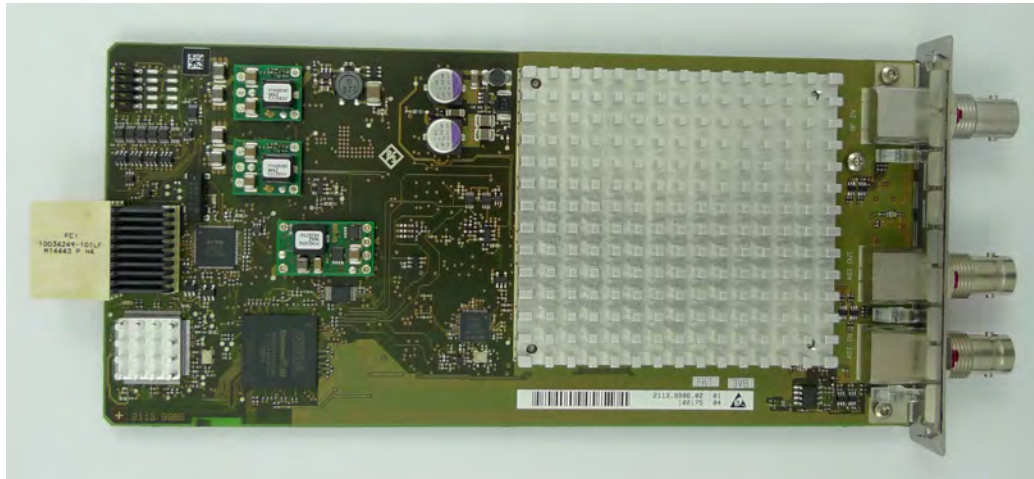


Figure 3-21: DVB-T/T2 Receiver

3.1.4.21 DVB-S/S2 Receiver

This board is using two single tuners and dual demodulator chips. In addition there is one dual LNB supply and control chip which can control two independent LNBs. There are two slots available to incorporate CI modules. With this modules the demodulated transport streams can be encrypted if necessary. The processed transport streams are connected via the backplane with the Exciter / GapFiller board (for further processing). It is possible to emit the demodulated and encrypted transport streams via the Ethernet connector X35 and the ASI out connector X25.

Features:

- DVB-S; DVB-S2
- Input frequency range 950 MHz to 2150 MHz
- Supports 1 to 45 Msymbol/s
- Continuously variable gain: 0 to 65 dB
- Programmable 5- to 36-MHz cut-off frequency
- RF input power for a single carrier: - 80 dBm up to - 10 dBm

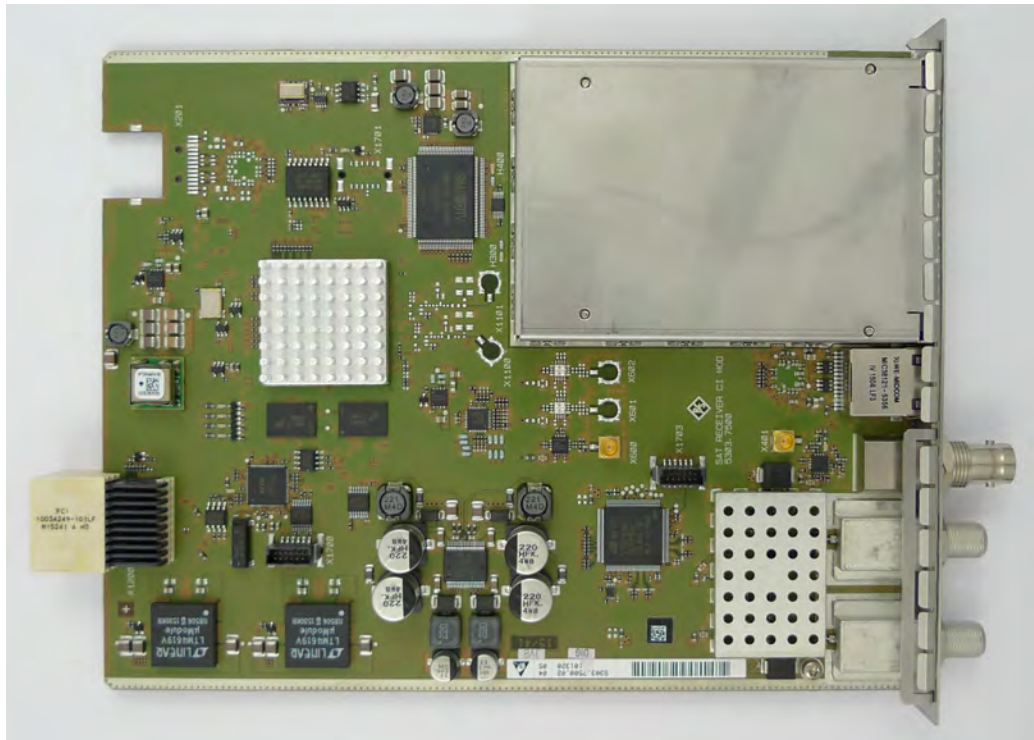


Figure 3-22: DVB-S/S2 Receiver

3.1.4.22 Mini LAN Switch Board

This board is offering 4 GBit Ethernet ports. Two LEDs per interface are for signaling

- Connectivity / activity (green LED)
- Valid Gigabit Ethernet connection (yellow LED)

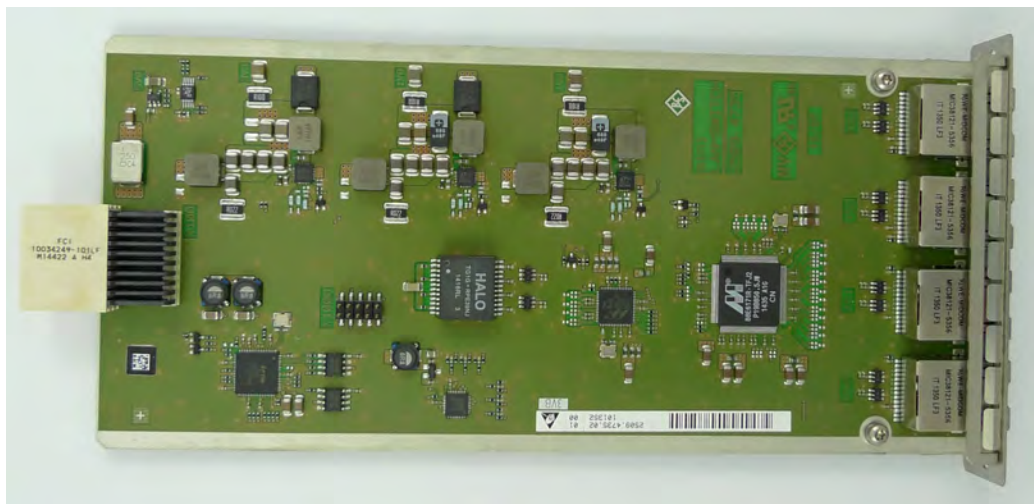


Figure 3-23: Mini LAN Switch Board

3.1.4.23 LAN Switch Board

This board is offering 8 GBit Ethernet ports. Two LEDs per interface are for signaling

- Connectivity / activity (green LED)
- Valid Gigabit Ethernet connection (yellow LED)

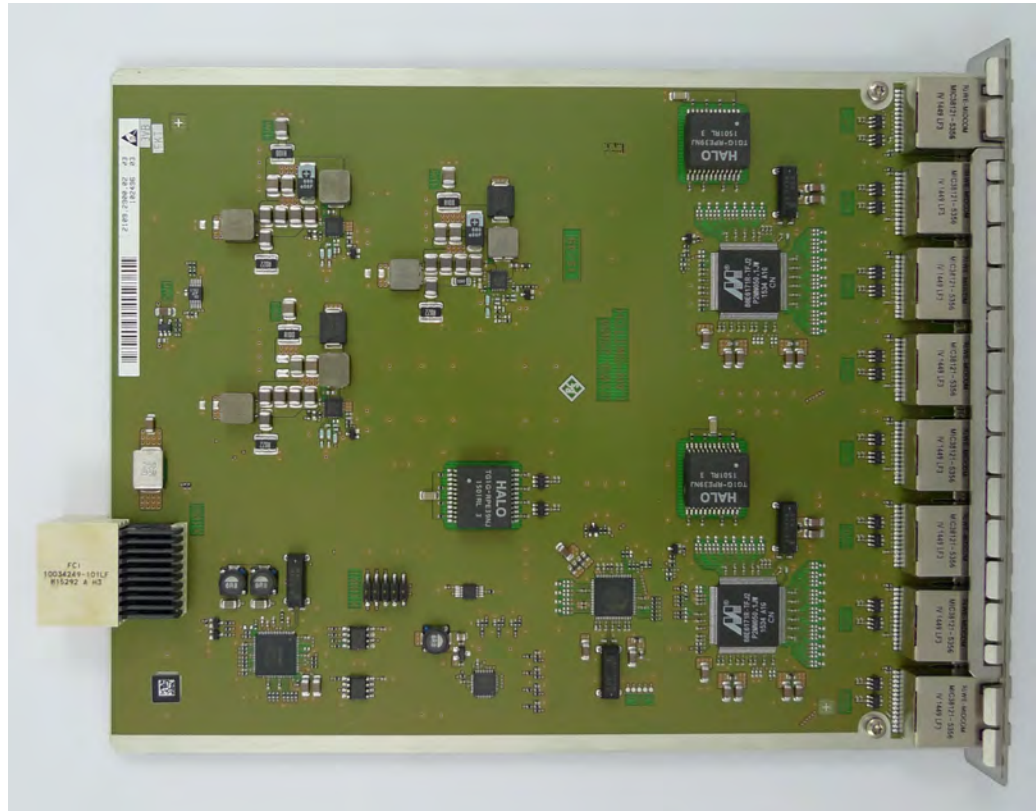


Figure 3-24: LAN Switch Board

3.1.4.24 Local LAN2 Board

The Local LAN2 Board is a passive board to route the Local LAN network connection from the Exciter / GapFiller Board via the Backplane to the Option Slot A (2 HU housing). This board is only used in 2HU device.

