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RI 241

Fading Emulator

Ranatec AB
Falkenbergsgatan 3 - 412 85 Gothenburg – Sweden
+46 (0)31 706 16 60 | info@ranatec.com | www.ranatec.com

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Background

Fixed radio links are frequently used for various purposes within telecommunications and broadcast networks. The justification for using a radio link instead of optical fibre link relates to geography, speed of deployment and/or economics. Fixed radio links are often used to provide high-capacity communication links between stations in a network supporting a different service (e g mobile networks): an application known as 'backhaul'.

Given the criticality of the backhaul, in e g a mobile network, any given radio link needs to exhibit a very high reliability. I e, considered the statistical nature of the radio channel, every individual link needs to be properly planned, dimensioned, and implemented, taking the characteristics of the actual radio link equipment into account. The performance characteristics in terms of immunity against channel anomalies have become a key criterion when selecting radio link equipment for a network. Modern radio link equipment contains advanced signal processing, adaptive link optimization and support for a variety of link configurations - all with the aim to secure high-capacity communication with the highest possible reliability.

A consequence of the ever-increasing performance and functionality of radio link equipment is that the tools for test and verification need to keep a similar development pace: A product claim that cannot be verified by proper testing has little value and, as a minimum, the characteristics and performances of the radio link equipment must be demonstrated to be compliant with the standards and recommendations of national and international organizations such as ETSI, FCC, ITU and CEPT.

Essential verifications that must be performed, includes the detection capability of the receiver. Typical examples of these measurements are:

- Receiver sensitivity (carrier to noise characterization)
- Receiver performance in the presence of dynamic, flat fading (adaptive modulation, fast recovery)
- Immunity against Multipath Fading (signature verification)
- Immunity against disturbing signals (co-channel and adjacent channels as well as Continuous Wave (CW))

The Ranatec RI 241 is a multichannel, high performance, fading emulator, designed to fit into any general purpose, radio link test bench. It is intended as a generic test tool all through the product lifetime of a radio link product:

- As an efficient evaluation tool during the design phase
- As an accurate verification instrument during product qualification
- As an integer part of a streamlined factory test set-up
- As a powerful troubleshooting tool to reproduce in-field events

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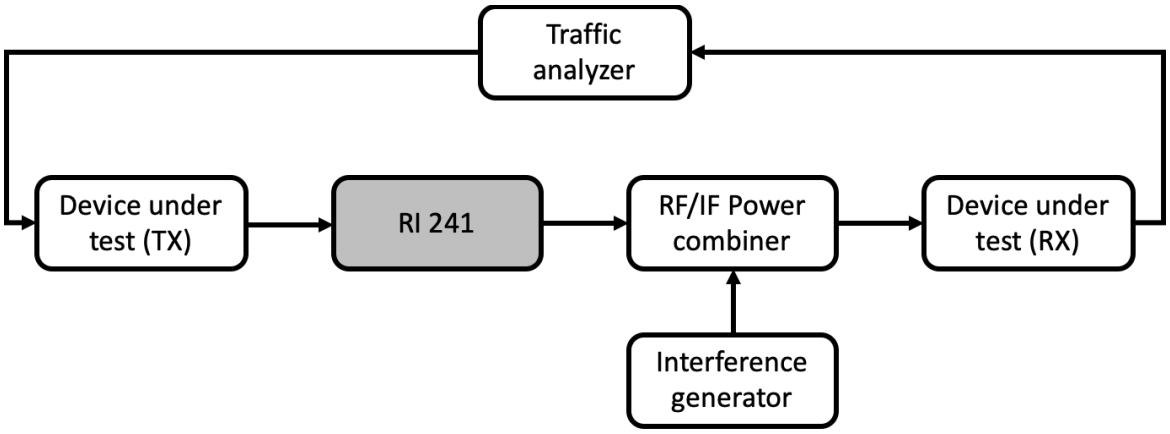
Product description

The Ranatec RI 241 can be equipped with up to 4 completely independent fading channels. Each channel can emulate multipath fading according to Rummler's model. The Rummler channel model has been widely accepted within the microwave long-haul community and is stipulated by ETSI and others.

A built-in Carrier-to-Noise (C/N_0) generator is available as an option. The modular concept and the fact that the main functionality is digitally implemented by means of programmable logics (FPGA), allows for smooth upgrade of the installed base.

The RI 241 Fading Emulator is designed to replace the obsolete Agilent 11757B that to date has been the state-of-art fading emulator for microwave long-haul. In addition to terrestrial radio link testing, RI 241 may also serve as a verification tool for satellite communications.

