fairwaves

UmTRX 2.3.1 - dual-channel embedded SDR

UmTRX 2.3.1 is a low-cost embeddable SDR transceiver designed for telecom grade *stability* and *reliability*.

UmTRX 2.3.1 features two full-duplex RF channels which can run on any frequency from 0.3 to 3.8 GHz. It has small footprint, industrial temperature range and durability and is perfectly suited for applications which require high frequency stability of a GPS synchronized clock.

Designed for long running applications

- Carrier grade base stations
- Radio protocol analysis for 2G, 3G, LTE and other wireless networks
- Radio signal detection and measurement
- Satellite and backhaul communications
- Test bench and education equipment

Ready for Immediate Use

- Easy to use UHD module driver
- Supported by GnuRadio, SoapySDR, Pothos, Osmocom/OpenBSC, OpenBTS, OpenBTS-UMTS

Optimized for Industrial Embedded Systems

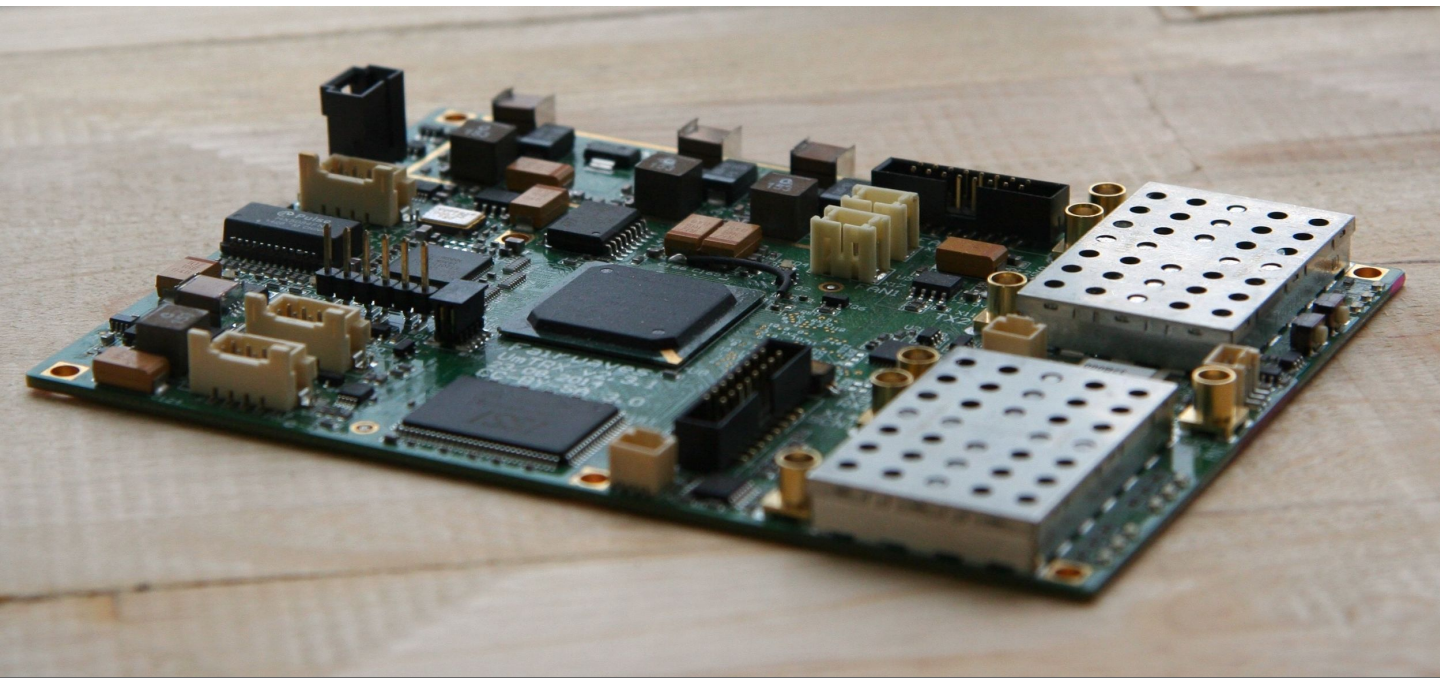
- Reliable 1GB Ethernet interface
- Remote control, including full power down
- External RF front-end connector
- Industrial-grade components
- Pin head connectors
- Wide input voltage range
- Golden plated bottom side for good heat dissipation
- Two temperature sensors and hardware overheat alarm/shutdown circuit

Meets GSM and UMTS BTS requirements

- On-board GPS for <0.01ppm frequency accuracy and geolocation
- Two independent channels (2 TRX)
- Supports all cellular frequency bands
- Single-ARFCN and Multi-ARFCN support
- Compatible with Fairwaves *UmSEL* board for improved GSM receive selectivity

Hi-End and Feature Rich Design

- Low noise synchronous DC power system
- Regulated power supply for power amplifiers
- PA output power and VSWR measurements



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UmTRX 2.3.1 specifications

PCB Dimensions: 128 mm x 95 mm x 15 mm
Weight: 90 g board only / 225 g with aluminium plate

Environmental conditions:
-40 °C to +85 °C working temperature range

RF Output
- PA pre-driver with P1dB = 20dBm
- 100mW @ 900MHz (per channel)
- 100mW @ 1800MHz (per channel)

Reference Clock
- Onboard 26 MHz VCTCXO with 100ppb frequency stability (without GPS)
- Onboard GPS for long-term <10ppb frequency stabilization (GPSDO function)
- External clock 23-41 MHz and 1 PPS inputs/outputs to synchronize multiple boards and support different wireless standards

AD/DA and RF processing
- Two LMS6002D single chip transceivers
- 300MHz to 3.8GHz tuning range
- 1 MHz to 28 MHz zero IF bandwidth
- 11.5-20.5 MSPS quadrature sample rate (13 MSPS with the onboard VCTCXO)
- 12-bit ADC/DAC

Power Amplifier controller
- Two power amplifier control ports
- DC/DC regulator 4.8V to 29.5V, up to 3A
- ADC inputs for PA output power and VSWR sensors monitoring

Electrical Specifications
- 8-36V DC input
- 12W peak power consumption (without power amplifiers)
- Up to 10W additional power consumption @ 100W power amplifiers (90% efficiency)

Onboard Peripherals
- Temperature sensors for temperature based calibration
- Overheat detector
- Programmable DC/DC converter
- GPS module with NMEA and 1pps
- ADC for RF power and SWR sensors input
- ADC for power system monitoring

External Interfaces
- Gigabit Ethernet
- External RF front-end control port
- Two PA control ports
- Remote control port
- RS-232 debug port
- Two fan connectors (1x constant speed, 1x temperature controlled)

Field proven robustness
UmTRX 2.3.1 is used in carrier-grade Fairwaves UmSITE base stations deployed in both Arctic and tropical climates, as well as in other industrial applications developed by our clients.

