

EMC TEST EQUIPMENT PART 2

RF-Relay Switching Unit, Electric Field Strength Meter,
RF-Power Meter, Striplines, GTEM-Cells, TEM-Cells



FRANKONIA

EMC TEST INSTRUMENTS:

Electric Field Strength Meter, 10 kHz - 9.25 GHz 3-4
EFS-10 / EFS-100

RF-Power Meter, 10 kHz - 6 GHz 5
PMS-1084

RF-Relay Switching Unit, DC - 12.4 GHz 6
optional: DC - 18 GHz, DC - 40 GHz
RSU

GTEM-Cells, 100 kHz - 18 GHz 7-12
GTEM 250 - GTEM 2000

Striplines, 50 Ω / 90 Ω 13
SR 50/1000, SR 90/1000

Open TEM-Cells 14
TEM 220 - TEM 3000

Closed TEM-Cells 15
TEMF 200 - TEMF 3000

EFS-10 / EFS-100 Field Strength Meter

for field strength measurements during radiated immunity tests acc. to IEC/EN 61000-4-3 / -20



Special features

- Extreme small size
- PC connection via fibre optic link
- Excellent isotropy (0.3 dB typical)
- Frequency range: 10 kHz to 9.25 GHz
- Field strength measurements from 0.14 V/m to 500 V/m
- Up to 80 hours operating time before recharging

General description:

The Frankonia EFS field strength meters especially have been designed for field strength measurements / field homogeneity measurements during radiated immunity tests according to IEC/EN 61000-4-3 / -20. But it could also be used to measure the radiation exposure of the environment, for example at workplaces or flats.

The EFS is an isotropic miniature E-field sensor to ensure that the E-field will not be influenced by the size of the sensor itself. It even does not need any metering unit (which could also influence the field strength), because of its direct fibre optic output which allows direct

connection of the sensor to the USB-interface of the control PC or laptop. The measuring values may be displayed via the individual IEC/EN 61000-4-3 / -20 control software or via a Windows software included in the delivery.

The EFS-10 / EFS-100 cover the frequency range from 10 kHz up to 9.25 GHz and are able to detect electrical field strength in the range from 0.14 V/m to 500 V/m (depending on type). The sensors are battery operated by Li-Mn batteries, which allow a maximum operation time of 80 hours before recharging.



EFS-10 / EFS-100 Field Strength Meter

for field strength measurements during radiated immunity tests acc. IEC/EN 61000-4-3 / -20

Technical specifications	EFS-10	EFS-100
Frequency range	10 kHz – 9.25 GHz	100 kHz – 9.25 GHz
Flatness	0.1 – 150 MHz: 0.4 dB	1 – 150 MHz: 0.8 dB
With frequency correction OFF	0.05 – 6 GHz: 1.6 dB	0.5 – 6 GHz: 1.6 dB
	0.03 – 7.5 GHz: 3.2 dB	0.3 – 7.5 GHz: 3.2 dB
With frequency correction ON	0.05 – 7.5 GHz: 0.4 dB	0.3 – 7.5 GHz: 0.4 dB
Dynamic range (single range)	0.5 – 500 V/m (60 dB)	0.14 – 140 V/m (60 dB)
Linearity	0.4 dB @ 50 MHz / 1-500 V/m	0.4 dB @ 50 MHz / 0.3 – 100 V/m
Resolution	0.01 V/m	
Sensors	6 monopoles	
Isotropy	0.5 dB (0.3 dB typical) (@ 50 MHz)	
Overload	1000 V/m	300 V/m
Measured data X-Y-Z axis	sampling simultaneous on X-Y-Z axis	
Sampling rate	22 S/s to 0.03 S/s, depending on filter setting	
Digital filter	2.3 to 28 Hz, low-pass, pre-settable	
Internal battery	3 V – 5 mAh, rechargeable Li-Mn	
Operation time	80 hours @ 0.4 S/sec., 28 Hz filter	
	60 hours @ 5 S/sec., 28 Hz filter	
Recharging time	48 hours for full operation time	
Internal data memory	serial number, calibration date, calibration factors, firmware version	
Communication	bidirectional fibre optic link	
Fibre optic connector	HFBR-0500	
Fibre optic length	10 m standard (20/40 m optional)	
Fibre optic to PC connection	fibre optic to RS232 converter, RS232 to USB converter	
PC Software	included (display of field, temperature and battery voltage measurements, setting of filters, sampling rate, frequency)	
Operating temperature	-10 °C ÷ +50 °C	
Temperature reading	0.1 °C resolution	
Battery voltage reading	10 mV resolution	
Dimensions	53 mm overall, (body: 17 mm diameter, sensor: 17 mm)	
Weight	25 g, including 1 m fibre optic pigtail	
Probe mount	20 UNC female	
Included accessories	10 m fibre optic cable, optical/RS232 adapter + RS232/USB adapter, software, battery charger	
Optional accessories	20 m fibre optic cable, order-no.: EFS-OF20	
	40 m fibre optic cable, order-no.: EFS-OF40	

