GAUSS INSTRUMENTS

# Content

# Company Profile

As an innovation leader in the specific field of measurement technology for electromagnetic interference (EMI), the company GAUSS INSTRUMENTS develops measurement systems and solutions for the fast growing demands and requirements of modern EMI testing brought by continuously increasing complexity of electronic equipment and systems as well as shorter getting product life cycles today.

By developing and introducing the TDEMI® Measurements System a new chapter has been opened in the field of emission testing offering absolutely new and so far unachieved possibilities to the operator. The scientific achievements and developements based on time-domain methods has been awarded with several prices, e.g. the E.ON Future Award 2007.

The combined application of digital signal processing in real-time, ultra high-speed analog-to-digital converters and radio frequency technology enables the realization of highly complex methods and techniques boosting the measurement speed and thus reducing the test time by several orders of magnitude. The team of GAUSS INSTRUMENTS has an experience of more than 10 years in the fields of ultra high-speed analog-to-digital converters, radio frequency technolgy and real-time signal processing on field programmable gate arrays.

The intention and effort of GAUSS INSTRUMENTS is to provide a technological and an economic winning margin to our customers and partners by leading-edge engineering solutions. Reducing the overall testing time at the one hand and increasing the quality and reliability of the measured results at the same time the product development cycle as well as the product certification are substantially accelerated and an additional benefit is generated at the customer's site.

Fig. 02 – **GAUSS INSTRUMENTS headquartered in Munich, Germany.** The metropolitan area of Munich is one of Europe's leading hubs in science and adavanced technology.

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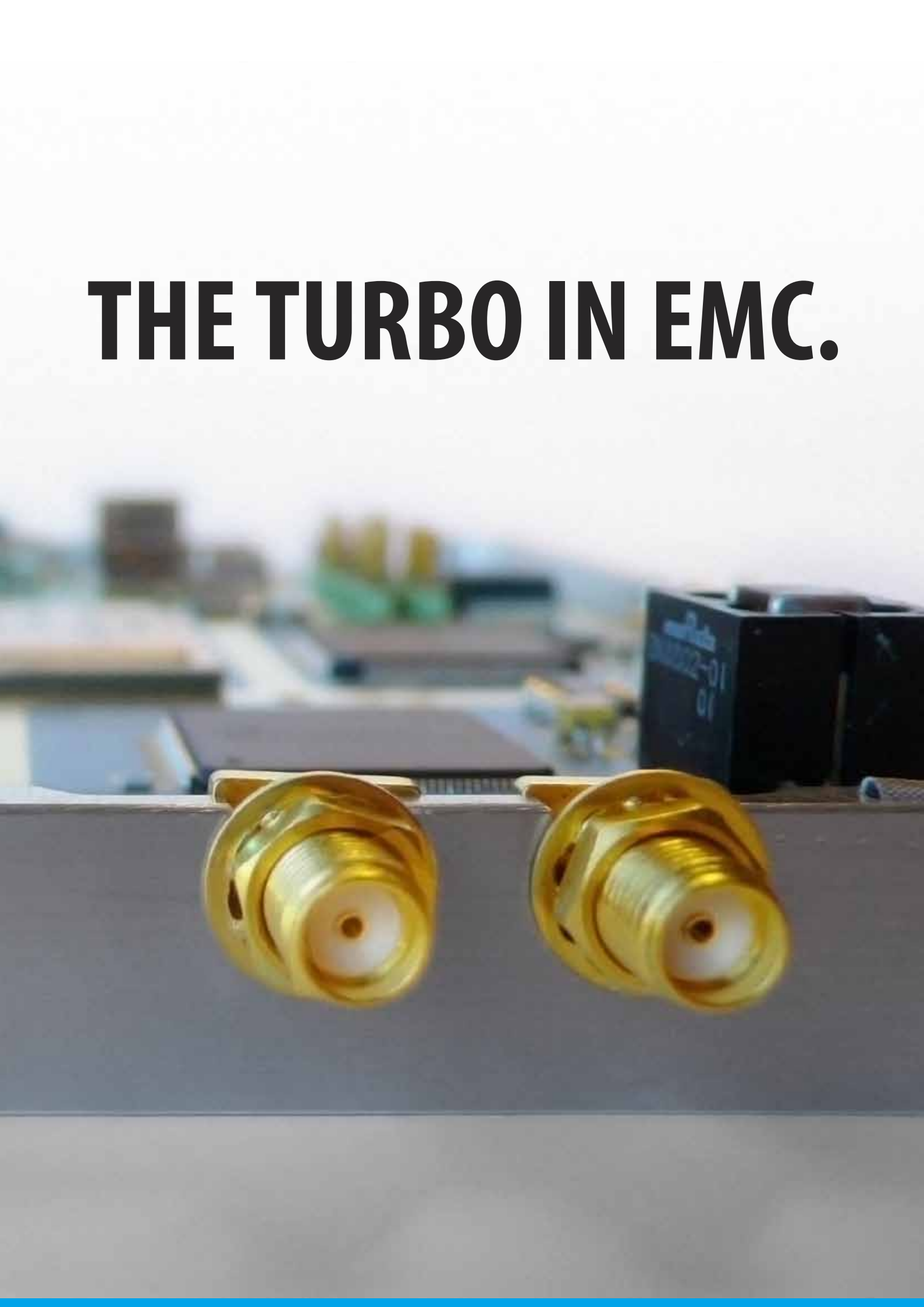
# THE TURBO IN EMC.



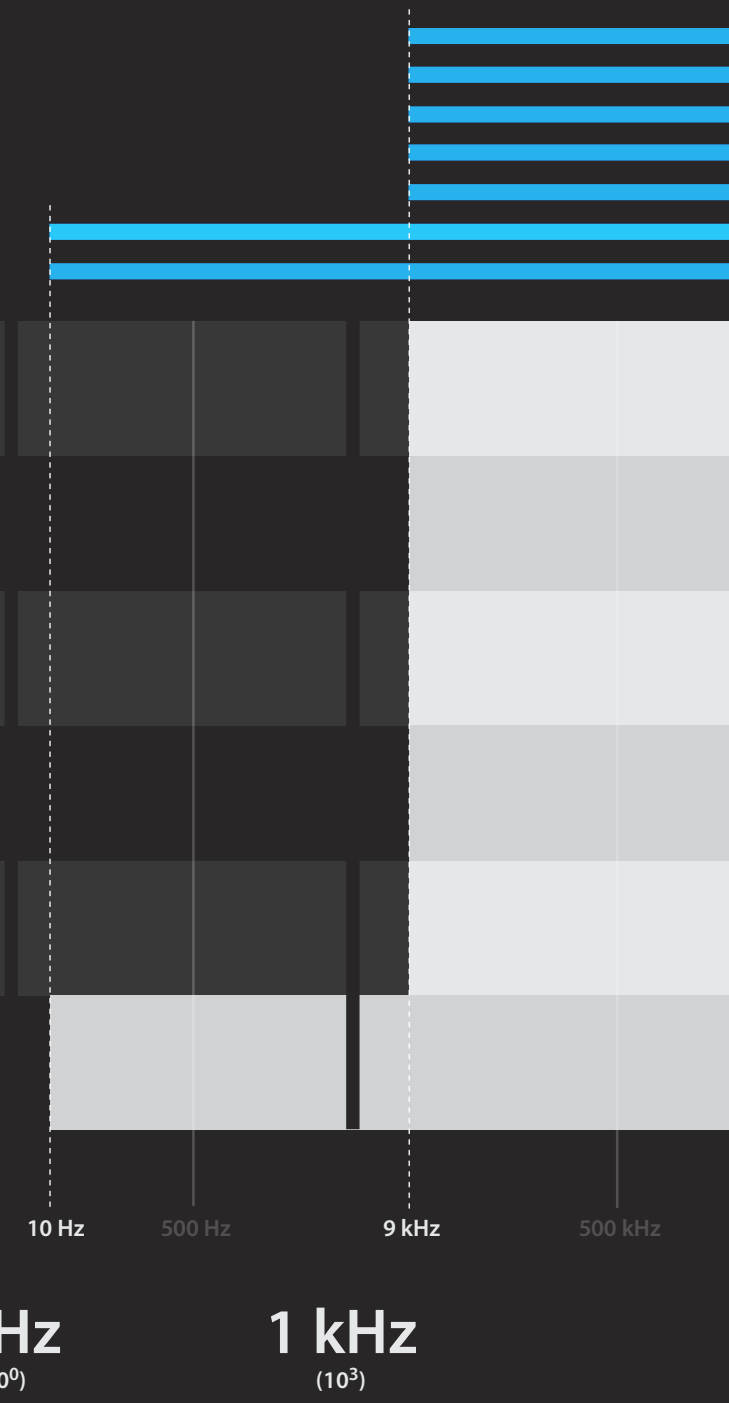
# Frequency Ranges and Applications

The electronification and digitalisation of our world is spreading more and more in all areas of daily life and industries. Examples are mobile internet, smart home, telemedical monitoring, driver assistance-, entertainment- or saftey systems, e-mobility or the intelligent use of ressources. The spectrum allocation is getting denser and the topic of electromagnetic interferences is getting more and more important.

The shown graph displays the classification of the frequency ranges and the corresponding TDEMI Measurement System using the example of six typical fields of applications.

**TDEMI 30M**
9 kHz - 30 MHz

**TDEMI 1G**
9 kHz - 1 GHz

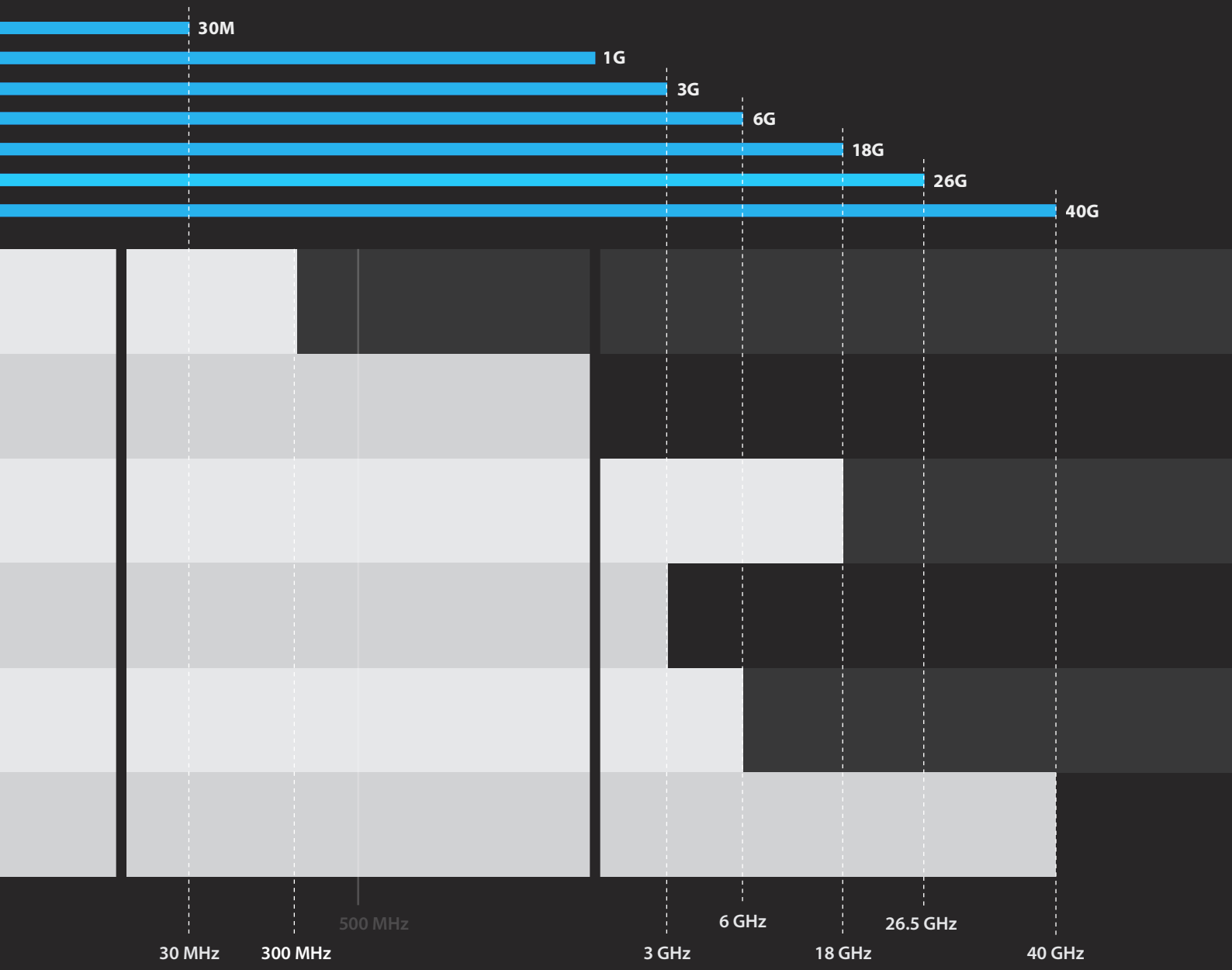


**TDEMI 3G & 6G**
9 kHz - 3 GHz (6GHz)

**TDEMI 18G**
9 kHz - 18 GHz

**TDEMI 26G**
10 Hz - 26.5 GHz

**TDEMI 40G**
10 Hz - 40 GHz




# 1 MHz
($10^6$)

# 1 GHz
($10^9$)

# Electrical Lighting

Emission measurements of electrical lighting and similar devices are typically performed in the frequency range 9 kHz - 300 MHz. In the frequency range, measurements are carried out by a Van Veen Loop Antenna, a Line Impedance Stabilisation Network (LISN) or a Coupling/Decoupling Network (CDN) according to the standard CISPR 15.

For example the magnetic field strength is measured in band A (9 kHz - 150 kHz), by using a Van Veen Loop Antenna. The conducted emissions are measured by using a LISN. Energy saving lamps use an internal oscillator. This oscillator shows a change of the emission characteristics in dependence of the temperature and the supply voltage. Therefore the emissions may change during the measurement. The measurements have to be performed with a quasi-peak detector over large frequency bands. These preconditions are resulting in very long total testing times. Measurement procedures that exhibit a fast prescan performed with a peak detector and a final scan performed with a quasi-peak detector are complex, as the frequency of the emission between pre- and final scan may have changed.

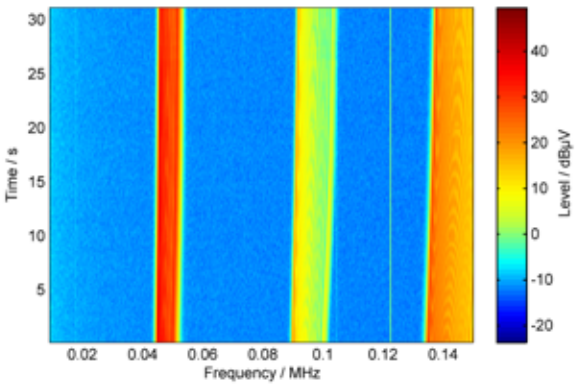



Fig. 05 – **Emission measurement of a energy saving lamp** in the frequency range 9 kHz - 150 kHz. It is shown that during the warm-up of the device the emission changes over the time and the emitted frequencies are shifting during the shown observation period of 30 seconds.

The emission measurement systems of the product family TDEMI allow to measure the corresponding frequency ranges with a scan time below one minute. In addition it is possible to record and analyse the time dependent characteristic of the emission. By this way also the drifting emissions can be correctly detected, and measured reproducible.

**Measurement of the magnetic field strength with a Van Veen Loop Antenna (9 kHz - 150 kHz)**

The measurement of the magnetic field strength is performed by using a Van Veen Loop Antenna. The measurement of the magnetic field strength is carried out at X, Y and Z direction. By the TDEMI for each of the three axis a very fast scan can be performed. The measurement procedure with the TDEMI can be automated by the selection of a single loop via the userport of the instrument (Option LISN-UG). An automated sequential measurement of all three loops reduces the total testing time to less than two minutes. By using the report generator the measurement results are automaticaly evaluated and the test report is created.

**Conducted Emission Measurements with a LISN (9 kHz - 150 kHz)**

The emission measurement with a LISN has to be performed for each phase. The selection of the phase (Option LISN-UG) is performed during the emission measurement automatically. The phases are selected sequentially and each phase is measured. The evaluation according to the limit lines is performed by the report generator. The emission measurement with a two-phase LISN is carried out with the TDEMI in less than one min-

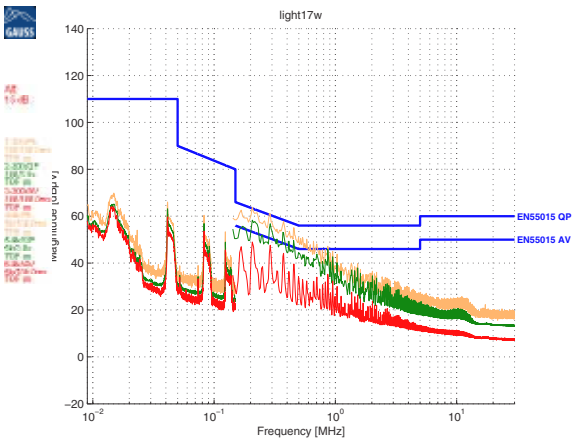



Fig. 06 – **Emission measurement of a lamp.** Measurement of band A (9 kHz - 150 kHz) and band B (150 kHz - 30 MHz). Measurement according to EN 55015.

ute. An example of such a measurement is shown in Fig. 6.

**Emission measurement with a CDN (30 MHz - 300 MHz)**
By the update of the Standard CISPR 15 the frequency range for measurements has been increased up to 300 MHz. In order to quantify the radiated emissions of electrical lighting equipment the measurement of the disturbance of the power supply is carried out with a Coupling/ Decoupling Network (CDN).

The measurement with a CDN according to CISPR 15 requires a scan with the quasi-peak detector mode. Such a scan can be carried out with the TDEMI in less than one minute. By a report generator the measurement is evaluated automatically and a test report is generated.

# Household Appliances

The emission measurement of household appliances is performed typically in the frequency range from 150 kHz to 1 GHz. If equipment contains oscillators, e.g. magnetrons in microwave ovens, emission measurements have to be carried out up to 18 GHz. Such devices are classified as ISM (industrial, scientific and medical) devices. Other technical features like power line communication (PLC) increase the frequency range of measurements perform down to 9 kHz.

