



ROHDE & SCHWARZ

Test and Measurement
Division

Operating Manual

EMI TEST RECEIVER 9 kHz to 2750 MHz

ESCS 30

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Supplement to Operating Manual ESCS as of Firmware Version 2.25

Selecting the weighting mode (DETECTOR)

The weighting modes that can be selected have been extended by the detector CISPR Average. The CISPR Average mode is only available in adequately configured instruments. In previous instrument models, the detector can be retrofitted with the aid of the Retrofit Kit ESCS-U1.

CISPR Average (CISPR AV)

For the measurement of the average according to CISPR 16-1, the maximum value of the linear average value is displayed during the measurement time and is used for the measurement of pulsed sinusoidal signals with low pulse frequency, for example. The maximum value is calibrated with the rms value of an unmodulated sinusoidal signal.

On the ESCS, averaging is analogous to that with lowpass filters of the 2nd order (simulation of a mechanical instrument). The lowpass time constants and the IF bandwidths are fixed depending on the frequency. The main parameters are listed in the following table:

	CISPR Band A	CISPR Band B	CISPR Band C/D
Frequency range	9 kHz to 150 kHz	150 kHz to 30 MHz	30 MHz to 1000 MHz
IF bandwidth	200 Hz	9 kHz	120 kHz
Lowpass time constant	160 ms	160 ms	100 ms

After a frequency change or a modification of the attenuation, the receiver waits until the lowpass has settled before the measurement time starts. The measurement time is selected depending on the IF bandwidth and the characteristics of the signal to be measured. Unmodulated sinusoidal signals as well as signals with high modulation frequency can be measured within a short time. Slowly fluctuating signals or pulse signals require longer measurement times.

Device-specific IEC/IEEE-bus commands

Command	Data	Unit	Meaning
DETECTOR DETECTOR?	AVERAGE CISPRAV PEAK QUASIPeAK RMS	---	Weighting mode (detector) RMS with option ESCS-B9

Weighting of pulsed sinusoidal signals

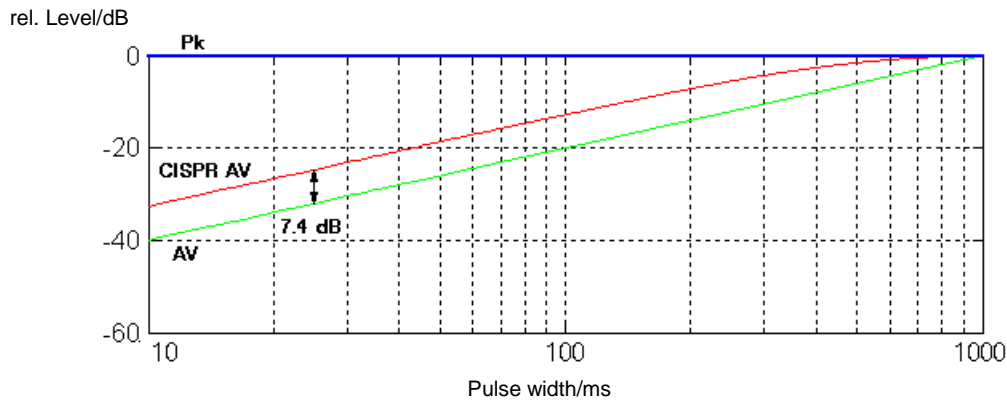


Fig. 1 Differences of the weighting of pulsed sinusoidal signals resulting from display modes AV, CISPR AV and Pk depending on the pulse width (measurement time = 2 s, pulse frequency = 1 Hz, IF bandwidth = 9 kHz, averaging time constant = 160 ms).

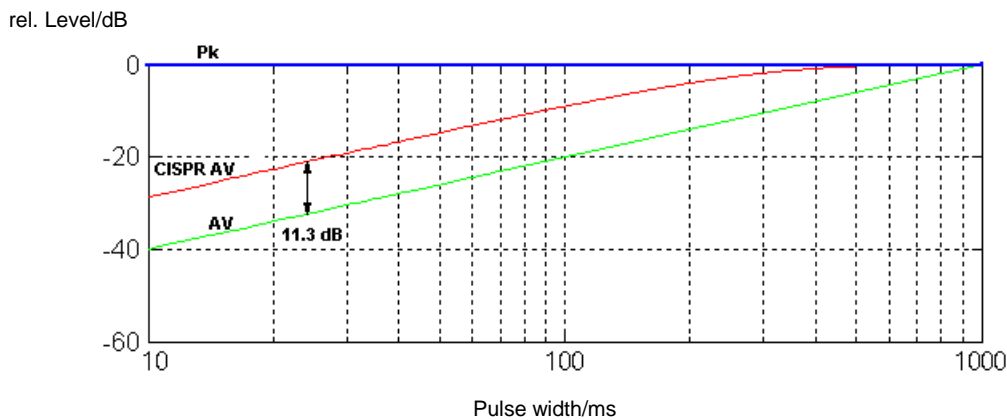


Fig. 2 Differences of the weighting of pulsed sinusoidal signals resulting from display modes AV, CISPR AV and Pk depending on the pulse width (measurement time = 2 s, pulse frequency = 1 Hz, IF bandwidth = 120 kHz, averaging time constant = 100 ms).

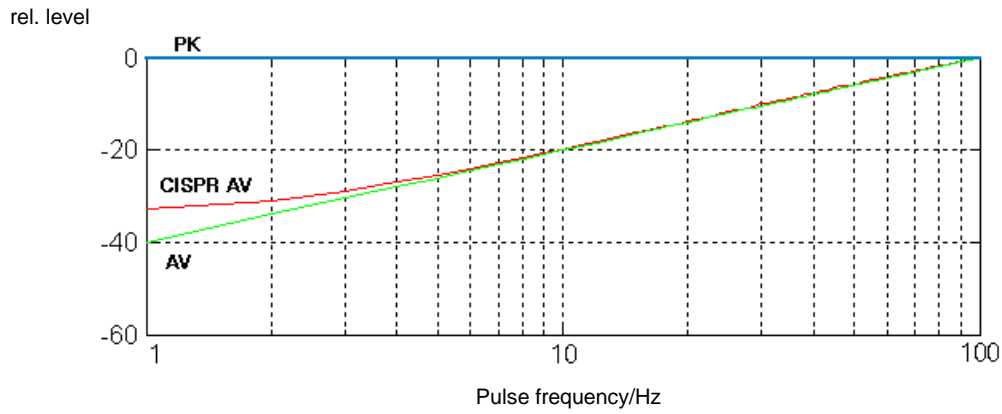


Fig. 3 Differences of the weighting of pulsed sinusoidal signals resulting from display modes AV, CISPR AV and Pk depending on the pulse width (measurement time = 2 s, pulse width = 10 ms, IF bandwidth = 9 kHz, averaging time constant = 160 ms).

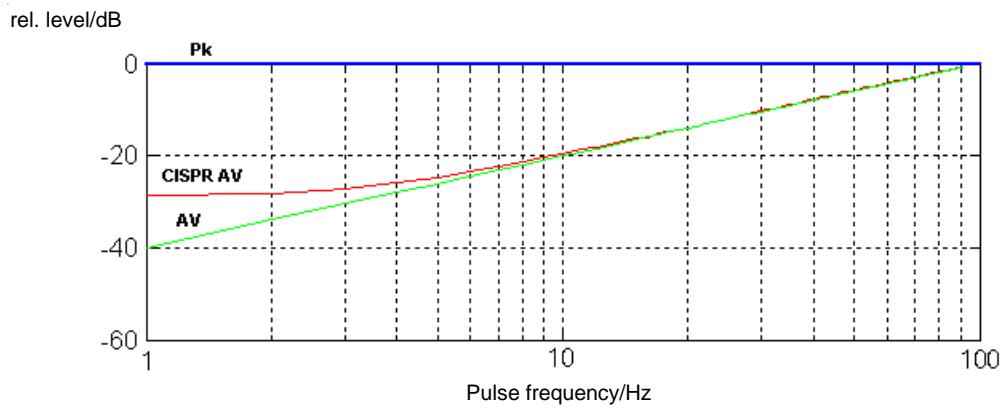
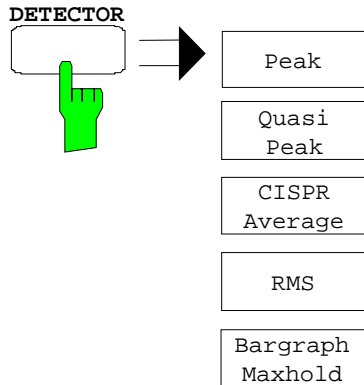


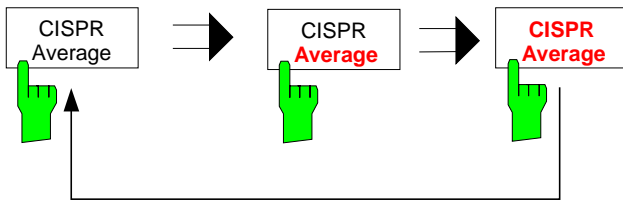
Fig. 4 Differences of the weighting of pulsed sinusoidal signals resulting from display modes AV, CISPR AV and Pk depending on the pulse frequency (measurement time = 2 s, pulse width = 10 ms, IF bandwidth = 120 kHz, averaging time constant = 100 ms).

Operation:

- Press DETECTOR key.
The detector menu is displayed on the screen.
- Scroll through the detectors by pressing the DETECTOR key several times (possible only if a detector is active) or
- Select the required detector or detectors using the associated softkeys.



- Press the *CISPR Average* softkey to set the required weighting mode.
The softkey labelling changes when the softkey is pressed.



Note: *The active CISPR AV detector is identified with AV on the frequency display and with CAV on the bargraph.*

Fixed coupling of the prescan and final measurement detectors are used for automatic measurement (Prescan/Final).

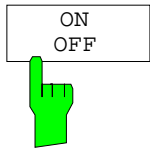
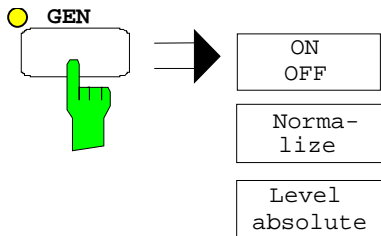
Prescan measurement	Final measurement
Pk	QP
AV	CISPR AV

Operation with internal tracking generator (option ESCS-B5)

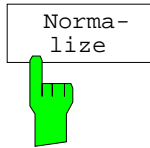
The tracking generator menu has been extended by the functions *Normalize* and *Level absolute*. The Normalize function is only available in adequately configured instruments.

Operation:

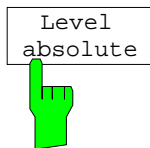
- Press GEN key.
The generator menu is displayed on the screen.



The *ON/OFF* softkey switches the tracking generator on or off. When the tracking generator is on, the yellow LED lights up and the display changes to a relative level display in dB, referred to the generator level of 90 dB μ V.



The *Normalize* softkey switches on the normalize function. The last scan result is transferred into the memory as a reference for normalizing and a stored curve (copy to memory) is discarded. Normalizing is not possible if two detectors are active.



The *Level absolute* softkey switches off the relative level display.

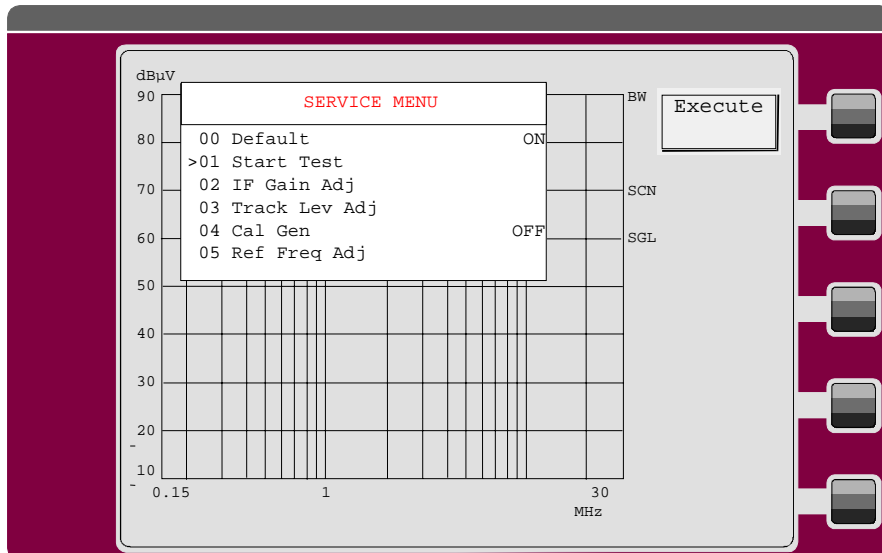
Device-specific IEC/IEEE-bus commands

Command	Data	Unit	Meaning
SCAN:NORMALIZE SCAN:NORMALIZE?	ON OFF	---	Activates and deactivates the normalize functions.

Service menu

The service menu has been extended by the battery capacity measurement function (06 CAL BATT. CAPACITY).

The measurement of the battery capacity is started with the service function *06 CAL BATT. CAPACITY*.



Function	Meaning
00	Resets the service functions to default state.
01	Performs the device selftest
02	Determines the most favourable gain adjustment in case of module replacement.
03	Sets the tracking generator level.
04	Switches on the internal calibration source.
05	Adjusts the internal reference oscillator.
06	Determines the charging capacity of batteries. This function is displayed only if options B1 and B2 are installed.

Operation:

- Operate the ESCS from AC supply until the batteries are charged (fan switches off).
- After charging is complete, unplug the AC connector and operate the unit with the battery.
- Call the service menu in the Config menu and start service function 06.
- Operate the ESCS continuously until automatic switch-off.
- The unit will then be connected to the AC supply and the batteries re-charged.

Tabbed Divider Overview

- Contents**
- Data sheet**
- Safety Intruction**
- EC Certificate of Conformity**
- Certificate of Quality**
- List of R & S Repreentatives**

1	Putting into Operation	Tabed Divider 1
2	Examples of Application	Tabed Divider 2
3	Manual Operation.....	Tabed Divider 3
4	Instrument Functions	Tabed Divider 4
5	Remote Control - Fundamentals.....	Tabed Divider 5
6	Device-specific Commands	Tabed Divider 6
7	Program Examples	Tabed Divider 7
8	Maintenance	Tabed Divider 8
9	Messages during.....	Tabed Divider 9
10	Index.....	Tabed Divider 9



Before putting the product into operation for the first time, make sure to read the following



Safety Instructions

Rohde & Schwarz makes every effort to keep the safety standard of its products up to date and to offer its customers the highest possible degree of safety. Our products and the auxiliary equipment required for them are designed and tested in accordance with the relevant safety standards. Compliance with these standards is continuously monitored by our quality assurance system. This product has been designed and tested in accordance with the EC Certificate of Conformity and has left the manufacturer's plant in a condition fully complying with safety standards. To maintain this condition and to ensure safe operation, observe all instructions and warnings provided in this manual. If you have any questions regarding these safety instructions, Rohde & Schwarz will be happy to answer them.

Furthermore, it is your responsibility to use the product in an appropriate manner. This product is designed for use solely in industrial and laboratory environments or in the field and must not be used in any way that may cause personal injury or property damage. You are responsible if the product is used for an intention other than its designated purpose or in disregard of the manufacturer's instructions. The manufacturer shall assume no responsibility for such use of the product.

The product is used for its designated purpose if it is used in accordance with its operating manual and within its performance limits (see data sheet, documentation, the following safety instructions). Using the products requires technical skills and knowledge of English. It is therefore essential that the products be used exclusively by skilled and specialized staff or thoroughly trained personnel with the required skills. If personal safety gear is required for using Rohde & Schwarz products, this will be indicated at the appropriate place in the product documentation.

Symbols and safety labels

Observe operating instructions	Weight indication for units >18 kg	Danger of electric shock	Warning! Hot surface	PE terminal	Ground	Ground terminal	Attention! Electrostatic sensitive devices

Supply voltage ON/OFF	Standby indication	Direct current (DC)	Alternating current (AC)	Direct/alternating current (DC/AC)	Device fully protected by double/reinforced insulation

Safety Instructions

Observing the safety instructions will help prevent personal injury or damage of any kind caused by dangerous situations. Therefore, carefully read through and adhere to the following safety instructions before putting the product into operation. It is also absolutely essential to observe the additional safety instructions on personal safety that appear in other parts of the documentation. In these safety instructions, the word "product" refers to all merchandise sold and distributed by Rohde & Schwarz, including instruments, systems and all accessories.

Tags and their meaning

DANGER	This tag indicates a safety hazard with a high potential of risk for the user that can result in death or serious injuries.
WARNING	This tag indicates a safety hazard with a medium potential of risk for the user that can result in death or serious injuries.
CAUTION	This tag indicates a safety hazard with a low potential of risk for the user that can result in slight or minor injuries.
ATTENTION	This tag indicates the possibility of incorrect use that can cause damage to the product.
NOTE	This tag indicates a situation where the user should pay special attention to operating the product but which does not lead to damage.

These tags are in accordance with the standard definition for civil applications in the European Economic Area. Definitions that deviate from the standard definition may also exist. It is therefore essential to make sure that the tags described here are always used only in connection with the associated documentation and the associated product. The use of tags in connection with unassociated products or unassociated documentation can result in misinterpretations and thus contribute to personal injury or material damage.

Basic safety instructions

1. The product may be operated only under the operating conditions and in the positions specified by the manufacturer. Its ventilation must not be obstructed during operation. Unless otherwise specified, the following requirements apply to Rohde & Schwarz products:
prescribed operating position is always with the housing floor facing down, IP protection 2X, pollution severity 2, overvoltage category 2, use only in enclosed spaces, max. operation altitude max. 2000 m. Unless specified otherwise in the data sheet, a tolerance of $\pm 10\%$ shall apply to the nominal voltage and of $\pm 5\%$ to the nominal frequency.
2. Applicable local or national safety regulations and rules for the prevention of accidents must be observed in all work performed. The product may be opened only by authorized, specially trained personnel. Prior to performing any work on the product or opening the product, the product must be disconnected from the supply network. Any adjustments, replacements of parts, maintenance or repair must be carried out only by technical personnel authorized by Rohde & Schwarz. Only original parts may be used for replacing parts relevant to safety (e.g. power switches, power transformers, fuses). A safety test must always be performed after parts relevant to safety have been replaced (visual inspection, PE conductor test, insulation resistance measurement, leakage current measurement, functional test).
3. As with all industrially manufactured goods, the use of substances that induce an allergic reaction (allergens, e.g. nickel) such as aluminum cannot be generally excluded. If you develop an allergic reaction (such as a skin rash, frequent sneezing, red eyes or respiratory difficulties), consult a physician immediately to determine the cause.

Safety Instructions

4. If products/components are mechanically and/or thermally processed in a manner that goes beyond their intended use, hazardous substances (heavy-metal dust such as lead, beryllium, nickel) may be released. For this reason, the product may only be disassembled, e.g. for disposal purposes, by specially trained personnel. Improper disassembly may be hazardous to your health. National waste disposal regulations must be observed.
5. If handling the product yields hazardous substances or fuels that must be disposed of in a special way, e.g. coolants or engine oils that must be replenished regularly, the safety instructions of the manufacturer of the hazardous substances or fuels and the applicable regional waste disposal regulations must be observed. Also observe the relevant safety instructions in the product documentation.
6. Depending on the function, certain products such as RF radio equipment can produce an elevated level of electromagnetic radiation. Considering that unborn life requires increased protection, pregnant women should be protected by appropriate measures. Persons with pacemakers may also be endangered by electromagnetic radiation. The employer is required to assess workplaces where there is a special risk of exposure to radiation and, if necessary, take measures to avert the danger.
7. Operating the products requires special training and intense concentration. Make certain that persons who use the products are physically, mentally and emotionally fit enough to handle operating the products; otherwise injuries or material damage may occur. It is the responsibility of the employer to select suitable personnel for operating the products.
8. Prior to switching on the product, it must be ensured that the nominal voltage setting on the product matches the nominal voltage of the AC supply network. If a different voltage is to be set, the power fuse of the product may have to be changed accordingly.
9. In the case of products of safety class I with movable power cord and connector, operation is permitted only on sockets with earthing contact and protective earth connection.
10. Intentionally breaking the protective earth connection either in the feed line or in the product itself is not permitted. Doing so can result in the danger of an electric shock from the product. If extension cords or connector strips are implemented, they must be checked on a regular basis to ensure that they are safe to use.
11. If the product has no power switch for disconnection from the AC supply, the plug of the connecting cable is regarded as the disconnecting device. In such cases, it must be ensured that the power plug is easily reachable and accessible at all times (length of connecting cable approx. 2 m). Functional or electronic switches are not suitable for providing disconnection from the AC supply. If products without power switches are integrated in racks or systems, a disconnecting device must be provided at the system level.
12. Never use the product if the power cable is damaged. By taking appropriate safety measures and carefully laying the power cable, ensure that the cable cannot be damaged and that no one can be hurt by e.g. tripping over the cable or suffering an electric shock.
13. The product may be operated only from TN/TT supply networks fused with max. 16 A.
14. Do not insert the plug into sockets that are dusty or dirty. Insert the plug firmly and all the way into the socket. Otherwise this can result in sparks, fire and/or injuries.
15. Do not overload any sockets, extension cords or connector strips; doing so can cause fire or electric shocks.
16. For measurements in circuits with voltages $V_{\text{rms}} > 30 \text{ V}$, suitable measures (e.g. appropriate measuring equipment, fusing, current limiting, electrical separation, insulation) should be taken to avoid any hazards.
17. Ensure that the connections with information technology equipment comply with IEC 950/EN 60950.
18. Never remove the cover or part of the housing while you are operating the product. This will expose circuits and components and can lead to injuries, fire or damage to the product.

Safety Instructions

19. If a product is to be permanently installed, the connection between the PE terminal on site and the product's PE conductor must be made first before any other connection is made. The product may be installed and connected only by a skilled electrician.
20. For permanently installed equipment without built-in fuses, circuit breakers or similar protective devices, the supply circuit must be fused in such a way that suitable protection is provided for users and products.
21. Do not insert any objects into the openings in the housing that are not designed for this purpose. Never pour any liquids onto or into the housing. This can cause short circuits inside the product and/or electric shocks, fire or injuries.
22. Use suitable overvoltage protection to ensure that no overvoltage (such as that caused by a thunderstorm) can reach the product. Otherwise the operating personnel will be endangered by electric shocks.
23. Rohde & Schwarz products are not protected against penetration of water, unless otherwise specified (see also safety instruction 1.). If this is not taken into account, there exists the danger of electric shock or damage to the product, which can also lead to personal injury.
24. Never use the product under conditions in which condensation has formed or can form in or on the product, e.g. if the product was moved from a cold to a warm environment.
25. Do not close any slots or openings on the product, since they are necessary for ventilation and prevent the product from overheating. Do not place the product on soft surfaces such as sofas or rugs or inside a closed housing, unless this is well ventilated.
26. Do not place the product on heat-generating devices such as radiators or fan heaters. The temperature of the environment must not exceed the maximum temperature specified in the data sheet.
27. Batteries and storage batteries must not be exposed to high temperatures or fire. Keep batteries and storage batteries away from children. If batteries or storage batteries are improperly replaced, this can cause an explosion (warning: lithium cells). Replace the battery or storage battery only with the matching Rohde & Schwarz type (see spare parts list). Batteries and storage batteries are hazardous waste. Dispose of them only in specially marked containers. Observe local regulations regarding waste disposal. Do not short-circuit batteries or storage batteries.
28. Please be aware that in the event of a fire, toxic substances (gases, liquids etc.) that may be hazardous to your health may escape from the product.
29. Please be aware of the weight of the product. Be careful when moving it; otherwise you may injure your back or other parts of your body.
30. Do not place the product on surfaces, vehicles, cabinets or tables that for reasons of weight or stability are unsuitable for this purpose. Always follow the manufacturer's installation instructions when installing the product and fastening it to objects or structures (e.g. walls and shelves).
31. Handles on the products are designed exclusively for personnel to hold or carry the product. It is therefore not permissible to use handles for fastening the product to or on means of transport such as cranes, fork lifts, wagons, etc. The user is responsible for securely fastening the products to or on the means of transport and for observing the safety regulations of the manufacturer of the means of transport. Noncompliance can result in personal injury or material damage.
32. If you use the product in a vehicle, it is the sole responsibility of the driver to drive the vehicle safely. Adequately secure the product in the vehicle to prevent injuries or other damage in the event of an accident. Never use the product in a moving vehicle if doing so could distract the driver of the vehicle. The driver is always responsible for the safety of the vehicle; the manufacturer assumes no responsibility for accidents or collisions.
33. If a laser product (e.g. a CD/DVD drive) is integrated in a Rohde & Schwarz product, do not use any other settings or functions than those described in the documentation. Otherwise this may be hazardous to your health, since the laser beam can cause irreversible damage to your eyes. Never try to take such products apart, and never look into the laser beam.



Por favor lea imprescindiblemente antes de la primera puesta en funcionamiento las siguientes informaciones de seguridad



Informaciones de seguridad

Es el principio de Rohde & Schwarz de tener a sus productos siempre al día con los standards de seguridad y de ofrecer a sus clientes el máximo grado de seguridad. Nuestros productos y todos los equipos adicionales son siempre fabricados y examinados según las normas de seguridad vigentes. Nuestra sección de gestión de la seguridad de calidad controla constantemente que sean cumplidas estas normas. Este producto ha sido fabricado y examinado según el comprobante de conformidad adjunto según las normas de la CE y ha salido de nuestra planta en estado impecable según los standards técnicos de seguridad. Para poder preservar este estado y garantizar un funcionamiento libre de peligros, deberá el usuario atenerse a todas las informaciones, informaciones de seguridad y notas de alerta. Rohde&Schwarz está siempre a su disposición en caso de que tengan preguntas referentes a estas informaciones de seguridad.

Además queda en la responsabilidad del usuario utilizar el producto en la forma debida. Este producto solamente fue elaborado para ser utilizado en la industria y el laboratorio o para fines de campo y de ninguna manera deberá ser utilizado de modo que alguna persona/cosa pueda ser dañada. El uso del producto fuera de sus fines definidos o despreciando las informaciones de seguridad del fabricante queda en la responsabilidad del usuario. El fabricante no se hace en ninguna forma responsable de consecuencias a causa del maluso del producto.

Se parte del uso correcto del producto para los fines definidos si el producto es utilizado dentro de las instrucciones del correspondiente manual del uso y dentro del margen de rendimiento definido (ver hoja de datos, documentación, informaciones de seguridad que siguen). El uso de los productos hace necesarios conocimientos profundos y el conocimiento del idioma inglés. Por eso se deberá tener en cuenta de exclusivamente autorizar para el uso de los productos a personas péritas o debidamente minuciosamente instruidas con los conocimientos citados. Si fuera necesaria indumentaria de seguridad para el uso de productos de R&S, encontrará la información debida en la documentación del producto en el capítulo correspondiente.

Símbolos y definiciones de seguridad

Ver manual de instrucciones del uso	Informaciones para maquinaria con un peso de > 18kg	Peligro de golpe de corriente	¡Advertencia! Superficie caliente	Conexión a conductor protector	Conexión a tierra	Conexión a masa conductora	¡Cuidado! Elementos de construcción con peligro de carga electrostática

potencia EN MARCHA/PARADA	Indicación Stand-by	Corriente continua DC	Corriente alterna AC	Corriente continua/alterna DC/AC	El aparato está protegido en su totalidad por un aislamiento de doble refuerzo

Informaciones de seguridad

Tener en cuenta las informaciones de seguridad sirve para tratar de evitar daños y peligros de toda clase. Es necesario de que se lean las siguientes informaciones de seguridad concienzudamente y se tengan en cuenta debidamente antes de la puesta en funcionamiento del producto. También deberán ser tenidas en cuenta las informaciones para la protección de personas que encontrarán en otro capítulo de esta documentación y que también son obligatorias de seguir. En las informaciones de seguridad actuales hemos juntado todos los objetos vendidos por Rohde&Schwarz bajo la denominación de „producto“, entre ellos también aparatos, instalaciones así como toda clase de accesorios.

Palabras de señal y su significado

PELIGRO	Indica un punto de peligro con gran potencial de riesgo para el usuario. Punto de peligro que puede llevar hasta la muerte o graves heridas.
ADVERTENCIA	Indica un punto de peligro con un potencial de riesgo mediano para el usuario. Punto de peligro que puede llevar hasta la muerte o graves heridas .
ATENCIÓN	Indica un punto de peligro con un potencial de riesgo pequeño para el usuario. Punto de peligro que puede llevar hasta heridas leves o pequeñas
CUIDADO	Indica la posibilidad de utilizar mal el producto y a consecuencia dañarlo.
INFORMACIÓN	Indica una situación en la que deberían seguirse las instrucciones en el uso del producto, pero que no consecuentemente deben de llevar a un daño del mismo.

Las palabras de señal corresponden a la definición habitual para aplicaciones civiles en el ámbito de la comunidad económica europea. Pueden existir definiciones diferentes a esta definición. Por eso se debiera tener en cuenta que las palabras de señal aquí descritas sean utilizadas siempre solamente en combinación con la correspondiente documentación y solamente en combinación con el producto correspondiente. La utilización de las palabras de señal en combinación con productos o documentaciones que no les correspondan puede llevar a malinterpretaciones y tener por consecuencia daños en personas u objetos.

Informaciones de seguridad elementales

1. El producto solamente debe ser utilizado según lo indicado por el fabricante referente a la situación y posición de funcionamiento sin que se obstruya la ventilación. Si no se convino de otra manera, es para los productos R&S válido lo que sigue: como posición de funcionamiento se define principalmente la posición con el suelo de la caja para abajo , modo de protección IP 2X, grado de suciedad 2, categoría de sobrecarga eléctrica 2, utilizar solamente en estancias interiores, utilización hasta 2000 m sobre el nivel del mar.
A menos que se especifique otra cosa en la hoja de datos, se aplicará una tolerancia de $\pm 10\%$ sobre el voltaje nominal y de $\pm 5\%$ sobre la frecuencia nominal.
2. En todos los trabajos deberán ser tenidas en cuenta las normas locales de seguridad de trabajo y de prevención de accidentes. El producto solamente debe de ser abierto por personal périto autorizado. Antes de efectuar trabajos en el producto o abrirlo deberá este ser desconectado de la corriente. El ajuste, el cambio de partes, la manutención y la reparación deberán ser solamente efectuadas por electricistas autorizados por R&S. Si se reponen partes con importancia para los aspectos de seguridad (por ejemplo el enchufe, los transformadores o los fusibles), solamente podrán ser sustituidos por partes originales. Despues de cada recambio de partes elementales para la seguridad deberá ser efectuado un control de

Informaciones de seguridad

- seguridad (control a primera vista, control de conductor protector, medición de resistencia de aislamiento, medición de medición de la corriente conductora, control de funcionamiento).
3. Como en todo producto de fabricación industrial no puede ser excluido en general de que se produzcan al usarlo elementos que puedan generar alergias, los llamados elementos alergénicos (por ejemplo el níquel). Si se produjeran en el trato con productos R&S reacciones alérgicas, como por ejemplo urticaria, estornudos frecuentes, irritación de la conjuntiva o dificultades al respirar, se deberá consultar inmediatamente a un médico para averiguar los motivos de estas reacciones.
 4. Si productos / elementos de construcción son tratados fuera del funcionamiento definido de forma mecánica o térmica, pueden generarse elementos peligrosos (povos de sustancia de metales pesados como por ejemplo plomo, berilio, níquel). La partición elemental del producto, como por ejemplo sucede en el tratamiento de materias residuales, debe de ser efectuada solamente por personal especializado para estos tratamientos. La partición elemental efectuada inadecuadamente puede generar daños para la salud. Se deben tener en cuenta las directivas nacionales referentes al tratamiento de materias residuales.
 5. En el caso de que se produjeran agentes de peligro o combustibles en la aplicación del producto que debieran de ser transferidos a un tratamiento de materias residuales, como por ejemplo agentes refrigerantes que deben ser repuestos en periodos definidos, o aceites para motores, deberán ser tenidas en cuenta las prescripciones de seguridad del fabricante de estos agentes de peligro o combustibles y las regulaciones regionales para el tratamiento de materias residuales. Cuiden también de tener en cuenta en caso dado las prescripciones de seguridad especiales en la descripción del producto.
 6. Ciertos productos, como por ejemplo las instalaciones de radiación HF, pueden a causa de su función natural, emitir una radiación electromagnética aumentada. En vista a la protección de la vida en desarrollo deberían ser protegidas personas embarazadas debidamente. También las personas con un bypass pueden correr peligro a causa de la radiación electromagnética. El empresario está comprometido a valorar y señalar áreas de trabajo en las que se corra un riesgo de exposición a radiaciones aumentadas de riesgo aumentado para evitar riesgos.
 7. La utilización de los productos requiere instrucciones especiales y una alta concentración en el manejo. Debe de ponerse por seguro de que las personas que manejen los productos estén a la altura de los requerimientos necesarios referente a sus aptitudes físicas, psíquicas y emocionales, ya que de otra manera no se pueden excluir lesiones o daños de objetos. El empresario lleva la responsabilidad de seleccionar el personal usuario apto para el manejo de los productos.
 8. Antes de la puesta en marcha del producto se deberá tener por seguro de que la tensión preseleccionada en el producto equivalga a la del la red de distribución. Si es necesario cambiar la preselección de la tensión también se deberán en caso dabo cambiar los fusibles correspondientes del prodcuto.
 9. Productos de la clase de seguridad I con alimentación móvil y enchufe individual de producto solamente deberán ser conectados para el funcionamiento a tomas de corriente de contacto de seguridad y con conductor protector conectado.
 10. Queda prohibida toda clase de interrupción intencionada del conductor protector, tanto en la toma de corriente como en el mismo producto ya que puede tener como consecuencia el peligro de golpe de corriente por el producto. Si se utilizaran cables o enchufes de extensión se deberá poner al seguro, que es controlado su estado técnico de seguridad.
 11. Si el producto no está equipado con un interruptor para desconectarlo de la red, se deberá considerar el enchufe del cable de distribución como interruptor. En estos casos deberá asegurar de que el enchufe sea de fácil acceso y nabejo (medida del cable de distribución aproximadamente 2 m). Los interruptores de función o electrónicos no son aptos para el corte de la red eléctrica. Si los productos sin interruptor están integrados en construcciones o instalaciones, se deberá instalar el interruptor al nivel de la instalación.

Informaciones de seguridad

12. No utilice nunca el producto si está dañado el cable eléctrico. Asegure a través de las medidas de protección y de instalación adecuadas de que el cable de eléctrico no pueda ser dañado o de que nadie pueda ser dañado por él, por ejemplo al tropezar o por un golpe de corriente.
13. Solamente está permitido el funcionamiento en redes de distribución TN/TT aseguradas con fusibles de como máximo 16 A.
14. Nunca conecte el enchufe en tomas de corriente sucias o llenas de polvo. Introduzca el enchufe por completo y fuertemente en la toma de corriente. Si no tiene en consideración estas indicaciones se arriesga a que se originen chispas, fuego y/o heridas.
15. No sobrecargue las tomas de corriente, los cables de extensión o los enchufes de extensión ya que esto pudiera causar fuego o golpes de corriente.
16. En las mediciones en circuitos de corriente con una tensión de entrada de $U_{eff} > 30 \text{ V}$ se deberá tomar las precauciones debidas para impedir cualquier peligro (por ejemplo medios de medición adecuados, seguros, limitación de tensión, corte protector, aislamiento etc.).
17. En caso de conexión con aparatos de la técnica informática se deberá tener en cuenta que estos cumplan los requisitos de la EC950/EN60950.
18. Nunca abra la tapa o parte de ella si el producto está en funcionamiento. Esto pone a descubierto los cables y componentes eléctricos y puede causar heridas, fuego o daños en el producto.
19. Si un producto es instalado fijamente en un lugar, se deberá primero conectar el conductor protector fijo con el conductor protector del aparato antes de hacer cualquier otra conexión. La instalación y la conexión deberán ser efectuadas por un electricista especializado.
20. En caso de que los productos que son instalados fijamente en un lugar sean sin protector implementado, autointerruptor o similares objetos de protección, deberá la toma de corriente estar protegida de manera que los productos o los usuarios estén suficientemente protegidos.
21. Por favor, no introduzca ningún objeto que no esté destinado a ello en los orificios de la caja del aparato. No vierta nunca ninguna clase de líquidos sobre o en la caja. Esto puede producir corto circuitos en el producto y/o puede causar golpes de corriente, fuego o heridas.
22. Asegúrese con la protección adecuada de que no pueda originarse en el producto una sobrecarga por ejemplo a causa de una tormenta. Si no se verá el personal que lo utilice expuesto al peligro de un golpe de corriente.
23. Los productos R&S no están protegidos contra el agua si no es que exista otra indicación, ver también punto 1. Si no se tiene en cuenta esto se arriesga el peligro de golpe de corriente o de daños en el producto lo cual también puede llevar al peligro de personas.
24. No utilice el producto bajo condiciones en las que pueda producirse y se hayan producido líquidos de condensación en o dentro del producto como por ejemplo cuando se desplaza el producto de un lugar frío a un lugar caliente.
25. Por favor no cierre ninguna ranura u orificio del producto, ya que estas son necesarias para la ventilación e impiden que el producto se caliente demasiado. No pongan el producto encima de materiales blandos como por ejemplo sofás o alfombras o dentro de una caja cerrada, si esta no está suficientemente ventilada.
26. No ponga el producto sobre aparatos que produzcan calor, como por ejemplo radiadores o calentadores. La temperatura ambiental no debe superar la temperatura máxima especificada en la hoja de datos.

Informaciones de seguridad

27. Baterías y acumuladores no deben de ser expuestos a temperaturas altas o al fuego. Guardar baterías y acumuladores fuera del alcance de los niños. Si las baterías o los acumuladores no son cambiados con la debida atención existirá peligro de explosión (atención celulas de Litio). Cambiar las baterías o los acumuladores solamente por los del tipo R&S correspondiente (ver lista de piezas de recambio). Baterías y acumuladores son deshechos problemáticos. Por favor tirenlos en los recipientes especiales para este fin. Por favor tengan en cuenta las prescripciones nacionales de cada país referente al tratamiento de deshechos. Nunca sometan las baterías o acumuladores a un corto circuito.
28. Tengan en consideración de que en caso de un incendio pueden escaparse gases tóxicos del producto, que pueden causar daños a la salud.
29. Por favor tengan en cuenta que en caso de un incendio pueden desprenderse del producto agentes venenosos (gases, líquidos etc.) que pueden generar daños a la salud.
30. No sitúe el producto encima de superficies, vehículos, estantes o mesas, que por sus características de peso o de estabilidad no sean aptas para él. Siga siempre las instrucciones de instalación del fabricante cuando instale y asegure el producto en objetos o estructuras (por ejemplo paredes y estantes).
31. Las asas instaladas en los productos sirven solamente de ayuda para el manejo que solamente está previsto para personas. Por eso no está permitido utilizar las asas para la sujecion en o sobre medios de transporte como por ejemplo grúas, carretillas elevadoras de horquilla, carros etc. El usuario es responsable de que los productos sean sujetados de forma segura a los medios de transporte y de que las prescripciones de seguridad del fabricante de los medios de transporte sean tenidas en cuenta. En caso de que no se tengan en cuenta pueden causarse daños en personas y objetos.
32. Si llega a utilizar el producto dentro de un vehículo, queda en la responsabilidad absoluta del conductor que conducir el vehículo de manera segura. Asegure el producto dentro del vehículo debidamente para evitar en caso de un accidente las lesiones u otra clase de daños. No utilice nunca el producto dentro de un vehículo en movimiento si esto pudiera distraer al conductor. Siempre queda en la responsabilidad absoluta del conductor la seguridad del vehículo y el fabricante no asumirá ninguna clase de responsabilidad por accidentes o colisiones.
33. Dado el caso de que esté integrado un producto de laser en un producto R&S (por ejemplo CD/DVD-ROM) no utilice otras instalaciones o funciones que las descritas en la documentación. De otra manera pondrá en peligro su salud, ya que el rayo laser puede dañar irreversiblemente sus ojos. Nunca trate de descomponer estos productos. Nunca mire dentro del rayo laser.