In 1HU devices a second local LAN is accessible at the front of the device. The 2HU device is missing the second local LAN connection. The board is only used in Backup TX systems.



Figure 3-25: Local LAN2 Board

3.1.4.25 RF Switch Board

This board as a TLx9 option card is to be mounted in the redundancy device (i.e. TX B) and has no fitting variant in this module.

GapFiller Redundancy 1+1 Antenna Redundancy

The main feature in this configuration is that it supports cross switching between antenna A to device A or B and antenna B to device A or B

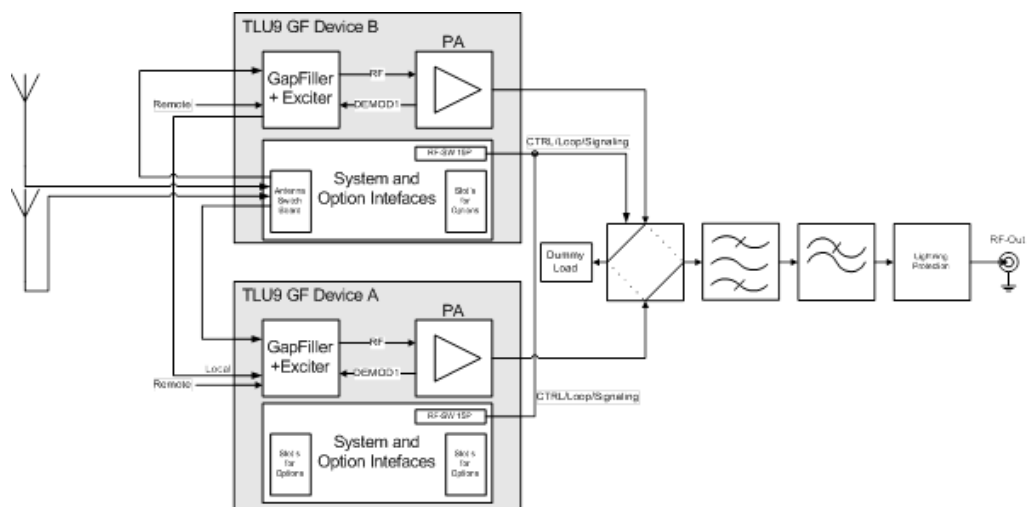


Figure 3-26: GapFiller Redundancy 1+1 Antenna Redundancy

GapFiller Redundancy in 1+1 Systems with Single Antenna

The main feature in this configuration is that switching between device A and B is possible. In normal operation mode, the device B will have no input and hence, no valid output signal (i.e. passive standby).

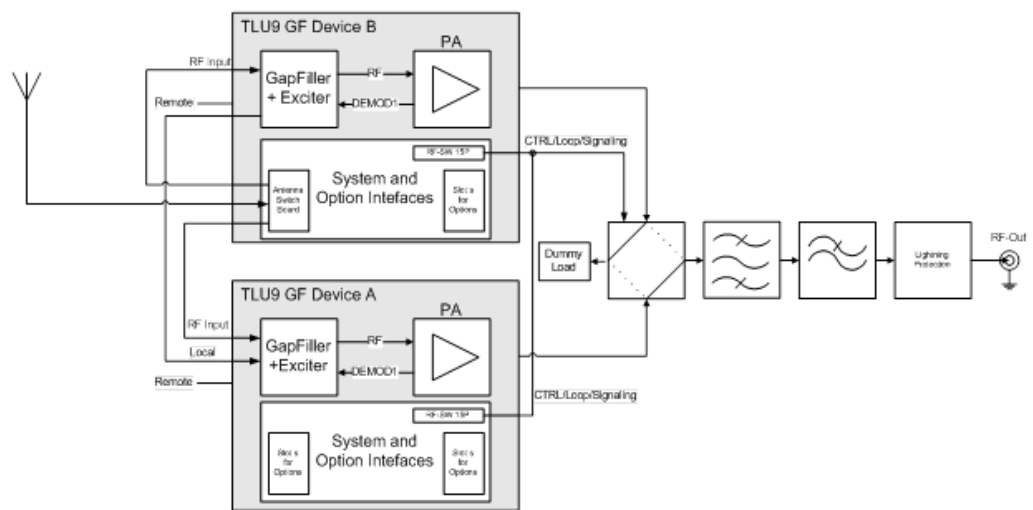


Figure 3-27: GapFiller Redundancy in 1+1 Systems with Single Antenna

1+1 RF Switch for 15W Backup TX Systems

In this configuration, the optional ASI board is required and has to be mounted in the redundancy device (i.e. TX B). With the prerequisite fulfilled, the RF Switch board can be used as a high power (15W OFDM max.) RF switch. In this configuration, the TX B, in the condition with no TX A connected, must be able to open up the RF loop to avoid “hot switching”.

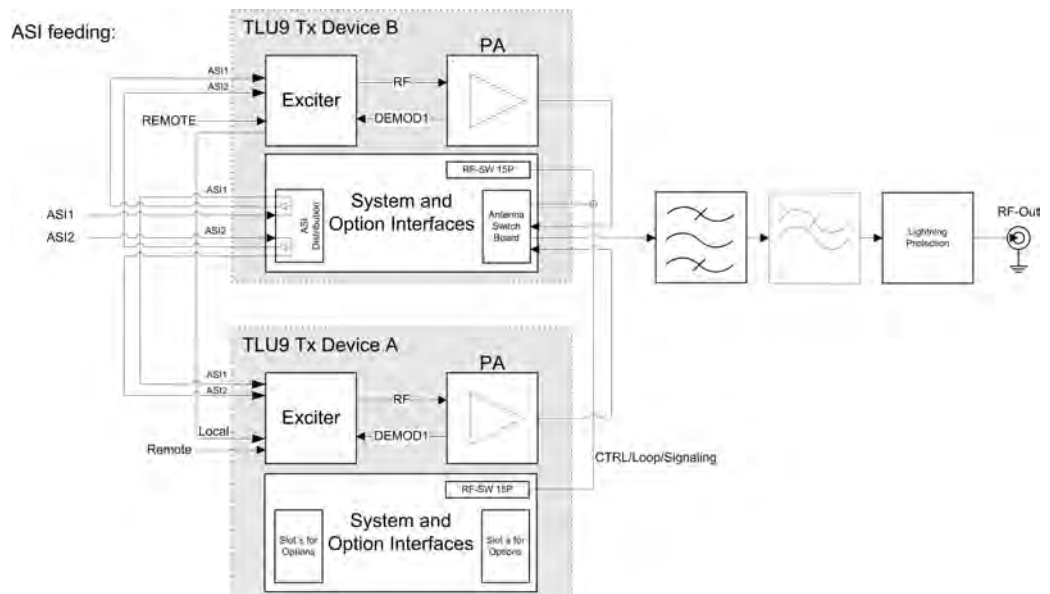


Figure 3-28: 1+1 RF Switch for 15W Backup TX Systems

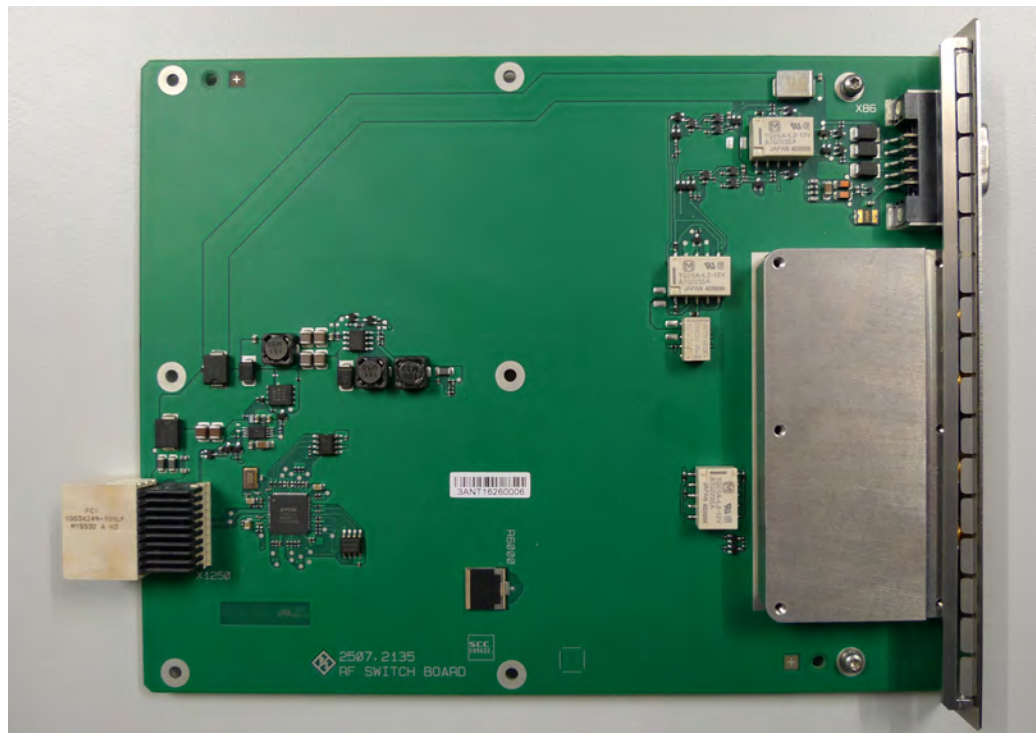


Figure 3-29: RF Switch Board

3.1.4.26 GapFiller 1+1 15W Redundancy System with RF Switching

In this configuration, 2 RF switch boards are required and has to be mounted in the redundancy device (i.e. TX B). With the prerequisite fulfilled, the RF Switch board at the input can be used to switch an input antenna or to support antenna redundancy with the second switch board as a high power (15W OFDM max) RF switch. In this configuration, the TX B, in the condition with no TX A connected, must be able to open up the RF loop to avoid “hot switching”.