Conducted emission measurements in the frequency range 9 kHz - 30 MHz are performed with a LISN. The measurement of disturbance power is carried out in the frequency range 30 MHz - 300 MHz with an absorbing clamp shifted along a slideway. The emission measurement is typically performed according to CISPR 14. Radiated emissions in the frequency range 30 MHz - 1 GHz are performed according to several other standards related to the device under test, its features or classification respectively.

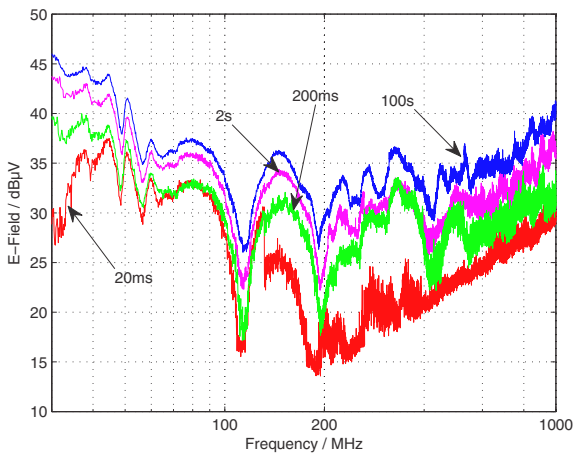



Fig. 07 – **The radiated emission of a brush motor** in dependance of the selected dwell time. It is shown that a sufficient high dwell time results in the full characterization of the emission of the device under test. The requirement is described in CISPR 16-2-X. Such a measurement can be performed very fast and efficient with the TDEMI.

# Applications

Due to the complexity of the devices and their instationary behavior very often, measurements performed with traditional EMI receiver operating in frequency domain are very time consuming. The use of the TDEMI allows to reduce the overall test time of devices considerably. In addition the measurement accuracy is enhanced. During the product developement devices can be tested and optimized in real-time. The evaluation of the emission of fully automated devices, e.g. fully automatic espresso machine, by the weighted spectrogram mode and the embedded Click Rate Analyzer (Option CLICK - UG) is possible by the TDEMI.

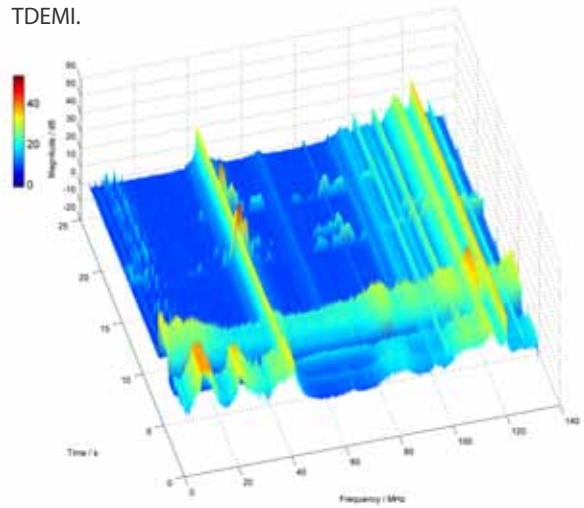


Fig. 08 – **Time dependent weighted spectrum of a fully automatic espresso machine.** From 2.5 s the beans are crunched. During the time interval 4 - 6 s the emission of the water pump can be observed. Later on further transient emissions are observed during the switching of the components as valves for example and internal cleaning.

**Conducted Emission Measurements with a LISN (9 kHz - 30 MHz)**

The emission measurement with a LISN is performed for each phase seperately. By the controller of the userport (Option LISN - UG) the selection of the phase is performed during the emission measurement automatically. The phases are selected sequentially and each phase is measured. The evaluation according to the limit lines is performed by a report generator fully automated as well. The emission measurement with a two-phase LISN is carried out with a TDEMI in less than one minute.

**Measurement of discontinuous disturbances (150 kHz - 30 MHz)**

The CISPR standards allow for discontinuous disturbances that the quasi-peak level may be above the limit line. However the emission has to be limited to a certain degree when observed over a longer period of time. Such an evaluation is performed by the click analysis. The click analysis is as available for all TDEMI Systems (Option CLICK - UG). This option enhances the TDEMI to a full click analyzer and is fully integrated into the system to a single box solution.

**Measurement with sliding clamp (30 MHz - 300 MHz)**

The emission measurement with an absorbing clamp is carried out at several positions of the slideway. At each position a scan is performed in the quasi-peak detector mode and the maximum emission over the position is compared with the limit line. By the software (Option SLIDE - UG) the measurement performed with a sliding clamp and the TDEMI can be automated.

**Radiated Emission Measurement (30 MHz - 18 GHz)**

Measurements in the frequency range 30 MHz - 1 GHz are performed on open area test sites, in full or semi-anechoic rooms. The extremely fast scans performed by the TDEMI in the peak detector mode allow to perform fast prescans. The provided zero span mode allows to perform the maximization at critical frequencies. Instationary emissions can be evaluated by features like the spectrogram mode. Above 1 GHz emission measurements are carried out in anechoic chambers at several angular turntable positions.

# Microwave Ovens

The emission of microwave ovens exhibits a time-dependent behaviour in level and frequency. This is caused by the rotating of the dish in the microwave oven or the meal placed on the dish respectively and resulting in various field distributions necessary to achieve uniform heating of the food. Furthermore the power of the magnetron is regulated dynamically.

By the TDEMI it is possible to measure and analyse such disturbances reliably. The measurement of the level is typically performed at the fundamental frequency as well as the harmonics.

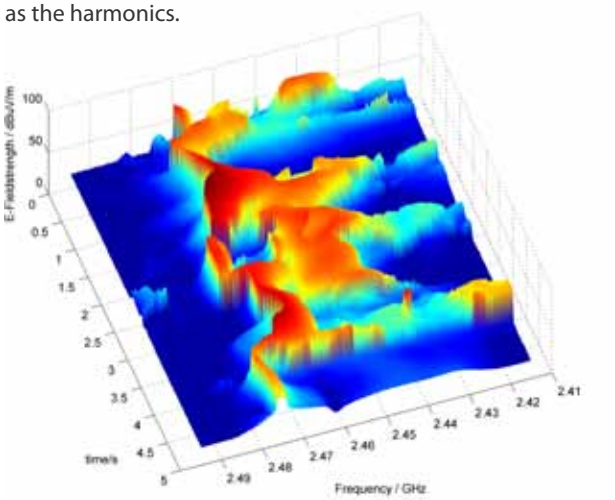



Fig. 09 – **Radiated emissions of a microwave oven at the fundamental frequency.** It is shown that the magnetron has a behaviour that changes the amplitude as well as the frequency of the emission spectrum. Also the regulation of the power - switching on and off - can be observed during the measured time interval.

### Emission Measurement with TDEMI

By using the TDEMI System the measurement can be performed with sufficient high dwell times at several thousand frequencies simultaneously. This enables the user to obtain test results in a sigificantly reduced test time, in comparison to the measurement carried out with spectrum analyzers. In an automated scan the measurement at critical

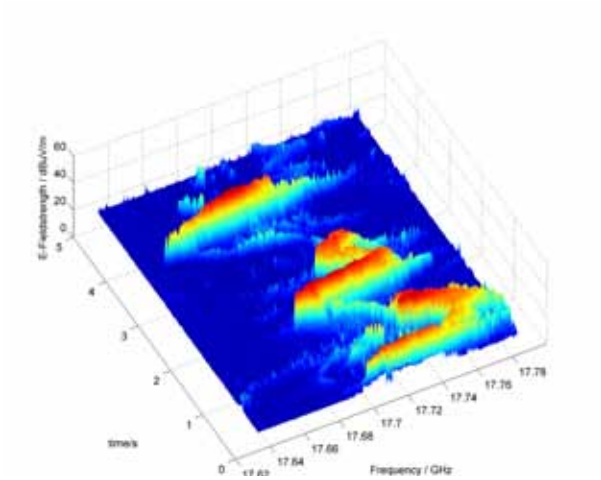



Fig. 10 – **Measurement of the 7th harmonic.** The deviation of the frequency is around 100 MHz.

frequency ranges can be carried out sequentially. Thus, it is not necessary to perform complete scans from 1 GHz to 18 GHz. Furthermore the TDEMI 18G has a switched filter preselection and an integrated low noise amplifier (Option LN-UG18G) that allows to measure the harmonics with highest dynamic range. There is no need of using external preamplifiers and filters in addition anymore.

### Precertification and EMC Debugging

During the development of microwave ovens various radio frequency components are used to reduce the radiated emission of the oven. For example a microwave oven contains gaskets and damped tuned resonators which are matched to reduce the emissions. Due to the fact, that the emission spectrum of microwave ovens consists of transient as well as frequency modulated parts the optimization of such components is quite challenging. The large real-time analysis bandwidth of 162.5 MHz of the TDEMI System enables to observe, analyze and optimize such components during the design and product development stage.

# Automotive

The emission measurement of vehicles and their components are performed typically in the frequency range 9 kHz - 3 GHz. Beside the EMC standards CISPR 25 and CISPR 12 which are applied to protect the on board receivers of vehicles as well as to limit the disturbance of a vehicle to its environment, various automotive OEM EMC standards of the manufacturers are applied.

A quite challenging task in automotive testing is the complexity of such an entire system, consisting of many subsystems and different components. One more difficulty is the protection of the on board receiver which is often coupled with the near field or even galvanically with the source of disturbance. In addition single transient emissions, e.g. during the ignition of an engine, are occuring. However, such single transients are not limited to single components. Typically via the on board bus systems other components are controlled to change and control the operation state of the car. But also disturbances can be via the bus systems. The measurement of a such an emission is shown in Fig. 11.

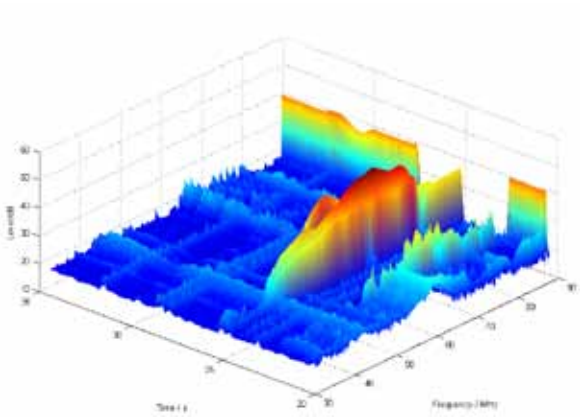


Fig. 11 – **Starting of a car.** At a time of 26 s the broadband emission of the starter enging can be observed. During the start-up event the smaller continuous disturbance at 88 MHz disappears. The measurement shows the complexity of such systems.

In the automotive area typically DC brush motors are used for many tasks. The brush motors produce electrical sparks at the brushes with statistical manner. Such components have to be measured according to CISPR 16-2-X at each frequency until the result is settled by +/- 1dB. In Fig. 12 the results of measurements in dependence to the dwell time with an EMI receiver are shown.

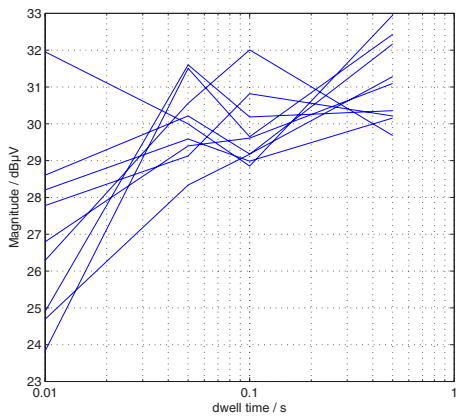



Fig. 12 – **Plot of the dependence of the measured value on the selected dwell time of the measuring instrument.**

Such investigations show clearly that some devices-under-test require a longer dwell time. The TDEMI Measurement Systems can perform a measurement at several thousand frequencies at the same time, which allows to speed up the measurement in such a way that also scans with much longer dwell times can be carried out economically.

**Measurement of the Magentic Field Strength with a Loop Antenna**

In the frequency range 9 kHz - 150 kHz the measurement is carried out with a loop antenna for example. The emission measurement is performed in a single scan and eval-

uated against the limit line. Such measurements can be carried out with the TDEMI in less than one minute.

**Measurement of Car Components with a LISN**

Conducted emission measurements of components of a car are performed over the frequency range 9 kHz - 108 MHz. In some cases the measurement is carried out up to 200 MHz. Therefore the disturbance of a component of the car is filtered by a LISN from a conductor and measured by the TDEMI. Also in this application the measurement of all frequency points can be carried out in less than one minute. Afterwards the spectrum is compared to the limit line.

**Radiated Emission Measurements of Car Components**

Measurements of radiated emissions of car components are performed on a metal table in an anechoic chamber with a metal ground plane. The antenna is positioned in front of the device-under-test and a single measurement is performed. The measurement is performed in a complete scan up to 3 GHz. The result is compared with the limit line. With the TDEMI the complete measurement up to 3 GHz is carried out in less than two minutes.

**Emission measurement of a complete vehicle**

During the measurement of a complete vehicle according to CISPR 25 the emission measurement of the internal antennas is performed. The outputs of the antennas of the car are connected to the TDEMI and an emission measurement is performed at each antenna. By the reduced scantime of the TDEMI all the antennas can be measured highly economically, even at the various operation modes of the vehicle. Especially the measurement of hybrid cars can be performed more accurate and more reliable test results are obtained.

# IT Equipment

Emission measurements of devices of the information technology (IT) and telecom are typically performed in the frequency range 150 kHz - 6 GHz. Typical additional technical features, e.g. power line communication (PLC), increase the lower frequency range down to 9 kHz.

The measurement in the frequency range 9 kHz - 30 MHz is performed with a LISN. In the frequency range 30 MHz - 6 GHz the radiated electromagnetic interference is measured. The test procedure as well as the evaluation is usually performed according to CISPR 22. Emission measurements according to the FCC standards are performed in the frequency range up to 26.5 GHz. Typical devices are for example personal computers, displays, wireless LAN-, Bluetooth- and PLC modules.

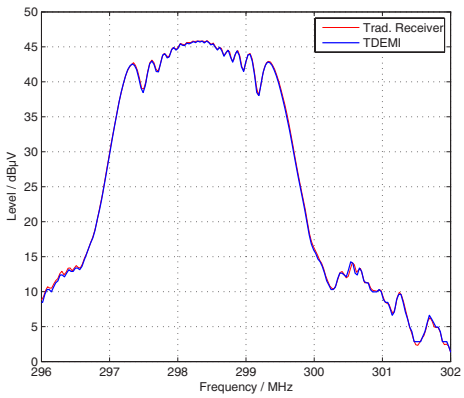



Fig. 13 – **Radiated emission of a personal computer** carried out with the TDEMI System and with a conventional EMI receiver. An excellent agreement between the results is shown. The PC uses a special controlling of the clock rate to spread the signal power over a wider frequency range and thus to reduce a high power level emission at a single frequency (so-called spread spectrum).

**Conducted Emission Measurements with a LISN (9 kHz - 30 MHz)**

The emission measurement with a LISN is performed for each phase separately. By the control unit of the userport

(Option LISN-UG) the selection of the phase is performed automatically during the measurement. A measurement sequence is set up to perform a full automated measurement. An evaluation according to limit lines is performed and a test protocal is created. The emission testing with a two-phase LISN and the TDEMI can be carried out in less than one minute. Additional measurements are performed with an absorbing clamp and other coupling networks to measure disturbances on signal lines.

**Measurement of Discontinuous Disturbance (150 kHz - 30 MHz)**

For discontinuous disturbances the CISPR standards allow that the quasi-peak level may be above the limit line. However the emission has to be limited to a certain degree when observed over a longer period of time. Such an evaluation is performed by the click analysis. The click analysis is as available for all TDEMI Systems (Option CLICK - UG). This option enhances the TDEMI to a full click rate analyzer and is fully integrated into the system to a single box solution.

**Radiated emission measurement (30 MHz - 26.5 GHz)**

Radiated emission measurements up to 1 GHz are typically performed on open area test sites, in full or semi-anechoic rooms. Above 1 GHz the emission measurement is carried out in a full-anechoic room at several angular positions of the turntable or the device under test respectively. The extremely high speed of the TDEMI allows to perform fast prescans and by the provided zero span mode to perform the maximization at selected frequencies afterwards. For instationary disturbances the TDEMI offers further evaluation features.

**Investigation of PLC Components**

Using the TDEMI for measuring the disturbances of PLC components according to the limits there is no need anymore of typically used external filter. Especially with the TDEMI 30M which provides a superior dynamic range. Further investigations like the dynamic notching or the maximum signal level over a longer time interval can be carried out in the receiver mode as well as in the weighted spectrogram mode - the perfect real-time analysis tool.

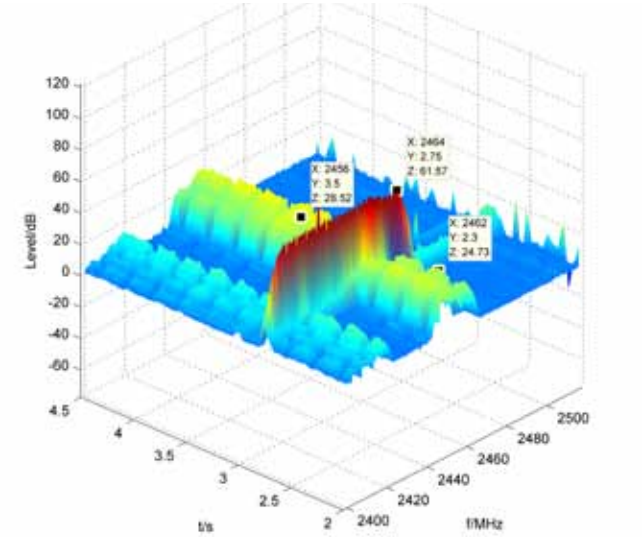



Fig. 14 – **Measurement and analysis of Wi-Fi signals.** The emission of a wirless LAN client shows a fluctuation of the level over the time. At 3.5 s a scan of the client was initialized. It can be seen that the signal steps through all reserved channels searching for wireless networks. The scan is performed is at maximum signal power.

