trays. When routing in solid cable ducts, use the next largest cable cross-sections and fuse ratings.

The fuse ratings apply for a maximum ambient temperature of 25 °C and a minimum undervoltage of 197 V AC.

Series fuses and cable cross-sections for a 3-phase power supply

For a 230/400 V AC, 50 Hz power supply with L1, L2, L3, N, and PE, the following information applies:

Number of amplifiers	Series fuse pH gG	Cable cross-section
1	3 x 40 A	5 x 6 mm^2
2	3 x 40 A	5 x 6 mm^2
3	3 x 40 A	5 x 6 mm^2
4	3 x 40 A	5 x 6 mm^2
5	3 x 40 A	5 x 6 mm^2
6	3 x 40 A	5 x 6 mm^2

Series fuses and cable cross-sections for a 1-phase power supply

For a 230 V AC, 50 Hz power supply with L1, N, and PE, the following information applies:

Number of amplifiers	Series fuse NH gG	Cable cross-section
1	3 x 40 A	3 x 6 mm^2
2	3 x 40 A	3 x 6 mm^2
3	3 x 50 A	3 x 10 mm^2

1. Run a power input cable of sufficient length to the series fuse.
2. Connect the cable to the series fuse.
3. Loosen the clamping screws at the strain relief (item 1 in the following figure).
4. Run a cable from the series fuse through the strain relief to the power input terminal X1 (item 3).
5. Remove the protective covers (item 2), open the respective terminals using a size 3 flat-head screwdriver, and connect the wires using the cable and terminal designations.
6. Check that the wires are secure and put the protective covers (item 2) back on.
7. Tighten the clamping screws of the strain relief.
8. Fasten the transparent protective cover to the rear of the mains distribution unit.

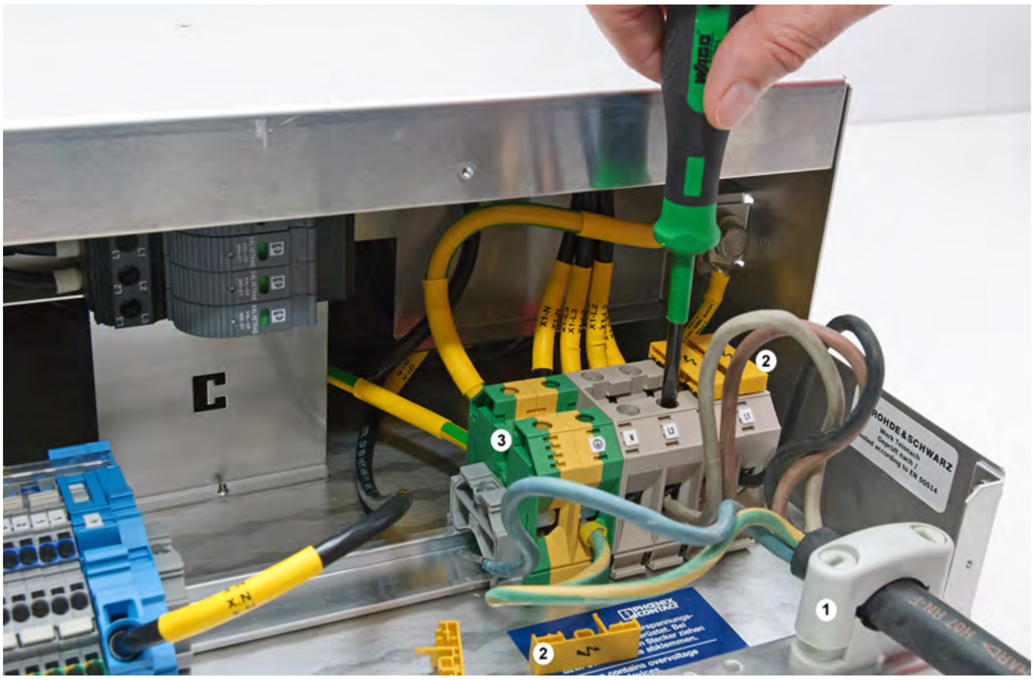

Fig. 3-13: Connecting the Power Input Cable

1 = Strain relief
2 = Protective covers
3 = Power input terminal X1

3.2.7 Installing the RF output

The output to the main antenna is an EIA connector. It is on the left-hand side of the transmitter roof, next to the directional coupler and connection panel.

3.2.7.1 Connecting the Antenna

Connect the antenna as follows, depending on the transmitter type:

► Fasten the coaxial cable, which is preassembled to the station, to the EIA flange of the transmitter's RF output. To prevent the screw connection from loosening, secure it using a plain washer and spring lock washer.

- Use 4 screws M8, 35 mm (for EIA 1 5/8")

In regions with high humidity, the supplied rubber ring can be inserted into the groove between the two EIA flanges.

3.2.7.2 Connecting the Dummy Antenna

The dummy antenna is connected only when putting the system into operation or for maintenance and repair purposes.

With some dummy antennas that have coolant monitoring and overtemperature monitoring, the monitoring equipment can be connected to the transmitter. The main RF carrier loop X41.1 and X41.2 on the CAN bus adapter or exciter switch can be used here as a temporary measure (e.g. while the unit is being put into operation).

1. To connect the main RF carrier loop, use the inserted jumper plug and remove the jumper.
2. Connect the monitoring cable in place of the jumper.

If you are using an RF patch panel that allows you to switch between the antenna and dummy antenna by means of an RF bridging link (permanent installation), attach the dummy antenna monitoring unit to the standby RF carrier loop (X41.1 and X41.2 with CAN bus adapter, X41.3 and X41.4 with exciter switch). For more details, see chapter 3.2.9, "Installing the RF Loop", on page 62.

3.2.8 Installing R&S TCE900 Customer Interfaces

The various versions of the TCE900 are already integrated into the rack with the delivery of a transmitter. Installation is limited to wiring at the device's customer interfaces. Which cables need to be connected depends on the transmitter configuration, the device version and the custom requirements.

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

IP and Ethernet connections should use class CAT6 cables should be used.

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

The following steps are required to install a R&S TCE900.

1. Insert the R&S TCE900 into the TCE pull-out frame without canting it (only one runner) and carefully push the unit back to the front stop.
2. Fasten the R&S TCE900 to the TCE pull-out frame using the two knurled screws.
3. Connect the cable in accordance with the wiring diagram and target designation.
4. Complete the TCE pull-out frame with the front panel
    a) To connect the Tx Control or Exciter A (for single drive) and TSP, plug the control cable into the mini USB socket on the TSP900.
    b) Hook the eyelets on the rear of the front panel into the hooks on the TCE pull-out frame and press the front panel down as far as it will go.
    c) Retighten the front panel to the sides of the TCE pull-out frame using four screws (size 20 Torx screwdriver).
5. Slide the TCE pull-out frame into the rack.

a) Push the left safety lever outwards and press one of the two right safety levers downwards.

Fig. 3-14: Releasing the safety lever (left side).

1 = Push the safety lever outward and hold it

Fig. 3-15: Releasing the safety lever (right side).

2 = Press down and hold the first safety lever
3 = Push the TCE pull-out unit toward the rack
4 = Push the second safety lever downwards, hold it, and push the TCE pull-out unit in all the way

b) First hold the two safety levers in this position and press the TCE pull-out frame toward the rack, until the safety lever retains its position on its own.
c) Also push the second safety lever on the right side downwards now and slide the TCE pull-out unit into the rack.
d) Retighten the four captive screws on the TCE pull-out frame.

3.2.9 Installing the RF Loop

3.2.9.1 Single Drive (CAN Bus Adapter)

A RF loop plug is plugged onto the CAN bus adapter (in the system component frame) that may have to be wired depending on whether or not the RF loop is used.

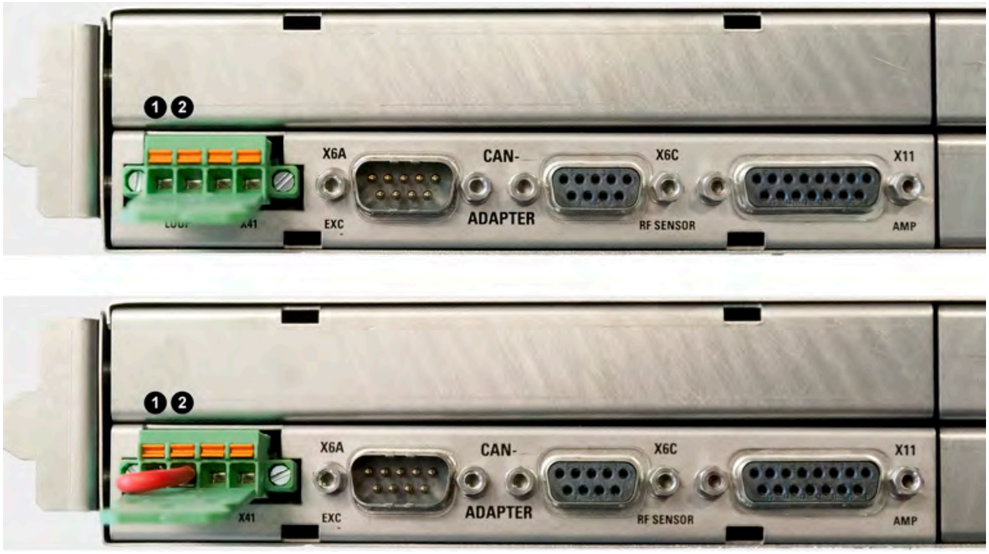

Fig. 3-16: RF loop plug X41 (LOOP), open and bypassed

1 = Pin 1
2 = Pin 2

⚠ WARNING

Risk of RF Burns

Interruptions to the RF sector during operation can lead to arc flashes and severe burns including shock that result from them. Before putting the transmitter into operation, ensure that the available RF interlock systems are connected correctly.

The RF loop is not used

► Bridge pins 1 and 2 on RF loop plug X41 (LOOP) using a jumper.

The RF loop is used

► Loop pins 1 and 2 from plug X41 (LOOP) into the RF loop connections coming from the RF sector (RF switch, switchover panel, etc.).

3.2.9.2 Dual Drive (RF Switch)

A RF loop plug is plugged onto the RF switch (in the system component frame) that may have to be wired depending on whether or not the RF loop is used.

Fig. 3-17: RF loop plug X41 (LOOP) - RF Switch

WARNING

Risk of RF Burns

Interruptions to the RF sector during operation can lead to arc flashes and severe burns including shock that result from them. Before putting the transmitter into operation, ensure that the available RF interlock systems are connected correctly.

In case of Dual Drive, the RF loop of the standby exciter is always bypassed via the exciter switch.

This is not valid for Dual Drive with active dual output stage.

The external RF loop is only used for the active exciter.

3.2.10 Installing the TM9-C1 Exhaust Kit

The following modules and components of the cooling system or exhaust kit are preassembled at the factory:

- Air Cooling Interface ACIF as rackmount in the R&S TCE900-SystemControl unit
- Exhaust air transfer duct (item 1 in the following figure) on the rear part of the transmitter roof
- Fans E1 and E2 in the rear door of the transmitter rack
- Pressure sensors S1 and S2 in the rear door of the transmitter rack
- Temperature sensors B1 and B2 in the rear door of the transmitter rack

The rear door with the preassembled components is delivered in separate packaging. The following steps are required:

1. Unpack the rear door and hang it on the door hinges (item 2 in the following figure) on the rear side of the rack.
2. Connect the potential equalization cable on the threaded bolt of the door (item 3) and on the left wall of the rack (Torx screw)

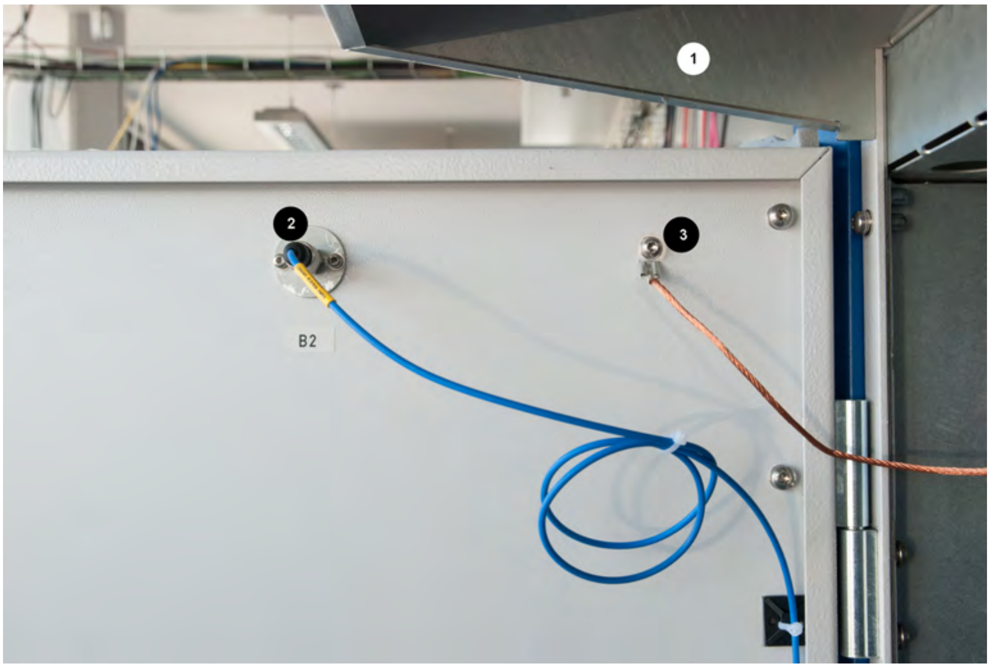

Fig. 3-18: Exhaust Kit, Rear door of transmitter rack

1 = Exhaust air transfer duct, top
2 = Connection of temperature sensor B2
3 = Connection of potential equalization cable (Torx screw)

