ELECTROMAGNETIC COMPATIBILITY

EM TEST

CONSULTING AND SIMULATION

BURST GENERATOR

Type EFT 500

MANUAL

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SPECIFIC PRECAUTIONS

EM TEST

Observe all of these precautions to ensure your personal safety and to prevent damage to the test equipment of our product range.
The generators correspond to installation category (overvoltage category) II.

Power Source
The equipment is intended to operate from a power source that will not apply more than 250VRMS between the supply conductors or between either supply conductor and ground. A protective ground connection, through the grounding conductor in the power cord, is essential for safe system operation.

Grounding the generators
The generators are grounded through the power cord. To avoid electric shock, plug the power cord into a properly wired receptacle where earth ground has been verified by a qualified service person. Do this before making connections to the input or output terminals of the test equipment.
Without the protective ground connection, all parts of generators are potential shock hazards. This includes knobs and controls that may appear to be insulators.

Use the Proper Power Cord
Use only the power cord and connector specified for you product. Use only a power cord that is in good condition.

Use the Proper Fuse
To avoid fire hazard, use only the fuse specified in the parts list for your product, matched by type, voltage rating and current rating.

Do Not Remove Covers or Panels
To avoid personal injury, do not operate the generators without the panels or covers.

Do Not Operate in Explosive Atmospheres

The generators provides no explosion protection from statistic discharges or arcing components. Do not operate them in an atmosphere of explosive gases.

Electric Overload

Never apply generators voltage to a connector which is not specified for that voltage range.

Read carefully the following operation manual!!!

Recommended Security Aspects

The Generators correspond to equipment of security class I.

Prior to Turning on the Equipment

- Before putting the instrument into operation please check the equipment you have received for damage due to transportation. Check the single boxes as well as the generator itself for mechanical damage. Please inform the manufacturer before switching the unit on.

Damage due to transportation

- Prior to turning on the equipment check if the selected supply voltage corresponds with the mains.

115V/230V ??

- Equipment of security class I which is powered by an autotransformer may be considered as follows:
- if the equipment is powered by an auto transformer connected to a mains of higher voltage, be sure that the low end of the autotransformer is connected with the neutral of the mains;
- equipment of security class I with removable neutral or with mains plug: It is only permitted to insert the power plug in a mains socket with protective earth lead. It is not allowed to interrupt or disconnect the protective earth connection.

Performance of Measurements

- Each interruption or disconnection of the protective earth connection inside or outside the equipment may lead to a dangerous situation. Intentional interruption is prohibited.
- Interconnections between such equipments or to others, e.g. remote control to personal computer, may be completed with original cables recommended by the manufacturer.

Maintenance, Adjustments, Exchange of Parts

- When removing the housing cover or other parts of the equipment, parts exposed to high voltage may become accessible. High voltage and high current signify danger to life.

- Do not perform maintenance or service work until you have disconnected the equipment from the mains. Be sure the capacitors or other voltage-carrying parts are discharged.
- If maintenance or service work is necessary, it must be performed only by experts who are familiar with the existing danger.
- It has to be assured that only fuses of recommended type and nominal current are used for replacement. It is not allowed to use repaired fuses.

Failures and Overstressing

- If it is assumed that a riskless operating mode of the equipment is no longer possible, the mains connection must be removed and the equipment secured from unintentional use.

  - It may be assumed that an endanger operating is given:
  - when the equipment shows recognisable damages;
  - when the equipment is not working;
  - after severe transportation stress;
  - after longer stock-keeping under disadvantageous conditions.

  It is suggested that you read the operating manual carefully and completely. It is absolutely necessary to observe and comply with the security indications.

Maintenance

The generator is absolutely maintenance-free by using a solid state semiconductor switch to generate the test events.

Coupling network

- Due to the various national safety instructions the coupling network has no ON/OFF key as well as no internal fuse protection. The EUT must be fused by the user.
- Special supply adapters with switch and fuse protection are available but must be specified by the user.
- Special supply cables are included as basic equipment.

Test set-up

!! Attention Immunity Tests !!

Burst test is an immunity test on electronic equipment. Therefore it is the responsibility of the user to avoid critical failures and risks to the environment and operator.

Long and distributed lines of the EUT are able to radiate a certain energy to their vicinity. Therefore it is also the responsibility of the user to decide whether it is allowed to conduct immunity tests in a given installation. Test voltages above 500V may generate spark discharges. Therefore it is forbidden to test in an explosive environment.

National and international recommendations regarding human safety must be followed.

Handicapped people, e.g. with a heart defibrillator, should be excluded from testing.

CONTENTS

1. Application 9
1.1. Introduction 9
1.2. Definitions 10
1.3. Sources of interference 11
2. Operating Functions 13
2.1. Front view 13
2.2. Rear view 15
3. Operation 17
3.1. Description of the menus 17
3.2. Quick Start 19
3.3. User test routines 21
3.4. Test routine as per to IEC 1000-4-4 26
3.5. Service 27
3.6. Set-up 28
4. Putting into Operation 29
4.1. Security Aspects 29
4.2. Immunity Tests Burst, using PC's 29
4.3. Generator function check 32
5. Test Equipment EFT 500 34
5.1. Construction 34
5.2. Control unit 35
5.3. High voltage unit 35
5.4. Coupling network 36
6. Technical Data 39
6.1. Pulse forming unit 39
6.2. Trigger 39
6.3. Burst impulses 39
6.4. Output 39
6.5. Test routines 40
6.6. General data 40
7. Maintenance 41
7.1. General 41
7.2. Limiting values 41
7.3. Coupling network 41
8. Delivery Groups 42
8.1. Basic equipment 42
8.2. Accessories and options 42
9. Remote Control 43
9.1. Interfaces 43
9.2. General information 44
9.3. Parameter of the remote commands 45
9.4. E commands 46
9.5. N commands 47

9.6. A commands 47
9.7. Back messages 48
10. Appendix 49
10.1. Declaration of CE-Conformity 49
10.2. Declaration for safety requirements 49
10.3. List of sales representatives 49
10.4. EFT 500 - General Diagram 49
10.5. EFT 500 - Overview 49

1. Application

1.1. Introduction

With more complex electronic devices and systems the tendency towards lower signal levels, particularly those involving microprocessors, has increased their susceptibility to interference, as the ratio between wanted and unwanted signals becomes increasingly unfavourable. When electronic circuits are subjected to interference, their performance may be degraded causing malfunction, or even catastrophic failure. The most common factors influencing electronic devices may be described as follows:

- Compared with tube-equipped instruments having mechanical switches, modern measuring and control technology incorporating microprocessors have had their signal and measuring levels decreased by one order of magnitude, while frequencies increased by a factor of 10. In addition, present process automation requirements dictate the use of commercially available microprocessors, which have to work impeccably - often online - under these hostile environmental conditions. The end is not yet in sight: newer devices will soon be appearing with still shrinking geometry and escalating sensitivity.
- Levels of interference are growing due to new technological developments.
- More and more plastic material is being used for case designs, increasing the tendency to expose vulnerable electronics to interference rich environments.

Further developments in microelectronic circuits will bring about a marked reduction in the interference thresholds. That is the reason why greater attention must be drawn towards the EMC behaviour of individual components and electronic systems.

National and international standardisation organisations have released or are still working on guidelines and recommendations to provide engineering with a greater harmonisation between EMC and electronic circuits and systems.

1.2. Definitions

- **Electromagnetic Compatibility (EMC)**
  Ability of a device to correctly function in its electromagnetic environment without introducing intolerable disturbances to that environment or to other equipment.

- **Coupling**
  Interaction between circuits, transferring energy from one circuit to another.

- **Electromagnetic Interference (EMI)**
  Electromagnetic disturbance which manifests itself in performance degradation, malfunction, or failure of electric or electronic equipment.

- **Immunity**
  Capability of a device, equipment or system to be unaffected by electromagnetic disturbances.

- **Surge**
  A transient wave of electric current, voltage or power in the circuit lasting from a few nanoseconds to several seconds.

- **Sink (victim)**
  An electronic equipment which causes a degradation, malfunction, or failure of electric or electronic equipment.

- **Susceptibility**
  The characteristic of electronic equipment to procedure an undesirable response when exposed to electromagnetic energy.

1.3. Sources of interference

Surges result from the redistribution of electromagnetic energy. Such redistributions and their most important sources are listed below.

- **Stationary and non-stationary transmitters**
  Both stationary high power radio transmitters and non-stationary walkie-talkies operating in the immediate vicinity of systems or equipment lead to uncontrolled electromagnetic irradiation into vulnerable electronic equipment.
  Parameters: narrow-band, continuous electromagnetic interference (modulated).

- **Electrical fast transients (burst)**
  Electromagnetic influences produced in the neighbourhood by rapid variation of voltage and current as a result of the abrupt change of a switch from a non- conductive to a fully conductive status or vice versa, e.g. switching inductive loads with mechanically moved contacts between which arcing occurs before they separate. Further examples are provided by arc-overs in the measuring and limiting spark gaps used in high voltage test facilities.
  Parameters: broad-band pulse interference, rise time of pulses of a few nanoseconds, small energy content and high repetition rate.

- **Atmospheric discharges, lightning and switching transients**
  Lightning and switching transients appearing in low voltage networks of industrial installations are the origin of pulse-cancelling interferences.
  Parameters: range of voltage some tens of kV, range of current some tens of kA, high-energy pulses with rise times in the microsecond range.

- **Breakdowns, power failures**
  Fuse blowing as the result of a short-circuit may affect equipment in the neighbourhood in the following way:

  a) power failure or voltage fluctuations of some milliseconds until fuse blows.

  b) whenever there is an abrupt break of the short-circuit current, an overvoltage of 2 or 3 times the nominal value with duration up to 1ms is generated.

