R&S® ENY81 Coupling Network

For radio disturbance measurements on unshielded, symmetrical telecommunications ports

- Eight-wire network
- Radio disturbance measurements in line with CISPR 22: 2005 and EN 55022: 2006 (150 kHz to 30 MHz)
- CISPR 16-1-2 complied with
- Adapter sets to meet standardized LCL requirements (55 dB and 65 dB) and to accommodate various telecommunications interfaces
- High transmission bandwidth for wanted signal (100 MHz)
At a glance

The R&S®ENY81 coupling network has been designed to measure the asymmetrical (common-mode) RFI voltage of unshielded, symmetrical telecommunications ports of EUTs. The measurements can be performed in the frequency range from 150 kHz to 30 MHz and are in line with the CISPR 22: 2005 and EN 55022: 2006 product standards.

The R&S®ENY81 can be used for disturbance measurements of the EUTs. The coupling network is tested and calibrated in line with CISPR 16-1-2. The calibration data supplied refers to a symmetrical impedance of 100 Ω.

Test methods

The R&S®ENY81 terminates the EUT’s interface with 150 Ω (asymmetrical or common-mode impedance) and couples the EUT’s asymmetrical impedance to the test receiver with a voltage division factor of typ. 10 dB. The wanted symmetrical (differential-mode) signal passes through the network almost without attenuation up to a bandwidth of 100 MHz (valid for a symmetrical impedance of 100 Ω). At the same time, the coupling network decouples the test circuit from disturbance effects (RFI voltage, impedance) at the associated equipment (AE) port.

In line with CISPR 22: 2005 and EN 55022: 2006, measurements of the RFI voltage on one unshielded symmetrical wire pair require the use of a two-wire ISN (R&S®ENY21). In the case of two unshielded symmetrical wire pairs, it is necessary to use a four-wire ISN (R&S®ENY41), and with four unshielded symmetrical wire pairs an eight-wire ISN (R&S®ENY81).

CISPR 22: 2005 and EN 55022: 2006 specify the following conformance test method:

Nomenclature

In the CISPR 22: 2005 and EN 55022: 2006 product standards, this type of coupling network is referred to as an impedance stabilization network (ISN). In basic standards, they are instead called asymmetrical artificial networks (AAN), Y-networks (CISPR 16), or coupling/decoupling networks (CDN), (IEC 61000-4-6).
The measurement of the EUT is to be performed with a suppression of the wanted symmetrical signal corresponding to the category of the connected cable (requirements for cable categories CAT 3, CAT 5, and CAT 6 are defined in the standard).

In order to implement these test methods, the R&S® ENY81 consists of one high-symmetry basic network and a number of adapter sets for implementing the required longitudinal conversion losses (LCL). Each adapter set contains adapters for LCL values of 55 dB (for cable category CAT 3) and 65 dB (for cable category CAT 5).

Adapters

The R&S® ENY81 eight-wire ISN comes with two adapter sets (see table), i.e. with RJ-45 connector and with connectors for user-selectable wiring (1 mm banana jack).

<table>
<thead>
<tr>
<th>Type</th>
<th>Application</th>
<th>Pin assignment in line with EIA/TIA T568B</th>
</tr>
</thead>
<tbody>
<tr>
<td>R&amp;S® ENY81 basic adapter</td>
<td>Ethernet (100BaseT4, 1000BaseT)</td>
<td>Connector pair 1/pin 4, 5 pair 2/pin 1, 2 pair 3/pin 3, 6 pair 4/pin 7, 8</td>
</tr>
<tr>
<td></td>
<td>user-selectable pin assignment</td>
<td>RJ-11, RJ-45, and 1 mm</td>
</tr>
</tbody>
</table>

Functional testing and mechanical design

The R&S® ENY-FTS option in connection with a network analyzer allows the functional testing of the ISNs. This functional testing includes the verification of the asymmetrical impedance and phase, voltage division factor, and longitudinal conversion loss.

The R&S® ENY81 coupling network features bare threaded sockets for connecting it to a reference ground plane that is arranged either horizontally or vertically.
The typical insertion loss of the symmetrical circuit – measured with a line impedance of 100 Ω (upper curve) – determines the transmission bandwidth of the coupling network for the wanted signal; the typical voltage division factor (lower curve) is to be added to the measured voltage for the frequency range 150 kHz to 30 MHz for comparison with the disturbance limit.