# Military and Avionics

The emission measurement of components and systems for military applications are performed according to the standard MIL461 covering the frequency range 30 Hz - 40 GHz. The measurement is performed with the peak detector and bandwidths according to MIL461. The selection of the IF bandwidth depends on the frequency range of interest. An overview of the IF bandwidths and the corresponding measurement bands shows the following table:

| Frequency Range | 6 dB Bandwidth |
|---|---|
| 30 Hz - 1 kHz | 10 Hz |
| 1 kHz - 10 kHz | 100 Hz |
| 10 kHz - 150 kHz | 1 kHz |
| 150 kHz - 30 MHz | 10 kHz |
| 30 MHz - 1 GHz | 100 kHz |
| > 1 GHz | 1 MHz |

Especially in the lower frequency ranges the scan time can be reduced by the TDEMI by several orders of magnitude. Additionally it is possible analyze single events.

The measurement of a device-under-test has to be carried out at each frequency with a sufficient long dwell time and the measured level at each frequency must be documented. A parallel measurement at several thousand frequencies performed by the TDEMI accelerates the measurement significantly. Measurements in the lower frequency range are performed by antennas with embedded preamplifier. In addition conducted emission measurements are performed. In the upper frequency range the measurement is performed by horn antennas.

Measurements in the avionic industry are performed according to DO160. The standard DO160 covers the frequency range 150 kHz - 6 GHz and the emission measurement is carried out with peak detector and IF bandwidth according to the application. The IF bandwidth is again selected according to the frequency band which has to be measured. The IF bandwidths according to DO160 are given as follows:

| Frequency Range | 6 dB Bandwidth |
|---|---|
| 150 kHz - 30 MHz | 1 kHz |
| 30 MHz - 400 MHz | 10 kHz |
| 400 MHz - 1 GHz | 100 kHz |
| > 1 GHz | 1 MHz |

Especially in the frequency range up to 400 MHz a huge number of frequencies has to be measured. By measuring with the TDEMI the overall testing time can be reduced significantly here.

The bandwidths according to the standards are also available in the spectrogram mode. The spectrogram mode simplifies the detection of emissions caused by single events like switching events or regulation procedures. Furthermore pulsed signals, e.g. radar pulses, can be easily detected and analyzed.

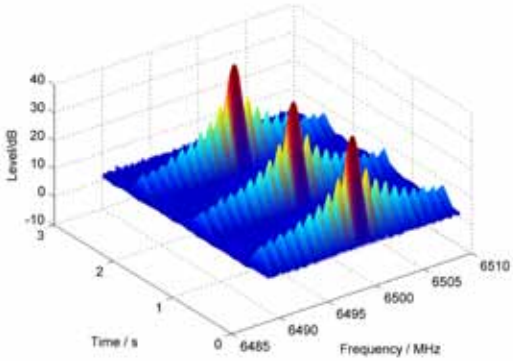



Fig. 17 – **Analysis in time and frequency of a pulse modulated signal.** Measured in the spectrogram mode.

Other applications are the analysis of communication signals, e.g. chirped signals, frequency hopping systems and the detection of intentional electromagnetic interference.

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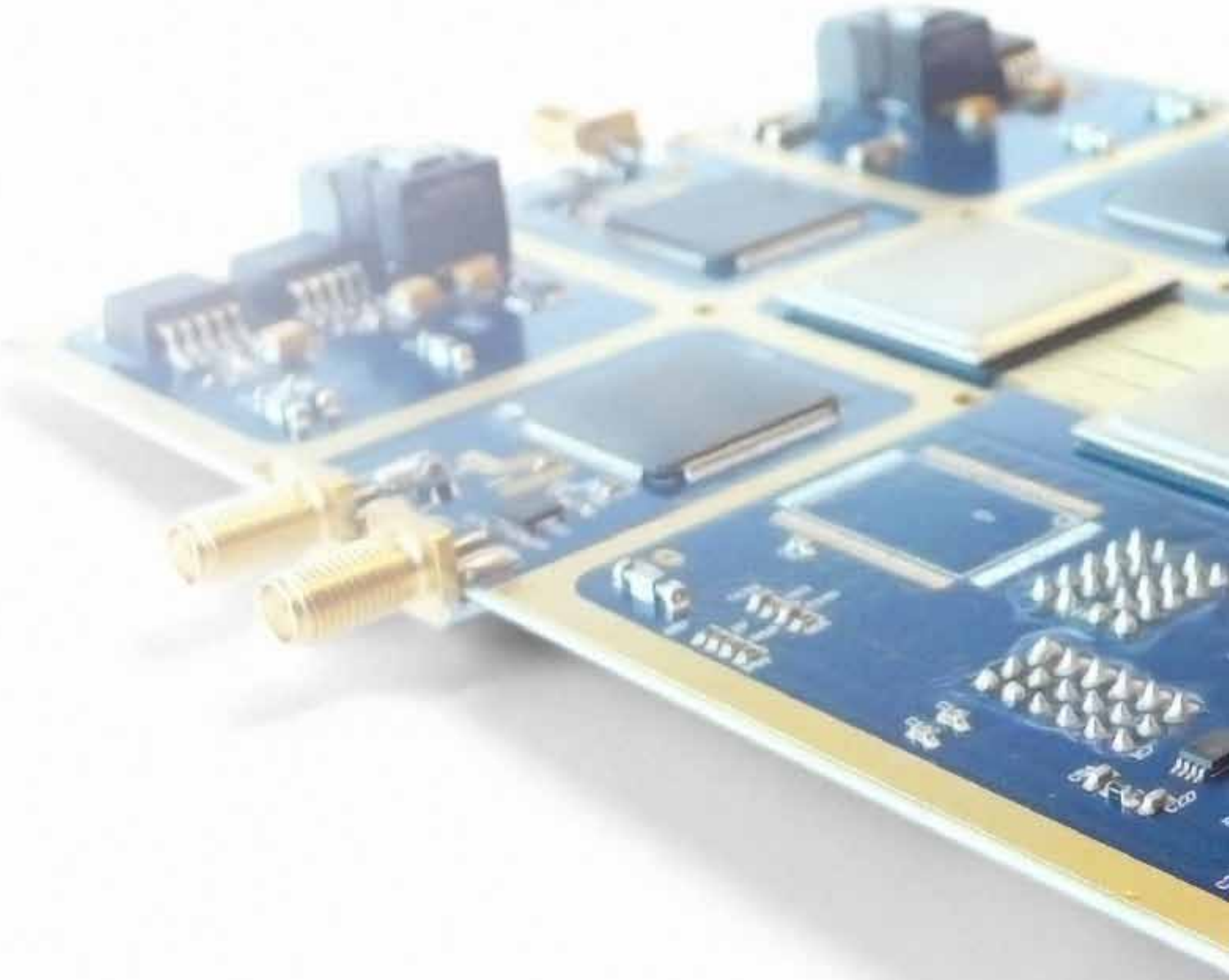
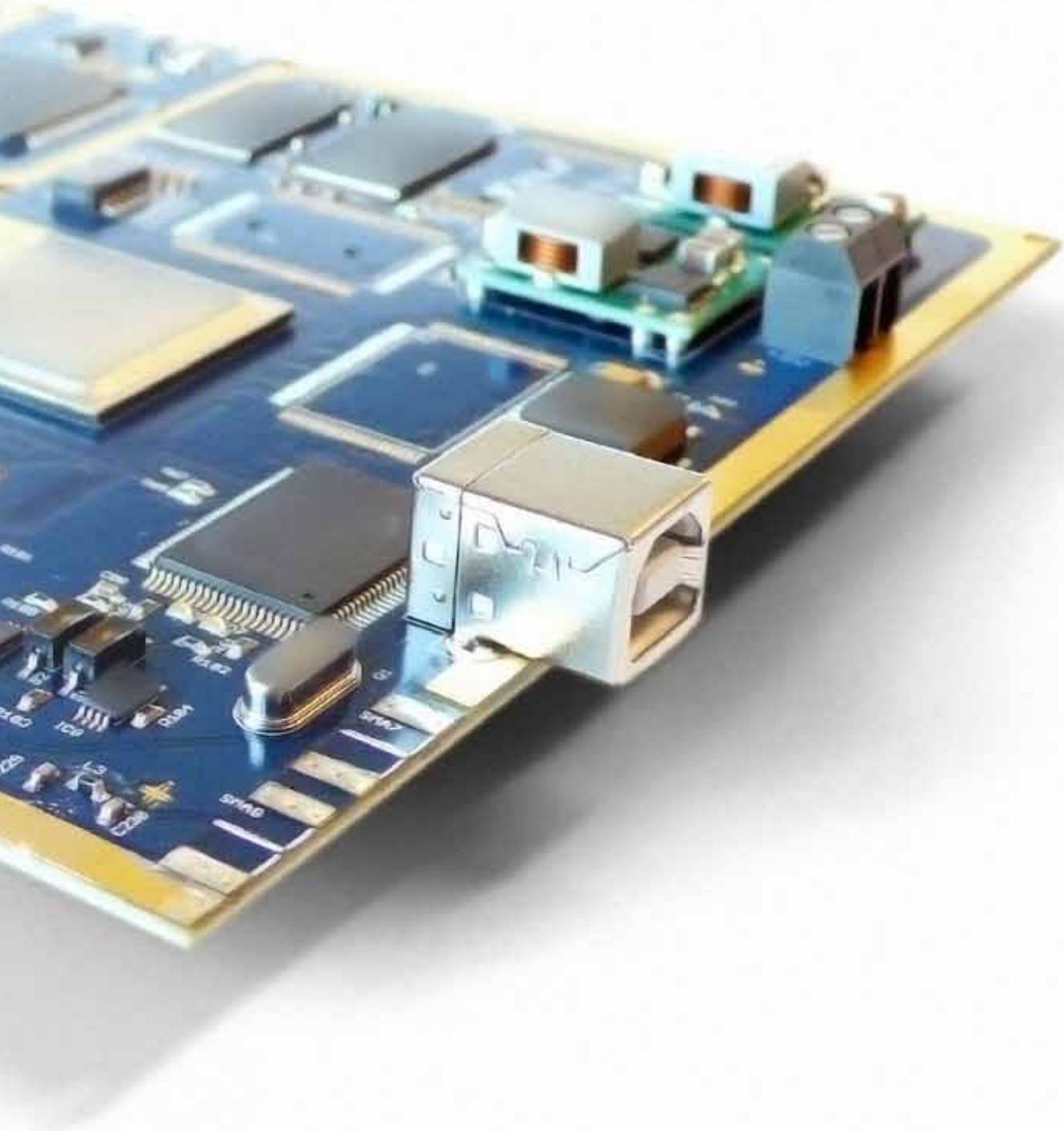




# TDEMI Products

The registered trademark TDEMI represents a novel generation of measurement systems based on leading-edge technology to investigate the electromagnetic compatibility of electrical and electronic components and systems.

Providing the possibility of real-time analysis the user gets a tool to carry out and evaluate measurements in a fraction of time in comparison to traditional super-heterodyn EMI receivers. Real-time analysis enables easy-to-handle investigations of changing emissions and debugging devices in real-time. Ultra high-speed analog-to-digital converters in combination with digital real-time signal processing provides the advantage of well-known measuring instruments like oscilloscopes, EMI receivers as well as spectrum analyzers all together in just a single measurement system.

By the extremely powerful digital signal processing hardware which provides a computation power of more than 20 standard PCs the TDEMI provides an unrivalled measurement speed in comparison to other technologies available on the market today. Measurement tasks can be improved regarding the measurement speed by up to a factor of 4000. The TDEMI Measurement System can be used for conducted emission measurements, radiated emission measurements as well as measurement of disturbance power. All measurement systems can be also controlled remotely via TCP/IP. With the weighted spectrogram mode the TDEMI provides a novel tool to find sources and solutions of EMI problems. In addition to the standard configuration a number of additional options are available to provide customized solutions for more and more challenging measurement tasks and customer's needs.

**40G**
10 Hz - 40 GHz

**26G**
10 Hz - 26.5 GHz

**18G**
9 kHz - 18 GHz

**3G** & **6G**
9 kHz - 3 GHz (6 GHz)

**1G**
9 kHz - 1 GHz

**30M**
9 kHz - 30 MHz

# TDEMI 30M

- 4000x faster than conventional EMI receivers
- Conducted emission measurements
- Automated report generation


The TDEMI 30M is the system with the smallest frequency range but it is unique regarding the measurement speed and other features. The frequency range 9 kHz - 30 MHz fits perfectly to a conducted emission measurement setup according to CISPR 16-2-1. It can be used for preinvestigations during development as well as for full compliance testing.

By its digital signal processing unit of the latest generation a really vast calculation power of more than 100 Gigamultiplications per second is achieved. A complete measurement at each frequency with quasi-peak detector up to 30 MHz can be carried out in about 12 seconds. This amazing short scan time for quasi-peak scans makes prescans with the peak detector and final measurements in the quasi-peak detector mode at critical disturbances completely obsolete. The measurement of instationary signals and transient emissions is performed reliable and reproducible with a single quasi-peak scan using the TDEMI Measurement System within such a short scan time.

A further unique feature of the TDEMI is its unparalleled dynamic range. The TDEMI 30M exhibits a multi-resolution system using several high resolution ADCs. Such a system provides a spurious free dynamic range of more than 90 dB. Signals with levels up to 100 dBµV can be measured with a noise level below 0 dBµV - also pulses up to 60 dBµV. This corresponds to pulses of several Volts. By an autorange stepped attenuator the dynamic range is enhanced up to 140 dB. For applications where this huge dynamic range is not enough, additional preselection for band A can be ordered optionally.

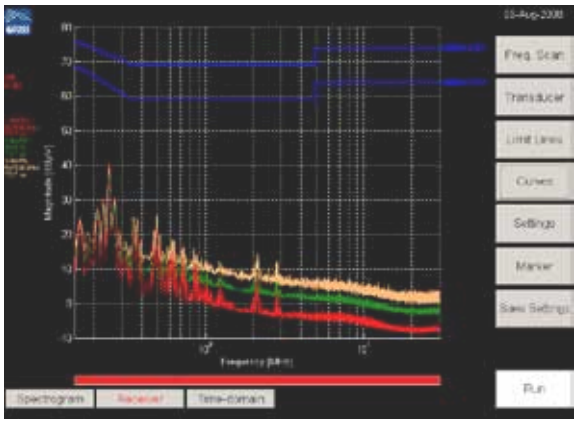



Fig. 21 – **Emission measurement of a energy saving lamp** in the frequency range 150 kHz - 30 MHz.

# TDEMI 30M Specifications

## FREQUENCY RANGE
9 kHz - 30 MHz

## REFERENCE (TCXO)

| | | |
|---|---|---|
| Temperature Drift (-40 .. 60° C) | | ± 50 ppm |
| SSB Phase Noise (1 Hz BW) | 100 Hz | -75 dBc/Hz |
| (typ. @ 312.5 MHz) | 1 kHz | -95 dBc/Hz |
| | 10 kHz | -105 dBc/Hz |
| | 100 kHz | -110 dBc/Hz |

## RECEIVER MODE (CISPR Standard)

**IF Bandwidth 200 Hz (9 kHz - 150 kHz)**

IF Filter: Gaussian Shaped Filter, Specification according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 100 dBµV Sinus): < 0 dBµV typ.
Frequency Step < 100 Hz
typical Scan Time: 4x Measurement Time
e.g. Quasi-Peak: 12 s
Quasi-Peak: 6 s (with Option DSP-UG30M)

**IF Bandwidth 9 kHz (9kHz - 30 MHz)**

IF Filter: Gaussian Shaped Filter, Specification according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 100 dBµV Sinus): < 0 dBµV typ.
Frequency Step < 400 Hz
typical Scan Time: 4x Measurement Time
e.g. Quasi-Peak: 12 s
Quasi-Peak: 6 s (with Option DSP-UG30M)

## WEIGHTED REAL-TIME SPECTROGRAM

| | |
|---|---|
| Weighted Spectrogram Mode | Peak, Average, RMS |
| Time-domain | Fully gapless |
| Minimum Time Step | 50 ms |

**Band A (9 kHz - 150 kHz)**

| | |
|---|---|
| Frequency Step: | 140 Hz for 200 Hz IF Bandwidth |
| Frequency Step Interpolation: | 100 Hz for 200 Hz IF Bandwidth |

**Band B (150 kHz - 30 MHz)**

| | |
|---|---|
| Frequency Step: | 7 kHz for 9 kHz IF Bandwidth |
| Frequency Step Interpolation: | 5 kHz for 9 kHz IF Bandwidth |

## TIME-DOMAIN ANALYSIS (RF)

| | |
|---|---|
| Bandwidth | 30 MHz |
| Sampling Rate | 312.5 MS/s |
| Acquisition Memory | 32000 Samples |

## ABSOLUTE MAXIMUM RATINGS (ATTENUATION 0 dB)

| | |
|---|---|
| Maximum DC Input Level, Pulses | 6 V |
| RF-CW Signal | 120 dBµV |

## INDICATION (ATTENUATION 0 dB)

| | |
|---|---|
| Maximum DC Input Level, Pulses | 5 V |
| RF-CW Signal | 95 dBµV |
| Pulses according to CISPR 16-1-1 (Quasi-Peak) | 55 dBµV |

## ATTENUATOR

| | |
|---|---|
| 0 - 20 dB, 20 dB Steps, Auto Attenuation | |
| max. Input Power: | 1W CW |

## PRESELECTION (OPTION PRE-UG)

| | |
|---|---|
| Preselection Band A, Highpass Filter | 150 kHz |

## INTERMODULATION, NONLINEARITIES

| | | |
|---|---|---|
| CW Signals: | Two Tone | < -40 dB (typ. -60 dB) |
| | Harmonics (> 40 dBµV, > 1 MHz) | < -40 dB (typ. <-90 dB) |
| | Inherent Reception Points | < -40 dB (typ. <-60 dB) |
| | Total Dynamic Range (9 kHz IF Bandwidth) | > 140 dB |
| | CISPR Intermodulation Test | > 36 dB |

## MEASUREMENT TIME
1 µs – 60 s (Average, RMS)
1 µs – infinite (Peak, Quasi-Peak, CISPR-Average, CISPR-RMS-AV (Option))

## MEASUREMENT ACCURACY

| | |
|---|---|
| Sinusoidal Signals | ± 1 dB |
| Pulses according to CISPR 16-1-1 | |

## RF INPUT
50 Ohm
VSWR < 1.7 (typ. 1.3), with 0 dB Attenuation
VSWR < 1.2 typ., with 10 dB Attenuation

## REMOTE CONTROL, INTERFACES
Remote control command set according to SCPI Standard
Ethernet/LAN, USB, RS232, GPIB (Option GPIB-UG), PS/2, VGA, HDMI, Audio