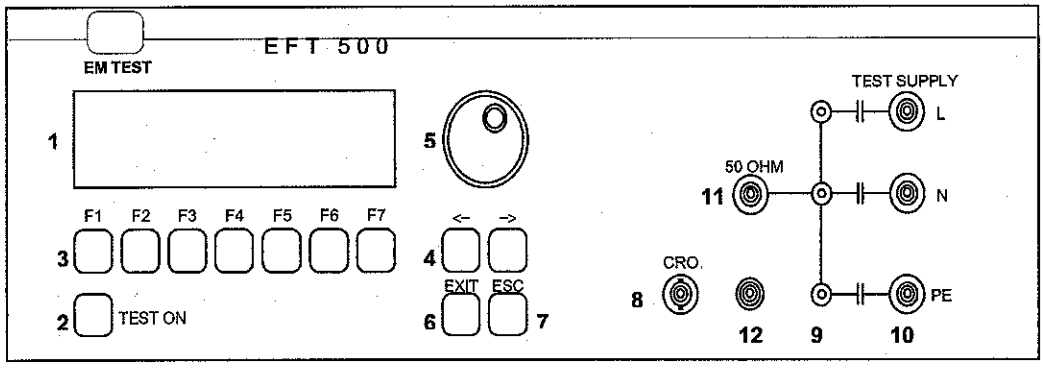
- **Harmonic frequency disturbances**
  Generation of harmonics takes place in most power equipments as a consequence of their reactive coupling.

- **Electrostatic discharge**
  Generation of an electrostatic charge is especially favoured by the combination of synthetic fabrics and dry atmosphere.
  There is a big variety in the charging process. A common situation is that an operator walks over a carpet and with each step loses electrons from his body to the fabric. Friction between the operators clothing and the chair can also produce an exchange of charges. The operators body may be charged either directly or by electrostatic induction; in the latter case a conducting carpet will not give protection unless the operator is adequately earthed to it.

  The effect of the operator discharge may be a simple malfunction of the equipment or damage of electronic components. The dominant effects can be attributed to the discharge current (< 100A) and voltage (< 30kV) with rise times in the nanosecond range.

2. Operating Functions

2.1. Front view



1	Display	**7**	Escape
2	"Test On"	**8**	CRO
3	Function keys "F1..F7"	**9**	Coupling mode
4	Cursor keys "←" and "→"	**10**	EUT test supply
5	Knob (Inc / Dec)	**11**	HV pulse output 50 ohm
6	Exit	**12**	Ground reference

1 Display
All functions and parameters are displayed (8 lines with max. 40 characters).

2 Test On
By pressing the key "Test On" the test procedure is initiated with the preselected parameters. The red LED indicates the trigger of a burst event.

3 Function keys "F1 .. F7"
Parameters and functions, displayed in the lowest line, can be selected with the related function key.

4 Cursor keys
Parameters and functions can be changed online. The selection of these parameters is realised with the cursor moving to the left or to the right.

5 Knob (Inc / Dec)
The knob increments or decrements test parameters with a numeric value or selects from a list of parameters.

6 Exit

Pressing of the Exit function will cause a reset of the firmware. This is only possible if no test routine is running.

7 ESC

When pressing the ESC button the user moves back one page in the menu.

8 BNC - CRO

At the BNC output the generator trigger can be checked, e.g. the burst duration, the burst repetition rate and the spike frequency (+15 V rectangular).

9 Coupling mode

The actual coupling mode is indicated by LED.

10 EUT test supply

For single-phase EUT the coupling / decoupling network is part of the generator. The EUT is powered via the safety banana plugs at the front panel of the simulator.

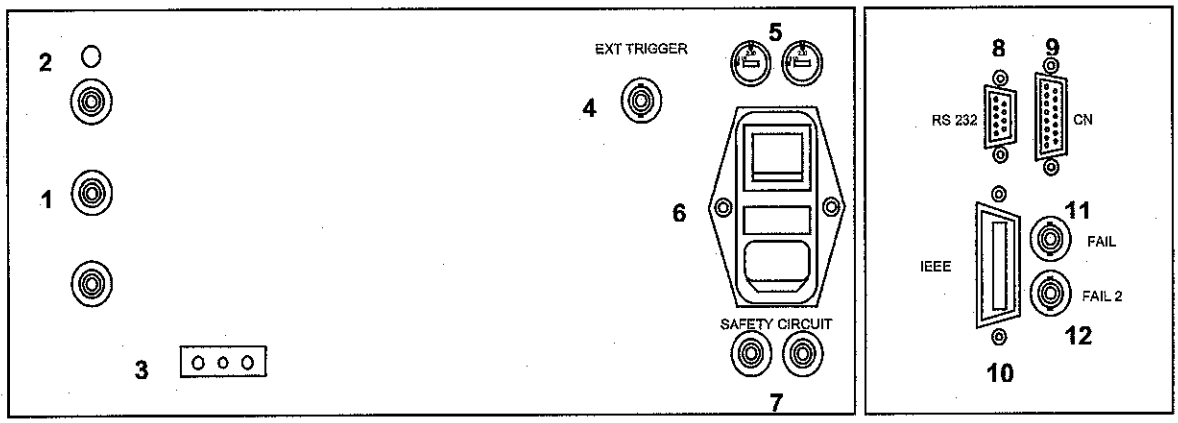
11 HV pulse output 50 ohm

External coupling devices such as the capacitive coupling clamp and the 3-phase coupling network are connected to the coaxial 50 ohm output. Also the calibration of the generator is handled at this output.

12 Ground reference

During test or calibration procedure the burst generator must be grounded at the reference ground plane.

2.2. Rear view



1 Test supply
2 Phase indication
3 Reference earth connection
4 External trigger
5 Mains selector 115V / 230V
6 Power on
7 Security circuit
8 Serial interface RS 232
9 Remote control connector
10 Parallel interface IEEE
11 Fail detection "Stop"
12 Fail detection "Pause"

1 Test supply
The power supply for the EUT is connected to the banana connectors L/ N/ PE. The input is decoupled by the coupling/ decoupling network incorporated in the generator mainframe.

2 Phase indication
The generator is synchronised to the line of the power supply connected at input L. To indicate that the phase is connected at this plug the lamp must be on.

3 Reference earth connection
The generator has to be connected to the reference earth plane of the test set up.

4 External trigger
One single burst can be released. Trigger level 5-15V positive going.

5 Mains selector
Selection of 115V / 230V

6 Power on switch
The switch is part of the mains filter. Mains fuses are part of the filter. 230V / 1A and 115V / 2A

7 Security circuit
Connector for external security circuit.

8 Serial interface
RS 232 interface with a 9-pole connector.

9 Remote control connector
External coupling devices are controlled via this remote control connector.

10 Parallel interface IEEE
IEEE 488 interface with IEEE connector.

11 Fail detection FAIL 1 (TEST STOP)
The BNC input FAIL 1 can be used for failure detection at the EUT. If the input is set to ground (chassis) the burst generator will be stopped and the actual test routine is finished. It is not possible to continue this test routine.
A complete restart of the routine is necessary.
A message of FAIL 1 is indicated in the LCD display as well as in the ISM software.

12 Fail detection FAIL 2 (TEST PAUSE)
The BNC input FAIL 2 can be used for failure detection at the EUT. If the input is set to ground (chassis) the actual test routine is paused as long as the low level signal is available at the FAIL 2 input.
Without the low level signal the test procedure continues automatically.
A message of FAIL 2 is indicated in the LCD display as well as in the ISM software.

3. Operation

3.1. Description of the menus

The simulator is handled by an easy menu control system. Seven function keys are available to select parameters and functions. The selected parameters can be changed by turning the knob (incr/decr), the digit to be changed can be selected with the cursor.
Esc will bring you one page back in the menu and Exit will reset the firmware to the beginning.

Esc will bring you one page back in the menu and Exit will reset the firmware to the beginning.

All functions are indicated on the display; max. 8 lines and 40 characters.

Start up display
EM TEST ident Name of the simulator Version- and serial no.

The serial number and the version number SWN are used for traceability reasons. These numbers are listed in the test reports and calibration certificates. These numbers also are listed within the test reports generated by the IEC WIN software.

Page 1 (Main menu)

MAIN MENU
F1 : Quick Start
F2 : User test routines
F3 : Test routines acc. to IEC 1000-4-4 / 61000-4-4
F7 : Service

F1 F2 F3 F4 F5 F6 F7

F1 Quick Start
Easy and fast operation of the equipment without special functions (memory).

F2 User test routines
The user can save and recall his own specific test routines. He can select standard routines or special functions such as automatic change of voltage or frequency during a test routine.

F3 Test routines as per IEC 61000-4-4 (prior: IEC 1000-4-4)
The user can call up the standard routines as per to IEC 1000-4-4, level 1 - 5 and start them immediately.

F7 Service
Set-up, self-test, addresses of EM Test can be selected and displayed.

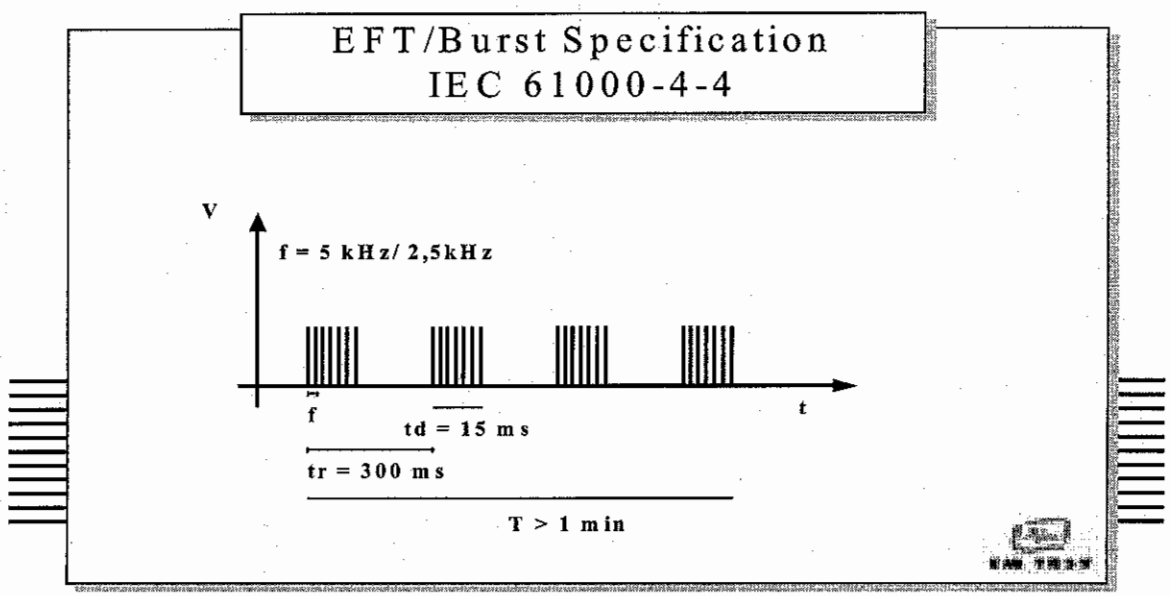
3.2. Quick Start

Easy and very fast operation of all standard functions of the equipment. The last simulator settings are stored automatically and will be recalled when Quick Start is next selected.