3. Attach the connecting cables for E1, E2, S1, S2, B1, and B2 to the connection panel at the bottom of the left wall of the rack as followed.
   - Power cable W.1N for fan E1 to X.1N
   - Control cable W.E1 for fan E1 to X.E1
   - Connection cable W.S1 for pressure sensor S1 to X.S1
   - Power cable W.2N for fan E2 to X.2N
   - Control cable W.E2 for fan E2 to X.E2
   - Connection cable W.S2 for pressure sensor S2 to X.S2
   - Connection cable W.B2 for temperature sensor B2 to X.B2

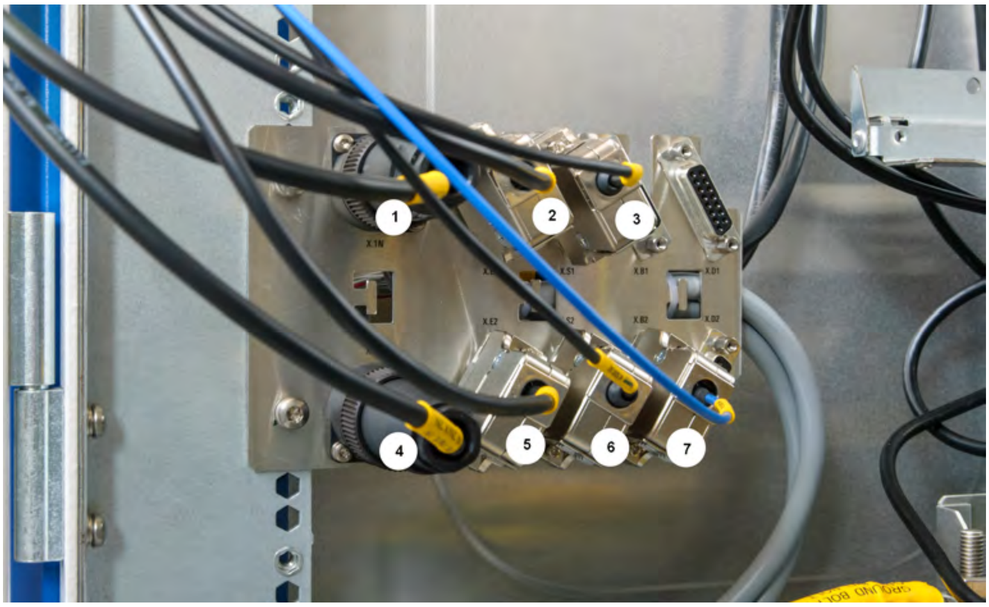

Fig. 3-19: Connection panel for exhaust kit.

1 = Power supply for fan E1 (X.1N)
2 = Connection of control line of Fan E1 (X.E1)
3 = Connection of pressure sensor S1 (X.S1)
4 = Power supply for fan E2 (X.2N)
5 = Connection of control line of Fan E2 (X.E2)
6 = Connection of pressure sensor S2 (X.S2)

3.3 Commissioning R&S TMU9

Commissioning of the transmitter system is described in the following document.

R&S THU9/TMU9 Transmitter System Operating Manual, Mat. No. 2109.9110.02

4 Exciter/Transmitter Control R&S TCE900

4.1 Design and Function R&S TCE900

4.1.1 R&S TCE900 General Design

The R&S TCE900 consists of a base module and various plug-in modules that enable the following versions of the R&S TCE900.

- R&S TCE900 SystemControl (TCE900 SysCtrl)
- R&S TCE900 Exciter (TCE900 Exc)

R&S TCE900

The basic R&S TCE900 unit is the same for all versions and consists of the following modules:

- Processor board (IPS1)
  The IPS1 processing unit has the following properties:
  – 1.6 GHz INTEL ATOM N processor
  – 2 GB RAM
  – CR2032 (3 V) battery for supplying the realtime clock with power in the event of a power failure.
  – Linux-based R&S TCE900 software

  A 4GB flash disk is located on the processor board; the operating system and all of the system settings are saved on it.
  The following interfaces are on the rear of the IPS1 unit:
  – 2 x USB 2.0 for connecting external devices (mouse, keyboard, USB stick)
  – 1 x Gigabit Ethernet 1000BaseT for externally controlling the R&S TCE900 via SNMP, VNC or remote desktop
  – 1 x DVI-D for connecting an external DVI-D monitor

  The IPS1 board also provides internal interfaces (via internal system connector #1).
  – 3 x PCIe 1.0a, Port A is used in the R&S TCE900 for exchanging data (TS or IP) between the option module and the computer. The other two PCIe interfaces are not used.

  Furthermore, there are additional internal interfaces for special applications:
  – 1 x SATA, interface (not used)
  – 1 x +5 V, hard disk power supply (not used)
  – 1 x mSATA socket for a 4GB flash disk (with operating system and system settings)
- System connection board (SCB)

The system connection board is the central board of the R&S TCE900 with a connection socket to the IPS1 processing unit (X17). The connector plugs for the backplane (X50, X51) are opposite the IPS1 connection socket.
The system connection board provides the following functions:

– The +12 V open-circuit voltage of the power supply is connected to the system connection board via the X1, X2 and X3 interfaces. All modules of the R&S TCE900 are supplied with a voltage of 12 V from there.
– FPGA D34 with PCIe interface for the IPS1 processing unit. This is used for transferring central control tasks, e.g. fan control.
– PCIe switch D28 for distributing one IPS1 PCIe lane to the 5 modular units on the backplane.
– USB hub D42 for distributing one IPS1 USB channel to the 5 modular units on the backplane.
– Smart card adapter X12 with USB interface for managing options.
– Ethernet switch D25 for additional network interfaces in the instrument.
– GPS receiver K1 with USB interface. The antenna signals travel from the external SMA input socket, "GPS ANT", to the GPS receiver via a cable. The GPS receiver generates an internal 1 pps signal for monitoring DVB-T SFN networks.

- Power supply
- Fans

R&S TCE900 SysCtrl

Fig. 4-1: R&S TCE900 Control - rear view

1 = Tx interface
2 = Cooling Interface / Air Cooling Interface
3 = Ethernet switch (opt. for N+1 systems)

In addition to the basic unit, the R&S TCE900 SysCtrl contains the following plug-in modules:

- Tx interface
  The TxIF in the R&S TCE900 is used as an interface from the IPS1 processor board to the mains distribution unit and in specific systems to control an RF switch and to monitor a switch-over panel. Additionally, there is an ethernet switch available, which is used for the commumication to the exciters.
  The TxIF is connected to the backplane via connection X100 (90-pin Airmax connector).
  The following connections are located on the rear panel:
  – X44: Interface for the mains distribution unit (15-pin)
  – X40-X43: 4 Ethernet interfaces (Gbit) for connecting the transmitter system's devices
  – X45: Interface to the RF switch and to a specific patch panel (15-pin)
- Air cooling interface (ACIF)
  The air cooling interface is an optional card for the R&S TCE900.

For a medium-power transmitter, the connection from the exhaust kit to the transmitter's control unit is established via the air cooling interface. This can be used to control 2 fans independently of each other using a 0 V to 10 V voltage signal. Simultaneously, 2 tachometer signals from the fans can be evaluated to determine their speed.
Two differential pressure sensors (1) are used to measure the pressure inside the frame enclosure with reference to the outside air pressure. Through the ACIF of the R&S TCE900, the RPM of the two fans (2) are regulated with the aim of maintaining normal air pressure within the enclosed frame.
Two examples for controlling of the normal air pressure in the rack:

– For example, when the temperature of the air fed to the transmitter rises, the RPM of the amplifier cooling fan will increase accordingly in order to adequately cool the amplifier. As a result, the pressure within the enclosed frame will increase and the ACIF will increase the RPM of the fans in the exhaust kit.
– When the temperature of the air fed to the transmitter decreases, the RPM of the amplifier cooling fan will decrease. As a result, the pressure within the enclosed frame will decrease and also the RPM of the fans in the exhaust kit.

During the initial commissioning of the system, a fallback RPM setting is configured. This setting ensures that adequate cooling of the transmitter is ensured, even if the ACIF goes off-line.
The air cooling interface is connected to the R&S TCE900 via USB on the backplane. In addition to this, interrupt lines are also provided, which run as a signal line (IRQSCB_OX, GPIO_OPTX_3) from the air cooling interface to the SCB/IPS1 and run as feedback lines (GPIO_OPTX_4, F0_1PPSSCB_OX) from the IPS1/SCB to the air cooling interface.
The plug position of the air cooling interface can be determined in the R&S TCE900 using SLOT_IDX.

● LAN switch
  Additional Ethernet connections are provided using a LAN switch.

In addition, connections for the R&S TDU900 display unit and additional external instruments (e.g. parallel remote control interface) are located here.

R&S TCE900 Exc

Fig. 4-2: R&S TCE900 Exciter - rear view

1 = RF Board
2 = Coder board

In addition to the basic unit, the R&S TCE900 Exc contains the following plug-in modules:

● Coder board
  The coder board in the R&S TCE900 is used for the transport stream's (TS) baseband coding. Depending on the standard in use, there are different models distinguished by how the FPGAs are equipped.
  The coder board is connected to the backplane using three Airmax connectors, X1 (90-pin), X2 (90-pin) and X3 (54-pin).

The following connections are located on the rear panel:
- X30/X31: Ethernet interface for TS via LAN
- X20/X21: BNC connections for TS via ASI
- X22: BNC connection for TS monitoring output
- X23: BNC connection for feeding in an external 1 pps pulse
- X24: BNC connection for outputting a reference signal (1 pps or 10 MHz)

● RF board
The RF board in the R&S TCE900 fulfills the following functions:
  - Converting baseband data from digital to analog and converting modulation to the final frequency (forward path).
  - Adaptive precorrection and signal analysis of the baseband data extracted this way (backward path).
  - Central creation and distribution of the system cycle.

  The RF board is connected to the backplane via connection X10 (90-pin Airmax connector) and receives the digital baseband data from the coder over this connection.
  JTAG interface X2 is provided for diagnostic purposes.
  The following connections are located on the rear panel:
  - X60: RF output (QMA)
  - X61: RF output monitor (SMA)
  - X64: Input for reference frequency (BNC)
  - X67/X68 RF traceability for precorrection (QMA)

A GPS receiver can also be activated.

The general block diagram for the R&S TCE900 unit is below.

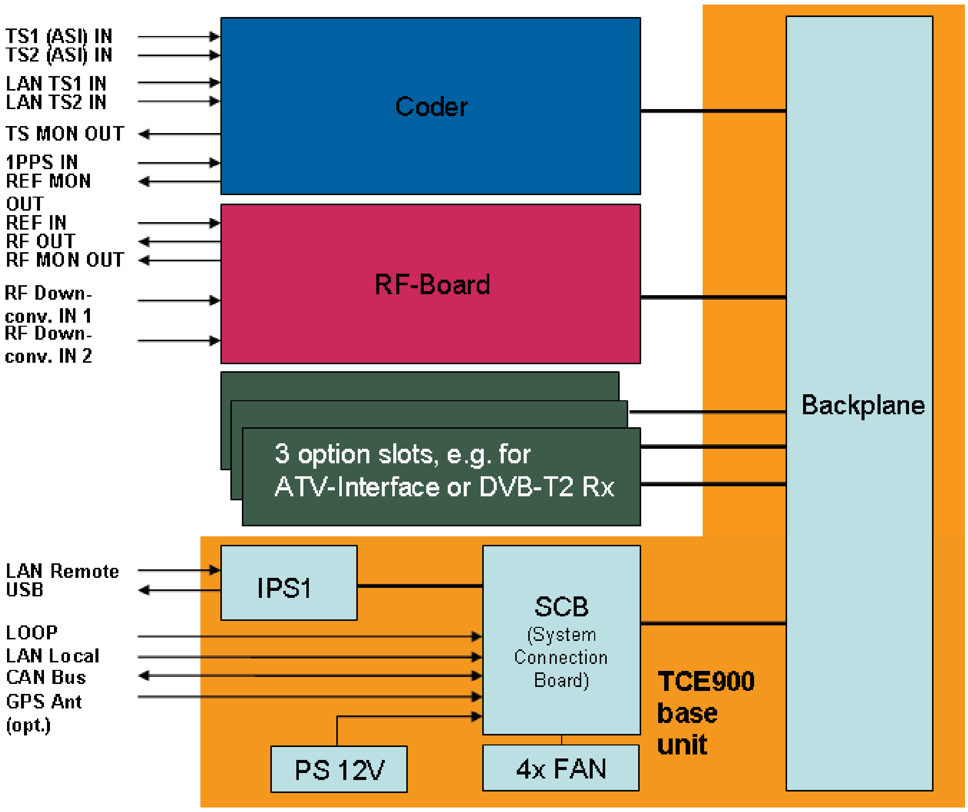

Fig. 4-3: R&S TCE900 block diagram

4.1.2 R&S TCE900 Functions

The individual versions of the R&S TCE900 perform the following functions:

R&S TCE900 SysCtrl

The R&S TCE900 SysCtrl takes over communications with the outside world and provides the connection to the R&S R&S TDU900.