Long-term on-board GPS disciplined reference clock at no cost. Even the best Temperature Compensated Crystal Oscillators (TCXO) are subject to significant frequency drift due to aging and temperature variation. To keep your device within rigid telecom requirements for frequency stability (50ppb) you typically use an expensive GPS disciplined clock (GPSDO). With UmTRX you get it for free and save up to $900.

Reliable 1GB Ethernet allows a wide selection of motherboards. Modern 1GBE adapters can easily get you stable full duplex 900-950 MBPS throughput with no performance compromise when running TX and RX simultaneously. Ethernet is more suitable for industrial application than USB3 due its stability and connection resilience. USB3 also introduces significant bus latency degrading performance of high speed wireless standards like LTE.

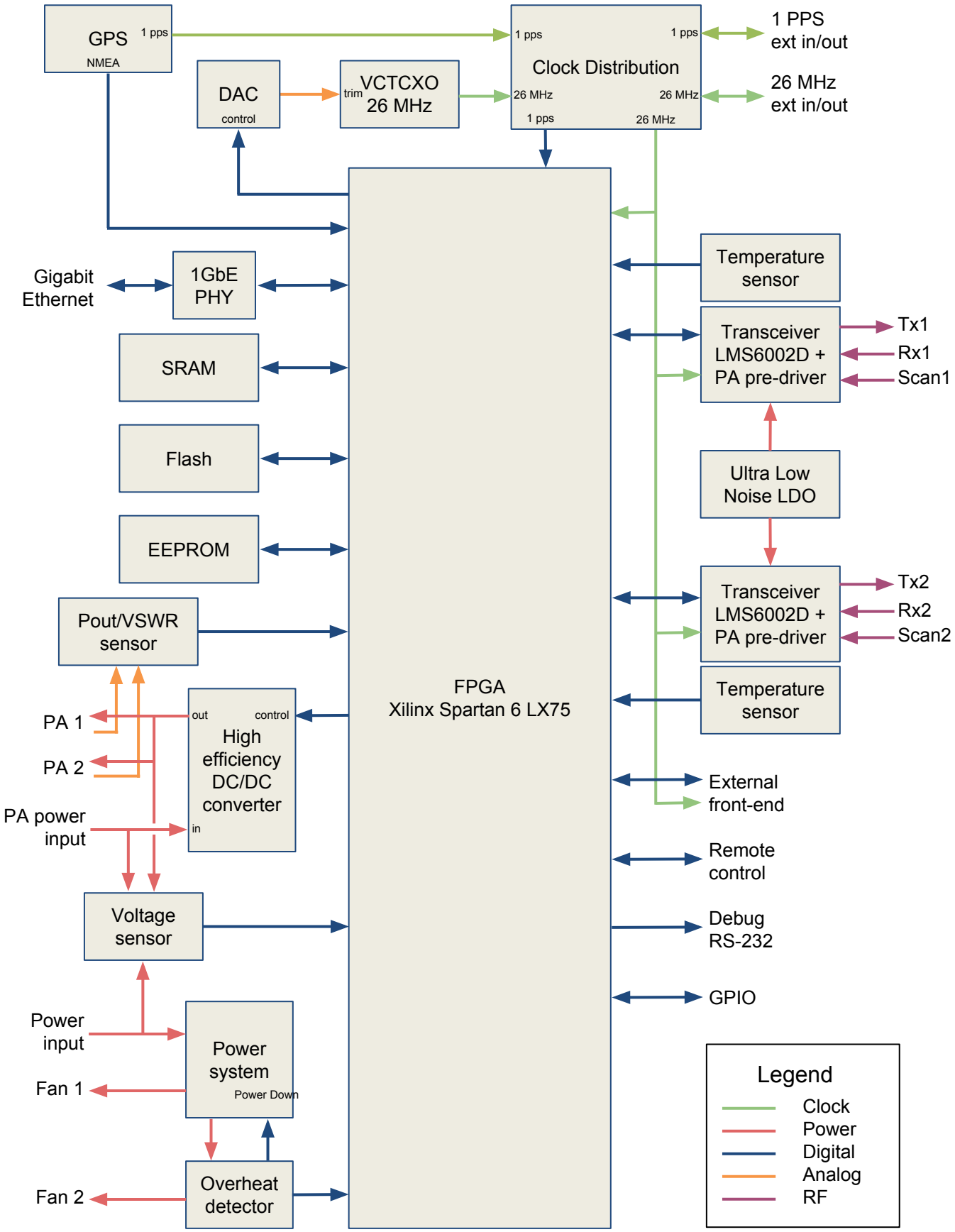
FPGA
- Spartan 6 LX75 FPGA

Software driver
- UHD 3.8+ plugin
- Rx/Tx DC offset and IQ imbalance automatic calibration

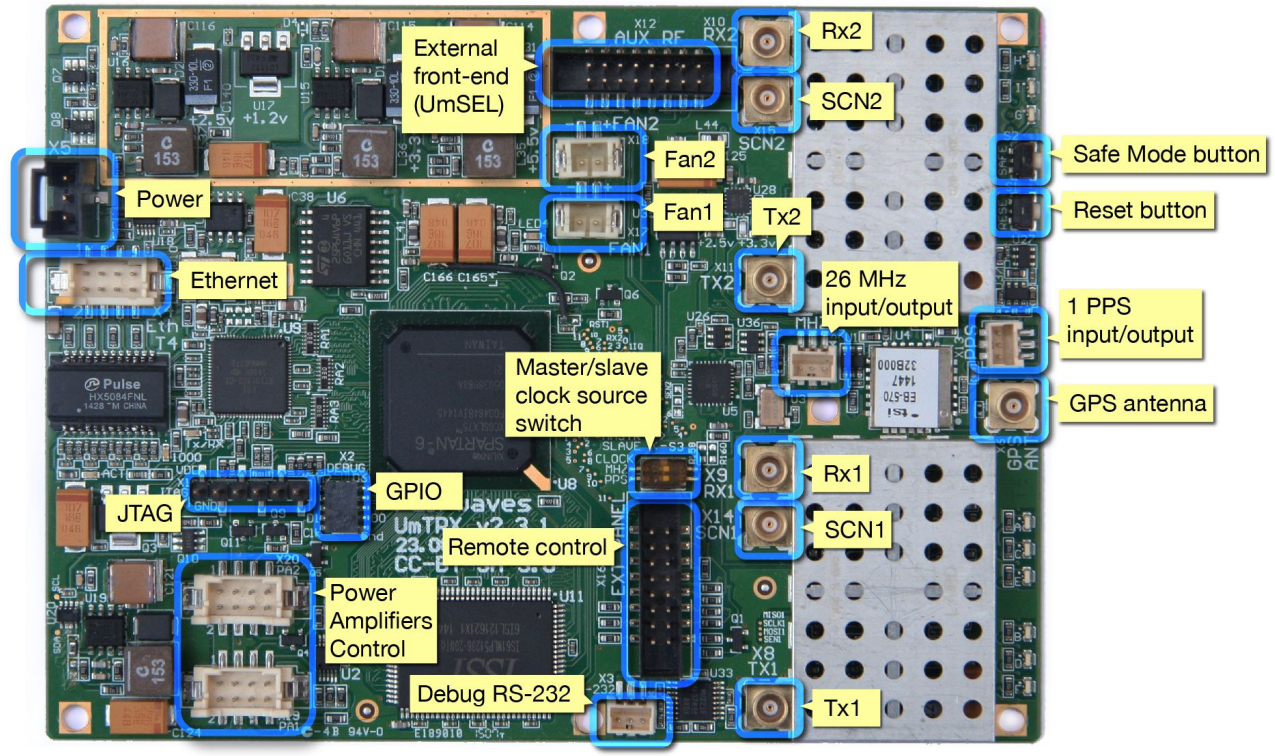
Software support
- GNURadio, Pothos, SDRangeLove
- Osmocom/OpenBSC, OpenBTS, OpenBTS-UMTS, OpenLTE, Amarisoft
- any other software supporting UHD or SoapySDR drivers