Page 2 (Show parameters)

QUICK START						
V	=	2000V	f	=	5.0kHz	
td	=	15.0ms	tr	=	300ms	
kop	=	L N PE	+/-	=	+	
T	=	5:00min				
START		CHANGE				PRINT
F1		**F2**	**F3**	**F4**	**F5**	**F6**	**F7**

Press **START** and the test routines begin to work.
Press **CHANGE** and the actual parameter can be changed.
PRINT will cause a hard copy of the set-up via the serial interface RS 232.



Page 3 (Change)

QUICKSTART							
Voltage		V	:	200V	-	4400V	
Frequency		f	:	0.1kHz	-	1000.0kHz	
Duration		td	:	0.1ms	-	999.9ms	
Repetition		tr	:	10ms	-	9999ms	
Test time		T	:	0:01min	-	99:59min	
U	f	td		tr	kop	+/-	T
200	5.0	15.0		300	L N PE	+	5:00
F1	**F2**	**F3**		**F4**	**F5**	**F6**	**F7**

The user can select the parameter with the related function key and change the value with the knob. The cursor allows the user to define the value of the digit to be changed (fast or slow change).

Pressing of the Esc button will bring the user back to the previous level from where the test can be restarted with new levels.

After restart the actual test time is displayed. All function keys except F2 (manual trigger) can stop the test routine. The latest setting will be displayed.

Any pressing of a function key will indicate the functions START, CHANGE, CONTINUE or PRINT. F3 will continue the same test routine. Also the test time will continue running. If the user first selects START, CHANGE or PRINT the test will be stopped completely.

The blinking value can be changed with the knob inc/dec. To select other values use the cursor keys.

Print prints the settings of the actual menu.

3.3. User test routines

The user can save his own specific test routines, recall and change them. All special functions and routines are stored in this part of the user menu.

Page 2 (Selection of the function)

USER TEST ROUTINES	page 1 / 2
F1 : Customised test routines	
F2 : Voltage change after T by ΔV	
F3 : Frequency change after T by Δf	
F4 : Frequency sweep in one single burst	
	Page 2

F1 F2 F3 F4 F5 F6 F7

USER TEST ROUTINES	page 2 / 2
F1 : Change duration after T by Δtd	
F2 : Change polarity after T	
F3 : Statistical burst release	
F4 : Synchronised at fixed angle	
	Page 1

F1 F2 F3 F4 F5 F6 F7

Each of these special functions can include 7 stored test routines.

Page 3 (Select store)

CUSTOMISED TEST ROUTINES	
F1 : Store F1	F5 : Store F5
F2 : Store F2	F6 : Store F6
F3 : Store F3	F7 : Store F7
F4 : Store F4	

F1 F2 F3 F4 F5 F6 F7

After selection of a stored test file the test parameters will be indicated on the display.

Page 4 (Show parameters)

CUSTOMISED TEST ROUTINES						Store F1
V	=	2000V	f	=	5.0kHz	
td	=	10.0ms	tr	=	200ms	
kop	=	L N PE	+/-	=	+	
T	=	2:00min				
START	CHANGE		SAVE			PRINT
F1	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**

All functions are the same as under Quick Start. The function SAVE will store the new parameter of a test file.

Page 5 (Save)

CUSTOMISED TEST ROUTINES	Store F1
Save in store ?	
F1 : Store F1	
F7 : Store F7	
F1 **F2** **F3** **F4** **F5** **F6** **F7**	

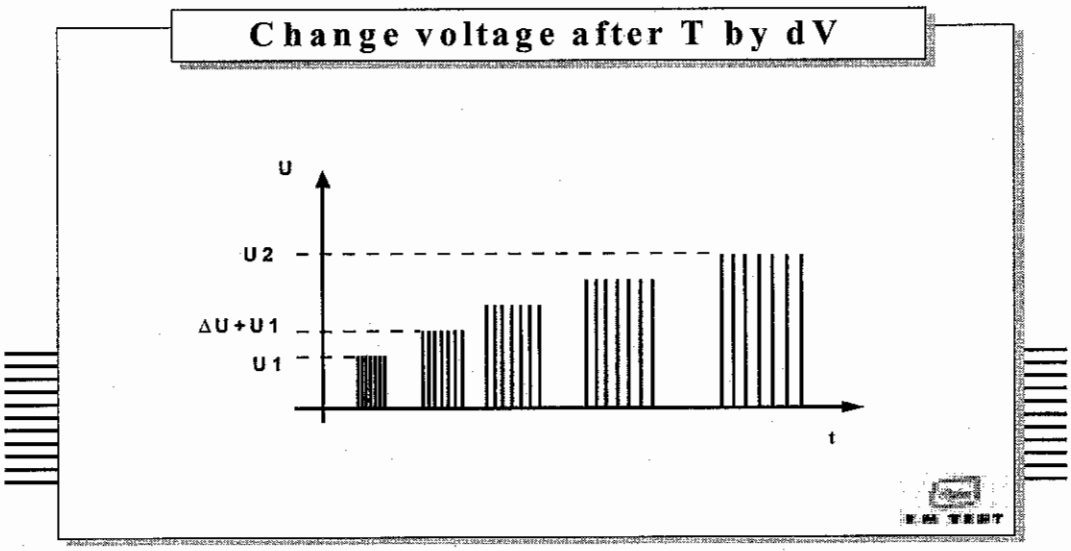
The user has to define a store. If there exists a saved test file the software will ask to overwrite the existing procedure or not.

Customised test routines

The software controls standard test routines according to the specification of the user. All limitations are the same as defined under Quick Start.

Voltage change after T by ΔV

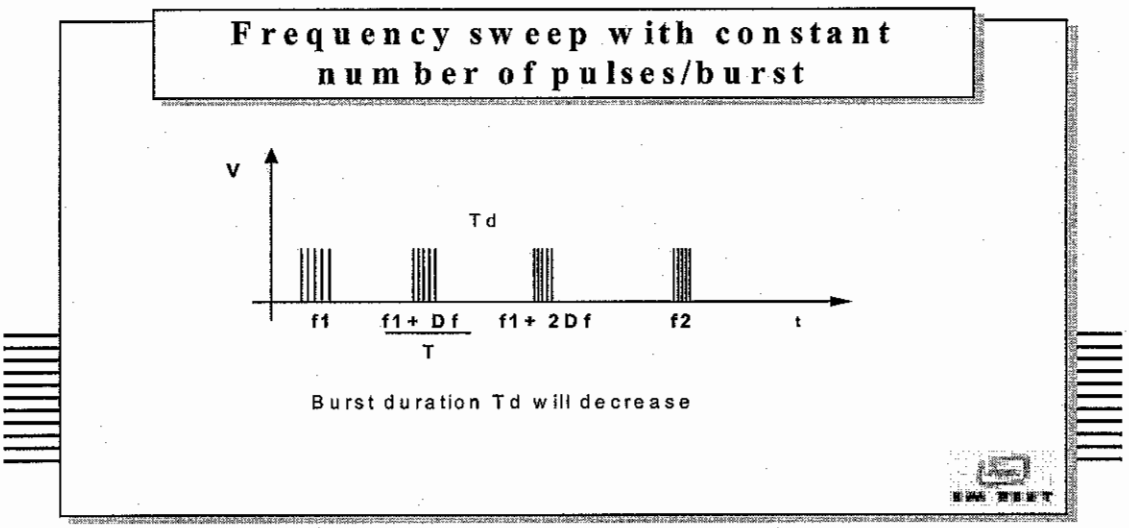
The test voltage is increased from V1 to V2 by steps of ΔV after the defined test time T. All limitations are the same as defined under Quick Start. The limitation of the max. generated number of spikes is related to the higher voltage of V1 or V2.



Frequency sweep with constant pulse numbers

The spike frequency is changed from f1 to f2. After the preselected test time T the frequency is changed by Δf until f2 is reached.

The same parameters as under Quick Start can be selected. For the limitation of the max. admissible number of pulses the higher frequency of f1 and f2 is valid. The number of pulses per burst will be held constant. This means for higher frequencies the burst duration will be reduced.