2/4-Channel RF-Power Meter – PMS 1084

10 kHz to 6 GHz



Description

The PMS 1084 is in the standard version a 2-channel RF-Power Meter for the frequency range from 100 kHz up to 6 GHz or from 10 kHz to 500 MHz (PMS 1084 B). The measuring range reaches from -60 dBm to $+20$ dBm. It is possible to upgrade the PMS 1084 up to max. 4 measuring channels at any time. The measured values can be displayed via a software which is included in the delivery or via the control software

of an automated test system. For the integration of the PMS 1084 into a remote-controlled test system it is equipped with serial and USB interface. Hence the PMS 1084 is very good suitable for the automated measurement of forward and reverse power in immunity test systems acc. to IEC/EN 61000-4-3 / -6. It is available for the installation into 19"-rack or as stand-alone unit.

Technical specifications	PMS 1084	PMS 1084B
Number of channels	2 (standard); up to 4 (option)	
Frequency range 2 x Input-Module LF		10 kHz - 500 MHz
Frequency range 2 x Input-Module HF	100 kHz - 6 GHz	
Measuring range	-60 dBm to $+20$ dBm ($10 \text{ kHz} \leq f \leq 4 \text{ GHz}$) -45 dBm to $+20$ dBm ($4 \text{ GHz} < f \leq 6 \text{ GHz}$)	
Accuracy	± 1 dB (0.5 dB typical)	
Resolution	0.1 dB	
Integration time	0.5 - 200 ms (firmware)	
Max. input level	$+27$ dBm (= 500 mW)	
VSWR	1.15	
RF-Impedance	50Ω	
Interface (PC)	USB, RS232 (9-pol Sub D. female)	
Input	N-type female connector	
Dimensions (D x W x H)	172 x 482.6 x 44.3 mm	
Weight	approx. 2.5 kg	
Power supply	115/230 V	
Accessories included	Power cord, USB cable, application software, user manual	
Options		
PMS-CHA	Expansion of 1 measuring channel (max. up to 4 channels); 100 kHz to 6 GHz	
PMS-CHAB	Expansion of 1 measuring channel (max. up to 4 channels); 10 kHz to 500 MHz	

RF-Relay Switching Unit - RSU

DC...12.4 GHz (up to 40 GHz optional)



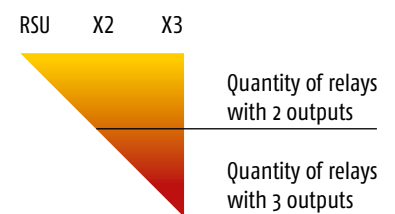
Main characteristics:

- Up to 4 pcs. Coax-Relays
- 1 input to 2 or 3 outputs
- Manual or remote-controlled
- USB, RS232 and GPIB interface
- Easy integration in test systems
- For RF- and EMC testing

Description

The RSU Relay Switching Unit is applicable for all fields of RF- and EMC measurements to switch (manual or remote-controlled) from one input to 2 or 3 outputs. Typical applications in measuring systems are changeover switching between different amplifiers, antennas or power meters. This does also prevent circuit faults due to wrong cabling. By means of a selector switch on the front panel of the RSU it is possible to work in manual mode or remote-control mode via the RS232, USB or GPIB interface. The input/output connectors of the relays are installed on the rear panel of the RSU, this allows an easy cabling when or where the RSU is mounted into a 19"-rack. A RSU can be equipped with a maximum of 4 relays with 2 or 3 outputs. The quantity of relays with 2 or respectively 3 outputs is variable. The delivery includes a Windows software for easy remote-controlled applications. However for extensive systems it is recommended to integrate the RSU driver into the system control software. The easy to follow commands for RS232 and GPIB interfaces are listed in the user manual.

Definition of the relay assembly:



RSU 2223 = 2 relays with 2 outputs
and 2 relays with 3 outputs

Technical specifications	RSU			
Frequency range	DC to 12.4 GHz (up to 40 GHz optional)			
	DC...1 GHz	1 GHz...5 GHz	5 GHz...10 GHz	10 GHz...12.4 GHz
VSWR	≤ 1.04	≤ 1.14	≤ 1.3	≤ 1.5
Isolation	≥ 90 dB	≥ 80 dB	≥ 70 dB	≥ 70 dB
Insertion loss	≤ 0.05 dB	≤ 0.1 dB	≤ 0.2 dB	≤ 0.3 dB
Max. power input	≤ 1.00 kW	≤ 0.44 kW	≤ 0.31 kW	≤ 0.28 kW
Impedance	50 Ω			
RF-connectors / Relays	N-female			
Switching time	≤ 60 ms			
Number of operations	Max. 10/Minute			
Operating temperature	+10 °C ... +40 °C			
Max. humidity	< 90 %			
Cabinet	19"-subrack or desktop case			
Dimensions (D x W x H)	435.5 x 448.9 x 132.55 mm			
Weight	7.6 kg			