## DISPLAY, USER INTERFACES
Resolution 800 x 600 pixels, 8.4", True Color (16.78 Mio. colors)
Touchscreen

## PC
Intel Core i, 2 GB RAM, 120 GB Hard Disk or higher
Operating system: Windows XP or Windows 7

## POWER SUPPLY
230 V +/-20%, 50 Hz or 110 V +/-10%, 60 Hz

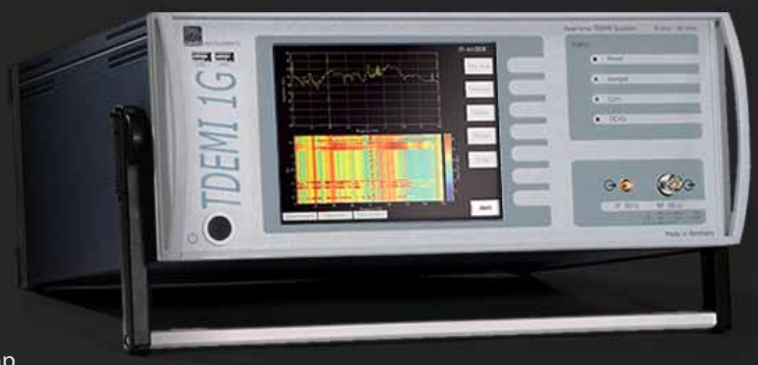
## WEIGHT
ca. 15 kg

## MAIN OPTIONS

| | |
|---|---|
| AT - UG30M | Attenuator 0 - 30 dB, 10 dB Steps |
| DSP - UG30M | Enhanced DSP Unit with doubled Frequency Resolution |
| PRE - UG | Preselection Band A |
| LISN - UG | Controller for Measuring Accessories (TTL, 5V) |
| LISNCable - UG | Customized Control Cabel for Accessories, e.g. LISN |
| TG - UG | Carrying Handle |
| PC - UG | Powerful multicore processor (Intel Core i or comparable) for advanced computing power, doubled hard disk capacity, doubled RAM size |
| KB - UG | Compact Keyboard incl. Touchpad |
| RG - UG | Report Generator |
| CAL - UG | Manufacturer Calibration with Certificate |
| CALD - UG | DAkks Calibration with Certificate |
| CLICK - UG | Click Rate Analyzer, fully integrated |
| SLIDE - UG | Software for Disturbance Power Measurements |

# TDEMI 1G

- 4000x faster than conventional EMI receivers
- Measurement of conducted emissions
- Radiated emission measurements
- Measurement with CDN and absorbing clamp




The TDEMI 1G was the first instrument commercially available providing totally novel methods and leading-edge technology enabling fully gapless real-time measurements. It was the result of several years of research and development to make the instrument suitable and usable for daily EMC testing at the customer's site. It enables conducted emission measurements, radiated emission measurements as well as the measurement of disturbance power in the frequency range from 9 kHz to 1 GHz. The measurement system can be used for preinvestigations as well as measurements for certification according to CISPR/EN standards.

The TDEMI 1G allows the user to carry out EMI measurements in so far unknown measurement speed. By an ultra high-speed floating-point ADC unit and real-time signal processing the TDEMI system is by a factor of 4000 faster than traditional EMI receivers.

In contrast to a traditional superheterodyne receiver that performs the scan by a sequential measurements at several thousand frequencies the TDEMI Measurements System uses a baseband bandwidth of 1 GHz. The signal is digitized and the spectrum is calculated by the short-time Fast Fourier Transform (STFFT) which corresponds to a bank of IF filters. By this way the total test time is reduced by orders of magnitude. The total test time for a single measurement in the full frequency range up to 1 GHz in the quasi-peak detector mode is less than two minutes while the measurement is performed at all frequencies.

By a multi-resolution ultra high-speed analog-to-digital converter system the required dynamic range for pulses according to CISPR 16-1-1 is achieved. An autorange attenuator and optional features like preselection band A and band B enhance the dynamic range up to 140 dB. An automated measurement, generation of test reports for conducted and radiated measurements and also for the measurement of disturbance power is performed by the measurement software of the TDEMI or as well as by an external automation software. The automated evaluation and documentation according to CISPR 16-2-1 and CISPR 16-2-2 is done by a report generator. The instrument can be operated via a touchscreen or remotely via TCP/IP.

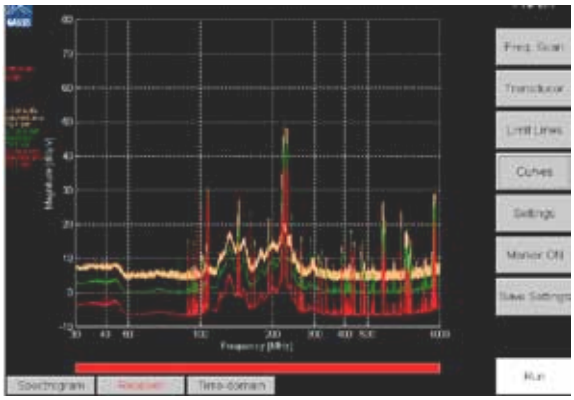


Fig. 23 – **Measurement of ambient noise** in the frequency range from 30 MHz to 1 GHz.

# TDEMI 1G Specifications

## FREQUENCY RANGE
150 kHz – 1 GHz, 9 kHz – 1 GHz (with Option LF - UG1G)

## REFERENCE (OCXO)

| | | |
|---|---|---|
| Aging | < ± 3.5 ppm / 15 years | |
| Temperature Drift (0 .. 60° C) | ± 1 x 10e-8 | |
| SSB Phase Noise (1 Hz BW) | 1 Hz | -95 dBc/Hz |
| (typ. @ 12.8 MHz) | 10 Hz | -120 dBc/Hz |
| | 100 Hz | -140 dBc/Hz |
| | 1 kHz | -145 dBc/Hz |

## RECEIVER MODE (CISPR Standard)

**IF Bandwidth 200 Hz Band A**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 85 dBµV Sinus): < 0 dBµV (typ. -3 dBµV)
Measurement at about 700 Frequencies in parallel
Frequency Step < 100 Hz

**IF Bandwidth 9 kHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus): < -15 dBµV (typ. -19 dBµV)
Measurement at 4096 Frequencies in parallel
Frequency Step < 400 Hz

**IF Bandwidth 120 kHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus): < -3 dBµV (typ. -6 dBµV)
Measurement at 1024 Frequencies in parallel
Frequency Step < 800 Hz

**IF Bandwidth 1 MHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus): < 6 dBµV (typ. 2 dBµV) 1 MHz – 1 GHz
Messung an 128 Frequenzen gleichzeitig
Frequenzschrittweite < 800 Hz

## WEIGHTED REAL-TIME SPECTROGRAM

| | |
|---|---|
| Weighted Spectrogram Mode | Peak, Average, RMS |
| Time-domain | Fully gapless |
| Frequency Step | 158 kHz for 120 kHz<br>1.2 MHz for 1 MHz |
| Frequency Step Interpolation | 40 kHz for 120 kHz<br>300 kHz for 1 MHz |
| Frequency Span | > 150 MHz |
| IF Bandwidths CISPR | 200 Hz, 9 kHz, 120 kHz, 1 MHz |
| Minimum Time Step | 50 ms |

## TIME-DOMAIN ANALYSIS (RF)

| | |
|---|---|
| Bandwidth | 1 GHz |
| Sampling Rate | 2.6 GS/s |
| Acquisition Memory | 32000 Samples |

## ABSOLUTE MAXIMUM RATINGS (ATTENUATION 0 dB)

| | |
|---|---|
| Maximum DC Input Level, Pulse | 6 V |
| RF-CW Signal | 120 dBµV |

## INDICATION (ATTENUATION 0 dB)

| | |
|---|---|
| Maximum DC Input Level, Pulse | 5 V |
| RF-CW Signal | 65 dBµV |

## ATTENUATOR
0 - 70 dB, 10 dB Steps, Auto Attenuation
max. Input Power for Attenuation > 15 dB: 1 W CW

## INTERMODULATION, NONLINEARITIES

| | | |
|---|---|---|
| CW Signals: | Two Tone | < -40 dB (typ. -53 dB) |
| | Harmonics (> 40 dBµV, > 1 MHz) | < -40 dB (typ. <-50 dB) |
| | Inherent Reception Points | < -40 dB (typ. <-50 dB) |
| | Total Dynamic Range (120 kHz IF Bandwidth) | > 140 dB |

## INHERENT RECEPTION POINTS (ATTENUATION 0 dB)
Inherent Reception Point 1/4 ADC Sampling Rate:
<< 25 dBµV (using Multi-sampling < -15 dBµV)
Further Inherent Reception Points
<< 5 dBµV (using Multi-sampling < -15 dBµV)

## MEASUREMENT TIME
1 µs – 60 s (Average, RMS)
1 µs – infinite (Peak, Quasi-Peak, CISPR-Average, CISPR-RMS-AV (Option))

## MEASUREMENT ACCURACY

| | |
|---|---|
| Sinusoidal Signals (9 kHz - 1 GHz) | ± 1 dB |
| Pulses according to CISPR 16-1-1 | |

## RF INPUT
50 Ohm
VSWR < 2.0 (typ. 1.3)
VSWR < 1.2 typ., with 10 dB Attenuation

## REMOTE CONTROL, INTERFACES
Remote control command set according to SCPI Standard
Ethernet/LAN, USB, RS232, GPIB (Option GPIB-UG), PS/2, VGA, HDMI, Audio

## DISPLAY, USER INTERFACE
Resolution 800 x 600 pixels, 8.4", True Color (16.78 Mio. colors)
Touchscreen

## PC
Intel Core i, 2 GB RAM, 120 GB Hard Disk or higher
Operating system: Windows XP or Windows 7

## POWER SUPPLY
230 V +/-20%, 50 Hz or 110 V +/-10%, 60 Hz

## WEIGHT
ca. 20 kg

## MAIN OPTIONS

| | |
|---|---|
| AT - UG1G | Attenuator 0 - 75 dB, 5 dB Steps, low Noise Figure |
| LF - UG1G | Frequency Extension down to 9 kHz (9 kHz - 150 kHz), IF Bandwidth 200 Hz, Quasi-Peak Band A |
| PRE - UG | Preselection Band A |
| MIL/DO - UG | Frequency Extension down to 10 Hz, IF Bandwidths 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz |
| LISN - UG | Controller for Measuring Accessories (TTL, 5V) |
| LISNCable - UG | Customized Control Cabel for Accessories, e.g. LISN |
| TG - UG | Carrying Handle |
| PC - UG | Powerful multicore processor (Intel Core i or comparable) for advanced computing power, doubled hard disk capacity, doubled RAM size |
| KB - UG | Compact Keyboard incl. Touchpad |
| RG - UG | Report Generator |
| CAL - UG | Manufacturer Calibration with Certificate |
| CALD - UG | DAkks Calibration with Certificate |
| CLICK - UG | Click Rate Analyzer, fully integrated |
| SLIDE - UG | Software for Disturbance Power Measurements |

# TDEMI 3G

- 4000x faster than conventional EMI receivers
- Measurement according to CISPR 25
- Analysis of single events


The TDEMI 3G provides all features and technological advantage of a TDEMI 1G and extends these features and benefits in the frequency range up to 3 GHz. The TDEMI 3G is used for EMC measurements in the frequency range from 9 kHz up to 3 GHz and covers all automotive tests.

In the frequency range above 1 GHz the TDEMI 3G provides a significant lower noise floor than conventional superheterodyne based EMI receivers. With a selected IF bandwidth of 1 MHz the typical noisefloor is below 3 dBµV. An external pre-amplifier is not necessary for this frequency range. This avoids a potential unrecognized overload of such an external preamplifier, which may invalidate the result of the emission measurement. The TDEMI uses an auto attenuator in order to set up the optimum attenuation. Further an automatic indication of an overload occuring during the measurement is available in the standard configuration.

The level of inherent spurious can be reduced further by using the TDEMI feature multisampling which has been developed by GAUSS INSTRUMENTS. This feature comes with the standard configuration of all TDEMI Measurement Systems. By activating this method a second measurement is performed. During the second measurement the sampling frequency as well as the local oscillator frequency is slightly changed. Thus all the position of inherent spurious are changed. By this way spurs originating from analog-to-digital converters as well as from mixing stages are completely suppressed down to a level of -15 dBµV. Each frequency can be measured with highest sensitivity.

By the extremely fast measurement speed of the TDEMI it is possible to perform economically measurements in the upper frequency range with highest frequency resolution, e.g. 120 kHz or 9 kHz, for the first time. By the optional preselection for band B (Option PRE - UG) and the ultra-fast RF switching unit it is possible to perform automated high resolution measurements over the complete frequency range from 9 kHz to 3 GHz below one minute.

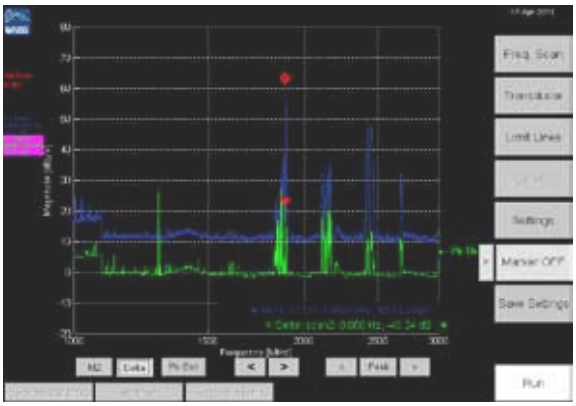



Fig. 25 – **Measurement of ambient noise** in the frequency range from 1 GHz to 3 GHz. Red marker shows the E-Service network of the GSM cell phone net.

# TDEMI 3G Specifications

## FREQUENCY RANGE
9 kHz - 3 GHz

## REFERENCE (OCXO)

| | | |
|---|---|---|
| Aging | < ± 3.5 ppm / 15 years | |
| Temperature Drift (0 .. 60° C) | ± 1 x 10e-8 | |
| SSB Phase Noise (1 Hz BW) | 1 Hz | -95 dBc/Hz |
| (typ. @ 12.8 MHz) | 10 Hz | -120 dBc/Hz |
| | 100 Hz | -140 dBc/Hz |
| | 1 kHz | -145 dBc/Hz |

## RECEIVER MODE (CISPR Standard)

**IF Bandwidth 200 Hz Band A**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 85 dBµV Sinus):
< 0 dBµV (typ. -3 dBµV)
Measurement at about 700 Frequencies in parallel
Frequency Step < 100 Hz

**IF Bandwidth 9 kHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus):
< -15 dBµV (typ. -19 dBµV)
Measurement at 4096 Frequencies in parallel
Frequency Step < 400 Hz

**IF Bandwidth 120 kHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus):
< -3 dBµV (typ. -6 dBµV)
Measurement at 1024 Frequencies in parallel
Frequency Step < 800 Hz

**IF Bandwidth 1 MHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus):
< 6 dBµV 1 MHz – 1 GHz
< 8 dBµV 1 GHz – 1.15 GHz
< 3 dBµV (< 6 dBµV with SW - UG) 1.15 GHz – 3 GHz
Measurement at 128 Frequencies in parallel
Frequency Step < 800 Hz

## WEIGHTED REAL-TIME SPECTROGRAM

| | |
|---|---|
| Weighted Spectrogram Mode | Peak, Average, RMS |
| Time-domain | Fully gapless |
| Frequency Step | 158 kHz for 120 kHz<br>1.2 MHz for 1 MHz |
| Frequency Step Interpolation | 40 kHz for 120 kHz<br>300 kHz for 1 MHz |
| Frequency Span | > 150 MHz |
| IF Bandwidths CISPR | 200 Hz, 9 kHz, 120 kHz, 1 MHz |
| Minimum Time Step | 50 ms |

## TIME-DOMAIN ANALYSIS (RF)

| | |
|---|---|
| Bandwidth | 1 GHz |
| Sampling Rate | 2.6 GS/s |
| Acquisition Memory | 32000 Samples |

## ABSOLUTE MAXIMUM RATINGS (ATTENUATION 0 dB)

| | |
|---|---|
| Maximum DC Input Level, Pulse | 6 V |
| RF-CW Signal | 120 dBµV |

## INDICATION (ATTENUATION 0 dB)

| | |
|---|---|
| Maximum DC Input Level, Pulse | 5 V |
| RF-CW Signal | 65 dBµV |

## ATTENUATOR
0 - 75 dB, 5 dB Steps, Auto Attenuation
max. Input Power for Attenuation > 15 dB: 1 W CW

## INTERMODULATION, NONLINEARITIES

| | | |
|---|---|---|
| CW Signals: | Two Tone | < -40 dB (typ. -53 dB) |
| | Harmonics (> 40 dBµV, > 1 MHz) | < -40 dB (typ. <-50 dB) |
| | Inherent Reception Points | < -40 dB (typ. <-50 dB) |
| | Total Dynamic Range (120 kHz IF Bandwidth) | > 140 dB |

## INHERENT RECEPTION POINTS (ATTENUATION 0 dB)
Inherent Reception Point 1/4 ADC Sampling Rate:
<< 25 dBµV (using Multi-sampling < -15 dBµV)
Further Inherent Reception Points
<< 5 dBµV (using Multi-sampling < -15 dBµV)

## MEASUREMENT TIME
1 µs – 60 s (Average, RMS)
1 µs – infinite (Peak, Quasi-Peak, CISPR-Average, CISPR-RMS-AV (Option))

## MEASUREMENT ACCURACY

| | |
|---|---|
| Sinusoidal Signals (9 kHz - 1 GHz) | ± 1 dB |
| Sinusoidal Signals (1 GHz - 3 GHz) | ± 2 dB |

Pulses according to CISPR 16-1-1

## RF INPUT
50 Ohm
VSWR < 3.0 (typ. 2.0), 1 GHz - 3 GHz
VSWR < 1.2 typ., 9 kHz - 1 GHz, with 10 dB Attenuation

## REMOTE CONTROL, INTERFACES
Remote control command set according to SCPI Standard
Ethernet/LAN, USB, RS232, GPIB (Option GPIB-UG), PS/2, VGA, HDMI, Audio

## DISPLAY, USER INTERFACE
Resolution 800 x 600 pixels, 8.4", True Color (16.78 Mio. colors)
Touchscreen

## PC
Intel Core i, 2 GB RAM, 120 GB Hard Disk or higher
Operating system: Windows XP or Windows 7

## POWER SUPPLY
230 V +/-20%, 50 Hz or 110 V +/-10%, 60 Hz

## WEIGHT
ca. 25 kg

## MAIN OPTIONS

| | |
|---|---|
| PRE - UG | Preselection Band A |
| SW - UG | Preselection Band B |
| MIL/DO - UG | Frequency Extension down to 10 Hz, IF Bandwidths 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz |
| LISN - UG | Controller for Measuring Accessories (TTL, 5V) |
| LISNCable - UG | Customized Control Cabel for Accessories, e.g. LISN |
| TG - UG | Carrying Handle |
| PC - UG | Powerful multicore processor (Intel Core i or comparable) for advanced computing power, doubled hard disk capacity, doubled RAM size |
| KB - UG | Compact Keyboard incl. Touchpad |
| RG - UG | Report Generator |
| CAL - UG | Manufacturer Calibration with Certificate |
| CALD - UG | DAkks Calibration with Certificate |
| CLICK - UG | Click Rate Analyzer, fully integrated |
| SLIDE - UG | Software for Disturbance Power Measurements |

# TDEMI 6G

- 4000x faster than conventional EMI receiver
- Measurement according to EN55022
- Analysis of Wi-Fi, Bluetooth


The TDEMI 6G covers the complete frequency range from 9 kHz to 6 GHz and is especially designed for the measurement of multimedia equipment, IT equipment, consumer electronics and devices for telecom applications. By the spread use of electronic systems and wireless communication systems the spectrum up to 6 GHz is more and more dense occupied by various services. Thus it is getting more and more important to reduce the overall testing time during EMC measurements for product certification as well as product development. As EMC tests are critical during the early design phase of a product fast and reliable testing is mandatory to save money and to make later product changes obsolet. By the weighted spectrogram mode, which is real-time displaying the emission over time, an excellent tool is provided for detection of potential EMI sources and investigations of EMI reduction methods. The weighted spectrogram mode is available in all TDEMI Measurement Systems and allows to measure and record frequency bands up to 162.5 MHz in a fully gapless manner. For evaluation peak, average and rms detectors are available. This tool provides a novel method to investigate instationary and intermitting signals.