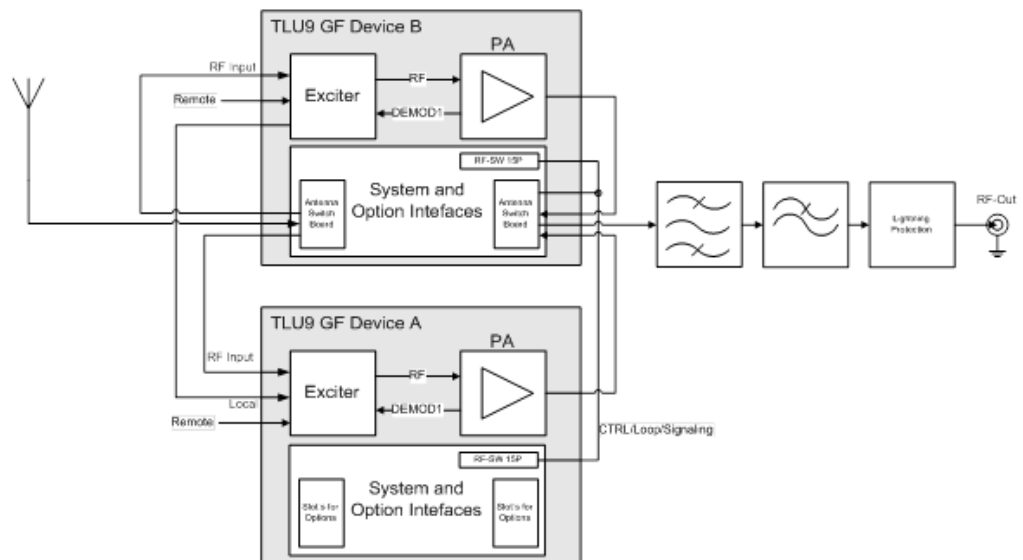


Figure 3-30: GapFiller 1+1 15W Redundancy System with RF Switching

3.1.5 Specifications

3.1.5.1 General Data

	DVB-T	DVB-T2	ISDB-T _(B)
Frequency range	UHF band IV/V (step size 1 Hz): 470 MHz to 790 MHz		
Channel bandwidth	6, 7, or 8 MHz	5, 6, 7, 8 or 10 MHz	6, 7 or 8 MHz
Standards	ETSI EN 300 744	ETSI EN 302 755	ARIB STD-B31 (ISDB-T) ABNT NBR 15601 (ISDB-T)
SFN / DTx Funktion	ETSI TS 101 191		ARIB STD-B31 (ISDB-T) ABNT NBR 15601 (ISDB-T _B)
EMC	ETSI EN 302 296/ 302 297 Rec. 1999/519/EC ETSI EN 301 489-1 / -14		ETSI EN 302 296/ 302 297 Rec. 1999/519/EC ETSI EN 301 489-1 / -14
DTV average Power	5 to 200 W (before bandpass filter)		
RF output power stability	± 0.253 dB (± 6 %)		
Directivity for VSWR measurement	typical 25 to 30 dB		
MER with predistortion	≥ 34 dB		
Shoulder distance with predistortion	≥ 37 dB		

	DVB-T	DVB-T2	ISDB-T _(B)
Harmonic distance	470 to 530 MHz: ≤ 33 dBc 530 to 790 MHz: ≤ 50 dBc		
Flatness with predistortion	≤ 0.5 dB		
VSWR at RF Output	≤ 1.65 (for VSWR ≥ 1.65 the TLx9 will reduce output power) (for VSWR ≥ 2 the TLx9 will be muted)		
Spurious emissions	Non harmonics, > 10 kHz offset from carrier with max. gain, sin signal: ≥ 50 dBc		
	Phase noise		
Frequency Carrier Offset			
10 Hz	-65 dBc/Hz (OCXO), -50 dBc/Hz typical (TCXO)		
100 Hz	-85 dBc/Hz		
1 kHz	-100 dBc/Hz		
20 kHz	-105 dBc/Hz		
100 kHz	-113 dBc/Hz		
1 MHz	-130 dBc/Hz		
	Aging		
OCXO variant	(average value after 10 days of operation)		
Aging (after 24 hours operation)	$< 1 \cdot 10^{-9}$		
Aging (after 30 days operation)	$< 2 \cdot 10^{-8}$		
Long term aging	$< 1 \cdot 10^{-7}$ /year (0.1 ppm/year)		
Heat up time	10 minutes		
TCXO variant	± 1 ppm/year		
	Redundancy		
	Backup TX (1+1) and N+1 redundancy		
	Environmental conditions		
Operation conditions	For indoor use only		

	DVB-T	DVB-T2	ISDB-T _(B)
Cooling system	Air-cooled		
Max. installation altitude	2000 m (above sea level)		
Operating temperature	+1 °C to +45 °C (Technical data guaranteed)		
Permissible temperature	0 °C to +50 °C (Technical data not guaranteed)		
Maximum relative humidity	95 % non-condensing		
Dust conditions	Pollution degree 2 (IEC 60664-1) (with air filter: pollution degree 3)		
Air Filter	Compliant with DIN EN 779 G2		
Environmental class	ETSI EN 300-019-1-3 Interior, in acc. with 3.2, with limited temperature range, non-condensing		
Immunity to radiated interference	Up to 10 V/m		
	Power supply		
Voltage supply	100 to 240 V AC $\pm$ 10 %		
AC supply frequency	50 Hz to 60 Hz $\pm$ 10 %, single phase		
Power consumption			
	200 W DTV average power: ~800 W		
	100 W DTV average power: ~465 W		
	50 W DTV average power: ~260 W		
	25 W DTV average power: ~180 W		
	15 W DTV average power: ~150 W		
	10 W DTV average power: ~135 W		
	5 W DTV average power: ~120 W		
	Immunity		
To fast transients and burst in line with IEC 61000-4-4	$\pm$ 2 kV (AC mains) $\pm$ 1 kV (signal inputs)		
To surges in line with IEC 61000-4-5	Symmetrical $\pm$ 1 kV (e. g. L-N) Asymmetrical $\pm$ 2 kV (e. g. L-PE, N-PE)		
	Mechanical resistance		

	DVB-T	DVB-T2	ISDB-T _(B)
Vibration (sinusoidal)	5 Hz to 150 Hz, max. 1.8 g at 55 Hz, max. 0.5 g from 55 Hz to 150 Hz Meets DIN EN 60068-2-6		
Vibration (random)	8 Hz to 500 Hz, acceleration 1.2 g (rms) Meets DIN EN 60068-2-64		
Shock	Shock response spectrum ramp up 6 dB/octave up to 45 Hz; 45 to 2000 Hz, max. 40 g Meets MIL-STD-810E		
	Safety standards		
ETSI EN 60215	Safety requirements for radio transmission equipment (VDE0866 / IEC 215)		
ETSI EN 60950	Safety of information technology equipment incl. electrical business equipment (VDE0805 / IEC 950)		
	Interfaces		
Transport Signal Inputs	1 (2) x ASI (75 Ω), 1 (2) x TSolP (Ethernet)		
Reference Signal Inputs	GPS antenna in (SMA, 50 Ω), 1 pps and 10 MHz (BNC, 50 Ω)		
Monitoring and control interfaces	2 x Ethernet (Local and Remote)		
RF output	SMA, 50 Ω, for 5/10/15 W N, 50 Ω, for 25/50/100/200 W		
TS Monitor output	BNC, 75 Ω		
RF Monitor output	SMA, 50 Ω		
Reference Monitor output	BNC, 50 Ω		
	Dimensions and weight		
	19", 1 HU, Depth 600 mm, for 5/10/15 W 19", 2 HU, Depth 450 mm, for 25/50/100/200 W (with integrated GPS-receiver, 1+1 redundancy components, DVB-S/S2 RX, DVB-T/T2 RX, Ethernet switch, Capacitor pack)		
Weight	5/10/15 W: ~7 kg 25/50 W: ~10 kg 100W: ~12.05 kg 200W: ~13.85 kg		