GTEM-Cells acc. to IEC/EN 61000-4-20

Septum-height: 250 mm to 2000 mm / 0.1 MHz to 18 GHz



Description

The GTEM-cell is a TEM waveguide with the upper frequency limit extended to the GHz range. It is a low-cost alternative measurement facility for both radiated emission and immunity measurements. It is included in the published standard IEC/EN 61000-4-20 "Emission and Immunity Testing in Transverse Electromagnetic (TEM) Waveguides". Compared to other measuring methods like EMC test in anechoic chambers or OATS (Open Area Test Sites), GTEM-cells offer some significant advantages for the testing of small and medium sized EUT's (Equipment

Under Test) up to a frequency range of 18 GHz. Quick turnarounds of the EUT as well as numerous testing variations are easy and fast to handle. Switching from emission to immunity testing requires only simple adjustments from receiver input to amplifier output. You are irrespective of long waiting times associated with off-site test labs or weather and ambient delays that can occur at OATS facilities. Whether you are at the design qualification, pre-compliance, compliance, or production sampling stage, the GTEM is the right choice for you.

Calculation of the required forward power for radiated immunity tests:

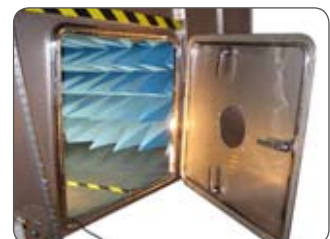
$$P = (E \times h)^2 / R \times \text{flatness factor (2)} \times \text{modulation factor (3.24 for 80 \%AM)}$$

E= required field strength; h=septum height in meter; R= input impedance 50 Ω

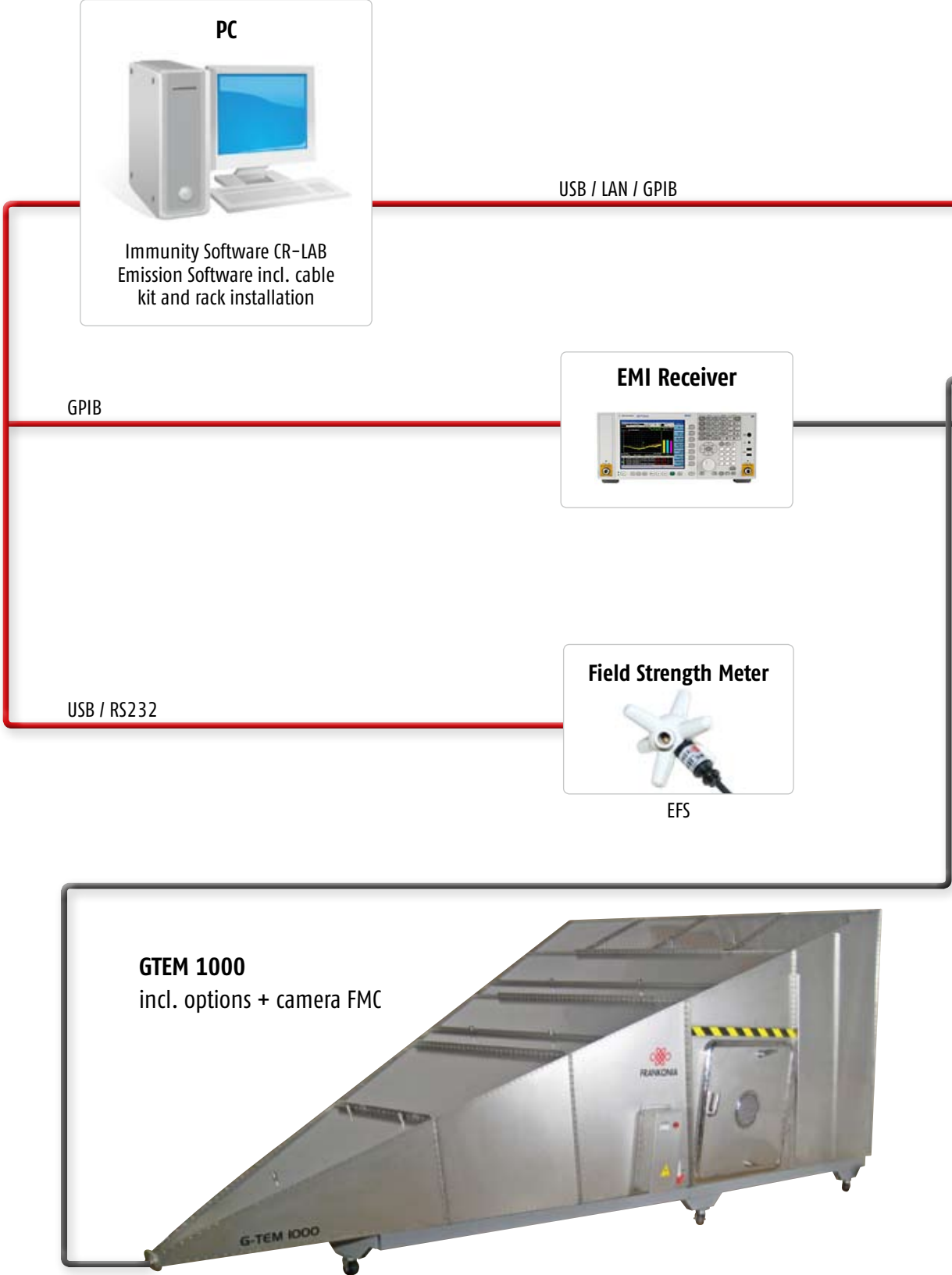
Example:

Field strength 10 V/m, 80 %AM with GTEM 1000:

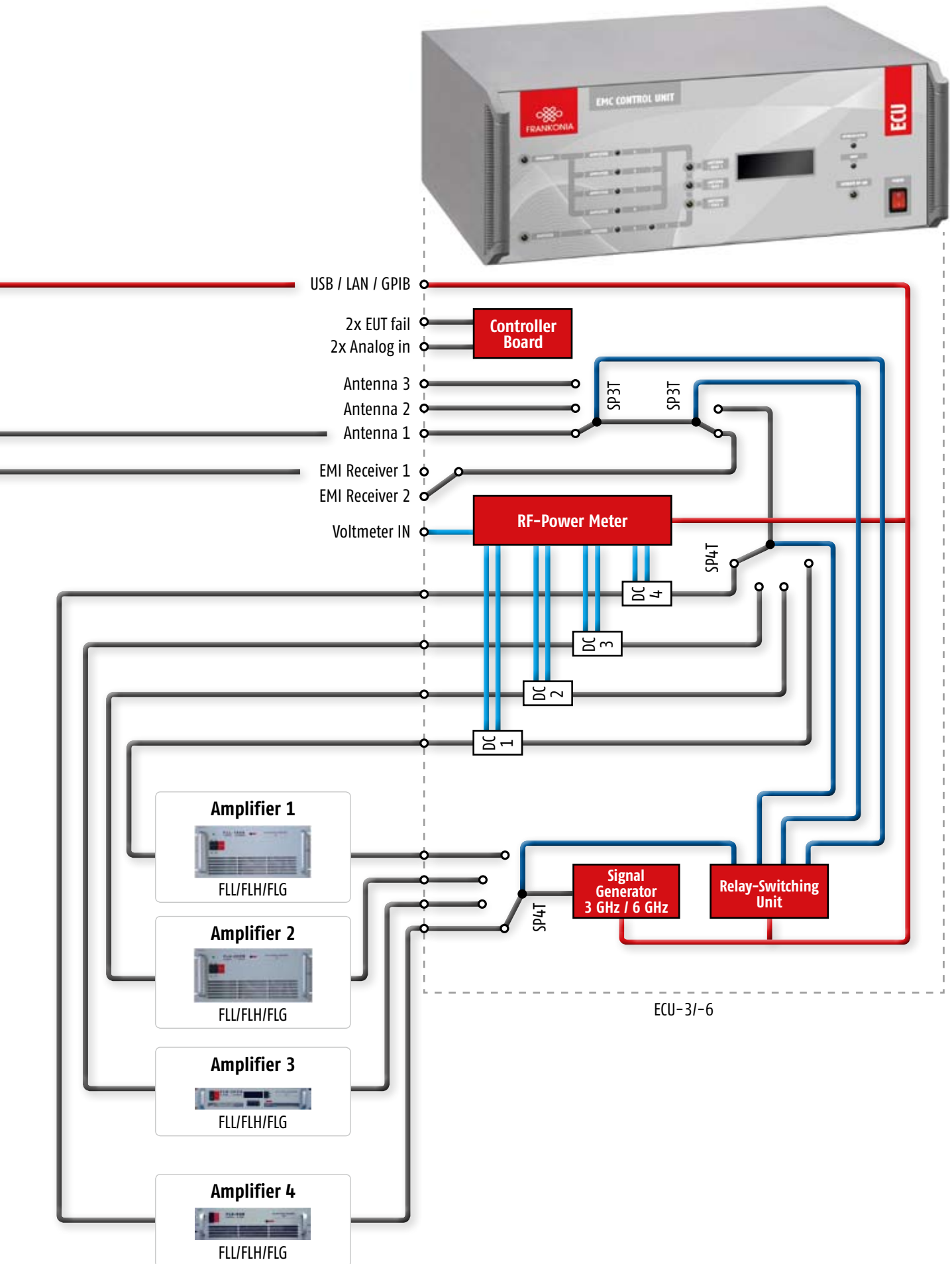
$$P = (10 \times 1.0 \text{ m})^2 / 50 \times 2 \times 3.24 = 12.96 \text{ W}$$



GTEM test set-up for radiated immunity tests and emission measurements:



GTEM test set-up for radiated immunity tests and emission measurements:



GTEM-Cells acc. to IEC/EN 61000-4-20

Technical specifications	250	400	500	750	1000
Electrical Data					
Input connector	N	N	N	N	N
Nominal impedance	50	50	50	50	50
Frequency range	0.01 MHz-18 GHz*	0.01 MHz-18 GHz*	0.01 MHz-18 GHz*	0.01 MHz-18 GHz*	0.01 MHz-18 GHz*
Typical VSWR	1:1.2	1:1.2	1:1.2	1:1.2	1:1.2
Typical VSWR at critical frequency	≤ 1:1.6	≤ 1:1.6	≤ 1:1.6	≤ 1:1.6	≤ 1:1.6
Max. input power, W continuous*/pulsed	500*/1 Kw	500*/1 Kw	500*/1 Kw	700*/1.5 Kw	700*/1.5 Kw
Electrical Equipment / Options					
Mains connectors	Fix/CEE	Fix/CEE	Fix/CEE	Fix/CEE	Fix/CEE
Input socket plug 10Aac	●	-	-	-	-
Input socket plug 16Aac	○	●	●	●	●
Output socket tape 16Aac	○	●	●	●	●
Additional sockets for EUT	○	○	○	○	○
Ground connection M6	●	●	●	●	●
AC filter 6 A / 3 wires	●	○	○	○	○
AC filter 10 A / 3 wires	○	●	●	●	●
AC filter 16 A / 5 wires	○	○	○	○	○
AC filter 30 A / 5 wires	○	○	○	○	○
AC filter 64 A / 5 wires	○	○	○	○	○
Electrical safety interlock	○	○	○	○	○
Indoor lighting 50 W	○	○	○	○	○
9-poles signal filter (DB9)	○	○	○	○	○
25-poles signal filter (DB25)	○	○	○	○	○
Channel for fibre optic leads (3 couple)	●	●	●	●	●
RF feed-thru connectors N Type	1	1	1	1	1
RF feed-thru connectors SMA Type	2	2	2	2	2
Mechanical Equipment / Options					
Second small door close to input	-	-	-	○	○
Window in door, 20 cm Ø	○	○	○	○	○
Gas / Water feed-thru plates	○	○	○	○	○
Honeycomb panel	○	○	○	○	○
Fans N.4 12x12 cm	-	○	○	○	○
Empty technical panels	-	-	1	3	3
Mechanical Dimensions / Max. EUT size					
Outer (LxWxH), cm	115x64x44	220x122x83	300x168x115	400x220x150	500x271x188
Door (WxH), cm	30x23	40x40	40x40	61x61	80x90**
Wheeled undercarriage	-	○	●	●	●
Weight kg approx.	24	60	200	400	600
Max. test volume (LxWxH), cm	20x20x15	35x40x25	40x40x30	60x60x50	75x75x70
Defined test vol. ± 3 dB < 1000 MHz (LxWxH), cm	15x15x10	25x30x13	30x35x17	45x45x25	60x60x30
Septum height	250 mm	400 mm	500 mm	750 mm	1000 mm

** Other sizes are available on request

*6 GHz standard, 18 GHz optional

● Standard

○ Costed option

- Not provided

GTEM-Cells acc. to IEC/EN 61000-4-20

Technical specifications	1250	1500	1750	2000
Electrical Data				
Input connector	N	N	N	N
Nominal impedance	50	50	50	50
Frequency range	0.01 MHz-18 GHz*	0.01 MHz-18 GHz*	0.01 MHz-18 GHz*	0.01 MHz-18 GHz*
Typical VSWR	1:1.2	1:1.2	1:1.2	1:1.2
Typical VSWR at critical frequency	≤ 1:1.6	≤ 1:1.6	≤ 1:1.6	≤ 1:1.6
Max. input power, W continuous/pulsed*	500/1000*	600/1200*	800/1400*	1000/1600*
Electrical Equipment / Options				
Mains connectors	Fix/CEE	Fix/CEE	Fix/CEE	Fix/CEE
Input socket plug 16Aac	●	●	●	●
Output socket tape 16Aac	●	●	●	●
Additional sockets for EUT	○	○	○	○
Ground connection M6	●	●	●	●
AC filter 10 A / 3 wires	●	●	●	●
AC filter 16 A / 5 wires	○	○	○	○
AC filter 30 A / 5 wires	○	○	○	○
AC filter 64 A / 5 wires	○	○	○	○
Electrical safety interlock	○	○	○	○
Indoor lighting 50W	○	○	○	○
9-pole signal filter (DB9)	○	○	○	○
25-pole signal filter (DB25)	○	○	○	○
Channels for fibre optic leads (3 couple)	●	●	●	●
RF feed-thru connectors N Type	1	1	1	1
RF feed-thru connectors SMA Type	2	2	2	2
Mechanical Equipment / Options				
Second small door close to input	○	○	○	○
Window in door, 20 cm Ø	-	○	○	○
Gas / Water feed-thru plates	○	○	○	○
Honeycomb panel	○	○	○	○
Fans N.4 12x12 cm	○	○	○	○
Empty technical panels	-	1	3	3
High power termination	○	○	○	○
Mechanical Dimensions / Max. EUT size				
Outer (LxWxH), cm	600x306x252	700x358x255	800x410x290	900x462x324
Door (WxH), cm	80x110**	80x120**	80x130**	80x140**
Wheeled undercarriage	●	●	●	●
Weight kg approx.	850	1000	1300	1650
Max. test volume (LxWxH), cm	95x95x85	120x120x100	140x140x60	175x175x70
Defined test vol. ± 3 dB < 1000 MHz, LxWxH, cm	75x75x42	100x100x50	125x125x58	150x150x65
Septum height	1250 mm	1500 mm	1750 mm	2000 mm