Typical longitudinal conversion losses (LCL) as required by CISPR 22:2005 and EN 55022:2006 for the CAT 3 and CAT 5 cable categories; all curves are valid for the frequency range from 150 kHz to 30 MHz.

Typical decoupling attenuation between AE port and receiver port with EUT port short.
### Specifications

**Frequency range**
- Radio disturbance measurements: 150 kHz to 30 MHz

**Asymmetrical impedance**
- Impedance (0.15 MHz to 30 MHz): $150 \pm 20 \Omega$
- Phase angle (0.15 MHz to 30 MHz): $0^\circ \pm 20^\circ$

**Voltage division factor in asymmetrical circuit**
- 150 kHz to 30 MHz: typ. 10 dB ± 2 dB (calibration data supplied 1)
- > 30 MHz to 80 MHz: typ. 10 dB ± 2 dB

**Transmission bandwidth (3 dB)**
- > 100 MHz (for 100 W source and load impedances)

**Longitudinal conversion loss (LCL)**
- 55 dB adapter:
  - LCL (dB): $55 - 10 \log (1 + (f/5)^2)$ dB
  - Tolerance: ± 3 dB, for 0.15 MHz ≤ f ≤ 30 MHz
- 65 dB adapter:
  - LCL (dB): $65 - 10 \log (1 + (f/5)^2)$ dB
  - Tolerance: ± 3 dB, for f < 2 MHz, ± 3 to ± 4.5 dB, for 2 MHz ≤ f ≤ 30 MHz

**Decoupling attenuation**
- 150 kHz to 1.5 MHz: > 35 dB to 55 dB (linear increase with logarithmic frequency)
- 1.5 MHz to 30 MHz: > 55 dB

**Crosstalk (PSELFEXT, EUT/AE)**
- 1 MHz to 100 MHz: ≥ 61 dB to ≥ 21 dB (linear increase with logarithmic frequency)

**Maximum values**
- Max. permissible RF input voltage: ≤ 15 V
- Max. permissible DC voltage between line and ground: 100 V
- Max. permissible AC voltage between line and ground: 63 V
- Max. permissible DC current: 400 mA (current on each individual wire of one pair or on different pairs)

**Connectors**
- Output to test receiver/input from signal generator: BNC female
- Connectors for EUT and AE: adapter with 1 mm connectors and RJ-11 or RJ-45 connectors

### General data

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operating temperature range</td>
<td>+5 °C to 40 °C</td>
</tr>
<tr>
<td>Storage temperature range</td>
<td>−20 °C to +70 °C</td>
</tr>
<tr>
<td>Overall dimensions (W × H × D)</td>
<td>Basic unit: 105 mm × 65 mm × 110 mm (4.1 in × 2.6 in × 4.3 in)</td>
</tr>
<tr>
<td></td>
<td>Basic unit with adapters: 105 mm × 65 mm × 190 mm (4.1 in × 2.6 in × 7.5 in)</td>
</tr>
<tr>
<td>Weight</td>
<td>Basic unit with adapters: 520 g (1.1 lb)</td>
</tr>
<tr>
<td>Carrying case with basic adapter set: 1640 g (3.6 lb)</td>
<td></td>
</tr>
</tbody>
</table>

### Ordering information

<table>
<thead>
<tr>
<th>Designation</th>
<th>Type</th>
<th>Order No.</th>
</tr>
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<tbody>
<tr>
<td><strong>Base units</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Eight-Wire ISN in line with CISPR 22: 2005</td>
<td>R&amp;S® ENY81</td>
<td>1309.8503.03</td>
</tr>
<tr>
<td>Options</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Functional Test Set</td>
<td>R&amp;S® ENY-FTS</td>
<td>1309.8703.03</td>
</tr>
<tr>
<td><strong>Accessories supplied</strong></td>
<td></td>
<td></td>
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<tr>
<td>Plastic carrying case with foam material, calibration data 1</td>
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</tbody>
</table>

1. The calibration data includes asymmetrical impedance and phase, voltage division factor, decoupling attenuation, longitudinal conversion loss (LCL), transmission bandwidth, and crosstalk.