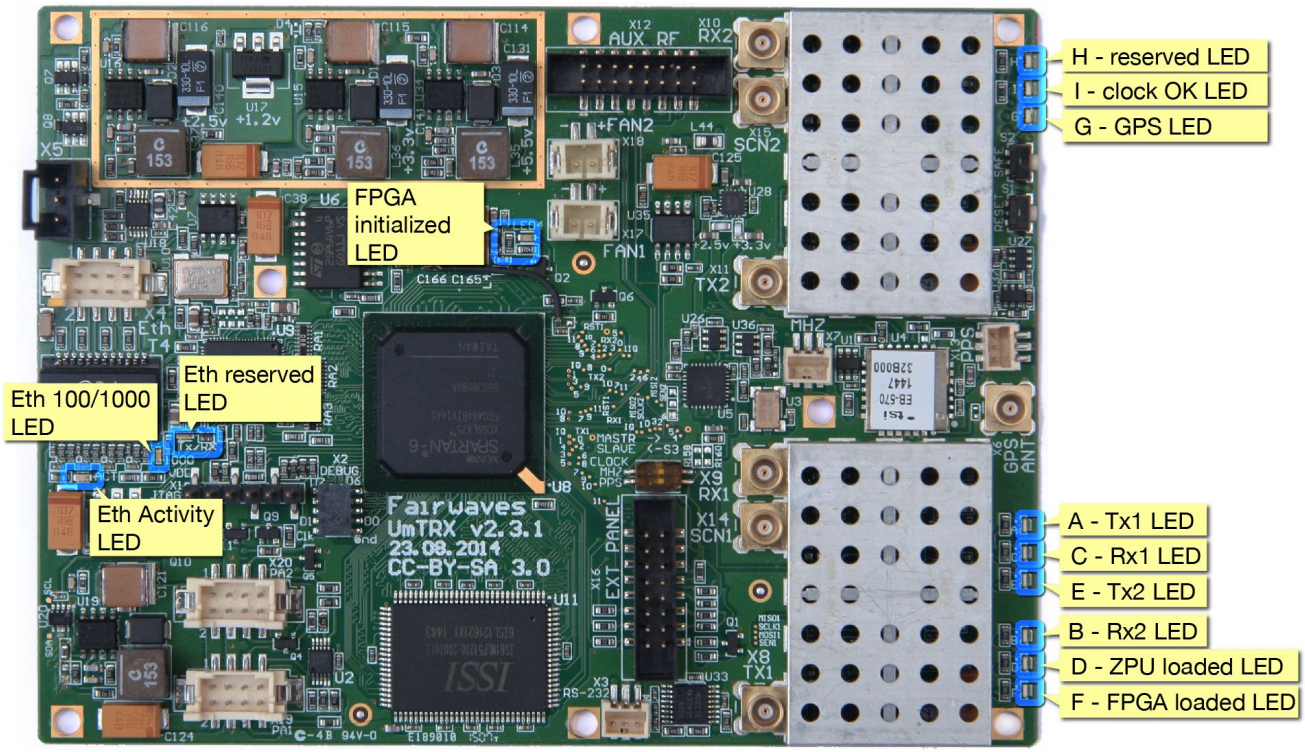
Packaging options
- Pinhead to RJ-45 plug Ethernet cable
- Pinhead to barrel 2.1/5.5 mm jack DC power supply cable
- AC to 12VDC power supply unit
- Pinhead to DB-9M RS-232 cable
- MCX to SMA-M cables
- Aluminum mounting plate

UmTRX 2.3.1 logical blocks diagram



UmTRX 2.3.1 connectors and LEDs

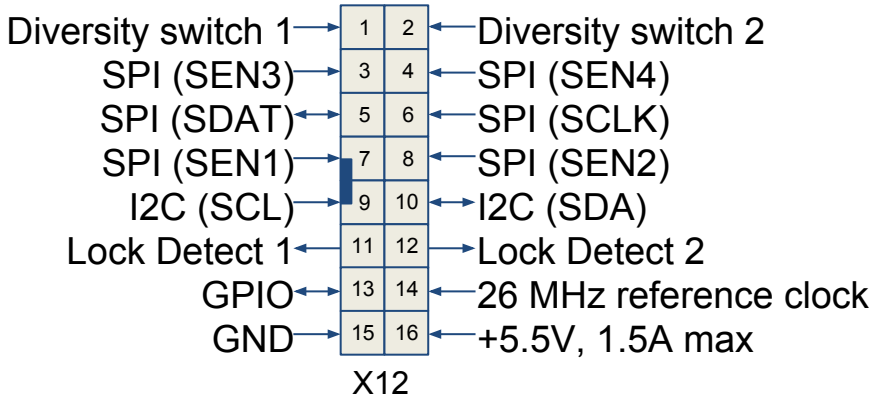




UmTRX 2.3.1 connector pinouts

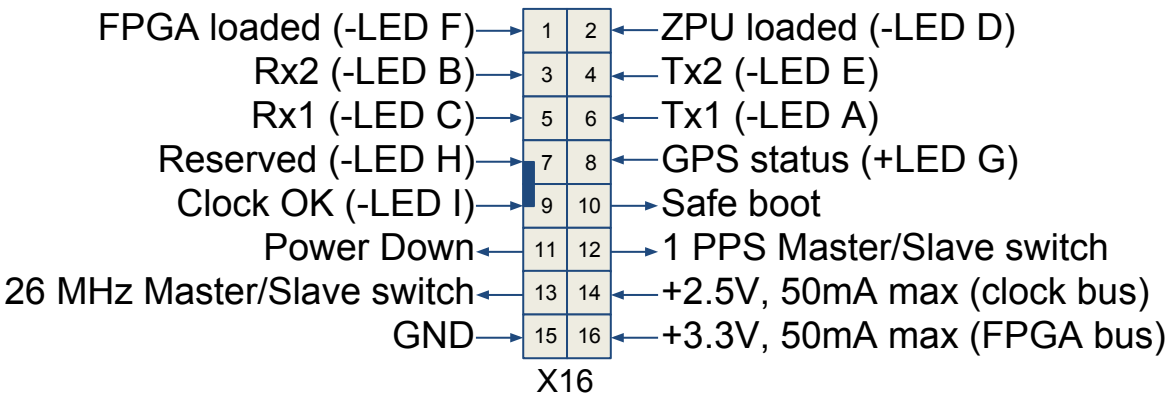
External front-end (AUX_RF)