** Other sizes are available on request

*6 GHz standard, 18 GHz optional

● Standard

○ Costed option

- Not provided

GTEM-Cells acc. to IEC/EN 61000-4-20

Type	I/O ports	GTEMs MODEL	
		250-400	500-750-1000-1250 1500-1750-2000
GTEM-B01	EIA 7/8" Flange input connector (up to 3 GHz)	○	○
GTEM-B02	7/16" Input connector (up to 3 GHz)	○	○
GTEM-B03	1 Kw max. input power, (up to 3 GHz) (the max. input power is limited by the spec. of the max input power of the selected GTEM)	○	-
GTEM-B04	Upgrade input power 1.6 Kw, (up to 3 GHz) (the max. input power is limited by the spec. of the max input power of the selected GTEM)	-	○
GTEM-B05	Channels for fibre optical feed-thru (additional 3 pairs)	○	○
GTEM-B06	Additional RF feed-thru connectors N type	○	○
GTEM-B07	Additional RF feed-thru connectors SMA type	○	○
Electrical Equipment / Options			
GTEM-B08	Additional socket for EUT	○	○
GTEM-B09	Internal illumination (halogene, 50 W)	○	○
GTEM-B10	AC filter 16 A / 5 wires	○	○
GTEM-B11	AC filter 30 A / 5 wires	-	○
GTEM-B12	AC filter 64 A / 5 wires	-	○
GTEM-B13	Electrical safety interlock	○	○
GTEM-B25	9-pole DB9 signal EMI filter	○	○
GTEM-B14	25-pole DB25 signal EMI filter	○	○
GTEM-B26	RJ11 (RJ9) feed-thru connector	○	○
GTEM-B32	RJ45 feed-thru connector	○	○
Mechanical Equipment / Options			
GTEM-B15	Second door close to input	-	○
GTEM-B16	Window in door, Ø 200 mm	○	○
GTEM-B17	Gas / water-feed-thru plates	○	○
GTEM-B18	Honeycomb panel	-	○
GTEM-B19	Fan kit for GTEM on technical panel	-	○
GTEM-B20	Door for tests acc. to SAE J1752/3	○	○
GTEM-B21	Wheeled undercarriage	○	●
GTEM-B23	Vertical positioning, turn of door position, plastic table over pyramids	○	-
GTEM-B27	Empty installation panel, Ø 200 mm	○	●
GTEM-B28	Fan kit incl. channel for heat sink	○	○