The pioneering technology of the TDEMI and the achieved reduction of test times up to a factor of 4000 makes the receiver mode of the TDEMI most suitable for extremely fast measurements with excellent accuracy. The test results can be used for preinvestigations as well as for full compliance measurements. With the optional report generator test protocols can be generated automatically. The measurement results can be evaluated according to the appropriate standard, e.g. CISPR 16-2-1 and CISPR 16-2-2.

With its already built-in low-noise pre-amplifier the noise floor above 1.15 GHz is typically below 3 dBµV (1 MHz IF bandwidth, average detector) which is lower than the noise floor of a state-of-the-art superheterodyne EMI receiver. The TDEMI uses an auto attenuator in order to set up the optimum attenuation. Further an overload indication comes with the TDEMI instrument.

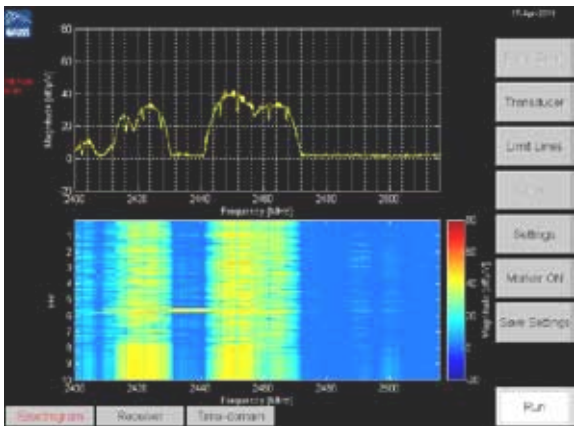



Fig. 27 – **Measurement of Wi-Fi activity** around 2.4 GHz. Lower part shows the changes of the emissions over the last 10 s recorded by the TDEMI.

# TDEMI 6G Specifications

## FREQUENCY RANGE
9 kHz - 6 GHz

## REFERENCE (OCXO)

| | | |
|---|---|---|
| Aging | < ± 3.5 ppm / 15 years | |
| Temperature Drift (0 .. 60° C) | ± 1 x 10e-8 | |
| SSB Phase Noise (1 Hz BW) | 1 Hz | -95 dBc/Hz |
| (typ. @ 12.8 MHz) | 10 Hz | -120 dBc/Hz |
| | 100 Hz | -140 dBc/Hz |
| | 1 kHz | -145 dBc/Hz |

## RECEIVER MODE (CISPR Standard)

**IF Bandwidth 200 Hz Band A**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 85 dBµV Sinus):
< 0 dBµV (typ. -3 dBµV)
Measurement at about 700 Frequencies in parallel
Frequency Step < 100 Hz

**IF Bandwidth 9 kHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus):
< -15 dBµV (typ. -19 dBµV)
Measurement at 4096 Frequencies in parallel
Frequency Step < 400 Hz

**IF Bandwidth 120 kHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus):
< -3 dBµV (typ. -6 dBµV)
Measurement at 1024 Frequencies in parallel
Frequency Step < 800 Hz

**IF Bandwidth 1 MHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus):
< 6 dBµV 1 MHz – 1 GHz
< 8 dBµV 1 GHz – 1.15 GHz
< 3 dBµV (< 6 dBµV with SW - UG) 1.15 GHz – 6 GHz
Measurement at 128 Frequencies in parallel
Frequency Step < 800 Hz

## WEIGHTED REAL-TIME SPECTROGRAM

| | |
|---|---|
| Weighted Spectrogram Mode | Peak, Average, RMS |
| Time-domain | Fully gapless |
| Frequency Step | 158 kHz for 120 kHz<br>1.2 MHz for 1 MHz |
| Frequency Step Interpolation | 40 kHz for 120 kHz<br>300 kHz for 1 MHz |
| Frequency Span | > 150 MHz |
| IF Bandwidths CISPR | 200 Hz, 9 kHz, 120 kHz, 1 MHz |
| Minimum Time Step | 50 ms |

## TIME-DOMAIN ANALYSIS (RF)

| | |
|---|---|
| Bandwidth | 1 GHz |
| Sampling Rate | 2.6 GS/s |
| Acquisition Memory | 32000 Samples |

## ABSOLUTE MAXIMUM RATINGS (ATTENUATION 0 dB)

| | |
|---|---|
| Maximum DC Input Level, Pulse | 6 V |
| RF-CW Signal | 120 dBµV |

## INDICATION (ATTENUATION 0 dB)

| | |
|---|---|
| Maximum DC Input Level, Pulse | 5 V |
| RF-CW Signal | 65 dBµV |

## ATTENUATOR
0 - 75 dB, 5 dB Steps, Auto Attenuation
max. Input Power for Attenuation > 15 dB: 1 W CW

## INTERMODULATION, NONLINEARITIES

| | | |
|---|---|---|
| CW Signals: | Two Tone | < -40 dB (typ. -53 dB) |
| | Harmonics (> 40 dBµV, > 1 MHz) | < -40 dB (typ. <-50 dB) |
| | Inherent Reception Points | < -40 dB (typ. <-50 dB) |
| | Total Dynamic Range (120 kHz IF Bandwidth) | > 140 dB |

## INHERENT RECEPTION POINTS (ATTENUATION 0 dB)
Inherent Reception Point 1/4 ADC Sampling Rate:
<< 25 dBµV (using Multi-sampling < -15 dBµV)
Further Inherent Reception Points
<< 5 dBµV (using Multi-sampling < -15 dBµV)

## MEASUREMENT TIME
1 µs – 60 s (Average, RMS)
1 µs – infinite (Peak, Quasi-Peak, CISPR-Average, CISPR-RMS-AV (Option))

## MEASUREMENT ACCURACY

| | |
|---|---|
| Sinusoidal Signals (9 kHz - 1 GHz) | ± 1 dB |
| Sinusoidal Signals (1 GHz - 6 GHz) | ± 2 dB |

Pulses according to CISPR 16-1-1

## RF INPUT
50 Ohm
VSWR < 3.0 (typ. 2.0), 1 GHz - 6 GHz
VSWR < 1.2 typ., 9 kHz - 1 GHz, with 10 dB Attenuation

## REMOTE CONTROL, INTERFACES
Remote control command set according to SCPI Standard
Ethernet/LAN, USB, RS232, GPIB (Option GPIB-UG), PS/2, VGA, HDMI, Audio

## DISPLAY, USER INTERFACE
Resolution 800 x 600 pixels, 8.4", True Color (16.78 Mio. colors)
Touchscreen

## PC
Intel Core i, 2 GB RAM, 120 GB Hard Disk or higher
Operating system: Windows XP or Windows 7

## POWER SUPPLY
230 V +/-20%, 50 Hz or 110 V +/-10%, 60 Hz

## WEIGHT
ca. 20 kg

## MAIN OPTIONS

| | |
|---|---|
| PRE - UG | Preselection Band A |
| SW - UG | Preselection Band B |
| MIL/DO - UG | Frequency Extension down to10 Hz, IF Bandwidths 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz |
| LISN - UG | Controller for Measuring Accessories (TTL, 5V) |
| LISNCable - UG | Customized Control Cabel for Accessories, e.g. LISN |
| TG - UG | Carrying Handle |
| PC - UG | Powerful multicore processor (Intel Core i or comparable) for advanced computing power, doubled hard disk capacity, doubled RAM size |
| KB - UG | Compact Keyboard incl. Touchpad |
| RG - UG | Report Generator |
| CAL - UG | Manufacturer Calibration with Certificate |
| CALD - UG | DAkks Calibration with Certificate |
| CLICK - UG | Click Rate Analyzer, fully integrated |
| SLIDE - UG | Software for Disturbance Power Measurements |

# TDEMI 18G

- 4000x faster than conventional EMI receiver
- Measurement of ISM devices
- Analysis of harmonics of microwave ovens


The TDEMI 18G covers the frequency range 9 kHz - 18 GHz and enables the emission measurements according to CISPR/EN and FCC Standards. For measurements of household appliances, IT equipment and industrial scientific and medical (ISM) the TDEMI 18G provides all typical features as well as all known advantages of the technology of the TDEMI product line. With the TDEMI 18G completely unexpected possibilities are provided to the user in the range up to 18 GHz, e.g. during the measurement of the harmonics of microwave ovens. An automated measurement at all frequencies can be performed in less then 2 minutes.

For the measurement of pulse modulated signals with highest sensitivity the option LN-UG18G is recommended for the frequency range 6 GHz - 18 GHz. With this option a further improved noise floor below 15 dBµV is achieved. The TDEMI uses an auto attenuation controller in order to set up the optimum attenuation. An indication of an overload occuring during the measurement comes with all the TDEMI Systems by the standard configuration. By the parallel measurement at several thousand frequencies an excellent ratio of dwell time and overall testing time is achieved. This enables fast scans with much longer dwell times. Due to the increasing complexity of the systems, as well as the number of operation modes and instationary behaviour fast and reliable measurement methods are mandatory during product development and product certification. Due to the measurement at all frequencies and a sufficient high selection of the dwell time the measurement uncertainty is reduced significantly. Such scans with long dwell times as required by the EMC standards can be performed in reasonable times with the TDEMI. The automated evaluation and documentation according to CISPR 16-2-1 and 16-2-2 can be performed by the report generator.

By the weighted spectrogram mode with a gap-less real-time analysis bandwidth of 162.5 MHz the TDEMI is an excellent tool for preinvestigations in order to detect potential EMI sources and investigate methods to reduce the electromagnetic interference. Such methods can be applied to devices while the result can be shown in real-time.

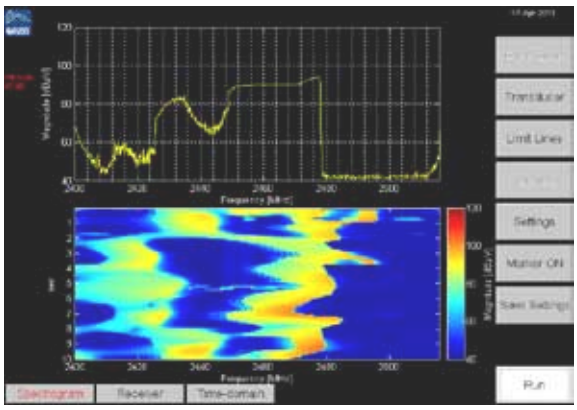



Fig. 29 – **Measurement of the magnetron of a microwave oven.** Lower graph shows the changes of the emission over time within an interval of 10 s.

# TDEMI 18G Specifications

## FREQUENCY RANGE
9 kHz - 18 GHz

## REFERENCE (OCXO)

| | | |
|---|---|---|
| Aging | < ± 3.5 ppm / 15 years | |
| Temperature Drift (0 .. 60° C) | ± 1 x 10e-8 | |
| SSB Phase Noise (1 Hz BW) | 1 Hz | -95 dBc/Hz |
| (typ. @ 12.8 MHz) | 10 Hz | -120 dBc/Hz |
| | 100 Hz | -140 dBc/Hz |
| | 1 kHz | -145 dBc/Hz |

## RECEIVER MODE (CISPR Standard)

**IF Bandwidth 200 Hz Band A**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 85 dBµV Sinus):
< 0 dBµV (typ. -3 dBµV)
Measurement at about 700 Frequencies in parallel
Frequency Step < 100 Hz

**IF Bandwidth 9 kHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus):
< -15 dBµV (typ. -19 dBµV)
Measurement at 4096 Frequencies in parallel
Frequency Step < 400 Hz

**IF Bandwidth 120 kHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus):
< -3 dBµV (typ. -6 dBµV)
Measurement at 1024 Frequencies in parallel
Frequency Step < 800 Hz

**IF Bandwidth 1 MHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus):
< 6 dBµV 1 MHz – 1 GHz
< 8 dBµV 1 GHz – 1.15 GHz
< 3 dBµV 1.15 GHz – 6 GHz
< 15 dBµV 6 GHz - 18 GHz (with LN - UG18G)
Measurement at 128 Frequencies in parallel
Frequency Step < 800 Hz

## WEIGHTED REAL-TIME SPECTROGRAM

| | |
|---|---|
| Weighted Spectrogram Mode | Peak, Average, RMS |
| Time-domain | Fully gapless |
| Frequency Step | 158 kHz for 120 kHz<br>1.2 MHz for 1 MHz |
| Frequency Step Interpolation | 40 kHz for 120 kHz<br>300 kHz for 1 MHz |
| Frequency Span | > 150 MHz |
| IF Bandwidths CISPR | 200 Hz, 9 kHz, 120 kHz, 1 MHz |
| Minimum Time Step | 50 ms |

## TIME-DOMAIN ANALYSIS (RF)

| | |
|---|---|
| Bandwidth | 1 GHz |
| Sampling Rate | 2.6 GS/s |
| Acquisition Memory | 32000 Samples |

## ABSOLUTE MAXIMUM RATINGS (ATTENUATION 0 dB)

| | |
|---|---|
| Maximum DC Input Level, Pulse | 6 V |
| RF-CW Signal | 120 dBµV |

## INDICATION (ATTENUATION 0 dB)

| | |
|---|---|
| Maximum DC Input Level, Pulse | 5 V |
| RF-CW Signal | 65 dBµV |

## ATTENUATOR
0 - 75 dB, 5 dB Steps, Auto Attenuation
max. Input Power for Attenuation > 15 dB: 1 W CW

## INTERMODULATION, NONLINEARITIES

| | | |
|---|---|---|
| CW Signals: | Two Tone | < -40 dB (typ. -53 dB) |
| | Harmonics (> 40 dBµV, > 1 MHz) | < -40 dB (typ. <-50 dB) |
| | Inherent Reception Points | < -40 dB (typ. <-50 dB) |
| | Total Dynamic Range (120 kHz IF Bandwidth) | > 140 dB |

## INHERENT RECEPTION POINTS (ATTENUATION 0 dB)
Inherent Reception Point 1/4 ADC Sampling Rate:
<< 25 dBµV (using Multi-sampling < -15 dBµV)
Further Inherent Reception Points
<< 5 dBµV (using Multi-sampling < -15 dBµV)

## MEASUREMENT TIME
1 µs – 60 s (Average, RMS)
1 µs – infinite (Peak, Quasi-Peak, CISPR-Average, CISPR-RMS-AV (Option))

## MEASUREMENT ACCURACY

| | |
|---|---|
| Sinusoidal Signals (9 kHz - 1 GHz) | ± 1 dB |
| Sinusoidal Signals (1 GHz - 18 GHz) | ± 2 dB |

Pulses according to CISPR 16-1-1

## RF INPUT
50 Ohm
VSWR < 3.0 typ., 1 GHz - 18 GHz
VSWR < 1.2 typ., 9 kHz - 1 GHz, with 10 dB Attenuation

## REMOTE CONTROL, INTERFACES
Remote control command set according to SCPI Standard
Ethernet/LAN, USB, RS232, GPIB (Option GPIB-UG), PS/2, VGA, HDMI, Audio

## DISPLAY, USER INTERFACE
Resolution 800 x 600 pixels, 8.4", True Color (16.78 Mio. colors)
Touchscreen

## PC
Intel Core i, 2 GB RAM, 120 GB Hard Disk, or higher
Operating system: Windows XP or Windows 7

## POWER SUPPLY
230 V +/-20%, 50 Hz or 110 V +/-10%, 60 Hz

## WEIGHT
ca. 25 kg

## MAIN OPTIONS

| | |
|---|---|
| LN - UG18G | Low-noise Preamplifier (6 GHz - 18 GHz) |
| PRE - UG | Preselection Band A |
| SW - UG | Preselection Band B |
| MIL/DO - UG | Frequency Extension down to10 Hz, IF Bandwidths 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz |
| LISN - UG | Controller for Measuring Accessories (TTL, 5V) |
| LISNCable - UG | Customized Control Cabel for Accessories, e.g. LISN |
| TG - UG | Carrying Handle |
| PC - UG | Powerful multicore processor (Intel Core i or comparable) for advanced computing power, doubled hard disk capacity, doubled RAM size |
| KB - UG | Compact Keyboard incl. Touchpad |
| RG - UG | Report Generator |
| CAL - UG | Manufacturer Calibration with Certificate |
| CALD - UG | DAkks Calibration with Certificate |
| CLICK - UG | Click Rate Analyzer, fully integrated |
| SLIDE - UG | Software for Disturbance Power Measurements |

# TDEMI 26G

- 4000x faster than conventional EMI receivers
- Measurement according to MIL and DO standards starting from 10 Hz
- Real-time analysis of single events


The TDEMI 26G system covers the frequency range 10 Hz to 26.5 GHz in its standard configuration and is ready for measurements in civil applications and especially for test ing in military applications and also avionics. It can be used for EMC tests according to CISPR, MIL461 and DO160 standard. The huge computation power of the digital signal processing unit of the TDEMI allows to reduce test time up to a factor of 4000 in comparison to traditional superheterodyn based receivers. A fast measurement at all frequencies and with higher frequency selectivities at the same time can be performed yielding in a even further reduced measurement uncertainty.