External front-end connector is designed to control an external dual-channel RF front-end. It provides I2C bus, SPI bus (up to 4 slaves), 26 MHz reference clock, 2x lock detect input pins and 2x diversity switch control pins. All signals are going from FPGA and have CMOS 3.3V logic levels, except I2C bus pins which are require 1~10 kOhm pull-up resistors on external board. The 26 MHz reference clock output goes from clock distribution chip and has CMOS 2.5V logic levels.



Remote control (EXT_PANEL)

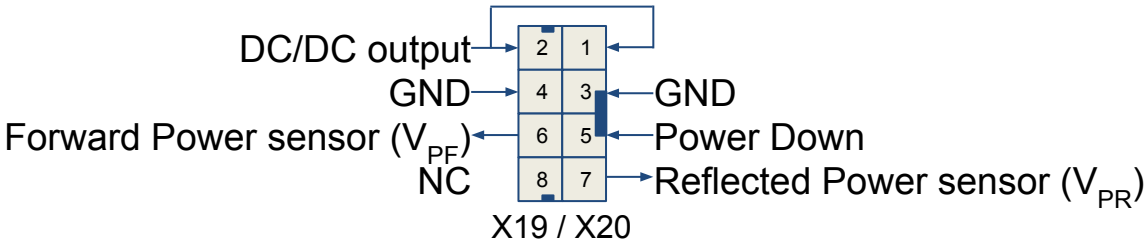
Remote control connector is designed to provide the same level of control over the board as physically holding the board in your hands. It could be used to connect an external control panel or to control UmTRX using GPIO.
In particular, remote control connector allows full board power down input for hardware reset and “safe” boot control input which are important for the board maintenance in production. It also allows selection of internal/external (master/slave) clock source and monitoring of all status LEDs.
Power down input has 10kOhm pull-down, active logic 1 above 1V. Safe boot control input has 1kOhm pull-up to +3.3V, active logic 0 below 1V. All LED outputs except GPS have active low level and are connected to FPGA (CMOS 3.3V) through 330 Ohm resistors. GPS LED output has active high level (CMOS 3V) and goes from GPS module through 330 Ohm resistor.



UmTRX 2.3.1 connector pinouts

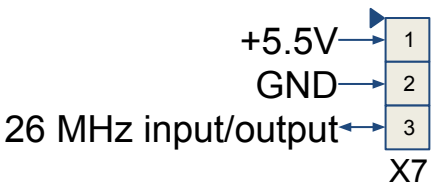
Power Amplifier 1/2 (PA1 / PA2)

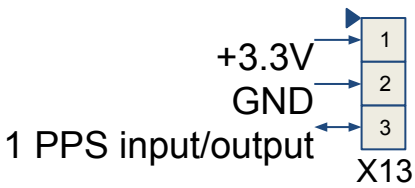
Power Amplifier (PA) control ports are used to connect power amplifiers with built-in VSWR (V_{PF}/V_{PR}) sensors. UmTRX features an onboard DC/DC converter which allows you to control PA output power by controlling its bias voltage. DC/DC converter is software controllable and provides from 4.8V to 29.5V output (at 30V input) with up to 3A current (up to 100W total). It also features software controllable bypass mode in which case input voltage is directly routed to the PA connectors. DC/DC converter is shared between PA1 and PA2 ports. PA disable control pins “Power Down” have “Open Collector” output logic level (0=enable).



Clock input/output (MHZ / PPS)

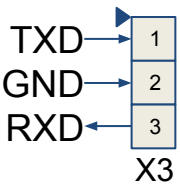
Clock input/output connectors are used to synchronize multiple UmTRX boards for MIMO operation and to provide flexible clock source. E.g. it can be used to feed UmTRX with 30.72MHz clock required for UMTS and LTE wireless standards. Direction is controlled by Master/Slave Clock switch (X9). In “Master” position these connectors serve as clock output, while in “Slave” position they serve as input for clock signals. Input/output logic levels are CMOS 3.3V.





Debug RS-232 (RS-232)

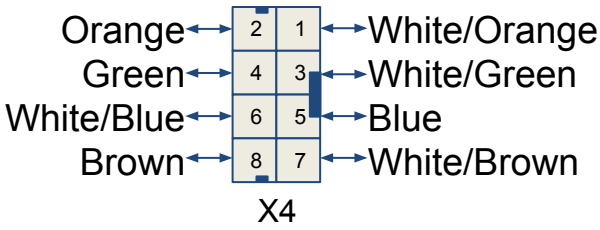
UmTRX uses Debug RS-232 port to provide boot log and various debug information during its operation. The port operates at 115,200 baud and is currently only used for output. RS-232 TxD output logic level is ±5V.



UmTRX 2.3.1 connector pinouts

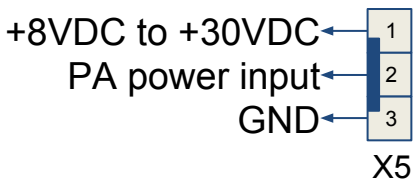
Ethernet (Eth)

Same functionality as a typical RJ-45 connector. Note, that UmTRX currently supports 1GbE only and does not support 10/100 Ethernet.



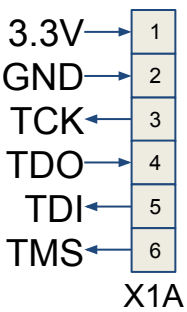
Power

Main board and PAs power connector. UmTRX 2.3.1 is designed to work from a variety of power supply options and thus main input supports wide range of input voltages (8V to 30V). PA input is routed to the DC/DC converter and then to the PA connectors (DC/DC mode) or directly to the PA connectors (bypass mode). DC/DC works as a down converter. In the DC/DC mode, if input voltage is lower than the defined output level of the DC/DC converter, its output voltage is about 0.5V lower than the input voltage.



JTAG

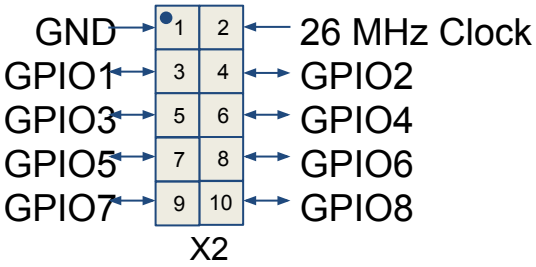
JTAG connector is used for UmTRX flashing when Ethernet flashing is not available for any of the reasons. JTAG flashing is slower, than Ethernet flashing and thus is rarely used.