3.1.5.2 Inputs

	DVB-T	DVB-T2	ISDB-T _(B)
Input signals	ASI TS over IP	ASI TS over IP	ASI TS over IP
Data rate	3 Mbps to 30 Mbps	3 Mbps to 50 Mbps	32.507937 Mbps
Data inputs	2 x ASI BNC 75 Ω	2 x ASI BNC 75 Ω	2 x ASI BNC 75 Ω
Data inputs IP	2 x GigaBit Ethernet; RJ-45		
Modulator interface	- - -	T2-MI ETSI TS 102773	- - -
Reference frequency	10 MHz; 0.1 to 5 V _{pp} or TTL, BNC 50 Ω		
Reference pulse	1 pps, TTL, BNC 50 Ω		
Monitoring	Current data rate, input signal present, TS synchronization present		
Packet length	204 byte / 188 byte	Fixed packet length 188 byte Generic cont. stream > 64 kbit Generic fixed packetized streams < 64 kbit Generic encapsulated streams (TS 102606) + high efficiency mode	204 byte / 188 byte
Modulation modes	QPSK, 16QAM, 64QAM	QPSK, 16QAM, 64QAM, 256QAM	DQPSK QPSK 16QAM 64QAM
FFT modes (bandwidth specifications for 8 MHz channel)	2K, 8K opt. 4K for DVB-H bandwidth 7.61 MHz	1K, 2K, 4K, 8K, 16K, 32K bandwidth 7.61 MHz	Mode 1: 2K Mode 2: 4K Mode 3: 8K
Extended carrier mode	- - -	8K, 16K, 32K bandwidth 7.77 MHz	- - -
Symbol period	224 μs (2K) 448 μs (4K) 896 μs (8K)	112 μs (1K) 224 μs (2K) 448 μs (4K) 896 μs (8K) 1792 μs (16K) 3584 μs (32K)	252 μs (2K) 504 μs (4K) 1008 μs (8K)
Guard interval	1/4, 1/8, 1/16, 1/32	1/4, 1/8, 1/16, 1/32, 19/128, 19/256, 1/128	1/4, 1/8, 1/16, 1/32
Code rate	1/2, 2/3, 3/4, 5/6, 7/8	1/2, 3/5, 2/3, 3/4, 4/5, 5/6	1/2, 2/3, 3/4, 5/6, 7/8
Trellis coding	- - -	- - -	- - -

	DVB-T	DVB-T2	ISDB-T _(B)
Hierarchical coding	included	---	---
PAPR	---	yes	---
Rot. constellation	---	yes	---
DVB-T2 modes	---	single PLP multi PLP	---
Delay correction	max. 1000 ms, automatic or manual setting		
Pre-correction	Adaptive digital equalization (ADE)	Adaptive digital equalization (ADE)	Adaptive digital equalization (ADE)

3.1.5.3 Quality

	DVB-T	DVB-T2	ISDB-T _(B)
MER	≥ 33 dB at P_{nom}	≥ 33 dB at P_{nom}	≥ 33 dB at P_{nom}
Frequency response before bandpass filter	$< \pm 0.5$ dB	$< \pm 0.5$ dB	$< \pm 0.5$ dB
Intermodulation suppression	≤ 37 dB ± 12 MHz BW 8 MHz at ± 4.2 MHz BW 7 MHz at ± 3.7 MHz BW 6 MHz at ± 3.2 MHz	≤ 37 dB ± 12 MHz BW 8 MHz at ± 4.2 MHz BW 7 MHz at ± 3.7 MHz BW 6 MHz at ± 3.2 MHz	≤ 37 dB ± 12 MHz BW 6 MHz at ± 3.15 MHz
Spectrum mask	in line with ETSI EN 302 296 with channel bandpass filter		ABNT STD-B31 (ISDB-T) ABNT NBR 15601 Part 1 (ISDB-T _(B)) with channel bandpass
Spurious emissions	≤ -50 dBc without channel bandpass filter		
Harmonics	470 to 530 MHz: ≤ 33 dBc 530 to 790 MHz: ≤ 50 dBc without channel bandpass and external harmonic filter		

3.2 Installation R&S TLx9

3.2.1 Unpacking and Setting Up

3.2.1.1 Equipment Supplied

The following items are supplied as standard:

- R&S TLx9 all-in-one transmitter system, integrated in a 19" x 1 or 2 HU housing (depending on the type)
- Short-circuit connector for X6
- Power cable (type depending on the target country)
- User documentation
- Delivery notes

3.2.1.2 Unpacking Instrument

Carefully remove the instrument from the carton and check the delivery for completeness against the delivery note.

3.2.1.3 Setting Up Instrument

The instrument can be built into a 19" rack. Depending on the transmitter type, 1 or 2 height units are required for installation.

NOTICE

Make sure the transmitter is firmly fixed in the rack and there is sufficient ventilation. Make sure in particular that the flow of air through the inlets and outlets is not obstructed.

3.2.2 Connecting Cables

⚠ CAUTION

Always make sure that the power supply is disconnected before connecting any devices. This will prevent injuries and damage to the devices.

NOTICE

The cables used to provide ASI, 10 MHz, PPS and GPS signals should be double shielded.

IP and Ethernet connections should use double shielded class CAT6 cables.

The optional R&S TDU900/901 display unit is connected to the USB Interface, using an USB 2.0 cable provided by Rohde & Schwarz. Any other cables are not allowed.

The RF cable for the optional satellite receiver should have a minimum screening attenuation of 110 dB.



Please refer to the system circuit diagram for the system wiring applicable to your system.

3.2.2.1 Overview of Connectors

Dependig on the transmitter type, maybe not all of the shown connectors are available.

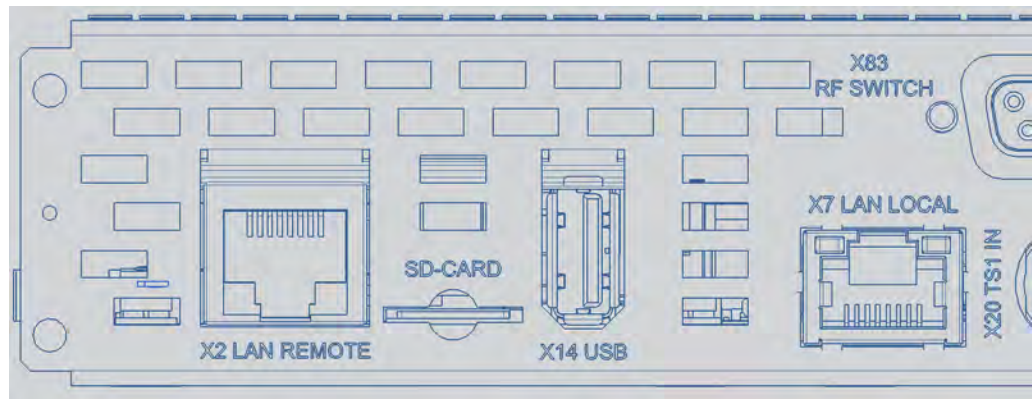


Figure 3-31: Connectors on rear panel of R&S TLx9 (left side)

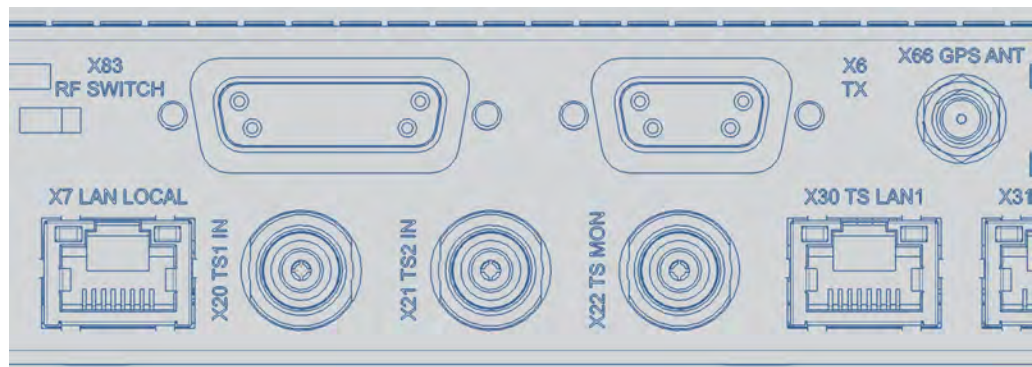


Figure 3-32: Connectors on rear panel of R&S TLx9 (mid)

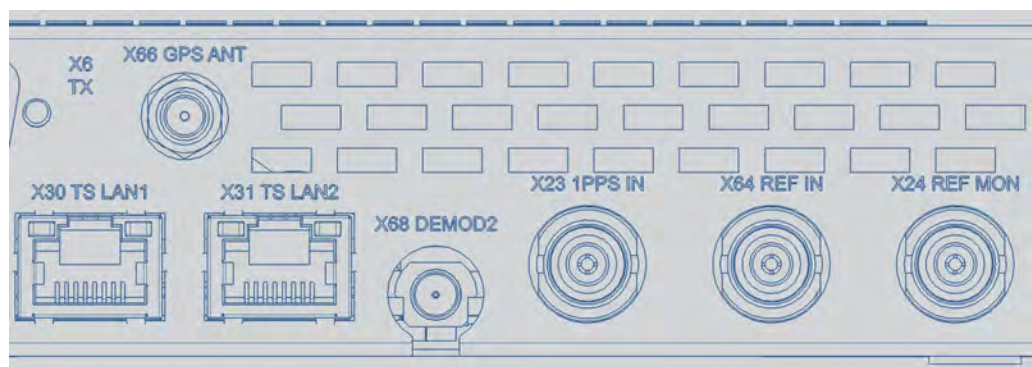


Figure 3-33: Connectors on rear panel of R&S TLx9 (right side)