R&S TCE900 Exc

The R&S TCE900 Exc takes over the tasks of an exciter, processes the data transport stream and encodes the extracted data packets. The DTV signal is then precorrected, modulated to the transmission frequency and forwarded to the transmitter output stage.

5 Amplifier R&S PMU901

5.1 Design and Function R&S PMU901

5.1.1 Device Purpose and Overview

The R&S PMU901 amplifier is a broadband unit that operates as a power amplifier in the frequency range from 470 MHz to 862 MHz with the following TV standards:

- digital (DTV) standards: DVB-T/H, DVB-T2, ATSC, ATSC Mobil, $ISDBT_B$
- analog (ATV) standards: ATVc (combined) B/G, D/K, K1, M/N, I, I1

It is based on the BLF888 transistor from NXP. The entire RF circuitry is on the A2 module (amplifier board).

Broadband and Doherty mode (DTV only)

Apart from conventional broadband mode, the amplifier can also be operated according to the Doherty principle in order to considerably improve AC efficiency (approx. 35 %).

Whereas the amplifier in the classic operating mode (as a linear amplifier with class AB output stage) operates as a broadband unit without the need for adjustment across the entire UHF range at AC efficiency levels around 25 %, the amplifier in Doherty mode is band-limited at efficiency levels > 35 %.

The operating mode of the amplifier is set using a tuning unit ("tunit") which can be accessed from outside and is part of the top cover. With the tunit in its normal installation position, the R&S PMU901 operates in AB mode as a conventional broadband linear amplifier with 6 parallel-connected BLF888 units. When turned through 180°, the tunit allows the output stage to operate according to the Doherty principle. Three BLF888 units then serve as the main amplifier and three as the auxiliary amplifier of the 6 dB Doherty system. The tuning of the tunit now determines the available frequency range. There are seven fixed tuning ranges or tunit variants for the entire UHF band (470 MHz to 862 MHz). One tuning range covers up to 12 channels.

This special patented architecture of the R&S PMU901 means that the amplifier itself actually remains invariant. Different variants do not need to be made available as replacement parts. Every amplifier can be used in every transmitter. If a (Doherty) amplifier needs to be replaced, the tunit is pulled out of the amplifier to be replaced and then inserted into the replacement amplifier. If the frequency of the entire transmitter has to be changed (very rare), only the tunits have to be changed (not necessary in all cases). If in doubt, the amplifiers of a transmitter can of course always be configured to conventional broadband mode by turning the tunit. This operating mode is indispensable, especially in the case of replacement transmitters in N+1 systems.

A control word is used to inform the amplifier control board of the installation position of the tunit and therefore the operating mode. In Doherty mode, the control word also informs the amplifier control board of the tuning range. If the tunit does not match the frequency of the transmitter or the wrong operating mode is configured, the amplifier remains switched off and signals FREQ_FAIL.

Control and monitoring

The amplifier is operated via the transmitter control unit only. Module A1 (amplifier control board), which operates independently of power and frequency band and is also used in other TX9 amplifiers, is responsible for the monitoring and control functions as well as CAN bus connection. The interface for the amplifier control board is largely compatible with the VH8xxx amplifiers. This means that the amplifier can be operated using the control unit from the 8000 family and outside of the transmitter for test purposes using the GT800A1 test box.

Power supply

The amplifier has a 3 kW power supply unit (regular power supply unit 1) which delivers both the amplifier operating voltage and the 15 V auxiliary voltage. As an option, an identical power supply unit can be parallel-connected as an active standby. Both power supply units can be replaced without the amplifier needing to be switched off or removed from the transmitter. The standby power supply unit can be assigned to a separate phase on the system side. The permissible mains voltage range of the amplifier is 170 V to 264 V AC.

At reduced output powers, the efficiency of the amplifier can be optimized by reducing the DC voltage of the power supply.

5.1.2 Mechanical Design

The amplifier is fully enclosed in a 19" metal housing. The height of the cabinet is 3.5 HU (156 mm). The housing consists of a mounting frame, top cover, front cover and rear panel. The two fans are attached to the rear panel. At the center of the housing is the amplifier board, under which is the heat sink and under that the power supply unit with power adaptor board.

After the mains voltage has been disconnected (after the pre-trip has been switched off), the amplifier can be removed from the rack without disconnecting any connectors while the transmitter is still in operation (self-engaging plug-in connections).

Although the R&S PMU901 amplifier is normally used in combination with a transmitter rack, it can also be operated as a stand-alone desktop unit together with the R&S TCE900 exciter.

Modules

The amplifier consists of the following modules:

- A1: Amplifier control board
- A2: Amplifier board
- A3, A4: Power supply 1, power supply 2 (standby, optional)
- A5: Tunit (tuning unit)

- A6, A7: Adaptor board 1, adaptor board 2 (standby)

The entire amplifier unit is on the top side of the amplifier.

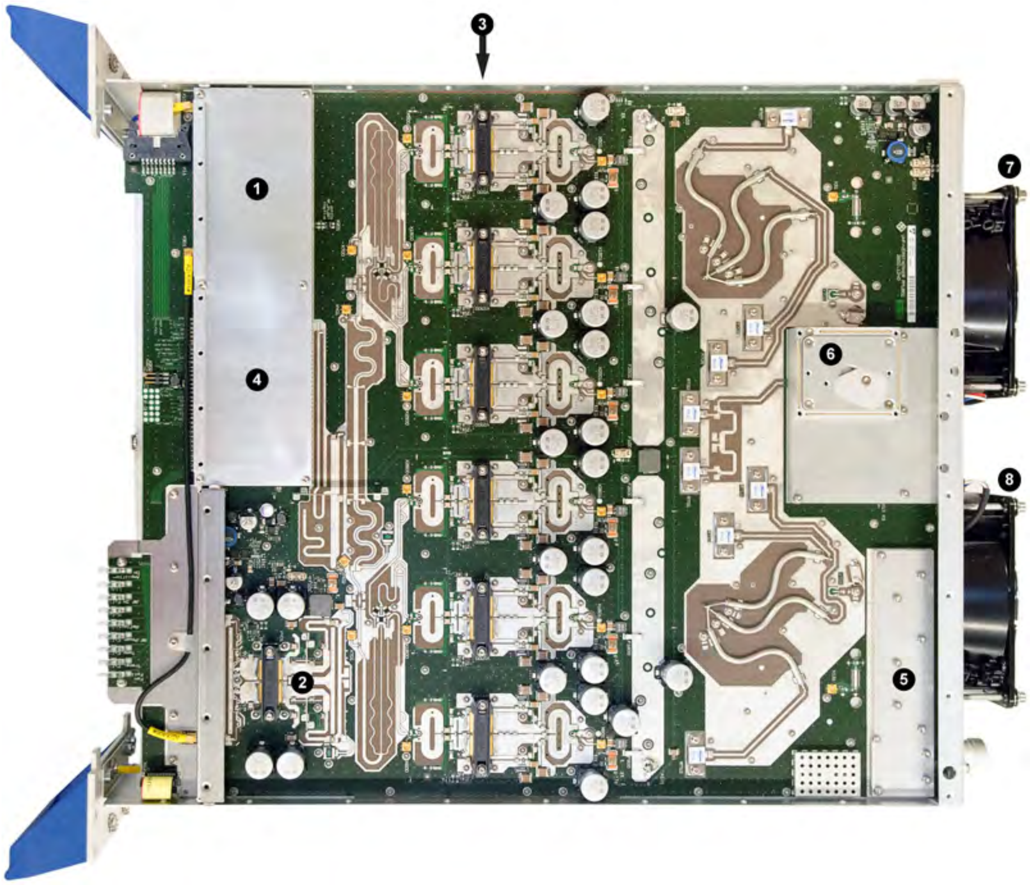

Fig. 5-1: Amplifier board – A2 (top cover removed)

1 = Preamplifier
2 = Driver amplifier
3 = Output stage with 6 transistors
4 = Amplifier control board – A1
5 = RF detectors
6 = Tunit – A5 (here in normal installation position for broadband mode)
7 = Fan 1
8 = Fan 2

One or two power supply units are in the lower part of the amplifier behind the front cover.

Fig. 5-2: Power supply unit and heat sink (front cover removed)

1 = Fins of heat sink
2 = Power supply 1 – A3
3 = Installation compartment for power supply 2 – A4 (option)

One or two power adaptor boards are on the underside of the amplifier behind the PAB cover.

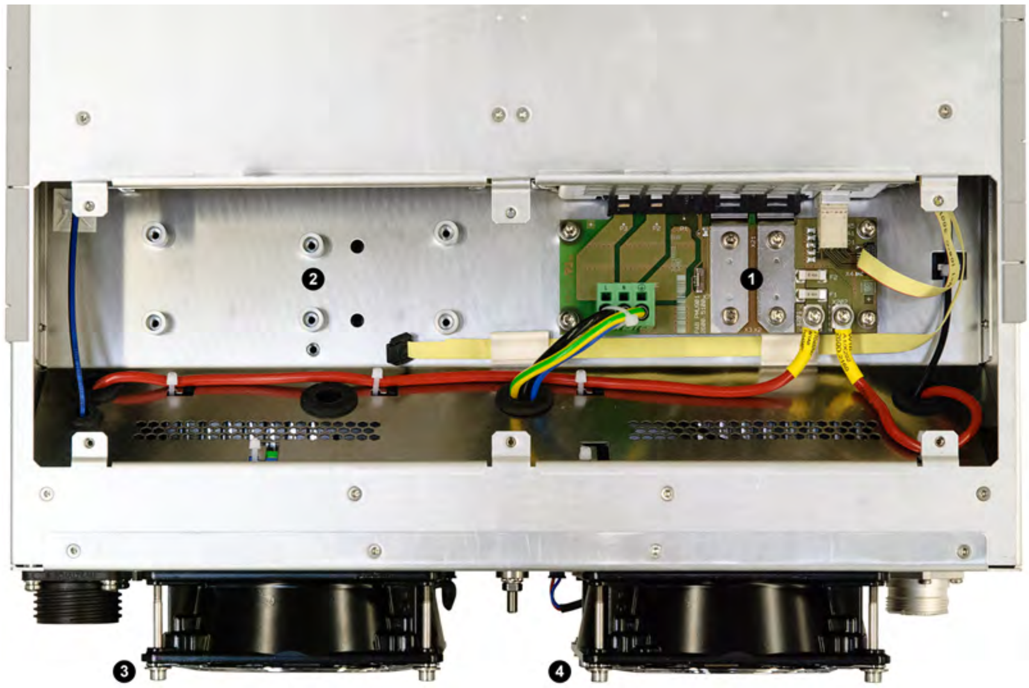

Fig. 5-3: Power adaptor board (cover removed)

1 = Power adaptor board 1 – A6
2 = Installation location for power adaptor board 2 – A7 (option)
3 = Fan 1
4 = Fan 2

Cooling

The amplifier is cooled by a high-performance copper heat sink and two dedicated amplifier fans. The cooling system features the following:

- The amplifier circuitry is cooled by means of thermal conduction to the heat sink which dissipates heat to the flow of cooling air inside the amplifier (no additional fans are used).

- The power supply unit has its own heat sink which also dissipates heat from the power supply unit to the flow of cooling air inside the amplifier.
- Part of the cooling air also flows through the power supply unit circuitry in order to cool the components.

Tunit

The installation position of the tuning unit ("tunit") determines whether the two groups of three identical output-stage transistors are parallel-connected to form a classic broad-band amplifier or whether they form a Doherty system with a main and auxiliary amplifier.

- With the tunit in its normal installation position ("B-Mode" on the top cover), the amplifier functions as a conventional linear amplifier with 6 parallel-connected out-put-stage transistors in AB mode. It thus operates as a broadband unit without the need for adjustment across the entire UHF range.
- When turned through 180° ("D-Mode" on the top cover), the tunit allows the output stage to operate according to the Doherty principle. Three output-stage transistors then serve as the main amplifier and three as the auxiliary amplifier of the 6 dB Doh-erty system. In this operating mode, the two tuning elements of the tunit determine the operating frequency(-ies) of the amplifier. They are indicated on the tunit label and are only valid for as long as the calibration sticker is undamaged.

The tunit is inserted from above into the cover of the amplifier section in the amplifier. It is therefore only accessible when the amplifier has been removed from the transmitter.

NOTICE

The amplifier **must** be switched off before the tunit is removed! Removal while the ampli-fier is still in operation can result in the transistors being irreparably damaged.