The generic test set-up for all testcases covered by the RI 241 is shown in the figure below. Typically, a host PC connected to all instrumentation would be used to automate the tests.



Receiver sensitivity measurements (carrier to noise characterization) is done by simply setting the wanted carrier to noise level (C/N_0 in dB) from the RI 241, while monitoring the traffic quality recorded by the traffic analyzer (e g Bit Error Rate, BER). Six different noise bandwidths are selectable and the C/N_0 can be set in 0.1 dB steps.

To verify the receiver performance in the presence of dynamic, flat fading, the RI 241 is set to emulate a true channel by sweeping the output power level between 0 and -40 dB (relative to a preset reference level) while monitoring the traffic analyzer recordings. Fading rates from 0 dB/second all the way up to 6500 dB/second can be emulated. Dynamic flat fading tests are typically performed to verify error free adaptation of modulation and coding schemes in the presence of dynamic fading.

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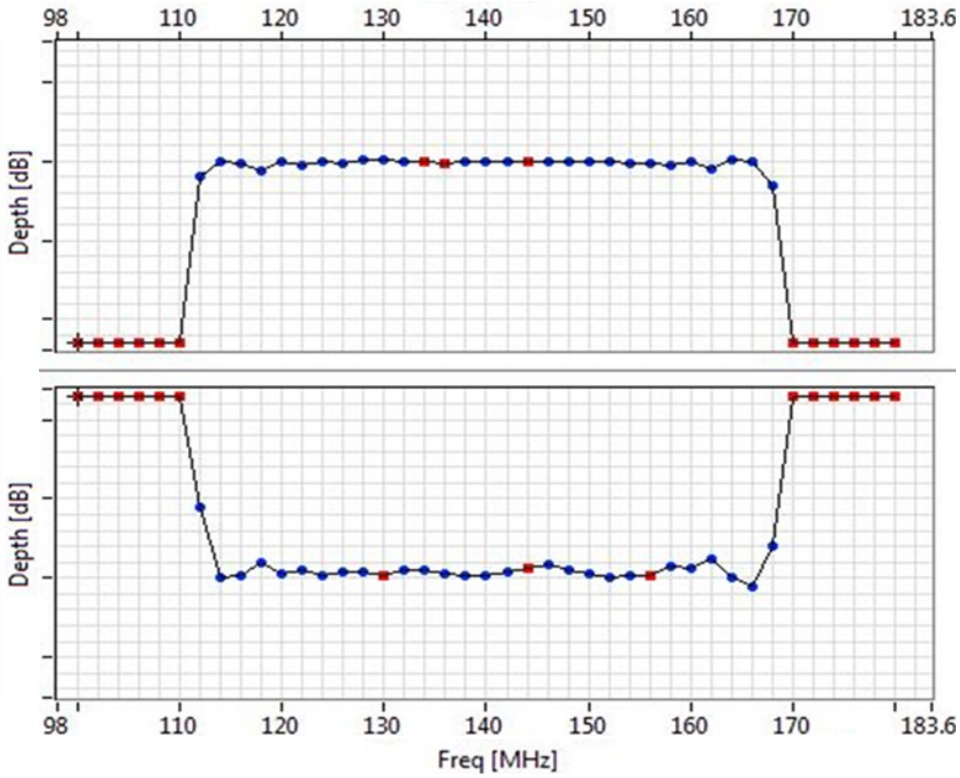
Verification of receiver immunity against multipath fading is a key feature of the RI 241. Selective fading is emulated in accordance with the Rummler model (ref ETSI EN 301 126-1). To obtain the signature of the device under test, the frequency of the notch is incrementally swept across the channel bandwidth. For each frequency, the notch is increased to determine at what notch depth a given traffic quality limit is exceeded. This is repeated for both minimum and non-minimum phase and the system signature can be plotted as shown in the figure below.



For a complete characterization of the device under test, the capability to add an interfering signal (co/adjacent channel or CW) may be added, as shown in the generic test set-up. In this case the RI 241 is set to generate the wanted C/N_0, while external equipment is needed to produce the interfering signal and the traffic analyzer records the traffic quality.