● Standard ○ Costed option - Not provided

50 Ω Stripline for Immunity Tests – SR 50/1000

acc. to ISO 11452-5

90 Ω Stripline for Immunity Tests – SR 90/1000



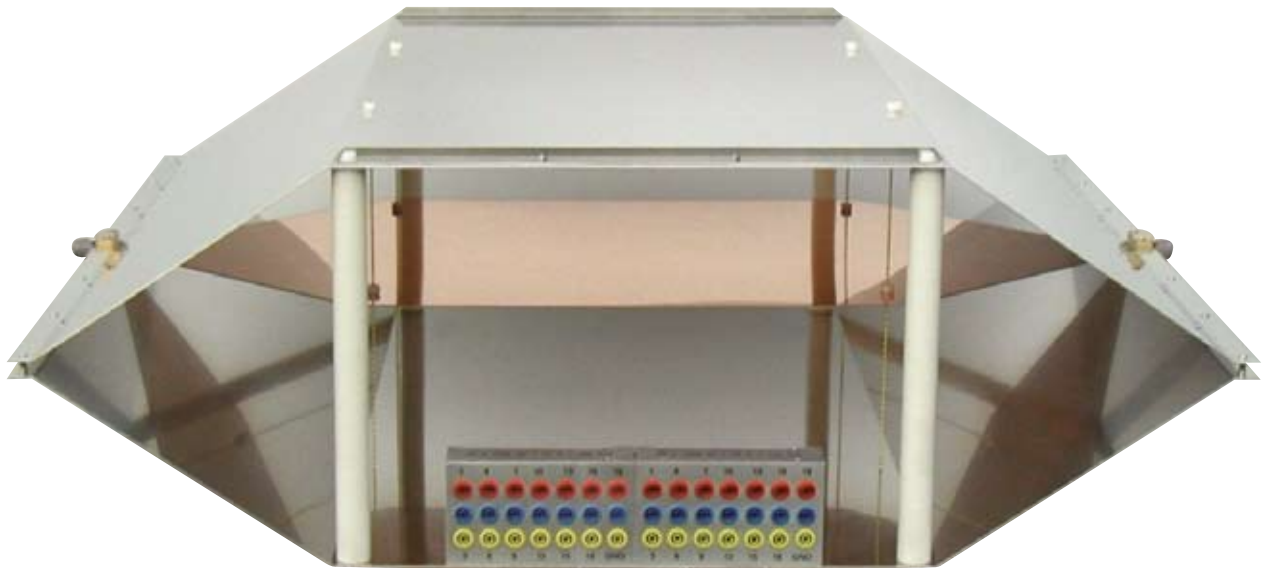
Description

This stripline is designed for immunity tests on automotive devices according to ISO 11452-5. The stripline is fixed on a table and easy to move. The table can be sloped vertically in order to reduce the width. It is also possible to divide the stripline very easy in two

parts for storage or during transport (50 Ω version). It is the only stripline on the market with the ability to carry out test up to 1 GHz with excellent return loss. The stripline is available with 50 Ω or 90 Ω impedance.

Technical specifications	SR 50/1000	SR 90/1000
Frequency range	0 to 1 GHz	0 to 1 GHz
Max. input power	1 kW continuous	>200 W continuous (>100 W with impedance adapter)
Wave impedance	377 Ω	377 Ω
Impedance	50 Ω ± < 5 Ω	90 Ω ± < 6 Ω
VSWR	better than 1.22	<1.92
Return loss	better than 20 dB	>10 dB up to 1 GHz
Connector type	N 50 Ω	N 75 Ω
Height of the plate	15 cm over ground plane	15 cm over ground plane
Height of the table	95 cm	80 cm
Size (L x W x H)	430 x 150 x 105 cm (service position) 2 * 215 x 85 x 165 cm (storage)	350 x 90 x 95 cm
Weight	approx. 140 kg	approx. 100 kg
Options	Filter box	Impedance adapter 50-90 Ω
		Filter box
		Other height under plate

Open TEM-Cells



Description

These open TEM-cells are well suited for immunity testing of small objects according to European (CE) and automotive standards (SAE J1113-25) or for biological experiments. The advantage of these TEM-cells is that they are open and it is very easy to control the functions of the EUT (Equipment Under Test). The applications are for instance the immunity testing of watches, pagers, telephones or PCB's.

In comparison with other closed TEM-cells, the price is low. The field decreases rapidly outside the open TEM-cells (approx. 33 dB at 1 meter) and it is therefore possible to use an open TEM-cell in ordinary facilities. Another interesting application is the calibration of field probes as the generated field inside the TEM-cell is very exact. TEM-cells are the most precise structures for field calibrations.

Technical specifications	TEM 220	TEM 500	TEM 1000 *	TEM 3000 *
Frequency range	DC - 220 MHz	DC - 500 MHz	DC - 1 GHz	DC - 3 GHz
Height under plate	33.3 cm	14.7 cm	7.3 cm	2.5 cm
Max. input power	1.5 kW	1 kW	750 W	400 W
Maximum field	800 V/m	1.5 kV/m	2.6 kV/m	5.6 kV/m
Field for a 25 W amplifier	105 V/m	215 V/m	480 V/m	1400 V/m
Dimensions (LxWxH)	180 x 160 x 73 cm	97 x 81 x 32cm	54 x 45 x 16.8 cm	44 x 18 x 8 cm
Weight	55 kg	12 kg	3.5 kg	1.1 kg
Field precision	± 5 %			
Connector	type N 50 Ω			
Cell impedance	50 Ω			
Wave impedance	377 Ω			
VSWR	< 1.2 (<1.9 for the TEM3000)			
Options	Signal and power supply filters			
	* Can be equipped with a test setup for IC or PCB acc. to SAE J1752-3			