ROHDE & SCHWARZ
EC Certificate of Conformity



Certificate No.: 970076

This is to certify that:

Equipment type	Order No.	Designation
ESCS30	1102.4500.30	EMI Test Receiver
ESCS-B1	1102.6490.02	Battery Controller
ESCS-B4	1102.6890.02	IF Analysis
ESCS-B5	1102.7097.02	Tracking Generator
ESCS-B6	1102.7397.02	Reference Oscillator
ESCS-B9	1102.7897.02	RMS Detector

complies with the provisions of the Directive of the Council of the European Union on the approximation of the laws of the Member States

- relating to electrical equipment for use within defined voltage limits
(73/23/EEC revised by 93/68/EEC)
- relating to electromagnetic compatibility
(89/336/EEC revised by 91/263/EEC, 92/31/EEC, 93/68/EEC)

Conformity is proven by compliance with the following standards:

EN61010-1 : 1991
EN50081-1 : 1992
EN50082-1 : 1992

Affixing the EC conformity mark as from 1997

ROHDE & SCHWARZ GmbH & Co. KG
Mühldorfstr. 15, D-81671 München

Munich, 1998-02-02

Central Quality Management FS-QZ / Becker

Contents

	<i>Page</i>
1 Putting into Operation	1-1
Front and Rear View.....	1-1
Front View.....	1-1
Rear view.....	1-13
Putting into Operation	1-16
Setting up the Receiver	1-16
Rackmounting.....	1-16
Power Supply.....	1-16
Mains Operation	1-16
Operation with Internal Battery	1-17
Display of the Residual Operating Time	1-18
Operation with External Battery	1-18
Switching-on	1-19
A.C. supply operation.....	1-19
Operation with internal or external battery	1-19
Selecting the Instrument Presetting.....	1-20
Connecting External Devices.....	1-24
Connecting the Transducers (ANTENNA CODE)	1-24
Connecting a Keyboard	1-25
Configuration of the External Keyboard.....	1-26
Connecting a Printer	1-26
Connection to the USER INTERFACE	1-27
Function Test.....	1-28

	<i>Page</i>
2 Examples of Application	2-1
Measuring the RFI voltage in the frequency range up to 30 MHz	2-2
Test setup	2-2
Setting of the test receiver	2-5
Example for a List of Final Measurement Results in the Test Report	2-9
Measuring the RFI Current in the Frequency Range up to 30 MHz.....	2-10
Test Setup	2-10
Setting of the test receiver	2-10
Test Run, Methods of Measurement and Analysis	2-10
Measuring the RFI Voltage or the RFI Current in the Frequency Range above 30 MHz	2-11
Test setup	2-11
Setting of the Test Receiver	2-12
Test Run, Methods of Measurement and Analysis	2-12
Measuring the RFI Field Strength in the Frequency Range up to 30 MHz.....	2-13
Test Setup	2-13
Test Setup for Open-Area Measurements:	2-15
Setting of the Test Receiver	2-15
Test Run, Methods of Measurement and Analysis	2-15
Measuring the RFI Field Strength in the Frequency Range above 30 MHz.....	2-16
Test setup for RFI field-strength measurement.....	2-16
Setting of the test receiver	2-17
Test Run, Methods of Measurement and Analysis	2-18
Example for a List of Final Measurement Values in the Test Report	2-20
Measuring the RFI Power Using the Absorbing Clamp.....	2-21
Test Setup	2-22
Setting of the Test Receiver	2-22
Test Run, Methods of Measurement and Analysis	2-23
Example for a List of Final Measurement Values in the Test Report	2-25
Measuring the Magnetic Interference in the Frequency Range between 9 kHz and 30 MHz.....	2-26
Test Setup	2-27
Setting of the test receiver	2-27
Test Run, Methods of Measurement and Analysis	2-28
Data Reduction and Subrange Maxima.....	2-30
Basic Operating Steps for Performing Automatic Measurements	2-32
Entry of Scan Data	2-32
Selection of Desired Detectors	2-34
Entry of Measurement Times.....	2-35
Switching on Limit Lines	2-36
Switching on a Transducer Factor	2-37
Switching on a Transducer Set.....	2-38
Switching on the desired option	2-39
Performing the measurement	2-40
Saving measurement results	2-43

	<i>Page</i>
3 Manual Operation.....	3-1
Connecting the Voltage to be Measured.....	3-2
Sinusoidal Signals and DC Voltage.....	3-2
Pulse Signals.....	3-2
Input of Numeric Values	3-3
Operation of the Menu Functions.....	3-4
Configuration of the Screen.....	3-4
Diagram Area.....	3-5
Calling the Softkey Menus	3-8
Operation of the Menu Functions.....	3-9
Input of Texts and Labelings.....	3-10
Operation of the Receiver Functions	3-11
Setting the Receiver Frequency	3-11
Numeric Input of Frequency.....	3-11
Frequency Setting using the Rotary Knob	3-12
Frequency Tuning using the Keys ↓ and ↑	3-12
Input of Tuning Step Size.....	3-12
Selection of RF Attenuation (ATTENUATION)	3-13
Selection of Operating Mode (MODE).....	3-14
Automatic Setting of Attenuation (Autorange Operation)	3-15
Level Indication.....	3-16
Digital Level Indication	3-16
Analog Level Indication	3-17
Overload of Receiver	3-17
Selection of IF Bandwidth (IF BW).....	3-18
Selection of Weighting Mode (DETECTOR)	3-19
Average Measurement (AV)	3-19
RMS (ESCS-B9)	3-19
Peak Value (Pk).....	3-19
Quasi-peak (QP).....	3-19
Pulse Weighting in Various Weighting Modes.....	3-20
Selection of Measuring Time (MEAS TIME).....	3-22
Selection of AF Demodulation (DEMOD)	3-24
Operation with Internal Tracking Generator (Option ESCS-B5).....	3-26
Calibration and Measurement Accuracy.....	3-27
Error Messages during Calibration	3-27
Measurement Accuracy	3-28

	<i>Page</i>
4 Instrument Functions	4-1
Selection of Instrument Presettings (SETUP Menu).....	4-1
Entering and Calling up Transducer Factors (TRANSDUCER Menu)	4-1
Entering Transducer Factors	4-5
Entering a Transducer Set.....	4-7
Entering Limit Lines	4-9
Copying limit lines	4-12
Entering a new limit line or editing an existing one	4-12
Calling up the Selftest (Service Menu).....	4-14
Automatic Test Runs (RF Spectrum and Time Domain)	4-15
The Operating Modes Spectrum Overview, Scan and Channel.....	4-16
Editing the scan data in the operating mode Spectrum Overview	4-17
Editing the scan data in the operating mode Scan	4-19
Editing the scan data in the operating mode Channel	4-20
The Operating Mode Time Domain	4-21
Display of Measurement Results	4-23
Triggering of the Measurement	4-24
Display Modes of the Curves.....	4-25
Extended Functions of RF Analysis (OPTIONS)	4-26
Using the Marker in RF Analysis and Time Domain.....	4-30
IF Spectrum Analysis	4-36
Using the Marker in IF Analysis	4-40
Output of Measurement Results on Plotter or Printer.....	4-45
Printer	4-45
Presetting of the Plotter	4-48
Input of Labeling	4-51
Output of Measurement Results on the Printer	4-52
Output of Measurement Results on a Plotter	4-53
Storing and Recalling of Settings and Measurement Results.....	4-54
Internal Memories	4-53
Floppy Disk Drive.....	4-55
Storing on Floppy Disk.....	4-57
Loading from the Floppy Disk	4-59
Floppy Disk Operations.....	4-60
Messages during Floppy Disk Operations	4-61

	<i>Page</i>
5 Remote Control - Fundamentals.....	5-1
Setting the Device Address.....	5-2
LOCAL / REMOTE Switchover	5-2
Interface Messages	5-3
Universal Commands	5-3
Addressed Commands	5-3
Device Messages.....	5-5
Commands Received by the Test Receiver in Listener Mode (Controller to Device Messages)	5-5
Messages Sent by the Test Receiver in Talker Mode (Device to Controller Messages)	5-8
Common Commands	5-10
6 Device-specific Commands	6-1
Service Request and Status Registers.....	6-16
Resetting of Device Functions.....	6-24
Command Processing Sequence and Synchronization.....	6-24
Output of Measurement Results via IEC-Bus.....	6-25
Single Measurements	6-25
Scan.....	6-26
Formats ASCII and BINARY	6-27
ASCII-format of the Block Elements	6-28
Formats for DUMP and SDUMP.....	6-28
Transfer of the IEC-Bus Controller Function.....	6-31
Error Handling	6-32

	<i>Page</i>
7 Program Examples	7-1
Initialization and Initial State.....	7-1
Sending a Device Setting Command.....	7-2
Reading of the Device Settings	7-3
Triggering a Single Measurement and Synchronization using *WAI.....	7-4
Service Request Routine.....	7-5
Synchronization with the End of the Scan using *OPC.....	7-6
Programming a Scan Data Set.....	7-7
Programming the Settings for Time Domain Analysis	7-8
Programming a Transducer Factor	7-9
Programming a Transducer Set.....	7-10
Output of a Test Report on Plotter	7-11
Block-Serial Output of the Scan Results in ASCII Format	7-13
Block-Serial Output of the Scan Results in Binary Format.....	7-16
Block-Serial Output of Scan Results in the Internal Data Format (Dump)	7-20
8 Maintenance	8-1
Mechanical Maintenance.....	8-1
Electrical Maintenance.....	8-1
Testing the Level Measuring Accuracy.....	8-1
9 Error Messages	9-1
10 Index	10-1

1 Putting into Operation

This section describes the controls of the front and rear view and shows step by step how to put the instrument into operation. It also describes how to connect a printer, an external monitor and an external keyboard.

Front and Rear View

Front View

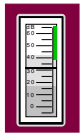
1

Screen and softkeys.

Key functions depending on the labelling next to the key on the screen

see section 3

2



Analog level display

see section 3

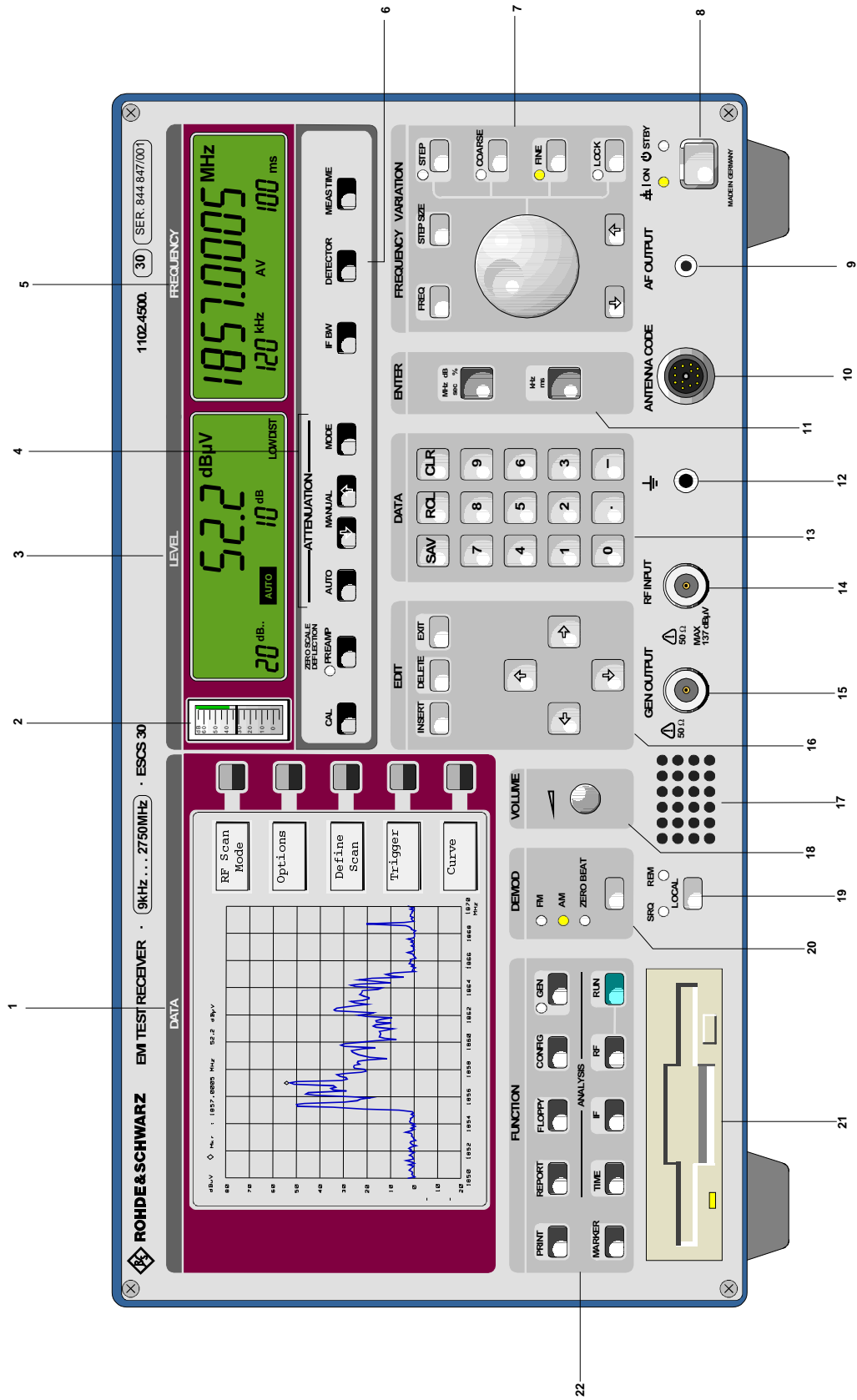


Fig. 1-1 Front view

3 LEVEL



- 3 ½-digit display of the level applied to RF-input, resolution 0.1 dB
- Units: dBµV, dBµA, dBm, dBµV/m, dBµA/m, dBpW and dBT;
- Display of overload of the signal path (OVERLOAD);
- Display of measurement mode (MODE: LOW NOISE and LOW DIST (low-distortion));
- Display of RF attenuation (RF ATT) 0 to 60 dB
- Display of automatic operation (AUTO),
- Display of lower limit of the scale span (ZERO SCALE DEFLECTION)

see section 3

4 ATTENUATION



Attenuation

- AUTO: RF-attenuation and MODE are automatically adjusted to input signal
- MANUAL: Switch-over of RF-attenuation:
 ↑ increasing by 5 dB,
 ↓ decreasing by 5 dB,
- MODE: Switch-over of IF-attenuation (LOW NOISE /LOW DISTORTION)

5 FREQUENCY



- 8-digit display of **receiver frequency** resolution 10 and 100 Hz, unit in MHz and kHz
- Display of **measuring time**, 1 ms to 100 s in 1,2,5-steps
- Indication of **detector**: AV, Pk and QP - RMS (with option ESCS-B9)
- Indication of **IF-bandwidths** 200 Hz, 9 kHz, 120 kHz and 1MHz

see section 3

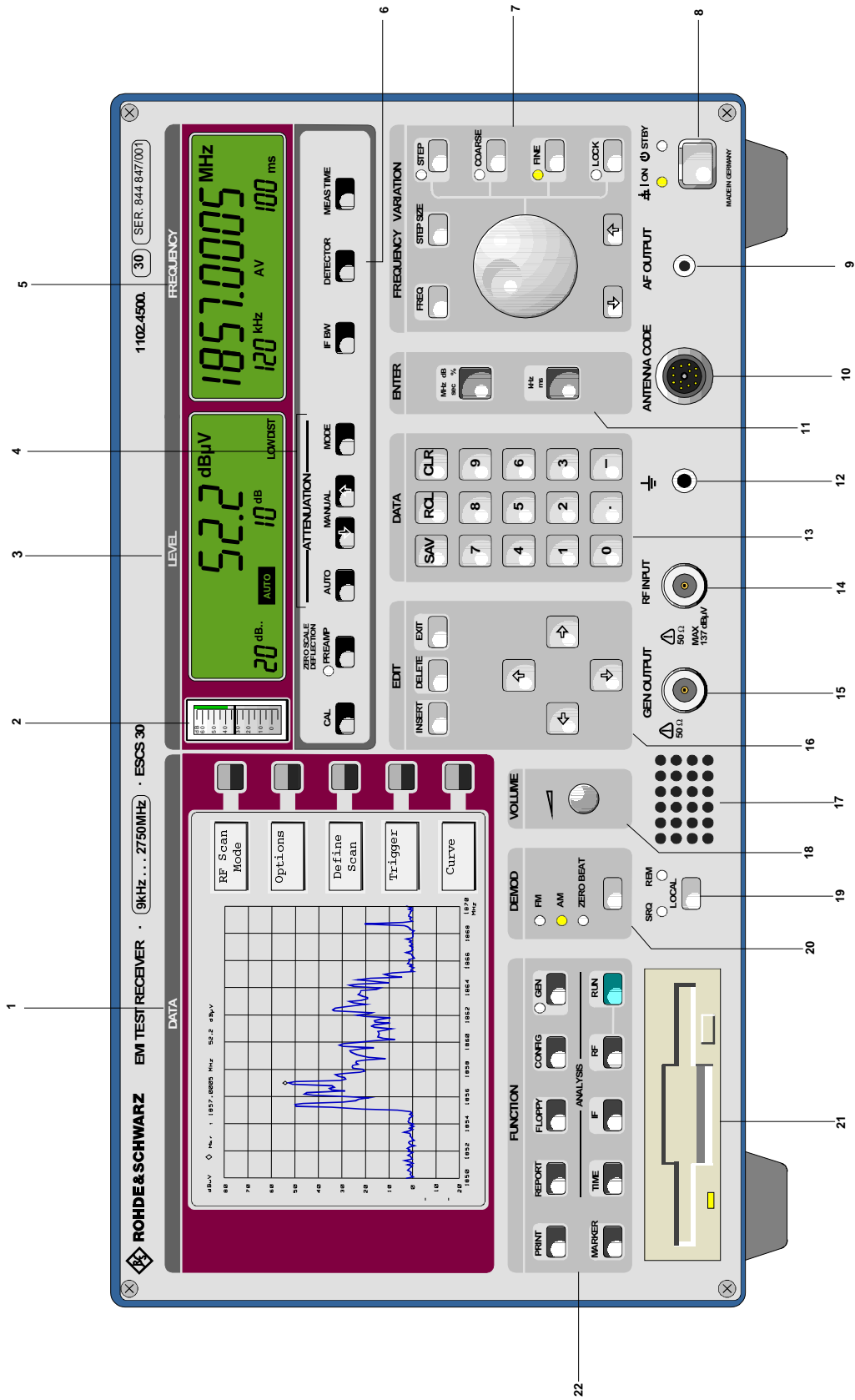



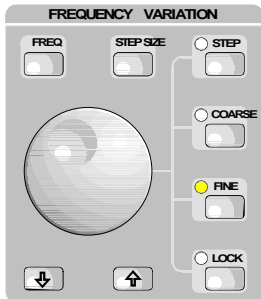


Fig. 1-1 Front view

6

- | | |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| <p>IF BW
</p> <p>DETECTOR
</p> <p>MEAS TIME
</p> | <p>IF BW: Key for switching over IF-bandwidth</p> <p>DETECTOR: Key for switching over the weighting</p> <p>MEAS TIME: Key for activating input of measuring time</p> |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|

7 FREQUENCY VARIATION



- Frequency tuning knob
- FREQ: Key for input of frequency
- STEP SIZE: Input of tuning step size
- STEP: Tuning in the step size entered in STEP SIZE
- COARSE: Frequency tuning coarse (10-, 100-kHz-steps, depending on range,)
- FINE: Frequency tuning fine (10- and 100-Hz-steps, depending on range,)
- ↑: Frequency is increased by the step size entered in STEP SIZE
- ↓: Frequency is reduced by the step size entered in STEP SIZE

8 ON/STANDBY



ON/STANDBY-switch

see section 1



Warning:

In standby mode, the A.C. supply voltage is still applied in the instrument.

9 AF OUTPUT



AF-output connector (3,5 mm, Stereo) with break contact for loudspeaker

see section 3

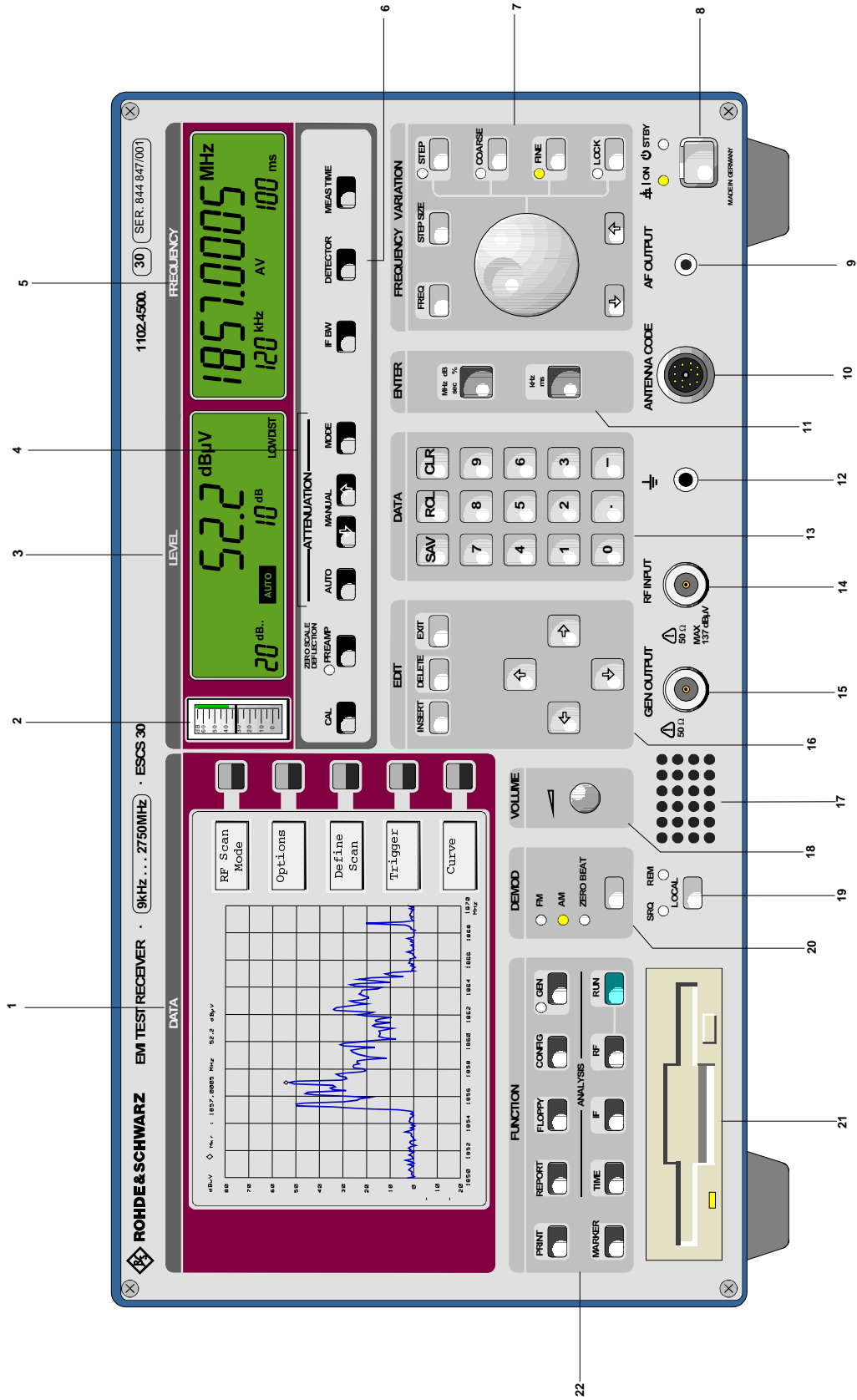


Fig. 1-1 Front view

10



Supply and code socket for connecting active and passive measuring transducers:
 Outputs: +10 V, -10 V, max 50 mA
 Inputs: Coding for level display

11



Input keys:
 MHz dB sec % Input key for the units MHz, dB, sec, % or for entries without unit
 kHz ms Input key for the units dB, kHz, % and ms or entries without unit

see section 3

12



Socket for connecting measuring earth

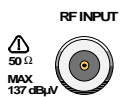
13 DATA



Numeric keypad
 SAV (0 to 9): Storing of instrument settings
 RCL (0 to 9): Calling of stored settings
 CLR: Deleting the character last entered
 0to9: Numeric input keypad
 -: Minus sign
 .: Decimal point

see section 3

14 RF INPUT



RF-input, N-input socket

see section 3

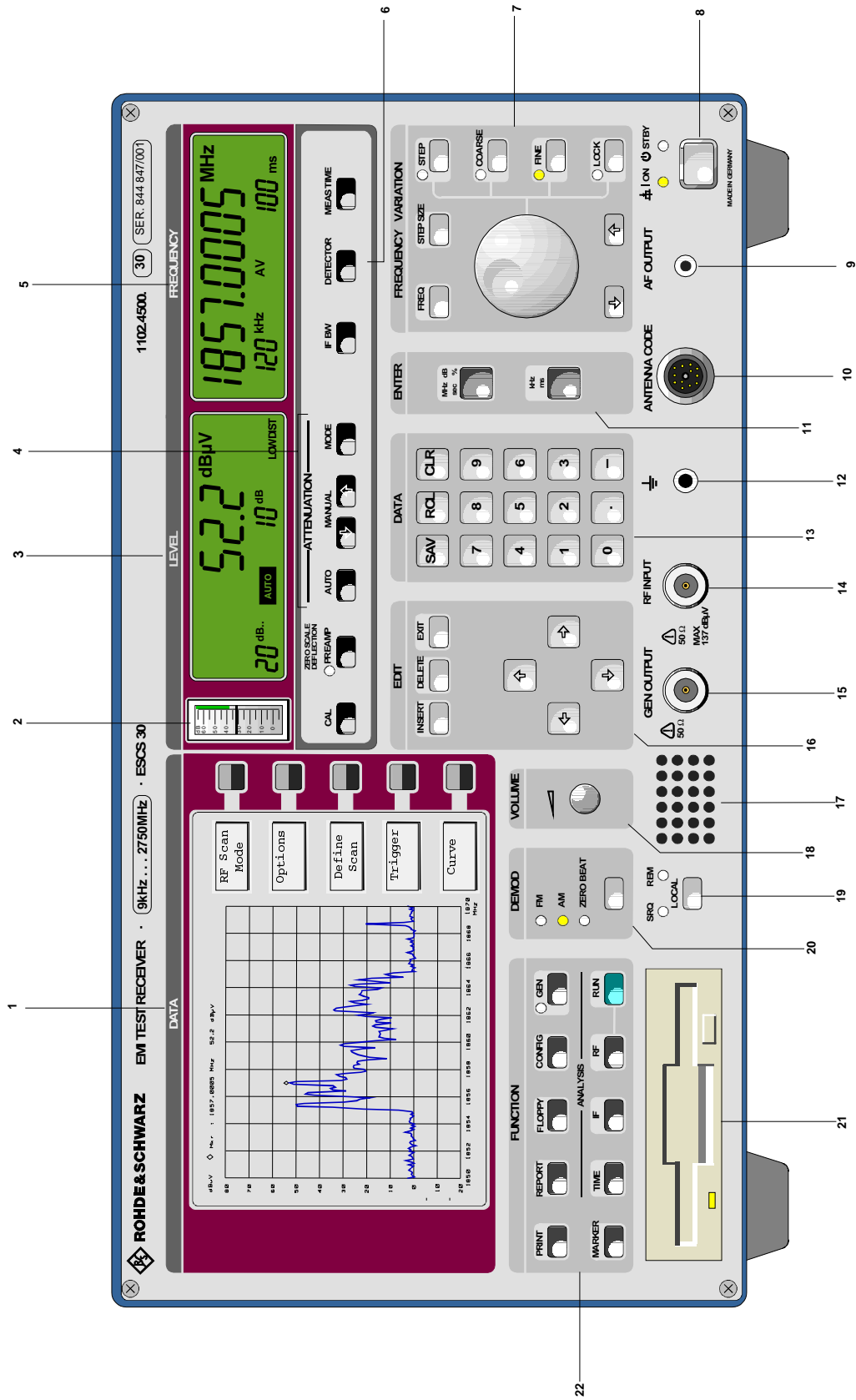


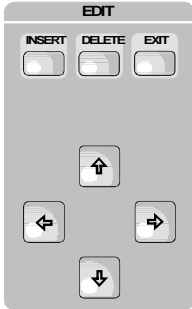
Fig. 1-1 Front view

15 GEN OUTPUT



Generator output, N socket

16 EDIT



Editing functions:

- EXIT: Exiting the current menu
- INSERT: Inserting in already existing lists
- DELETE: Deleting input lines or characters
- ⇒: The cursor moves to the right or to the next submenu; the marker moves one pixel to the right
- ⇐: The cursor moves to the left or one menu back; the marker moves one pixel to the left
- ↑: The cursor moves one line up; the marker moves 40 pixels to the right
- ↓: The cursor moves one line down; the marker moves 40 pixels to the left

17



Internal loudspeaker, which is switched off when a connector is inserted into the socket AF OUTPUT

18 VOLUME



Rotary knob for setting the volume.

see section 3

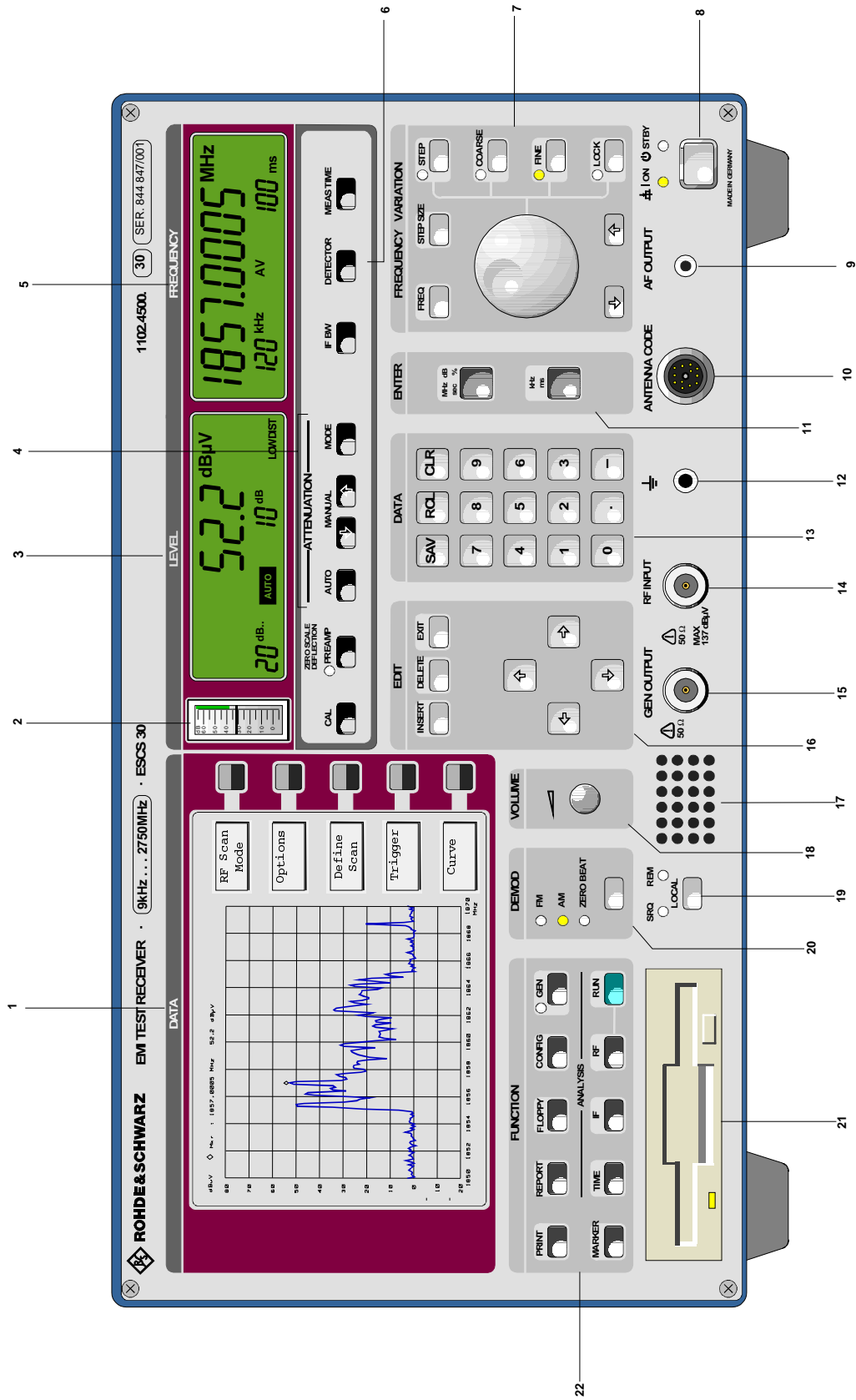


Fig. 1-1 Front view

19 VOLUME



- LOCAL: Key for switching from remote control to manual operation | see section 3
- SRQ: LED indicates service request present at IEC-bus
- REM: LED for indicating remote control of ESCS

20 DEMOD



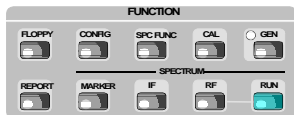
- FM: Indicates when FM-demodulation is switched on | see section 3
- AM: Indicates when AM-demodulation is switched on
- ZERO BEAT: Indicates when zero beat demodulation is switched on
- Key for switching over the demodulation mode and calling the demodulation menu

21



- Disk drive 3¹/₂ inch, 1.44 Mbyte, MS-DOS-compatible formatting | see section 4

22



- CONFIG: Calling of softkey menu for the default setting and for editing of transducer factors | see section 4
- FLOPPY: Calling of softkey menu for operation of disk drive
- REPORT: Calling of softkey menu for operation of a printer or plotter for the output of measurement results
- MARKER: Calling of softkey menu for operation of the marker
- IF: Calling of IF analysis
- RF: Calling of the menu for configuration of RF analysis
- RUN: Starting the automatic test runs

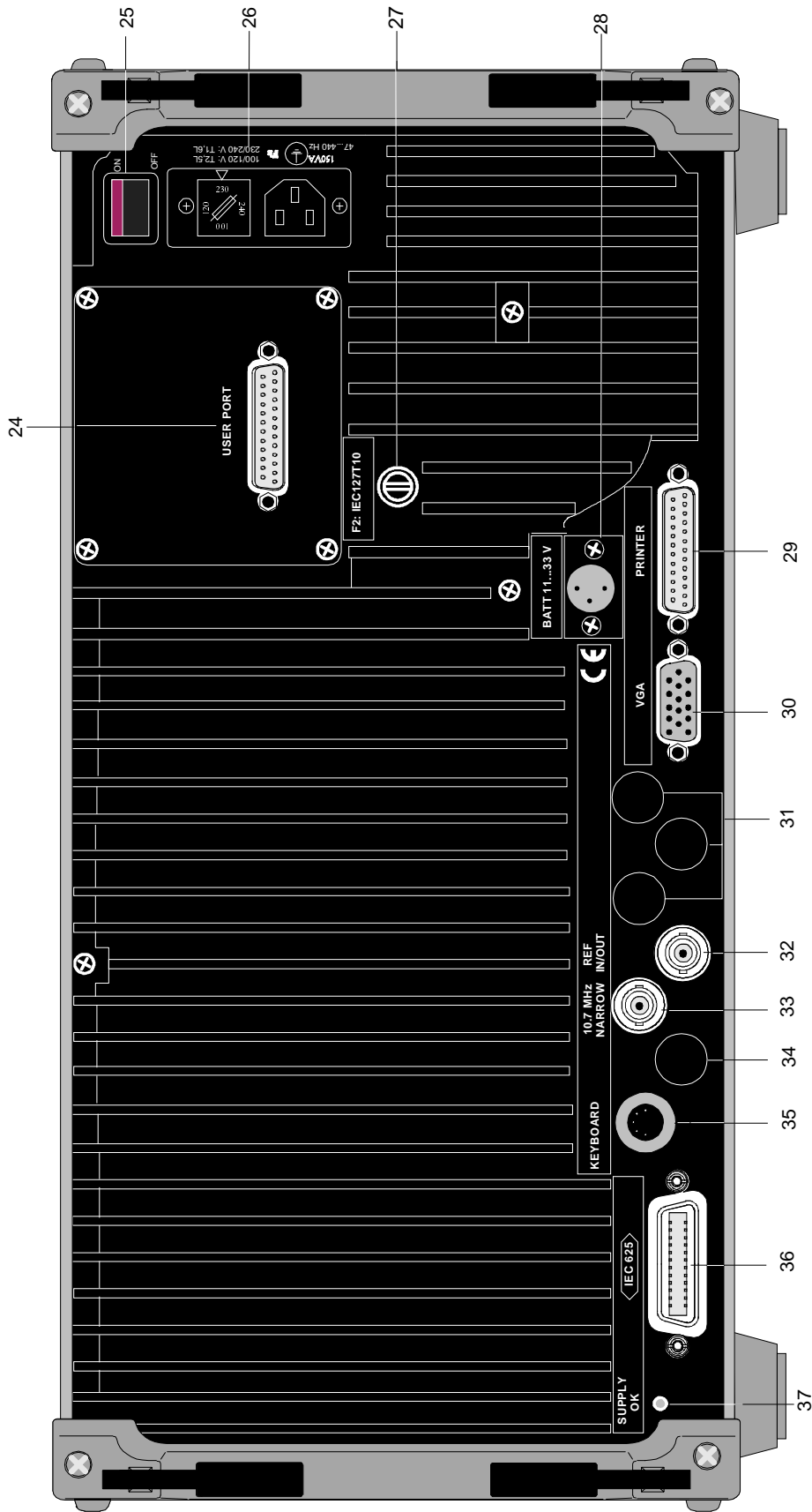
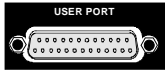


Fig.: 1-2 Rear view

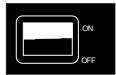
Rear view

24 USER PORT



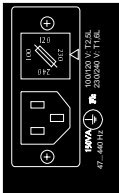
User interface with various inputs and outputs, 25-contact socket

25 ON/OFF



Power switch

26



Power input with integrated voltage selector and power fuse

see section 1

27 F2



Fuse for the external battery, IEC127T10H 250 V

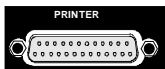
28 BATT



Input for an external battery 11 to 33 V, 3-contact special connector

see section 1

29 PRINTER



Parallel interface for connection of a printer, 25-contact socket

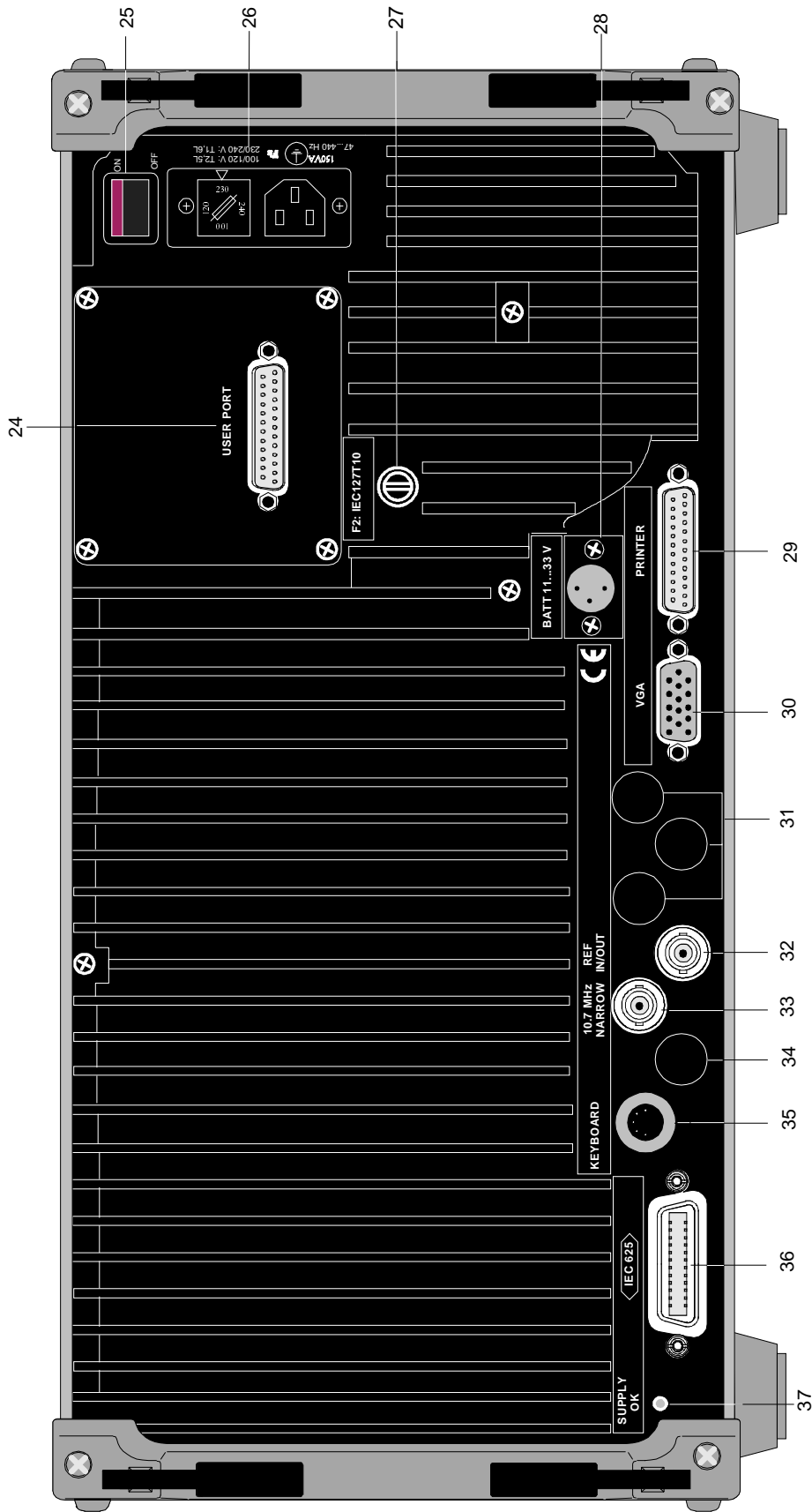
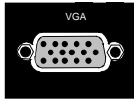


Fig.: 1-2 Rear view

30 VGA

Socket for connection of an external monitor

see section

31

not used

32 REF IN/OUT

10-MHz reference input/output

33 10.7 MHz NARROW

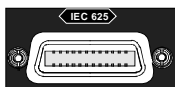
BNC socket for IF output 10.7 MHz, bandwidth corresponds to the IF bandwidth set (200 Hz, 9 kHz or 120 kHz)

34

not used

35 KEYBOARD

Connector for an external keyboard

36 IEC 625

IEC-bus interface, 24-contact socket

see section 6

37 SUPPLY OK

LED is illuminated if all internal supply voltages of the power supply are okay.

see section 1

Putting into Operation

Setting up the Receiver

If an angled power plug (R&S-stock no. DS0086.4400) and retractable supporting feet at the rear of the instrument are used, the receiver can be operated in any position.