Figure 3-34: RF output and RF monitor connectors on rear panel of R&S TLx9

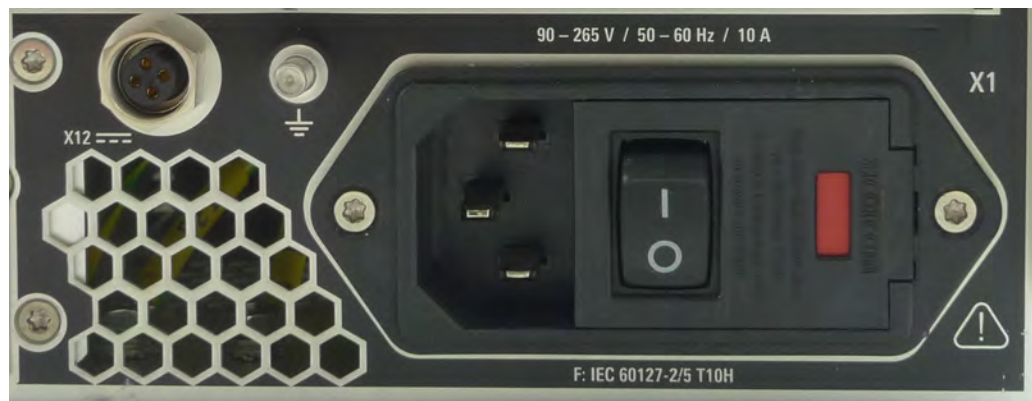


Figure 3-35: Terminal supply and Mains connectors on rear panel of R&S TLx9

Signal Name/Description	Connection point	Remarks
MAINS	X1	Power supply AC input
LAN REMOTE	X2	Remote LAN connection
TX IF	X6	TX connector (CAN bus, 12 V external, position detection)
LAN LOCAL	X7	Local LAN connection
TERMINAL SUPPLY	X12	12 V, 1 A for external components (e.g. RCB)
USB	X14	USB port (for e.g. backup restore configuration via USB stick)
TS1 IN	X20	ASI input feeding
TS2 IN	X21	ASI input feeding
TS MONITOR OUT	X22	Transport stream / ASI monitor output

Signal Name/Description	Connection point	Remarks
1PPS IN	X23	1 PPS input
REF MONITOR	X24	Reference monitor output (10 MHz or 1 PPS)
TS LAN1	X30	Transport stream Input feeding
TS LAN2	X31	Transport stream Input feeding
RF_OUT	X60	RF output
RF_MON	X61	RF monitor output
REF IN	X64	10 MHz reference input
GPS ANT	X66	GPS antenna input
DEM0D2	X68	RF input for demodulator (linear predistortion)
RF Switch	X83	Interface to control a mechanical RF switch
SD-CARD		Slot for SD-Card

3.2.2.2 Connecting Input Signals

Inputs for digital TV

The input signals can be fed in ASI, T2MI (DVB-T2) or SMPTE format.

- Connect the first transport stream to X20 (TS 1 IN). With hierarchical coding (DVB-T only), X20 is the input for the HP stream
- If signal standby is required, connect a second transport stream to X21 (TS 2 IN). With hierarchical coding, X21 is the input for the LP stream
- Alternatively the input signals can be fed in via IP using X30 (TS LAN1) and X31 (TS LAN2)

3.2.2.3 Connecting External Reference Sources

- To increase frequency accuracy, connect an external reference source (10 MHz) to X64 (REF IN)



Alternatively, the second pulse of an external 1 pps signal (at X23) or of the optional internal GPS receiver (GPS antenna at X66) can be used as the frequency reference

- For SFN operation, additionally feed a 1 pps signal to allow time synchronization:
 1. If the optional internal GPS receiver is used, connect the GPS antenna to X66 (GPS ANT)

2. Alternatively, feed the 1 pps signal of an external reference source via X23 (1PPS IN)

3.2.2.4 Connecting Antenna System

** DANGER****Risk of RF burns**

Before connecting the antenna cable, make sure that the instrument cannot output RF at the output.

NOTICE

For EMC reasons, only cables with double shielding are to be used at the RF output.

Connect the antenna system to X60 (RF Output).

3.2.2.5 Preparing RF Carrier Loop

** DANGER****Risk of RF burns**

Before putting the instrument into operation, make sure that the available interlock loop systems are in use.

- Prepare the interlock loop system (if available) for connection to X6 (TX IF)
 - If no interlock loop devices are available in the transmitter system (only permissible with low power), have the supplied short-circuit connector at the ready
-

NOTICE

The interlock loop is only closed after (!) startup via X6 (TX IF), after which the instrument can then produce RF

3.2.2.6 Connecting User Interface

For operating the system, it is possible to connect the transmitter to a PC, using an Ethernet link via RJ-45 connector X7 (LAN LOCAL).

For connection to a remote monitoring network use RJ-45 connector X2 (LAN REMOTE).

NOTICE

Rohde & Schwarz recommends the use of an double shielded RJ-45 cable which complies with the CAT 6 specification

3.2.2.7 Connecting AC Power Supply**NOTICE**

The instrument can be damaged by overvoltage. Make sure that the AC supply voltage provided by your local power supply network complies with the specifications of the power supply unit installed in your instrument.

⚠ DANGER**Risk of electric shock**

Check the power cable for damage.

⚠ CAUTION**Risk of fire**

Make sure that the power cable has the appropriate current carrying capacity necessary for power consumption over the entire temperature range.

- Set the power switch on the rear of the instrument to 0 (OFF)
- Connect the instrument to the power supply using the power cable

3.3 Commissioning R&S TLx9

Commissioning and operation of the transmitter system is described in the following document. R&S® Transmitter System Tx9 Operating Manual Mat. No. 2109.9110.02

Annex

A R&S TLx9 Interface Description

A.1 Base unit and Exciter / GapFiller Board Interfaces

A.1.1 Overview

Signal Name/Description	Connection point	Remarks
MAINS	X1	Power supply AC input
LAN REMOTE	X2	Remote LAN connection
LAN LOCAL	X3	Front LAN local for 1HU or for 2HU with option card
TX	X6	TX connector (CAN bus, 12 V external, position detection)
LAN LOCAL	X7	Local LAN connection
TERMINAL SUPPLY	X12	12 V, 1 A for external components (e.g. RCB)
USB	X14	USB port (for e.g. backup restore configuration via USB stick)
TS1 IN	X20	ASI input feeding
TS2 IN	X21	ASI input feeding
TS MONITOR OUT	X22	Transport stream / ASI monitor output
1PPS IN	X23	1 PPS input
REF MONITOR	X24	Reference monitor output (10 MHz or 1 PPS)
TS LAN1	X30	Transport stream Input feeding
TS LAN2	X31	Transport stream Input feeding
RF_OUT	X60	RF output
RF_MON	X61	RF monitor output
REF IN	X64	10 MHz reference input
GPS ANT	X66	GPS antenna input
DEM0D2	X68	RF input for demodulator (linear predistortion)

Signal Name/Description	Connection point	Remarks
RECEIVER	X70	Receiver input for Exciter / GapFiller Board
RF Switch	X83	Interface to control a mechanical RF switch

A.1.2 Description

Table A-1: X1 - Mains

Signal Name/Description	Direction	Value range	Connection point	Remarks
L1	Input	100 to 240 V AC $\pm$ 10 %	X1.L	Mains connection
N	Input	0 V	X1.N	Mains connection
PE	Input	0 V	X1.PE	Mains connection

IEC (standard with integrated fuses 10 A) for RF output power $\leq$ 100W OFDM.

EC11 (high current up to 16 A, no integrated fuse) for RF output power 200 W OFDM.