5.1.3 Display Elements and Interfaces

5.1.3.1 LEDs and Test Point – Front Panel

The following LEDs for indicating states and faults are on the front panel:

Name	No.	Signaling	Meaning
AMPLIFIER ON	H1	LED, green	The LED lights up when the amplifier is ready for operation, i.e. the supply voltage is present and the transmitter is in operation.
LINK	H2	LED, green	Amplifier communication with the BUS. ● Flashing rapidly: No master ● Flashing slowly: Not operational but communication link present ● Permanently lit: Normal communication ● OFF: Processor is not being supplied with power (no V_AUX)
RF IN FAIL	H3	LED, yellow	The LED lights up if the RF input level (X10) is below the preset threshold.
MUTE	H4	LED, yellow	The RF output signal (X1) is suppressed (caused by the SHUT_DOWN command, if the external power combiner overheats, with the RF_IN_FAIL message or with the RF_MUTE signal).
REFLECTION	H5	LED, yellow	The LED lights up if the reflection at the RF output exceeds a threshold. The message is stored in a nonvolatile memory in the amplifier and can be reset at the transmitter control unit (Reset).
RF POWER FAIL	H6	LED, red	The LED lights up if the RF output power is below half (-3 dB) of the nominal value.
TEMP FAIL	H7	LED, red	The LED lights up in the case of overtemperature in the amplifier unit. The message is stored in a nonvolatile memory in the CAN controller and can be reset at the transmitter control unit (Reset). The output power is suppressed for as long as overtemperature exists.
TRANSISTOR FAIL	H8	LED, red	The LED lights up if a transistor fails in the output stage or driver.
FAN FAIL	H9	LED, yellow	The LED lights up if one or more fans fail.

Indication of other operating states:

- H6 – H8 flash

A problem has occurred during initialization. Certain hardware conditions are not fulfilled, e.g.:
- Internal operating voltages are missing.
- The tunit installed in the transmitter does not correspond to that expected by the transmitter (returned FREQ_ID).
- No FREQ_ID has yet been returned by the transmitter.

- H3 – H5 chaser light
  Bias adjustment is active (duration: approx. 2 min.).
- H1 to H8 flash for 10 s
  The command to detect an amplifier has been activated

The generated status displays and measurement values are shown in the GUI of the transmitter control unit (R&S TDU900).

Front RF test connector

At the RF MONITOR test point (**X3**, SMA socket), part of the output signal from the amplifier circuitry is output via a directional coupler (1 V test point). This allows evaluation of the signal quality downstream of the amplifier.

The coupling attenuation of the RF MONITOR test point has a frequency response of -6 dB per octave. The attenuation at 650 MHz is stored and can be queried via the transmitter control unit. The level at **X3** changes slightly (approx. 0.1 dB) if a connection is disconnected or connected at **X13** (ADE OUT, rear panel).

5.1.3.2 Connectors – Rear Panel

The following connectors are on the rear panel of the amplifier:

- X1 – Mains voltage feed for 1 or 2 power supply units
- X2 – HF output **RF OUT**(7/16 female connector)
- X10 – HF input **RF IN**(SMA female connector)
- X11 – **AMPLIFIER CONTROL** interface to the amplifier control board with integrated connection to the CAN bus (D-Sub male connector, 15-contact)
- X13 – Second **ADE OUT** RF test connector for connecting the ADE demodulator for automatic digital precorrection upstream of the channel bandpass filter (with 1 amplifier in the transmitter; SMA female connector)
- X22, X23 – Connection for fan 1 and fan 2 (Molex male connector)
- 3 connection possibilities for the additional PE conductor (a second PE conductor is always required!)

Fig. 5-4: Rear panel of R&S PMU901 with connections for a second PE conductor

1 = Threaded hole (M6) for screwing on a ground cable with cable lug (alternative to 3)
2 = Multilam female connector for self-engaging connection of second PE conductor in transmitter rack
3 = Ground bolt (M5) for connection of second PE conductor at test station

Amplifier control

All control functions in the TX9 transmitters are executed by means of CAN commands via the X11 interface.

5.1.4 Circuit Descriptions

5.1.4.1 Block Diagram

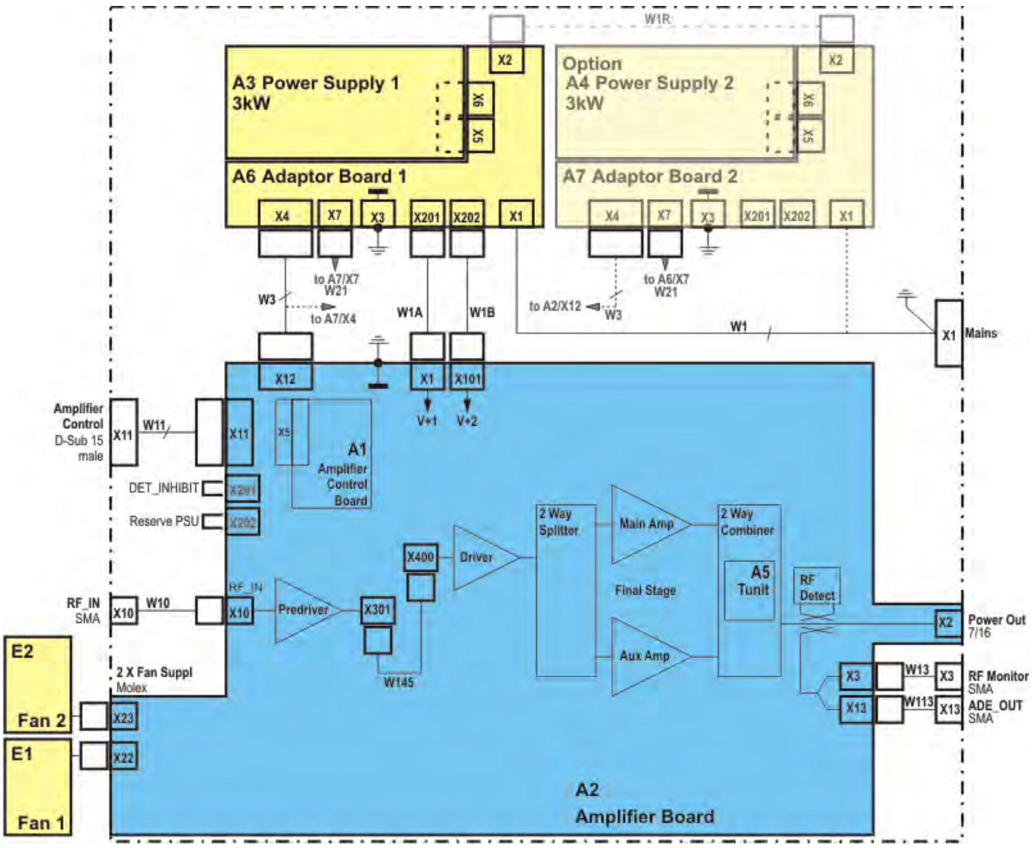

Fig. 5-5: Block diagram of R&S PMU901

5.1.4.2 Signal Gain in Preamplifier and Driver

The entire signal gain process takes place on the amplifier board (module A2). It goes though the following steps in the preamplifier and driver.

- The RF input signal passes from the amplifier input X10 on the rear panel of the instrument along the RF line W10 and into the preamplifier, which is under an RF-shielded cover.
- In the preamplifier, the signal passes through the following components in sequence:
  – Amplitude regulator
  – Small-signal amplifier
  – Phase regulator
- This is followed by an LDMOS transistor stage (BLF642, single-ended, A mode) as a preliminary driver.

- The signal leaves the preamplifier and is fed to the input of the driver amplifier via the cable W145x. This input consists of two single-ended LDMOS transistor stages which are interconnected by means of 90° jumpers. The two transistor halves of the BLF888B push-pull transistor are used for this purpose.
- The cable W145x is also used for phase adjustment (in the case of design modifications or for tolerance adjustment). It connects the connectors X301 and X400.
- The output signal of the driver is fed to the output-stage splitter via a harmonic filter. This filter is used especially at low frequencies to suppress the first harmonic.

NOTICE

The cable W145x must not be removed and should only be replaced with a cable with the same R&S part number. Failure to observe this point can result in destruction of absorbers of the power combiner in the transmitter (if more than one amplifier is installed).

5.1.4.3 Signal Gain in Doherty-Capable Output Stage

The output stage is divided into two groups, each with three transistors. In Doherty mode, one group forms the main amplifier (3 x BLF888B) and the other forms the auxiliary amplifier (3 x BLF888A). If the two groups have equal priority, however, they can also form a conventional output stage.

The following steps take place in the output stage:

- The output signal of the driver is fed via a 90° splitter to two output-stage groups each with three transistors.
- The two power streams are divided between the three transistors of each output-stage group via a 0° splitter. The output-stage group which forms the main amplifier in Doherty mode uses BLF888B transistors, and the output-stage group for the auxiliary amplifier uses BLF888A transistors.
- Two 0° combiners combine each group of three partial power streams and make them available at the inputs of a 2-way power combiner ready for addition.
- The tunit connected at the power combiner determines the operating mode of the amplifier:
  – Conventional broadband AB mode in the normal installation position
  – Doherty mode if the tunit is turned through 180°
- Directional couplers upstream of the RF output of the amplifier (downstream of the 2-way power combiner) detect forward and reflected power. Their signals are fed to RF detectors. A further directional coupler provides two free decoupled RF test points (RF MONITOR, ADE OUT) via a small splitter.

The operating points of the transistors of the main and auxiliary amplifier can be set separately. In Doherty mode, the main amplifier operates in AB mode and the auxiliary amplifier in C mode. When the amplifier operates as a conventional broadband amplifier, all of its output-stage transistors operate in AB mode.

5.1.4.4 Power Control

To ensure that the required power is always present at the amplifier output, the level tolerances at the following points are adjusted by means of a power control circuit.

- at the amplifier output
- at the entire RF amplifier stage

During power control, a control amplifier which is on the amplifier board (module A2, preamplifier section) is supplied with an actual voltage and a nominal voltage. The nominal voltage is the VREF_PWR signal which is fed as a CAN command and is used to adjust the output power.

Intelligent control brake

In the case of the R&S PMU901 with the special output-stage architecture necessary for the Doherty operating mode, it is not possible to apply the control principle with transistor-failure tolerance which is traditionally used at Rohde & Schwarz and features two independent actual value detectors downstream of the subamplifiers with the same output power.

The PWR_OUT signal which is proportional to the sum output power is used as the actual value for control. In order to still retain tolerance with regard to transistor failures, the principle of the "intelligent control brake" is applied (IPLIM = **I**ntelligent **P**ower **LIM**iter). Here, the adjustment range of the control amplifier is simply limited adaptively in such a way that overloading of the intact transistors in the event of a transistor failure cannot result in their failure. The control brake therefore always adapts to the current conditions in the control circuit. This principle exploits the fact that changes in gain and input signal which are the result of temperature and aging take place only slowly.

The manipulated variable (the regulating voltage of the PIN attenuator) is recorded at long intervals. The control brake (i.e. the maximum possible value for the regulating voltage) is derived from the measured value plus the difference which is not exceeded until the next measurement, provided that normal temperature and aging processes exist. This means that the control brake will also increase slowly if, for example, the gain drops with increasing temperature and the regulating voltage of the PIN attenuator increases in order to maintain the output power. In the case of dramatic changes resulting from transistor failure or dramatic changes in the input signal, adaptation of the control brake with respect to this is stopped and the control brake thus becomes fully effective.

The amplifier control now analyzes the current situation without disturbance and responds according to the determined cause. If the cause is, for example, a transistor failure, the amplifier control adapts the nominal regulation value according to the remaining performance of the amplifier. In this way, a stabilized condition is achieved, albeit with reduced output power. At power ON and if the nominal regulation value is changed, the control brake is of course stopped briefly.

Reflected power test point

In the case of reflection at the amplifier output, the forward power is reduced in order to protect the amplifier. For this purpose, the REFL_SAVE signal is acquired at the reflected power test point. This signal is superimposed on the actual value signal during power control by means of a diode. If the REFL_SAVE signal exceeds the voltage of the forward power detector PWR_OUT, the reflected power test point takes over power control. The control amplifier supplies the control voltage V_REG as the output quantity and this voltage is fed to the amplitude regulator in the preamplifier.

Additionally, the REFL_OUT signal is acquired at the reflected power test point. This signal together with the PWR_OUT signal (forward power) is used for VSWR indication at the amplifier output.

5.1.4.5 Self-Protection Mechanisms

The amplifier has a series of self-protection and monitoring mechanisms which protect it against irreparable damage in the case of impermissible operating conditions and enable transmission to continue for as long as possible. The following mechanisms are available.

- Power supply monitoring
- Input level monitoring
- Output power limitation
- Temperature monitoring incl. fan control
- Reflection monitoring
- Operating mode monitoring

Power supply unit monitoring

The power supply unit has the following self-protection mechanisms:

- Overtemperature shutdown for the duration of overtemperature
- Short-circuit current limitation
- Input voltage monitor (enables shutdown to limit the input current in the case of undervoltage)
- Overvoltage limitation (on DC side)

If no standby power supply unit is installed, failure of the power supply unit (/ DC_OK = high) will mean failure of the amplifier. If a standby power supply unit is installed, there will be no operational restrictions. The amplifier will however be completely deactivated if both power supply units fail.