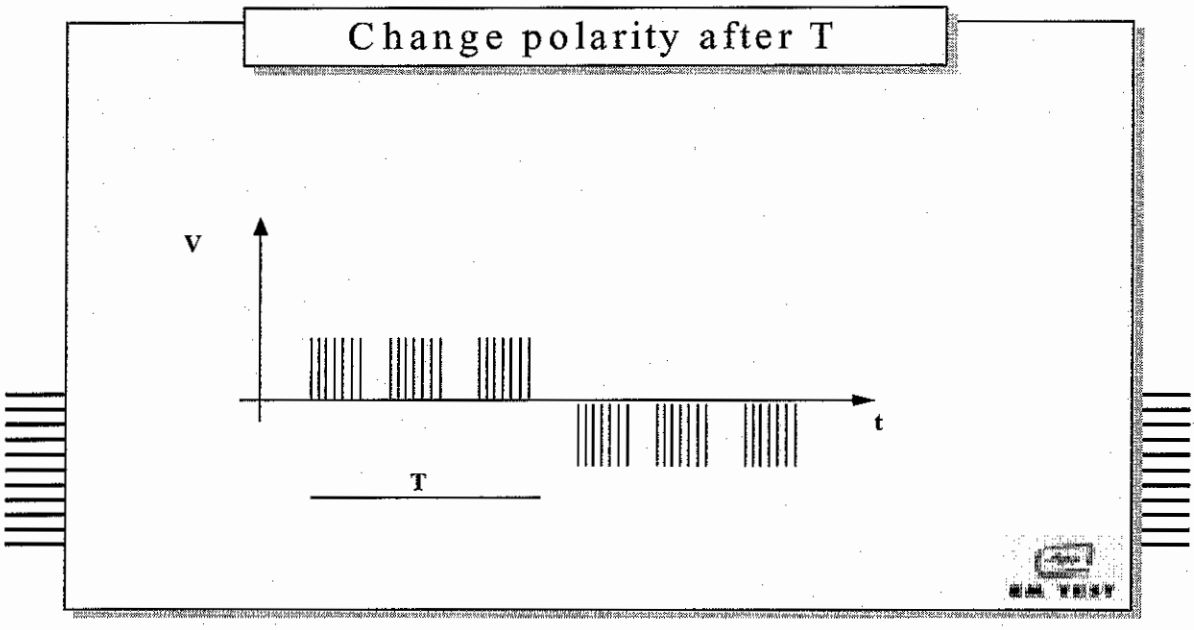


Frequency sweep in one single burst
During one single burst the frequency sweeps from f1 to f2. For is function the following limitations have to be respected:

tr	>=	100ms
f1	<=	f2
td	>=	5.0ms
td	>=	5 / f1
tr -td	>=	50ms

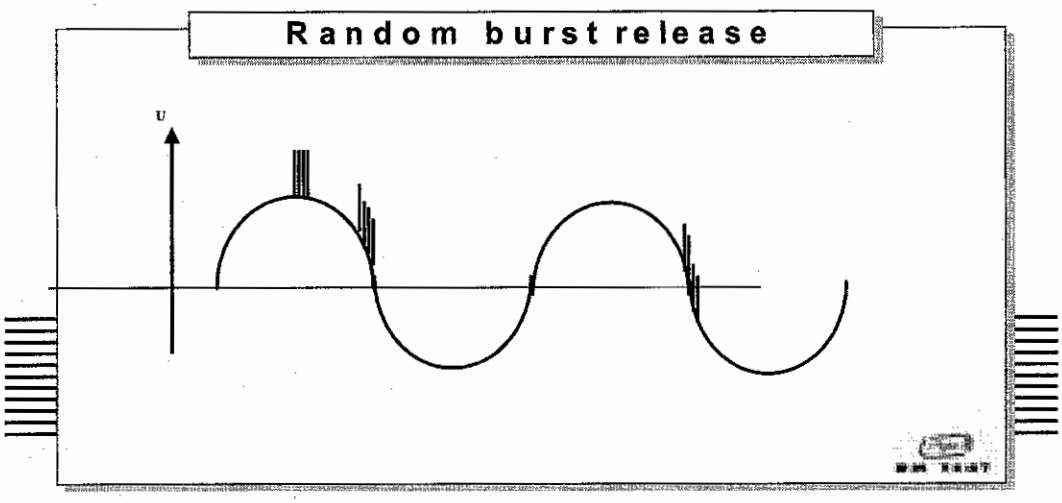
Change burst duration after T by Δtd
The burst duration is increased from td1 to td2 by steps of Δtd after the defined test time T. All limitations are the same as defined under Quick Start. The limitation of the max. generated number of spikes is related to the higher duration of td1 or td2.

Change polarity after T
After the defined test time T, the test will be repeated with the other polarity for the same test time T.



Random burst release

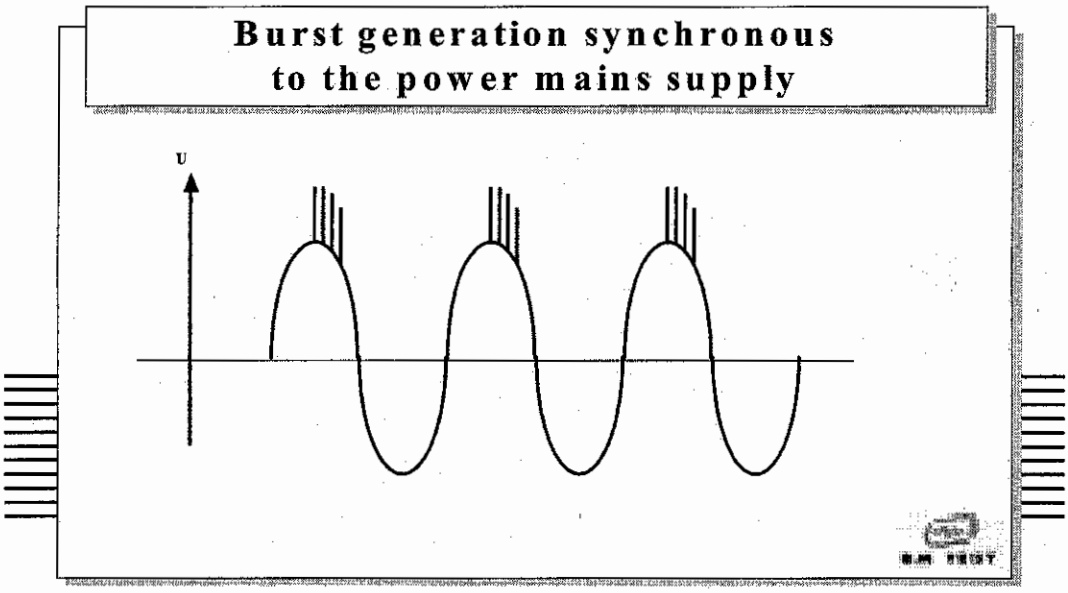
No repetition rate is selected. The single burst will be triggered by randomly in the limits of 20 to 2000ms as time between two bursts. All limitations are the same as defined under Quick Start.



Synchronised with a fixed phase angle ***

The burst is triggered with respect to the phase angle of the power supply connected to L input at the rear panel of the equipment. The power supply must be an AC voltage with a nominal frequency of 16 to 500Hz. The phase must be connected to L. This can be checked by the lamp connected to the L input.

*** To guarantee full function of the synchronisation to the EUT power supply the phase must be connected to the L input at the rear part of the simulator. Optical control by the related lamp.



3.4. Test routine as per to IEC 1000-4-4

The display shows a list of test levels acc. to the standards IEC 1000-4-4.

Page 2 (Standard test levels)

TEST ROUTINES				IEC 1000-4-4
F1	:	Level 1 250V	/	5.0kHz
F2	:	Level 2 500V	/	5.0kHz
F3	:	Level 3 1000V	/	5.0kHz
F4	:	Level 4 2000V	/	5.0kHz
F5	:	Level 5 4000V	/	2.5kHz
F6	:	Level X - Level Y		

F1 F2 F3 F4 F5 F6 F7

With the function keys the desired level can be selected.
The function key F6 selects a procedure which starts at test level X and stops at test level Y. The test level is changed automatically after the preselected test time T. (X <= Y)

Page 3 (Show values)

Standard IEC 1000-4-4					Level 3
V	=	2000V	f	:	5kHz
td	=	15ms	tr	:	300ms
kop	=	L N PE	+/-	:	+
T	=	1:00min			
START	CHANGE				

F1 F2 F3 F4 F5 F6 F7

The functions START, CHANGE and PRINT are the same as defined under Quick Start. The function key CHANGE can only handle the coupling, polarity and the test time. All other parameters are defined by the standard.

3.5. Service

All service functions are indicated on the display.

Page 2 (Overview service)

SERVICE
F1 : Addresses
F2 : Self-test
F3 : Set-up
F4 : Change standard levels
F5 : Print all

F1 F2 F3 F4 F5 F6 F7

F1 Addresses
All important data regarding EM TEST and the official sales agencies can be listed.

F2 Self-test
With the assistance of the software the operator can test some parts of the equipment. The software will clearly explain the self-test procedure.

F3 Set-up
The software will clearly explain the set-up procedure.

F4 Change standard levels
Future product family or dedicated product standards may use other test levels or test parameters. This procedure allows the user to change the standard values to his actual requirements.

F5 Print all
With this all settings can be printed.

3.6. Set-up

This menu helps the user to define the configuration of the EFT 500.

Page 3 (Set-up overview)

SET-UP
F1 : Change language
F2 : LCD backlighting
F3 : Interfaces
F4 : Keyboard beeper
F5 : Running time meter
F6 : Safety circuit

F1 F2 F3 F4 F5 F6 F7

F1 Change language
The user can chose between two languages, German and English.

F2 LCD backlighting
With the use of F2 the backlighting can be switched on or off. Additionally the Auto Off function can be programmed to switch off the backlighting after a defined time that the equipment has not been in operation (1 - 30min). Because of the limited lifetime of LCD displays, approx. 10,000h this function should always be activated.

F3 Interfaces
This menu will help the user to define the status of the integrated serial and parallel interfaces, e.g. the baudrate of the RS 232 or the address of the IEEE interface.

F4 Keyboard beeper
F1 is the selector for the beeper ON/OFF mode.
The beeper is always on when a test routine is finished. To indicate that a running test is finished the beeper sounds 3 times.

F5 Running time meter
Pressing of F5 will show the total operating time of the test equipment.

F6 Safety circuit
F6 shows the state of the safety circuit. It can be switched on and off.

4. Putting into Operation

4.1. Security Aspects

See the safety instructions at the beginning of the instruction manual.