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Technical data

Parameter	Value	Remarks
Number of channels	1 to 4	
Impedance	50 ohm	
Bandwidth	140 +/- 56 MHz	-2 dB bandwidth
Group delay variations	+/- 1 ns	At 140 +/- 20 MHz
Noise Figure	14 dB	At Pin = -10 dBm
Notch frequency range	140 +/- 56 MHz	
Notch frequency resolution	1 kHz	
Notch frequency accuracy	+/- 20 kHz	
Notch depth	0 to 43 dB	
Notch depth resolution	0.1 dB	
Notch depth accuracy	+/- 0.5 dB	Relative to the flat fading level
Flat fading range	0 to 40 dB	
Flat fading resolution	0.1 dB	
Flat fading accuracy	+/- 2 dB	
C/N_0 frequency range	140 +/- 70 MHz	AWGN
C/N_0 accuracy	+/- 0.2 dB	At noise bandwidth = 40 MHz
Sweep time range	10 ms to 99.9 s	
Sweep time resolution	10 ms	
Max slew rate, notch frequency	10 000 MHz/s	
Max slew rate, notch depth	4 300 dB/s	
Max slew rate, flat fading	6 500 dB/s	
Max input/output DC voltage	30 V	
Max input power	+18 dBm	
Max power into output	+20 dBm	
Remote control interface	Ethernet / RJ-45	

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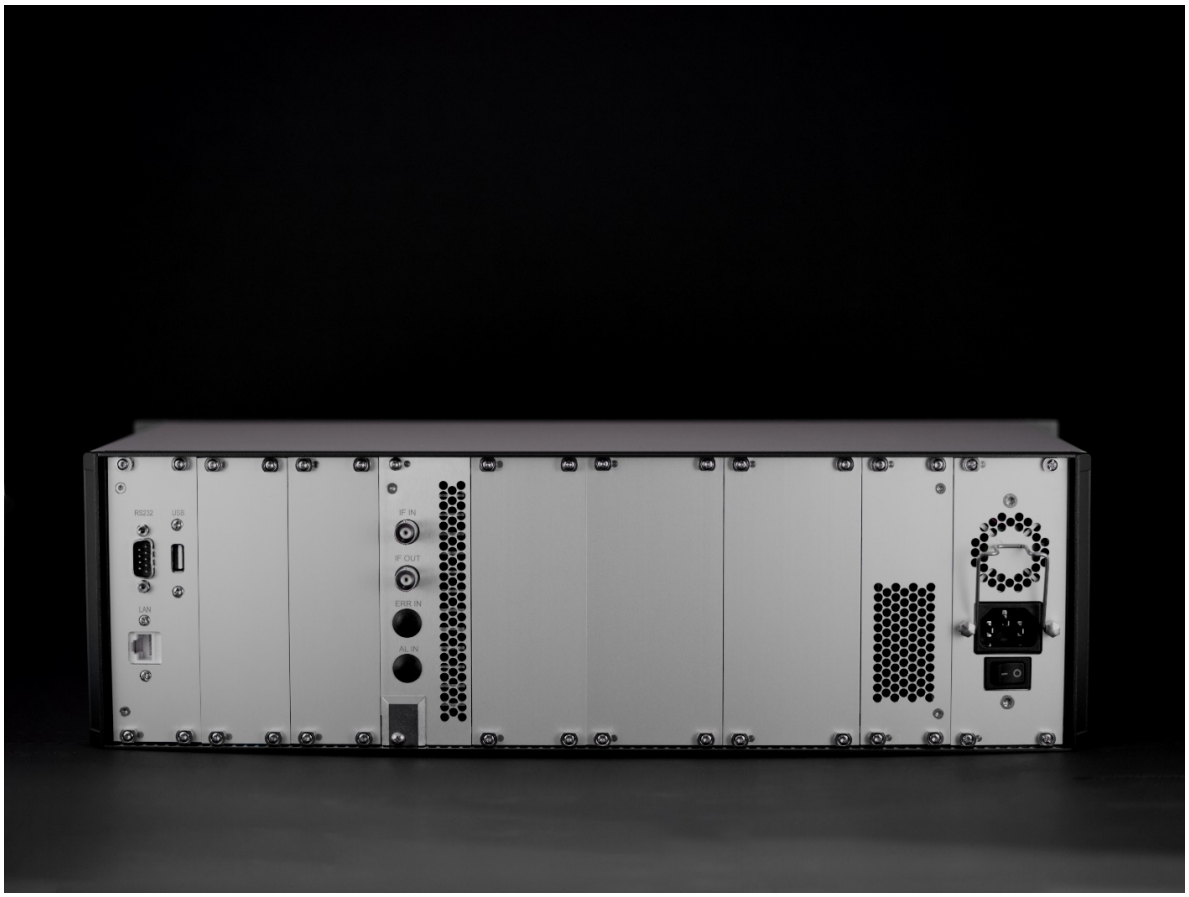

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