The overtemperature shutdown in the power supply is intended purely as a self-protection mechanism only and is not indicated by the front LED as the DC voltage is switched off. A temperature shutdown at the power supply is signaled only indirectly by the message / DC_OK_x. The power supply unit has status LEDs for normal operation and fault indication. These LEDs are indirectly visible after removal of the front cover (and, where applicable, the air filter).

Input level monitoring

If the input level drops below a defined threshold (RF_IN_FAIL), power control is influenced by the following measures:

- The amplitude regulator for power control is switched to maximum attenuation
- The internal reference voltage for power control is suppressed

A soft start is performed as soon as the input signal returns. The selected threshold is such that the amplifier can be reliably operated across the entire temperature range in all permissible operating modes, even at the lower tolerance limit of the RF_IN input signal at X10.

Output power limitation

The output power is set by means of the VREF_PWR signal. The output power is limited such that the amplifier cannot be damaged at excessively high VREF_PWR values. In addition, the average output power of the amplifier is also limited by means of hardware. Excessive power if the forward power test point fails as well as subsequent failures if a transistor fails are countered by the intelligent control brake.

Temperature monitoring and fan control

The power supply units and amplifier circuit each have a dedicated hardware overtemperature shutdown mechanism. If a temperature threshold is exceeded, the amplifier is disabled (TEMP_FAIL message), whereby the threshold for the overtemperature shutdown is above the permissible operating temperature. This ensures that the remaining overall power loss does not lead to overheating of the instrument, even with total failure of the cooling system.

The fan has four different speed settings, whereby the second speed is the standard speed which has been optimized with regard to the average junction temperature of the output stage and to noise generation.

To ensure that transmission can continue for as long as possible, the temperature and fan control functions work together as follows:

- If the temperature rises in the amplifier circuit, the fan speed is first increased before the hardware shutdown threshold is reached.
- If this is not enough, at temperatures above 83 °C the amplifier control begins to reduce the output power in steps of 1 dB (DTV only, REDUCED_PWR message).
- With ATV, the output power is not reduced at excessively high temperatures. Instead, the amplifier is shut down by means of software at 85 °C.
- At temperatures above 90 °C, the amplifier remains switched off by means of hardware for as long as the overtemperature exists. Overtemperature on the amplifier board is indicated by means of the front TEMP FAIL LED (with ATV: at 85 °C and higher).
- An appropriate hysteresis is integrated to prevent deactivation and activation from occurring too soon. A soft start is performed as soon as power returns.

In addition, the inlet and outlet temperature is measured by means of two sensors (on the front and rear side of the amplifier board, thermally insulated from the rest of the printed board). This allows, for example, a fouled air filter to be detected and changed in good time (AIR_FILT_FAIL message).

Reflection monitoring

A distinction is made between the following types of reflection monitoring (REFLECTION message):

- With major reflection above reflection threshold 2 (s = 2), the power is briefly cut off completely first of all; a soft start is performed immediately afterwards. If any reflection remains, the amplifier protects itself by reducing the output power. The time constant selected for the shutdown is such that damage to the amplifier is prevented in the case of total reflection and at all phase angles of the reflection at X2.
- With weaker reflection above reflection threshold 1 (S = 1.5), the output power is reduced without preceding shutdown.
- When reflection no longer exists, the power reduction is canceled automatically.

Operating mode monitoring

Using a 5-bit code (FREQ_ID), the transmitter notifies the amplifier of the expected operating mode and, in Doherty mode, the expected tuning variant (transmit frequency). If this code is not the same as the code of the tunit installed in the amplifier, the amplifier ignores the ON command and signals FREQ_FAIL.

For conventional broadband operation, the FREQ_ID is 00000. If no tunit is installed, the amplifier signals FREQ_ID 11111. All other FREQ_IDs are reserved for Doherty mode.

5.1.4.6 Emergency Shutdown

The amplifier can be disabled externally by means of the SHUT_DOWN signal at X11, for example to ensure self-protection for the absorber of the power combiner in the transmitter. The signal, which is immune to cable breaks, is fed via an optocoupler on CAN_GND and is therefore insulated from amplifier ground. The output power is suppressed for as long as no connection to CAN_GND exists.

To activate the amplifier when the R&S GT800A1 test box is being used, it is necessary to connect X20 (GND) to X21 on the test box.

5.1.5 Specifications

5.1.5.1 General Data

Frequency range	470 MHz to 862 MHz (band 4 and 5)
Power supply (3 separate phases)	
- Nominal voltage range	200 V to 240 V
- Tolerance range	170 V to 264 V
- Nominal frequency range	50 Hz to 60 Hz
- Tolerance range	47 Hz to 63 Hz
Power factor (cosφ)	≥0.98 at nominal power

Operating temperature range ($T_u$room)	+1 °C to +45 °C
Inlet air temperature ($T_{inlet\ air}$)	+1 °C to +45 °C
Storage and transport temperature range	-40 °C to +85 °C
Setting range for amplifier phase (via CAN)	±12.5° to ±17.5°
Harmonics	
- up to 550 MHz	≤ -30 dBc
- as of 550 MHz	≤ -50 dBc
VSWR RF input (X10)	≤ 1.4
VSWR RF output (X2)	
- compliance with specifications	≤ 1.3
- reduction	as of 1.6±0.3
Overtemperature shutdown	90 °C ±4 K (sensor on heat sink)
Permissible humidity	≤ 95 % at 40 °C, non-cyclical, non-condensing
Ambient conditions	Complies with ETSI EN 300-019-1-3 (V2.3.2 2009-07) Class 3.2 with reduced ambient temperature and humidity range
Maximum installation altitude above sea level	2000 m (higher on request; power supply units up to 3000 m)
Vibration, sinewave	5 Hz to 150 Hz, max. 1.8 g at 55 Hz, max. 0.5 g at 55 Hz to 150 Hz in line with EN60068-2-6, EN61010-1
Vibration, random	10 Hz to 300 Hz Acceleration 1.2 g (rms)
Shock	Shock spectrum 40 g/11 ms to MIL-STD 810E Method No. 516.4
Dimensions (depth, width, height)	550 mm, 153 mm, 19" (3.5 HU)
Weight	< 25 kg

5.1.5.2 Digital TV (DTV)

Input power P_{avg}nominal (DVB-T / ATSC)	0 dBm / 1 dBm
Maximum input power $P_{avg,in}$	≤ +13 dBm
Control range (DVB-T / ATSC)	-6 dBm to +6 dBm / +5 dBm to +7 dBm
Detector setting (signal PEAK_AV, X11)	Low (AV)
Output power P_{avg}nominal (VREF_PWR = 4 V)	600 W

Setting range for output power referenced to P_{avg}nominal	-10 dB to +1.2 dB
Output power DVB-T, P_{avg} (nominal value / maximum value)	600 W / 700 W; Doherty: 600 W / 650 W*
Output power ATSC, P_{avg} (nominal value / maximum value)	750 W / 750 W; Doherty: 600 W / 650 W*
Shoulder attenuation at P_{avg}nominal (without precorrection / with precorrection)	≥ +26 dB / ≥ +37 dB
MER with DVB-T, P_{avg}nominal (shoulder precorrected > 37 dB)	≥ 33 dB
Power consumption:	
- at 230 V, DVB-T, 650 W	≤ 3000 VA (Doherty: ≤ 2000 VA)
- at 230 V, ATSC, 750 W	≤ 3000 VA

* Depends on MER and channel

5.1.5.3 Analog TV (ATV Combined)

Input power P_{sync}nominal	+3.5 dBm
Maximum input power $P_{avg,in}$	≤ +13 dBm
Control range $P_{sync,in}$	-2.5 dBm to +9.5 dBm
Detector setting (signal PEAK_AV, X11)	High (PEAK)
Output power P_{sync}nominal (VREF_PWR = 4 V)	1000 W
Output power $P_{avg,max}$	675 W
Setting range for output power referenced to P_{sync}nominal	-10 dB to +0 dB
Power consumption at 1000 W:	
- at 230 V, APL = 0 % (all-black picture)	≤ 3000 VA
- at 230 V, APL = 50 % (gray picture)	≤ 2400 VA

5.1.5.4 CW Mode

Input power P_{avg}nominal	+1 dBm
Maximum input power $P_{avg,in}$	≤ +13 dBm
Control range $P_{avg,in}$	-5 dBm to +7 dBm
Detector setting (signal PEAK_AV, X11)	Low (AV)

Output power P_{avg}nominal	675 W
Power consumption: at 230 V, CW, 600 W	≤ 2500 VA

A R&S TMU9 Interface Description

A.1 External Transmitter Interfaces

A.1.1 Transmitter Input AC

Table 1-1: Q1: Supply input

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
Line L1	Input	230 V ± 15%	Q1.2	230 V L-N
Line L2	Input	230 V ± 15%	Q1.4	230 V L-N
Line L3	Input	230 V ± 15%	Q1.6	230 V L-N
Neutral N	Input	0 V	Q1.8/N	Neutral conductor input N

Table 1-2: Q1: Protective conductor terminal

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
PROTECTION EARTH PE	Input	0 V	X.PE.1	PE terminal NVT
PROTECTION EARTH PE	Input	0 V	X.PE	Station PE

The mains distribution unit designed for the TMU9 is limited to 230 V power supplies.

- AC power supply: 230 V; 2W + PE (L1/N/PE)
- AC power supply: 400 V / 230 V; 4W + PE (L1/L2/L3/N/PE)

All other network configurations can be covered by the optional use of the R&S ZR800Z10 mains distribution unit:

- AC power supply: 230 V; 2W + PE (L1/N/PE)
- AC power supply: 240 V; 2W + PE (L1/L2/PE)
- AC power supply: 400 V / 230 V; 4W + PE (L1/L2/L3/N/PE)
- AC power supply: 208 V Y; 3W + PE (L1/L2/L3/PE)
- AC power supply: 240 V Y; 3W + PE (L1/L2/L3/PE)
- AC power supply: 240 V delta; 3W + PE (L1/L2/L3/PE)

A.1.2 Input Signals (TS, RF, Reference)

The following interfaces are present again with each additional signal processing and therefore are listed only once at the transmitter level.

- With dual drive, another TS splitter (dual drive) is put upstream of the signal processing modules (TCE900 exciter).
- With N+1 systems, a TS splitter (N+1) is put upstream of the signal processing module(s) (TCE900 exciter) of the transmitter(s) TxA, and another ASI routing switch is put upstream of the signal processing module(s) (TCE900 exciter) of the transmitter(s) TxB.

TS feed (ASI, IP)

Table 1-3: X20 – TS1 in: BNC jack 75 Ω

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

Table 1-4: X21 – TS2 in: BNC jack 75 Ω

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

Table 1-5: X30 – TS1 LAN: 8-pin RJ-45 socket

Signal Name/Description	Direction	Value range	Connection point	Remarks
TX+	Output	Ethernet	X32.1	Transmitting line
TX-	Output	Ethernet	X32.2	Transmitting line
RX+	Input	Ethernet	X32.3	Receiving line
	Bidirectional	75 Ω termination	X32.4	
	Bidirectional	75 Ω termination	X32.5	
RX-	Input	Ethernet	X32.6	Receiving line
	Bidirectional	75 Ω termination	X32.7	
	Bidirectional	75 Ω termination	X32.8	

Table 1-6: X31 – TS2 LAN: 8-pin RJ-45 socket

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
TX+	Output	Ethernet	X33.1	Transmitting line
TX-	Output	Ethernet	X33.2	Transmitting line
RX+	Input	Ethernet	X33.3	Receiving line
	Bidirec-tional	75 Ω termination	X33.4	
	Bidirec-tional	75 Ω termination	X33.5	
RX-	Input	Ethernet	X33.6	Receiving line
	Bidirec-tional	75 Ω	X33.7	
	Bidirec-tional	75 Ω	X33.8	

Receiver module (optional)

Table 1-7: X69 – RF IN DVB-T2 Receiver: BNC jack 50 Ω

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
ANTENNA 1	Input	30 MHz to 1 GHz -92 dBm to 0 dBm 75 Ω	X69.1	RF input BNC jack
GND	Bidirec-tional	0 V	X69.2	

Reference feed

Table 1-8: X66 – GPS ANTENNA: SMA socket 50 Ω

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
GPS ANT	Input	-144 dBm to -5 dBm	X66.1	50 Ω SMA socket
GND	Bidirec-tional	0 V	X66.2	

Table 1-9: X23 – 1PPS IN exciter: BNC jack 50 Ω

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
1PPS_EXTERN	Input	TTL level (pos.edge)	X23.1	Seconds pulse from external GPS receiver
GND	Bidirec-tional	0 V	X23.2	GND / shield

Table 1-10: X64 – REF IN: BNC jack 50 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
REF IN	Input	-5.0 dBm to 20 dBm or TTL	X64.1	50 Ω BNC jack
GND	Bidirectional		X64.2	GND / shield

A.1.3 Transmitter Output

Table 1-11: Transmitter RF output: Connection depending on transmitter output power

Signal Name/Description	Direction	Value range	Connection point	Remarks
Tx RF output	Output	DVB-T; ATSC P_{AVG} = 200 W to 2.85 kW ATV P_{AVG} = 400 W to 4.75 kW 470 MHz to 862 MHz	RF	RF output on the transmitter roof 1 5/8" EIA upstream of channel filter
GND	Bidirectional		RF	GND / shield

A.1.4 Monitoring Signals (TS, RF, Reference)

The monitoring signals for transport stream, reference frequency, 1PPS, and local oscillator are directly implemented at the exciters. The RF test point is accessible at the directional coupler on the rear side of the rack. With the "Front test points" option, the monitoring interfaces are wired to the front of the transmitter.