It is however recommended to operate the receiver in the horizontal position for the following reasons:

- The LC-displays can be optimally read when seen obliquely from above; thus the best contrast can be achieved in this position.
- The temperature within the receiver is the lowest in this position, as convection through the perforations in the top and bottom cover is optimal.

For measurements carried out on the test bench, it is recommended to fold out the retractable feet at the bottom of the instrument.

Note: *To ensure proper operation of the receiver, note the following:*

- *Do not cover the ventilation openings!*
- *Ambient temperature 0 to +50 °C*
- *Avoid moisture condensation. If it however occurs, the instrument must be wiped dry before switching-on.*

Rackmounting

The receiver can be mounted into 19"-racks with the help of the rack adapter, type ZZA-95 (order no. 0369.4911.00) in accordance with the mounting instructions supplied. Since the ESCS without battery pack is not provided with a fan, it is recommended to provide for forced ventilation in the rack.

Note: *As the power switch is situated at the rear of the instrument, an all-pole mains disconnection must be near at hand for safety reasons when the receiver is mounted into the rack.*

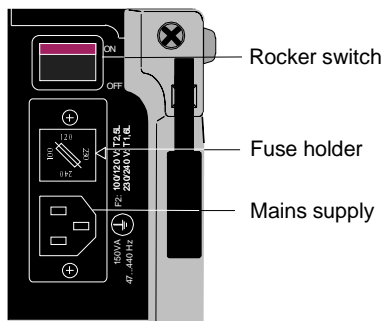
Power Supply

The receiver can be supplied either from the mains, an inserted internal battery or an external battery.

Mains Operation

The ESCS can be operated from ac supply voltages of 100 V, 120 V, 230 V and 240 V $\pm 10\%$ and frequencies of 47 to 420 Hz.

Prior to initial switch-on, check whether the ESCS is set to the correct supply voltage. If this is not the case, it must be set in the following way:



- Disconnect the power cable.
- Unlever the cap of the voltage selector (rear panel of instrument) using a screwdriver and pull out.
- Take the fuse out of the fuse holder.
- Insert the fuse with the required value (included in the accessories supplied).
For 100 to 120 V a fuse IEC 127 T2.5L,
for 230 to 240 V a fuse IEC 127 T1.6 is required.
- Insert the voltage selector such that the white arrow on the fuse holder points to the desired voltage.

Operation with Internal Battery

The ESCS can be operated from three integrated NiMH battery packs. These are charged during mains operation (standby or instrument switched on) and during external battery supply. They also serve as backup batteries in the case of a power failure.

During mains operation in standby mode, the charging time of completely flat batteries is approx. 3 hours and, with the instrument switched on (mains or battery supply), approx. 6 hours. When the instrument is operated from the internal batteries, an operating time of the receiver or more than 3 hours is to be expected if the batteries are fully charged (basic instrument with 3 battery packs). If the battery voltage falls below 10.8 V, the receiver is automatically switched off in order to prevent the batteries from being totally discharged and damaged. The STANDBY LED on the front panel flashes after switching-off to indicate that the batteries need be charged.

Note: *In order to optimize the lifetime of the battery, a discharging/recharging cycle must be carried out monthly. Batteries which are not used for a longer period of time should be deactivated (see service manual „Instrument“)*

Display of the Residual Operating Time

During charging and discharging, the battery capacity is permanently measured. In conjunction with the current power consumption, the measured value is used to calculate the operating time, which is output in hours and minutes next to the diagram.

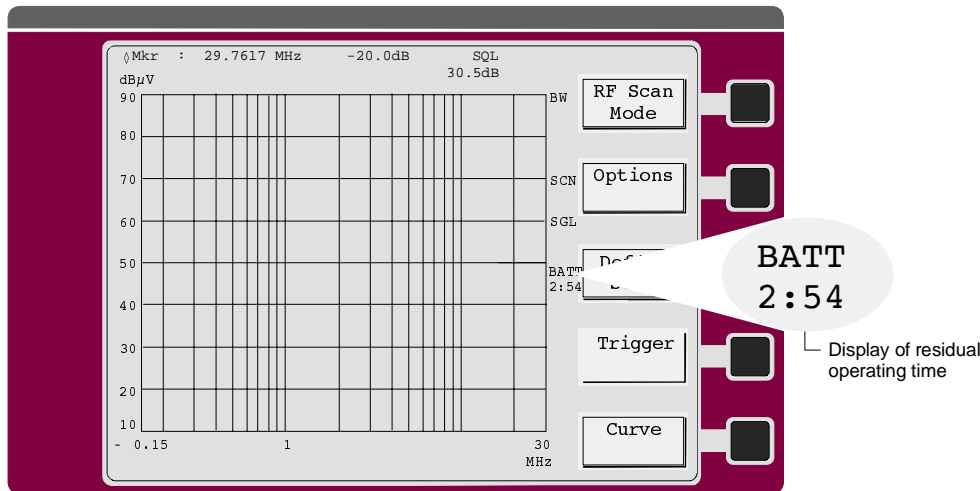
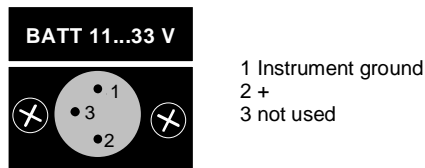


Fig. 1-3 State of charge of the batteries

Operation with External Battery

The instrument can be supplied from an external d.c. voltage source via the connector BATTERY 11...33 V situated at the rear of the instrument. Due to the wide voltage range it can be supplied both from a 12-V-battery and a 24-V-battery. The battery connector required is included in the accessories supplied. The battery is connected to the instrument in the following way:



The receiver is protected against reverse voltage applied to the battery connector, i.e. a wrongly connected supply will not lead to damages.

Spare fuses for operation with external battery are contained in the accessories (IEC 127 T 10H 250 V).

If the a.c. supply is connected to the receiver at the same time, the latter is supplied only from this supply. The external battery is then not charged. Battery back-up with external battery is possible, but whenever a.c. supply is switched over to external battery an instrument reset takes place.

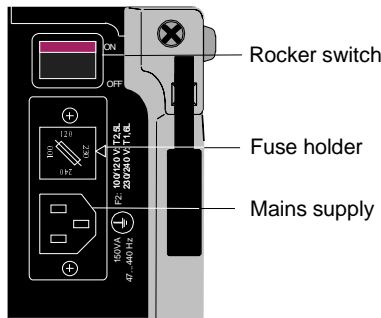
During operation the external battery voltage can be continuously increased from 11 V to 33 V without the instrument switching off. When, however, the voltage is increased to more than 15.5 V or decreased to below 14.5 V, an instrument reset occurs, which is due to the internal switch-over of the switching power supply from 24-V-operation to 12-V-operation. When the receiver is supplied from a 12-V or 24-V battery, this is not of importance as in this case the voltages stated above never occur. If the instrument is however operated from an external generator, this fact must be considered.

Note: The ESCS can only be switched on if the voltage at the battery connector is at least 12 V. During operation, the voltage may be maximally reduced to 11 V. This is due to an internal switch-on hysteresis which prevents the instrument from being switched on and off continuously with an almost flat battery. In practice, this does not imply any restriction, since the open-circuit voltage of an intact 12-V battery is always at least 12 V.

Switching-on

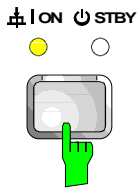
A.C. supply operation

Power switch at rear of instrument



- Connect the power cable to the mains supply.
- Set the rocker switch to ON. After switching on (ON position), the instrument is in standby mode (LED STANDBY is illuminated) or in operation (LED ON is illuminated), depending on the position of the ON/STANDBY switch at the front of the instrument (see above).

Note: The power switch may remain switched on continuously. Switching off is only required if the instrument is to be completely disconnected from the mains.



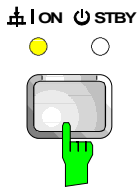
- Press the ON STBY key (front panel). The receiver is switched on and the LED on the front panel is illuminated. If the power supply functions properly, the LED SUPPLY OK on the rear panel of the instrument is illuminated, indicating that all internal voltages are within the permissible range.



Warning:

In standby mode, the AC supply voltage is still applied in the instrument.

Operation with internal or external battery



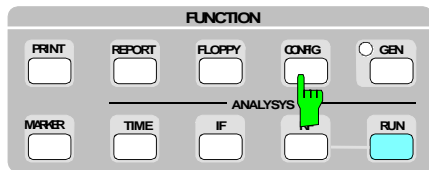
If the receiver is operated from internal or external battery (a.c. supply is not connected), it is switched on using the ON STBY switch on the front panel. The power switch on the rear panel is without any meaning. If the instrument is switched on, the LED ON flashes. If the voltage of the internal battery or the external supply is not sufficient for operation, the LED STANDBY flashes and thus indicates that the battery must be charged.

After switching on, the R&S logo and the instrument type appear on the screen for a few seconds. Then the ESCS changes to the operating mode that was valid prior to switch-off.

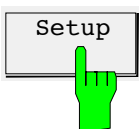
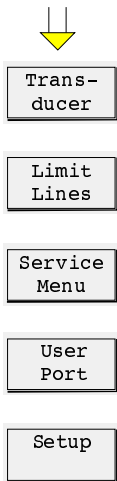
Selecting the Instrument Presetting

The SETUP menu permits to display and, if applicable, perform the following settings:

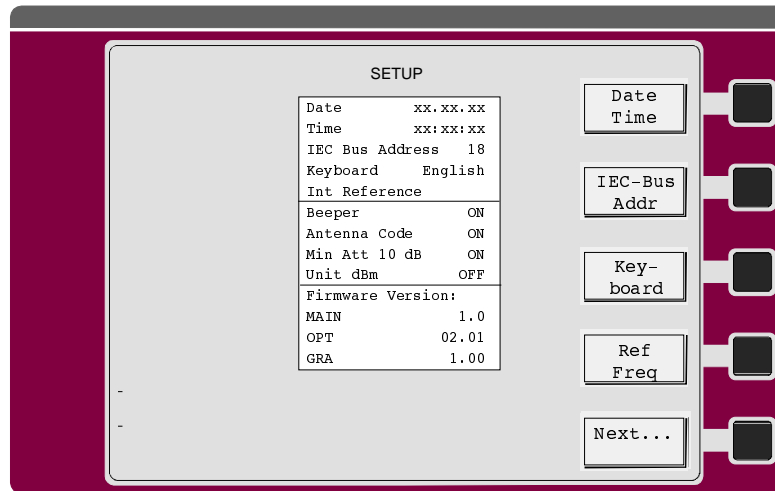
- date and time,
- display of battery operating time in the case of internal battery operation
- selection of the IEC-bus address (*IEC 625*),
- configuration of the external keyboard,
- operation with external reference,
- setting of user port switching inputs (see section 4)
- display of firmware version
- switch-on of beeper
- configuration of antenna code connector
- switch-on of minimum RF attenuation and
- switch-on of display unit dBm.



- Press CONFIG key.
The CONFIG menu appears on the screen.



- Press *Setup* softkey.
The following submenu appears:



Date and time are continuously updated in the table. The currently used reference (*internal reference* or *external reference*) is switched over with the reference setting. The current version of the 3 different data sets in the memory is displayed with the firmware versions:

MAIN: Version of the instrument firmware for the main CPU, stored in flash EPROMS and loadable with the aid of an AT-compatible PC via the serial interface of the ESCS

OTP: Boot PROM, contains the loading program for the flash EPROMS, cannot be reloaded externally.

GRA: Firmware for the graphics, stored in flash EPROMS and loadable with the aid of an AT-compatible PC via the serial interface of the ESCS.

Date, time, IEC-bus address, keyboard and reference input and output can be set as follows.

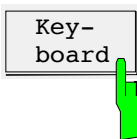
Operation:



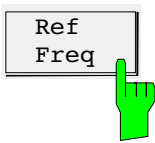
- Press the *Date Time* softkey.
- Enter the date in the format day.month.year via the numeric keypad. The cursor jumps to the time.
- Enter the time in the 24-hour format in hours:minutes:seconds via the numeric keypad.



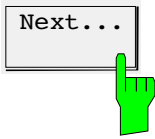
- Press the *IEC Bus Addr* softkey. The cursor jumps to the IEC-bus address.
- Enter the IEC-bus address. Values between 0 and 31 are permissible for the IEC-bus address. The default setting is 18.



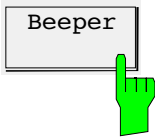
- Press the *Keyboard* softkey. The keyboard assignment changes from English to German or vice versa.



- Press the *Ref Freq* softkey.
The reference frequency is switched over. Default setting is Internal.

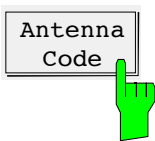


- Press the *Next...* softkey.
The softkey menu is switched over.

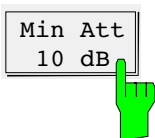


- Press the *Beeper...* softkey.
The internal beeper, which draws the attention of the user to various states of the instrument, is switched on. A beep can be heard in the following cases:
 - end of a frequency scan,
 - end of a plotting process,
 - end of a printing process,

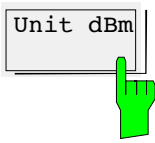
It is however required that the AF is switched on. The loudness of the beep is independent of the volume setting, i.e. if the demodulated AF-signal is not desired, the volume control can be turned down completely.
Default setting is OFF.



- Press the *Antenna code...* softkey.
The coding of the conversion factor is switched off. Transducers from Rohde & Schwarz, such as the Current Probe ESV-Z1 or the Broadband Dipole feature an approximately constant conversion factor in their specified frequency range. It can be considered using a coding plug at the ANTENNA CODE socket. The individual conversion factor can be entered via the transducer factor (cf. section 3 „Operation of the Menu Functions“). Coding at the ANTENNA CODE socket is then always ineffective regardless of the setting of the special function.
Default setting is ON.



- Press the *Min Att 10 dB* softkey.
This function permits to configure the minimum RF attenuation in autorange mode and when switching on the instrument.
The minimum RF attenuation of 10 dB selected for protection of the input mixer after switching-on of the instrument and in autorange mode (see section 3 „Automatic attenuation setting“) can be rendered ineffective by switching to OFF when an external pulse limiter is used or in the case of RFI field-strength measurements. If the receiver is switched off with an attenuation of 0 dB, this attenuation is reset after the instrument is switched on again. Even when using the Scan Option RFI Voltage the 0-dB attenuation can be switched on.



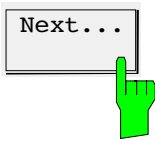
- Press Softkey *Unit dBm*.

The unit dBm is used for the power level at 50 Ω . The voltage indicated in the selected indicating mode together with the rated input resistance of 50 Ω is only converted into the respective power level. Solely the power of a signal that has not been amplitude-modulated is correctly indicated. The ESCS measures the true RMS value using the RMS detector (Option ESCS-B9).

As the unit can only be used for power levels related to 1 mW, the special function is only effective when no unit is coded at the ANTENNA CODE socket. The unit is also only active with transducer factors with the unit dB, i.e. only four-terminal networks with specified power attenuation or power gain can be taken into account.

When coding a unit at the ANTENNA CODE socket or entering a unit other than dB in the transducer factor, the unit dBm becomes ineffective and the selected unit is displayed.

Default setting is OFF.



- Press the *Next...* softkey.
The softkey menu is switched over.

Connecting External Devices

Connecting the Transducers (ANTENNA CODE)

The ANTENNA CODE socket is provided for the supply and coding of the transducer factors of transducers. It serves to code the transducer factor of high-impedance probes, current probes and antennas in 10-dB steps. In addition, the receiver is informed on the quantity to be measured (field-strength, current and voltage). Active transducers can be supplied with ± 10 V from this socket.

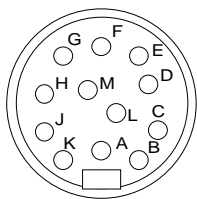
The following R&S accessories are available with suitable coding:

- | | | |
|---------------------|-------------------|----------|
| • Passive Probe | 9 kHz to 30 MHz | ESH2-Z3, |
| • Active Probe | 9 kHz to 30 MHz | ESH2-Z2, |
| • Rod Antenna | 9 kHz to 30 MHz | HFH2-Z1, |
| • Rod Antenna | 9 kHz to 30 MHz | HFH2-Z6, |
| • Loop Antenna | 9 kHz to 30 MHz | HFH2-Z2 |
| • Broadband Dipole | 20 to 80 MHz | HUF-Z2 |
| • RF Current Probe | 100 kHz to 30 MHz | ESH2-Z1 |
| • VHF Current Probe | 20 to 300 MHz | ESV-Z1 |
| • Current Probe | 20 Hz to 100 MHz | EZ-17 |
| • Preamplifier | 10 to 1000 MHz | ESV-Z2. |

It is, however, recommended to enter the exact conversion factor via the transducer factors to achieve higher measurement accuracy (cf. section 4).

The coding can be rendered ineffective by deselecting *Antenna Code softkey*. This is useful if with an active transducer the supply is to be used, however the coding is not desired. If a transducer is used during the measurement, the coding at the ANTENNA CODE socket is automatically rendered ineffective.

For fieldstrength measurements in shielded rooms, if the ESCS is operated outside the room, the shield of the supply and coding cable must be fed through the screen of the room, such that there is no emitted interference inside the room. The ANTENNA CODE socket is assigned as follows:



- A ground
- B +10 V, max. 50 mA
- C $\mu\text{V}/\text{m}$ (electr. field str.)
- D μA
- E 10 dB
- F 20 dB
- G 40 dB
- H 80 dB
- K - 10 V, max. 50 mA
- M - Sign reversal of factor

Fig. 1-4 Assignment of 12-contact Tuchel-type female connector

A 12-contact connector (Tuchel-type, R&S order number 0018.5362.00) is used. The inputs for the code must be connected to ground.

Example: An antenna for electric field-strength measurements has an antenna factor of 10 dB, i.e. a field strength of 10 dB μ V/m produces a voltage of 0 dB μ V at the RF input.

- Connect pins C and E to ground.

Connecting a Keyboard



Caution: Connect the keyboard only with the instrument switched off (STANDBY). Otherwise, faulty functions of the keyboard cannot be excluded.

The test receiver permits to connect an external PC keyboard via the 5-contact DIN socket (KEYBOARD) at the rear of the instrument.

In measurement mode, the keyboard simplifies the input of comments, file names etc.

The keyboard connector (KEYBOARD) is located at the rear of the instrument.



Pin	Signal
1	Keyboard Clock
2	Data
3	free
4	ground
5	+5-V supply

Fig. 1-5 Assignment of the KEYBOARD socket

Configuration of the External Keyboard

The mode of the external keyboard can be switched between English and German using one of the ENTER keys toggling the function "Keyboard English" / "Keyboard German". The setting also affects the Auxiliary Line Editor (see Section 3)

Connecting a Printer

The 25-contact socket PRINTER INTERFACE at the rear panel of the receiver is provided for connecting a printer. The interface is compatible with the CENTRONICS-interface. A special cable can be supplied for connecting the interface to the printer.

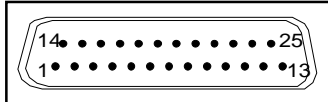
The ESCS supports the printer types laser jet, desk jet, desk jet color and EPSON 24-needle. A large number of other printers are compatible and can also be addressed by the ESCS. The supported operating modes can be obtained from the manual of the printer in question.

Connection to the USER INTERFACE

The USER INTERFACE at the rear panel of the ESCS is a 25-contact CANNON socket, to which five different signal groups are assigned. It contains the following interfaces:

- Serial Interface (RS232-C) for loading the firmware,
- Internal serial bus for control of accessories,
- 6 parallel TTL-control lines (port 1 to port 6),
- +5-V- and +12-V-voltage for supply of external devices and
- analog outputs for the display voltage.

The pin assignment is shown in the following figure:



Pin	Signal	Input (I) Output (O)	Meaning
1	EXTTRIG	I	Ext. trigger, switchable pos./neg trigger
2	RxD	I	Receive Data; transmits ASCII-data from computer to ESCS
3	TxD	O	Transmit Data; transmits ASCII-data to computer
4	$\overline{\text{DSR}}$	I	Data Set Ready
5	$\overline{\text{DTR}}$	O	Data Terminal Ready
6	$\overline{\text{RTS}}$	O	Request to Send
7	AGND		Analog Ground
8	-	-	-
9	-	-	-
10	-	-	-
11	-	-	-
12	DGND		Ground
13	+5 V	O	Supply for external accessory, $I_{\text{max}}=0,1 \text{ A}$
14	PORT1	O	User port Data 1
15	PORT2	O	User port Data 2
16	PORT3	O	User port Data 3
17	PORT4	O	User port Data 4
18	PORT5	O	User port Data 5
19	PORT6	O	User port Data 6
20	$\overline{\text{CTS}}$	O	Clear to Send
21	-	-	-
22	RI	I	Ring Indicator
23	REC1	O	Recorder Output Voltage proportional to level with 50 mV/dB and 3.75 V with full-scale deflection on meter
24	AGND		Analog Ground
25	+12 V	O	Supply voltage for accessories, $I_{\text{max}}=0.1 \text{ A}$

Fig. 1-6 Assignment of the user interface X 37 (USER INTERFACE)

Function Test

The function test of the ESCS is carried out in the following steps:

- Automatic test when switching on the receiver,
- Total calibration, which ensures correct operation when it has been successfully completed, and
- Self-test, which, once it is called up by the user, checks all of the modules at significant points and indicates errors via display.

When switching on the receiver all functions of the processor are initialized and thus simultaneously checked and the test A/D-converter automatically adjusted.

The calibration process as well as the self-test process and the error messages are described in section 3.

Cold Start: Pressing the decimal point in the numeric keypad during switch-on sets all the functions of the ESCS to their default status. The memory with battery back-up is cleared, i.e. all the stored settings, limit lines and transducer factors get lost. An extensive computer hardware test is subsequently performed in addition to the normal switch-on test. The message *INI COLD* is read out in the LEVEL display during the test. If a computer hardware error not permitting further operation was detected, the message ERR CPU is output in the display. After successful completion of the extended switch-on test, the receiver is set to its default status.

Note: *After a "cold start" of the receiver (or when a new firmware has been loaded), a total calibration is to be performed as the correction values were completely erased.*

2 Examples of Application

The RF analysis options are used to determine the optimal test runs for the various ranges of application of the ESCS.

The semi-automatic test runs described in the following can be used if the interference is stable within the measurement time. It is recommended to perform a manual measurement for intermittent, quickly drifting and cyclical interference with long cycle times.

Automatic measurements serve the following purposes:

- Saving time
- Reliability and accuracy
- Reproducible results
- Automatic and complete result display

RFI measurements may require a lot of time because the time constants prescribed by the standard for quasi-peak weighting cause transient effects that lead to long measurement times per measured value. Moreover, the standards prescribe search procedures in order to search for local RFI maxima, e.g. shifting of the absorbing clamp, variation of the antenna height and rotation of the EUT. Measuring with

In this chapter, solutions for typical EMI measurement tasks are outlined. The operating steps to take on the test receiver for solving these measurement tasks are explained in detail in section **"Basic Operating Steps for Performing Automatic Measurements"** further down in this chapter.

The following applications are described:

- Measuring the RFI voltage in the frequency range up to 30 MHz
- Measuring the RFI current in the frequency range up to 30 MHz
- Measuring the RFI voltage or RFI current in the frequency range above 30 MHz
- Measuring the RFI field strength in the frequency range up to 30 MHz
- Measuring the RFI field strength in the frequency range above 30 MHz
- Measuring the RFI power using the absorber clamp
- Measuring the magnetic interfering emission in the frequency range between 9 kHz and 30 MHz

Measuring the RFI voltage in the frequency range up to 30 MHz

RFI voltage measurements up to 30 MHz are performed either using line impedance stabilization networks or probes with an impedance of 1.5 kΩ or ≥100 kΩ.

The following R&S accessories are used for RFI voltage measurements:

- 200-A 4-line V-network ENV4200
- Active probe, $R_e \geq 100 \text{ k}\Omega$ ESH2-Z2
- Passive probe, $R_e = 1.5 \text{ k}\Omega$ ESH2-Z3
- 4-line V-network ESH2-Z5
- T-network ESH3-Z4
- 2-line V-network ESH3-Z5
- V-network 5 $\mu\text{H}/50\Omega$ ESH2-Z6
- 4-wire T-network EZ 10

The probes and V-networks are used for measurement of the non-symmetrical, the T-network for measurement of the asymmetrical RFI voltage. In general, the frequency range of RFI voltage measurements is restricted to a range from 9 kHz to 30 MHz in national and international standards. RFI voltage measurements on motor vehicle accessories are performed up to 108 MHz.

Detailed information on which line impedance stabilization networks to be used in which cases is to be obtained from the latest standards - CISPR standards, European standards, VDE regulations, FCC Rules & Regulations, VCCI recommendations and other.

Test setup

In order to avoid measurement errors due to ambient interference, the EUT and the measuring device (LISN or probe) should be operated in a shielded room, the test receiver and the printer/plotter outside.

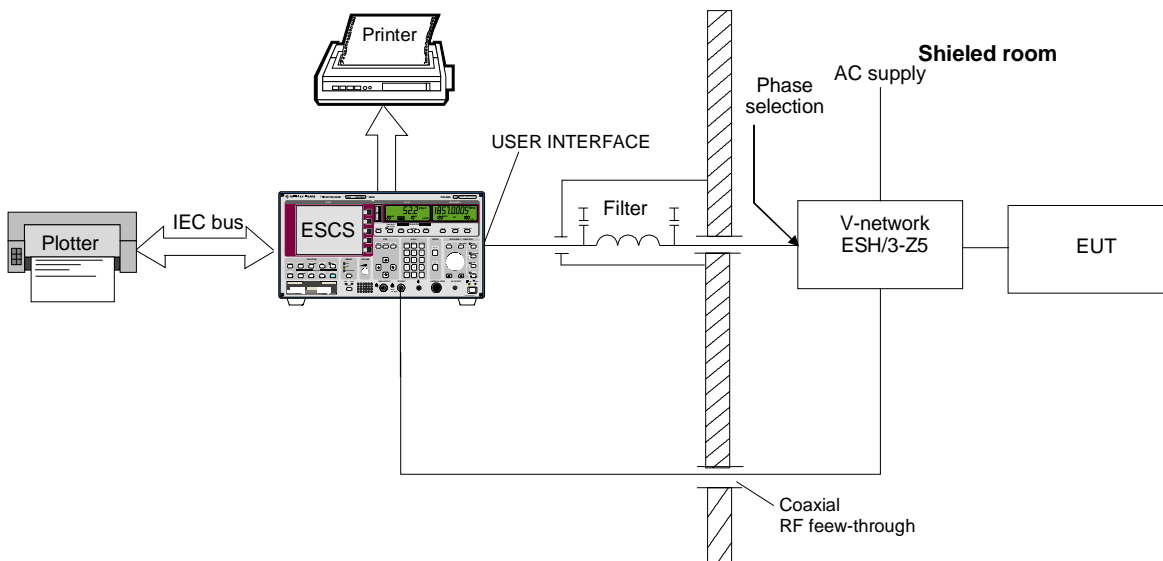


Fig. 2-1 Block diagram of a test setup with V-network and EUT in a shielded room

As a result of its low RF leakage, the Test Receiver ESCS can also be placed inside the shielded room. However, simultaneous operation of printer and plotter in the shielded room may cause problems if they are arranged unfavorably. In this case, the test report should be output after the measurement.

For automatic phase selection with the V-networks ESH2-Z5 and ESH3-Z5 the following connections between the ESCS user interface and the V-networks are used:

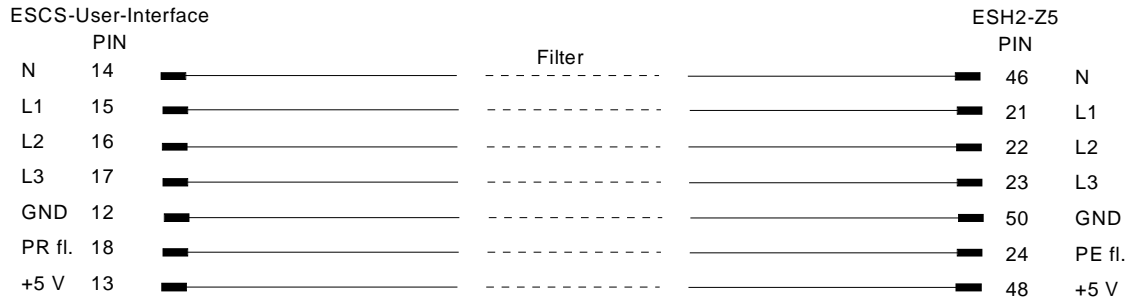


Fig. 2-2 Connection ESCS with ESH2-Z5 (for direct connection without filter: cable EZ-13)

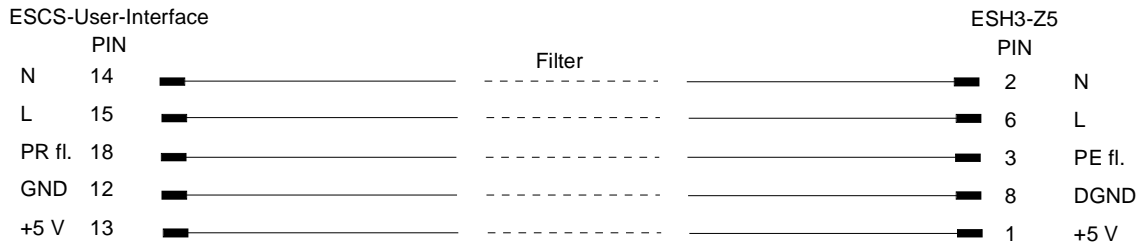


Fig. 2-3 Connection ESCS with ESH3-Z5 (for direct connection without filter: cable EZ-14, mod. 02)

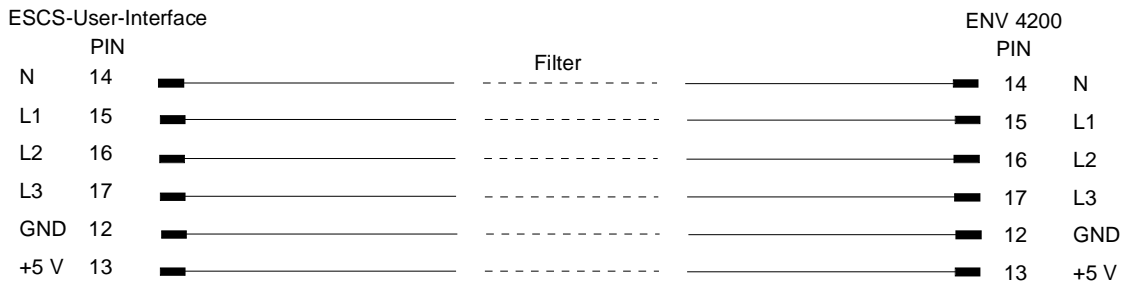


Fig. 2-4 Connection ESCS with ENV4200 (for direct connection without filter: cable EZ-21)

For controlling the phase selection and the PE simulating network of the V-networks ESH2-Z5 and ESH3-Z5, the +5-V supply voltage and some control lines are to be routed through the wall of the shielded room.

The connection cables EZ-14 and EZ-5 can be provided for the 4-line V-network ESH2-Z5, the connection cable EZ-14 and EZ-6 for the two-line V-network ESH3-Z5.

Recommended arrangement of the connection cables EZ-147EZ-5/EZ-6/EZ-21

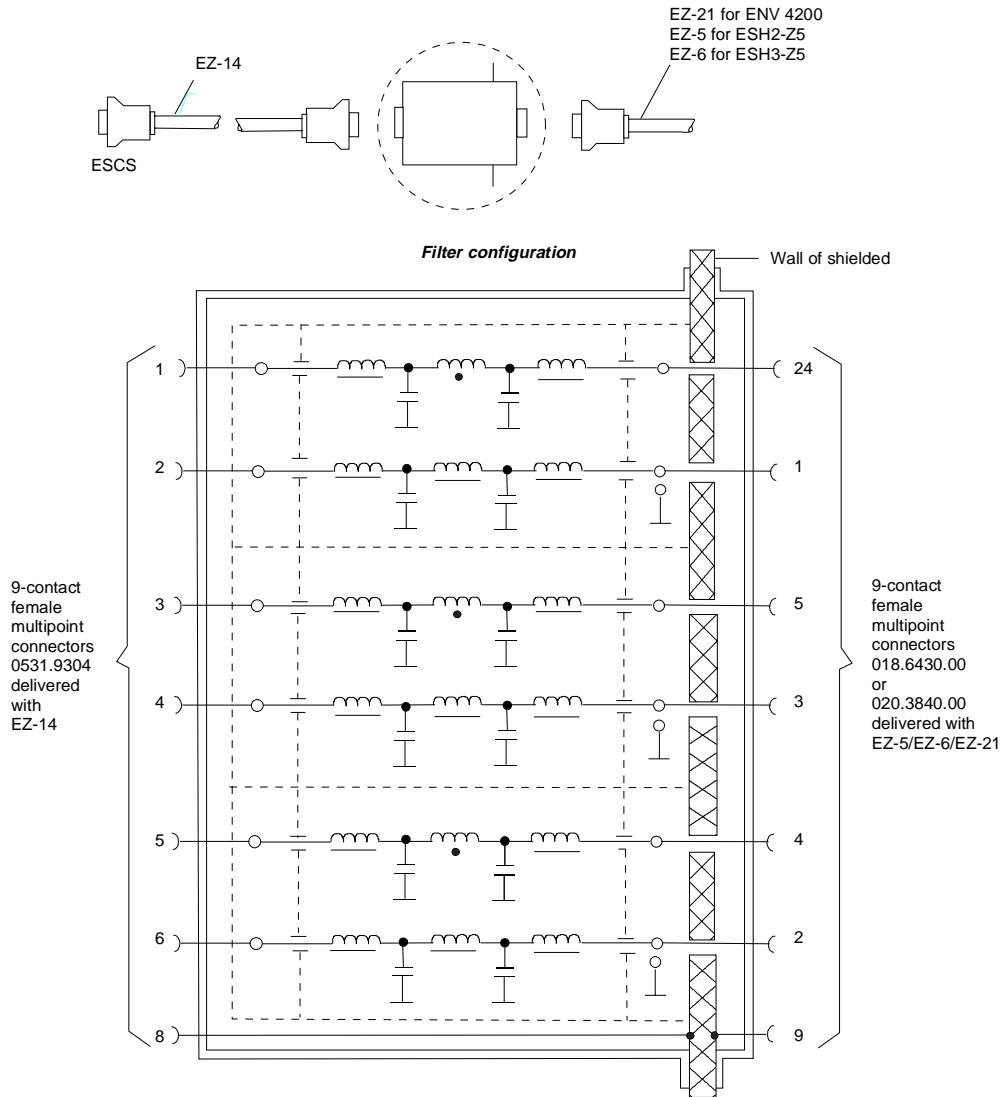


Fig. 2-5 Assignment of connection cables EZ-5, -14 and -21 with AF filters for feeding the 5-V supply and the control information for the V-networks ESH2-Z5, ENV4200 and ESH3-Z5 into a shielded room.

Note: When the ESCS is used inside the shielded room, the filter configuration is omitted. The cable EZ-14 is then used for controlling the ESH3-Z5, the cable EZ-13 for controlling the ESH2-Z5 and the cable EZ-21 for controlling the ENV-4200.

Recommendation for lowpass filters for feed-through into the shielded room:
 Siemens Order No.: B 84312-C30-B3 and B 84312-F30-B3 includes lowpass filters for 2 lines. The ESH2-Z5 thus requires 3 pieces, the ESH3-Z5 2 pieces.
 The test setup of the EUT in the shielded room is specified in the relevant standards, e.g. CISPR 16-2.