4.2. Immunity Tests Burst, using PC's

During immunity tests high frequency interferences are generated which are mostly conducted.
Due to the length of the connected lines, their impedance and the physical layout a certain part of this energy will be transformed into radiated interference.

Therefore the operator shall be aware that systems and installations in the neighbourhood, even those not being part of the test set-up can be disturbed.

Especially for fully automated test systems, where simple pc's may be used, EMC problems within the test system may occur. To avoid such disturbances in the following paragraphs some information is given to which the operator has to taken care:

- EM TEST test generators are tested with the maximum test level. If no demage has been occured the equipment must be seen as immune.
- The interference always will enter into a system at the weakest part. Within a pc controlled system the weakest unit is almost the pc with its interconnection lines and the peripheral equipments.
- The most critical test concerning the above mentioned problems is the burst test according to IEC 1000-4-4. This is a high frequency test, which may radiate extreme interference fields to the environment.

Concerning the test set-up the following points be explained:

1. The burst generator must be connected very good to the ground reference plane on the table.
2. The ground reference plane shall be connected to the protective earth system. For tests within a shielded room the connection shall be made to the walls of the room.
3. The test set-up shall have one single ground reference point (not several)

GROUND LOOPS SHALL BE STRICTLY AVOIDED

4. The central ground reference point shall be located where the EFT generator is connected to the ground reference plane. At the same point the reference ground plane shall be connected to the protective earth system or to the shielded room.

For conducting the test the following points shall be taken under consideration:

1. It is not allowed to touch the EUT or the cables under test during a running test. The test results will be influenced and are no more reproducable.

2. If the operator in contrary touches directly the EUT or the connected lines increased radiation from the test set-up is generated. The operator itself will radiate and/or will cause ground currents into the whole environment.

3. As larger the dimensions of an EUT are, as higher the radiation of high frequency energy will be.

4. Especially the capacitive coupling clamp with its lenght of 1m radiates.

5. Auxilary equipment as well as pc'can be influenced directly due to the radiation.

Remarks:
Even the use of fiberoptic links for the communication between pc and EFT does not help in case of direct radiation. The pc and ist lines will be directly influenced and the data transmission will be dirsurbed.

6. The influece of direct radiation can be reduced by increasing the distance between pc and test set-up. In any case a minimum distance of 3m shall be available.
   It is not only the length of the cable but also the physial distance between pc and test set-up which is important to take care to.

7. It is shall be strictly avoided to put the pc directly into the ground reference plane of the test set-up. The pc than is part of the test set-up and will also tested. Mostly all pc are not immune to this test and will be disturbed.

What to say about the PC:

1. Do not use oldest equipment available in your company. Latest pc's shows better behaviour to what EMC concerns.
2. EM TEST is selling special EMC hardened pc's, which are designed for this test applications. Please ask your responsable sales partner for more information.
3. **Do not use notebooks for this application. Notebooks are fully manufactured within a plastic housing and therefore are very sensitive to all interfernces.**
4. It would be better to use tower- or mini-tower equipment. They are at least patially screened. The interface connectors are mounted on metallic surfaces so that the screen of the communication lines can be connected to the chassis.
5. The screens of the RS 232 and IEEE cables must be connected to the chassis of the instruments at both sides, pcö and EFT.
6. **The communication cables, RS 232 and IEEE, shall be screened. Do not use standard cables, consumer products with plastic connectors.**
   These cable types are using mostly very bad designed cable screens. The contact to the housing of the connector is mostly realized with a small cable, which is very bad under the aspect of hf screening.
   Please take care that the screen is connected very good to the metallic housing of the connector and that the connector is screwed to the housing of the generator.
   This mostly is the problem when using the RS 232 interface. Especially those cables are badly designed. For IEEE cables very good products are available (e.g. HP).
7. The weakest parts within the pc system are the peripherals, as keyboard and mouse. Both equipments are badly designed under the aspect of EMC.

It is very easy to make the design better. The operator would be able to do it for himself.

What is the problem ?
The screen of the cables between pc and keyboard (mouse) are soldered direclty to the printed circuit board.
The screen shall not be soldered to the print, but ot another „ground reference plane".

e.g. put into the keyboard, directly under the keyboard print a broad copper foil area. Connect the screen of the cable to this copper foil, without any connection to the print. You will see a dramatic change to better results.

4.3. Generator function check

As with all other measuring equipment, the function of the generator should be checked from time to time.

The test procedure is as follows:

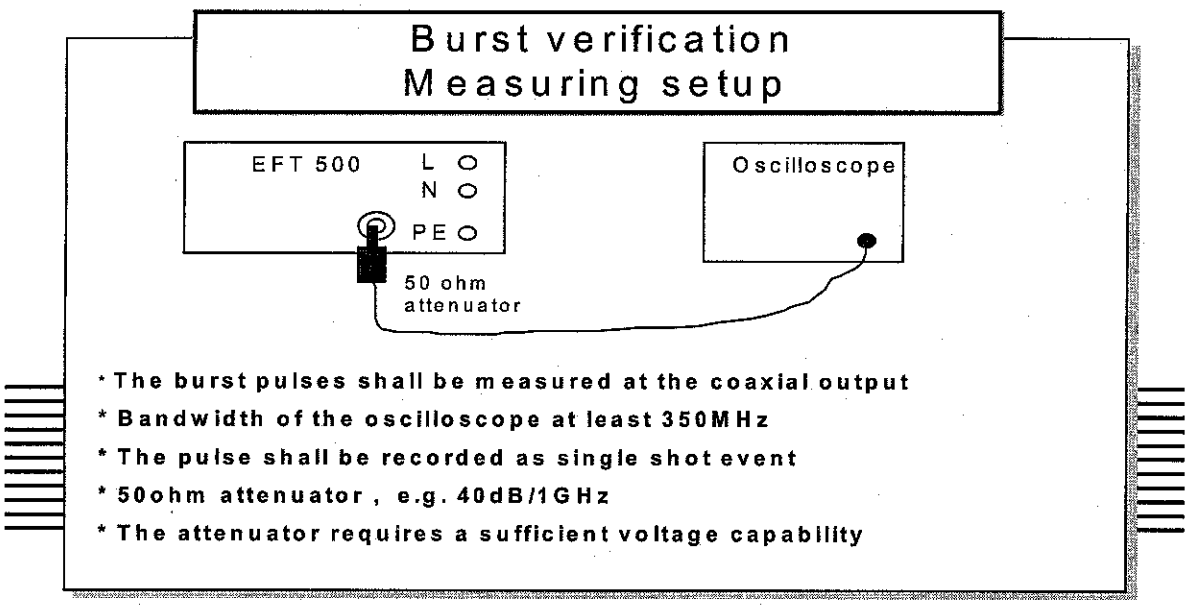
- Switch on power supply.
- Preselect the mode "Quick Start"
- Preselect test parameters:

Test voltage	:	2000V
Frequency	:	5kHz
Burst duration	:	15ms
Burst rate	:	300ms
Polarity	:	+
Coupling	:	/

- Press button Test On and start the test.

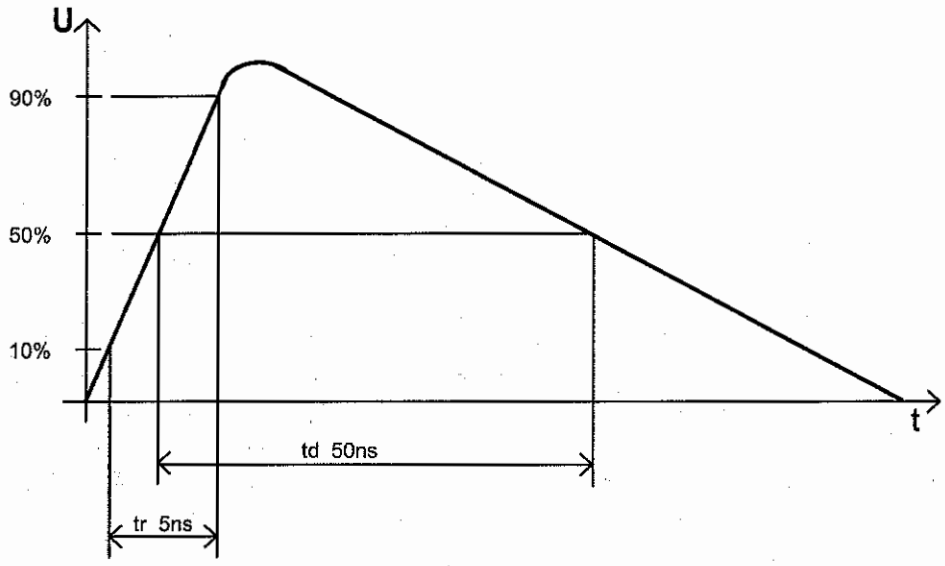
The user can also select one of the standard settings as per IEC 1000-4-4 . At the coaxial output "CRO" the trigger of the simulator can be checked, e.g. spike frequency, burst duration and burst repetition rate.

For the measurement of single spikes, a minimum bandwidth of 350MHz and a memory scope is absolutely necessary.