UmTRX 2.3.1 connector pinouts

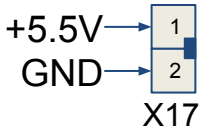
GPIO (Debug)

GPIO port can be used as a debug port for FPGA development or as a GPIO port for external devices control. All GPIO pins have CMOS 2.5V logic levels.

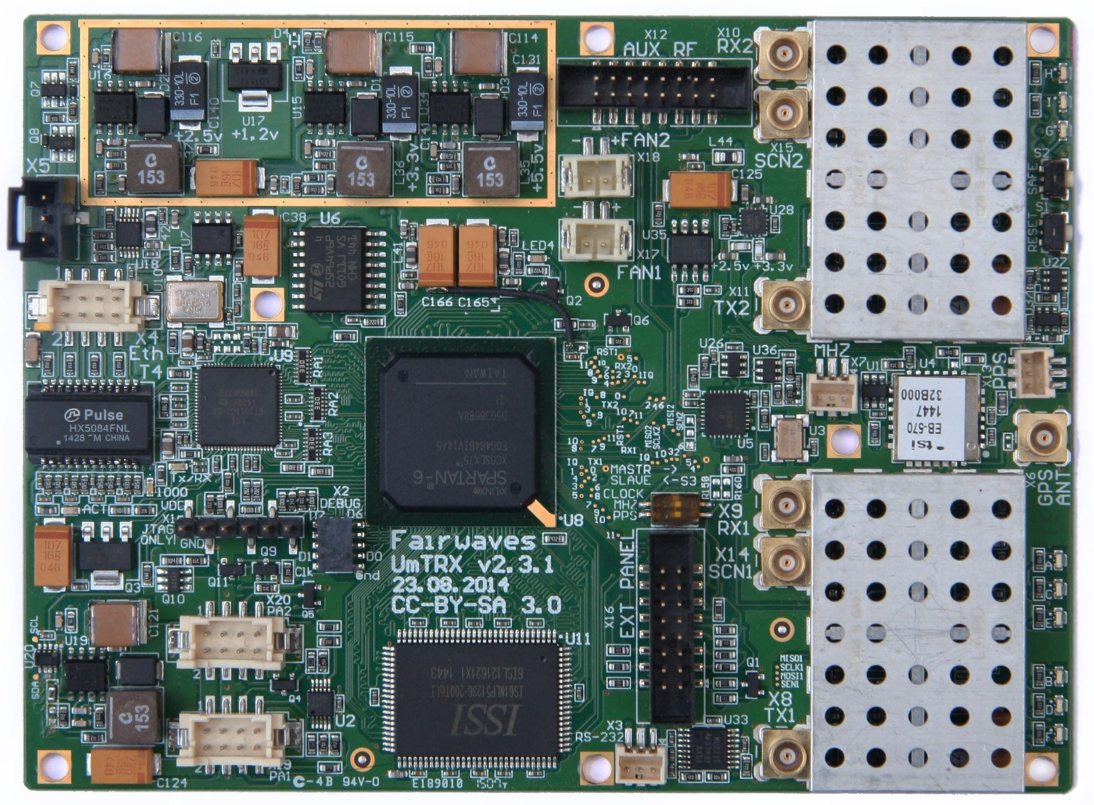


Fan (FAN1 / FAN2)

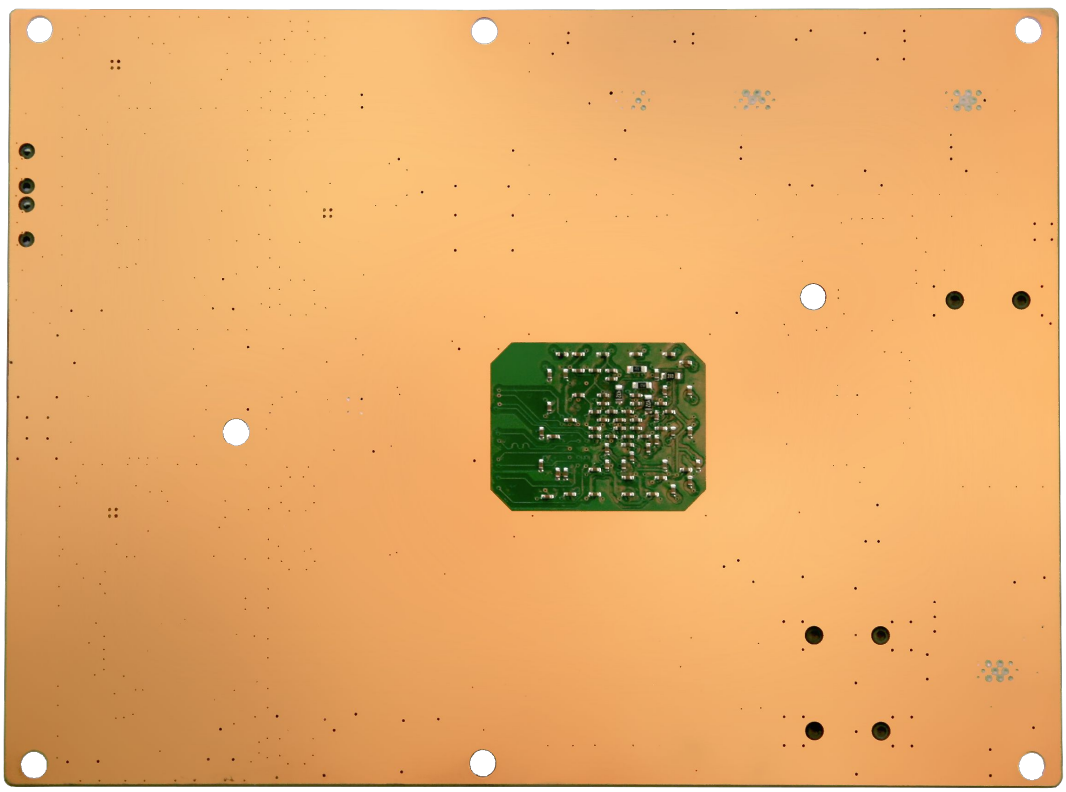
FAN ports are useful if you want to provide air cooling for the board. FAN1 (X17) port is connected to the power bus directly, while FAN2 (X18) is connected through an overheat protection. This allows to connect a fan which will be turned on only when the board temperature is over +60°C.