Setting of the test receiver

Scan

The scan setting of the test receiver determines the prescan data. In general, it comprises the frequency range from 0.15 to 30 MHz or two ranges from 0.009 or 0.01 to 0.15 and 0.15 to 30 MHz for the RFI voltage measurement and the range from 0.45 to 30 MHz for measurements to FCC Part 15.

Further data:

Frequency range/MHz	0.009 - 0.15	0.15 - 30
Step size/kHz	0.1	5 ¹⁾
Bandwidth (IF BW)/kHz	0.2	9
Detector	Pk + Av	Pk + Av ²⁾
Meas. Time/s	0.05	0.02 ³⁾
Attenuation	Auto Low Noise	Auto Low Noise

- 1) In the case of pure broadband interference, a frequency-proportional step size (LOG Step) can also be used for the measurement instead of steps of half the bandwidth.
- 2) For the measurement to standards with narrowband and broadband interference limit values or average and quasi-peak limit values, it is useful to measure the peak and average value simultaneously in one frequency scan. If only one limit value is provided, it is sufficient to switch on one detector, e.g. Pk or Av.
- 3) The measurement time per measured value depends on the type of interference signal. It should be selected such that the highest value is recorded in the case of time fluctuations. Line-synchronous pulse interference (50 Hz or 100 Hz) therefore requires minimum measurement times of 20 or 10 ms.

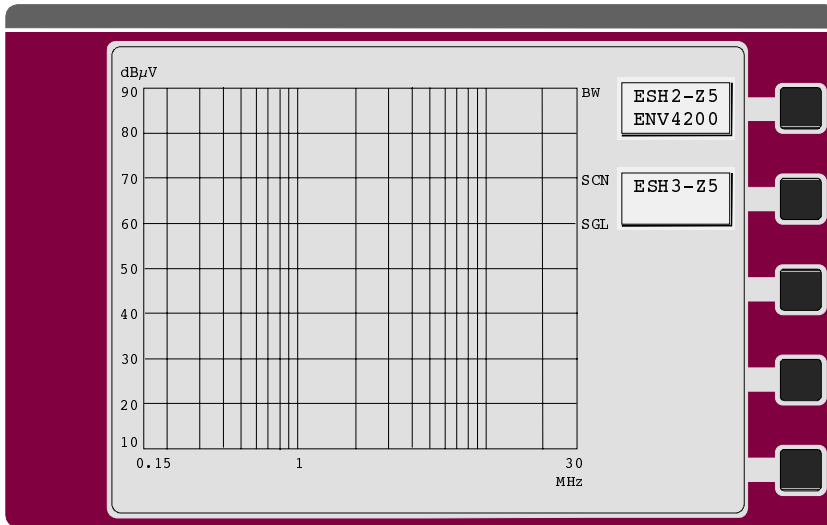
Option

The scan option RFI Voltage Test is used as follows:

- It defines the type of V-network. For measurements using a probe or a single-phase V-network, none of the V-networks ESH2-Z5, ENV4200 or ESH3-Z5 is switched on. For standards prescribing RFI current measurements it is possible to measure the RFI current instead of the RFI voltage using an RF probe by entering the transducer factor with the unit dB μ A. In this case, the V-networks need not be specified either.
- Whenever of the V-networks is active, a minimum RF attenuation of 10 dB is switched on. This reduces the risk of damaging the receiver input, which is particularly high for measurements using V-networks.
- The details for measurements using V-networks are defined (phase for prescan, phases for the final measurements).

Operation

- Press the RF key.
The *SCAN* menu is called up.
- Press the Options softkey.
The *SCAN OPTIONS* menu is called up.
- Press the RFI Voltage key.
The inscription on the *RFI Voltage* softkey turns red; the function is activated.
The first menu is called up:



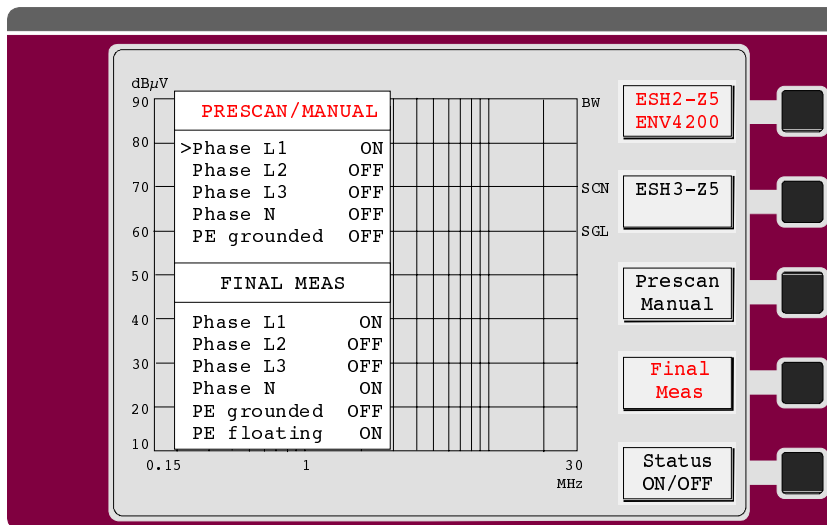
- Determine the type of line impedance stimulating network (LISN) by switching on the respective softkey.

If none of the LISNs is switched on, the RFI voltage measurement is made on one line only. This is the case if a probe, a single-phase V-network (ESH3-Z4, ESH3-Z6) or an RF probe is to be used for the measurement. Only one LISN can be selected at maximum. The next menu is only displayed if one of the two LISNs is selected.

- Press the *Prescan Manual* softkey.

The next menu is called up so that the test configuration for the prescan can be determined:

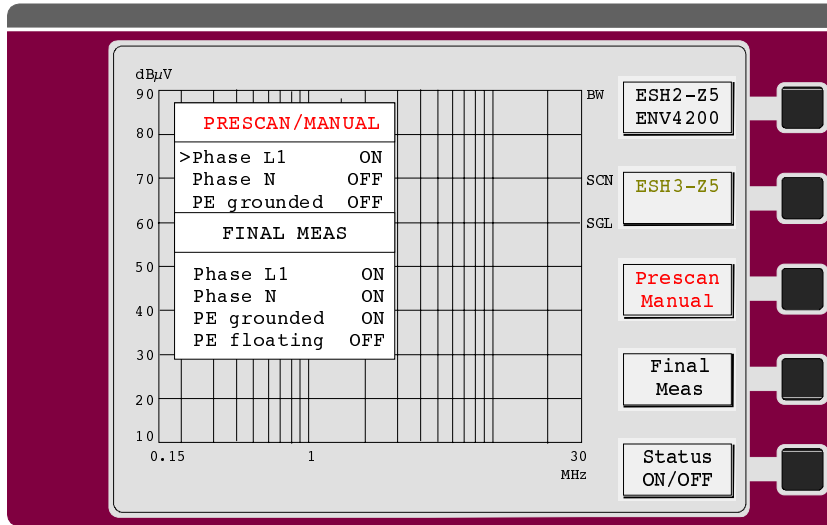
- **With the ESH2-Z5 or ENV4200:**



Only one phase can be switched on for the prescan. If "PE grounded" is set to OFF, the PE choke is switched on.

Selection of "PE floating" is not possible for ENV4200.

• With the ESH3-Z5:

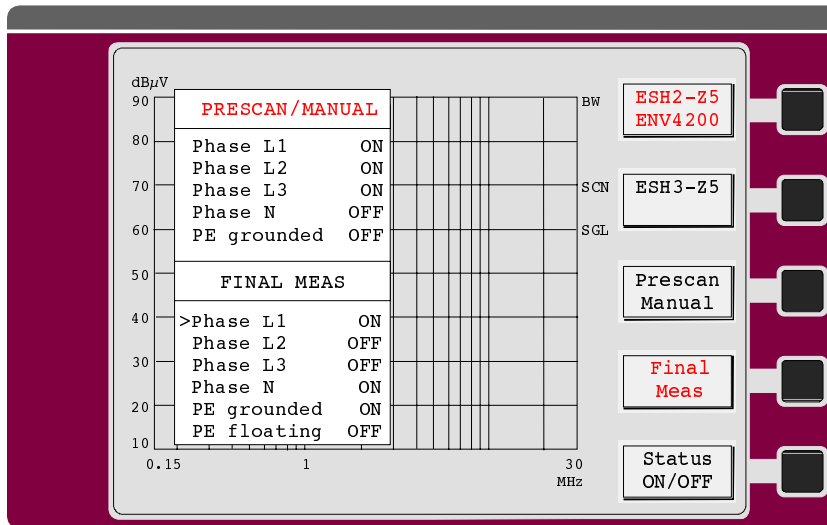


Only one phase can be switched on for the prescan. If „PE grounded“ is set to OFF, the PE simulating network is switched on.

Note: The LISN settings defined in this menu are effective directly at the user port or at the simulating network, if the latter is connected.

- Press the *Final Meas* softkey. The next menu determining the test configuration for the final measurement is called up.

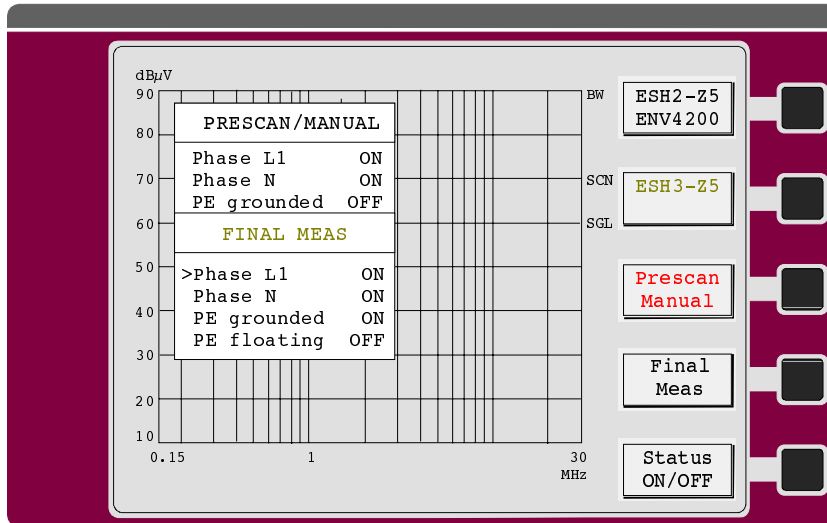
• With the ESH2-Z5 or ENV4200:



With this setting, only one phase is used for the final measurement. If both *PE grounded* and *PE floating* are set to *ON*, two measurements per phase are performed at each of the frequencies determined by means of the data reduction. This allows to determine the configuration with the highest interference voltage.

For ENV4200, *PE grounded* is the only setting possible. Selection of *PE floating* doesn't have any effect.

- With the ESH3-Z5:



In this example the measurement is made on both phases.

As V-networks provide the correct voltage level no transducer factors are required. How the final measurement is performed depends on the detector selected:

Detector Average

Comparison of the A_v values of the interference voltage on all phases provided in the *FINAL MEAS* menu with the possible PE configurations and determination of the phase with the highest A_v level at the frequency of the subrange maximum.

Detector Peak

Comparison of the QP values of the interference voltage on all phases provided in the *FINAL MEAS* menu with the possible PE configurations and determination of the phase with the highest QP level at the frequency of the subrange maximum.

Detector Average and Peak and/or Quasi Peak

With Pk maximum of subrange:

Comparison of the QP values of the interference voltage on all phases provided in the *FINAL MEAS* menu with the possible PE configurations and determination of the phase with the highest QP level.

With A_v maximum of subrange:

Comparison of the A_v values of the interference voltage on all phases with the possible PE configurations and determination of the phase with the highest A_v level.

Example for a List of Final Measurement Results in the Test Report

Scan Settings (1 Range)

Frequencies			Receiver Settings				
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp
150k	30M	5k	9k	PK+AV	20ms	AUTO LN	OFF

Final Measurement: x QP / + AV
 Meas Time: 2 s

Final Measurement Results:

Frequency MHz	QP Level dBuV	Delta Limit dB	Phase -	PE -
0.16000	14.1	-51.4	L1	gnd
0.24000	5.1	-57.0	N	gnd
0.55000	20.4	-38.5	N	gnd
1.00000	23.8	-35.1	L1	gnd
1.40000	15.7	-43.2	L1	gnd
2.00000	11.0	-47.9	N	gnd
3.50000	9.0	-49.9	L1	gnd
6.00000	16.6	-47.3	N	gnd
10.00000	32.5	-31.4	N	gnd
11.08750	36.3	-27.6	N	gnd
12.58400	22.6	-41.3	L1	gnd
20.27900	36.7	-27.2	N	gnd
21.72000	29.4	-34.5	L1	gnd
22.00000	37.9	-26.0	L1	gnd
29.90000	31.5	-32.4	L1	gnd

Frequency MHz	AV Level dBuV	Delta Limit dB	Phase -	PE -
0.16000	-0.9	-59.3	L1	gnd
0.24000	0.9	-52.5	N	gnd
0.55000	15.8	-33.1	L1	gnd
1.00000	17.8	-31.1	L1	gnd
1.40000	7.5	-41.4	N	gnd
2.00000	5.1	-43.8	N	gnd
3.50000	3.1	-45.8	N	gnd
6.00000	10.4	-43.5	N	gnd
10.00000	23.8	-30.1	L1	gnd
11.08750	34.4	-19.5	N	gnd
12.58400	16.5	-37.4	L1	gnd
20.27900	35.1	-18.8	N	gnd
21.72000	21.6	-32.3	N	gnd
22.00000	30.1	-23.8	N	gnd
29.90000	27.9	-26.0	N	gnd

* limit exceeded

Measuring the RFI Current in the Frequency Range up to 30 MHz

Test Setup

In order to avoid measurement errors due to ambient interference, the EUT and the RF probe should again be operated in a shielded room, the test receiver with printer and plotter outside.

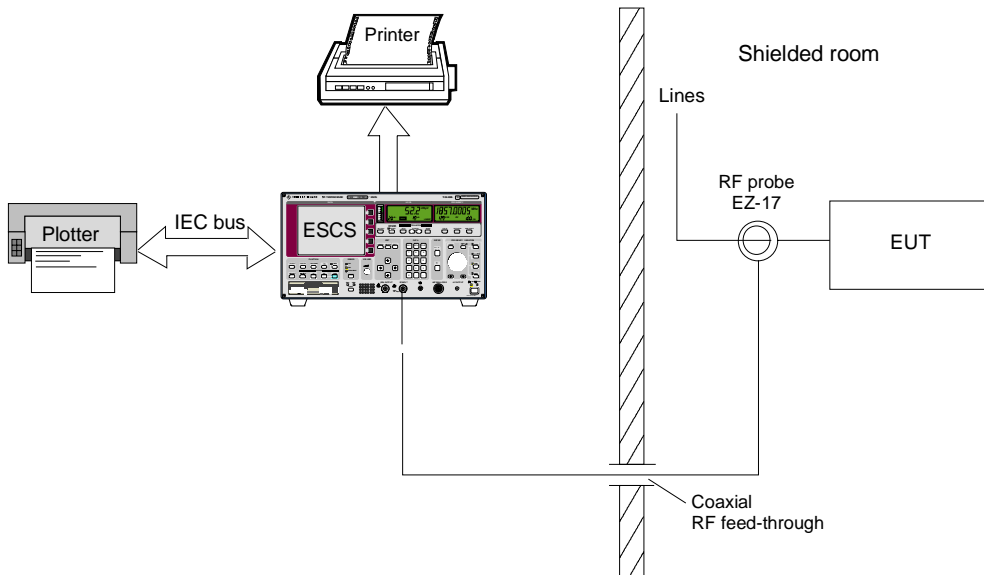


Fig. 2-6 Block diagram of a test setup with RF probe (EZ-17) and EUT in a shielded room

Setting of the test receiver

The test configuration is determined using the option RFI Voltage. As explained in the section “Measuring the RFI voltage in the frequency range up to 30 MHz”, no LISN is selected. An RF current measurement is prepared by defining a transducer with the unit dB μ A.

The scan setting determines the prescan (for recommended setting data refer to section “Measuring the RFI voltage in the frequency range up to 30 MHz”).

The selected detectors are the main criterion for the final measurement.

Test Run, Methods of Measurement and Analysis

What was said in section “Measuring the RFI voltage in the frequency range up to 30 MHz” is also valid in this case. No automatic comparison is made between interference currents on different phases because no LISN was switched on in the RFI voltage menu.

Measuring the RFI Voltage or the RFI Current in the Frequency Range above 30 MHz

In commercial standards, RFI voltage measurements in the frequency range above 30 MHz are usually made either with LISNs for this frequency range or directly on the vehicle-mounted antenna to VDE 0879 Part 2 (draft). In general, probes such as the R&S probes ESH2-Z2 and -Z3 are no longer used above 30 MHz.

The following R&S accessories can be used for RFI measurements above 30 MHz:

- T-network ESH3-Z4
- 4-wire T-network EZ-10
- V-network 5 μ H//50 Ω ESH2-Z6

The V-networks are used for measuring the non-symmetrical, the T-networks for measuring the asymmetrical RFI voltage. In general, the frequency range of RFI voltage measurements is restricted to the frequency range from 9 kHz to 30 MHz in national and international standards. RFI voltage measurements on vehicle accessories are performed in the frequency range from 150 kHz to 108 MHz.

Details on the type of line impedance stimulating network (LISN) to be used and the required test setups are to be obtained from the latest standards - CISPR publications, European standards, VDE regulations, FCC Rules & Regulations, VCCI recommendations and other.

RFI current measurements with RF probes, e.g. with the ESV-Z1 or EZ-17 have not been specified in commercial standards so far, but they are already commonly used for investigation of interference sources and testing radio interference suppression methods.

Test setup

To avoid measurement errors due to ambient interference, the EUT and the LISN should be operated in a shielded room, the test receiver with printer and plotter outside.

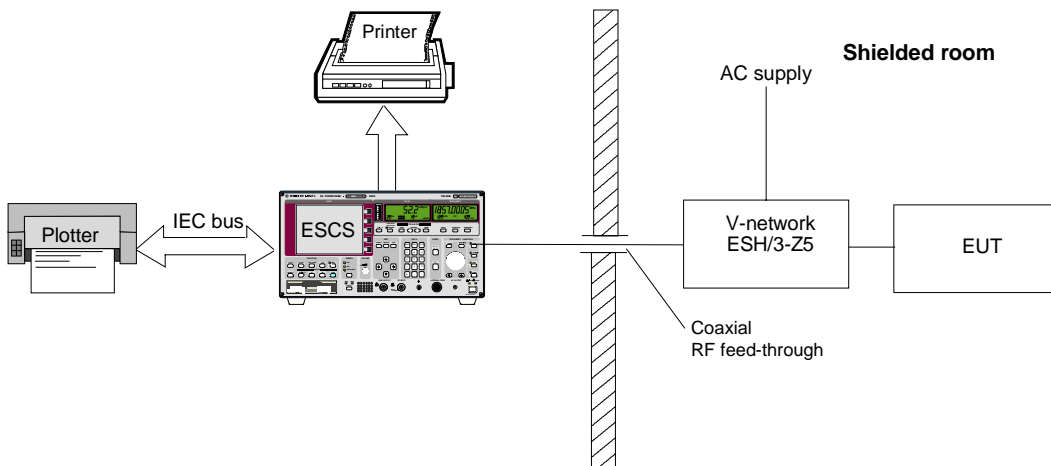


Fig. 2-7 Block diagram of a test setup with LISN and EUT in a shielded room

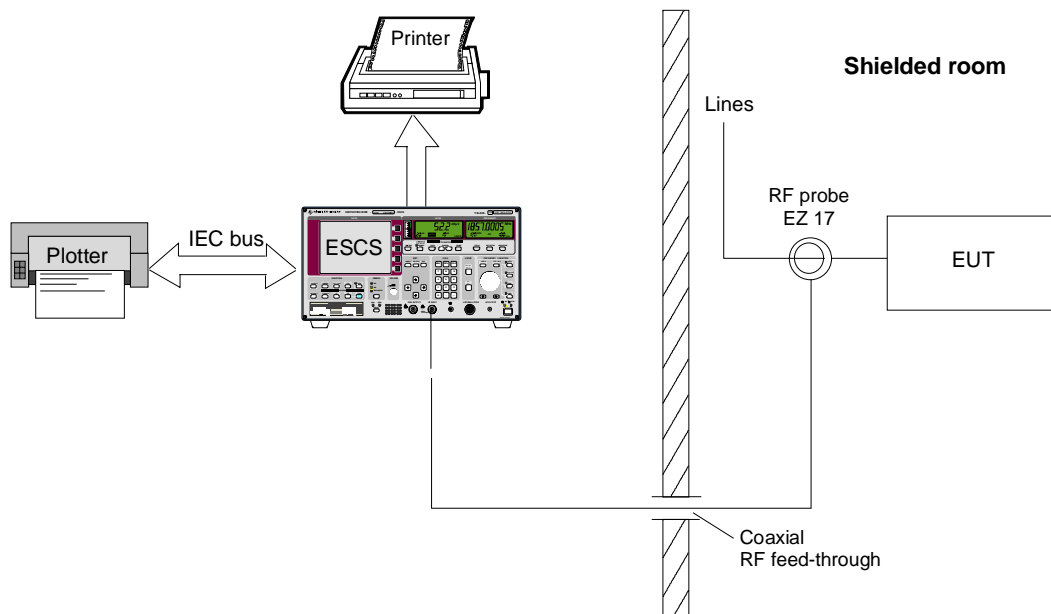


Fig. 2-8 Block diagram of a test setup with RF current probe and EUT in a shielded room

As a result of its low RF leakage, the Test Receiver ESCS can also be placed inside the shielded room. However, the simultaneous operation of printer and plotter in the shielded room may cause problems if they are arranged unfavorably. In this case, the test report can output after the measurement only.

Setting of the Test Receiver

The scan setting of the test receiver determines the prescan data. E.g. for RFI voltage measurements on vehicle components, it comprises a range from 0.15 to 108 MHz.

Scan data:

Frequency range/MHz	0.15 - 108
Step size/kHz	60 ¹⁾
Bandwidth (IF BW)/kHz	120
Detector	Pk + Av ²⁾
Meas. Time/s	0,02 ³⁾
Attenuation	Auto Low Noise

- 1) In the case of pure broadband interference, a frequency-proportional step size (LOG Step) can also be used for the measurement instead of steps of half the bandwidth.
- 2) For the measurement to standards with narrowband and broadband interference limit values or average and quasi-peak limit values, it is useful to measure the peak and average value simultaneously in one frequency scan. If only one limit value is provided, it is sufficient to switch on one detector, e.g. Pk or Av.
- 3) The measurement time per measured value depends on the type of interference signal. It should be selected such that the highest value is recorded in the case of time fluctuations. Line-synchronous pulse interferences (50 Hz or 100 Hz) therefore require minimum measurement times of 20 or 10 ms.

The option RFI Voltage Test can be switched on for RFI voltage or current measurements. In this case, no LISNs are switched on in the associated menu.

Test Run, Methods of Measurement and Analysis

The measurement is performed as described above.

Measuring the RFI Field Strength in the Frequency Range up to 30 MHz

Test Setup

The measurement of the RFI field strength to commercial standards is performed in the frequency range from 9 kHz to 30 MHz using the R&S Loop Antenna HFH2-Z2. Though the shielded room offers the advantage of avoiding ambient interference, it may affect the magnetic field in particular in the case of small dimensions. Therefore, the measurement in the shielded room does not replace the open-area measurement in general.

Test setup for measurement inside the shielded room:

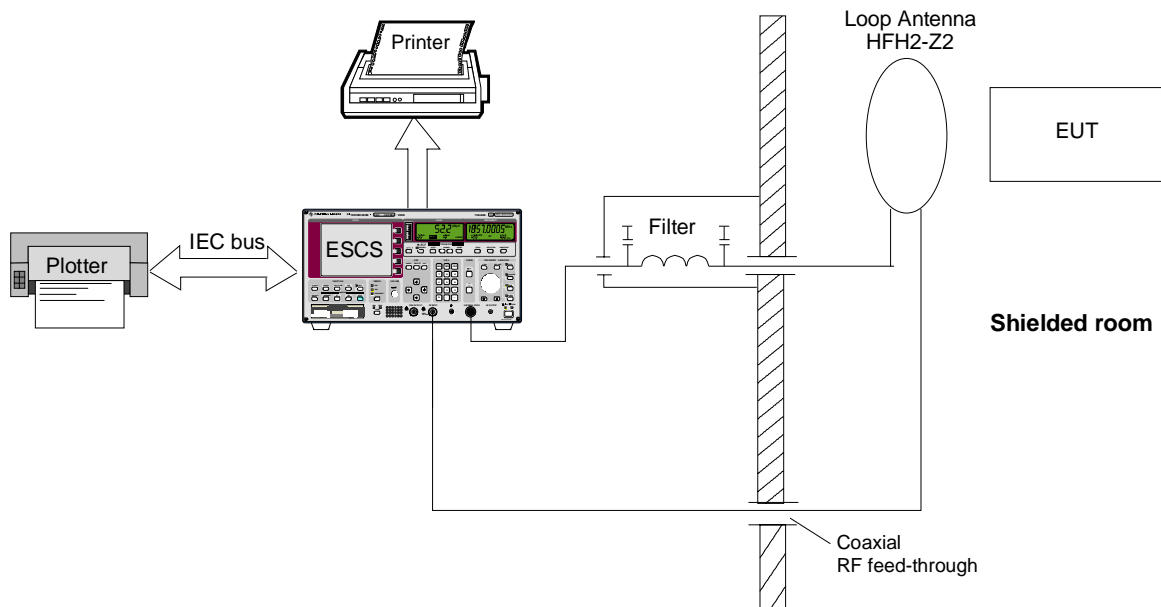


Fig. 2-9 Block diagram of a test setup with Loop Antenna HFH2-Z2 and EUT inside the shielded room

For the Loop Antenna HFH2-Z2, the supply voltages +10 V and -10 V, the codings of the antenna factor and the dimension "electrical field strength" (Unit: dB μ V/m) are to be taken through the wall of the shielded room. The connection cables HZ-3 (3 m) and HZ-4 (10 m) are used for this purpose.

When the magnetic field strength is displayed in dB μ A/m, a transducer factor of -31.5 dB is to be entered.

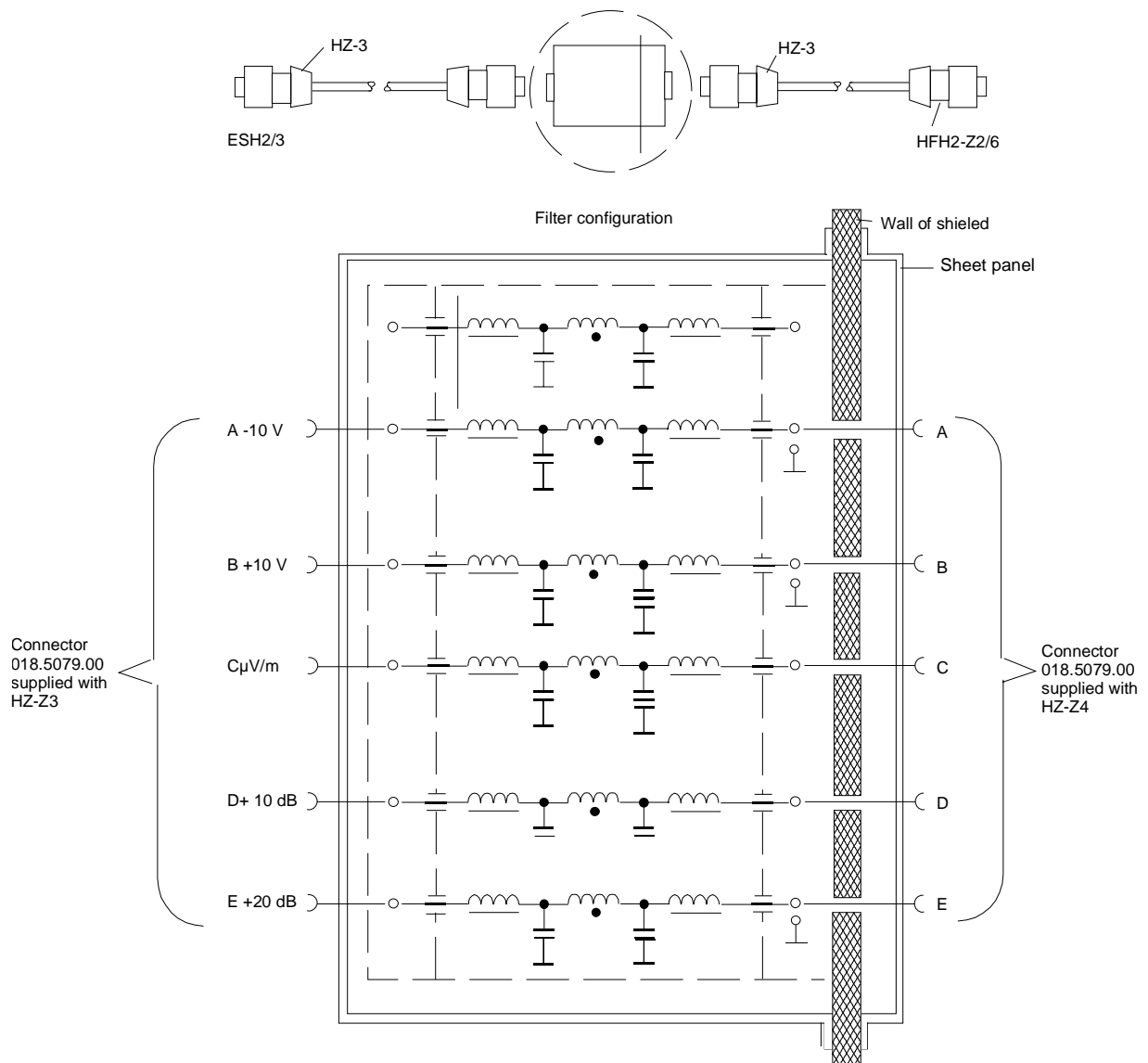


Fig. 2-10 Configuration of connection cables HZ-3/4 with AF filters for supply and coding of the active antennas HFH2-Z2 and -Z6 in shielded rooms

Note: *If the plugs are configured favorably, the AF filters can also be used for controlling the LISNs. When the transducer factor is used, it is not necessary to feed through the coding line. If the power supply unit is used for active antennas HZ-9 in the shielded room, the supply voltage need not be fed through either.*

Test Setup for Open-Area Measurements:

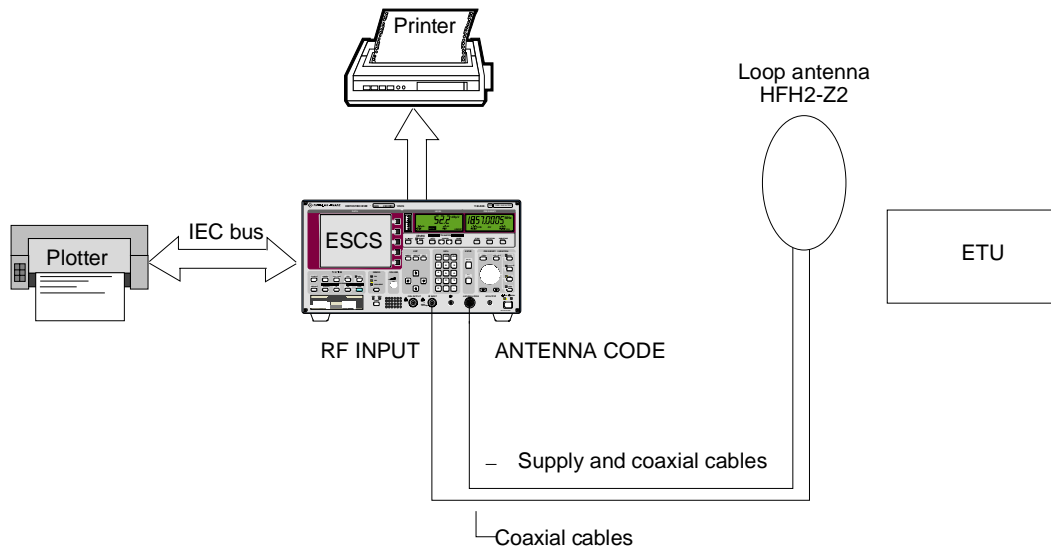


Fig. 2-11 Block diagram of a test setup for open-area measurements. Make sure that the antenna is decoupled from the printer and plotter.

Setting of the Test Receiver

An automatic test run can only be recommended for the measurement in the shielded room, e.g. as prescan for rough determination of the field strength and the interference frequencies with subsequent testing at single frequencies in open-area measurements.

A test configuration does not have to be determined. Before starting the scan, it is advisable to adjust the antenna and the EUT to the maximum level display at the frequency with the highest interference field strength (e.g. at the switching frequency of a switching power supply or at the line frequency of a monitor).

The scan setting determines the prescan. The setting data recommended in the section “Measuring the RFI voltage in the frequency range up to 30 MHz” are also valid in this case. Pk is to be used as detector since only one QP limit value exists.

Test Run, Methods of Measurement and Analysis

What has been said in section “Measuring the RFI voltage in the frequency range up to 30 MHz” also applies to RFI field-strength measurements, of course without the phase selection.

Measuring the RFI Field Strength in the Frequency Range above 30 MHz

In the frequency range from 30 to 1000 MHz, RFI field-strength measurements are in most cases performed at open-area test sites at a distance of 3, 10 or 30 m from the EUT. Linearly polarized broadband dipoles serve as antennas for horizontal and vertical polarization. In general, two antennas are used, e.g. a HK 116 (30...300 MHz) and a HL 223 (200...1000 MHz) or a HUF-Z1 (30...80 MHz) and a HL 023 A1 (80...1000 MHz).

The field-strength test sites feature a conductive ground plane and must comply with a test-site attenuation characterized by a strict tolerance. Therefore, there are only few proper test sites in shielded (anechoic) chambers, since the required facilities are very expensive. Due to the conductive ground plane, the field strength does not only depend on the polarization, but also on the height. The antenna must therefore be shifted in height in a range from 1 to 4 m. Since the EUT itself also features an emission depending on the direction, it is to be rotated and operated in various operating modes and cable configurations, if applicable. A considerable problem is caused by ambient interference present on open-area test sites, which is often intermittent, i.e. not constant with respect to time.

For these reasons, it is not advisable to perform a fully automatic test run without the aid of a computer with a test receiver. The ESCS therefore offers the following solution:

In a not quite ideal anechoic chamber, a prescan is performed without height variation of the antenna (e.g. in the short-range field at a distance of 1 m from the EUT) for searching the subrange maxima. The frequencies are stored in the ESCS for subsequent manual open-area measurements. If there is a ground reflector (semi-anechoic chamber) the optimal height may have to be set.

Test setup for RFI field-strength measurement

The shielded room contains the EUT and the antenna, whereas the test receiver and the peripheral equipment are located outside. The test configuration of the EUT including all connected lines should be identical with that used in the open-area measurement. The antenna should possibly be located in the main direction of emission of the EUT.

It is recommended to use an antenna setting below 45 degrees for the prescan (i.e. neither horizontal nor vertical). Therefore, one scan is sufficient.

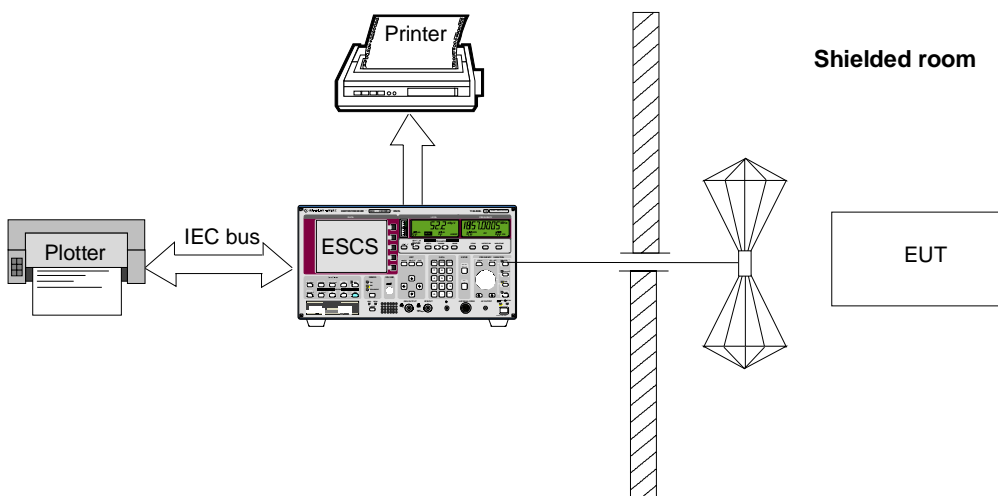


Fig. 2-12 Test configuration for the RFI field-strength measurement in the shielded room

In open-area measurements, the EUT may be located on a turntable that is manually operated or remote-controlled. The configuration of the lines on the EUT is to be obtained from the valid specifications. It should be possible to operate the antenna mast and the EUT turntable from the test receiver. Make sure that the test assembly (test receiver and peripheral equipment) is reflection-free.

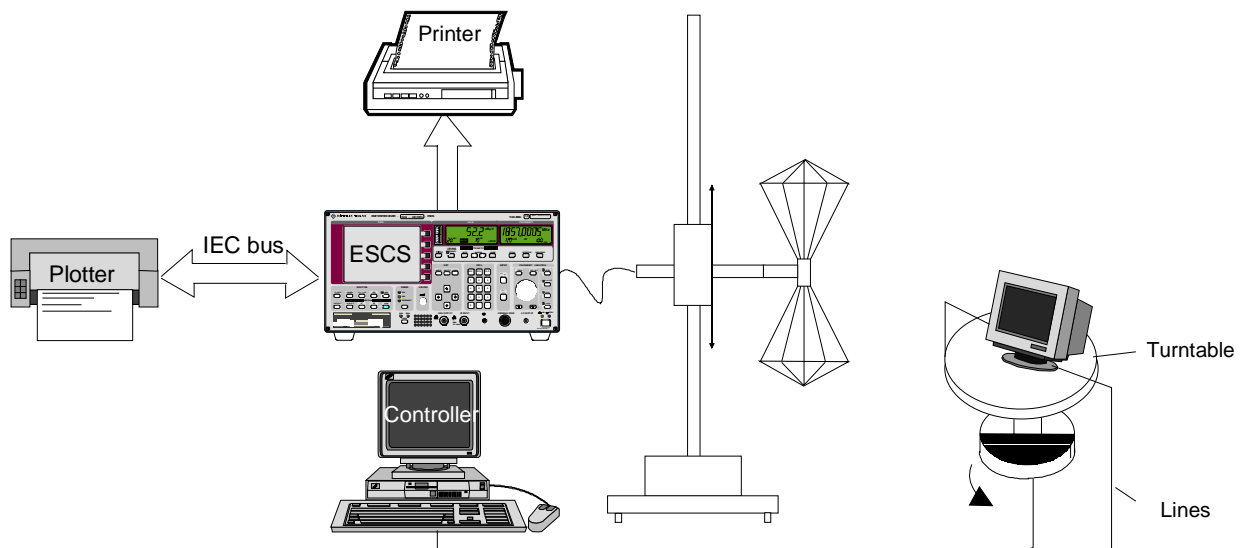


Fig. 2-13 Test setup for open-area RFI field-strength measurement

Setting of the test receiver

The scan setting of the test receiver determines the prescan data.

Scan data:

Frequency range/MHz 30 - 1000

Step size/kHz 60 ¹⁾

Bandwidth (IF BW)/kHz 120

Detector Pk

Meas. Time/s 0,02 ²⁾

Attenuation Auto Low Noise

- 1) In the case of pure broadband interference, a frequency-proportional step size (LOG Step) can also be used for the measurement instead of steps of half the bandwidth.
- 2) The measurement time per measured value depends on the type of interference signal. It should be selected such that the highest value is recorded in the case of time fluctuations. Line-synchronous pulse interference (50 Hz or 100 Hz) therefore requires minimum measurement times of 10 or 20 ms.