Table A-2: X2 - LAN Remote: 8-pin RJ-45 socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
BI_DA+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X2.1	
BI_DA-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X2.2	
BI_DB+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X2.3	
BI_DB-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X2.4	
BI_DC+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X2.5	
BI_DC-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X2.6	
BI_DD+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X2.7	
BI_DD-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X2.8	

Table A-3: X6 - TX: 9-pin Sub-D socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
SORT1 / Position1	Bidirectional	0 to + 8,9 V $\pm$ 10 %	X6.1	
CAN_L	Bidirectional	CAN-Level	X6.2	
GND	Bidirectional	0 V	X6.3	
LOOP-	Bidirectional	Open: protection loop open connection to LOOP+ : protection loop closed	X6.4	
SORT2 / Position2	Bidirectional	0 to + 8,9 V $\pm$ 10 %	X6.5	
/AC_FAIL	Input	0 to + 11,2 V Input Pullup: 5 k Ω Input Pulldown: 136 k Ω Idle Level: 11,2 V $\pm$ 5 %	X6.6	Externally pulled down to GND by resistor > 5 k Ω resp. $\leq$ 100 Ω
CAN_H	Bidirectional	CAN-Level	X6.7	
LOOP+	Bidirectional	Open: protection loop open connection to LOOP+ : protection loop closed	X6.8	
+12V_RC	Output	+ 12 V $\pm$ 1,5 %	X6.9	Supply for system components

Table A-4: X7 - LAN Local: 8-pin RJ-45 socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
BI_DA+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X7.1	
BI_DA-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X7.2	
BI_DB+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X7.3	
BI_DB-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X7.4	
BI_DC+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X7.5	
BI_DC-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X7.6	
BI_DD+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X7.7	
BI_DD-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X7.8	

Table A-5: X12 - Terminal Supply: 4P connector

Signal Name/Description	Direction	Value range	Connection point	Remarks
TERMINAL SUPPLY	Output	12 V DC $\pm$ 1,5 V	X12.1	$I_{\max.} = 1.6 \text{ A}$
GND	Bidirectional	0 V	X12.2	
USB SUPPLY	Output	5 V DC $\pm$ 0,5 V	X12.3	$I_{\max.} = 1 \text{ A}$
GND	Bidirectional	0 V	X12.4	

Table A-6: X14 - USB: USB connector type A

Signal Name/Description	Direction	Value range	Connection point	Remarks
+5V USB	Output		X14.1	
USB Data-	Bidirectional		X14.2	
USB Data+	Bidirectional		X14.3	
GND	Bidirectional		X14.2	GND / shield

Table A-7: X20 – TS1 IN: BNC jack 75 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
TS1	Input	ASI / SMPTE310M	X20.1	
GND	Bidirectional	0 V	X20.2	GND / shield

Table A-8: X21 – TS2 IN: BNC jack 75 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
TS2	Input	ASI / SMPTE310M	X21.1	
GND	Bidirectional	0 V	X22.2	GND / shield

Table A-9: X22 – TS Monitor: BNC jack 75 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
TS_MON	Output	ASI / SMPTE310M	X22.1	
GND	Bidirectional	0 V	X22.2	GND / shield

Table A-10: X23 – 1PPS IN: BNC jack 50 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
1PPS_EXTERN	Input	3.3 V-LVTTL or TTL $R_i = 50 \Omega$ for AC pos. edge	X23.1	Seconds pulse from external GPS receiver
GND	Bidirectional	0 V	X23.2 to X23.5	GND / shield

Table A-11: X24 – REF MON: BNC jack 50 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
REF_MON	Output	3.3 V-LVTTL	X24.1	
GND	Bidirectional	0 V	X24.2	GND / shield

Table A-12: X30 - TS LAN1: 8-pin RJ-45 socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
BI_DA+	Bidirectional	$V_{odiff} = 670$ to 820 mV _{ss}	X30.1	
BI_DA-	Bidirectional	$V_{idiff} = 750$ mV _{ss} typ.	X30.2	
BI_DB+	Bidirectional	$V_{odiff} = 670$ to 820 mV _{ss}	X30.3	
BI_DB-	Bidirectional	$V_{idiff} = 750$ mV _{ss} typ.	X30.4	
BI_DC+	Bidirectional	$V_{odiff} = 670$ to 820 mV _{ss}	X30.5	
BI_DC-	Bidirectional	$V_{idiff} = 750$ mV _{ss} typ.	X30.6	
BI_DD+	Bidirectional	$V_{odiff} = 670$ to 820 mV _{ss}	X30.7	
BI_DD-	Bidirectional	$V_{idiff} = 750$ mV _{ss} typ.	X30.8	

Table A-13: X31 - TS LAN2: 8-pin RJ-45 socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
BI_DA+	Bidirectional	$V_{odiff} = 670$ to 820 mV _{ss}	X31.1	
BI_DA-	Bidirectional	$V_{idiff} = 750$ mV _{ss} typ.	X31.2	
BI_DB+	Bidirectional	$V_{odiff} = 670$ to 820 mV _{ss}	X31.3	
BI_DB-	Bidirectional	$V_{idiff} = 750$ mV _{ss} typ.	X31.4	
BI_DC+	Bidirectional	$V_{odiff} = 670$ to 820 mV _{ss}	X31.5	
BI_DC-	Bidirectional	$V_{idiff} = 750$ mV _{ss} typ.	X31.6	

Signal Name/Description	Direction	Value range	Connection point	Remarks
BI_DD+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X31.7	
BI_DD-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss typ.}}$	X31.8	

Table A-14: X60 - RF output: N-connector 50 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
RF_OUT	Output	$P_{\text{AVG, max.}} = 200 \text{ W (DVB-T)}$ 470 MHz to 790 MHz at 50 Ω load, $s \leq 1.4$	X60.1	
GND	Bidirectional		X60.2	GND / shield

Table A-15: X61 – RF Monitor: SMA socket 50 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
RF_MON	Output	-7 dBm ± 2 dB	X61.1	
GND	Bidirectional		X61.2	GND / shield

Table A-16: X64 – REF IN: BNC jack 50 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
EXT_REF_IN	Input	5 MHz / 10 MHz -5.0 dBm to 20 dBm or TTL	X64.1	
GND	Bidirectional		X64.2	GND / shield

Table A-17: X66 – GPS ANT: SMA socket 50 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
GPS ANTENNA	Input	-144 dBm to -5 dBm	X66.1	
GND	Bidirectional	0 V	X66.2	GND / shield

Table A-18: X68 – DEMOD2: QMA socket 50 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
DEMOD2	Input	+7 dBm (-9 / +1 dB) DTV 160 to 790 MHz $S_{11} \leq -16 \text{ dB}$	X68.1	RF Input for Demodulator (linear predistortion)
GND	Bidirectional	0 V	X68.2	GND / shield

Table A-19: X83 - RF SWITCH: 15-pin Sub-D socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
+12V_RFSW	Output	+12V $\pm$ 20 % Loading current up to 120 mA	X83.1	This pin is protected by a 0.14 A PTC@23 °C
LOOP+	Output	Opened Loop: Loop+ to Loop- voltage is 12 V $\pm$ 10 % Closed Loop: Current is 2.5 mA $\pm$ 10 %	X83.2	Loop control output
STATUS_POS1/2_ULINK	Input	3 states: OPEN / 0 V / 12 V	X83.3	ULINK position detection: OPEN for position open 0 V for position 2 12 V for position 1
CONTROL_SWITCH_POS2	Output	0 V to 28 V	X83.4	Open collector output: 1.25 W@25°C maximum
EXT_DOOR_CONTACT	Input	2 states: 0 V / 12 V	X83.5	Connect to 0V_RFSW: Door closed Connect to 12V_RFSW: Door open
COOLING_DL_1	Output		X83.6	Relay controlled pins to open/short dummy load for antenna cooling Maximum voltage applied on these pins is 30 V $\pm$ 10 %
+12V	Output	+12 V $\pm$ 10 % Loading current up to 2 A (100 ms)	X83.7	This pin is protected by a 1.5 A PTC@20 °C
0V_RFSW	Output	0 V	X83.8	
LOOP-	Input	Opened Loop: Loop+ to Loop- voltage is 12 V $\pm$ 10 % Closed Loop: Current is 2.5 mA $\pm$ 10 %	X83.9	Loop control input
STATUS_POS1/2_SWITCH	Input	3 states: OPEN / 0 V / 12 V	X83.10	RF Switch position detection: OPEN for position open 0 V for position 2 12 V for position 1
CONTROL_SWITCH_POS1	Output	0 V to 28 V	X83.11	Open collector output: 1.25 W@25°C maximum

Signal Name/Description	Direction	Value range	Connection point	Remarks
OVER_VOLTAGE	Input	2 states: 0 V / 12 V	X83.12	Connect to 0V_RFSW is OK Connect to 12V_RFSW is Over Voltage
GND	Bidirectional	0 V	X83.13	MAS
COOLING_DL_2	Output	Maximum short current is 1 A $\pm$ 10 %	X83.14	Relay controlled pins to open / short dummy load for antenna cooling Maximum voltage applied on these pins is 30 V $\pm$ 10 %
EXT_SWITCH-OVER	Input	2 states: 0 V / 12 V	X83.15	Connect to 0V_RFSW is Switched Over Connect to 12V_RFSW is Not Switched Over.