Table 1-12: X22 – TS MONITOR OUT: BNC jack 75 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
TS MON OUT	Output	ASI / SMPTE310M	X22.1	R_i = 75 Ω
GND	Bidirectional		X22.2	GND / shield

Table 1-13: X24 – REF MONITOR: BNC jack 50 Ω

Signal Name/Description	Direction	Value range	Connection point	Remarks
REF MON	Output	TTL level	X24.1	Reference monitoring exciter
GND	Bidirectional	0 V	X24.2	GND / shield

Table 1-14: X61 – RF measurement output DTV exciter n: SMA socket 50 Ω

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
RF MONITOR OUT	Output	-7 dBm ±2 dB	X61.1	RF OUT monitoring for exciter A
GND	Bidirec-tional		X61.2	GND / shield

A.1.5 Remote interfaces

Table 1-15: X2 – LAN remote (1000BaseT): 8-pin RJ-45 socket

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
TX+	Output	Ethernet	X2.1	Transmitting line
TX-	Output	Ethernet	X2.2	Transmitting line
RX+	Input	Ethernet	X2.3	Receiving line
	Bidirec-tional	75 Ω termination	X2.4	
	Bidirec-tional	75 Ω termination	X2.5	
RX-	Input	Ethernet	X2.6	Receiving line
	Bidirec-tional	75 Ω termination	X2.7	
	Bidirec-tional	75 Ω termination	X2.8	

A.2 Internal Transmitter Interfaces

A.2.1 Internal RF Interfaces

Table 1-16: Single transmitter with one amplifier

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
W1160A		470 MHz to 862 MHz 4 dBm DTV 1 dBm Sync Peak ATV	X60/X10	RF signal from the TCE900 to input of amplifier

Table 1-17: Backup exciter / dual drive with one amplifier

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
W1160A		470 MHz to 862 MHz 4 dBm DTV 1 dBm Sync Peak ATV	X60 / X60A	RF signal from program exciter / exciter A to input X60A of the exciter switch
W1160B		470 MHz to 862 MHz 4 dBm DTV 1 dBm Sync Peak ATV	X60 / X60B	RF signal from control exciter / exciter B to input X60B of the exciter switch
W1160C		470 MHz to 862 MHz 3 dBm DTV 0 dBm Sync Peak ATV	X60 / X10	RF signal from output X60C of the exciter switch to RF input of the amplifier

Table 1-18: Single transmitter with more than one amplifier

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
W1160A		470 MHz to 862 MHz 13 dBm DTV 14 dBm Sync Peak ATV	X60 / X.E	RF signal from exciter to input of splitter
W307A to E		470 MHz to 862 MHz 3 dBm DTV 4 dBm Sync Peak ATV	X.A1 to A5 / X10	RF signal from output of splitter to the inputs of 2 to 5 amplifiers
		470 MHz to 862 MHz $P_{AVG} \approx 57.75$ dBm	X2 / X.E1 to E5	RF signal from outputs of 2 to 5 amplifiers to the coupler inputs
Wxx		470 MHz to 862 MHz $P_{AVG\ 2\ amps}$ = 60.57 dBm $P_{AVG\ 3\ amps}$ = 62.33 dBm $P_{AVG\ 4\ amps}$ = 63.58 dBm $P_{AVG\ 5\ amps}$ = 64.55 dBm	X.A	RF signal from coupler output to antenna (optionally to bandpass filter)

Table 1-19: Backup exciter / dual drive with more than one amplifier

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
W1160A		470...862 MHz 13 dBm DTV 14 dBm Sync Peak ATV	X60 / X60A	RF signal from pro-gram exciter / exciter A to input X60A of the exciter switch
W1160B		470...862 MHz 13 dBm DTV 14 dBm Sync Peak ATV	X60 / X60B	RF signal from con-trol exciter / exciter B to input X60B of the exciter switch
W1160C		470...862 MHz 12 dBm DTV 13 dBm Sync Peak ATV	X60C / X.E	RF signal from output X60C of the exciter switch to input of the splitter
W307A to E		470...862 MHz 3 dBm DTV 0 dBm Sync Peak ATV	X.A1 to A5 / X10	RF signal from output of splitter to the inputs of 2 to 5 ampli-fiers
		470 MHz to 862 MHz $P_{eff, nom}$ ≈ 57.75 dBm	X2 / X.E1 to E5	RF signal from out-puts of 2 to 5 amplifi-ers to the coupler inputs
		470 MHz to 862 MHz $P_{AVG\ 2\ amps}$ = 60.57 dBm $P_{AVG\ 3\ amps}$ = 62.33 dBm $P_{AVG\ 4\ amps}$ = 63.58 dBm $P_{AVG\ 5\ amps}$ = 64.55 dBm	X.A	RF signal from cou-pler output to antenna (optionally to bandpass filter)

A.2.2 Internal Ethernet Interfaces

Table 1-20: Dual Drive

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
W1041	Bidirec-tional		X41 / X7	LAN LOCAL from system control to exciter A
W1042	Bidirec-tional		X42 / X7	LAN LOCAL from system control to exciter B

A.2.3 Transmitter Control Bus (CAN bus)

Table 1-21: X6 – TX (CAN bus, 9-pin Sub-D socket)

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
n.c.			X6.1	
CAN_L	Bidirec-tional	CAN-Level	X6.2	CAN bus signal
CAN_GND	Bidirec-tional	0 V	X6.3	CAN GND
n.c.			X6.4	
CAN_SHLD	Bidirec-tional	GND	X6.5	Shield
GND	Bidirec-tional	GND	X6.6	GND
CAN_H	Bidirec-tional	CAN+Level	X6.7	CAN bus signal
n.c.			X6.8	
CAN_V+	Bidirec-tional	12 V ± 1 V	X6.9	

A.2.4 RF Loops

Table 1-22: X41 – RF loop:

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
MAIN TX LOOP		+12 V ±2 V	X41.1	-12 V floating
LOOP COM (+)		+12 V ±2 V	X41.2	+12 V floating
RESERVE TX LOOP		+12 V ±2 V	X41.3	-12 V floating
LOOP COM (+)		+12 V ±2 V	X41.4	+12 V floating

A.2.5 TSP900 – Display Interface

Table 1-23: DVI interface

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
W1014		Data lines Power supply GND	X14/X3	USB interface to the TSP900

A.2.6 TDU900 – Display Interfaces (Optional)

Table 1-24: DVI interface

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
W1015		Data lines, clock lines Power supply Shielding, GND	X15 / X1	DVI connecting cable between TCE (IPS board) and TDU900 display

Table 1-25: Terminal supply

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
W1012		Power supply GND	X12 / X1	12 V power supply for the TDU900

Table 1-26: LAN LOCAL

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
W1043		Data lines	X7 or X43	Connection of the local Ethernet inter-face at the front LAN connection of the TDU900

Table 1-27: USB 2.0

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
W1014		Data lines Power supply GND	X14 / X3	USB interface to the TDU900 and connec-tion of the front USB connection (on the back of the display)

A.2.7 Air Cooling Interface (Optional)

Table 1-28: X46: FAN 1 (15-pin cable, transfer point in the rack for splitting into individual cables for exhaust fan control, temperature, pressure)

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
CTRL_FAN1	Output	0 V to 10 V or PWM	X46.4	Speed control for exhaust fan 1
SPEED_FAN1	Input	Open collector, 1 pulse per revolution	X46.12	Speed output for exhaust fan 1, 1 pulse per revolution

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
10V_FAN1	Input	10 V (max. 1.1 mA)	X46.11	10 V voltage output Exhaust fan 1
GND	Bidirec-tional		X46.5	
PRESSURE_1	Input	4 mA to 20 mA	X46.14	Measured value from differential pressure sensor 1
GND	Bidirec-tional		X46.7	
TEMP_IN	Input	4 mA to 20 mA	X46.8	Measured value from the temperature sen-sor at the rack input
GND	Bidirec-tional		X46.15	

Table 1-29: X47: FAN 2 (15-pin cable, transfer point in the rack for splitting into individual cables for exhaust fan control, temperature, pressure)

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
CTRL_FAN2	Output	0 V to 10 V or PWM	X47.4	Speed control for exhaust fan 2
SPEED_FAN2	Input	Open collector, 1 pulse per revolution	X47.12	Speed output for exhaust fan 2, 1 pulse per revolution
10V_FAN2	Input	10 V (max. 1.1 mA)	X47.11	10 V voltage output Exhaust fan 2
GND	Bidirec-tional		X47.5	
PRESSURE_2	Input	4 mA to 20 mA	X47.14	Measured value from differential pressure sensor 2
GND	Bidirec-tional		X47.7	
TEMP_OUT	Input	4 mA to 20 mA	X47.8	Measured value from the temperature sen-sor at the rack output
GND	Bidirec-tional		X47.15	
DIG_IN	Input	0 V to 5 V	X47.9	Digital input for "Filter clogged" message
GND	Bidirec-tional		X47.1	

B R&S TCE900 Interface Description

B.1 Interfaces of Base Unit

B.1.1 X1: MAINS

Signal Name	Direction	Value range	Connection point	Remarks
L1	Input	100V-240V AC, 50-60Hz±10%	X1.L	Supply Input
N	Input		X1.N	Supply Input
PE	Input		X1.PE	Supply Input

B.1.2 Interfaces of Main Computer IPS1

B.1.2.1 X2 LAN REMOTE

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

B.1.2.2 X14 USB 1

Signal Name	Direction	Value range	Connection point	Remarks
+5V USB	Output		X 14.1	
USB Data-	Bi-directional		X 14.2	

Signal Name	Direction	Value range	Connection point	Remarks
USB Data+	Bi-directional		X 14.3	
GND	Bi-directional		X 14.4	

B.1.2.3 X15 USB 2

Signal Name	Direction	Value range	Connection point	Remarks
+5V USB	Output		X 15.1	
USB Data-	Bi-directional		X 15.2	
USB Data+	Bi-directional		X 15.3	
GND	Bi-directional		X 15.4	

B.1.2.4 X11 DVI

Signal Name	Direction	Value range	Connection point	Remarks
Data 2-			X 11.1	
Data 2+			X 11.2	
Shielding data 2,4			X 11.3	
Data 4-			X 11.4	
Data 4+			X 11.5	
DDC clock			X 11.6	
DDC data			X 11.7	
V-Sync			X 11.8	
Data 1-			X 11.9	
Data 1+			X 11.10	
Shielding Data 1,3			X 11.11	
Data 3-			X 11.12	
Data 3+			X 11.13	
+5V			X 11.14	
GND			X 11.15	
Hotplug-Detect			X 11.16	
Data 0-			X 11.17	
Data 0+			X 11.18	

Signal Name	Direction	Value range	Connection point	Remarks
Shielding data 0,5			X 11.19	
Data 5-			X 11.20	
Data 5+			X 11.21	
Shielding data			X 11.22	
Clock +			X 11.23	
Clock -			X 11.24	
Red			X 11.C1	
Green			X 11.C2	
Blue			X 11.C3	
H-Sync			X 11.C4	
GND			X 11.C5	

B.1.3 Interfaces of System Connection Boards (SCB)

B.1.3.1 X3 LAN LOCAL FRONT

Signal Name	Direction	Value range	Connection point	Remarks
BI_DA+	Bi-directional	V_{odiff}= 670…820mV$_{ss}$	X3.1	
BI_DA-	Bi-directional	V_{idiff}= 750mV$_{ss}$typ.	X3.2	
BI_DB+	Bi-directional	V_{odiff}= 670…820mV$_{ss}$	X3.3	
BI_DB-	Bi-directional	V_{idiff}= 750mV$_{ss}$typ.	X3.4	
BI_DC+	Bi-directional	V_{odiff}= 670…820mV$_{ss}$	X3.5	
BI_DC-	Bi-directional	V_{idiff}= 750mV$_{ss}$typ.	X3.6	
BI_DD+	Bi-directional	V_{odiff}= 670…820mV$_{ss}$	X3.7	
BI_DD-	Bi-directional	V_{idiff}= 750mV$_{ss}$typ.	X3.8	

B.1.3.2 X7 LAN LOCAL REAR

Signal Name	Direction	Value range	Connection point	Remarks
BI_DA+	Bi-directional	V_{odiff}= 670…820mV$_{ss}$	X7.1	
BI_DA-	Bi-directional	V_{idiff}= 750mV$_{ss}$typ.	X7.2	

Signal Name	Direction	Value range	Connection point	Remarks
BI_DB+	Bi-directional	V_{odiff}= 670…820mV_{ss}	X7.3	
BI_DB-	Bi-directional	V_{idiff}= 750mV_{ss}typ.	X7.4	
BI_DC+	Bi-directional	V_{odiff}= 670…820mV_{ss}	X7.5	
BI_DC-	Bi-directional	V_{idiff}= 750mV_{ss}typ.	X7.6	
BI_DD+	Bi-directional	V_{odiff}= 670…820mV_{ss}	X7.7	
BI_DD-	Bi-directional	V_{idiff}= 750mV_{ss}typ.	X7.8	