The scan option RFI Fieldstrength Test is switched on for the RFI field-strength measurement. Subranges and margin are defined as required.

Usually, field-strength limit values are valid for the QP detector. Therefore, it makes sense to switch on the peak detector. The prescan is then performed using the peak detector and the final measurement using the quasi-peak detector.

Test Run, Methods of Measurement and Analysis

- Press *RUN* key and, if required, *Prescan* softkey to start the prescan.

If a transducer set with several domains is used to support the inclusion of two antennas, a message is displayed when the scan is started and another one at the frequency where the antenna must be changed. The scan is interrupted.



- Press the ENTER key or the *Continue* softkey.
The prescan runs until the end or until the antenna is changed for the next time.

The maximum values of all subranges are now stored in the ESCS. If required, the list of subrange maxima can be output as list of measured values.

The *RUN* menu which is automatically displayed after the prescan offers the *Copy Det. #1* softkey. This softkey serves to copy the list of subrange maxima determined in the prescan to the frequency list memory of the ESCS.

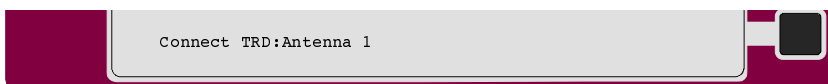
This list of frequencies is used for the initial measurement in the *Channel Scan* mode and for the final measurement if any of the limits are exceeded. In the modes *Scan* and *Overview*, the final measurement is performed at these frequencies provided that option *Fixed Final* is switched on. This means that the frequencies for the final measurement and the result of the initial measurement are totally independent.

- Press the *Copy Det. #1* softkey in order to save the subrange maxima of the initial measurement. The frequency list will be preserved even if the instrument is switched off.

After changing to the free-field, the final measurement can be performed:

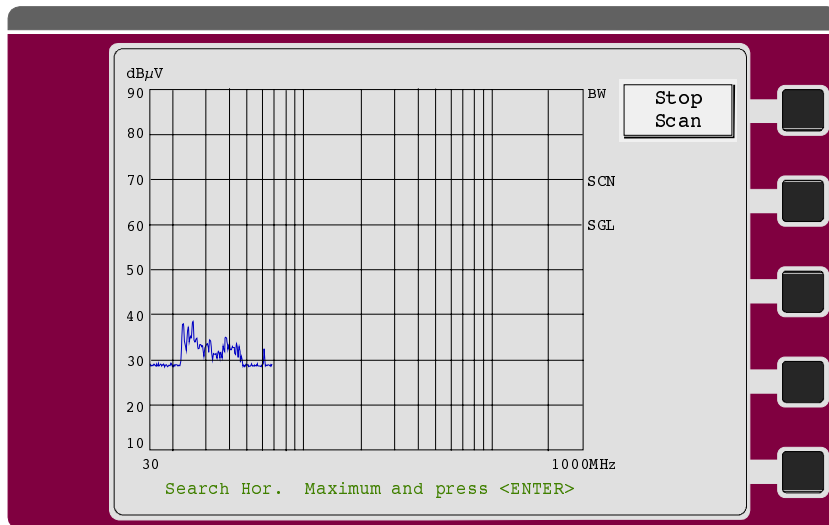
- Press *Transducer* softkey in the *CONFIG* menu to select the transducer factors for the antennas used in the free-field.
- Press *RF* key and *Options* softkey. Press *Fixed Final* softkey to activate final measurements at fixed frequencies.
- Press *RUN* key to start scan. The prescan determines new subrange maxima, however, these maxima are not used for the final measurement.
- After the prescan, press *Final Meas* softkey.

If a transducer set with several domains is used to support the inclusion of two antennas, a message is displayed when the final measurement is started and another one at the frequency where the antenna must be changed.



- Press one of the ENTER keys to continue the procedure.
- Press one of the ENTER keys to continue the procedure.

The ESCS selects the first frequency of the list with the corresponding receiver settings of the scan subrange, including the detector for the final measurement (e.g. a quasi-peak detector) and a measurement time of 0.5 s. For the maximum search, the measurement time is limited to 0.5 s so that the result is obtained more quickly. The marker is automatically set to the corresponding frequency.

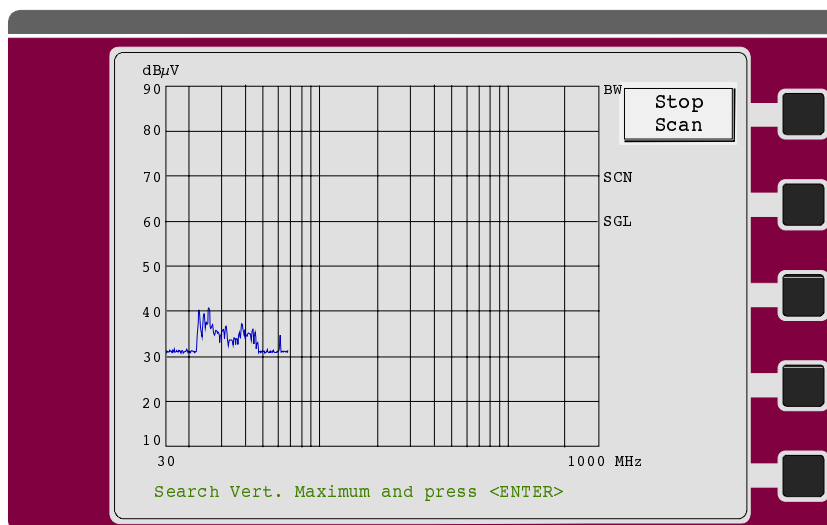


- The frequency can now be varied using the rotary knob in order to follow drifting interference. The actually set frequency appears in the list of measured values.
- If necessary, press *IF* key to switch over to *IF* analysis and clearly identify the source of the drifting interference. The *RF* key switches back to the final measurement.
- With horizontal polarization vary the antenna height and the azimuth of the turntable until the maximum ambient interference has been found.
- Press one of the ENTER keys

The actual final measurement is now performed using the measurement time defined previously. The result is stored in the memory of measured values together with the frequency which was possibly changed. The measurement is represented in the diagram with an "x" symbol.

Note: *If the measurement of the EUT interference is not possible at a particular frequency due to ambient interference, the next frequency in the list can be selected using the arrow key (⇒).*

After the horizontal maximum has been stored, the following prompt appears:



With vertical polarization the antenna height and the azimuth of the turntable can be varied until the vertical maximum of the interference has been found.

The ESCS performs the final measurement using the measurement time set previously and stores the result, together with the possibly modified frequency, in the memory of measured values. The measured value is represented in the diagram with a "+" symbol.

Afterwards, the ESCS sets the next frequency. The whole procedure including the maximum search starts again.

- Using the arrow key ⇐, it is possible to return to one of the previous frequencies. This allows to either repeat the measurement with modified operating conditions applied to the EUT or to overwrite a value which was erroneously stored using the *ENTER* key.

Example for a List of Final Measurement Values in the Test Report

```
Scan Settings (1 Range)
|----- Frequencies -----|----- Receiver Settings -----|
  Start      Stop      Step      IF BW  Detector  M-Time  Atten  Preamp
  30M        1000M    50k      120k   PK        10ms   0dBLN  ON

Transducer No. Start      Stop      Name
                21      30M      1000M    bilog

Final Measurement: x Hor-Max / + Vert-Max
                   Meas Time:      1 s
                   Subranges:      8
                   Acc Margin:     20dB
```

Final Measurement Results:

Frequency MHz	QP Level hor. dBuV/m	QP Level vert. dBuV/m	Delta Limit dB
35.05000	19.7	26.6	-3.3
69.45000	18.7	21.4	-8.6
120.00000	25.2	24.9	-4.8
240.00000	26.3	24.1	-3.7
260.00000	32.2	28.1	-4.8
431.00000	37.3 *	31.2	0.3
540.00000	36.1	31.0	-0.9
972.70000	22.5	22.6	-14.4

* limit exceeded

Measuring the RFI Power Using the Absorbing Clamp

In the frequency range from 30 to 300 MHz, the RFI power is to be measured e.g. to CISPR 14 and VDE 0875 Part 1 on signal and supply lines with a length of more than 1 m. The Absorbing Clamp MDS 21 is used for the measurement. It is supplied with a transducer factor, which permits to determine the RFI power in dBpW from the RFI voltage in dB μ V displayed on the test receiver. The signal and supply lines are lengthened to approx. 6 m (= half the wavelength at 30 MHz (5 m) + length of clamp). The clamp is to be shifted to half the wavelength until the maximum display is obtained on the test receiver. In fact, the complete spectrum would have to be measured at each position (every 10 cm). This, however, would result in excessive measurement times.

Instead, the complete frequency range is divided into a sufficient number of subranges, where almost the same conditions apply to all frequencies (i.e. source and load impedance are approximately equal).

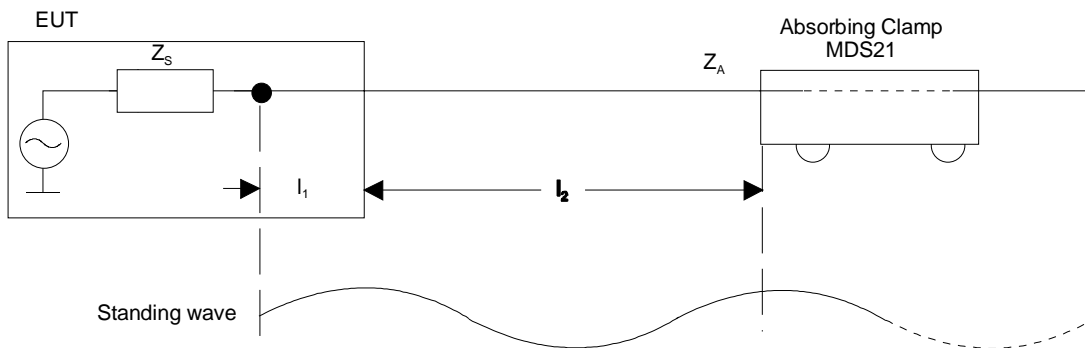


Fig. 2-14 Impedances Z_S and Z_A and line lengths l_1 and l_2 when measuring the RFI power. Z_S , Z_A and l_1 are approximately constant over a subrange, it is sufficient to find the local maximum l_2 at the subrange maximum.

The assumption can be made that the standing wave of the subrange maximum (maximum level of subrange spectrum with fixed clamp) has its local maximum (the first maximum when the clamp is shifted) at the same place as all over the frequency subrange. Therefore, it is not necessary to search for the local maxima for all frequencies of the subrange, because these levels always remain smaller than the level at the local maximum of the frequency subrange maximum. The subrange maximum thus becomes the representative frequency of the frequency subrange.

As the current flowing into the clamp is never 0 because the clamp does not terminate the interference source with high impedance, the complete spectrum can be covered at one position - most reliably at the 0-position - with an acceptance margin of approx. 10 dB. A number of e.g. 16 or 25 subranges is sufficient to keep the error at a minimum.

Test Setup

In order to avoid measurement errors due to ambient interference, the EUT and the measuring device (MDS clamp) should be operated in a shielded anechoic chamber; a low-interference environment in the cellar, for example, will be sufficient in most cases. Due to its low RF leakage, the test receiver ESCS can also be placed inside the shielded room. However, problems may arise if the printer and/or plotter are switched on simultaneously. It is possible to output the test report after the measurement instead or operate the ESCS with printer and plotter outside the shielded room.

It should be possible to move the absorbing clamp from the test receiver with a cord via pulleys.

It is useful to record a frequency scale on the test bench such that the frequency value is entered at a distance of half the wavelength from the EUT, i.e. "300 MHz" with 0.5 m; "200 MHz" with 0.75 m; "150 MHz" with 1 m; "100 MHz" with 1.5 m;"30 MHz" with 5 m. With increasing frequency, the search range of the clamp decreases.

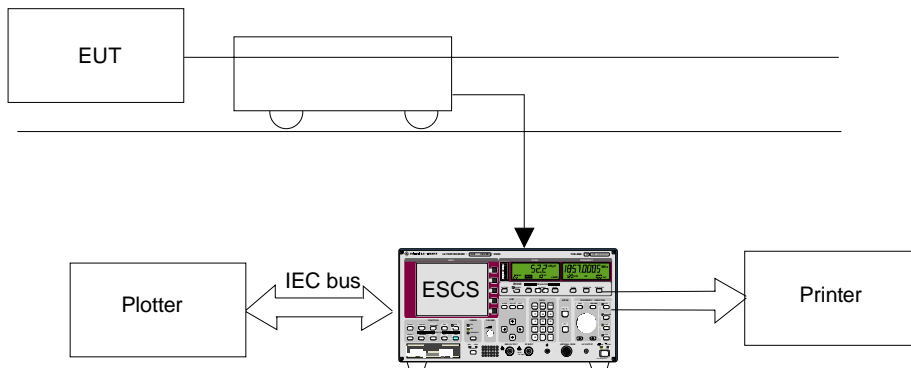


Fig. 2-15 Block diagram of a test setup with MDS clamp and EUT in a shielded room

Details on the height of the table, distance of the MDS clamp from the wall etc. are to be obtained from the valid standards.

Setting of the Test Receiver

The scan setting of the test receiver sets the prescan data. As already mentioned, it comprises a range from 30 to 300 MHz e.g. for the RFI power measurement.

Scan data:

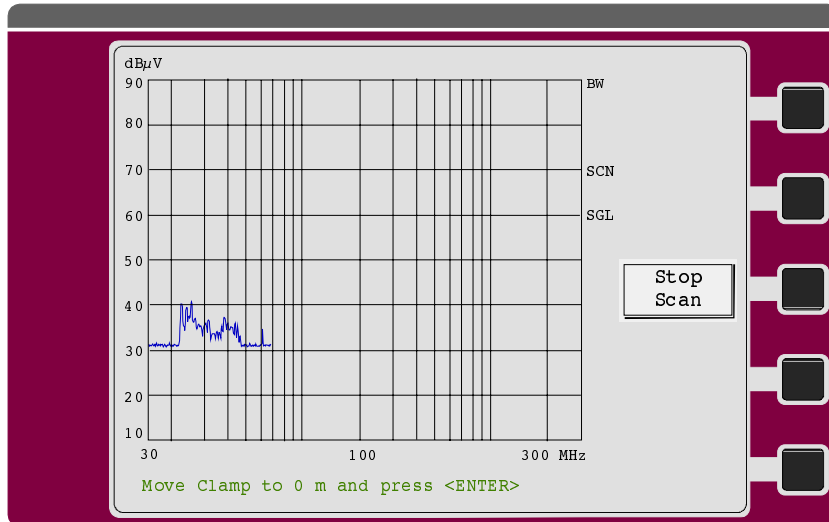
Frequency range/MHz	30 - 300
Step size/kHz	60 ¹⁾
Band width (IF BW)/kHz	120
Detector	Pk + Av ²⁾
Meas. Time/s	0,02 ³⁾
Attenuation	Auto Low Noise

- 1) In the case of pure broadband interference, a frequency-proportional step size (LOG Step) can also be used for the measurement instead of steps of half the bandwidth.
- 2) For the measurement to standards with narrowband and broadband interference limit values or average and quasi-peak limit values, it is useful to measure the peak and average value simultaneously in one frequency scan. If only one limit value is provided, it is sufficient to switch on one detector, e.g. Pk or Av.
- 3) The measurement time per measured value depends on the type of interference signal. It should be selected such that the highest value is recorded in the case of time fluctuations. Line-synchronous pulse interference (50 Hz or 100 Hz) therefore require minimum measurement times of 20 or 10 ms.

The scan option RFI Power Test is switched on for RFI power measurements. It is used for interactive measurements at the subrange maxima after termination of the prescan. The transducer factor of the MDS clamp must be entered.

Test Run, Methods of Measurement and Analysis

➤ Press the RUN key and, if necessary, the *Prescan* softkey. The initial measurement is started:



➤ Move the clamp as near as possible to the EUT and press one of the ENTER keys.

The prescan runs until the stop frequency is reached and determines the subrange maxima (Pk and/or Av) for the measurement. All subrange maxima are stored in the ESCS. If required, the list of these subrange maxima can be output as a list of measured values.

In the *Scan* mode the initial measurement can be combined with the final measurement to form a single process. For the interactive measurement of the interfering power, this means that the final measurement is started immediately after the initial measurement and the following menu is not displayed.

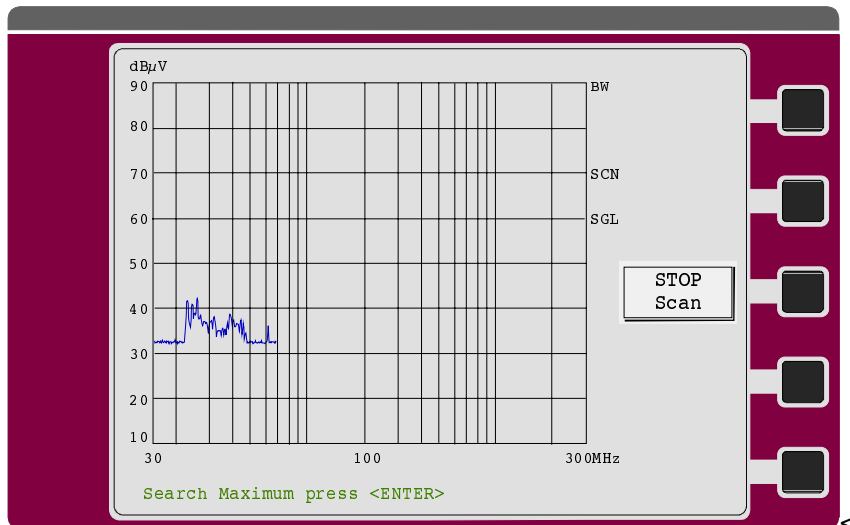
The *RUN* menu which is automatically displayed after the prescan offers the *Copy Det. #1* softkey. This softkey serves to copy the list of subrange maxima determined in the prescan to the frequency list memory of the ESCS.

This list of frequencies is used for the initial measurement in the *Channel Scan* mode and for the final measurement if any of the limits are exceeded. In the modes *Scan* and *Overview*, the final measurement is performed at these frequencies provided that option *Fixed Final* is switched on. This means that the frequencies for the final measurement and the result of the initial measurement are totally independent.

➤ After the prescan, press the *Final Meas* softkey. If the measurement was started using the *Prescan + Final* softkey, the final measurement is started by the receiver automatically.

The ESCS selects the first frequency of the list with the corresponding receiver settings of the scan subrange, including the detector for the final measurement (e.g. a quasi-peak detector) and a measurement time of 0.5 s. For the maximum search, the measurement time is limited to 0.5 s so that the result is obtained more quickly. The marker is automatically set to the corresponding frequency.

The following diagram is displayed:



- Press one of the ENTER keys to continue.
- The frequency can now be varied using the rotary knob in order to follow drifting interference. The actually set frequency appears in the list of measured values.
- If necessary, press *IF* key to switch over to *IF* analysis and clearly identify the source of the drifting interference. The *RF* key switches back to the final measurement.
- Observe the pointer of the measuring instrument or the bargraph display and simultaneously shift the clamp until the maximum is found.
- Press one of the ENTER keys.

The actual final measurement is now performed using the measurement time defined previously. The result is stored in the memory of measured values together with the frequency which was possibly changed. The measurement is represented in the diagram with an "x" symbol.

Note: *If the measurement of the EUT interference is not possible at a particular frequency due to ambient interference, the next frequency in the list can be selected using the arrow key (⇒).*

If the initial measurement was performed using a peak and an average detector, the subrange maxima were determined separately. This means that, in the final measurement, it is possible to search for the maximum at both frequencies separately. The ESCS sets the second final detector (average value) together with the corresponding frequency.

- Observe the pointer of the measuring instrument or the bargraph display and simultaneously shift the clamp until the maximum is found.
- Press one of the ENTER keys.

The ESCS performs the final measurement using the measurement time set previously and stores the result, together with the possibly modified frequency, in the memory of measured values. The measured value is represented in the diagram with a "+" symbol.

Afterwards, the ESCS sets the next frequency. The whole procedure including the maximum search starts again.

- Using the arrow key ⇐, it is possible to return to one of the previous frequencies. This allows to either repeat the measurement with modified operating conditions applied to the EUT or to overwrite a value which was erroneously stored using the *ENTER* key.

Example for a List of Final Measurement Values in the Test Report

Overview Scan Settings (1 Range)

Frequencies			Receiver Settings				
Start	Stop	Step	IF BW	Detector	M-Time	Atten	Preamp
30M	300M	62.5k	120k	PK	0.05ms	20dBLN	OFF

Transducer No.	Start	Stop	Name
5	30M	300M	MDS_20

Final Measurement: x QP / + AV
 Meas Time: 2 s
 Subranges: 8
 Acc Margin: 0dB

Final Measurement Results:

Frequency MHz	QP Level dBpW	Delta	Limit dB
32.25000	87.4 *	42.1	
50.87500	82.6 *	35.3	
57.75000	80.5 *	32.7	
72.68750	71.5 *	22.7	
96.81250	70.8 *	20.7	
164.18750	67.5 *	15.2	
177.43750	67.0 *	14.3	
236.81250	59.3 *	5.3	

Frequency MHz	AV Level dBpW	Delta	Limit dB
32.25000	47.1 *	11.8	
50.87500	41.3 *	4.1	
57.75000	36.7	-1.1	
72.68750	31.1	-7.6	
96.81250	32.2	-7.8	
164.18750	26.5	-15.8	
177.43750	26.3	-16.3	
236.81250	21.0	-22.9	

* limit exceeded

Measuring the Magnetic Interference in the Frequency Range between 9 kHz and 30 MHz

Limits for the magnetic interference field strength in the frequency range between 9 kHz and 30 MHz are specified in the standards CISPR 11 and EN 55011. The limits quoted there are valid for distances of 30 m which in practice can be only reached in free-field measurements. At low frequencies, however, the inevitable ambient interferences prevent those free-field measurements from providing any useful results. Thus the desire of performing measurement in shielded rooms where ambient interferences and the influence of the weather can be excluded.

Shielded rooms, however, have a considerable influence on the propagation of electromagnetic waves so that the field strength measured inside differs noticeably and unpredictably from the values in the free-field. An additional complication for the measurement resides in the fact that the maximum of the field strength must be determined by rotating the antennas and the equipment under test.

All these difficulties are circumvented by the triple-loop antenna HM 020. The basic idea is to place the EUT inside of three electrically independent loops which are orthogonal to each other. In lieu of performing a maximum search, it is sufficient to measure once at each of the loop outputs and use the largest of the three signals for an estimate of the maximum.

This offers several advantages:

- Neither the EUT nor the loops must be rotated during the measurement.
- The influence of the shielded room on the EUT is considerably reduced provided that a minimum distance of 0.5 m to the conducting walls is observed.
- If HM 020 is used for free-field measurements, ambient interferences are strongly suppressed.

By means of the user port of the receiver the individual frames of HM 020 can be switched on manually.

Test Setup

The EUT is placed on a table (deliverable as an equipment) in the height of the center of the loops. The folded-up triple-loop antenna is put next to the table and then unfolded. The largest extension of the EUT can be 1.6 m.

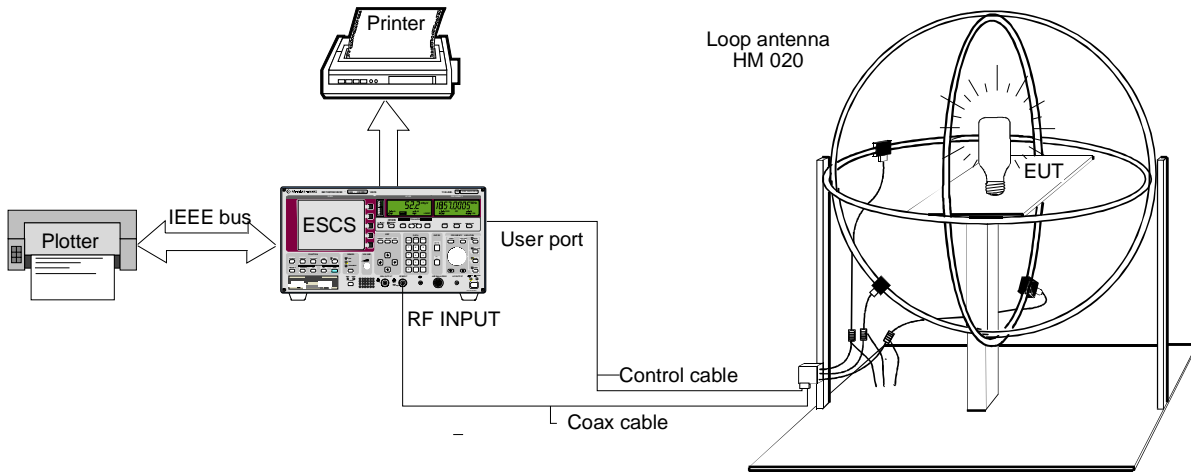


Fig. 2-16 Test setup containing a triple-loop antenna HM 020 and an EUT

By virtue of its low radio interference the test receiver ESCS itself can be placed inside the shielded room. However, operating in addition a printer and plotter inside the shielded room may cause problems if the total arrangement is disadvantageous. It is recommended to read out the test report after the measurement.

Setting of the test receiver

The scan setting of the test receiver determines the prescan data.

Scan data:

Frequency range/MHz	0,15 - 30
Step size/kHz	5 ¹⁾
Bandwidth (IF BW)/kHz	9
Detector	Pk + Av ²⁾
Meas. Time/s	0,02 ³⁾
Attenuation	Auto Low Noise

- 1) In the case of pure broadband interference, a frequency-proportional step size (LOG Step) can also be used for the measurement instead of steps of half the bandwidth.
- 2) For the measurement to standards with narrowband and broadband interference limit values or average and quasi-peak limit values, it is useful to measure the peak and average value simultaneously in one frequency scan. If only one limit value is provided, it is sufficient to switch on one detector, e.g. Pk or Av.
- 3) The measurement time per measured value depends on the type of interference signal. It should be selected such that the highest value is recorded in the case of time fluctuations. Line-synchronous pulse interference (50 Hz or 100 Hz) therefore require minimum measurement times of 20 or 10 ms.

The scan option RFI Fieldstrength Test is switched on for the measurements. No LISN is selected in the corresponding menu.

Recommended arrangement of the connection cables EZ-14/EZ-5/EZ-6/EZ-21

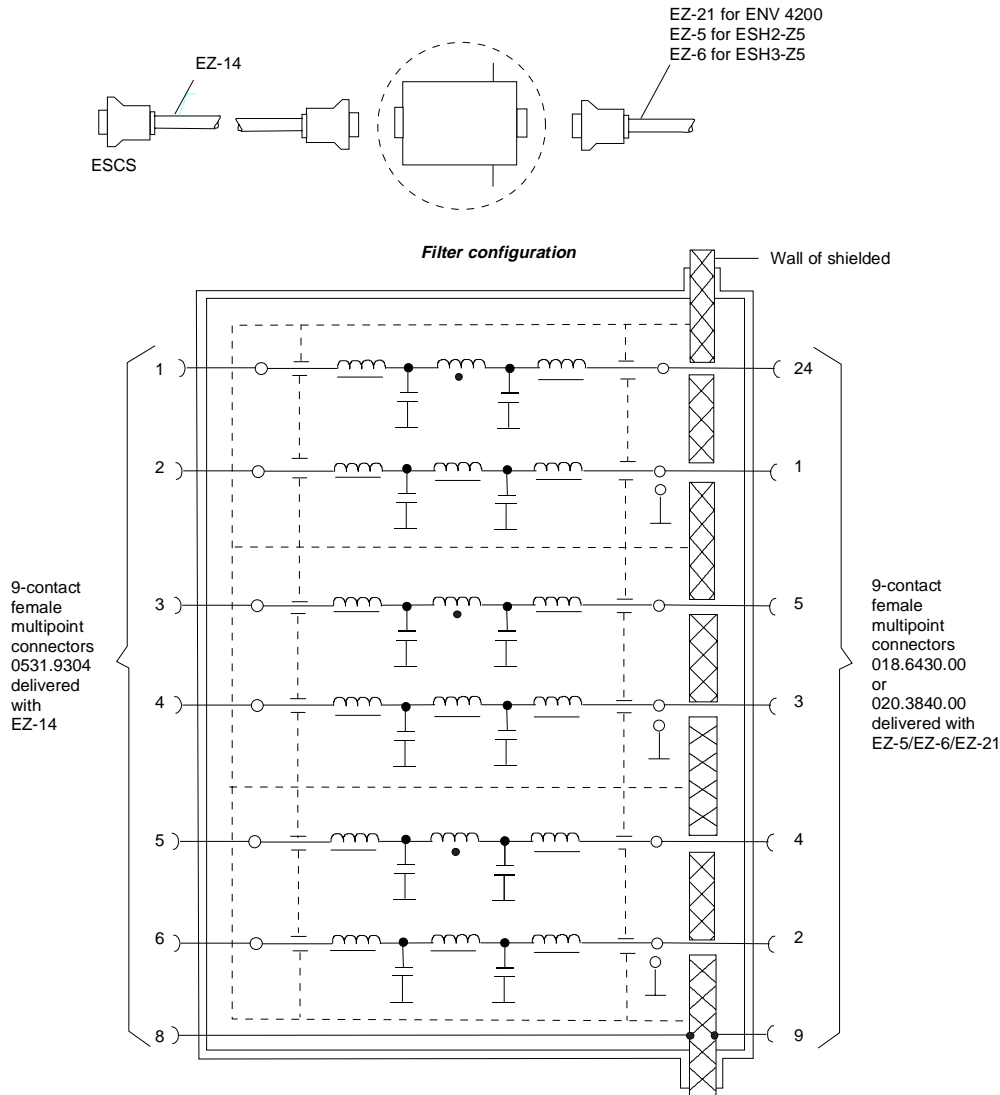


Fig. 2-17 Assignment of connection cables EZ-14 and -6 with AF filters for feeding the control information for the triple-loop antenna HM 020 into a shielded room.

Note: When the ESCS is used inside the shielded room, the filter configuration is omitted. The cable EZ-6 is then used for controlling the HM 020.

Recommendation for lowpass filters for feed-through into the shielded room:
 Siemens Order No.: B 84312-C30-B3 and B 84312-F30-B3 includes lowpass filters for 2 lines. The HM 020 requires 2 pieces.

Test Run, Methods of Measurement and Analysis

The three orthogonal loops of the triple-loop antenna HM 020 must be switched on one after the other and the emissions on each of them must be measured.

One option is to carry out three complete measurement cycles, each containing an initial and a final measurement, and to pick the largest interference subsequently.

Another option is to switch over to continuous scan by selecting the recording mode *Clear Write + Max Hold*. After at least one frequency cycle the scan is interrupted with *Interrupt*. The *Userport* menu where the loop can be changed is selected by activating the *Userport* softkey in the *Interrupt* menu. The *Max Hold* function shows on which loop the largest interferences were measured. Prior to the final measurement this loop is switched on again via the *Userport* menu.

During a continuous scan with the recording mode *Clear Write + Max Hold* only one detector can be used for the measurement.

Operation

Option Scan

- Press *RF* key and *Options* softkey.
- Switch on option *RFI Voltage* by pressing the corresponding softkeys. No LISN must be switched on in the submenu.

Trace Mode

- Press *RF* key and *Curves* softkey.
- Switch on *Repetitive* softkey.

Initial Measurement

- Press *RUN* key and – if necessary – *Prescan* softkey.
The scan is started.
- Press *Interrupt* softkey.
The scan is interrupted; the *Interrupt* menu is called up.
- Press *User Port* softkey.
The *Userport* menu is called up.
- Use the arrow keys to select the userport line desired.
When using cable EZ-16 model 05, the following relation between userport lines and antenna loops applies:

Userport No.	Loop
1	1
2	2
3	3

- Use *ON/OFF* softkey to switch over the line.
- Use *RF* key to switch back to the *Interrupt* menu.
- The scan is continued by pressing the *Cont at Int.* softkey.

Final Measurement

- Press *SETUP* key before starting the final measurement.
- Use *Userport* softkey to call the corresponding menu and switch on the loop with the largest interferences as described before.
- Press *RUN* key.
- Use *Final Meas* softkey to start the automatic final measurement.

The EMI software ES-K1 is available for fully automatic measurements. This software allows to control complex processes which go beyond the functionality implemented in the ESCS.

Data Reduction and Subrange Maxima

Since the time constants prescribed by the standard for quasi-peak weighting involve settling processes and therefore a long measurement time per value, radio interference measurements can be very time-consuming. The standards also prescribe methods for detecting interference maxima, e.g. moving the absorbing clamp, varying the height of the test antenna and turning round the DUT. Measurements performed with quasi-peak weighting at each frequency and each setting of the test system would involve unacceptable processing times. For this reason R&S developed a method which reduces the time-consuming measurements to a minimum at optimized reliability and accuracy.

To optimize the measurement time, the RFI spectrum is first analyzed in a fast prescan. Then the obtained data are reduced so that the time-consuming final measurement need to be performed at a few key frequencies only:

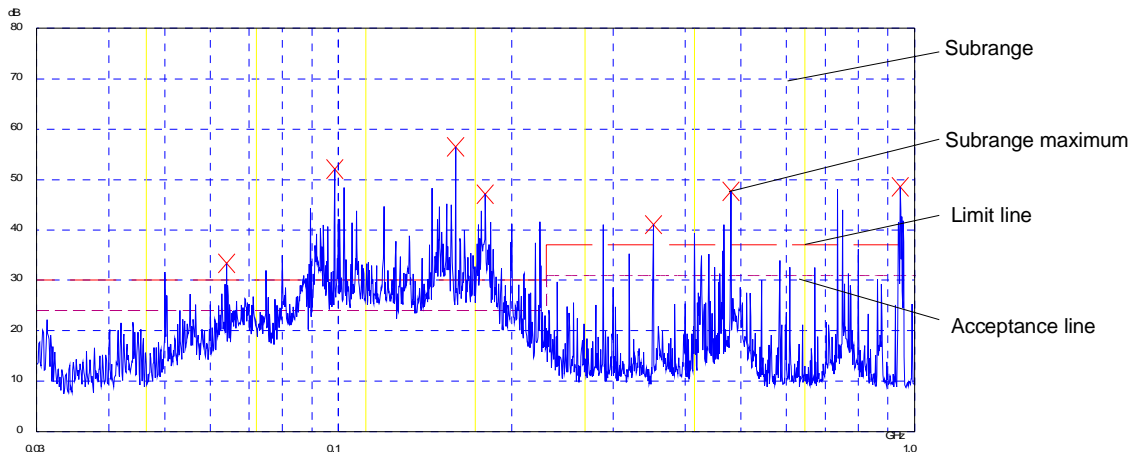


Fig. 2-18 Example for a division of the spectrum in eight subranges

Data reduction is of essential importance. It is performed automatically by the receiver for each prescan, i.e. frequencies with a high interference level are selected during the prescan. Two data reduction methods are used:

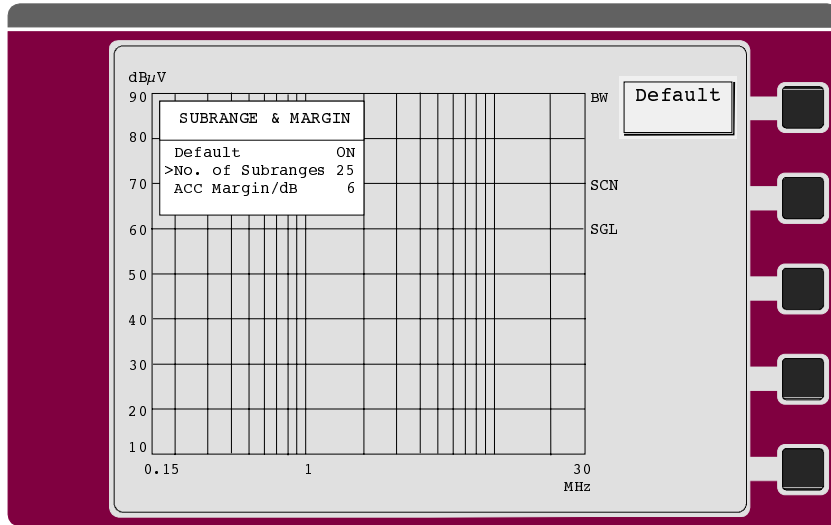
- Determination of subrange maxima, i.e. a detailed analysis of the interference spectrum is performed at the frequencies with the highest interference level in a frequency subrange.
- Acceptance analysis, i.e. a further analysis of the interference spectrum is performed at frequencies with levels exceeding a line drawn in parallel to a limit line.

The total frequency range is divided into equidistant subranges. During prescan a maximum is determined for each subrange. If the prescan is performed in parallel with two detectors (typically a peak and an average detector), the subrange maxima are determined separately to allow for the different distribution of narrowband and broadband interference. The final measurement using the average detector is then performed at the frequency of the subrange maximum determined with the average detector, and the final measurement with the quasi-peak detector at the frequency determined with the peak detector during prescan.

Taking the limit lines into consideration ensures that the final measurement is not performed at frequencies with an interference level far below the limit value. The margin between the acceptance line and the limit line can be selected by the user as *Acceptance Margin* in dB. When detector pairs are used, the two associated limit lines can be switched on. The line at the higher level is automatically used for the peak and quasi-peak detector, the lower one for the average detector.

- For this reason two values have to be defined:
- the number of subranges (*No of Subranges*: 8, 16, 25, 50, 100, 200 or 400; default value: 25)
- the acceptance margin (*Acc. Margin/dB*; default value: 6 dB). This value applies to each of the two limit lines.

Pressing the *Subrange Margin* softkey in the Limit Lines menu opens a menu where these values can be selected and entered. The cursor can be moved to the required line using keys \uparrow and \downarrow . The values for *No of Subranges* and *ACC Margin/dB* may be numerically entered and confirmed with ENTER. Default values are set with the *Default* softkey. A default setting is signalled by ON in the *Default* line.



As an alternative, a list of frequencies can be entered at which the final measurements are to be performed. This method may be used, for instance, when several instruments are to be tested for statistical evaluation.

If no limit lines are switched on the instrument behaves as if all measured values exceeded the limits.

Basic Operating Steps for Performing Automatic Measurements

This section lists the operating steps required – at least partially – for each of the interference measurements described so far. These steps can be used like a check list. A detailed description of the individual measurements performed in line with various standards and regulations is given in the respective sections above.

Data to be defined and operations performed by the user:

- Entry of scan data
- Selection of desired detectors
- Entry of measurement times
- Switching on limit lines
- Switching on transducer factor, if applicable
- Switching on desired option
- Performing the measurement
- Storing measurement results

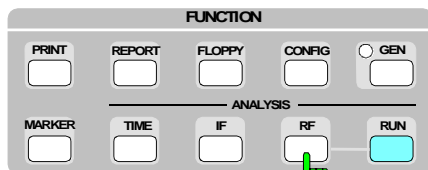
Operating steps to be performed:

Entry of Scan Data

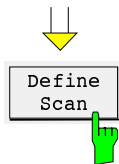
Three different modes can be selected:

- Spectrum overview uses the fastest scan with fixed RF attenuation and preset step widths.
- Scan with autoranging; the step width can be defined by the user.
- Channel measures at up to 400 discrete frequencies.

The described measurements can be performed in all three operating modes.



- Press RF key.
The scan menu is opened.