Especially in the lower frequency range up to several hundred MHz a large number of frequency points have to be measured. The parallel digital implementation of several thousand receivers using the short-term fast Fourier transform (STFFT) allows the TDEMI to reduce the overall testing time significantly. Especially for longer dwell times the scan time remains very short compared to superheterodyne EMI receivers and right after the results measured at all frequencies can be stored and documented.

The availability of the IF bandwidths according to MIL461 and DO160 are also in the weighted spectrogram modeand its real-time analysis bandwidth of up to 162.5 MHz makes it an ideal tool for EMC debugging. It supports the user in detecting, localizing and analyzing emissions and in finding solutions for reduction EMI of components and systems for military and avionic industry.

The noise floor of a TDEMI 26G in the Frequency 1.15 GHz up to 6 GHz is typically below 3 dBµV (1 MHz IF bandwidth, average detector) which is significantly lower than of a conventional EMI receiver. In the frequency range of 6 GHz - 26.5 GHz by an additional low-noise preamplifier the sensitivity of the TDEMI can be further improved. The recommended option LN-UG26G lowers the noise floor in the frequency range 6 GHz - 26.5 GHz below 22 dBµV.

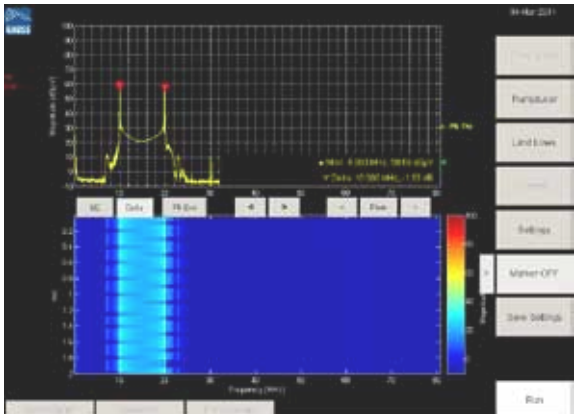


Fig. 31 – **Measurement of a frequency hopping signal at 10 MHz and 20 MHz respectivley.**

# TDEMI 26G Specifications

## FREQUENCY RANGE
10 Hz – 26.5 GHz

## REFERENCE (OCXO)

| | | |
|---|---|---|
| Aging | < ± 3.5 ppm / 15 years | |
| Temperature Drift (0 .. 60° C) | ± 1 x 10e-8 | |
| SSB Phase Noise (1 Hz BW) | 1 Hz | -95 dBc/Hz |
| (typ. @ 12.8 MHz) | 10 Hz | -120 dBc/Hz |
| | 100 Hz | -140 dBc/Hz |
| | 1 kHz | -145 dBc/Hz |

## RECEIVER MODE (CISPR Standard)

**IF Bandwidth 200 Hz Band A**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 85 dBµV Sinus): < 0 dBµV (typ. -3 dBµV)
Measurement at about 700 Frequencies in parallel
Frequency Step < 100 Hz

**IF Bandwidth 9 kHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus): < -15 dBµV (typ. -19 dBµV)
Measurement at 4096 Frequencies in parallel
Frequency Step < 400 Hz

**IF Bandwidth 120 kHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus): < -3 dBµV (typ. -6 dBµV)
Measurement at 1024 Frequencies in parallel
Frequency Step < 800 Hz

**IF Bandwidth 1 MHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus):
< 6 dBµV 1 MHz – 1 GHz
< 8 dBµV 1 GHz – 1.15 GHz
< 3 dBµV 1.15 GHz – 6 GHz
< 15 dBµV 6 GHz - 18 GHz (with LN - UG26G)
Measurement at 128 Frequencies in parallel
Frequency Step < 800 Hz

## RECEIVER MODE (MIL/DO Standard)

**IF Bandwidth 10 Hz (10 Hz - 10 kHz)**

IF Filter: Gaussian Shaped Filter, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS
Displayed Average Noise Floor typ.: < 40 dBµV (10 Hz - 500 Hz)
< 25 dBµV (500 Hz - 1 kHz)

**IF Bandwidth 100 Hz (1 kHz - 150 kHz)**

IF Filter: Gaussian Shaped Filter, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS
Displayed Average Noise Floor typ.: < 30 dBµV

**IF Bandwidth 1 kHz (10 kHz - 30 MHz)**

IF Filter: Gaussian Shaped Filter, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS
Displayed Average Noise Floor typ.: < 5 dBµV (10 kHz - 150 kHz)
< -27 dBµV > 1 MHz

**IF Bandwidth 10 kHz (150 kHz - 26.5 GHz)**

IF Filter: Gaussian Shaped Filter, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS
Displayed Average Noise Floor typ.: < -17 dBµV > 1 MHz

**IF Bandwidth 100 kHz (150 kHz - 26.5 GHz)**

IF Filter: Gaussian Shaped Filter, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS
Displayed Average Noise Floor typ.: < -5 dBµV (1 MHz - 1 GHz)

**IF Bandwidth 1 MHz (150 kHz - 26.5 GHz)**

IF Filter: Gaussian Shaped Filter, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS
Displayed Average Noise Floor typ.: < 6 dBµV 1 MHz - 1 GHz
< 8 dBµV 1 GHz - 1.15 GHz
< 3 dBµV 1.15 GHz - 6 GHz
< 22 dBµV 6 GHz - 26.5 GHz

## WEIGHTED REAL-TIME SPECTROGRAM

| | |
|---|---|
| Weighted Spectrogram Mode | Peak, Average, RMS |
| Time-domain | Fully gapless |
| Frequency Step | 158 kHz for 120 kHz<br>1.2 MHz for 1 MHz |
| Frequency Step Interpolation | 40 kHz for 120 kHz<br>300 kHz for 1 MHz |
| Frequency Span | > 150 MHz |
| IF Bandwidths CISPR | 200 Hz, 9 kHz, 120 kHz, 1 MHz |
| IF Bandwidths MIL/DO | 10 Hz, 100 Hz, 1 kHz,<br>10 kHz, 100 kHz, 1 MHz |
| Minimum Time Step | 50 ms |

## TIME-DOMAIN ANALYSIS (RF)

| | |
|---|---|
| Bandwidth | 1 GHz |
| Sampling Rate | 2.6 GS/s |
| Acquisition Memory | 32000 Samples |

## ABSOLUTE MAXIMUM RATINGS (ATTENUATION 0 dB)

| | |
|---|---|
| Maximum DC Input Level, Pulse | 6 V |
| RF-CW Signal | 120 dBµV |

## INDICATION (ATTENUATION 0 dB)

| | |
|---|---|
| Maximum DC Input Level, Pulse | 5 V |
| RF-CW Signal | 65 dBµV |

## ATTENUATOR
0 - 55 dB, 5 dB Steps

## INTERMODULATION, NONLINEARITIES

| | | |
|---|---|---|
| CW Signals: | Two Tone | < -40 dB (typ. -53 dB) |
| | Harmonics (> 40 dBµV, > 1 MHz) | < -40 dB (typ. <-50 dB) |
| | Inherent Reception Points | < -40 dB (typ. <-50 dB) |
| | Total Dynamic Range (120 kHz IF Bandwidth) | > 140 dB |

## INHERENT RECEPTION POINTS (ATTENUATION 0 dB)
Inherent Reception Point 1⁄4 ADC Sampling Rate:
<< 25 dBµV (using Multi-sampling < -15 dBµV)
Further Inherent Reception Points
<< 5 dBµV (using Multi-sampling < -15 dBµV)

## MEASUREMENT TIME
1 µs – 60 s (Average, RMS)
1 µs – infinite (Peak, Quasi-Peak, CISPR-Average, CISPR-RMS-AV (Option))

## MEASUREMENT ACCURACY

| | |
|---|---|
| Sinusoidal Signals (9 kHz - 1 GHz) | ± 1 dB |
| Pulses according to CISPR 16-1-1 | |

## RF INPUT
50 Ohm
VSWR < 3.0 typ., 1 GHz - 26.5 GHz
VSWR < 1.2 typ., 10 Hz - 1 GHz, with 10 dB Attenuation

## REMOTE CONTROL, INTERFACES
Remote control command set according to SCPI Standard
Ethernet/LAN, USB, RS232, GPIB (Option GPIB-UG), PS/2, VGA, HDMI, Audio

## DISPLAY, USER INTERFACES
Resolution 800 x 600 pixels, 8.4", True Color (16.78 Mio colors)
Touchscreen

## PC
Intel Core i, 2 GB RAM, 120 GB Hard Disk, or higher
Operating system: Windows XP or Windows 7

## POWER SUPPLY
230 V +/-20%, 50 Hz or 110 V +/-10%, 60 Hz

## WEIGHT
ca. 25 kg

## MAIN OPTIONS

| | |
|---|---|
| LN - UG26G | Low-noise Preamplifier (6 GHz - 26.5 GHz) |
| PRE - UG | Preselection Band A |
| SW - UG | Preselection Band B |
| LISN - UG | Controller for Measuring Accessories (TTL, 5V) |
| LISNCable - UG | Customized Control Cabel for Accessories, e.g. LISN |
| TG - UG | Carrying Handle |
| PC - UG | Powerful multicore processor (Intel Core i or comparable) for advanced computing power, doubled hard disk capacity, doubled RAM size |
| KB - UG | Compact Keyboard incl. Touchpad |
| RG - UG | Report Generator |
| CAL - UG | Manufacturer Calibration with Certificate |
| CALD - UG | DAkks Calibration with Certificate |
| CLICK - UG | Click Rate Analyzer, fully integrated |
| SLIDE - UG | Software for Disturbance Power Measurements |

# TDEMI 40G

- 162.5 MHz full real-time analysis bandwidth up to 40 GHz
- Measurement according to MIL and DO standards starting from 10 Hz
- 4000x faster than conventional EMI receivers


The TDEMI 40G system covers the frequency range 10 Hz to 40 GHz in its standard configuration and is ready for measurements in civil applications and especially for testing in military applications and also avionics. All IF bandwidths according to MIL461 and DO160 are available in the preselected spectrogram mode of the instrument also. The fully gapless real-time analysis bandwidth of 162.5 MHz of the spectrogram mode up to 40 GHz makes the TDEMI 40G unique in the instrumentation market and provides an ideal tool for real-time EMC debugging up to 40 GHz. It supports the user in detecting, localizing, observing and analyzing emissions and in finding solutions for reduction EMI of components and systems for military and avionic industry.

The receiver mode of the TDEMI 40G system can be used for full compliance EMC tests according to CISPR, MIL461 and DO160 standard. The huge computation power of the digital signal processing unit of the TDEMI allows to reduce test time up to a factor of 4000 in comparison to traditional superheterodyn based receivers. A fast measurement at all frequencies and with higher frequency selectivities at the same time can be performed yielding in a reduced measurement uncertainty.

Especially in the lower frequency range up to several hundred MHz a large number of frequency points have to be measured. The parallel digital implementation of several thousand receivers using the short-term fast Fourier transform (STFFT) allows the TDEMI to reduce the overall testing time significantly. Especially for longer dwell times the scan time remains very short compared to superheterodyne EMI receivers and right after the results are measured at all frequencies all the data can be stored and documented. Thus, it is easily possible to reduce the measurement uncertainty even further by increasing the dwell time, which means a longer observation time at each frequency point. But not only broadband, also single frequencies can be measured in the same way. For a higher sensitivity in the upper frequency range the instrument comes with a broadband preselected low noise amplifier already integrated in its standard configuration.

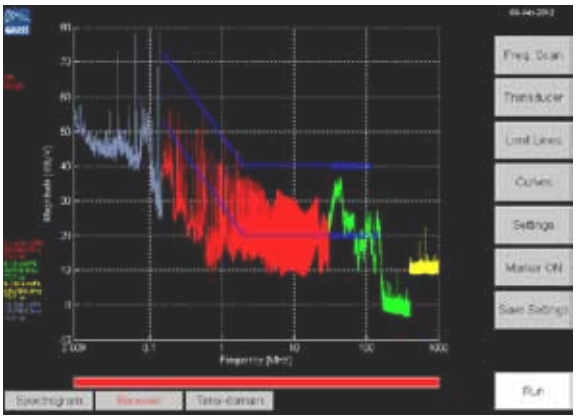



Fig. 32 – **Measurement of a switched power supply according to DO160. Measured emissions above limit line for peak detector in band B.**

# TDEMI 40G Specifications

## FREQUENCY RANGE
10 Hz – 40 GHz

## REFERENCE (OCXO)

| | | |
|---|---|---|
| Aging | < ± 3.5 ppm / 15 years | |
| Temperature Drift (0 .. 60° C) | ± 1 x 10e-8 | |
| SSB Phase Noise (1 Hz BW) | 1 Hz | -95 dBc/Hz |
| (typ. @ 12.8 MHz) | 10 Hz | -120 dBc/Hz |
| | 100 Hz | -140 dBc/Hz |
| | 1 kHz | -145 dBc/Hz |

## RECEIVER MODE (CISPR Standard)

**IF Bandwidth 200 Hz Band A**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 85 dBµV Sinus):
< 0 dBµV (typ. -3 dBµV)
Measurement at about 700 Frequencies in parallel
Frequency Step < 100 Hz

**IF Bandwidth 9 kHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus):
< -15 dBµV (typ. -19 dBµV)
Measurement at 4096 Frequencies in parallel
Frequency Step < 400 Hz

**IF Bandwidth 120 kHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Quasi-Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus):
< -3 dBµV (typ. -6 dBµV)
Measurement at 1024 Frequencies in parallel
Frequency Step < 800 Hz

**IF Bandwidth 1 MHz**

IF Filter: Gaussian Shaped Filter, Specifications according to CISPR 16-1-1, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS, CISPR-AV
Displayed Average Noise Level (Input Level < 65 dBµV Sinus):
< 6 dBµV 1 MHz – 1 GHz
< 8 dBµV 1 GHz – 1.15 GHz
< 3 dBµV 1.15 GHz – 6 GHz
< 15 dBµV 6 GHz - 18 GHz
Measurement at 128 Frequencies in parallel
Frequency Step < 800 Hz

## RECEIVER MODE (MIL/DO Standard)

**IF Bandwidth 10 Hz (10 Hz - 10 kHz)**

IF Filter: Gaussian Shaped Filter, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS
Displayed Average Noise Floor typ.: < 40 dBµV (10 Hz - 500 Hz)
< 25 dBµV (500 Hz - 1 kHz)

**IF Bandwidth 100 Hz (1 kHz - 150 kHz)**

IF Filter: Gaussian Shaped Filter, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS
Displayed Average Noise Floor typ.: < 30 dBµV

**IF Bandwidth 1 kHz (10 kHz - 30 MHz)**

IF Filter: Gaussian Shaped Filter, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS
Displayed Average Noise Floor typ.: < 5 dBµV (10 kHz - 150 kHz)
< -27 dBµV > 1 MHz

**IF Bandwidth 10 kHz (150 kHz - 40 GHz)**

IF Filter: Gaussian Shaped Filter, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS
Displayed Average Noise Floor typ.: < -17 dBµV (1 MHz - 1 GHz)

**IF Bandwidth 100 kHz (150 kHz - 40 GHz)**

IF Filter: Gaussian Shaped Filter, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS
Displayed Average Noise Floor typ.: < -5 dBµV (1 MHz - 1 GHz)

**IF Bandwidth 1 MHz (150 kHz - 40 GHz)**

IF Filter: Gaussian Shaped Filter, Bandwidth Deviation < 10 %
Detector Modes: Peak, Average, RMS
Displayed Average Noise Floor typ.: < 6 dBµV 1 MHz - 1 GHz
< 8 dBµV 1 GHz - 1.15 GHz
< 3 dBµV 1.15 GHz - 6 GHz
< 20 dBµV 6 GHz - 40 GHz

## WEIGHTED REAL-TIME SPECTROGRAM

| | |
|---|---|
| Weighted Spectrogram Mode | Peak, Average, RMS |
| Time-domain | Fully gapless |
| Frequency Step | 158 kHz for 120 kHz<br>1.2 MHz for 1 MHz |
| Frequency Step Interpolation | 40 kHz for 120 kHz<br>300 kHz for 1 MHz |
| Frequency Span | > 150 MHz |
| IF Bandwidths CISPR | 200 Hz, 9 kHz, 120 kHz, 1 MHz |
| IF Bandwidths MIL/DO | 10 Hz, 100 Hz, 1 kHz,<br>10 kHz, 100 kHz, 1 MHz |
| Minimum Time Step | 50 ms |

## TIME-DOMAIN ANALYSIS (RF)

| | |
|---|---|
| Bandwidth | 1 GHz |
| Sampling Rate | 2.6 GS/s |
| Acquisition Memory | 32000 Samples |

## ABSOLUTE MAXIMUM RATINGS (ATTENUATION 0 dB)

| | |
|---|---|
| Maximum DC Input Level, Pulse | 6 V |
| RF-CW Signal | 120 dBµV |

## INDICATION (ATTENUATION 0 dB)

| | |
|---|---|
| Maximum DC Input Level, Pulse | 5 V |
| RF-CW Signal | 65 dBµV |

## ATTENUATOR
0 - 70 dB, 10 dB Steps

## INTERMODULATION, NONLINEARITIES

| | | |
|---|---|---|
| CW Signals: | Two Tone | < -40 dB (typ. -53 dB) |
| | Harmonics (> 40 dBµV, > 1 MHz) | < -40 dB (typ. <-50 dB) |
| | Inherent Reception Points | < -40 dB (typ. <-50 dB) |
| | Total Dynamic Range (120 kHz IF Bandwidth) | > 140 dB |