- During the verification at the coaxial output the coupling mode shall be in position /
- Switch on the test procedure by pushing the TEST ON key
- Start the test by pushing finction key F1 „START“
- Record the single pulse and verify the pulse parameters

Burst - Single Spike at V = 2000V (example)

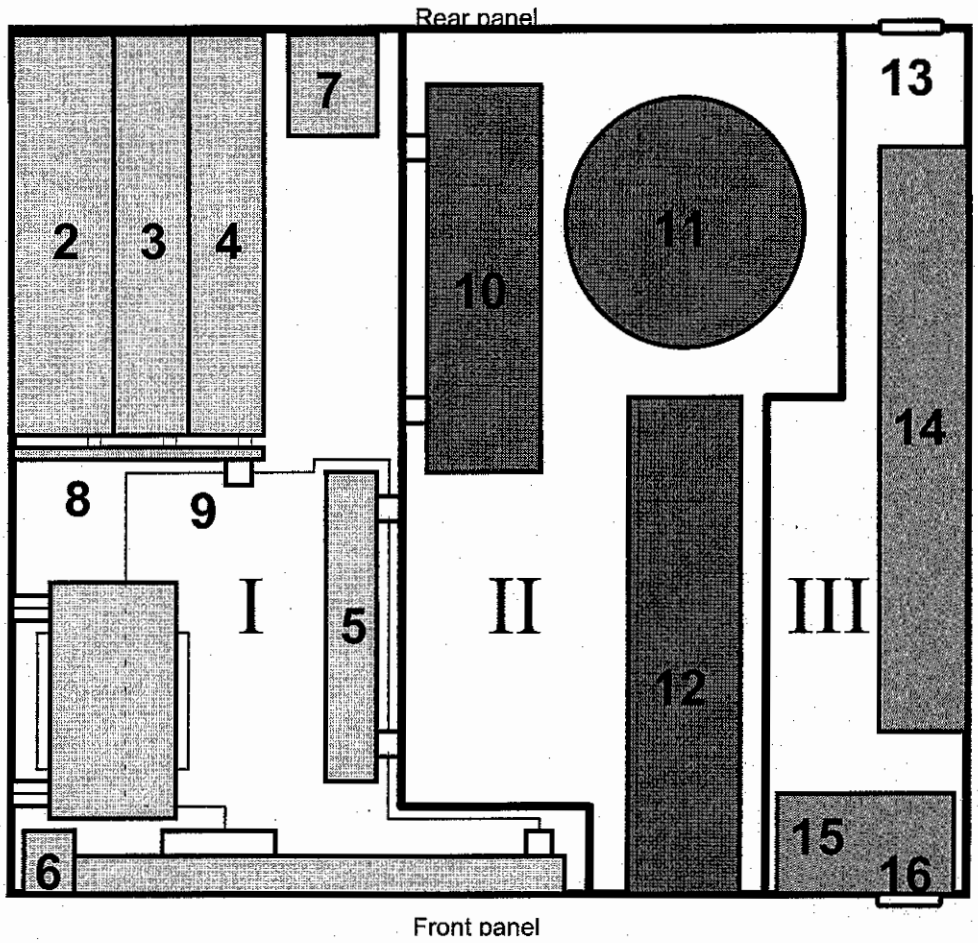


Measuring	**50 Ω**		**> 1000 Ω**	
U	5V	+/-10%	20V	+/-10%
tr 10/90%	5ns	+/-10%	5ns	+/-10%
td 50/50%	50ns	+/-30%	50ns	+/-30%

5. Test Equipment EFT 500

5.1. Construction

The EFT 500 burst generator is divided into three main parts. The control unit is completely separated and decoupled from the high voltage part.



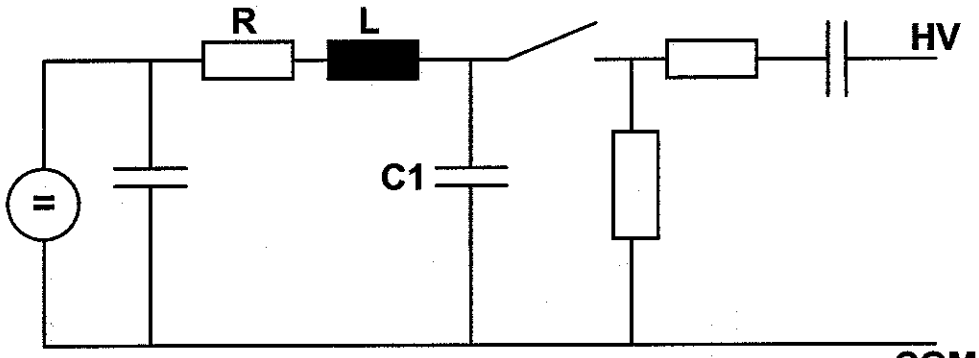
I	**Control unit**		
1	Transformer	6	Keyboard / LCD display
2	Power supply	7	Power supply filter
3	Interface board	8	Connection board
4	Processor board	9	Flat band cable to front panel
5	Filter board		
II	**High voltage unit**		
10	High voltage power supply	12	Pulse forming unit
11	Energy storage capacitor		
III	**Coupling/ decoupling network**		
13	Test supply input	15	Coupling
14	Decoupling impedance	16	EUT test supply

5.2. Control unit

The control part includes the processing unit and the driver electronics for the high voltage part. All signals coming from and going to the processing part are decoupled.

5.3. High voltage unit

The high voltage part includes the high voltage power supply and the complete pulse forming part. The complete high voltage part is floating.



General diagram of the pulse unit

The pulse capacitor C1 is charged from the storage capacitor and will be discharged into the pulse forming network as soon as the specified voltage level is reached.

The discharge switch is a highly reproducible semiconductor switch.
Spike frequencies up to 1000kHz are by a factor of 200 higher than recommended in the actual EFT standards. This means of course that also the pulse energy would be 200 times higher. This is not generally possible for the high voltage switch. Therefore the following limitation is realised to protect the pulse forming circuit against overload:

Voltage U	**max. pulse / burst** **td * f**	**max. pulse / s** **td * f / tr**
< 1'500V	1,000	10,000
>= 1'500V < 2'500V	1,000	linear decrease to 5,000
>= 2'500V	linear decrease to 500	linear decrease to 1,500

5.4. Coupling network

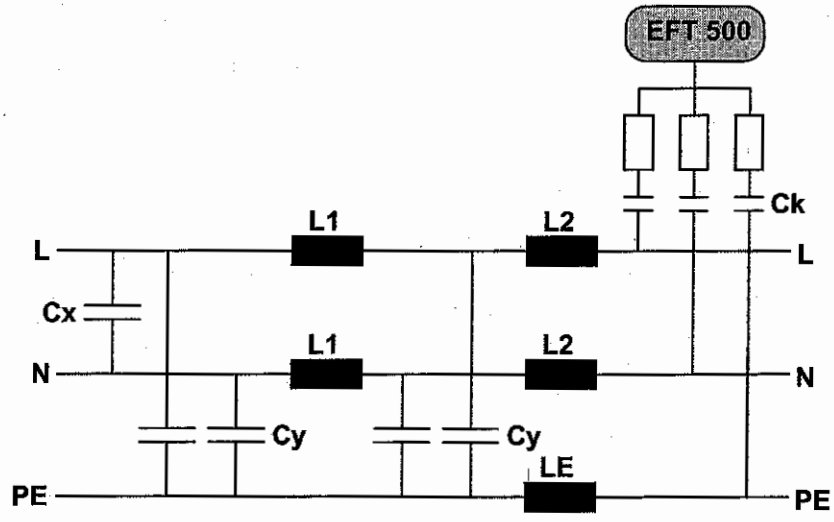
The coupling network has to couple the interference pulses to the lines of a power supply system (AC or DC). As coupling devices 33nF capacitors of sufficient strength and bandwidth shall be used.

The burst generator EFT 500 has an integrated coupling network in accordance with IEC 1000-4-4. It must be possible to test with different coupling modes:

- Normal Mode	Line	=>	GND
	Neutral	=>	GND
- Common Mode	Line + Neutral	=>	GND
- Protective Earth PE	The PE of the EUT is decoupled from the power supply side by a choke. The interference source is coupled directly to the PE of the EUT.		

The decoupling part of the coupling network has two purposes:

- to filter the interference pulses in the direction of the power supply side;
- to protect other systems that are connected to the same power supply and
- to realise a high impedance of the power supply, e.g. battery supply.



Coupling network acc. to IEC 1000-4-4 (prior: IEC 801-4)

The coupling on signal lines can usually not be effected capacitively without interfering with the signal flow. It is often impossible to contact the required circuit (direct), e. g. coaxial or shielded cables. In this case the coupling is realised with the capacitive coupling clamp. The interference simulator can be connected on both sides of the coupling clamp.

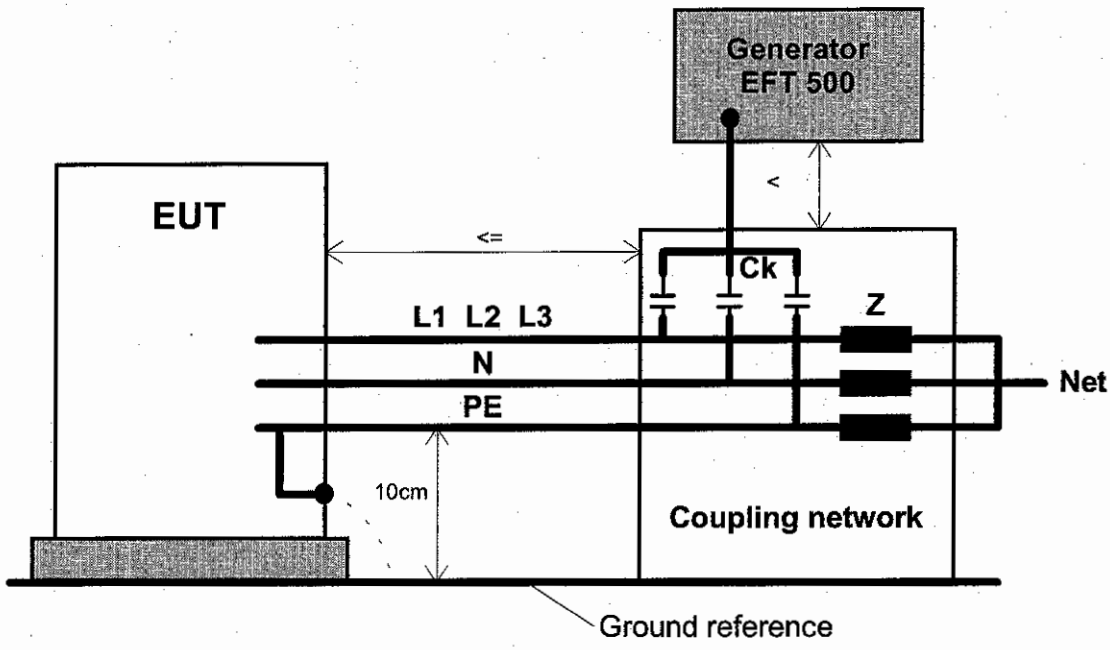
Following hints are important

- The test generator and the coupling network should be connected to the reference ground plane (acc. to high frequency requirements).