- Press *Define Scan* softkey.
The menu for entering scan data is opened (see chapter 4, Performing Frequency Scans)

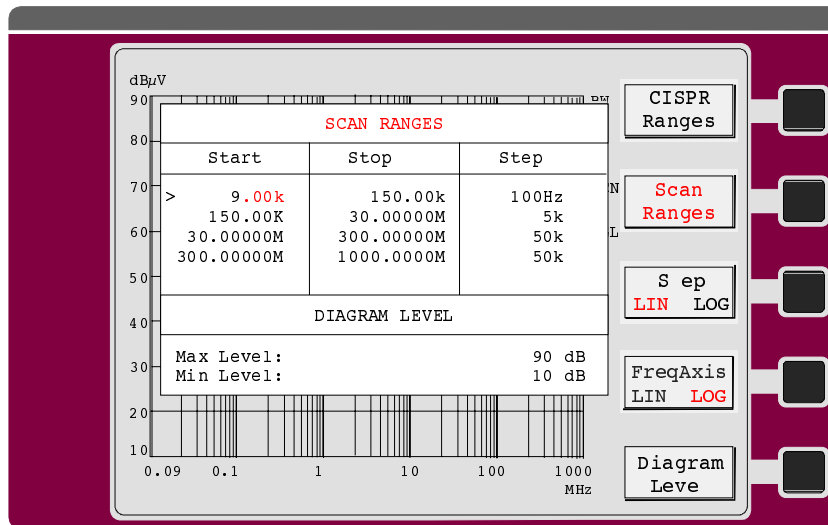
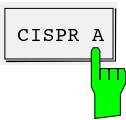
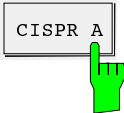
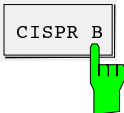
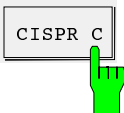
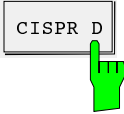


Fig. 2-19 Table for entering scan data



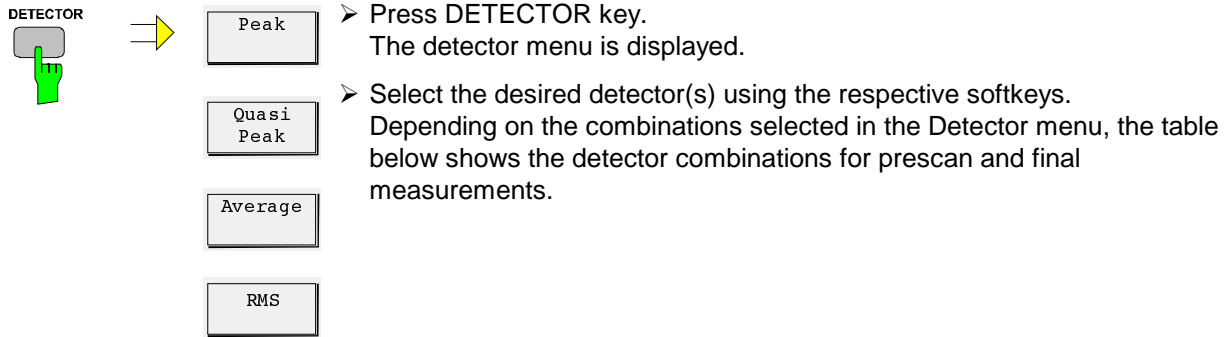
- If required press the *CISPR Ranges* softkey. Predefined settings simplify the entry of standard frequency ranges and pertaining receiver settings.

The following parameters can be set in the CISPR Ranges menu after pressing the respective softkey:

 <p>CISPR A</p>	<p>Start frequency 9 kHz Stop frequency 150 kHz Step width 100 Hz IF bandwidth 200 Hz Attenuation AUTO, Low Noise Meas. time 100 ms</p>
 <p>CISPR B</p>	<p>Start frequency 150 kHz Stop frequency 30 MHz Step width 5 kHz IF bandwidth 9 kHz Attenuation AUTO, Low Noise Meas. time 20 ms</p>
 <p>CISPR C</p>	<p>Start frequency 30 MHz Stop frequency 300 MHz Step width 50 kHz IF bandwidth 120 kHz Attenuation AUTO, Low Noise Meas. time 1 ms</p>
 <p>CISPR D</p>	<p>Start frequency 300 MHz Stop frequency 1000 MHz Step width 50 kHz IF bandwidth 120 kHz Attenuation AUTO, Low Noise Meas. time 1 ms</p>

Selection of Desired Detectors

The final measurement can be performed with quasi-peak and/or average detectors. A selection is made in the Detector menu.



Selected detector	Detector for <i>Prescan</i>	Detector for <i>Final Meas</i>
Peak	Peak	Quasi-peak
Average	Average	Average
Quasi-peak	Peak	Quasi-peak
Peak/average	Peak/average	Quasi-peak/average
Peak/quasi-peak	Peak	Quasi-peak
Quasi-peak/average	Peak/average	Quasi-peak/average
Peak/quasi-peak/average	Peak/average	Quasi-peak/average
RMS	Average	Average

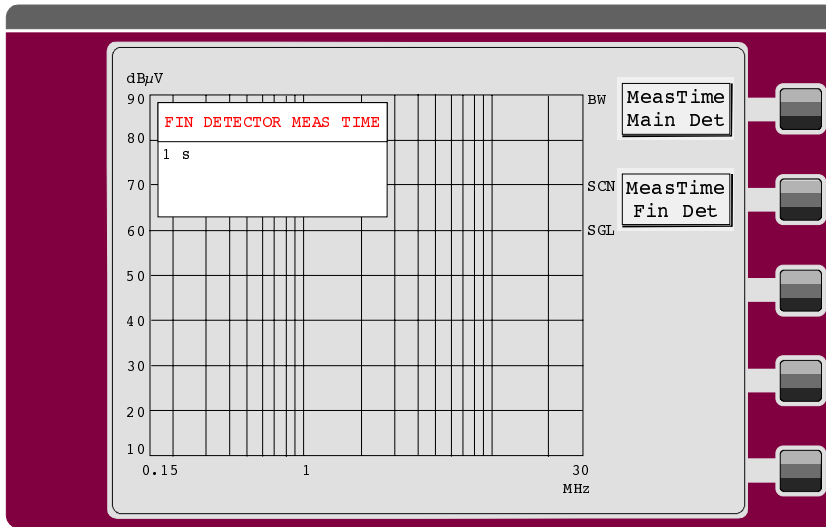
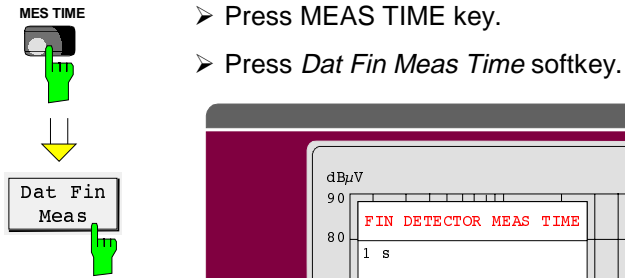
If no option is switched on, the scan can be performed with quasi-peak weighting.

The RMS detector (available as an option for ESCS) is not mentioned in the RFI measurement standards. It cannot be combined with other detectors and is not considered in automatic measurements.

Entry of Measurement Times

The measurement times for prescan measurements can be determined separately for each subrange and are entered together with the scan data.

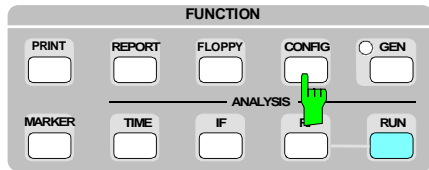
The measurement time for the final measurement is separately set.



Measurement times are specified by the standards and are, for instance 1, 5 or 15 s.

Switching on Limit Lines

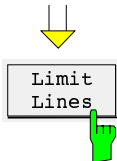
The limit lines for the individual measurement standards have to be entered and activated prior to the measurement. Two limit lines can be simultaneously displayed on the ESCS, the upper being used for the quasi-peak, the lower for the average detector.



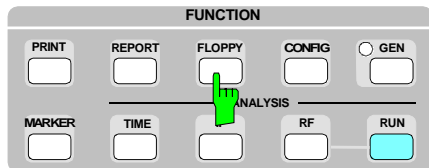
- Press CONFIG key.
- Press *Limit Lines* softkey.

The entry of new limit lines is described in chapter 4, Entering Limit Lines.

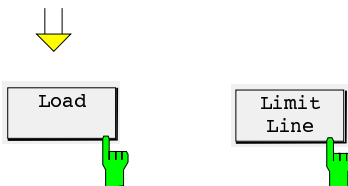
It is advisable to store defined limit lines of a floppy disk and to load them into the receiver as required.



For loading:



- Press FLOPPY key.

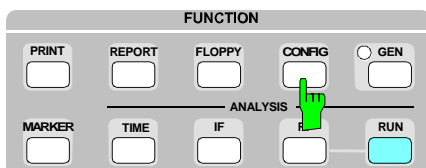


- Press *Load - Limit Line* softkeys.
- Select the desired limit line and confirm with ENTER.
- Select the internal memory location.
The receiver verifies that the limit line is not too high for the selected memory location. (Three types are available with 10, 20 and 50 measured values).

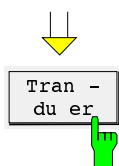
Switching on a Transducer Factor

Transducer factors are required when the connected transducer has a frequency response. This is the case, for instance, with antennas, absorbing clamps or current probes. The factors contain the associated unit (dB μ V/m, dB μ A, dBpT, etc.). Cable losses can also be considered in the transducer factor. Artificial mains networks do not require transducer factors as they operate at the correct voltage level.

The test receiver automatically considers the interpolated correction factor in the measurement result. This applies to both prescan and final measurements.



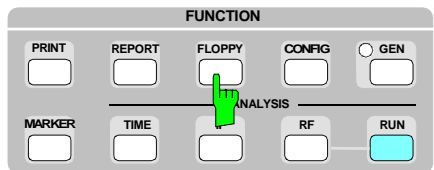
- Press CONFIG key.



- Press *Transducer* softkey.
The entry of new transducer factors is further described in chapter 4, Entering Transducer Factors.

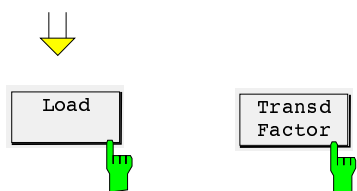
It is advisable to store defined transducer factors on a floppy and to load them into the receiver as required.

Loading:



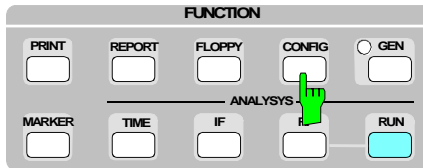
- Press FLOPPY key.
- Press *Load - Transd Factor* softkey.
- Select the desired factor and confirm with ENTER.
- Select the internal memory location.

The receiver verifies that the transducer factor is not too large for the selected memory location. (Three types are available with 10, 20 and 50 measured values).

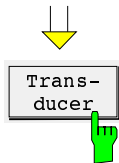


Switching on a Transducer Set

If several transducers, e.g. antennas for various frequency ranges, or if the attenuation of a cable in addition to a transducer factor must be taken into account it is suitable to use a transducer set. This also allows for combining several transducer factors according to their frequency ranges. The test receiver automatically takes into account the sum of the interpolated correction factors for the measurement result.



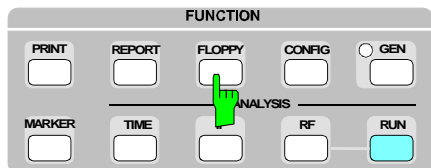
- Press CONFIG key.



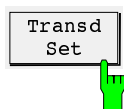
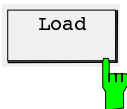
- Press *Transducer* softkey.
The entry of new transducer sets is described in chapter 4, „Entering of a Transducer Set“.

It is suitable to store the transducer sets once defined on a floppy disk so that they can be recharged into the test receiver as required.

Loading:

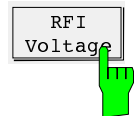
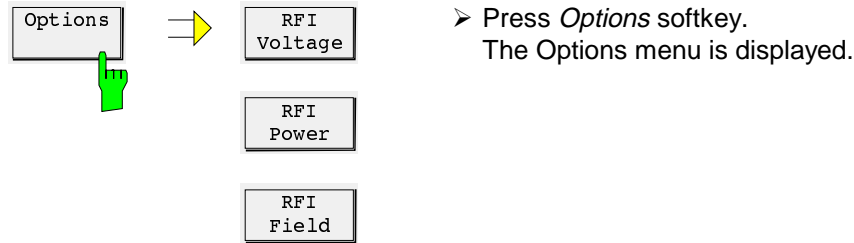


- Press Floppy key.
- Press *Load - Transd Set* softkeys.
- Select a transducer set and confirm with Enter.



- Select internal memory.
The dataset also contains the corresponding transducer factors.
- Finally, switch on the transducer set in the *Transducer* menu.

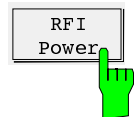
Switching on the desired option



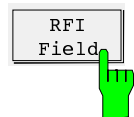
This function permits a complete RFI voltage measurement with result logging to be performed using ESCS, V-Network ESH2-Z5 or ESH3-Z5 and a plotter and/or printer.

Activating the phase in the PRESCAN/MANUAL submenu also switches the connected V-network. Thus phases can be selected manually on the receiver. If the V-network is deactivated with *OFF*, remote control is disabled.

During an automatic measurement the V-network is switched by the test receiver automatically.



This function permits a complete RFI power measurement with result logging to be performed interactively using ESCS, an absorbing clamp and a plotter and/or printer.



This function permits prescan measurements of the RFI field strength to be performed in an anechoic chamber as well as the subsequent measurement in the open field.



The *Fixed Final* function permits final measurements at user-defined frequencies to be performed. The frequencies are not determined by the receiver. A maximum of 400 frequencies can be defined. The frequency list is identical to the *Channel Scan* list. Only the frequencies within the specified scan range are used for the final measurement.

When the function is selected with the *Fixed Final* softkey, a table for entering the final measurement frequencies is displayed.

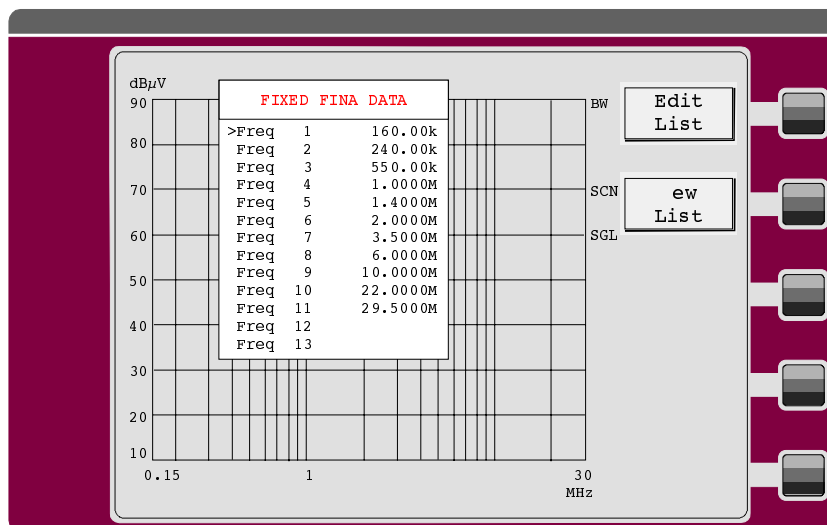
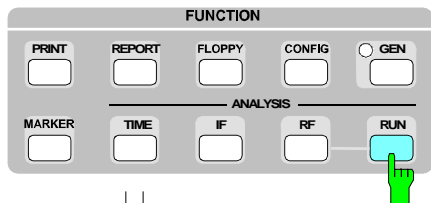
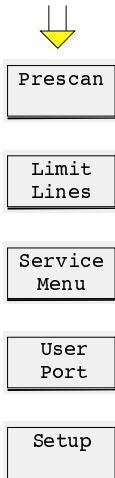


Fig. 2-20 Fixed final entry table

Performing the measurement



- Press RUN Key.
The run menu is displayed.



The prescan is started. At the end of each subrange a final measurement is performed and, if required, the phase with the highest RFI voltage is determined.

This measurement combines the prescan and final measurement functions described below. This combination has the advantage that the time interval between prescan and final measurements is shorter and drifting narrowband interferers can be more reliably detected.

This softkey is not active in the *Overview* mode. It is not displayed either if the scan was switched to *Continue* in the *Curves* menu.



Prescan is started with the *Prescan* softkey. It can be interrupted with the *Interrupt* softkey and aborted with the *Stop Scan* softkey. (For details refer to chapter 4, Automatic Test Runs). The prescan can be repeated as often as required. The subrange maxima are determined each time.

While the prescan is interrupted the receiver settings can be changed. This can be useful, e.g., for examining an unexpected interference in detail. Switching over to IF spectrum analysis is possible as well.



A final measurement is performed at the frequencies determined during prescan. If no V-network is switched on, a measurement is performed at each frequency. With a V-network switched on, the level is determined at each of the phases selected for the final measurement. The measurement time for the final measurements can be set via the MEAS TIME key.

The Final Meas is displayed after a subrange maxima has been determined during prescan. The prescan data can also be loaded from a floppy disk.

The final measurement can be repeated as often as desired. Until another prescan is performed the final measurement will be performed at the same frequencies.



The frequencies of the subrange maxima determined during the prescan are copied to the frequency list of the channel scan. This means that they can be used for scans at discrete frequencies (channel scans). The same frequency list is used for the final measurement with the option Fixed Final. If this option is switched on, the final

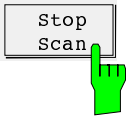
measurement is always performed at these frequency values.

The softkey is available only if subrange maxima relevant for the final measurement, i.e. maxima which are located close enough to or above the limit line, are determined. The softkey is not available if the option Fixed Final is switched on.

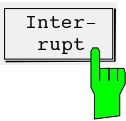
For scans with two detectors this softkey copies the subrange maxima of the first detector which is generally a peak detector.



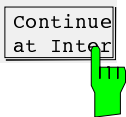
This softkey is available for scans with two detectors only. It copies the subrange maxima of the second detector which is generally an average detector.



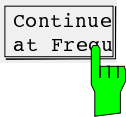
Prescan or the final measurement is interrupted. The RUN menu is displayed again. If subrange maxima have already been defined, the final measurement can be subsequently started at these frequencies.



The Interrupt softkey opens the *Interrupt* menu.



Prescan is continued where it has been stopped. The receiver settings specified in the scan data are restored. The scan menu is displayed again.



Prescan is continued at the currently set frequency. With this function, spectrum subranges can be measured several times during a scan. Receiver settings specified in the scan data are restored. The scan menu is displayed again.



When this softkey is pressed, the userport menu is opened which is otherwise called with the CONFIG key. From this menu accessories can be called for instance via the userport interface.

Overview of menus in scan mode:

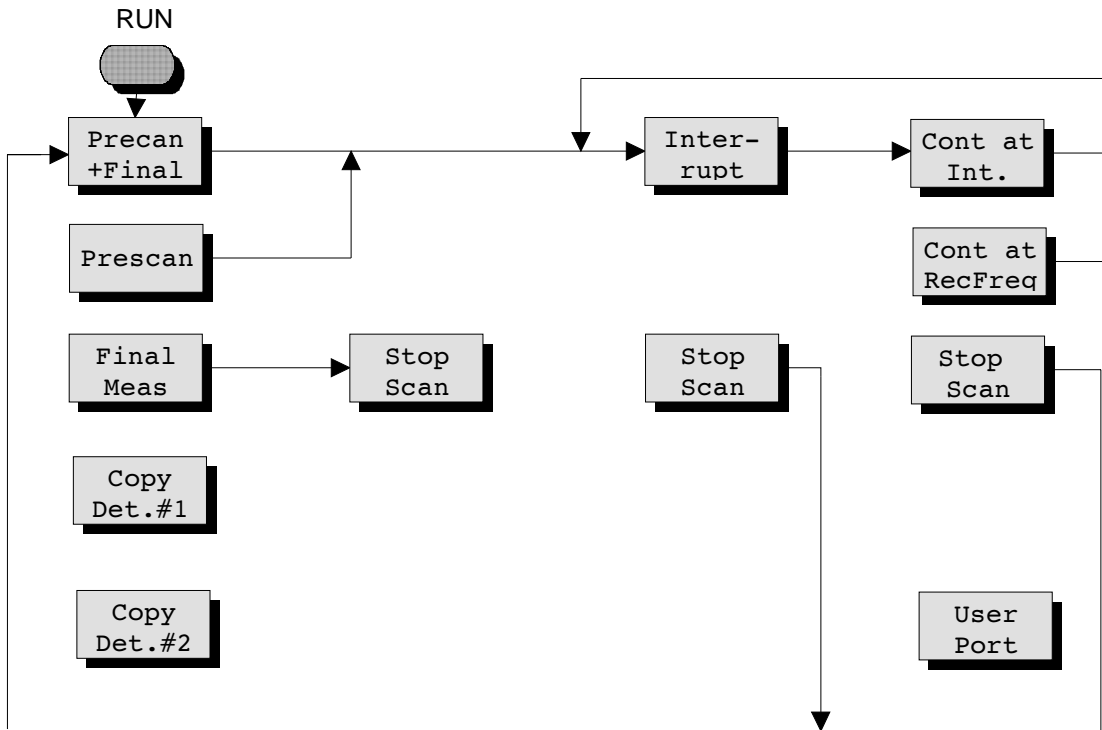
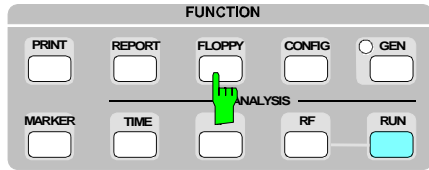


Fig. 2-21 Overview of scan menus

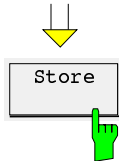
Saving measurement results

Measurement results can be stored and documented in different ways.

Storing results and receiver settings on built-in floppy-disk drive.



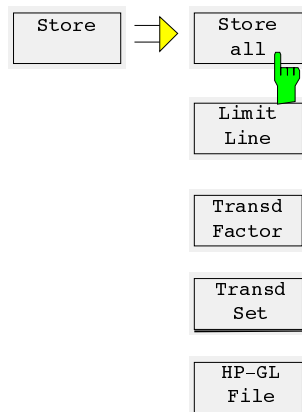
- Press FLOPPY key.
The respective menu is displayed from which the menus for storing and loading receiver settings and results can be accessed.



- Press *Store* softkey.
The menu below is displayed permitting the files to be stored on 720 Kbyte or 1.44 Mbyte floppies in a PC-compatible format.

For processing the stored data on a PC, a program is available which converts the files from ESCS to ASCII format. The files can then be read by means of a text editor and imported and processed by word processing or spreadsheet programs.

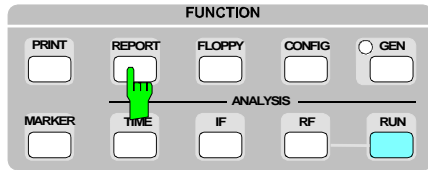
The *ESXS2ASC* program can be obtained from your local R&S agency free of charge.



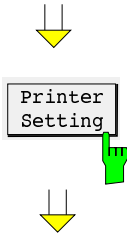
- Press *Store All* softkey in the store menu.
- Enter the file name which may be eight characters long and confirm with ENTER. An existing file can be overwritten by selecting it with the ↑ and ↓ keys and confirmation with ENTER. To ensure the correctness of the action, a query is displayed in the status line (Overwrite *Enter/Exit*).

Measurements stored on a floppy can be loaded into the receiver any time. Receiver settings, limit lines and transducer factors are stored together with the results and loaded into the receiver. Measurements are thus completely documented and can be repeated with the same settings. It is also possible to load prescan measurements from the floppy and to perform final measurement at the critical frequencies.

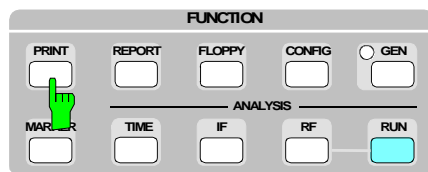
Result output to a printer.



- Press REPORT key.

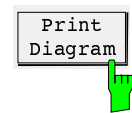


- Press *Printer Setting* softkey and select the desired parts of the test report and the printer to be used.



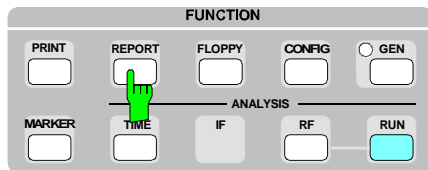
- Press PRINT key.
The test report is printed according to the selected configuration.

or



- Or press *Print Diagram* softkey.
The diagram and the scan table are printed on the selected printer.

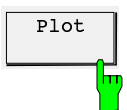
Result output to a plotter



- Press REPORT key.

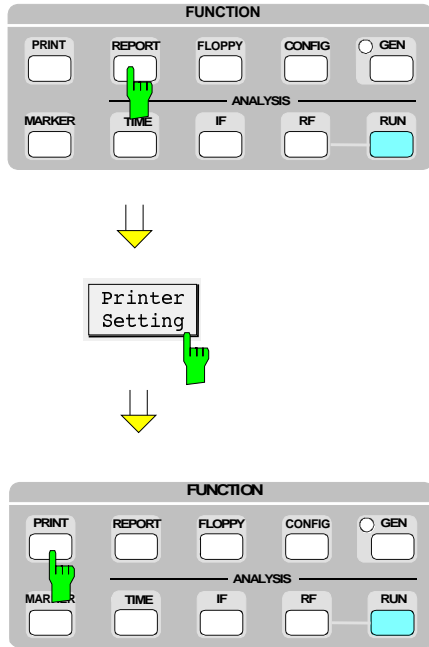


- Press *Plotter Setting* softkey and select the desired parts of the test report, plotter address, pin numbers and, if required, the scale.



- Press *Plot* softkey.
The test report is output according to the configuration on an IEC/IEEE-bus plotter.

Result output to the screen

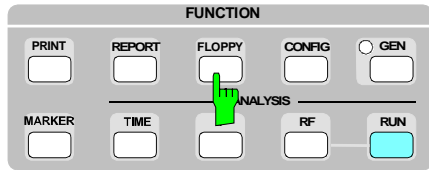


The output to a printer can also be displayed on a screen. This allows a quick check of measured values if no printer is available. Limit violations are marked in the final results. Invalid results are also marked, i.e. values measured (with fixed RF attenuation) with the receiver overdriven.

- Press REPORT key.
- Press *Printer Setting* softkey and switch on screen display by selecting *Screen* in the *PRINTER DRIVER* submenu.

-
- Press PRINT key.
The test report without diagram is displayed according to the configuration.

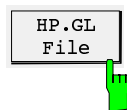
Storing results and receiver settings in HPGL format using the built-in floppy disk drive.



- Press FLOPPY key.



- Press Store softkey.



- Press *HP-GL File* softkey.
- Enter a file name which may be eight characters long and confirm with ENTER. An already existing file can be overwritten by selecting it with the ↑ and ↓ keys and confirmation with ENTER. To ensure the correctness of the action a query is displayed in the status line.

Results stored in HPGL format (plotter language) can not be loaded into the receiver, but they can for instance be integrated in a word processing or graphics program with import capabilities and processed.

Example of a test report:

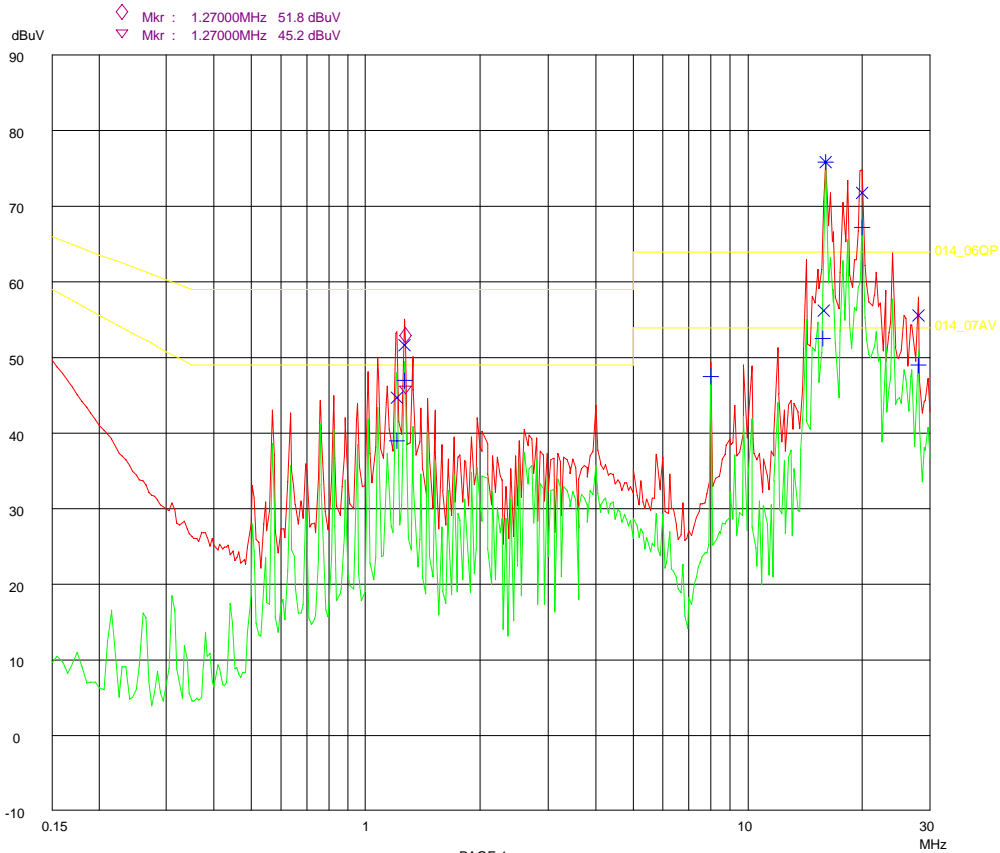
06. Jan 00 01:15

RFI Voltage

EUT: Power
Op Cond: fdl
Operator: M.
File name: LISN.RES

Scan Settings (1 Range)
----- Freqencies ----- Receiver Settings -----
Start Stop Step IF BW Detector M-Time Atten Preamp
150k 30M 5k 9k PK+AV 20ms 10dB LN OFF

Final Measurement: x QP / + AV
Meas Time: 1 s
Subranges: 25
Acc Margin: 6dB



RFI Voltage Test

06. Jan 00 01:15

EUT: Power Supply
Op Cond: idle
Operator: M. Keller
File name: LISN.RES

Final Measurement Results:

Frequency MHz	QP Level dBuV	Delta Limit dB
1.20500	44.7	-14.3
1.26500	51.6	-7.3
15.87000	56.1	-7.8
15.99500	75.9 O*	11.9
20.00000	71.8 O*	7.8
28.00000	55.5	-8.4

Frequency MHz	AV Level dBuV	Delta Limit dB
1.20500	39.0	-9.9
1.26500	47.0	-1.9
8.00000	47.5	-6.4
15.75000	52.5	-1.4
16.00000	75.9 O*	21.9
20.00000	67.2 O*	13.2
28.00000	48.9	-5.0

* limit exceeded

3 Manual Operation

This chapter contains the description of the screen setup, instructions for setting the parameters, the receiver functions and the menus.

Receiver functions:

- frequency input,
- selection of attenuation (RF attenuation and IF attenuation),
- selection of IF bandwidth,
- selection of weighting mode (detector),
- selection of measuring time,
- selection of AF demodulation,
- Level indication (analog and digital),
- Calibration of receiver

The menus include:

- selection of the receiver configuration,
- use of transducer factors (transducer),
- setting and performing frequency scans,
- input of limit lines,
- carrying out special measurements (OPTIONS) during frequency scan,
- output of measurement results to printer or plotter,
- input of headers for printer or plotter outputs,
- setting of printer or plotter configuration and
- carrying out the self-test.

Connecting the Voltage to be Measured

The voltage to be measured is connected to the RF INPUT via a 50- Ω -coaxial cable. The input resistance of the receiver is 50 Ω . The ESCS measures sinusoidal and pulse voltages within the frequency range of 9 kHz to 2750 MHz. The total RF voltage of all signals that may be applied to the input socket of the receiver without causing any permanent damage depends on RF attenuation (cf. Specifications).

Sinusoidal Signals and DC Voltage

With an RF attenuation of 0 dB the RMS value of the total voltage applied to the RF input may not exceed 3 V at 50 Ω . For RF attenuations ≥ 10 dB the total voltage must not exceed 7 V (=1 W). The max. dc voltage with all RF attenuations is 50 V.

Pulse Signals

With an RF attenuation of 0 dB the pulse spectral density must not exceed 97 dB μ V/MHz at 50 Ω .

With an RF attenuation > 0 dB the max. permissible pulse energy at 50 Ω is 10 mWs.

The input attenuator, pre-amplifier, preselection filter or input mixer may be destroyed, if these values are exceeded. For higher voltages as occur e. g. with measurements at ignition cables using the absorbing clamp MDS 21 it is recommended to use the external Pulse Limiter ESH3-Z2 (see Recommended Extras in the data sheet). This 10-dB attenuator pad is designed for pulse voltages up to max. 1500 V and pulse energies up to 100 mWs, thus protecting the receiver input from destruction.

Note: *The minimum RF attenuation can be set to 0 dB or 10 dB using the function Min Att 10 dB in the Setup menu.*

Input of Numeric Values

The numeric keypad DATA and the unit field ENTER are used for the input of figures both in the receiver part and menu part.

The keys SAV and RCL that serve to save and call instrument settings are dealt with in section 4. Numeric values are input in accordance with the following flowchart:

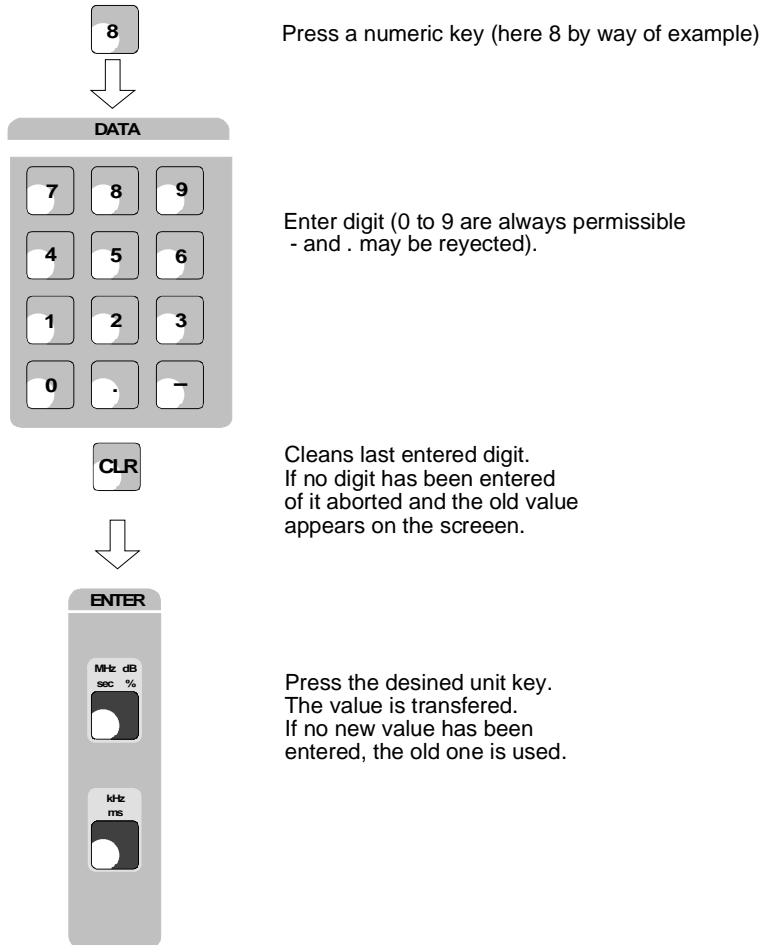


Fig. 3-1 Flowchart for the input of numeric values

Operation of the Menu Functions

The following functions are called via the FUNCTION keys as well as via the 5 softkeys (on the right of the screen):

- Presetting of instrument parameters
- Control of complex test runs
- Input of limit lines and transducer factors
- Output of measurement results
- Calling of the instrument selftest

Configuration of the Screen

The screen is subdivided into two areas:

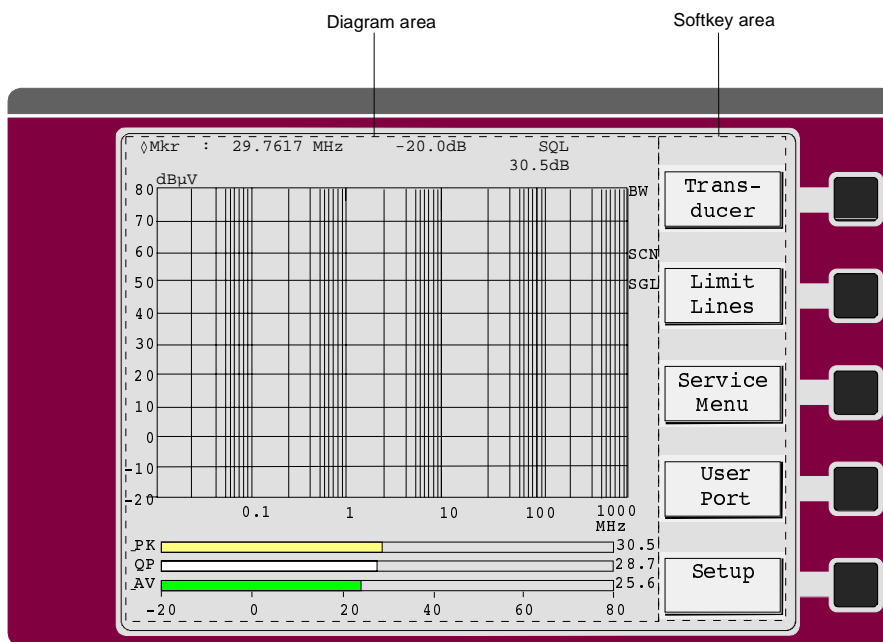


Fig. 3-2 Basic screen configuration

Diagram area

This area contains the measuring diagrams and other measured-value information as well as the parameters and status information which are important for analysis of the results. In addition, message fields, entry windows and tables may be shown in this area.

Softkey area

This area contains the instrument functions which can be selected via the softkeys. The softkey area is not superimposed by other graphics.

Diagram Area

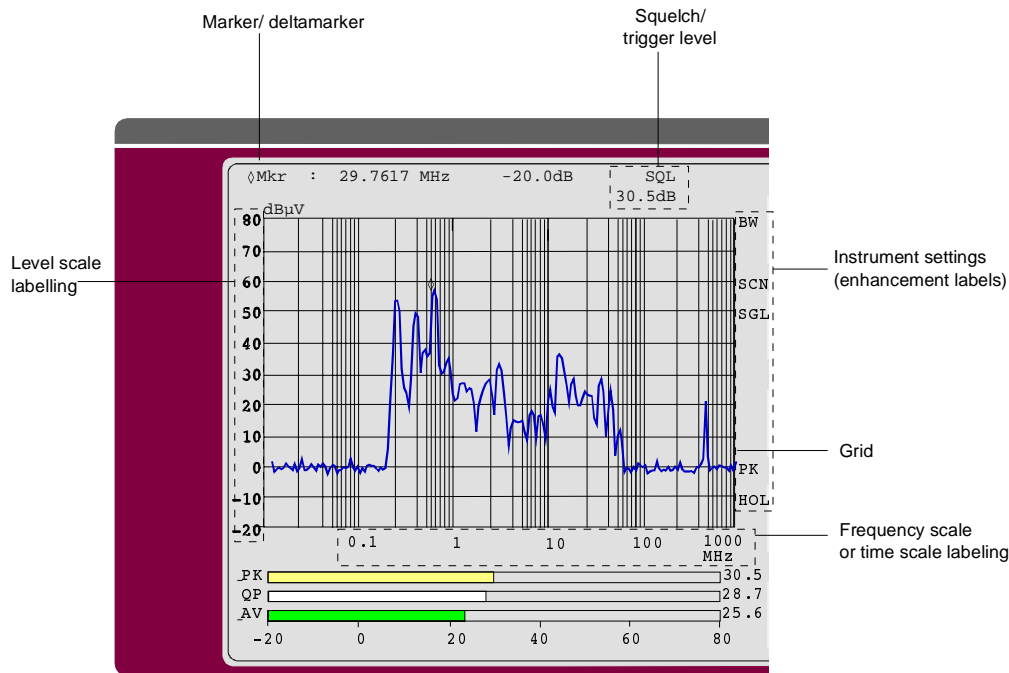


Fig. 3-3 Subdivision of the ESCS

- The following graphic elements are displayed in the diagram area:

Squelch/ trigger level SQL Indication of the squelch or trigger level set in the demod or trigger menu.