## INHERENT RECEPTION POINTS (ATTENUATION 0 dB)
Inherent Reception Point 1⁄4 ADC Sampling Rate:
<< 25 dBµV (using Multi-sampling < -15 dBµV)
Further Inherent Reception Points
<< 5 dBµV (using Multi-sampling < -15 dBµV)

## MEASUREMENT TIME
1 µs – 60 s (Average, RMS)
1 µs – infinite (Peak, Quasi-Peak, CISPR-Average, CISPR-RMS-AV (Option))

## MEASUREMENT ACCURACY

| | |
|---|---|
| Sinusoidal Signals (9 kHz - 1 GHz) | ± 1 dB |
| Pulses according to CISPR 16-1-1 | |

## RF INPUT
50 Ohm
VSWR < 3.0 typ., 1 GHz - 40 GHz
VSWR < 1.2 typ., 10 Hz - 1 GHz, with 10 dB Attenuation

## REMOTE CONTROL, INTERFACES
Remote control command set according to SCPI Standard
Ethernet/LAN, USB, RS232, GPIB (Option GPIB-UG), PS/2, VGA, HDMI, Audio

## DISPLAY, USER INTERFACES
Resolution 800 x 600 pixels, 8.4", True Color (16.78 Mio. colors)
Touchscreen

## PC
Intel Core i, 2 GB RAM, 120 GB Hard Disk, or higher
Operating system: Windows XP or Windows 7

## POWER SUPPLY
230 V +/-20%, 50 Hz or 110 V +/-10%, 60 Hz

## WEIGHT
ca. 25 kg

## MAIN OPTIONS

| | |
|---|---|
| PRE - UG | Preselection Band A |
| SW - UG | Preselection Band B |
| LISN - UG | Controller for Measuring Accessories (TTL, 5V) |
| LISNCable - UG | Customized Control Cabel for Accessories, e.g. LISN |
| TG - UG | Carrying Handle |
| PC - UG | Powerful multicore processor (Intel Core i or comparable) for advanced computing power, doubled hard disk capacity, doubled RAM size |
| KB - UG | Compact Keyboard incl. Touchpad |
| RG - UG | Report Generator |
| CAL - UG | Manufacturer Calibration with Certificate |
| CALD - UG | DAkks Calibration with Certificate |
| CLICK - UG | Click Rate Analyzer, fully integrated |
| SLIDE - UG | Software for Disturbance Power Measurements |

# Product Comparison

## Options

## Products

| | AT-UG | DSP-UG[1)] | LF-UG | LN-UG | PRE-UG | SW-UG | MIL/DO-UG | LISN-UG | LISNCable-UG |
|---|---|---|---|---|---|---|---|---|---|
| TDEMI 30M | ○[2)] | ○ | ● | | ○ | | | ○ | ○ |
| TDEMI 1G | ○ | | ○ | ●[3)] | ○ | | ○ | ○ | ○ |
| TDEMI 3G | ● | | ● | ●[4)] | ○ | ○ | ○ | ○ | ○ |
| TDEMI 6G | ● | | ● | ●[5)] | ○ | ○ | ○ | ○ | ○ |
| TDEMI 18G | ● | | ● | ○[6)] | ○ | ○ | ○ | ○ | ○ |
| TDEMI 26G | ● | | ● | ○[7)] | ○ | ○ | ● | ○ | ○ |
| TDEMI 40G | ● | | ● | ●[8)] | ○ | ○ | ● | ○ | ○ |

## Applications

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Electrical Lighting** | | | | | | | | | |
| - Line Imp. Stab. Network (LISN) | ■ | ■ | ■ | | ■ | | | ■ | ■ |
| - De-/Coupling Network (CDN) | ■ | ■ | ■ | | ■ | | | | |
| - Loop Antenna | ■ | | ■ | | ■ | | | ■ | ■ |
| **Household Appliances/ISM** | | | | | | | | | |
| - Line Imp. Stab. Network (LISN) | ■ | ■ | ■ | | ■ | | | ■ | ■ |
| - Slideway/Absorbing clamp | ■ | ■ | ■ | | ■ | | | | |
| - radiated | ■ | | ■ | | ■ | | | | |
| **Automotive** | | | | | | | | | |
| - Line Imp. Stab. Network (LISN) | ■ | ■ | ■ | | ■ | ■ | | ■ | ■ |
| - radiated | ■ | | ■ | ■ | ■ | ■ | | | |
| **IT Equipment** | | | | | | | | | |
| - Line Imp. Stab. Network (LISN) | ■ | ■ | ■ | | ■ | | | ■ | ■ |
| - radiated | ■ | | ■ | ■ | ■ | ■ | | | |
| **Military/Avionics** | | | | | | | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ | ■ |

● already integrated (standard)
○ optionally available
■ option is recommended for this application
blank not available

| | TG-UG | PC-UG | KB-UG | RG-UG | CAL(D)-UG | CLICK-UG | APD-UG | SAM-UG |
|---|---|---|---|---|---|---|---|---|
| | ○ | ○ | ○ | ○ | ○ | ○ | | |
| | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| | ○ | ○ | ○ | ○ | ○ | ○ | ○ | ○ |
| | ■ | ■ | ■ | ■ | ■ | | | |
| | ■ | ■ | ■ | ■ | ■ | | | |
| | ■ | ■ | ■ | ■ | ■ | | | |
| | ■ | ■ | ■ | ■ | ■ | ■ | | |
| | ■ | ■ | ■ | ■ | ■ | | | |
| | ■ | ■ | ■ | ■ | ■ | | ■ | ■ |
| | ■ | ■ | ■ | ■ | ■ | | | |
| | ■ | ■ | ■ | ■ | ■ | | | ■ |
| | ■ | ■ | ■ | ■ | ■ | ■ | | |
| | ■ | ■ | ■ | ■ | ■ | | | ■ |
| | ■ | ■ | ■ | ■ | ■ | | | ■ |

1) option DSP-UG available for TDEMI 30M only
2) for TDEMI 30M attenuator with 10dB steps, 0 - 30 dB
3) low-noise preamplifier for frequences up to 1 GHz, integrated
4) low-noise preamplifier for frequences up to 3 GHz, integrated
5) low-noise preamplifier for frequences up to 6 GHz, integrated
6) additional low-noise preamplifier for the frequency range 6 GHz - 18 GHz
7) additional low-noise preamplifier for the frequency range 6 GHz - 26.5 GHz
8) low-noise preamplifier for frequences up to 40 GHz, integrated

## Product-specific Options

| | |
|---|---|
| **TDEMI 30M** | **AT-UG30M:** Input attenuator 10 dB steps, 0 -30 dB (Standard: 20 dB step, 0-20 dB) |
| | **DSP-UG30M:** Enhanced signal processing unit with doubled frequency resolution |
| **TDEMI 1G** | **AT-UG1G:** Input attenuator 5 dB steps, 0 - 75 dB, low noise figure (Standard: 10 dB step-size) |
| | **LF-UG1G:** Frequency extension down to 9 kHz (9 kHz - 150 kHz), IF bandwidth 200 Hz, quasi-peak detector for band A |
| **TDEMI 18G** | **LN-UG18G:** Additional preamplifier with low noise figure (ca. 3 dB) for the frequency range 6 GHz - 18 GHz |
| **TDEMI 26G** | **LN-UG26G:** Additional preamplifier with low noise figure (ca. 4 dB) for the frequency range 6 GHz - 26.5 GHz |

## Product-spanning Options

**PRE-UG:** Preselection Band A, bandpass filter 150 kHz - 300 MHz, high-pass filter 150 kHz (TDEMI 30M), enhanced dynamic range in Band B and Band C

**SW-UG:** Preselection Band B, highpass filter 30MHz - 1.1 GHz, enhanced dynamic range in Band C and in Band D

**MIL/DO-UG: Frequency** extension down to 10 Hz (10 Hz - 9 kHz), enhanced DSP unit, bandwidth 10 Hz, 100 Hz, 1 kHz, 10 kHz, 100 kHz, 1 MHz according to MIL461 and DO160 standards

**LISN-UG:** Controller for measuring accessories, TTL signals 5V, supply of 5V and 200 mA available, automated assignment of scans

**LISN-Cable-UG:** Customized cable for LISN control, triple loop antenna or other accessories with control input specified for TTL standard

**TG-UG**: Carrying handle, with snap in for positioning the instrument

**PC-UG:** Powerful multicore processor (Intel Core i or comparable) for advanced computing, double hard disk capacity, double RAM size

**KB-UG:** Compact keyboard incl. touchpad, USB interface, English (US) or German keyboard layout

**RG-UG:** Report generator, automated creation of test reports, evaluation in subranges and against limit lines, configuration of LISN taken into account

**CAL-UG:** Calibration by the manufacturer, test protocol according to ISO 17025 included

**CALD-UG:** DAkks calibration with certificate (formerly DKD)

**CLICK-UG:** Click rate analyzer, fully integrated into the TDEMI System, measurement at 4 frequencies in parallel, automated evaluation and generation of test reports

**APD-UG:** Amplitude Propability Distribution Measuring Function, measuring on up to 1024 frequencies simultaneously

**SAM-UG:** Ultra-fast Multichannel Spectrum Analyzer Mode - Multichannel analyzer functionality, 3dB and 6dB Bandwidths (in 145 steps) for measurements according to telecommunication standards (ETSI) as well as CISPR

## Accessories

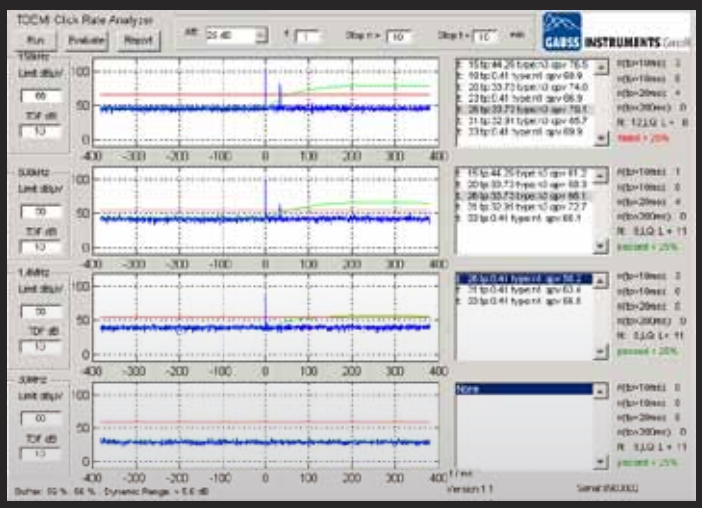
**TD-Cable:** Tailored coaxial cables, customized

**TD-NFS:** Near field probes set for the frequency range up to 6 GHz, consisting of H-Field loop probes with diameter 0.3 cm, 1 cm and 6 cm as well as E-Field probes with a length of 0.5 cm and 2 cm

**TD-VLISN216:** Two-phase line impedance stabilisation network for conducted emission measurements according to CISPR, EN, VDE, ANSI, frequency range 9 kHz – 30 MHz, max. 16 A per phase, remote control via TTL signals

# Click Rate Analyzer

- Measurement at all 4 frequencies in parallel
- Measurement according to CISPR 16-1-1 & CISPR 14-1
- Evaluation according to CISPR 14-1
- Multifunctional system reduces calibration effort
- Report including graphs of all single events
- Available for all TDEMI Measurement Systems




The optional available click rate analyzer expands the existing TDEMI Measurement System to complete integrated click rate analyzer. So the combination of a receiver, as the TDEMI, according to CISPR 16-1-1, a click rate analyzer and advanced evaluation methods, as the spectrogram mode, is available in a single box solution for the first time. The measurement is performed at all for frequencies in parallel. Hereby the total testing time is reduced significantly compared to sequential measurements performed by conventional heterodyne EMI receivers. By using the same digital data base of the TDEMI System as in the receiver mode the calibration of the click rate analyzer is covered automatically by the standard calibration of the TDEMI System.

The click rate analysis is operated by an own graphical user interface. The software measures and displays the current signal at four frequencies in parallel as peak and quasi-peak value each. Both detector values are fully stored and evaluated during performing the measurement. After finishing testing every single disturbance can be seleced from a list and the response of the IF signal and the quasi-peak value can be displayed. A test report can be automatically created containing all measurement graphs of the single events optionally.

## Main Specification

**Frequencies**

| |
|---|
| 150 kHz, 500 kHz, 1.4 MHz, 30 MHz |
| Parallel evaluation in real-time at all 4 frequencies |

**Output**

| |
|---|
| Peak envelope, quasi-peak response |
| Resolution in time: < 0.41 ms |
| Maximum testing time: 120 min |

**Evaluation**

| |
|---|
| Evaluation of clicks according to CISPR 16-1-1 and CISPR 14-1 |
| Counting of clicks with pulse width < 10 ms |
| Counting of clicks with pulse width < 20 ms |
| Counting of clicks with pulse width < 200 ms |
| Counting of other than clicks |
| Determination of click rate N |
| Determination of new click limit LQ |
| Evaluation according to limit and click limit |
| Evaluation according to upper quartile method |
| Passed/Failed examination |

**Reportgenerator**

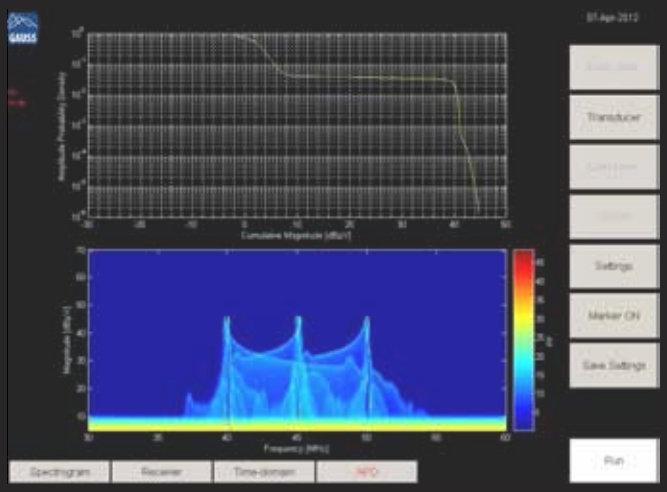
| |
|---|
| Test report |
| Illustration of measurement graphs of all single events |

**Ordering Information**

| |
|---|
| Option CLICK - UG |

# APD Measuring Function

- Measurement at 128 or 1024 Frequencies in parallel
- Full Compliant according to CISPR 16-1-1
- Scanning over Frequency Bands
- Color Shaded Display for Propablity Distribution
- 6dB CISPR Bandwidths 120kHz, 1 MHz
- Measurement of ISM Devices according to CISPR 11



The Amplitude Probability Distribution (APD) function describes a weighting of the interference according to the statistical distribution of the amplitude of a signal. The standard CISPR 11 regulates the APD value to be below 0.1 at an electric field strength of 70dBµV/m over the frequency range from 1 GHz up to 18 GHz, excluding the reserved frequency band around 2.4 GHz. The APD Measuring Function (APD-UG) is available as an option for the TDEMI product family. The APD measurement can be performed at 128 or 1024 frequencies simultaneously for measurements according to CISPR 11. A very easy to use graphical user interface provides a highly efficient tool for performing the measurements of the APD as defined in CISPR 11. By setting up a scan a full automated measurement using auto-range function is performed and the absolute frequency of the amplitude values are shown in a 2D color plot. By selecting the frequency with a marker, the APD measuring function as well as the classical values are shown.

The statistical view of the spectrum can be used for further applications like analysis of disturbance as well as surveillance. By the coloured plot even masked signals can be made visible. A special algorithm developed by GAUSS INSTRUMENTS allows to visualize the result in true colors (16.7 Mio). The TDEMI System provides unprecedented amount of information that you can observe at a glance.

## Main Specifications

**Frequencies**

| | |
|---|---|
| 6 dB CISPR Bandwidths: | 120 kHz, 1 MHz |
| 1 MHz: | 128 Frequencies in parallel |
| 120 kHz: | 1024 Frequencies in parallel |
| Resolution: | 0.25 dB |

**Scanning**

Scanning over Frequency Bands
Autorange
Remote Control according to SCPI Standard
Dwell time: 1 ms – 100 s
Single Run, Continuous Run

**Display**

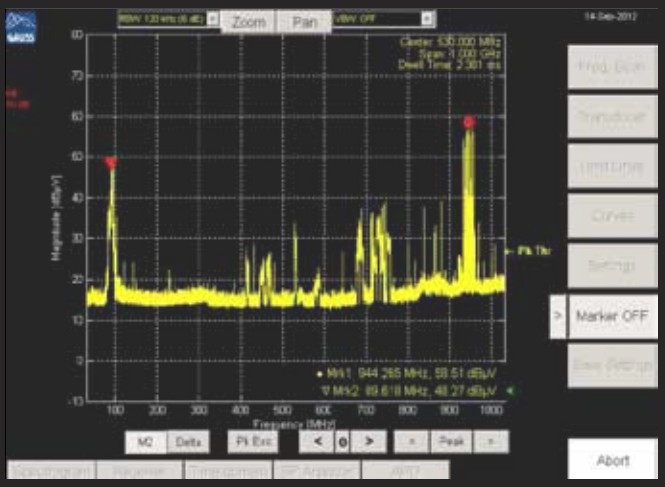
Split Display
Relative Propability
Color shaded Display 16.7 Mio
Color shaded Dynamic Range: > 300 dB
Amplitude Propablity Distribution Function
Marker Function to select Frequencies

**Export of Data**

3D-Plot, APD Measuring Function, Raw Data
Format: PDF, JPG, Matlab

# Spectrum Analyzer Mode

- Multichannel Mode: 1000 Frequencies in parallel
- Ultra fast pre-scanning e.g. 40ms in Band C/D
- Excellent pre-scan accuracy and ultra high-speed
- 3 db Resolution Bandwidths 1 Hz – 30 MHz in 145 Steps
- 6 dB Bandwidths CISPR, MIL461 & DO160
- Easy operation via Zoom and Pan functions




The spectrum analyzer mode (Option SAM-UG) is available for all TDEMI 1G – 40G Measurement Systems. The spectrum analyzer mode of the TDEMI Measurement System is absolutely unique. It uses a ultra high performance computing hardware, providing up to 1000 digital spectrum analyzers in parallel. This multichannel mode achieves an excellent ratio of dwell time and scan time setting a new standard in spectrum analysis.
The spectrum analyzer mode is an excellent tool to perform pre-scans with unparalleled measurement accuracy also for non-stationary emissions during EMC testing.