- The equipment under test must be isolated from the reference ground plane. The distance should be 10cm. Being part of the EUT, these requirements are also recommended for all connected lines. The EUT should only be grounded if this is recommended by the installation guideline. For safety reasons, the test without any ground connection should be conducted as well (at 100MHz 1m ground cable has an impedance of about 600 ohm)

- Whenever possible the test set-up and the cabling should always be the same; e.g. for testing power lines it would be possible to fix the cables on the test table for all tests in the same way.

- Lines under test and all other lines should be decoupled strictly.



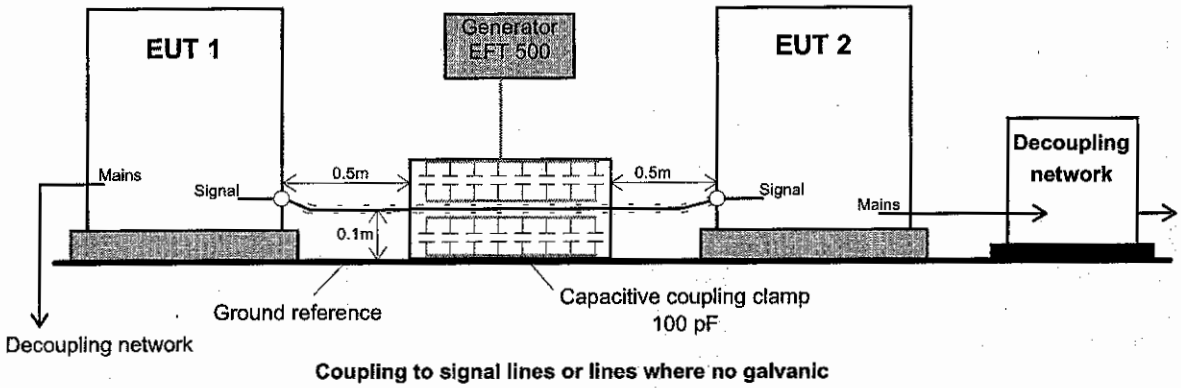
Coupling to power supply lines

Tests with the capacitive coupling clamp

- The coupling clamp is not matched by 50 ohm. If the clamp is matched there exists an additional magnetic coupling, which may cause completely different test results.

- The clamp should be placed in a distance of 0.5m to the equipment under test. When using shorter distances, the EUT may be influenced by radiation.

- If the EUT is built up by two different equipments, the test should be conducted on each single equipment with the required distance.



Coupling to signal lines or lines where no galvanic contact is possible (e.g. shielded lines)

6. Technical Data

6.1. Pulse forming unit

Open circuit	U = 200V - 4400V	± 10 %
at 50 ohm	U = 100V - 2200V	± 10 %
Waveshape	5/50ns	± 30%
Source impedance	Zq = 50 Ω	± 20%
Polarity	positive / negative	

6.2. Trigger

Automatic	Automatic repetition of bursts
Manual	Manual trigger of one single burst
External	External trigger of one single burst
Synchronisation	0° - 360° (16 - 500Hz) resolution 1°

6.3. Burst impulses

Burst duration	td = 0.1ms - 999.9ms
Burst repetition rate	tr = 10 ms - 9,999ms/man
	tr ≤ 9,999ms ⇒ Auto Trigger
	tr > 9,999ms ⇒ Man Trigger
Spike frequency	f = 0.1kHz - 1000kHz
Test time	T = 0:01min - 99:59min / T > 99:59min - ∞

6.4. Output

Direct	via HV coaxial connector 50 Ω
Coupling network	to L, N, PE, all coupling modes possible
EUT supply AC	250V / 16A / 50/60 Hz
EUT supply DC	250V / 10A
CRO Trigger	15V rectangular trigger signal

6.5. Test routines

Quickstart	Immediate start, all parameters can be changed on line
Customised routines	1. Specific customer routines 2. Voltage change after T by ΔV 3. Frequency change after T by Δf 4. Frequency sweep during one burst 5. Change duration after T by Δtd 6. Change polarity after T 7. Random trigger of bursts 8. Synchronised trigger of bursts at a defined phase angle
Standard test routines	1. IEC 1000-4-4 level 1 - 4 2. Automatic from level X to level Y
Service	Customised routines, set-up

6.6. General data

Dimensions	19" / 3 HE
Weight	approx. 8kg
Power supply	230V +10/-15% 50/60Hz (optional 115V)
Fuses	2 x T 1A

=>> Non compulsory specification may subject to change <<=

7. Maintenance

7.1. General

The generator is absolutely maintenance-free by using a solid state semiconductor switch to generate the fast transients.

7.2. Limiting values

The limiting repetition rate as per IEC 1000-4-4 of a burst sequence of

5kHz	at	U	<=	2kV
2.5kHz	at	U	>	2kV

is much higher with the burst generator type EFT 500.

7.3. Coupling network

- Due to the various national safety instructions the coupling network has no ON/OFF key as well as no internal fuse protection. The EUT must be fused by the user.
- Special supply adapters with switch and fuse protection are available but must be specified by the user.
- Special supply cables are included as basic equipment.

8. Delivery Groups

8.1. Basic equipment

- Burst generator type EFT 500
- Mains cable
- Mains cable for the EUT supply
- Adapter for power cable
- Manual

8.2. Accessories and options

- 50 Ω matching resistor (1:100)

- 6dB / 50 Ω attenuator

- Capacitive coupling clamp acc. to IEC 1000-4-4 (prior: IEC 801-4)

- External 3-phase coupling network CNE 503 with

Line voltage	max. 440V AC ±10% (line to line)
Line current	max. 16A / 25A / 32A / 40A
Frequency	50Hz / 60Hz
Coupling	L1 / L2 / L3 / N / PE all coupling modes

  The coupling will be controlled by the generator EFT 500

- User software "WIN_ISM"
  Test, analysis and documentation with windows (see separate documentation)

- External coupling matrix for burst and surge (1000-4-4 and 1000-4-5)

1-phase CNI 501

Line voltage	250V max.
Line current	IN = 16A / 25A
Frequency	50 / 60 z
Coupling	EFT and VCS

3-phase CNI 503

Line voltage	440V max.
Line current	IN = 16A / 25A /32A / 100A
Frequency	50 / 60Hz
Coupling	EFT and VCS

- ITP Immunity test probes

9. Remote Control

9.1. Interfaces

All following interfaces are standard features of the EFT 500.

Serial RS 232 interface with 1,200 - 19,200 Baud

(8-databit, 1 start/stop bit)

25- Pin SubD PC / Printer	Signal		Signal	9- Pin SubD EFT 500
2	TxD	----	RxD	3
3	RxD	----	TxD	2
7	GND	----	GND	5
	Shield		Shield	

Parallel IEEE 488 interface, addresses 1 - 31 selectable

- Command: (SH1, AH1, T4, L2, SR1, RL2, PP1, DC0, DT0, C0, E1)
- Connector and pin layout acc. to IEEE - 488 - 1975
- 24-pin Amphenol connector
- 8 ground pins

Equipment interface

The parallel equipment interface controls the external coupling networks.

Printer

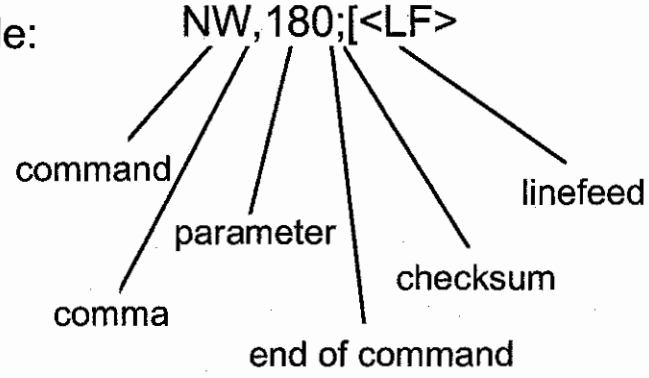
The printer may be connected over the serial RS 232 interface.

9.2. General information

The commands must be closed by an <LF>. Just before the <LF> the check sum of the complete string must be transmitted.

Calculating : check sum = 100_H - (sum of all ASCII codes in one byte)

Example: NW,180;[<LF>



	ASCII Hex
N	$4E_H$
W	57_H
,	$2C_H$
1	31_H
8	38_H
0	30_H
;	$3B_H$
SUMME	$1A5_H$

=>

in Byte
$A5_H$

=>

100_H - Byte
100_H-$A5_H$=$5B_H$

=>

Check-Sum
[

Remark: sum of all ASCII codes in one byte: Only the last 2 Digits of the sum of all ASCII codes in HEX wil be considered.

- The messages coming back from the EFT are sent without check sum. At the end of the message there is also an <LF>.

9.3. Parameter of the remote commands

Name	Descript.	Min - Max.	Step	Unit	Parameter
Voltage	U, U1, U2, ΔU	200 - 4400 20 - 4200	20 20	V V	200 - 4400 20 - 4200
Frequency	f, f1, f2, Δf	0.1 - 10 10 - 100 100 - 250 250 - 1000	0.1 1 10 50	kHz	1 - 10000
Duration	td, td1, td2, Δtd	0.1 - 999.9	0.1	ms	1 - 9999
Repetition	tr	10 - 9999 manual	1	ms	10 - 9999 10000
Coupling **INT** **CNI 1 Ph** **CNI 3 Ph**	cop	 /,L,N,PE /, 50Ω, L,N,PE /, 50Ω ,L1, L2,L3,N,PE all combinations			 0 - 7 8 - 16 17 - 49
Polarity	pol	+,-		-	0 - 1
Test time	T	0:01 - 99:59 endless	0:01	min	1 - 5999 6000
Angle	W, ΔW	0 - 360	1	°	0 - 360

Note
The coupling modes are controlled binary. L resp. L1 is the LSB and PE the MSB.