Grid X-axis: frequency or time, Y-axis: level

Frequency axis labeling Display of the x-axis

Level axis labeling Display of the y-axis

Limit lines Limit lines are used to mark level curves or spectral distributions which must not be exceeded or dropped below.

Bargraphs The ESCS allows for a level measurement with simultaneous use of up to three different detector types. In a bargraph, the colors are **permanently** assigned to the detectors:

- Peak detector yellow bar
 - Quasi-peak detector white bar
 - Average detector green bar
 - RMS detector yellow bar
- The color of the bars changes to red when the limit lines are exceeded.

The meaning of the abbreviations (in alphabetical order) will be explained in the table below:

Enhancement label	Abbreviation for	Meaning
AVRG	Average	Subsequent curves are digitally averaged. In the case of signals fluctuating with respect to time, the average time is represented. Averaging is continued until it is aborted by the user by means of the Clear/Write function or restarted by pressing the "Average" softkey. The function is possible in the IF spectrum analysis.
BATT :	Battery h:min	Display with integrated NiMH battery packs. These are automatically charged during mains operation (standby or ON) or external battery supply. With internal battery supply, the time of operation that corresponds to the state of charge is indicated in h:min.
BLNK	Blank	The selected curve is blanked. The function can be canceled using the Clear/Write function. The function is possible in IF spectrum analysis.
BW	Bandwidth	Display when an IF bandwidth is selected that deviates from the CISPR bandwidth prescribed for the set input frequency. This is only true for peak, average and RMS detector; if the quasi-peak detector is activated, IF bandwidth and frequency are coupled so that this display never appears.
C1:	Curve 1	Assignment of the following enhancement label to curve 1 (only in IF spectrum analysis).
C2:	Curve 2	Assignment of the following enhancement label to curve 2 (only in IF spectrum analysis).
CHAN	Channel	Selection of the operating mode "Channel Scan": measurement at up to 400 discrete frequencies.
CHCK	Check	Selection of the function "Check Transducer". Instead of the measured value, the transducer value with unit calculated at the set receiver frequency is indicated on the display. No level measurement is performed.
CLWR	Clear/Write	Operating mode, in which the measured values of the curve are continuously updated. The frequency scan is repetitive.
CWMH	Clear/Write + Max Hold	Operating mode with simultaneous display of two curves, ie: Max. Hold curve: The maximum measured value of subsequent measurements is displayed; lower measured values are overwritten. Clear/Write curve: The measured values of the curve are continuously updated.
EXRF	External Reference	Selection of the operating mode with an external frequency standard of 10 MHz for increasing the frequency accuracy of the ESCS30.
EXT+	External Trigger +	An external trigger signal (TTL) with positive edge at the user port starts the level measurement.
EXT-	External Trigger -	An external trigger signal (TTL) with negative edge at the user port starts the level measurement.
GATE	Gated Scan	The measurement is triggered by an external positive TTL trigger edge at the user port. It is continued as long as a HIGH level is applied to the trigger input. When the trigger level changes to LOW, the frequency scan is interrupted. With the next change to HIGH, the scan is continued at the frequency where it was interrupted.
INT	Internal	Internal trigger for time domain activated. The measurement starts as soon as the level exceeds the selected trigger threshold at the set frequency.
MAXH	Max. Hold	The maximum measured value of subsequent measurements is displayed; lower measured values are overwritten.
MIN	Min. Hold	The minimum measured value of subsequent measurements is displayed; higher measured values are overwritten.

Enhancement label	Abbreviation for	Meaning
OVER	Overview	Selection of the operating mode "Spectrum Overview": It provides a fast overview of the defined frequency range. The step size depends on the set IF bandwidth.
SCAN	Scan	Selection of the operating mode "Scan". Step size and measuring time per frequency point can be freely selected. 2 detectors may be active at a time.
SNGL	Single	A single measurement is performed.
TIME	Time domain	Selection of the operating mode "Time domain analysis". Analysis of the timing of disturbances.
TRD	Transducer	Transducer factor or transducer set activated, ie the frequency-dependent transducer factor of the preceding coupling network (antenna, current clamp, etc.) are taken into account, which converts the disturbance to be measured into an interfering voltage at 50 ohms.
VIEW	View	The selected curve is frozen. The function can be canceled using the Clear/Write function.

Calling the Softkey Menus

By pressing a FUNCTION key, the appropriate softkey menu is called. The screen will then display a table that contains a data list or a function select list. The softkey menus may comprise further submenus. The limited depth of the softkey structure makes for easy and clear menu operation. Another main menu can be entered from any submenu by pressing the appropriate key.

Note: The next higher menu level can be attained by pressing the EXIT key.

Selection via a softkey

The softkey selection is the most frequently used type of selection. It is effected by pressing the respective softkey. There are several possibilities:

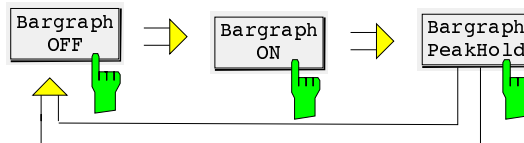
1. The softkey is active or inactive.

- **Example:** Switch on the squelch.
 - Press the *DEMODO* key.
 - Press the *Squelch* softkey.

If the softkey is active, the labeling changes from black to red.

2. The softkey acts like a switch, each time it is pressed, the active selection is changed.

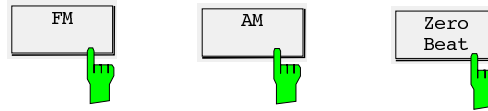
- Example: Activation of the bargraph display
 - Press the *DETECTOR* key.
 - Press the *BARGRAPH* softkey.
 - Each time the softkey is pressed, its labeling changes.



3. Several softkeys act like selection switches.

- **Example:** Setting of the AF demodulation.
 - Press the *DEMODO* key.
 - Press the softkey *FM*, *AM* or *Zero Beat*.

The AF demodulation is selected. Only one of the 3 softkeys can be active at a time, i.e. the softkeys act like selection switches.



Operation of the Menu Functions

For entering parameters and selecting the data and functions, the ESCS uses lists which are displayed on the screen in the form of tables. The upper screen line contains the designation of the currently active menu.

Selecting the table elements

After calling a menu, a table with data or functions appears on the screen. A cursor symbol for selecting the individual table elements usually indicates the first input field. The currently active input line is shown in bright notation. If the screen area is not sufficient for display of the complete selection list, the list can be scrolled up or down. Continuation of lists is marked by the symbol \uparrow or \downarrow at the upper or lower edge, respectively.

An element can be selected using the keys \uparrow and \downarrow in the EDIT keypad:

- Position the cursor (\rightarrow) to the desired function or, in the case of a table, to the respective data field and trigger the function using the *Status ON/OFF* softkey.

Some tables use numbers for designation of the table elements. In this case, the elements can also be selected by directly entering numbers in the table.

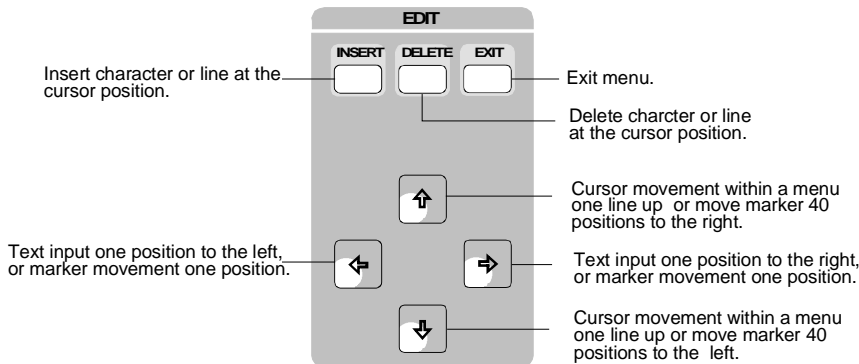


Fig. 3-4

Input of numerical values

Numerical values are directly entered in the table at the current cursor position. To this end, the numerical keypad is used, and the entry is terminated using ENTER. INSERT or DELETE can be used to enter or delete a character or line at the cursor position.

If entry of a numerical value is required when switching on special functions, this is not done in the table but in the status line.

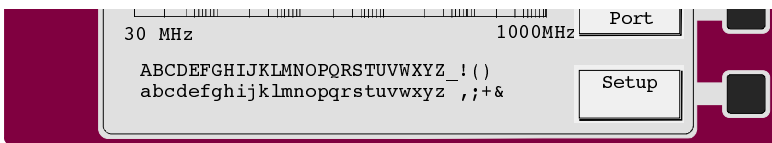
Input of Texts and Labelings

Transducer factors and sets, limit lines, files on floppy disk, internally stored data sets as well as test reports output on the plotter or printer can be assigned names or labeled by the user. The name or labeling can be entered via a standard MF keyboard connected to the rear panel of the receiver (cf. Section 1) or, if no keyboard is available, via an auxiliary line editor. The use of a keyboard is recommended, in particular for labeling test reports, since this ensures a much more convenient input.

Operation of the auxiliary line editor:

The auxiliary line editor can be used for labelings and text entries without an external keyboard being connected to the ESCS. The selection lines with characters are always displayed automatically when text entry is possible and no external keyboard is connected. (Exception: In the menus *Floppy Store all* and *Report Title* the INSERT key must be pressed to call the auxiliary line editor).

The first line with upper-case letters, blank and special characters is faded in above the status line. The two arrows at the end of the line indicate that the \uparrow key serves to reach the input line and likewise the \downarrow key to reach the second line (with lower-case letters). The individual characters are selected using the \leftarrow and \rightarrow keys and inserted into the text in the input field using the INSERT key. Numerals in the DATA keypad can be entered at any time. Characters may be cleared using the CLR key (character ahead of the cursor) or DELETE key (character below the cursor). Text input is terminated by pressing one of the ENTER keys.



Operation of the Receiver Functions

Setting the Receiver Frequency

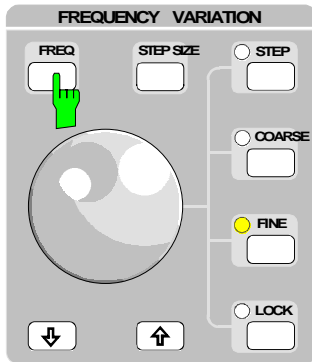
The frequency of the receiver can be entered using the rotary knob, the keys \uparrow and \downarrow or via the numeric keypad after having pressed the **FREQ** key. The functions **STEP**, **COARSE** and **FINE** permit to select the frequency increment or decrement for the rotary knob setting.

Numeric Input of Frequency

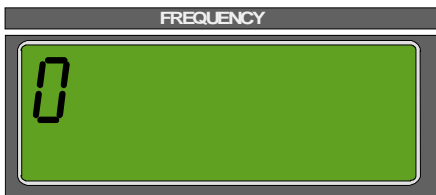
The desired receiver frequency in the range of 9 kHz to 2750 MHz can be entered directly using the **FREQ** key in the keypad **FREQUENCY VARIATION**. On pressing the **FREQ** key, the current receiver frequency in the **FREQUENCY** display is deleted and a new frequency can be entered.

Operation:

The frequency is entered as follows:



➤ Press the key **FREQ**.



In the **FREQUENCY** display, the set frequency is extinguished and a 0 appears. When entering a digit, this appears in the display (see section 3 „Input of Numeric Values).

Frequency Setting using the Rotary Knob

The rotary knob in the keypad FREQUENCY VARIATION only serves for varying the frequency. Irrespective of any other selected input function, the frequency can always be tuned using this knob. The step size with which the frequency is tuned can be selected using the keys STEP, COARSE, FINE and LOCK. The step size selected is indicated by an LED next to the corresponding key. Tuning is performed in the step sizes given in the following table:

Table 3-5

Tuning in position	Step size in frequency range < 1000 MHz	frequency range \geq 1000 MHz
COARSE	10 kHz	100 kHz
FINE	10 Hz	100 Hz
LOCK	Rotary knob is blocked	Rotary knob is blocked
STEP	0 to 2750 MHz	0 to 2750 MHz

When the rotary knob is turned slowly, every step between detent positions corresponds to a frequency step. To allow for comfortable tuning of the receiver over relatively wide frequency ranges, tuning is additionally accelerated when the knob is turned quickly.

Frequency Tuning using the Keys \Downarrow and \Uparrow

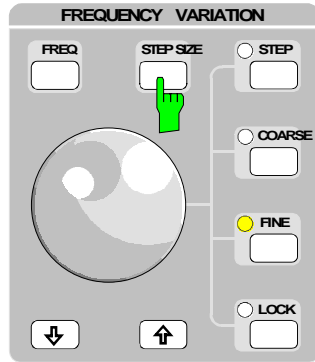
If signals are to be measured in known frequency steps, it is useful to change the receiver frequency in the appropriate steps. This is for example the case with harmonics of the clock frequency of processors. For this purpose the \Uparrow and \Downarrow keys are provided in the keypad FREQUENCY VARIATION. Frequency is changed in the step sizes entered with the help of STEP SIZE using these keys. In addition the receiver frequency can be fine-tuned using the rotary knob in position FINE, when for example the maximum of a harmonic wave is to be determined in the case of a source that is not frequency-stable. Fine-tuning is taken into account when changing the frequency the next time using the \Uparrow and \Downarrow keys, i.e. the receiver proceeds taking the new frequency as basis

Input of Tuning Step Size

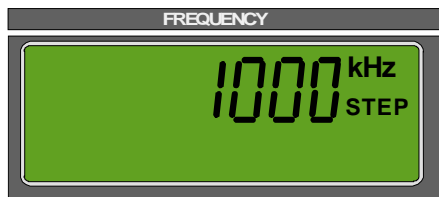
Any step size for tuning the receiver frequency can be input using the STEP SIZE key in the keypad FREQUENCY VARIATION. The defined step size is used when tuning the frequency with the \Uparrow and \Downarrow keys or with the tuning knob in the step size setting STEP.

Operation:

Step size is entered as follows:



➤ Press *STEP* key.



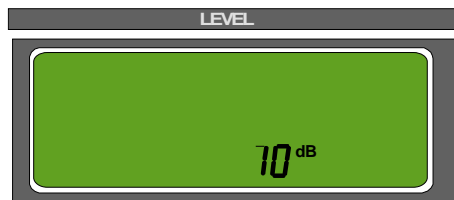
The frequency in the FREQUENCY display is extinguished, and the set step size appears with the addition STEP below the unit. When a digit is entered, the old step size is extinguished, and the digit appears in the display (see section 3 „Input of numerical values“).

The step size is variable between 0 kHz/MHz and 2750 MHz. After termination of input, the receiver frequency is shown again in the display FREQUENCY with the unit MHz or kHz.

Selection of RF Attenuation (ATTENUATION)

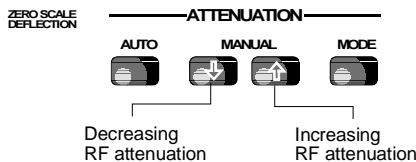
Attenuation of the RF input attenuator can be set in 5-dB steps in the range from 0 to 60 dB. The attenuator at the input is AC-coupled for protection against high-energy pulses of low frequency. The test receiver may have somewhat less accuracy in the 0-dB position as a result of the higher input reflection coefficient (VSWR < 2). In the case of quasipeak measurements in accordance with CISPR 16, minimum attenuation of 10 dB must therefore be switched on (VSWR < 1.2).

Operation:



RF attenuation is increased or decreased in 5-dB steps using the ↑ and ↓ keys in the ATTENUATION keypad. When pressing the respective key for a longer time (> 1 s) the repetition function is switched on, i.e. attenuation is stepwise switched.

The RF attenuation selected is shown in the LEVEL display.



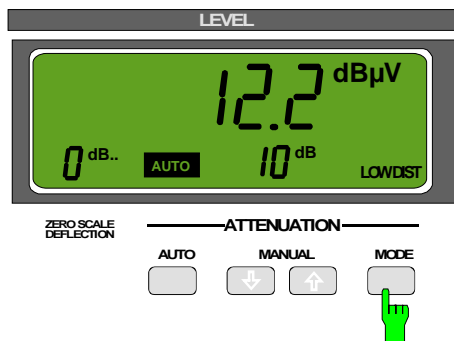
Selection of Operating Mode (MODE)

The ESCS provides the operating modes LOW NOISE (low-noise measurement) and LOW DISTORTION (low-distortion measurement). When measuring in the latter mode IF gain of the receiver is set such that the noise indication is always below the beginning of the meter scale (ZERO SCALE DEFLECTION). The set IF gain is a function of the selected detector and IF bandwidth. In the LOW NOISE mode the IF gain is by 10 dB lower and consequently the input level of ESCS giving the same meter deflection 10 dB higher than in the LOW DISTORTION mode. As a result the signal-to-noise ratio for signals within the permissible meter range is 10 dB higher than in the LOW DISTORTION mode. With manual attenuator setting in the LOW DISTORTION mode the maximum receiver sensitivity is obtained because of the higher IF amplification. With automatic attenuator setting (AUTO key pressed) and low signal-to-noise ratio, the IF gain is automatically set so that maximum sensitivity is achieved independent of the selected operating mode.

The LOW DISTORTION mode should be used when low signal levels are to be measured in the vicinity of strong interference signals or when quasi-peak display has been selected at a low pulse frequency. For obtaining the same meter deflection, an RF attenuation 10 dB higher than that of the LOW NOISE mode has to be selected. As a result signals are reduced by 10 dB at the input mixer thus loading the input less.

In the case of uncritical measurements, the LOW NOISE mode should be used as in this case a higher measurement accuracy can be expected because of the higher signal-to-noise ratio.

Operation:



- Press the MODE key.
The toggle switch switches from LOW DISTORTION to LOW NOISE and vice versa.

The set mode is shown in the LEVEL display.

Automatic Setting of Attenuation (Aurorange Operation)

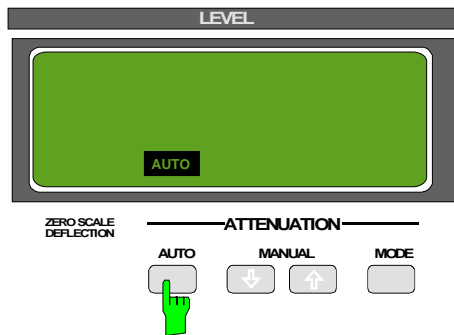
With automatic operation selected, the receiver sets the RF attenuation and the operating mode (MODE) such that the level applied to the RF input is always within the valid operating range. The input mixer has to be protected against spikes as may be caused when the DUT is switched on or upon switchover of the measurement path between phase and neutral wire with an artificial mains network connected. In the basic receiver setup, an attenuation of at least 10 dB is permanently set in the aurorange mode and after receiver switch-on. An RF attenuation of 0 dB is only used in aurorange mode if this value is set with automatic operation selected. The 0-dB setting can be canceled by switching off the aurorange mode and switching it on again after setting an RF attenuation of ≥ 10 dB. When measuring RFI voltages with an external Pulse Limiter ESH3-Z2 or in the case of RFI fieldstrength measurements, this protective measure is not appropriate for reasons of sensitivity. In this case select function Min ATT 10 dB (see section 1 „Selecting the instrument presettings“) to allow the use of 0-dB attenuation. When the ESCS is switched off with the 0-dB attenuation set, this value is reset upon switching on the instrument again. The following criteria are of importance for setting the optimum attenuation:

- overload at the positions critical in the receiving path,
- the peak value at the output of the envelope demodulator and
- the measured value in the set indicating mode (DETECTOR).

Settings in keeping with these criteria make sure that levels measured in aurorange operation are valid in any case and not invalidated by overloading in a receiver stage.

Hysteresis for changing over attenuation at the lower end of the operating range prevents continuous switching on and off of attenuation due to varying input levels.

Operation:



Press the AUTO key.
Automatic operation is switched on or off.

Automatic operation can be switched off by

- pressing the AUTO key or
- manual switching of attenuator

Level Indication

Digital Level Indication

The test level is indicated in the digital LEVEL display. In addition, it is displayed in a bar diagram on the screen if the bargraph display is switched on. All active detectors are displayed as bars. The scaling is made in parallel with the level scaling of the diagram. The basic unit of the indication is dB μ V. Other units can be selected by coding the connector ANTENNA CODE (cf. section 1), entering a transducer factor or switching on the unit "dBm" (cf. section 4 "Configuration of the Receiver"). The possible units are listed in table 3-6.

Operation:



- Press the DETECTOR key.
The menu for selecting the detectors is displayed on the screen.

- Press the softkey *Bargraph OFF/Peak Hold*.
The bargraph display is switched on.

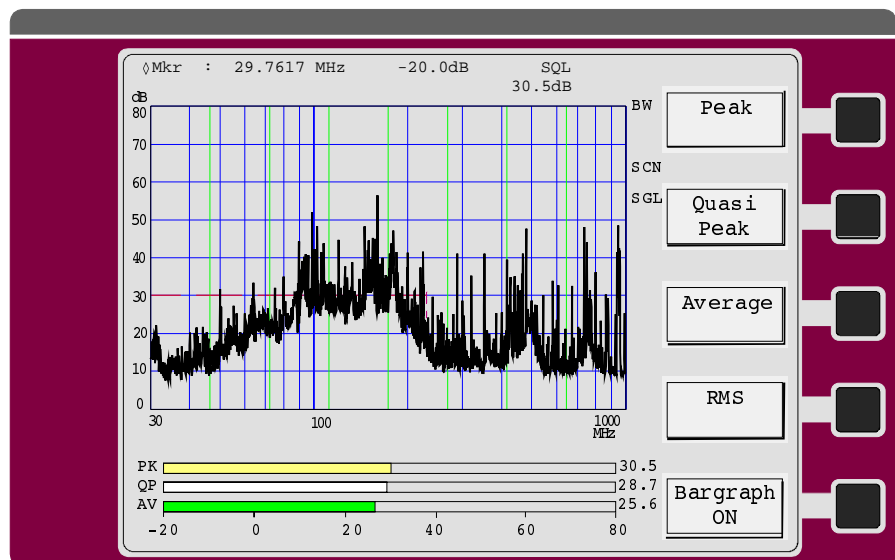


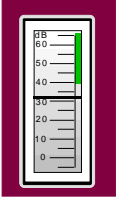
Table 3-6

dB μ V	Voltage level at 50 Ω at RF input of receiver
dB μ A	Current level, settable by coding connector ANTENNA CODE or by the unit of the transducer factor.
dB μ V/m	Electrical fieldstrength level, settable by coding connector ANTENNA CODE or by the unit of the transducer factor.
dB μ A/m	Magnetic fieldstrength level, settable by the unit of the transducer factor.
dBpW	Power level in dB relating to 1 picowatt, settable by the unit of the transducer factor
dBm	Power level in dB relating to 1 milliwatt, settable by way of <i>Config</i> softkey
dBpT	Power level relating to the magnetic flux density 1 pT, settable by the unit of the transducer factor.

Analog Level Indication

The level of analog indication is the result of adding the value for ZERO SCALE DEFLECTION in the LEVEL display to that of the meter display in the selected operating range.

Example:



The unit of the digital measured value is also valid for indication on the analog meter.

Non-decadic transducer factors or the pseudo unit dBm, too are correctly taken into account with analog indication. In this case the complete tens digit is added to the zero-scale deflection, whereas the one digit and the digit after the comma are internally added to the meter voltage by way of a digital/analog converter. The operating range of the meter is thus usually shifted, either to higher or to lower values (max. 6 dB). For this purpose, the scale is extended by 6 dB at the upper and lower end of the scale respectively.

Overload of Receiver

Although analog level indication is within the valid range, the receiver may be overloaded. This is, e.g. the case when a relatively weak signal is within the measuring bandwidth, however a strong signal is present outside the range. This strong signal may overload the stages before the IF filter. For this reason in the ESCS, the level is monitored at these critical positions. If a stage in the signal path is overloaded, the user will be informed about this by the message *OVERLOAD* on the LEVEL display.



To guarantee a correct measurement RF attenuation must additionally be switched on until the OVERLOAD display disappears. In autorange operation, attenuation is automatically set such that no overload occurs.

Selection of IF Bandwidth (IF BW)

Due to the narrow specification of a 6-dB-drop, the 10-kHz bandwidth meets the requirements of CISPR 16, band B (150 kHz to 30 MHz) and VDE 0876 as well as of various military standards that require tolerances of 10% for a 10-kHz measurement bandwidth.

The 120 kHz bandwidth meets the tolerance for the bandwidth of bands C and D (30 to 1000 MHz) specified in CISPR 16 or VDE 0876.

With receiving frequencies below 30 kHz, the 200-Hz bandwidth is always recommended for use since the oscillator for first conversion is not sufficiently suppressed with the 10-kHz bandwidth and thus the sensitivity of the receiver is considerably reduced.

The 200-Hz bandwidth meets the tolerance for the bandwidth of band A (9 kHz to 150 kHz) specified in CISPR 16 or VDE 0876.

All filters have optimal settling characteristics and are thus suitable for average measurement of pulse signals in accordance with CISPR 16.

In the indication mode quasi-peak (QP), the bandwidth is linked to the receiver frequency. In band A ($f_{rec} < 150$ kHz) the 200-Hz bandwidth, in band B ($f_{rec} \geq 150$ kHz) the 10-kHz bandwidth and in bands C/D ($f_{rec} \geq 30$ MHz) the 120-kHz bandwidth is automatically switched on.

Effective selectivity of the filters is shown in the following figure:

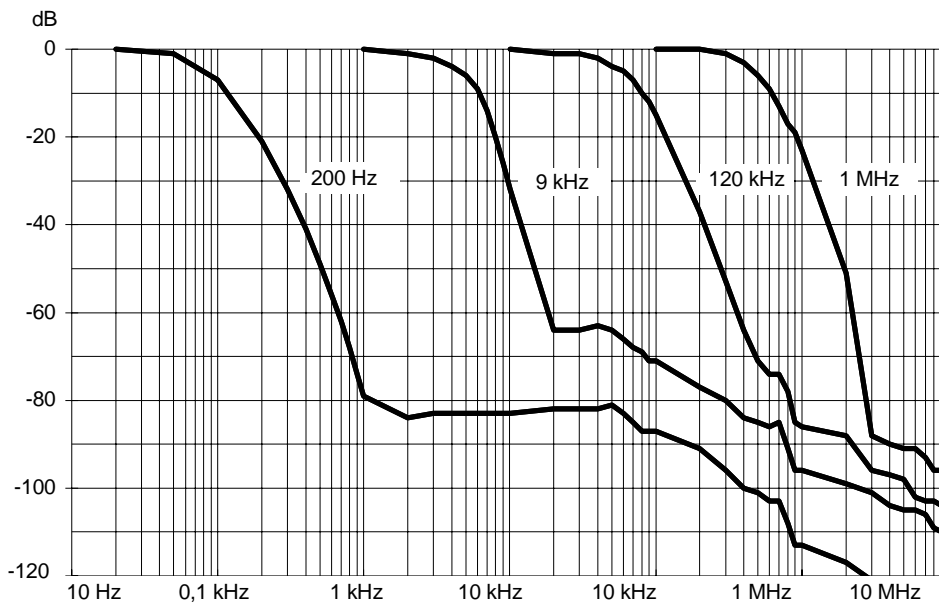
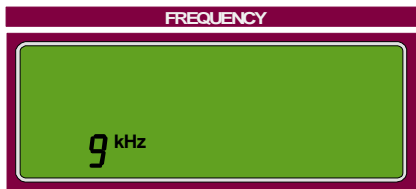
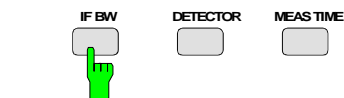


Fig. 3-6 Dynamic IF selectivity

Operation:



- Press IF BW key.
IF bandwidth is switched over (1 MHz ⇒ 120 kHz ⇒ 9 kHz ⇒ 200 Hz) and the newly set IF bandwidth is underlined to indicate that a new entry is possible using the numeric keypad DATA.
- Press ENTER key.
The bar disappears again (input of bandwidth is inactive).



Selection of Weighting Mode (DETECTOR)

The indicating mode specifies how to weight the envelope of the IF signal. The weighting modes (detectors) average value (AV), peak value (Pk) and quasi-peak value (QP) can be switched on in the ESCS. In addition, the weighting mode RMS is available (option ESCS-B9).

Any three detectors can be active at a time. The detector that usually provides the highest value is indicated on the level display. The order of priorities is as follows: peak, quasi-peak, average and RMS. The measured values for all activated detectors are indicated in a bargraph.

The consequences brought about by the selection of the indicating mode will be explained in the following.

Average Measurement (AV)

In the case of average measurement the linear time-averaged value of the rectified voltage at the output of the envelope demodulator is indicated. It is calibrated using the RMS value of an unmodulated sinusoidal signal. If an unmodulated sinusoidal signal is applied to the receiver input, its RMS value is thus indicated; if an AM signal is present, the RMS value of the carrier is indicated.

With the ESCS, analog averaging is performed using lowpass filters, the time constants of which are switched over depending on the measuring time (cf. section 4 „Selecting the Measuring Time“). Weighting of pulses is described in sections „Pulse Weighting in Various Weighting Modes“ and „Selection of Measuring Time“.

RMS (ESCS-B9)

For RMS value measurements the RMS value of the rectified voltage at the envelope demodulator output is indicated. Irrespective of the signal shape, the envelope demodulator power is indicated. Analog RMS value generation is performed. The time constant for RMS value generation is set via the measuring time and is identical with the time constant of average value generation with the measuring time already specified. Weighting of pulses is described in sections „Quasi-peak“ and „Selecting the Measuring Time“.

Peak Value (Pk)

In the case of peak value measurement, the maximum value of the rectified voltage at the output of the envelope demodulator within the selected measuring time is indicated. It is calibrated using the RMS value of an unmodulated sinusoidal signal that supplies the same detection voltage. Average and peak value of an unmodulated sinusoidal signal result basically in the same indication. As, however, with peak value weighting, the noise voltage indication is about 11 dB higher than with average weighting, higher values are indicated when the signal-to-noise ratio is not sufficient (refer also to section 4 „Measurement Accuracy“).

Peak value indication serves for determining the levels of keyed carriers or pulse signals or peak voltages of AM signals. As peak value measurement can be carried out considerably faster than quasi-peak measurement, it is recommended for RFI measurements to first perform a general measurement in indicating mode Pk and then a quasi-peak measurement at the critical frequencies.

Quasi-peak (QP)

Quasi-peak measurement weights pulse signals using a quasi-peak detector with defined charge and discharge time. IF bandwidth and mechanical time constant of the meter are also specified. The characteristics the receiver has in this indication mode are defined in CISPR 16 or in VDE 0876. The most important parameters are listed in the following table:

Table 3-7

	CISPR Band A	CISPR Band B	CISPR Band C/D
Frequency range	9 kHz to 150 kHz	150 kHz to 30 MHz	30 to 1000 MHz
IF bandwidth	200 Hz	9 kHz	120 kHz
Charge time of QP detector	45 ms	1 ms	1 ms
Discharge time of QP detector	500 ms	160 ms	550 ms
Time constant of meter	160 ms	160 ms	100 ms

The meter time constant of the ESCS is simulated electrically, so that it is also valid for digital indication. The meter itself operates much more quickly so that its own time constant does not affect the measurement result.

Due to the long time constants of weighting, it takes relatively long until a valid measurement result is displayed after every change in frequency or attenuation at the receiver. It is therefore futile to use measuring times of less than 1 s, especially in the case of automatic measurements.

The maximum level value during the measuring time set is shown on the digital level display. The timing of the quasi-peak test voltage can be observed on the analog meter at the same time. In addition to monitoring of the interference source this often allows to draw useful conclusions as to the character of the interference.

Quasi-peak weighting places high demands on the dynamic characteristics of the receiver. With low pulse frequencies, however, the operating range cannot be fully utilized, as otherwise the RF input would be overloaded. When an overload occurs the user is informed about it by way of the overload indication (*OVERLOAD*) in the LEVEL display. The user should then increase the RF attenuation to such an extent that the overload message disappears. In automatic operation the receiver itself correctly sets the attenuation.

Pulse Weighting in Various Weighting Modes

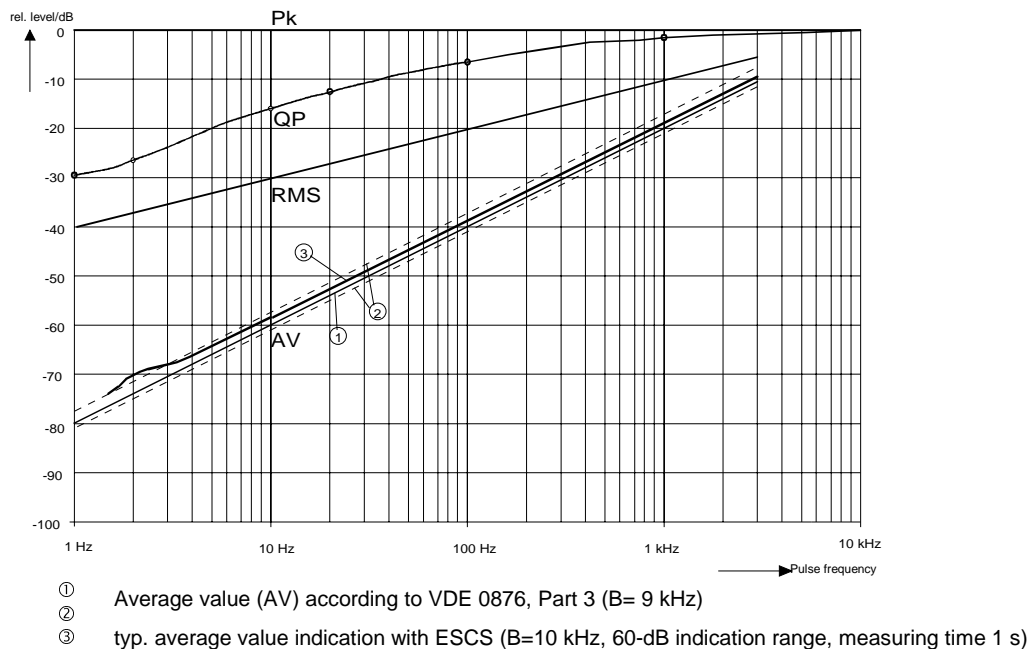
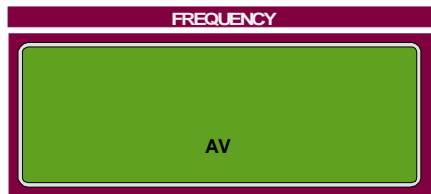


Fig. 3-7 Differences in weighting of pulses between the indicating modes AV, RMS, Pk and QP with an IF bandwidth of 10 kHz.

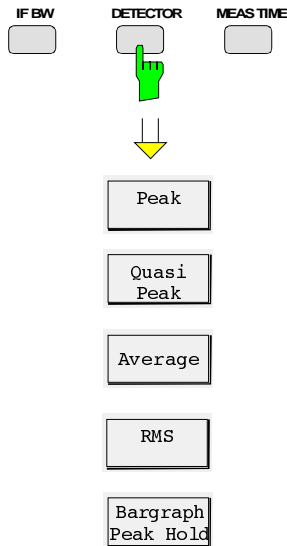
- Sinusoidal signals and pulses with a high repetition frequency result in the same indication in all three weighting modes.

- Peak value indication (Pk) always shows the peak value of the highest pulse independently of the number of pulses during measuring time.
- In quasi-peak mode (QP) level indication drops with decreasing pulse repetition frequency due to time constants specified in CISPR 16.
- Average value indication (AV) weights pulses proportionally to pulse frequency. Level indication decreases most rapidly (20 dB per decade) when pulse frequency is reduced. With the ESCS, the characteristic curve of average value indication is about 1 dB above the theoretical curve, however always within the error limits of +3 and -1 dB, which are agreed upon in VDE 0876 Part 3. The reason is a slight overshoot of the IF filter. Increase in indication for pulse repetition frequencies below 10 Hz is caused by internal receiver noise.

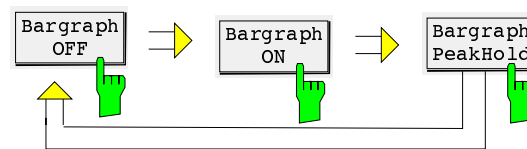
Operation:



- Press the DETECTOR key. The detector menu appears on the screen.
- Select the single detectors by repeatedly pressing the DETECTOR key (only possible if a detector is active) or
- select the desired detectors using the associated softkeys.



- Press the softkey *Bargraph*. Each time it is pressed, the softkey labeling changes.



The bargraphs are updated at the end of the measuring time. The peak hold display is reset when a test parameter is changed which always leads to another measurement, eg receiver frequency or IF bandwidth. However, this is not true when the measuring time is changed.

Selection of Measuring Time (MEAS TIME)

The measuring time is the time during which the input signal is monitored. The time that is required by the selected detector to settle following a change of attenuation or frequency is not part of it. The measuring time can be chosen within the range of 1 ms to 100 s in the steps 1, 2, 5, 10. In the operating mode Time Domain, the minimum measuring time is 0.1 ns.

Significance with Peak Measurement:

In indicating mode Pk the maximum value of the level during measuring time is shown. At the beginning of measurement the peak detector is discharged. When the measuring time has elapsed, the output voltage of the detector is A/D-converted and then indicated. With measuring times of over 100 ms the peak voltage is A/D-converted every 100 ms and the maximum value of the individual measurements is taken as measurement value. Unmodulated signals can be measured using the shortest measuring time possible. In the case of pulse signals, measuring time must be set such that at least one pulse occurs during measuring time.

Significance with Average Measurement:

Averaging in indicating mode AV is performed using analog low-pass filters at the output of the linear envelope detector before the logarithmic amplifier. Following a change in frequency or attenuation the receiver therefore waits until the lowpass has settled and then measuring time begins. To keep waiting time as short as possible the receiver monitors the output signal during settling time. If it has already stabilized prior to the end of maximum waiting time, measurement is started earlier. If measurement times of more than 100 ms are selected, the linear output signal of the average value low-pass is also digitally averaged(linear averaging).

Which measuring time to select depends on the IF bandwidth set and the character of the signal to be measured.

Unmodulated sinusoidal signals and signals with correspondingly high modulation frequencies can be measured using short times. Slowly varying signals or pulse signals require longer measuring times. The following table indicates the repetition frequencies up to which pulses are still measured correctly as a function of the measuring time (add. error of level indication < 1 dB).

Table 3-8

Measuring time	Pulse-repetition frequency
1 ms to 20 ms	1 kHz
50 ms to 200 ms	100 Hz
≥ 0.5 s	10 Hz

Thus the shortest measuring time (1 ms) can be used for RFI voltage measurements due to the following reasons: The difference between the limit values for quasi-peak and those for average value in the case of RFI voltage measurements amounts to maximally 13 dB (CISPR, publ. 22, instruments of class A). According to figure 3-7 showing the weighting curves this difference occurs at a pulse frequency of 1.8 kHz.