Other models are available on request



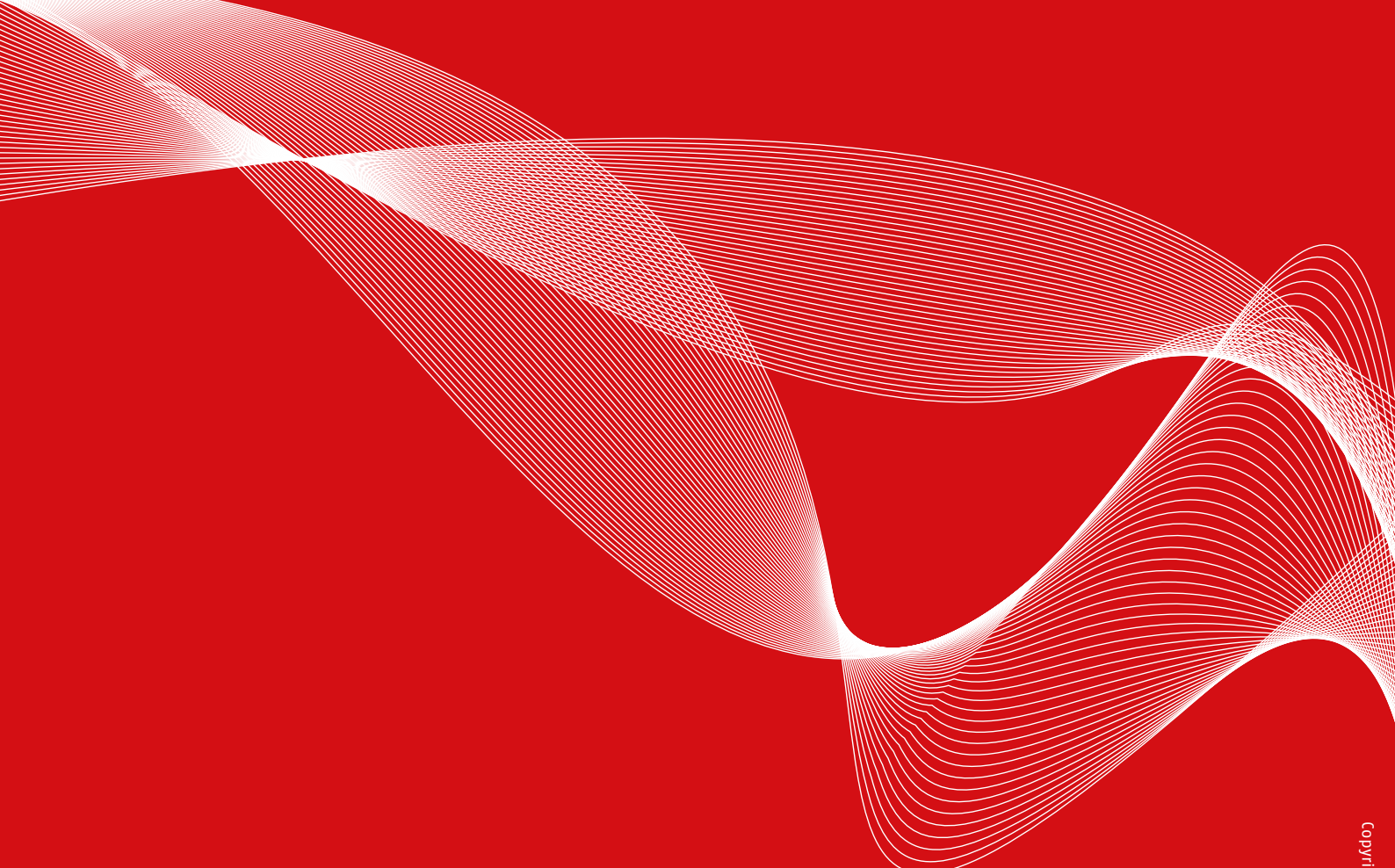
Description

The closed TEM-cells TEMF 200 and TEMF 500 are specially designed for immunity tests on automotive devices according to ISO 11452-3 and to SAE J1113-24. The TEMF 1000 and TEMF 3000 allow immunity tests on small devices and require a low power amplifier. Therefore the test installation is much cheaper compared to an absorber room with antennas. The TEM (Transverse Electro-Magnetic) mode is the only mode produced in the cell below the cut-off frequency. The electric field is

vertical, the magnetic field horizontal and the wave impedance 377Ω . The field conditions inside the cell are similar to far field conditions. An optional filter box can be placed behind the cell for power and signal line connections. For automotive tests the recommended minimum amplifier power is 100 W (TEMF 200) and 50 W (TEMF 500). It is also possible to use the cell for radiation measurements under certain conditions.

Technical specifications	TEMF 200	TEMF 500	TEMF 1000 *	TEMF 3000 *
Frequency range	DC - 200 MHz	DC - 500 MHz	DC - 1 GHz	DC - 3 GHz
Height under the plate	30 cm	10 cm	7.3 cm	2.35 cm
Dimensions (LxWxH)	130 x 70 x 62 cm	60 x 30 x 22 cm	54 x 45 x 18 cm	15 x 8 x 6 cm
Max. input power	1.6 kW long term	1 kW long term	750 W long term	400 W long term
Field for a 25 W amplifier	118 V/m	350 V/m	475 V/m	1.4 kW/m
Impedance	$50 \Omega \pm 5 \Omega$	$50 \Omega \pm 5 \Omega$	$50 \Omega \pm 7 \Omega$	$50 \Omega \pm 7 \Omega$
VSWR	< 1.1	< 1.1	< 1.2	< 1.2
Return loss	> 25 dB	> 25 dB	> 20 dB	> 20 dB
Connector type	N 50 Ω	N 50 Ω	N 50 Ω	N or SMA 50 Ω
Weight	approx. 29 kg	approx. 20 kg	approx. 4.8 kg	approx. 1.6 kg
Options	Signal and power supply filters			
	* Can be equipped with a test setup for IC or PCB acc. to SAE J1752-3			

Other models are available on request



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