UmTRX 2.3.1 top and bottom view

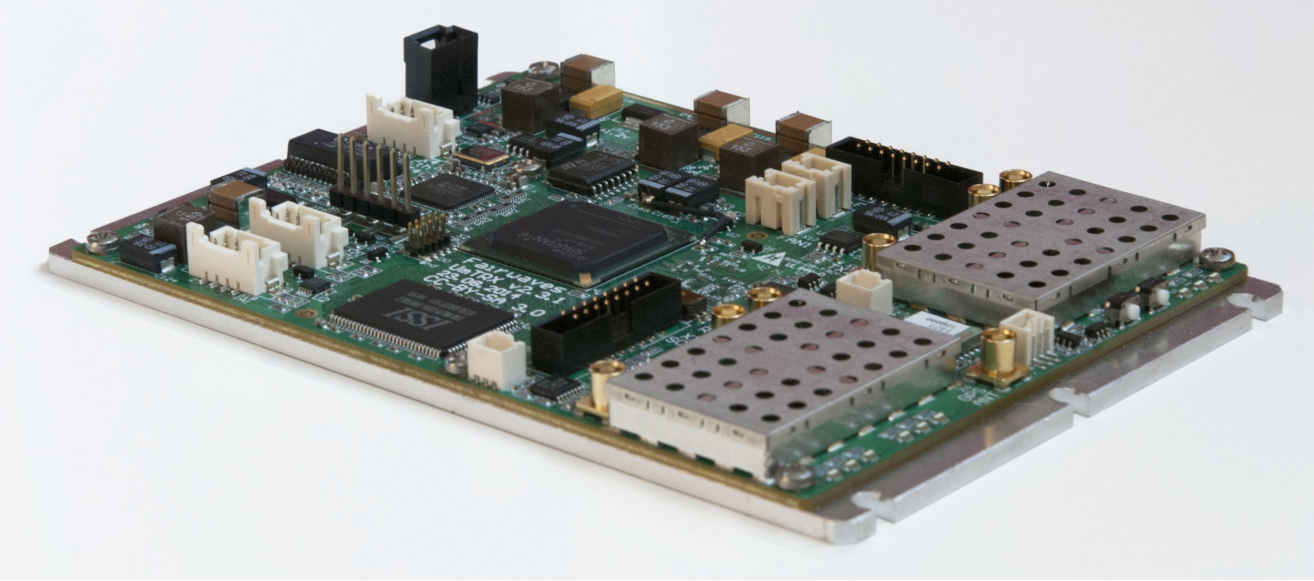


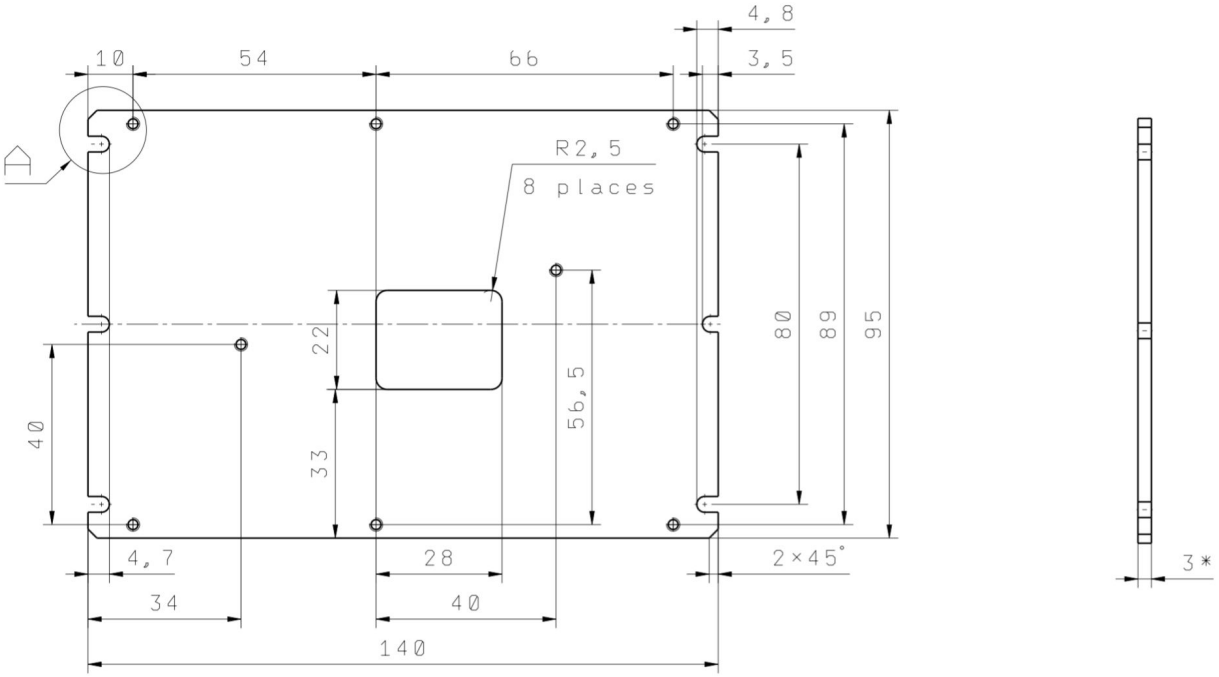
UmTRX 2.3.1 Top view

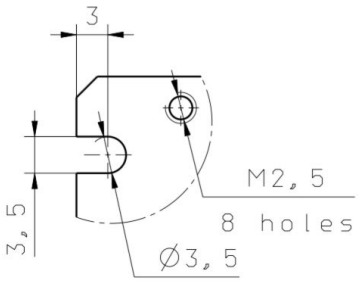


UmTRX 2.3.1 Bottom view

UmTRX 2.3.1 Aluminium plate

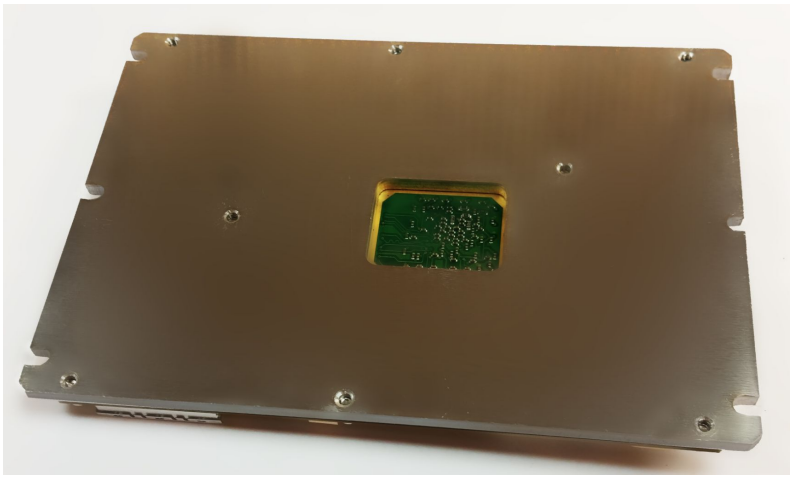




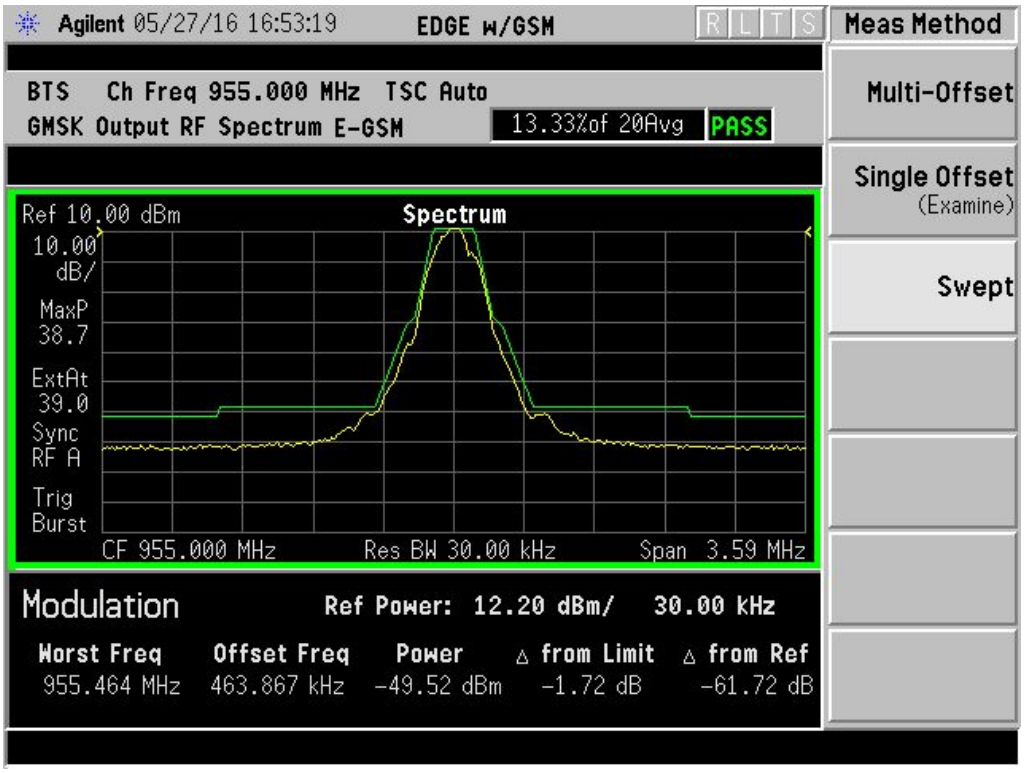


Detail A (scale 1:2)