A.2 Option Board Interfaces

A.2.1 LAN Switch

Table A-20: X50 - LAN1: 8-pin RJ-45 socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
BI_DA+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X50.1	
BI_DA-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X50.2	
BI_DB+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X50.3	
BI_DB-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X50.4	
BI_DC+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X50.5	
BI_DC-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X50.6	
BI_DD+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X50.7	
BI_DD-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X50.8	

Table A-21: X51 - LAN2: 8-pin RJ-45 socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
BI_DA+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X51.1	
BI_DA-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X51.2	
BI_DB+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X51.3	
BI_DB-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X51.4	
BI_DC+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X51.5	
BI_DC-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X51.6	
BI_DD+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X51.7	
BI_DD-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X51.8	

Table A-22: X52 - LAN3: 8-pin RJ-45 socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
BI_DA+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X52.1	
BI_DA-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X52.2	
BI_DB+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X52.3	
BI_DB-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X52.4	
BI_DC+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X52.5	
BI_DC-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X52.6	
BI_DD+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X52.7	
BI_DD-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X52.8	

Table A-23: X53 - LAN4: 8-pin RJ-45 socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
BI_DA+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X53.1	
BI_DA-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X53.2	
BI_DB+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X53.3	
BI_DB-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X53.4	
BI_DC+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X53.5	
BI_DC-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X53.6	
BI_DD+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X53.7	
BI_DD-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X53.8	

Table A-24: X54 - LAN5: 8-pin RJ-45 socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
BI_DA+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X54.1	
BI_DA-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X54.2	
BI_DB+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X54.3	
BI_DB-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X54.4	
BI_DC+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X54.5	
BI_DC-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X54.6	
BI_DD+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X54.7	
BI_DD-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X54.8	

Table A-25: X55 - LAN6: 8-pin RJ-45 socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
BI_DA+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X55.1	
BI_DA-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X55.2	
BI_DB+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X55.3	
BI_DB-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X55.4	
BI_DC+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X55.5	
BI_DC-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X55.6	
BI_DD+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X55.7	
BI_DD-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X55.8	

Table A-26: X56 - LAN7: 8-pin RJ-45 socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
BI_DA+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X56.1	
BI_DA-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X56.2	
BI_DB+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X56.3	
BI_DB-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X56.4	
BI_DC+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X56.5	
BI_DC-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X56.6	
BI_DD+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X56.7	
BI_DD-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X56.8	

Table A-27: X57 - LAN8: 8-pin RJ-45 socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
BI_DA+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X57.1	
BI_DA-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X57.2	
BI_DB+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X57.3	
BI_DB-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X57.4	
BI_DC+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X57.5	
BI_DC-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X57.6	
BI_DD+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X57.7	
BI_DD-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X57.8	

A.2.2 Local LAN2 Board

Table A-28: X3 - Network Port: 8-pin RJ-45 socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
TX+ (D1+)	Bidirectional	-1 V to +1 V Differential to TX- Impedance: 100 Ω	X3.J1	
TX- (D1-)	Bidirectional	-1 V to +1 V Differential to TX+ Impedance: 100 Ω	X3.J2	
RX+ (D2+)	Bidirectional	-1 V to +1 V Differential to RX- Impedance: 100 Ω	X3.J3	
D3+	Bidirectional	-1 V to +1 V Differential to D3- Impedance: 100 Ω	X3.J4	
D3-	Bidirectional	-1 V to +1 V Differential to D3+ Impedance: 100 Ω	X3.J5	
RX- (D2-)	Bidirectional	-1 V to +1 V Differential to RX+ Impedance: 100 Ω	X3.J6	

Signal Name/Description	Direction	Value range	Connection point	Remarks
D4+	Bidirectional	-1 V to +1 V Differential to D4- Impedance: 100 Ω	X3.J7	
D4-	Bidirectional	-1 V to +1 V Differential to D4+ Impedance: 100 Ω	X3.J8	

A.2.3 DVB-T/T2 RX

Table A-29: X69 – RF IN: BNC jack 50 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
RF IN	Input	30 MHz to 1 GHz -92 dBm to 0 dBm 75 Ω	X69.1	RF input
GND	Bidirectional	0 V	X69.2	GND / shield

Table A-30: X28 – ASI IN: BNC jack 75 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
ASI IN	Input	270 Mbit/s $U_{ss} = 800$ mV, 75 Ω	X28.1	ASI input
GND	Bidirectional	0 V	X28.2	GND / shield

Table A-31: X29 – ASI OUT: BNC jack 75 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
ASI OUT	Output	270 Mbit/s $U_{ss} = 800$ mV, 75 Ω	X29.1	ASI output
GND	Bidirectional	0 V	X29.2	GND / shield

A.2.4 DVB-S/S2 RX

Table A-32: X75 – RF IN 1: F jack 75 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
RF IN 1	Bidirectional	<i>Input:</i> 950 MHz to 2150 MHz -80 dBm to -10 dBm, 75 Ω <i>Output:</i> DC 13 to 19 V, max. 500 mA	X75.1	RF input, LNB output
GND	Bidirectional	0 V	X75.2/.3	GND / shield

Table A-33: X76 – RF IN 2: F jack 75 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
RF IN 2	Bidirectional	<i>Input:</i> 950 MHz to 2150 MHz -80 dBm to -10 dBm, 75 Ω <i>Output:</i> DC 13 to 19 V, max. 500 mA	X76.1	RF input, LNB output
GND	Bidirectional	0 V	X76.2/.3	GND / shield

Table A-34: X35 - LAN OUT SAT RX: 8-pin RJ-45 socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
BI_DA+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X35.J1	
BI_DA-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X35.J2	
BI_DB+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X35.J3	
BI_DB-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X35.J4	
BI_DC+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X35.J5	
BI_DC-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X35.J6	
BI_DD+	Bidirectional	$V_{\text{odiff}} = 670 \text{ to } 820 \text{ mV}_{\text{ss}}$	X35.J7	
BI_DD-	Bidirectional	$V_{\text{idiff}} = 750 \text{ mV}_{\text{ss}}$ typ.	X35.J8	

Table A-35: X25 – TS OUT: BNC jack 75 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
ASI OUT 1	Output	$U_{ss} = 400 \text{ mV}_{ss} \text{ to } 800 \text{ mV}$ 75 Ω	X25.1	ASI output
GND	Bidirectional	0 V	X25.2 to 5	GND / shield

Table A-36: X36.1 – CI SAT RX: Slot 1 for CAM Module

Signal Name/Description	Direction	Value range	Connection point	Remarks
GND	Output		X36.1.A1	
D1[3]	Bidirectional		X36.1.A2	CI1 data 3
D1[4]	Bidirectional		X36.1.A3	CI1 data 4
D1[5]	Bidirectional		X36.1.A4	CI1 data 5
D1[6]	Bidirectional		X36.1.A5	CI1 data 6
D1[7]	Bidirectional		X36.1.A6	CI1 data 7
CE1[1]	Output		X36.1.A7	
A1[10]	Output		X36.1.A8	CI1 addr 10
OE1	Output		X36.1.A9	
A1[11]	Output		X36.1.A10	CI1 addr 11
A1[9]	Output		X36.1.A11	CI1 addr 9
A1[8]	Output		X36.1.A12	CI1 addr 8
A1[13]	Output		X36.1.A13	CI1 addr 13
A1[14]	Output		X36.1.A14	CI1 addr 14
WE1	Output		X36.1.A15	
IREQ1	Input		X36.1.A16	
+5 V (VCC)	Output		X36.1.A17	
+5 V (VCC)	Output		X36.1.A18	
MIVAL1	Output		X36.1.A19	CAM data in
MCLKI1	Output		X36.1.A20	CAM data in
A1[12]	Output		X36.1.A21	CI1 addr 12
A1[7]	Output		X36.1.A22	CI1 addr 7
A1[6]	Output		X36.1.A23	CI1 addr 6
A1[5]	Output		X36.1.A24	CI1 addr 5
A1[4]	Output		X36.1.A25	CI1 addr 4

Signal Name/Description	Direction	Value range	Connection point	Remarks
A1[3]	Output		X36.1.A26	Cl1 addr 3
A1[2]	Output		X36.1.A27	Cl1 addr 2
A1[1]	Output		X36.1.A28	Cl1 addr 1
A1[0]	Output		X36.1.A29	Cl1 addr 0
D1[0]	Bidirectional		X36.1.A30	Cl1 data 0
D1[1]	Bidirectional		X36.1.A31	Cl1 data 1
D1[2]	Bidirectional		X36.1.A32	Cl1 data 2
+5 V (10k Pullup)	Output		X36.1.A33	
GND	Output		X36.1.A34	
GND	Output		X36.1.A35	
CD1[1]	Output		X36.1.A36	
MDO1[3]	Input		X36.1.A37	CAM data out
MDO1[4]	Input		X36.1.A38	CAM data out
MDO1[5]	Input		X36.1.A39	CAM data out
MDO1[6]	Input		X36.1.A40	CAM data out
MDO1[7]	Input		X36.1.A41	CAM data out
CE1[2]	Output		X36.1.A42	
+5 V (100k Pullup)	Output		X36.1.A43	
IORD1	Output		X36.1.A44	
IOWR1	Output		X36.1.A45	
MISTR1	Output		X36.1.A46	CAM data in
MDI1[0]	Output		X36.1.A47	CAM data in
MDI1[1]	Output		X36.1.A48	CAM data in
MDI1[2]	Output		X36.1.A49	CAM data in
MDI1[3]	Output		X36.1.A50	CAM data in
+5 V (VCC)	Output		X36.1.A51	
+5 V (VCC)	Output		X36.1.A52	
MDI1[4]	Output		X36.1.A53	CAM data in
MDI1[5]	Output		X36.1.A54	CAM data in
MDI1[6]	Output		X36.1.A55	CAM data in
MDI1[7]	Output		X36.1.A56	CAM data in
MCLKO1	Input		X36.1.A57	CAM data out
RESET1	Output		X36.1.A58	

Signal Name/Description	Direction	Value range	Connection point	Remarks
WAIT1	Output		X36.1.A59	
INPACK1	Output		X36.1.A60	
REG1	Output		X36.1.A61	
MOVAL1	Input		X36.1.A62	CAM data out
MOSTRT1	Input		X36.1.A63	CAM data out
MDO1[0]	Input		X36.1.A64	CAM data out
MDO1[1]	Input		X36.1.A65	CAM data out
MDO1[2]	Input		X36.1.A66	CAM data out
CD1[2]	Output		X36.1.A67	
GND	Output		X36.1.A68	