A typical application is the height and angular scan during the measurement in a semi-anechoic chamber. With a dwell time of 4 ms and a total sweep time of 80 ms a highly excellent performance regarding measurement uncertainty and sweep time is achieved. The spectrum analyzer mode uses the high dynamic range of the TDEMI Measurment Systems and is full compliant according to CISPR 16-1-1 2010.
Other unique features are 145 steps in the resolution bandwidth within the range of 1 Hz – 30 MHz. In addition, 6 dB bandwidths according to CISPR 16-1-1, MIL461 and DO160 standard are also available. The spectrum analyzer mode is the ideal choice for signal analysis and investigation of ambient noise signals.

## Main Specification

**Resolution Bandwidth**

| | |
|---|---|
| 3 dB Bandwidth: | 1 Hz – 30 MHz in 145 Steps |
| 6 dB CISPR: | 200 Hz, 9kHz, 120 kHz, 1 MHz |
| 6 dB MIL/DO: | 10 Hz, 100 Hz, 1 kHz, 100kHz, 1 MHz |

**Video Filter**

Relative to Resolution Bandwidth in Steps of:
1, 1/2, 1/5, 1/10, 1/20, 1/50, 1/100
Detectors: MaxPeak, MinPeak, Sample

**Detectors (Video Filter off)**

MaxPeak, Average, RMS
Dynamic Range according to CISPR 16-1-1 (Peak, AVG)

**Sweep Time**

| | |
|---|---|
| Traditional Mode: | 10 µs – 1000 s |
| Multichannel Mode: | 10 µs – 1000 s |
| Definition via dwell time: | 10 µs – 150 s |

Auto

**Typical Sweep Times For Pre-Scanning**

| | |
|---|---|
| 30 MHz – 1 GHz: | 40 ms (dwell time 2 ms) (120 kHz) |
| 1 GHz – 6 GHz: | 1 s (dwell time 0.5ms) (1 MHz) |
| 30 GHz – 40 GHz: | 1 s (dwell time 0.1ms) (1 MHz) |
| 30 GHz – 40 GHz: | 3 s (dwell time 0.1ms) (120 kHz) |

**Multichannel Mode**

Automatic selection: Channels according to Span and Resolution Bandwidth

| | |
|---|---|
| Number of Channels: | 1 - 1024 |
| Improvement of ratio scan time / dwell time: | 1024 |
| Real-time Analysis Bandwidth: | 162.5 MHz |

# Testing Accessories

The field of measurement application of the TDEMI System can be enhanced by software tools and additional accessories for testing and measuring.

### Conducted Emission Measurements with a LISN

For conducted emission measurements the TDEMI can be equipped with the options LISN-UG, LISNCable-UG as well as RG-UG. A conducted emission measurement can be performed, e.g. according to EN55022, with a two-phase LISN. The two-phase LISN (TD-VLISN216) is available as auxiliary equipment. It can be remote-controlled via the TDEMI, enabling a full automated measurement.

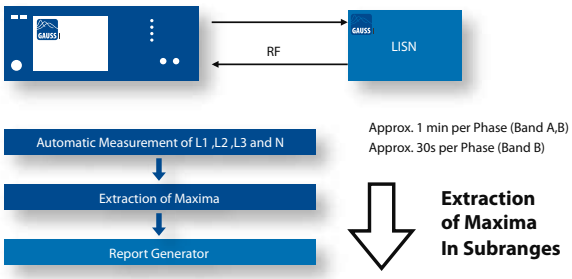
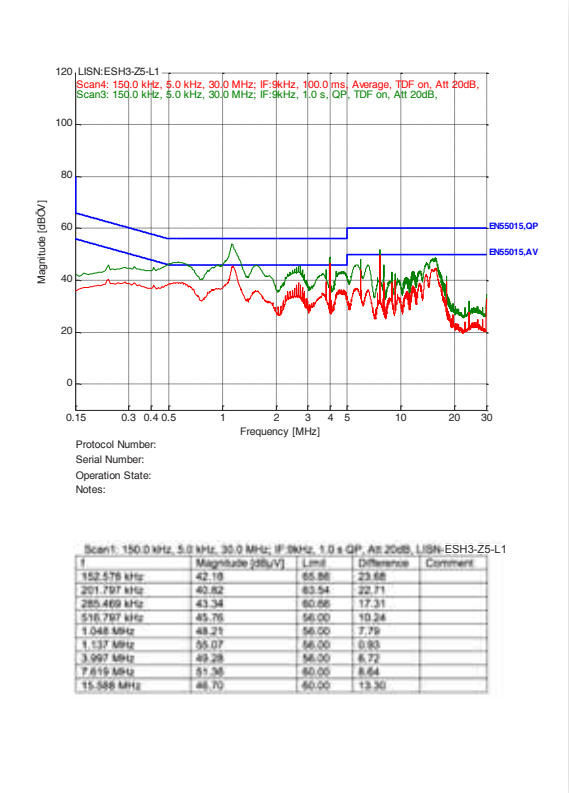



Fig. 34 – **Automated measurement procedure and evaluation of an emission measurement according to EN55022.**

At first the configuration of the measurement to be performed can be loaded. Afterwards an emission measurement with average and quasi-peak detector is performed with the selected phases L and N. The switching of the appropriate phase is done automatically via remote control by the TDEMI. Typically during switching of the phases of a LISN, high pulses may occur. Therefore the input of the TDEMI is protected by setting the attenuator to maximum level during switching. After the measurement the test results are evaluated according to sub-ranges and according to the limit lines.

The generation of the test report is performed as a Microsoft® Word document. Such a test report contains measurement graphics and also a table of the measured and evaluated values. The automation can be also performed with external control software. Such a software additionally provides the control of auxiliary equipment like turntable, antenna mast and slideway.




| f | Magnitude [dBµV] | Limit | Difference | Comment |
|---|---|---|---|---|
| 152.578 kHz | 42.18 | 65.86 | 23.68 | |
| 201.797 kHz | 40.82 | 63.54 | 22.71 | |
| 285.469 kHz | 43.34 | 60.66 | 17.31 | |
| 516.797 kHz | 45.76 | 56.00 | 10.24 | |
| 1.048 MHz | 48.21 | 56.00 | 7.79 | |
| 1.137 MHz | 55.07 | 56.00 | 0.93 | |
| 3.997 MHz | 49.28 | 56.00 | 6.72 | |
| 7.619 MHz | 51.36 | 60.00 | 8.64 | |
| 15.588 MHz | 46.70 | 60.00 | 13.30 | |

Fig. 35 – **Exctact from a test report according to EN 55015.**

### Measurement of Disturbance Power

With an optional software (Option SLIDE-UG) measurements with absorbing clamp and TDEMI can be easily automated. In Fig. 36 on the next page a measurement performed with a sliding load is shown. A single measurement is performed at each position in quasi-peak de-

detector mode. Afterwards the maxima are calculated and evaluated. There is also the possibility to evaluate the single positions and perform a remeasurement. A test report is created, containing overview graphics as well as the evaluation of level and position of the slideway.

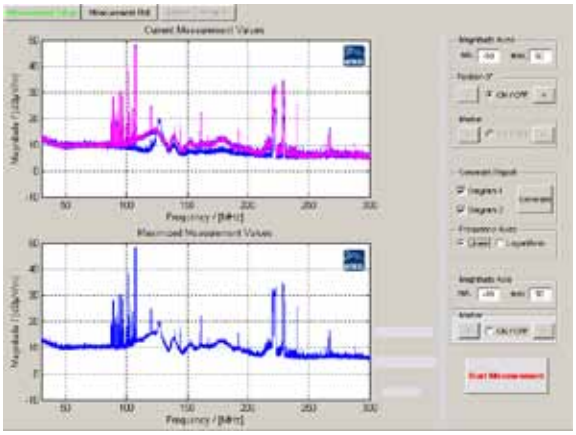
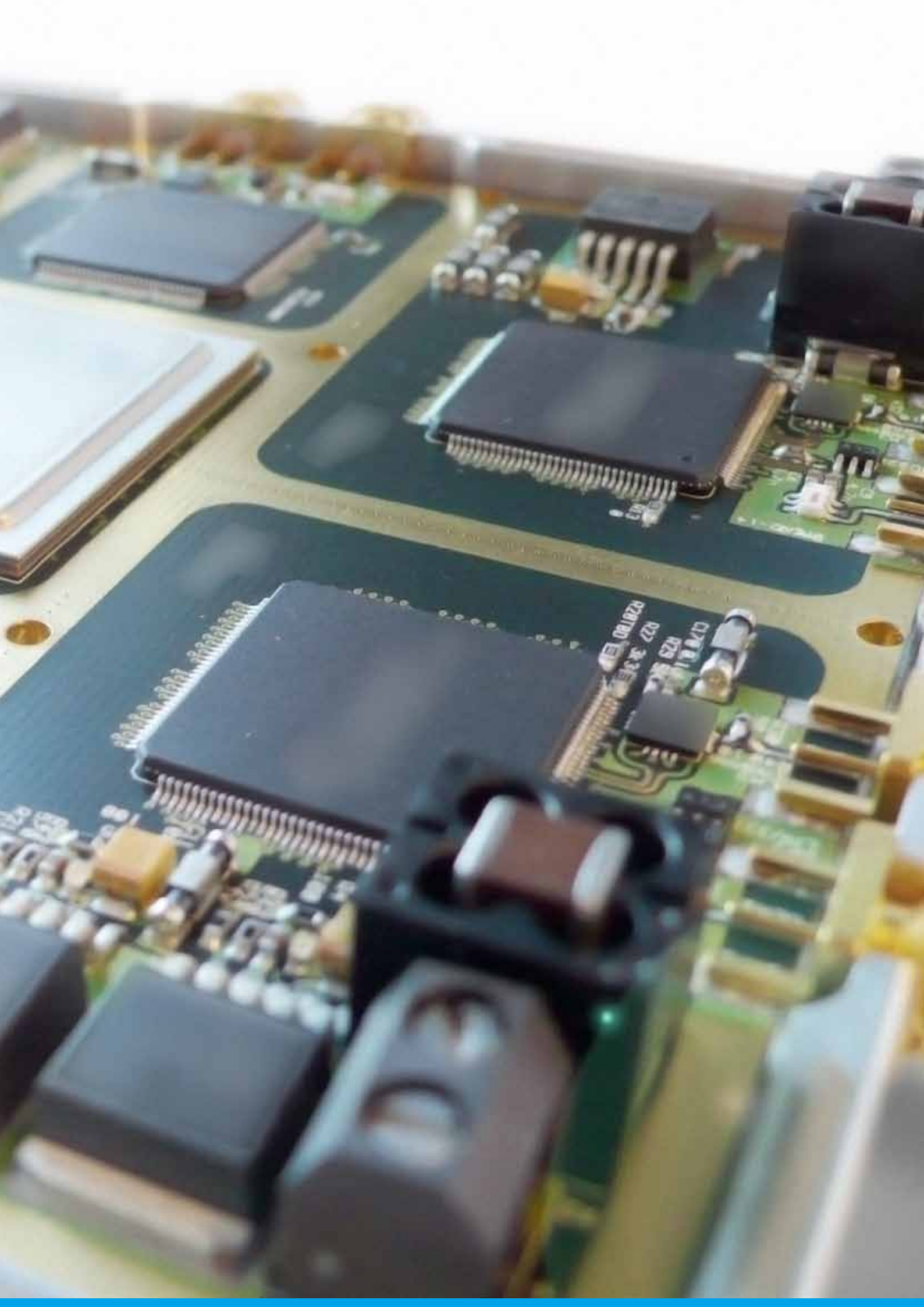


Fig. 36 – **Measurement along a slideway.** Remote control software.

**Measurement with near field probes**

For test and measurements during the development of products, often near field probes are used. Such near field probes can be moved along the axis of a device-under-test to find the hot-spots of the emission. Further it is possible to detect and localize EMI sources in real-time. By this way also the coupling mechanism can be analysed. In order to measure the electrical field short monopoles are used. The maximum frequency is determined by the length of the monopole. Shorter monopoles provide a higher resolution while longer monopoles have more sensitivity. For the measurement of the magnetic field shielded loops are used. The shielding is mandatory to decouple the sensor from the electric field.

As test accessory the near field probe set (TD-NFS) for the frequency range up to 6 GHz is available. This near field probe set consists of three loop probes with a diameter of 6 cm, 1 cm and 0.3 cm for the magnetic field as well as two E-Field probes with a length of 2 cm and 0.5 cm.



# Leading-Edge Digital Circuits

The instruments are using novel ultra high-speed analog-to-digital converters with sample rates of several GS/s (Gigasamples per second), most modern Field Programmable Gate Arrays (FPGAs) which use logic and calculation blocks for the emulation of several thousand EMI receivers in parallel.

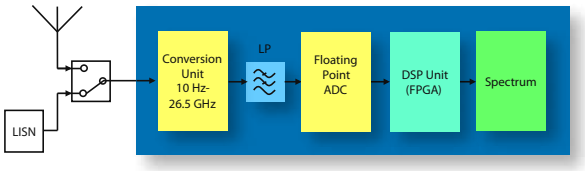



Fig. 38 – **Block diagram of a TDEMI Measurement System**, here using the example of the TDEMI 26G.

In Fig. 38 the block diagram of a TDEMI Measurement System is shown using the example of the TDEMI 26G. The received EMI signal of the frequency range from 10 Hz to 1.1 GHz is digitized with a floating-point ADC. The frequency range above 1.1 GHz is down-converted with an ultra-broadband multi-stage down-converter unit which exhibits a real-time analysis bandwidth of 162.5 MHz. Afterwards the signal is digitized in the baseband.

The emulation of up to 4000 EMI receivers in parallel based on a Fast Fourier Transform (FFT) filterbank is performed by FPGAs. These FPGAs have a computational power of more than 20 standard personal computers. This leading-edge technology allows to speed up the measurements performed by the TDEMI by several orders of magnitude in comparison to traditional superheterodyne receivers. Fully gapless real-time analysis is possible within frequency bands of 162.5 MHz for the first time.

The simplified block diagram of such a digital implementation of several thousand receivers is shown in Fig. 39.

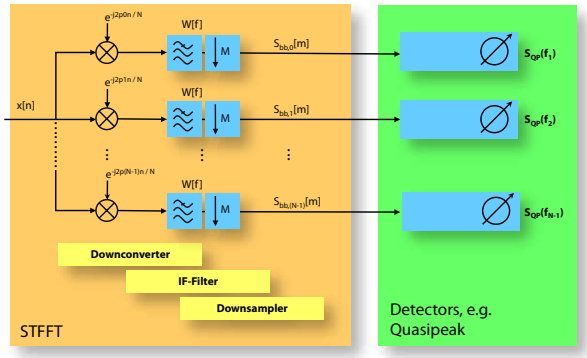



Fig. 39 – **Several thousand receivers as digital logic.**

In general an EMI receiver consists of a down-converter, an IF filter and a detector for weighting, e.g. quasi-peak. The use of a short-term FFT (STFFT) based filter bank allows to perform a down-conversion of a large set of frequencies with equidistant step-size. A highly parallel implementation of detectors by a digital bank of filters allow the simultaneous calculation at a vast number of frequencies.

The floating point ADC unit that performs the digitization of the EMI signal consists of three 8-bit ADCs with a sampling rate up to 3 GS/s. The scaling of the three branches is in logarithmic scale to digitize pulses and other transient signals with a high dynamic range, which corresponds to the dynamic range of a 20 bit ADC for pulses. These huge dynamic range is required for the digitization of pulses according to CISPR 16-1-1 that are necessary for calibration of the instrument. Such pulses can have an amplitude of several Volts, while the instrument must be able to provide simultaneously a very high sensitivity for signals of few µV which are close to the noise floor.

# Radio Frequency & Microwave Technology

Analog-to-digital converter systems are manufactured in impeadance controlled multi-layer technology with up to 12 layers. Such high performance systems are assembled in mechanically precise manufactured enclosures machined from a single piece of aluminium thus providing an excellent heat dissipation and best long term stability over the years of operation.

The TDEMI Measurement Systems in the upper GHz range use circuits with excellent RF performance. Such circuits have been developed and optimized especially for the application in EMC measurements. In Fig. 40 a part of a multi-channel switch for the frequency range up to 26.5 GHz is shown. A special substrate and monolithic integrated circuits enable highest performance. The complete mounted circuits are assembled in enclosures with highly mechanical precision made of gold-plated brass providing excellent RF characteristics. In the upper frequency range filter, mixer and switches are used which exhibit excellent RF performance, e.g. the pre-selection up to 26.5 GHz uses filters with a loss of less than 1 dB. Filters with low dispersion allow excellent impulse response for broadband signals.

Fig. 40 – **Switch for the frequency range up to 26.5 GHz.** Width of microstrip line < 0.2mm, ribbon bondwire connecting the transmission line with the die.

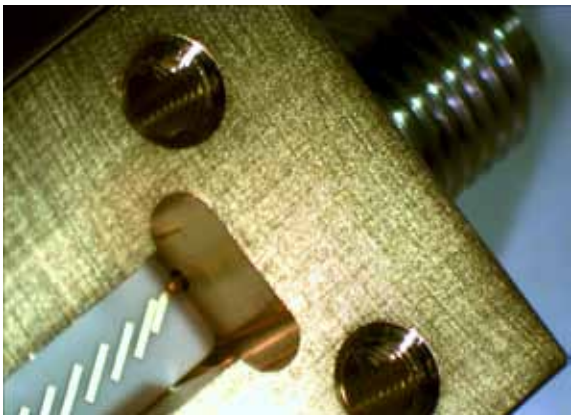


Fig. 41 – **Bandpass filter in mm-wave rang.** Gaps between microstrip lines < 20 µm compared to screw thread of size M2 and connector typ K in the upper corner on the right hand side.

Fig. 41 shows a bandpass filter. For the development of such circuits powerful simulation tools are used. The filters are manufactured on ceramic substrates which are assembled in gold-plated precision enclosures finally.

Emission measurements in the frequency range can be carried out on open area test sites (OATS) or in anechoic chambers.

Fig. 42 – **Fully anechoic chamber.** The emission measurement is performed on a turntable in distance of 3 m. For diagnostic pre-investigation near field probes (E-Field probes and H-Field probes) can be used.

# Notes

# Imprint

Specifications subject to change without notice. Technically conditioned color divergences are possible.



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