B.1.3.3 X66 GPS ANTENNA

Signal Name	Direction	Value range	Connection point	Remarks
GPS ANTENNA	Input	-144dBm ... -5dBm	X66.1	50Ω SMA-Buchse
GND	Bi-directional	0V	X66.2	

B.1.3.4 X12 TERMINAL SUPPLY

12V, 1A Versorgung für externes Display

Typische Stromaufnahme der TDU900:

Background light	DVI Signal	USB connection on input side (no load)	Ub on TDU900 12V	Ub on TDU900 10,5V
inactive	inactive	open		
active	inactive	open	414mA	472mA
active	active	open	483mA	550mA
active	active	connected with PC	530mA	605mA

Signal Name	Direction	Value range	Connection point	Remarks
TERMINA	Output	12V +- 1,5V	X12.1	$I_{max.}$ = 1A
GND	Bi-directional		X12.2	
NC				X12.3
NC				X12.4

B.1.3.5 X6 TX

(CAN bus, proceted loop, 12V supply for systemcomponents, positions recogniction)

Signal Name	Direction	Value range	Connection point	Remarks
Position1	Input		X6.1	
GND	Bi-directional	0V	X6.6	
CAN_L	Bi-directional	CAN-Bus	X6.2	
CAN_H	Bi-directional	CAN-Bus	X6.7	
GND	Bi-directional	0V	X6.3	
LOOP+	Bi-directional	Open -> protective loop open Connection to LOOP -> protective loop closed	X6.8	
LOOP-	Bi-directional	Open -> protective loop open Connection to LOOP+ -> protective loop closed	X6.4	
+12V_RC	Output	+12V +- 1,5V, max 1A	X6.9	supply of system components
Position2	Input		X6.5	

B.2 Module Slots

B.2.1 Coder Board

B.2.1.1 X30 TS LAN 1

Signal Name	Direction	Value range	Connection point	Remarks
BI_DA+	Bi-directional	V_{odiff}= 670…820mV_{ss}	X30.J1	
BI_DA-	Bi-directional	V_{idiff}= 750mV_{ss}typ.	X30.J2	
BI_DB+	Bi-directional	V_{odiff}= 670…820mVss	X30.J3	
BI_DB-	Bi-directional	V_{idiff}= 750mV_{ss}typ.	X30.J4	
BI_DC+	Bi-directional	V_{odiff}= 670…820mVss	X30.J5	

Signal Name	Direction	Value range	Connection point	Remarks
BI_DC-	Bi-directional	V_{idiff}= 750mV_{ss}typ.	X30.J6	
BI_DD+	Bi-directional	V_{odiff}= 670…820mVss	X30.J7	
BI_DD-	Bi-directional	V_{idiff}= 750mV_{ss}typ.	X30.J8	

B.2.1.2 X31 TS LAN 2

Signal Name	Direction	Value range	Connection point	Remarks
BI_DA+	Bi-directional	V_{odiff}= 670…820mVss	X31.J1	
BI_DA-	Bi-directional	V_{idiff}= 750mV_{ss}typ.	X31.J2	
BI_DB+	Bi-directional	V_{odiff}= 670…820mVss	X31.J3	
BI_DB-	Bi-directional	V_{idiff}= 750mV_{ss}typ.	X31.J4	
BI_DC+	Bi-directional	V_{odiff}= 670…820mVss	X31.J5	
BI_DC-	Bi-directional	V_{idiff}= 750mV_{ss}typ.	X31.J6	
BI_DD+	Bi-directional	V_{odiff}= 670…820mVss	X31.J7	
BI_DD-	Bi-directional	V_{idiff}= 750mV_{ss}typ.	X31.J8	

B.2.1.3 X23 1PPS IN

Signal Name	Direction	Value range	Connection point	Remarks
1PPS_EXTERN	Input	TTL-level pos. edge	X23.1	seconds pulse from external GPS-receiver
GND	Bi-directional	0V	X23.2	BNC-socket

B.2.1.4 X24 REF MONITOR

Signal Name	Direction	Value range	Connection point	Remarks
1REF_MON	Output	TTL-Pegel	X24.1	BNC-socket
GND	Bi-directional	0V	X24.2	

B.2.1.5 X20 TS1 IN

Signal Name	Direction	Value range	Connection point	Remarks
TS1	Input	ASI, SMPTE310M / ETI	X20.1	Ri=75Ω BNC
GND	Bi-directional	0V	X20.2	

B.2.1.6 X21 TS2 IN

Signal Name	Direction	Value range	Connection point	Remarks
TS1	Input	ASI , SMPTE310M / ETI	X21.1	Ri=75Ω BNC
GND	Bi-directional	0V	X21.2	

B.2.1.7 X22 TS MONITOR OUT

Signal Name	Direction	Value range	Connection point	Remarks
TS_MON	Output	ASI , SMPTE310M / ETI	X22.1	Ri=75Ω BNC
GND	Bi-directional	0V	X22.2	

B.2.2 RF Board

B.2.2.1 X64 REF IN

Signal	Direction	Value range	Connection point	Remarks
EXT_REF_IN	Input	-5 … 20 dBm oder TTL	X64.1	50R BNC-socket
GND	Bi-directional	0V	X64.2	

B.2.2.2 X60 RF OUT

Signal Name	Direction	Value range	Connection point	Remarks
RF_OUT	Output	13 dBm DTV 20 dBm Sync Peak ATV	X60.1	50R SMA-socket
GND	Bi-directional	0V	X60.2	

B.2.2.3 X61 RF MONITOR OUT

Signal Name	Direction	Value range	Connection point	Remarks
RF_MON_OUT	Output	ATV / DVB 0 / -7 dBm ± 2dB	X61.1	Z = 50 Ohm SMA-socket
GND	Bi-directional		X61.2	

B.2.2.4 X67 RF DOWNCONVERTER 1 IN

For automatic non-linear equalization for DTV, ATV / HF-surveillant for ATV

Signal Name	Direction	Value range	Connection point	Remarks
RF_DOWN-CONVERTER_1	Input	+7 dBm (-2 … +1dB) DTV +13dBm Sync.Peak (- 2 … +1dB) ATV	X67.1	50R SMA-socket
GND	Bi-directional	0V	X67.2	

B.2.2.5 X68 RF DOWNCONVERTER 2 IN

For automatic linear equalization / quality monitoring of the output signal

Signal Name	Direction	Value range	Connection point	Remarks
RF_DOWN-CONVERTER_2	Input	+7 dBm (-2 … +1dB) DTV +13dBm Sync.Peak (- 2 … +1dB) ATV	X68.1	50R SMA-socket
GND	Bi-directional	0V	X68.2	

B.2.3 Tx Interface

B.2.3.1 X40 LAN 1

Ethernet Port P0

Signal Name	Direction	Value range	Connection point	Remarks
TX+ (D1+)	Bi-directional	-1 V … +1 V Differential to TX+ Impedance: 100Ω	X40.J1	
TX- (D1-)	Bi-directional	-1 V … +1 V Differential to TX+ Impedance: 100Ω	X40.J2	
RX+ (D2+)	Bi-directional	-1 V … +1 V Differential to RX+ Impedance: 100Ω	X40.J3	
D3+			X40.J4	
D3-			X40.J5	
RX- (D2-)	Bi-directional	-1 V … +1 V Differential to RX+ Impedance: 100Ω	X40.J6	
D4+			X40.J7	
D4-			X40.J8	

B.2.3.2 X41 LAN 2

Ethernet Port P1

Signal Name	Direction	Value range	Connection point	Remarks
TX+ (D1+)	Bi-directional	-1 V … +1 V Differential to TX+ Impedance: 100Ω	X41.J1	
TX- (D1-)	Bi-directional	-1 V … +1 V Differential to TX+ Impedance: 100Ω	X41.J2	
RX+ (D2+)	Bi-directional	-1 V … +1 V Differential to RX+ Impedance: 100Ω	X41.J3	
D3+			X41.J4	

Signal Name	Direction	Value range	Connection point	Remarks
D3-			X41.J5	
RX- (D2-)	Bi-directional	-1 V … +1 V Differential to RX+ Impedance: 100Ω	X41.J6	
D4+			X41.J7	
D4-			X41.J8	

B.2.3.3 X42 LAN 3

Ethernet Port P2

Signal Name	Direction	Value range	Connection point	Remarks
TX+ (D1+)	Bi-directional	-1 V … +1 V Differential to TX+ Impedance: 100Ω	X42.J1	
TX- (D1-)	Bi-directional	-1 V … +1 V Differential to TX+ Impedance: 100Ω	X42.J2	
RX+ (D2+)	Bi-directional	-1 V … +1 V Differential to RX+ Impedance: 100Ω	X42.J3	
D3+			X42.J4	
D3-			X42.J5	
RX- (D2-)	Bi-directional	-1 V … +1 V Differential to RX+ Impedance: 100Ω	X42.J6	
D4+			X42.J7	
D4-			X42.J8	

B.2.3.4 X43 LAN 4

Ethernet Port P3

Signal Name	Direction	Value range	Connection point	Remarks
TX+ (D1+)	Bi-directional	-1 V … +1 V Differential to TX+ Impedance: 100Ω	X43.J1	
TX- (D1-)	Bi-directional	-1 V … +1 V Differential to TX+ Impedance: 100Ω	X43.J2	
RX+ (D2+)	Bi-directional	-1 V … +1 V Differential to RX+ Impedance: 100Ω	X43.J3	
D3+			X43.J4	
D3-			X43.J5	
RX- (D2-)	Bi-directional	-1 V … +1 V Differential to RX+ Impedance: 100Ω	X43.J6	
D4+			X43.J7	
D4-			X43.J8	

B.2.3.5 X44 Power Distributor

Sub D15

Signal Name	Direction	Value range	Connection point	Remarks
OVERVOLTAGE_1	Input	0 V / 12 V	X44.1	GND_FLOAT for OK +12V_FLOAT for Error
OVERVOLTAGE_3	Input	s. X44.1	X44.2	s. X44.1
OVERVOLTAGE_5	Input	s. X44.1	X44.3	s. X44.1
OVERVOLTAGE_7	Input	s. X44.1	X44.4	s. X44.1
GND_FLOAT (out)	Output	0 V	X44.5	Galvanically seperated external power supply
COOLING_DL1	Output	0 V…30 VDC; 2 A max., 60 W max.	X44.6	Closed contact for CoolingON
+12V_FLOAT (out)	Output	12 V ± 20%, max. 320 mA (Total current with X45.7 and internal consumption on BG)	X44.7	Galvanically seperated external power supply

Signal Name	Direction	Value range	Connection point	Remarks
EXT_VOLT-AGE_MONITORING	Input	0 V…30 V	X44.8	Monitoring of an external voltage
OVERVOLTAGE_2	Input	s. X44.1	X44.9	s. X44.1
OVERVOLTAGE_4	Input	s. X44.1	X44.10	s. X44.1
OVERVOLTAGE_6	Input	s. X44.1	X44.11	s. X44.1
OVERVOLTAGE_8	Input	s. X44.1	X44.12	s. X44.1
COOLING_DL2 D	Output	0 V…30 VDC; 2 A max., 60 W max.	X44.13	Closed contact for CoolingON
EXT_DOORCON-TACT	Input	0 V / 12V	X44.14	GND_FLOAT for closed +12V_FLOAT for open
EXT_SWITCHOVER I D D	Input	0 V / 12 V	X44.15	GND_FLOAT for Switchover desired +12V_FLOAT for Switchover not desired
		GND	X44.M1	shielding material
		GND	X44.M2	shielding material

B.2.3.6 X45 Rf Switch PAR IO

Signal Name	Direction	Value range	Connection point	Remarks
POS1/2_TX1	Input	OPEN / 0 V / 12 V	X45.1	Indicator position HF-switch and USV-disturbance OPEN for open 0 V for Pos2 12 V for Pos1
STATUS_POS1/2_TX3	Input	s. X45.1	X45.2	s. X45.1
STATUS_POS1/2_TX5	Input	s. X45.1	X45.3	s. X45.1
CON-TROL_SWITCH_POS1	Output	0 V … 28 V, 1.35 W max. (external series resistor necessary)	X45.4	Open Collector against GND
GND_FLOAT (out)	Output	0 V	X45.5	galvanically seperated external power supply

Signal Name	Direction	Value range	Connection point	Remarks
GPO2 OD D X45.6	Output	0 V / 12 V	X45.6	GND_FLOAT for Active (100Ω series resistor +12V_FLOAT for Inactive (4k7Ω pull-up resistor)
+12V_FLOAT (out)	Output	12 V ± 20%, max. 320 mA (total current with X44.7 and internal consumption on BG)	X45.7	galvanically seperated external power supply
USV_ERROR	Input	0 V / 12 V	X45.8	USV-disturbance GND_FLOAT for ResetFaults
STATUS_POS1/2_TX2	Input	s. X45.1	X45.9	s. X45.1
STATUS_POS1/2_TX4	Input	s. X45.1	X45.10	s. X45.1
STATUS_POS1/2_TX6	Input	s. X45.1	X45.11	s. X45.1
CONTROL_SWITCH_POS2	Output	0 V … 28 V, 1.35 W max. (external series resistor necessary)	X45.12	Open Collector against GND
GPO1	Output	0 V /12 V	X45.13	GND_FLOAT for Active (100Ω series resistance) +12V_FLOAT for Inactive (4k7Ω pull-up resistance)
+12V (out)	Output	+12 V ± 5%, max. 1.1 A (total input current in BG <2A and backplane < 7A has to be adhered to)	X45.14	ensured over SI FF 7A (Backplane) ensured over 2A5 and 1A1 (TXINTERFACE)
GPI5	Input	0 V / 12 V	X45.15	External- Switchover GND_FLOAT for ResetFaults
		GND	X45.16	shielding material
		GND	X45.17	shielding material

B.2.4 Cooling Interface (CIF)

B.2.4.1 X46 Pump

15-pin SUB-D socket

All potentials on this socket refer to GND_FLOAT.