Table A-37: X36.2 – CI SAT RX: Slot 2 for CAM Module

Signal Name/Description	Direction	Value range	Connection point	Remarks
GND	Output		X36.2.A1	
D2[3]	Bidirectional		X36.2.A2	CI1 data 3
D2[4]	Bidirectional		X36.2.A3	CI1 data 4
D2[5]	Bidirectional		X36.2.A4	CI1 data 5
D2[6]	Bidirectional		X36.2.A5	CI1 data 6
D2[7]	Bidirectional		X36.2.A6	CI1 data 7
CE2[1]	Output		X36.2.A7	
A2[10]	Output		X36.2.A8	CI1 addr 10
OE2	Output		X36.2.A9	
A2[11]	Output		X36.2.A10	CI1 addr 11
A2[9]	Output		X36.2.A11	CI1 addr 9
A2[8]	Output		X36.2.A12	CI1 addr 8
A2[13]	Output		X36.2.A13	CI1 addr 13
A2[14]	Output		X36.2.A14	CI1 addr 14
WE2	Output		X36.2.A15	
IREQ2	Input		X36.2.A16	
+5 V (VCC)	Output		X36.2.A17	
+5 V (VCC)	Output		X36.2.A18	
MIVAL2	Output		X36.2.A19	CAM data in

Signal Name/Description	Direction	Value range	Connection point	Remarks
MCLKI2	Output		X36.2.A20	CAM data in
A2[12]	Output		X36.2.A21	CI1 addr 12
A2[7]	Output		X36.2.A22	CI1 addr 7
A2[6]	Output		X36.2.A23	CI1 addr 6
A2[5]	Output		X36.2.A24	CI1 addr 5
A2[4]	Output		X36.2.A25	CI1 addr 4
A2[3]	Output		X36.2.A26	CI1 addr 3
A2[2]	Output		X36.2.A27	CI1 addr 2
A2[1]	Output		X36.2.A28	CI1 addr 1
A2[0]	Output		X36.2.A29	CI1 addr 0
D2[0]	Bidirectional		X36.2.A30	CI1 data 0
D2[1]	Bidirectional		X36.2.A31	CI1 data 1
D2[2]	Bidirectional		X36.2.A32	CI1 data 2
+5 V (10k Pullup)	Output		X36.2.A33	
GND	Output		X36.2.A34	
GND	Output		X36.2.A35	
CD2[1]	Output		X36.2.A36	
MDO2[3]	Input		X36.2.A37	CAM data out
MDO2[4]	Input		X36.2.A38	CAM data out
MDO2[5]	Input		X36.2.A39	CAM data out
MDO2[6]	Input		X36.2.A40	CAM data out
MDO2[7]	Input		X36.2.A41	CAM data out
CE2[2]	Output		X36.2.A42	
+5 V (100k Pullup)	Output		X36.2.A43	
IORD2	Output		X36.2.A44	
IOWR2	Output		X36.2.A45	
MISTR2	Output		X36.2.A46	CAM data in
MDI2[0]	Output		X36.2.A47	CAM data in
MDI2[1]	Output		X36.2.A48	CAM data in
MDI2[2]	Output		X36.2.A49	CAM data in
MDI2[3]	Output		X36.2.A50	CAM data in
+5 V (VCC)	Output		X36.2.A51	
+5 V (VCC)	Output		X36.2.A52	

Signal Name/Description	Direction	Value range	Connection point	Remarks
MDI2[4]	Output		X36.2.A53	CAM data in
MDI2[5]	Output		X36.2.A54	CAM data in
MDI2[6]	Output		X36.2.A55	CAM data in
MDI2[7]	Output		X36.2.A56	CAM data in
MCKO2	Input		X36.2.A57	CAM data out
RESET2	Output		X36.2.A58	
WAIT2	Output		X36.2.A59	
INPACK2	Output		X36.2.A60	
REG2	Output		X36.2.A61	
MOVAL2	Input		X36.2.A62	CAM data out
MOSTRT2	Input		X36.2.A63	CAM data out
MDO2[0]	Input		X36.2.A64	CAM data out
MDO2[1]	Input		X36.2.A65	CAM data out
MDO2[2]	Input		X36.2.A66	CAM data out
CD2[2]	Output		X36.2.A67	
GND	Output		X36.2.A68	

A.2.5 1+1 ASI Distribution Board

Table A-38: X20 – IN: BNC jack 75 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
ASI_IN1	Input	$U_{ss} = 400 \text{ mV}_{ss} \text{ to } 800 \text{ mV}$ 19.39 to 270 Mb/s	X20.1	ASI input 1
GND	Bidirectional	0 V	X20.2	GND / shield

Table A-39: X21 – IN: BNC jack 75 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
ASI_IN2	Input	$U_{ss} = 400 \text{ mV}_{ss} \text{ to } 800 \text{ mV}$ 19.39 to 270 Mb/s	X21.1	ASI input 2
GND	Bidirectional	0 V	X21.2	GND / shield

Table A-40: X20A – OUT: BNC jack 75 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
ASI_OUT1_ACTIV	Output	$U_{ss} = 400 \text{ mV}_{ss} \text{ to } 800 \text{ mV}$ 19.39 to 270 Mb/s	X20A.1	ASI output 1 Active (to TX A)
GND	Bidirectional	0 V	X20A.2	GND / shield

Table A-41: X20C – OUT: BNC jack 75 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
ASI_OUT1_PASSIV	Output	$U_{ss} = 400 \text{ mV}_{ss} \text{ to } 800 \text{ mV}$ 19.39 to 270 Mb/s	X20C.1	ASI output 1 Passiv (to TX B)
GND	Bidirectional	0 V	X20C.2	GND / shield

Table A-42: X21A – OUT: BNC jack 75 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
ASI_OUT2_ACTIV	Output	$U_{ss} = 400 \text{ mV}_{ss} \text{ to } 800 \text{ mV}$ 19.39 to 270 Mb/s	X21A.1	ASI output 2 Active (to TX A)
GND	Bidirectional	0 V	X21A.2	GND / shield

Table A-43: X21C – OUT: BNC jack 75 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
ASI_OUT2_PASSIV	Output	$U_{ss} = 400 \text{ mV}_{ss} \text{ to } 800 \text{ mV}$ 19.39 to 270 Mb/s	X21C.1	ASI output 2 Passiv (to TX B)
GND	Bidirectional	0 V	X21C.2	GND / shield

A.2.6 RF Switch Board

Table A-44: X60A - RF IN/OUT: SMA socket 50 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
X60A	Bidirectional	$P_{AVG, max.} < 20\text{ W}$ 174 MHz to 790 MHz at 50 Ω load, $s < 1.4$	X60A.1	This port can be used as input from TX_A in a TX 1+1 system or as an output to TX_A in a single or antenna 1+1 system.
GND	Bidirectional		X60A.2	GND / shield

Table A-45: X60B - RF IN/OUT: SMA socket 50 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
X60B	Bidirectional	$P_{AVG, max.} < 20\text{ W}$ 174 MHz to 790 MHz at 50 Ω load, $s < 1.4$	X60B.1	This port can be used as output to Antenna_A in a TX 1+1 system or as an input from Antenna_A in a single or antenna 1+1 system.
GND	Bidirectional		X60B.2	GND / shield

Table A-46: X60C - RF IN/OUT: SMA socket 50 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
X60C	Bidirectional	$P_{AVG, max.} < 20\text{ W}$ 174 MHz to 790 MHz at 50 Ω load, $s < 1.4$	X60C.1	This port can be used as input from TX_B in a TX 1+1 system or as an output to TX_B in a single or antenna 1+1 system.
GND	Bidirectional		X60C.2	GND / shield

Table A-47: X60D - RF IN/OUT: SMA socket 50 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
X60D	Bidirectional	$P_{AVG, max.} < 20\text{ W}$ 174 MHz to 790 MHz at 50 Ω load, $s < 1.4$	X60D.1	This port can be used as output to a dummy load in a TX 1+1 system or as an input from Antenna_B in a single or antenna 1+1 system.
GND	Bidirectional		X60D.2	GND / shield

Table A-48: X86 - Control: 9-pin Sub-D socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
+12V_RFSW	Input	12 V $\pm$ 0.5 V, $\leq 0.2\text{ A}$	X86.1	+12 V DC for message relay
LOOP+	Output	LVDS	X86.2	
GND	Bidirectional	0 V	X86.3	GND
ControlPos1	Input	LV-CMOS (2.5 V)	X86.4	Commands the RF relays to position 1 when connected to GND (default: high resistance)
0V_RFSW	Bidirectional	0 V	X86.5	GND for message relay
LOOP-	Input	LVDS	X86.6	
STATUS_POS1/2_SW	Output	LV-CMOS (2.5 V)	X86.7	Position info of the RF relays (from message relay)
ControlPos2	Input	LV-CMOS (2.5 V)	X86.8	Commands the RF relays to position 2 when connected to GND (default: high resistance)
+12VIN	Input	12 V $\pm$ 0.5 V, $\leq 2\text{ A}$	X86.9	+12 V DC backup
GND	Bidirectional	0 V	X86.10.11	Shielding (GND)