For the parameters U, f, td and tr please keep to care to the limitations of the EFT 500. Otherwise the parameters will be limited as follows:

U : no change
td : 15ms
tr : 300ms
f : 5kHz

Following a message will be given at the interface that the generator has limited the actual test values.

9.4. E commands

Comm.	Syntax	Description
EC	EC;	EC checks the connection of the interface. Additionally it will be checked if an external coupling network is connected. The EFT sends back: EFT 500,CN,SWN; - Instead of CN you can read a number between and 3. 0 -> no CNI 1 -> CNI 501 2 -> CNE 503 or CNI 503 3 -> not defined (open) - SWN is the software number of the equipment. Example: 000015
EN	EN,U,f,td,tr,cop,pol,T;	The EN command handles the parameters for the Quickstart mode.
EU	EU,U1,U2,Δ U,f,td,tr,cop,pol,T;	The EU command handles the parameter for the mode 'voltage change' after T by ΔU.
EF	EF,U,f1,f2,Δ f,td,tr,cop,pol,T;	The EF command handles the parameters for the mode 'frequency change' after T by Δf.
EG	EG,U,f1,f2,td,tr,cop,pol, T;	The EG command handles the parameters for the mode 'frequency sweep in one burst'.
ED	ED,U,f,td1,td2,Δtd,tr, cop,pol,T;	The ED command handles the parameters for the mode 'change duration' after T by Δtd.
EZ	EZ,U,f,td,cop,pol,T;	EZ handles the parameters for 'statistical trigger'
ES	ES,U,f,td,tr,W,cop,pol,T;	The ES command handles the parameters for the mode 'synchronised with fixed phase angle'.
EP	EP,U,f,td,tr,cop,T;	The EP command handles the parameters for the mode 'change polarity after T'.

9.5. N commands

Comm.	Syntax	Description
NU	NU,U;	The NU command sends a new voltage level. This handling can be realised on-line during a running test.
NF	NF,f;	The NF command sends a new frequency value. This handling can be realised on-line during a running test.
ND	ND,td;	The ND command sends a new value for burst duration. This handling can be realised on-line during a running test.
NR	NR,tr;	The NR command sends a new value for burst repetition. This handling can be realised on-line during a running test.
NC	NC,cop;	The NC command sends a new value for coupling. This handling can be realised on-line during a running test.
NP	NP,pol;	The NP command changes polarity. This handling can be realised on-line during a running test.
NW	NW,W;	The NW command sends a new value for phase angle. This handling can be realised on-line during a running test.

9.6. A commands

Comm.	Syntax	Description
AA	AA;	The AA command starts the test routine. At first all parameters and the routine must be handled by an E command.
AT	AT;	The AT command triggers one single burst, if the Manual mode has been selected before (tr = 10000). The test must have been started with AA-command.
AS	AS;	The AS command stops a running test.
AW	AW;	The AW command continues a stopped test routine (break).
AR	AR;	The AR command stops a running test and resets t.

9.7. Back messages

Message	Description
RR,00; <LF>	The test routine has been finished correctly.
RR,01; <LF>	Iff the capacitor is charged and the burst trigger starts.
RR,05; <LF>	Fail signal on Fail 1 The running test will be stopped.
RR,06; <LF>	Fail signal on Fail 2.
RR,07;<LF>	Continue after RR 06<LF>
RR,08; <LF>	Overtemperature.
RR,09; <LF>	Continue after Overtemperature.
RR,10; <LF>	There was an error in data transmission, this means too few or too many characters.
RR,11; <LF>	Test start is not possible because Test On is not switched on.
RR,13; <LF>	No, or wrong CNx connected. The required coupling mode cannot be selected.
RR,14; <LF>	One or several values are limited by the simulator.
RR,15; <LF>	Check sum error.
RR,16; <LF>	Synchrony error. For synchronised test routines there must be an AC signal available at the input of the coupling network.
RR,20; <LF>	Not correctable limitation error.

10. Appendix

10.1. Declaration of CE-Conformity

10.2. Declaration for safety requirements

10.3. List of sales representatives

10.4. EFT 500 - General Diagram

10.5. EFT 500 - Overview

EM TEST AG

Sternenhofstrasse 15 CH 4153 REINACH

DECLARATION OF CONFORMITY

BURSTGENERATOR TYPE EFT 500

Date of declaration:	November 1995

Standards	Emission EN 50081-2, edition 1993 Immunity EN 50082-2, edition 1994

Type of equipment	Burstgenerator EFT 500
Function	The test generator is designed according IEC 1000-4-4 standard, so called basic standard. It is generating fast transients to verify the conducted immunity of products . The function of the generator therefore can be specified as „generating and coupling interferences (high frequency) to the lines and ports of equipments under test".

This is to certify that the burst generator type EFT 500 is tested and measured according the above mentioned standards.

The product is conform with the COUNCIL EMC directive 89/336/EEC of the european community.
For emission, the measuring conditions are specified by a report of a competent body.

The declaration of conformity for each single equipment is part of the operating manual. Additionally special installation requirements, whenever necessary or useful, are listed as well in the manual.

The declaration of conformity, together with the measuring/test reports, the measuring/test conditions and the failure criterions are available at the EMC laboratory of EM TEST AG in switzerland as well as at the EMC laboratory of EM TEST GmbH in germany.

European representative		Manufacturer
EM TEST GmbH		EM TEST AG
Lünenerstr. 211		Sternenhofstr. 15
D 59174 Kamen		CH 4153 REINACH
Tel: 00492307-260700		Tel: 004161-7179191
Fax: 00492307-17050		Fax: 004161-7179199
U. FLOR		H. KUNKEL

U. Flor
General manager

H. Kunkel
Design and Research

1. CE Conformity

The generators must be conform with the EMC directive of the EU. This means, that basically the generic standards EN 50081.1/2 and/or EN 50082-1/2 must be applied. At the moment, november 1995, no product standard is applicable.

1.1 Immunity according 50082-2

An assignement to the generic standard for industry is realistic, because

- the test equipment is used in an environment with heavy interferences.
  (other test are running simultaneously)
- it is the function of the equipment to generate interferences, which may also radiate in the neighbourhood of the test setup.

1.2 Emission according 50081-2

EMC test equipment generates conducted broadband transients, which in some cases may be changed from conducted to radiated interference due to the test setup, to the EUT and of course to the spectrum of the pulses.

High frequency:
The burst simulators are generating transients with a very broad spectrum up to several 100 MHz bandwidth. Due to the functional requirements in the basic standards, IEC 1000-4-4, radiation from the lines of the EUT can not be avoided.

Under consideration of the special functional requirements of this test equipment the following definitions are made:

1. Emissions according to the EMC directive are such, generated by the test equipment under nominal conditions, without a connected EUT (self emissions).
2. Functional based emissions are such, generated by the complete test setup, encluding the test equipment, the EUT and all necessary cabling.

2. Applicability to the products.

For the burst generator type EFT 500 and its coupling networks, the measuring conditions are specified according to the report of a competent body, DELTA ELECTRONICS TESTING in Denmark, ref. A1951/95 JDC/jh.

EFT 500	**Burstgenerator acc IEC 1000-4-4, max. 4400V**
CNI 500	**Coupling network acc IEC 1000-4-4 and -5, 1phase**
CNI 503	**Coupling network acc IEC 1000-4-4 and -5, 3phase**
CNE503	**Coupling network acc IEC 1000-4-4, 3phase**

According to the report of the competent body, DELTA ELECTRONICS TESTING, the emission of burst generators shall be measured under the following conditions:

Burst generators.

- The generator is set to the max test level
- The generator is loaded at its output with 50 ohm, as required in IEC 1000-4-4.
- Test supply cables for the EUT are not plugged in (Input and output).
- All other cables are plugged in; e.g. control cables and interface cables.

Reason: The fast transients are coupled to the test supply lines. For functional reasons (specification of IEC 1000-4-4) it is not allowed to suppress the emission of these lines.

The input of the test supply can only be decoupled by the specified decoupling network (app. 35dB). The output lines will anyhow radiate to the input lines due to the test setup.

The immunity test generator is within the emission limits specified in the generic standard under the specified test conditions. The generator is therefore conform with the emc directive and can be signed with the CE mark.

3. Extended emissions during burst testing.

As mentioned under paragraph 2 burst testing may generate high frequency emissions higher than the emission levels specified in the generic standard.

Connecting any equipment under test to the output of the generator, increased emissions can be generated. These emissions are caused due to

- **the functional use of the generator as specified in basic standards as well as in the generic standard.**
- **the use of decoupling network, which may result in a higher emission of the EUT.**

Therefore the user may have to take precautions not to disturb other equipments near to the test facility. The following measures can be taken to reduce emission from the EMC test laboratory:

- **increase the distance of other facilities to the emc test setup**
- **the test setup should have a filtered and seperated power supply to its environment (conducted emissions are reduced by at least 35dB).**
- **partial screening of walls and test setups against other laboratories or facilities near by.**
- **installation of the emc lab in sub floors, e.g. cellar rooms.**
- **complete shielded rooms This will result in more than 100dB attenuation.**

Declaration of Conformity

We: EM TEST AG
Sternenhofstrasse 15
CH 4153 Reinach
Switzerland

Declare under our sole responsability the products:

Burst generators	**Type EFT 200, EFT 500, EFT 503 and EFT 800**

To which this declaration relates in conformity with the following standard

EN 61010	**Safety requirements for electrical equipment for measurement, control and laboratory use.**

Following the provisions of Directive 73/23/EEC as amended by 93/68/EC

Reinach, Switzerland, 12 December 1996

H. Kunkel
Technical Director