Signal Name	Direction	Value range	Connection point	Remarks
RS485_3_A	Bi-directional	0-5V	X46.	RS485
RS485_3_B	Bi-directional	0-5V	X46.9	RS485
CAN_H	Bi-directional	CAN	X46.2	CAN Bus
CAN_L	Bi-directional	CAN	X46.10	CAN Bus
GND_FLOAT	Output	0V	X46.3	Ground, external potential, LP-filtered
PRES_WARN	Input	0-5V	X46.11	Digital input, pressure warning, Pull-up with 4k7 on 5V, high active
PRES_FAULT	Input	0-5V	X46.4	Digital input, pressure failure, Pull-up with 4k7 on 5V, high active
24V_FLOAT_SUPPLY_FAN	Output	22V- 25V (nominal: 24V)	X46.12	power supply for fan with 0.5A ensured, LP-filterd
RACK2_FAULT	Input	0-5V	X46.5	Digital input, Rack2 failure, Pull-up with 4k7 on 5V, high active
TEMP_IN_RACK_2	Input	0-5V	X46.13	analogue or digital input to temperature measurement of the cooling agent temperature on input of rack 2
5V_FLOAT	Output	4.60V-5.25V (nominal: 4.92V)	X46.6	with 0.5A ensured, LP-filterd
PRES_ANA_RACK_2	Input	0-12V	X46.14	analogue input to measure the pressure in cooling circuit of rack 2
RS485_4_A	Bi-directional	0-5V	X46.7	RS485
RS485_4_B	Bi-directional	0-5V	X46.15	RS485
TEMP_OUT_RACK_2	Input	0-5V	X46.8	analogue in put to measure the cooling agent temperature on output of rack 2

B.2.4.2 X47 HEX

15-pin SUB-D socket

All potentials on this socket refer to GND_FLOAT.

Signal Name	Direction	Value range	Connection point	Remarks
RS485_1_A	Bi-directional	0-5V	X47.1	RS485
RS485_1_B	Bi-directional	0-5V	X47.9	RS485
EXT_COOL_ON_1 B D	Bi-directional	Max. 2A, 30V DC	X47.2	contact 1 without potential
EXT_COOL_ON_2	Bi-directional	Max. 2A, 30V DC	X47.10	contact 2 without potential
GND_FLOAT	Output	0V	X47.3	Ground, external potential, LP-filtered
EXT_COOL_WARN	Input	0-5V	X47.11	Digital input, external cooling warning, Pull-up with 4k7 on 5V, high active
EXT_COOL_FAULT	Input	0-5V	X47.4	Digital input, external colling failure, Pull-up with 4k7 on 5V, high active
24V_FLOAT_SUP-PLY_FAN	Output	22V- 25V (nominal: 24V)	X47.12	power supply for fan with 0.5 A ensured, LP-filtered
RACK1_FAULT	Input	0-5V	X47.5	Digital input, rack1 failure, Pull-up with 4k7 on 5V, high active
TEMP_IN_RACK_1	Input	0-5V	X47.13	Analogue input to measure the cooling agent temperature on input of rack 1
5V_FLOAT	Output	4.60V-5.25V (nomi-nal: 4.92V)	X47.6	power supply with 0.5A ensured, LP-fil-tered
PRES_ANA_RACK_1	Input	0-12V	X47.14	Analogue input to measure the pres-sure in cooling circuit of rack 1
RS485_2_A	Bi-directional	0-5V	X47.7	RS485
RS485_2_B	Bi-directional	0-5V	X47.15	RS485
TEMP_OUT_RACK_2	Input	0-5V	X47.8	Analogue input to measure the cooling agent temperature on output of rack 1

B.2.5 Air Cooling Interface (Optional)

B.2.5.1 Connection to Exhaust Fan, Differential Pressure Sensor, X46 FAN1

15-pin SUB-D socket

All potentials on this socket refer to GND_FLOAT.

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
CTRL_FAN1	Output	0 V to 10 V or PWM	X46.4	Speed control for exhaust fan 1
SPEED_FAN1	Input	Open collector, 1 pulse per revolution	X46.12	Speed output for exhaust fan 1, 1 pulse per revolution
10V_FAN1	Input	10 V (max. 1.1 mA)	X46.11	10 V voltage output Exhaust fan 1
GND	Bidirec-tional		X46.5	
PRESSURE_1	Input	4 mA to 20 mA	X46.14	Measured value from differential pressure sensor 1
GND	Bidirec-tional		X46.7	
TEMP_IN	Input	4 mA to 20 mA	X46.8	Measured value from the temperature sen-sor at the rack input
GND	Bidirec-tional		X46.15	

B.2.5.2 Connection to Exhaust Fan, Differential Pressure Sensor, X47 FAN2

15-pin SUB-D socket

All potentials on this socket refer to GND_FLOAT.

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
CTRL_FAN2	Output	0 V to 10 V or PWM	X47.4	Speed control for exhaust fan 2
SPEED_FAN2	Input	Open collector, 1 pulse per revolution	X47.12	Speed output for exhaust fan 2, 1 pulse per revolution
10V_FAN2	Input	10 V (max. 1.1 mA)	X47.11	10 V voltage output Exhaust fan 2

Signal Name/Description	Direc- tion	Value range	Connection point	Remarks
GND	Bidirec- tional		X47.5	
PRESSURE_2	Input	4 mA to 20 mA	X47.14	Measured value from differential pressure sensor 2
GND	Bidirec- tional		X47.7	
TEMP_OUT	Input	4 mA to 20 mA	X47.8	Measured value from the temperature sen- sor at the rack output
GND	Bidirec- tional		X47.15	

C R&S PMU901 Interface Description

C.1 X1: Supply Input; Schaltbau M3 connector

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
L	Input	V AC = 170 V to 264 V I ≤ 15 A 47 Hz to 63 Hz cos φ ≥ 0.95 at 230 V and P_{nom}	X1.1	Power supply connection for the regular power supply
N	Input	0 V	X1.2	
LReserve	Input	V AC = 170 V - 264 V I ≤ 15 A 47 Hz to 63 Hz cos φ ≥ 0.95 at 230 V and P_{nom}	X1.3	Power supply connection for the standby power supply
NReserve	Input	0 V	X1.5	
PE	Input	0 V	X1.PE	Power supply connection

Since the PE connections also need to be fed in separately for separate electrical circuits, a second protective earth must be ensured via a grounding bolt (40 A test current), since only one shared PE is fed in on the X1.

⚠ CAUTION

Increased leakage current! The instrument must first be connected to the protective ground. An additional ground wire connection is provided since two power supply circuits are possible: Automatically pluggable (socket 3587.4188.00, at pin contact 3587.4194.00 on the rack side) for rack installation and as a stud for table operation as well.

Shutoff at all poles for the connecting cables is necessary for two-phase networks (2W + PE).

C.2 X2: RF Output 7/16 - Socket (Rear)

Signal Name/Description	Direction	Value range	Connection point	Remarks
RF_OUTPUT	Output	$P_{avg,nom}$=600 W (DVB-T) $P_{avg,max}$ = 650 W/ 750 W $P_{sync,nom}$ = 1400 W (combined) 470 MHz to 862 MHz to 50 Ω load, S ≤ 1.4	X2	RF output

C.3 X3: RF Test Socket; SMA Female (Front)

Signal Name/Description	Direction	Value range	Connection point	Remarks
RF_MONITOR	Output	0.5 V to 1 V / at $P_{sync,nom}$ -54 dBc to -48 dBc 470 MHz to 862 MHz	X3	RF monitor as an open test point on the front panel

C.4 X10: RF Input SMA Female (Rear)

Signal Name/Description	Direction	Value range	Connection point	Remarks
RF_IN	Input	$P_{avg,nom}$ = ±0 dBm ± 3 dB (DVB-T) $P_{sync,nom}$= +3.5 dBm ± 3 dB (ATV combined) 470 MHz to 862 MHz S11 matching: ≤-16 dB	X10	RF input

C.5 X13: Second RF Test Socket for ADE; SMA Female (Rear)

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
ADE_OUT	Output	0.5 V to 1 V / at $P_{sync,nom}$ -54 dBc to -48 dBc 470 MHz to 862 MHz	X13	RF test point preferably for connecting the ADE demodulator

C.6 X22: Fan Connection 1; 4-pin Molex Connector

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
VCC_FAN	Output	+18 V DC to +28 V DC	X22.1	
VCC_GND	Bidirectional	0 V	X22.2	
FAN_SPEED	Input	Open collector	X22.3	
NC			X22.4	

The fan connection is located directly on the amplifier board.

C.7 X23: Fan Connection 2; 4-pin Molex Connector

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
VCC_FAN	Output	+18 V DC to +28 V DC	X23.1	
VCC_GND	Bidirectional	0 V	X23.2	
FAN_SPEED	Input	Open collector	X23.3	
NC			X23.4	

The fan connection is located directly on the amplifier board.

C.8 X11: Amplifier Control Unit; 15-pin D-Sub connector (rear)

Signal Name/Description	Direction	Value range	Connection point	Remarks
SORT1	Bidirectional	0 V to 13 V	X11.1	Sort PIN 1, short-circuit-proof, relative to CAN_GND, <1 V: low, >8 V: high
ADGND	Input	0 V ± 1 V	X11.9	Analog and digital ground (in amplifier isolated from GND in order to prevent ground loops)
GND	Input	0 V	X11.2	Amplifier ground
/AC_FAIL	Output	Open collector, I ≤ 10 mA (with ESD protection), Ri ≤ 100 Ω, U≤12 V low: ≤ 2.5 V at 10 mA	X11.10	AC voltage phase monitor open: AC OK low (≤ 2.5 V): No AC, phase failure, overvoltage and undervoltage relative to CAN_GND
RESET (Not used in Rohde & Schwarz generation 9 transmitters)	Input	0 V to 5 V, ≤ 5 mA Ri approx. 3.3 kΩ (optocoupler input)	X11.3	high (≥ 1 mA, ≥ 3.0 V): Reset, resets the stored messages TEMP_FAIL and REFLECTION relative to ADGND
AMPL_ON (Not used in Rohde & Schwarz generation 9 transmitters)	Input	0 V to 5 V, ≤ 5 mA Ri approx. 3.3 kΩ (optocoupler input)	X11.11	high (≥ 1 mA, ≥ 3.0 V): Amplifier ON; relative to ADGND
VREF_PWR (Not used in Rohde & Schwarz generation 9 transmitters)	Input	0 V to 5.58 V, relative to ADGND R_L = 74,4 kΩ , 4 V = nominal value	X11.4	Reference voltage for output power, relative to ADGND
PEAK_AV	Input	0 V to 5 V, ≤ 5 mA Ri approx. 3.3 kΩ (optocoupler input)	X11.12	Peak/AVG measurement toggling; high: (≥ 1 mA, ≥ 3.0 V): PEAK position; low: AV position; relative to ADGND

Signal Name/Description	Direc-tion	Value range	Connection point	Remarks
SHUT_DOWN	Input	0 V to 13 V, ≤ 5 mA Internal pull-up to CAN_V+ via optocou-pler	X11.5	Amplifier emergency shutoff, open: amplifier inac-tive (mute) low (≥ 2 mA, ≤ 3.0 V): Ampli-fier in normal mode, relative to CAN_GND
CAN_GND	Input	0 V ± 1 V	X11.13	CAN ground (isola-ted from GND)
CAN_L	Bidirec-tional	CAN_L	X11.6	CAN low
CAN_H	Bidirec-tional	CAN_H	X11.14	CAN high
CAN_V+	Input	+ 12 V ± 1 V, ≤ 40 mA (for 100 % dominant level) typical: 15 mA	X11.7	CAN transceiver sup-ply; relative to CAN_GND (isolated from GND)
/AC_OK	Output	Open collector, I ≤ 10 mA (with ESD protection via Zener diode), Ri ≤ 100 Ω, U≤12 V low: ≤ 1.5 V at 10 mA	X11.15	AC voltage phase monitor low: AC OK open: No AC, phase failure, overvoltage and undervoltage rel-ative to GND
SORT2	Bidirec-tional	0 V to 13 V	X11.8	Sort PIN 2, relative to CAN_GND, <1 V: low, >8 V: high