Aluminium plate drawing

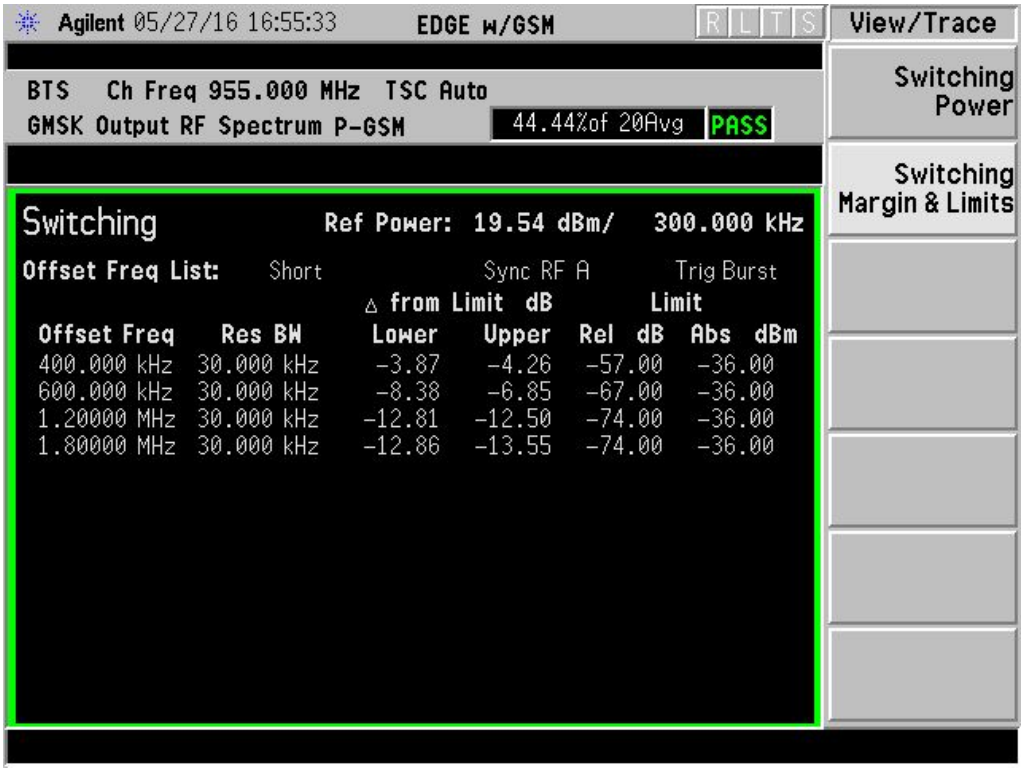


GSM-900 modulation spectrum mask with osmo-trx

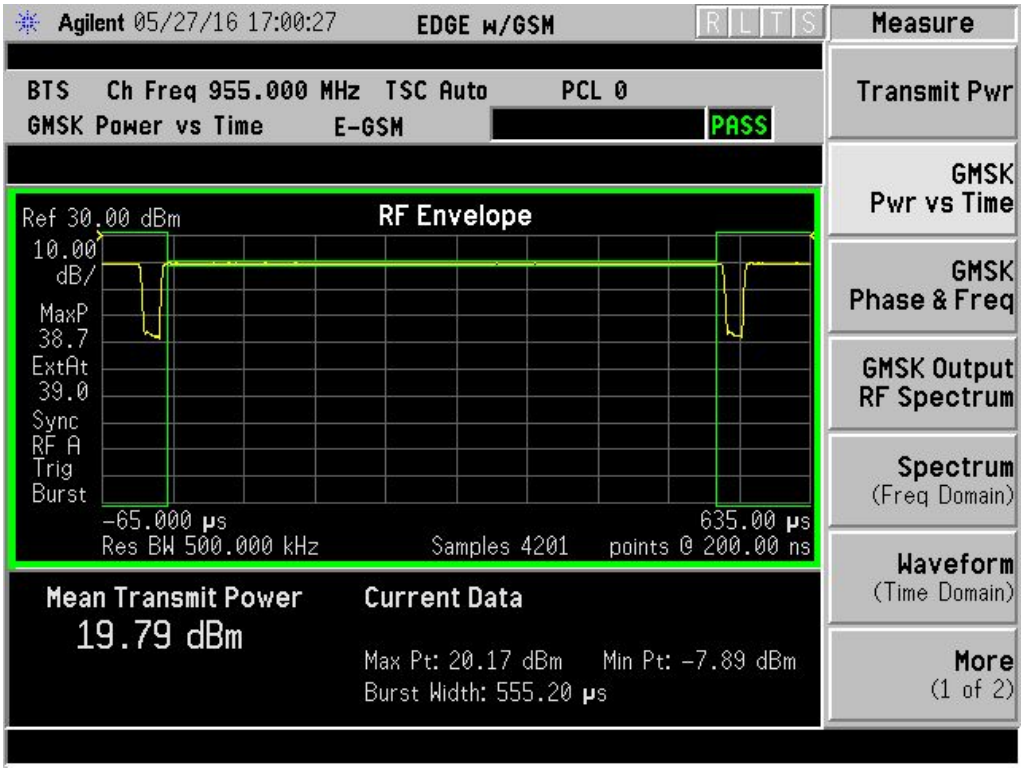


GSM-900 modulation spectrum mask with osmo-trx

UmTRX 2.3.1 GSM specific measurements

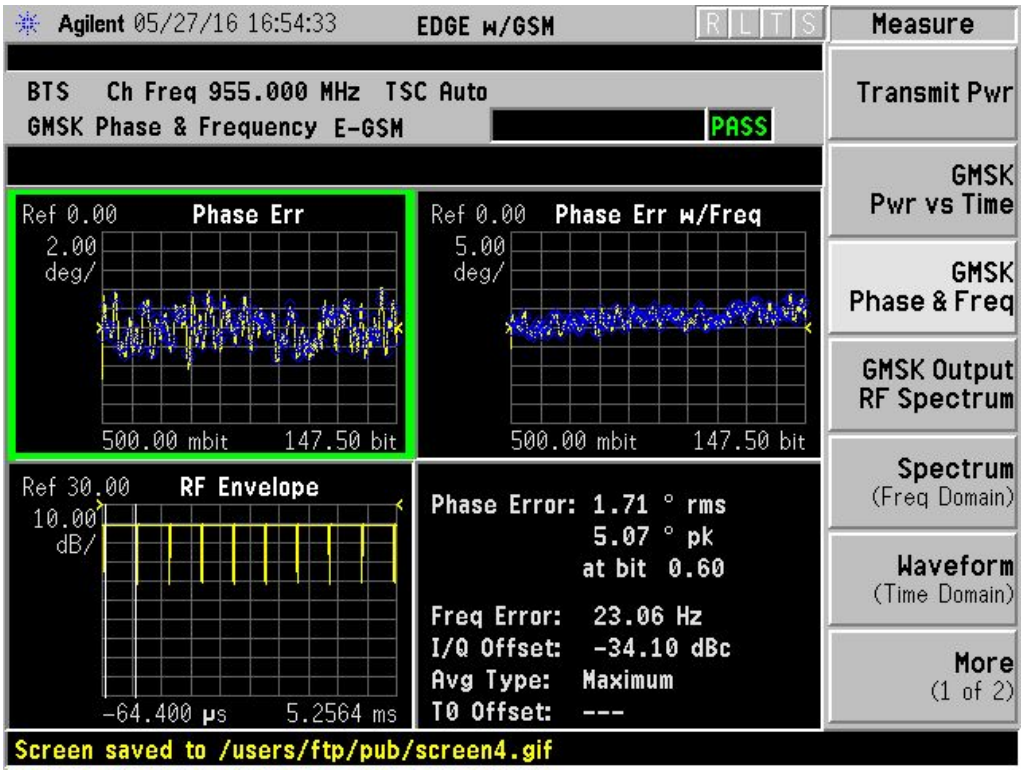


GSM-900 switching spectrum mask with osmo-trx

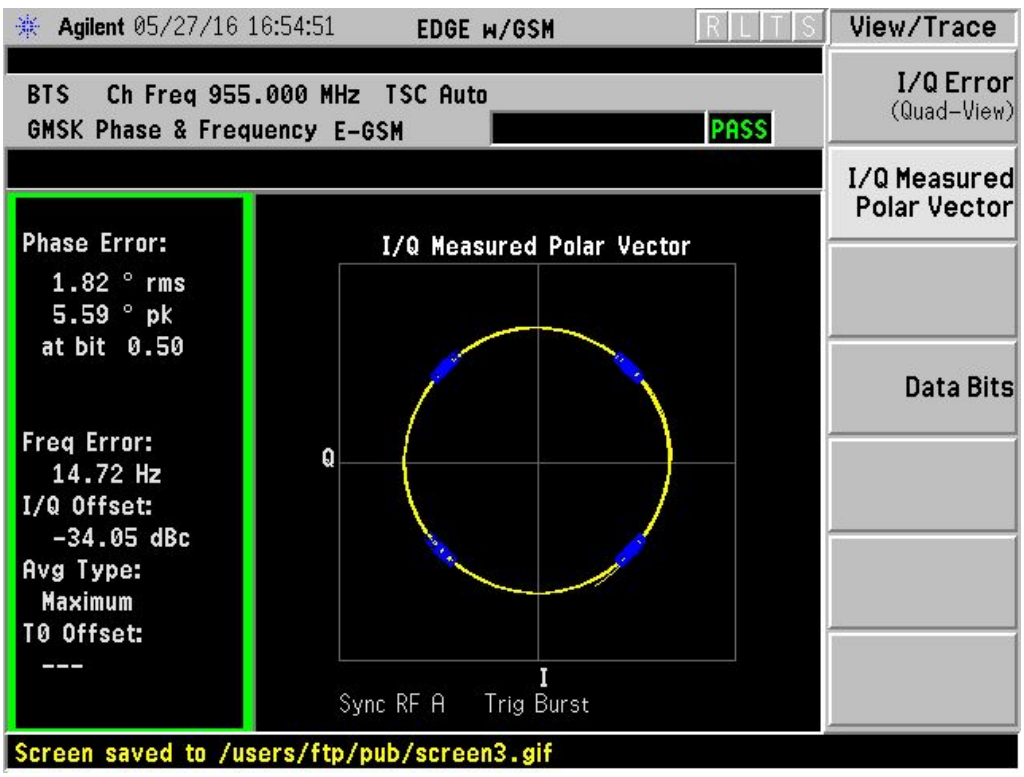


GSM-900 power envelop with osmo-trx

UmTRX 2.3.1 GSM specific measurements



GSM-900 phase error with osmo-trx



GSM-900 constellation with osmo-trx

Revision history

Version	Date	Changes
Rev. 1.0	2016-06-09	Initial release

About Fairwaves

Fairwaves make mobile networks profitable. We are building technologies that significantly lowers the cost of deploying and operating mobile networks, especially in remote and rural areas. Basic components of Fairwaves' systems, including UmTRX transceiver, are available for the wide engineering community, allowing everyone research and develop cutting-edge wireless technologies.