The decisive value for lower pulse frequencies is always the quasi-peak limit value. This means that average value indication has to be correct only up to this pulse frequency. As pulses with repetition frequencies of down to 1 kHz can be averaged correctly using a measuring time of 1 ms, it can be applied without reservation for this type of measurement.

Significance with RMS Measurement

The recommendations given for the measuring time to be selected in an average measurement apply to RMS measurements as well.

Significance with Quasi-peak Measurement

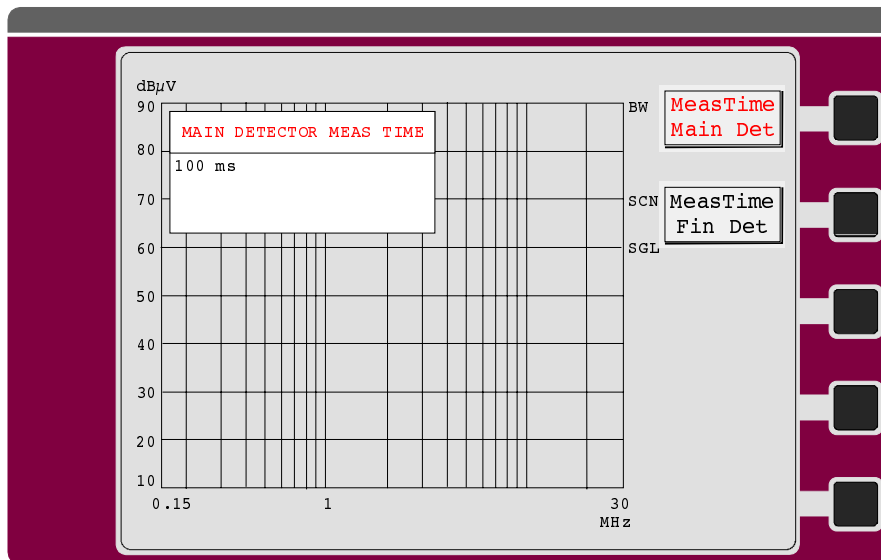
The relatively long time constants occurring with quasi-peak weighting result inevitably in relatively long measuring times that must be set in order to obtain a correct test result. In any case it should amount to not less than 1 second, if the signals to be measured are unknown. A measuring time of that length ensures that pulses with a repetition rate of down to about 5 Hz are correctly weighted.

When switching over attenuation or changing frequency the receiver waits until the measurement voltage has settled and then starts measuring. To reduce waiting time it is monitored whether the signal at the output of the weighting circuit has already stabilized before maximum waiting time has elapsed. If this is the case, measurement is started earlier.

Operation:



- Press MEAS TIME key.
The menu for entering the measuring time is displayed. The input field is already activated.



- Enter a new measuring time via the numeric keypad DATA (cf. section 3 "Input of Numeric Values").
- Terminate the input with the desired unit.
The new measuring time is displayed together with the unit.

Selection of AF Demodulation (DEMODO)

The ESCS offers the demodulation modes FM, AM and ZERO BEAT.

FM is used to demodulate frequency-modulated signals. The bandwidth and slope of the demodulator are matched to the selected IF bandwidth to ensure an optimal AF signal-to-noise ratio. In the case of 10-kHz IF bandwidth, narrowband FM emissions and, in the case of the 120-kHz IF bandwidth, FM broadcast emissions are optimally demodulated. The AF bandwidth is 5 kHz with 10-kHz IF bandwidth and 30 kHz with 120-kHz IF bandwidth.

AM stands for amplitude-modulated emissions. The AF bandwidth is limited to 5 kHz. In the indicating mode quasi-peak (QP), noise in the AF path is suppressed to some extent in order to show more clearly the devices interfering with pulses. Distortion of signals to which sine-wave modulation has been applied is however higher due to this measure than in other indicating modes.

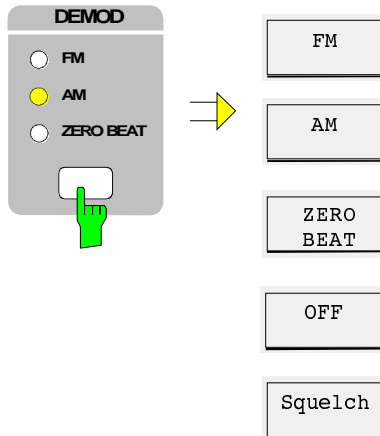
In the case of ZERO BEAT a carrier with the frequency of the IF is mixed to the signal on its last IF. If it is an unmodulated signal that is tuned to the receiver center frequency, zero beat (no audible tone) is the result. When the receiver is detuned, a tone can be heard the frequency of which corresponds to the difference between input signal and receiver frequency. This is helpful when a sinusoidal signal must be discovered in a signal mixture or when the receiver should be tuned exactly to a signal.

Both the volume of the internal loudspeaker and that of the headphones connected to AF OUTPUT socket is set using the rotary knob. The loudspeaker is automatically switched off when a 3.5-mm connector is plugged into the AF OUTPUT socket (e.g. with headphones operation).

The ESCS is equipped with a squelch function which switches off the AF at a low RF signal level. The threshold is compared with the measured signal level and can therefore be entered as level value. Transducer factors are taken into account, if applicable. The squelch is part of the level measuring function, ie it is only active while the measurement is running. If the ESCS is waiting for an external trigger event or if no level measurement is active in remote-control mode, the squelch will not switch. The respective yellow LED in the DEMODO field flashes if the AF has been muted by the squelch.

Note: When the beeper is activated, AF demodulation must be switched on, as otherwise the beeper is not audible. Nevertheless the volume control knob may be at the left stop so that the demodulated AF cannot be heard.

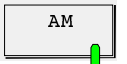
Operation:



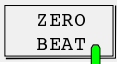
- Press the DEMODO key. The softkey menu for setting the AF demodulation appears on the screen. The yellow LED in the DEMODO field indicates the selected type of demodulation.
- By repeatedly pressing the DEMODO key, the demodulation types are cyclically selected.
- By pressing the respective softkey, the demodulation can as well directly be selected.



The softkey *FM* switches on the FM demodulation.



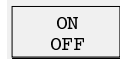
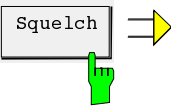
The softkey *AM* switches on the AM demodulation.



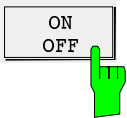
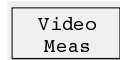
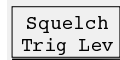
The softkey *ZERO BEAT* switches on the demodulation type ZERO BEAT.



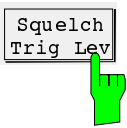
The softkey *OFF* permits to switch off the demodulation.



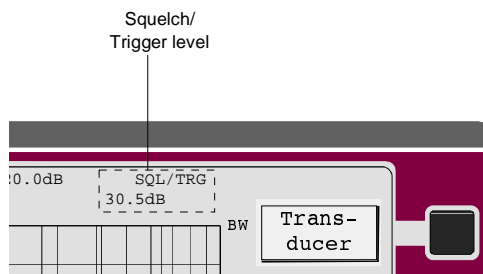
➤ The *Squelch* softkey calls up the submenu for setting the squelch functions. The squelch function is switched on at the same time.



The softkey *ON OFF* switches the squelch function on or off.



The softkey *Squelch Trig Lev* opens up an input field for definition of the squelch threshold. This value is also used for the internal trigger of the time domain analysis.



The selector switch *Video Meas* permits to switch over the characteristic of the squelch function. With the setting *Video*, the unweighted video signal is compared with the switching threshold. If *Meas* is selected, the signal weighted with the set detector is compared with the threshold.

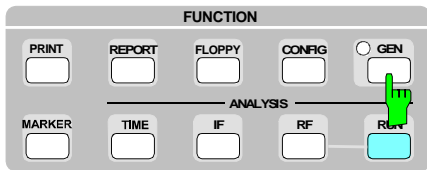
Average detector with a measuring time of 1 s means eg that the squelch is slowed down with a time constant of 100 ms.

Operation with Internal Tracking Generator (Option ESCS-B5)

The tracking generator can be used to perform attenuation and gain measurements on four-terminal networks with a very high dynamic range. It is available in the frequency range from 9 kHz to 2750 MHz. The output level amounts to 90 dBµV ±2 dB at 50 Ω. The measurement range comprises -120 dB to +10 dB (with preamplifier and an IF bandwidth of 200 Hz).

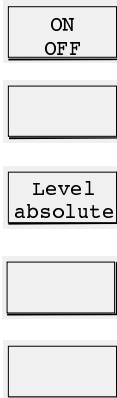
For four-terminal network measurements the average value detector (AV) is recommended for use. The other indicating modes provide the same measurement result, however limit the dynamic range on account of the increased basic noise. If any detector other than AV is set when switching on the generator, the hint *Select AV detector* is read out on the screen.

Operation:



- Press GEN key.
The tracking generator is switched on, which is indicated by the yellow LED. At the same time, the display unit changes to dB. The screen shows the softkey menu for setting the tracking generator.

- On pressing the key again, the generator is switched off, the unit switches back to its initial state.



The *ON OFF* softkey switches the tracking generator on or off.



The *Level absolute* softkey switches between relative and absolute level indication.

Calibration and Measurement Accuracy

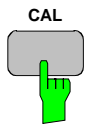
The ESCS is equipped with two internal harmonics generators that generate a 100-kHz spectrum which is flat from 10 kHz to 2750 MHz. The entire receiver is calibrated in a complex process.

In the calibration, the following parameters are recorded and stored in a non-volatile memory:

- frequency response,
- correction values for the IF bandwidths ,
- correction values for IF gain (low noise and low distortion),
- correction values for quasi-peak weighting
- linearity correction values for the display range and IF spectrum analysis, if applicable.

Calibration takes about 90 seconds. It eliminates the need for a calibration of the receiver after having switched over a receiver setting. Thus optimal measurement speed is possible while high measurement accuracy is ensured. It is recommended to carry out the total calibration about 30 minutes after the instrument has warmed up. Due to high stability of the receiver the correction values remain constant for a long time and therefore need not be set anew daily.

Operation:



- Press the CAL key.
The status line on the screen indicates the following:
CAL TOTAL (total calibration).
After the calibration has been completed, the message *CAL COMPLETE* is displayed on the screen.

Error Messages during Calibration

During calibration all correction values recorded are checked for compliance with the tolerances internally specified. If one of the tolerances is exceeded, an error (ERR) is output. The calibration is aborted if the gain cannot be controlled at the reference frequency. During remote control, the error messages are presented to the user via IEC-bus (cf. section 6).

The following error messages are possible:

<i>ERR: Gain at 5,9 MHz</i>	Gain at the reference frequency 5.9 MHz cannot be controlled. Calibration is aborted.
<i>ERR: BW 200 Hz</i>	Gain at 200-Hz IF bandwidth can no longer be corrected.
<i>ERR: BW 120 kHz</i>	Gain at 120-kHz IF bandwidth can no longer be corrected.
<i>ERR: BW 1 MHz</i>	Gain at 1-MHz IF bandwidth can no longer be corrected.
<i>ERR: IF ATT</i>	The IF-gain switch is faulty so that it is no longer possible to correct its gain error.
<i>ERR: 60 dB Range</i>	The 60-dB operating range is faulty and can no longer be used.
<i>ERR: QP</i>	The quasi-peak weighting is faulty.
<i>ERR: Gain at xx MHz</i>	A filter range of the preselection is faulty. Measurements in this range are not possible.

Measurement Accuracy

When performing a total calibration, all the values determined are related to the internal calibration generator and RF attenuator. The linearity of the operating ranges is recorded in 10-dB steps. An interpolation is made between the sampled values. Due to the high linearity of the envelope detector and logarithmic amplifier (typ. error < 0.25 dB), the sampled values are sufficient for an optimal correction. The measurement value is internally (by the instrument itself) determined in $1/100$ dB so that rounding errors are of no significance.

The error limits are composed of:

- Error limits of attenuator: 0.7 dB
- Error limits of calibration generator: 0.4 dB
- Setting accuracy of gain: 0.05 dB
- Non-linearity of envelope detector: 0.05 dB

In the most unfavorable case, a measurement error of maximally 1.2 dB results for the entire measurable level range. Since the individual errors do not depend on each other in terms of statistics, quadratic addition is permissible. The total error is thus < 0.9 dB. In practice, the measuring accuracy is considerably higher for signals with sufficiently high signal-to-noise ratio.

An additional measurement error, which is determined by physics, is due to the inherent noise of the receiver. The error is least significant with average value indication; with peak value indication, however, it is considerably higher. In indicating mode quasi-peak the error strongly depends on the type of signal to be measured.

In the case of average and peak value the error as a result of the signal-to-noise ratio can be determined approximately using the following formulas:

$$\text{Average value} = \text{error} / \text{dB} \approx 20 \log \left(1 + 0,3 \frac{N_1}{s} \right)$$

$$\text{Peak value} = \text{error} / \text{dB} \approx 20 \log \left(1 + 0,8 \frac{N_2}{s} \right)$$

s = level of unmodulated signal

N_1 = Noise indication with average value (AV) in μV

N_2 = Noise indication with peak value (Pk) in μV

$N_2 = N_1 + 11 \text{ dB}$

Table 3-9 and Fig. 3-8 illustrate an increase in indication in the case of average measurement of sinusoidal signals and peak measurement as a function of the signal-to-noise ratio.

Table 3-9 Error occurring when measuring an unmodulated sinusoidal signal with average or peak indication as a function of the signal-to-noise ratio.

Signal-to-noise ratio	Increase in indication in dB with	
	Average value (AV)	Peak value (Pk)
0	2.28	5.10
1	1.86	4.67
2	1.50	4.27
3	1.21	3.98
4	0.98	3.54
5	0.79	3.22
6	0.63	2.92
7	0.50	2.65
8	0.40	2.39
9	0.32	2.16
10	0.26	1.95
12	0.16	1.59
14	0.10	1.28
16	0.06	1.03
18	0.04	0.83
20	0.02	0.67
25	0.01	0.38
30		0.22
40		0.07
50		0.02

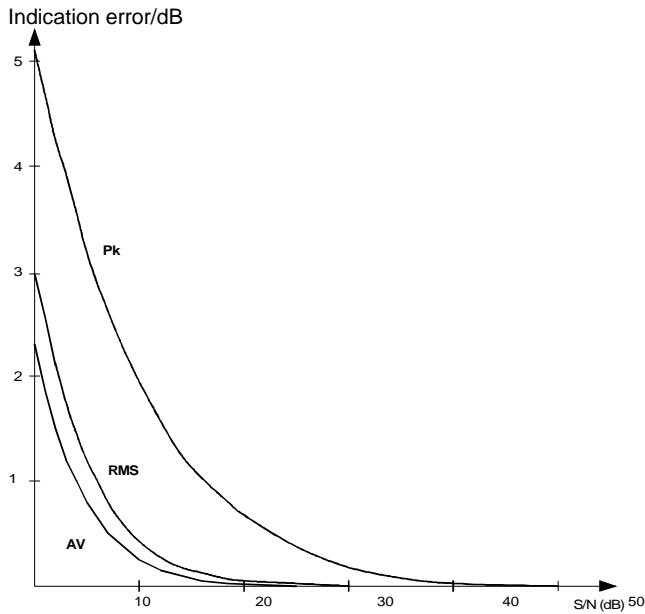


Fig. 3-8 Increase in indication of an unmodulated sinusoidal signal as a result of noise as a function of the signal-to-noise ratio.

Fig. 3-9 illustrates the increase in indication as a result of receiver-internal noise with quasi-peak indication for sinusoidal signals and pulse signals with a pulse repetition frequency of 100 Hz. Due to pulse weighting the error strongly depends on the type of input signal. In the case of sinusoidal signals the increase in indication is almost as high as with peak value indication. With pulses the indication error due to noise is reduced with decreasing pulse frequency.

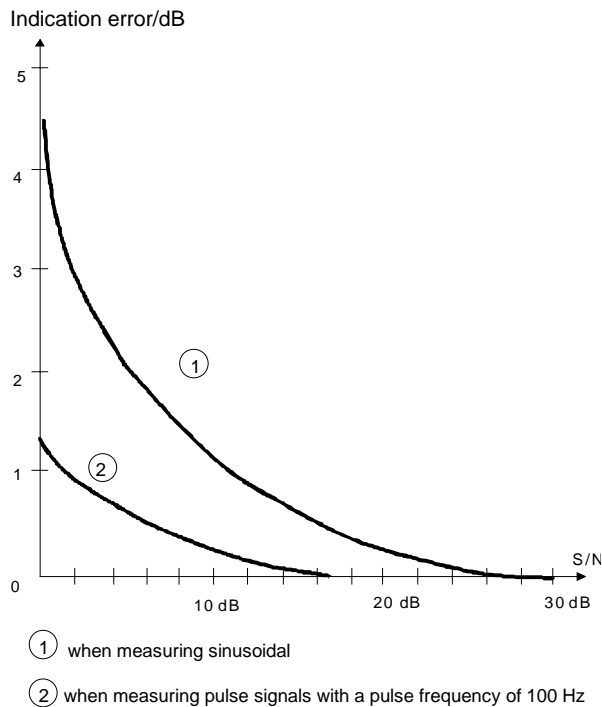


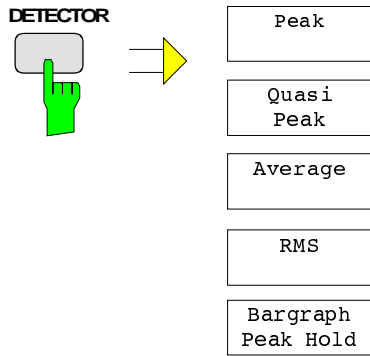
Fig. 3-9 Indication error due to noise with quasi-peak indication

For measurements carried out in practice the following can be recommended:

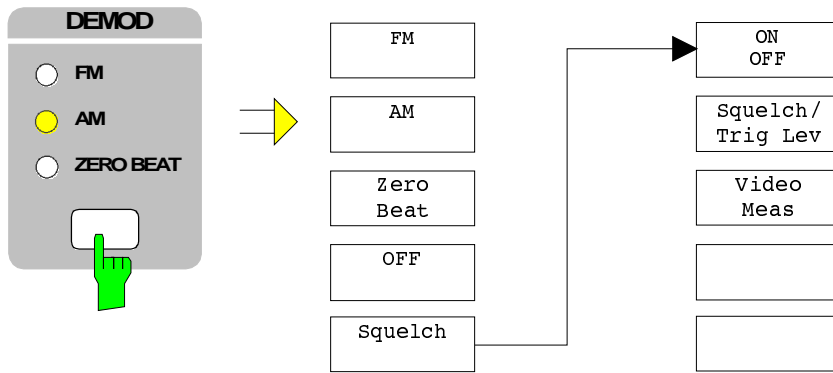
- To make full use of the accuracy of the ESCS, carry out measurements with a high signal-to-noise ratio, i.e. low noise setting and no superfluous RF attenuation.
- When measuring sinusoidal signals use average value indication as it is the least sensitive to the signal-to-noise ratio.
- Carry out quasi-peak measurements using low noise, if the type of input signal permits this mode (cf. section „Selecting the Operating Mode“). In autorange operation, this is taken into account by the receiver itself.

Menu Overview

Detector Key

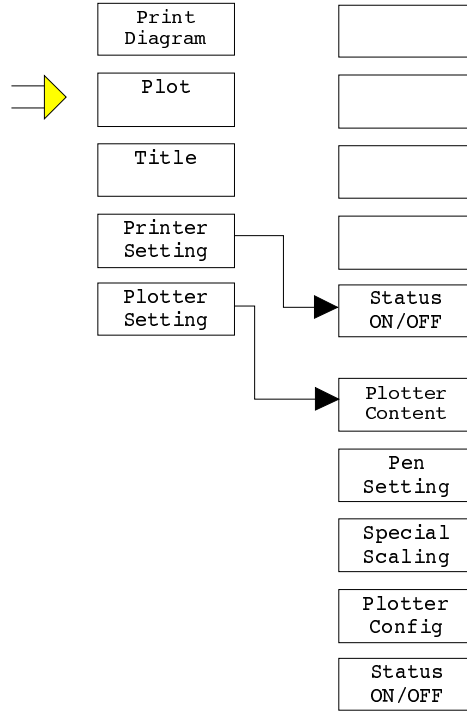
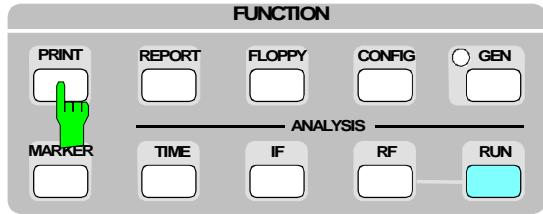


DEMOD Keys

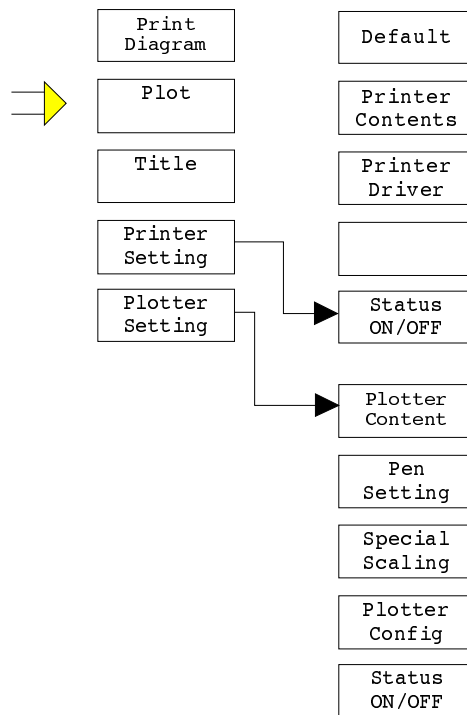
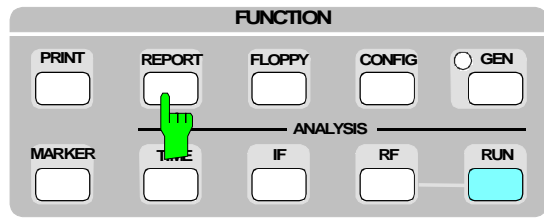


FUNCTION Keys

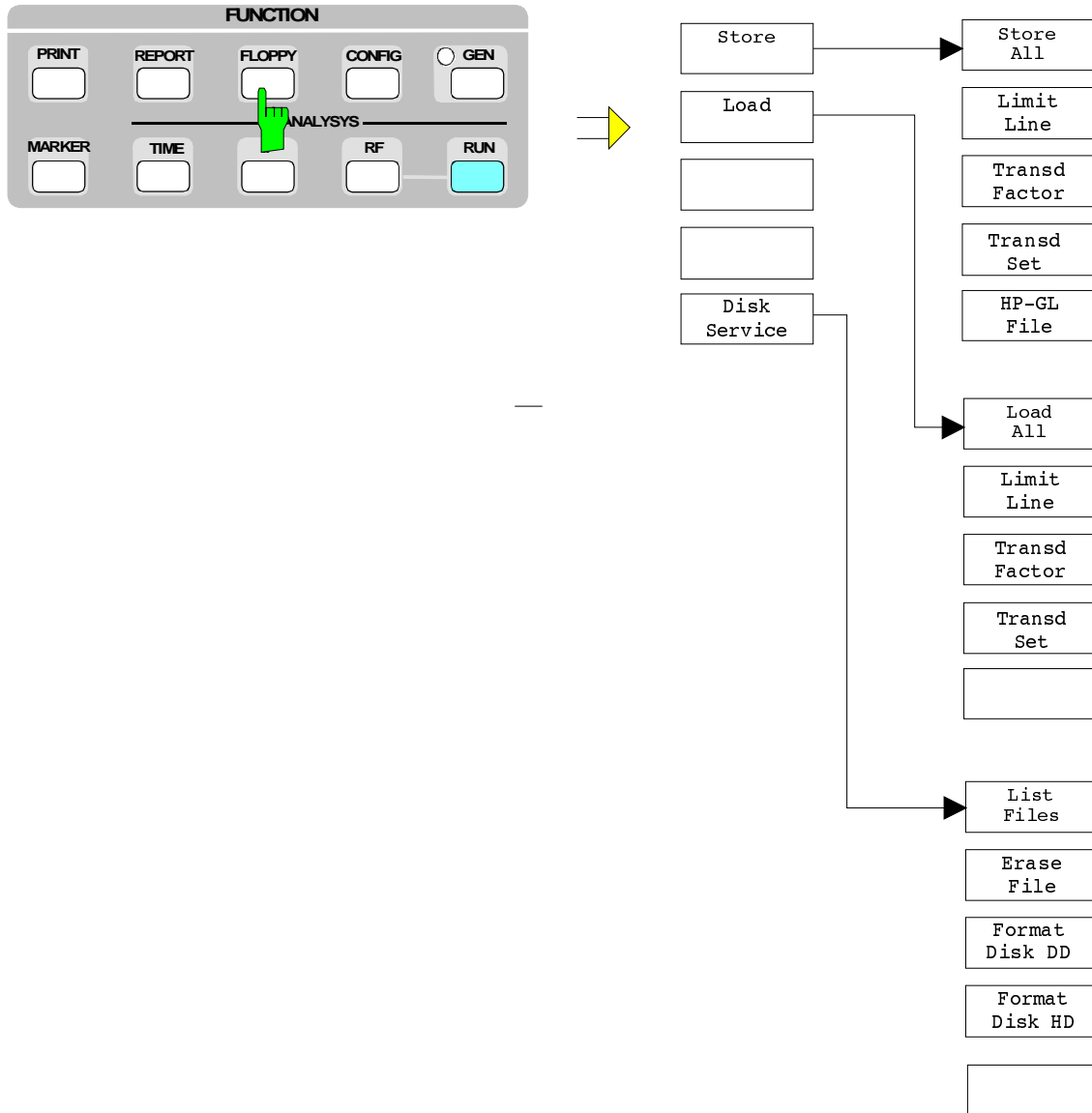
PRINT key



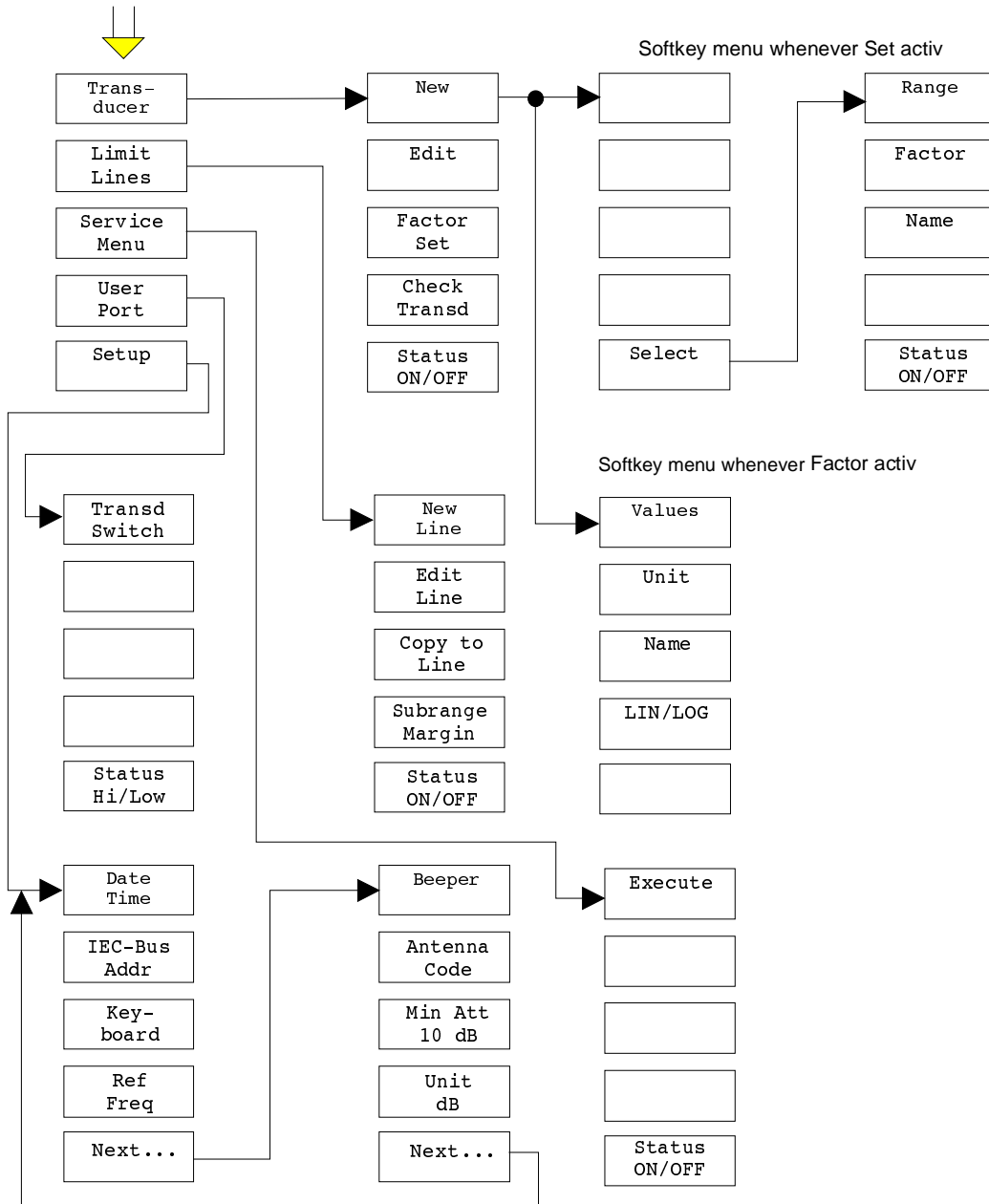
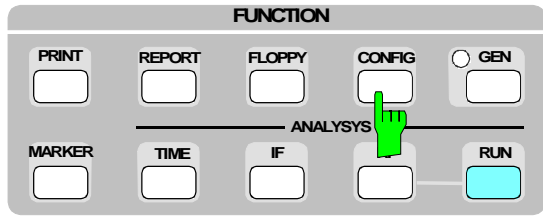
REPORT key



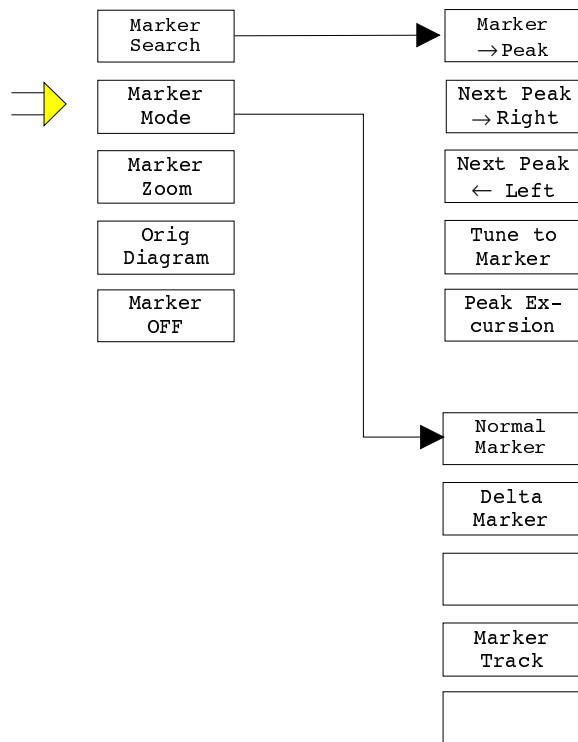
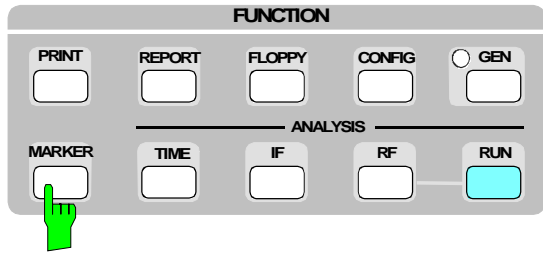
FLOPPY key



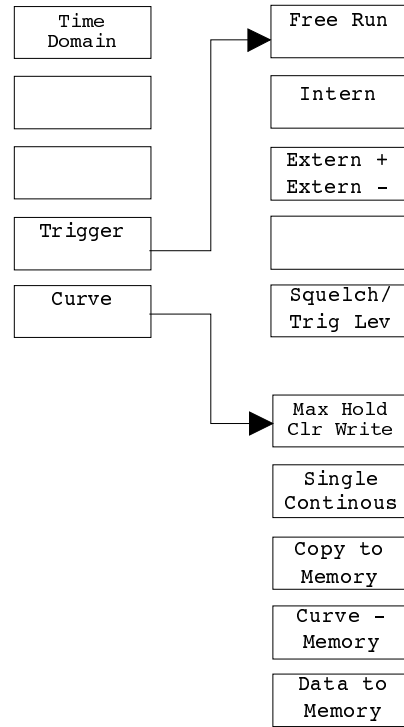
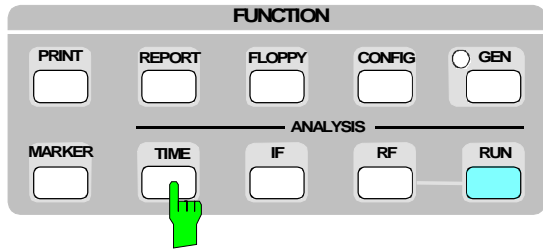
CONFIG key



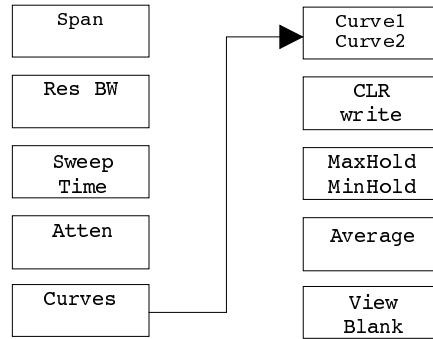
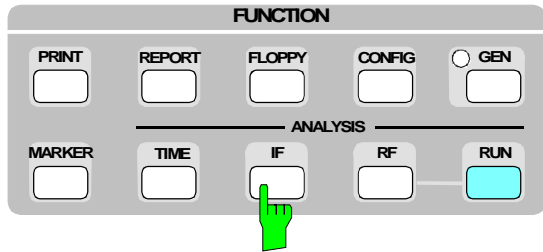
MARKER key



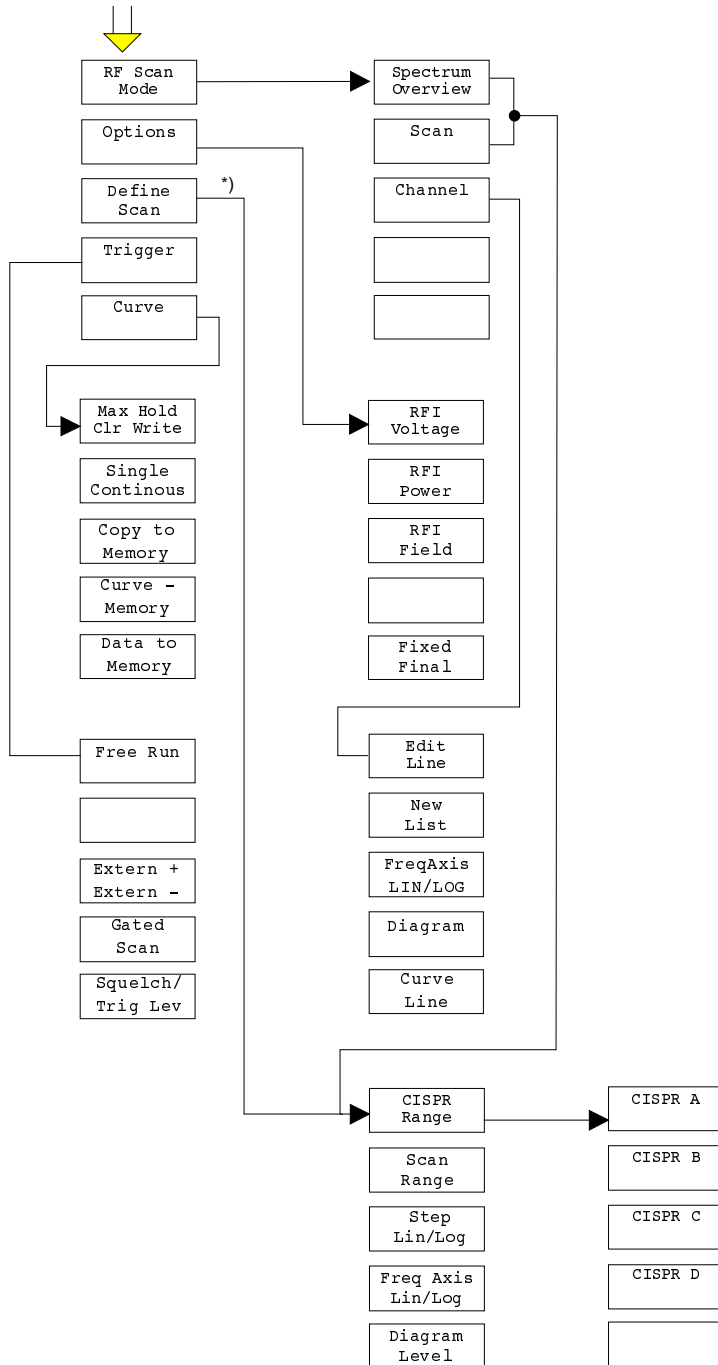
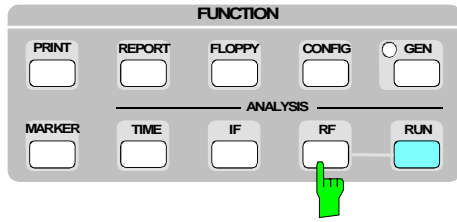
TIME key



IF key



RF key



*) Sub menu depends on the RF san mode

4 Instrument Functions

This chapter gives a detailed description of the instrument functions and their operation. It constitutes the so-called reference part of the manual.

Selection of Instrument Presettings (SETUP Menu)

The SETUP menu permits to display and newly enter the presettings

- input of date and time,
- selection of IEC-bus address (IEC 625),
- configuration of external keyboard
- setting of user port switching outputs
- display of firmware version
- operation with external reference
- switching-on of beeper
- configuration of the antenna code connector
- switching-on of minimum RF attenuation and
- switching-on of display unit dBm.

Operation is described in section 1.

Entering and Calling up Transducer Factors (TRANSDUCER Menu)

When carrying out interference measurements, a coupling network, which converts the disturbance to be measured into a voltage at 50Ω , is usually connected ahead of the receiver. Coupling networks may be antennas, artificial mains networks or current probes. They often feature a frequency-dependent transducer factor. Transducers with a transducer factor that is independent of the frequency can be coded in 10-dB steps at the ANTENNA CODE connector. Non-decadic conversion factors must be considered in the transducer factor. The receiver indicates the quantity to be measured that is present at the input of the coupling network, if the transducer is activated.

In the case of the ESCS a distinction is made between transducer factor, in the following text abbreviated by "factor", and transducer set, briefly "set". A factor consists of sampling points, which are defined by frequency and transducer factor, and the unit that determines the unit of the level display. For frequencies between the known sampling points the transducer factor is approximated using modified spline interpolation.

The unit of the transducer applies to the entire frequency range of the receiver even if the transducer only covers part of the range. Outside the definition range, the transducer factor is assumed to be 0 dB. The receiver therefore delivers illegal measurement values if the receiver frequencies exceed the transducer definition range. This is indicated by the hint *Warn: Transd undef* on the screen. In practice, it does not make sense to use a transducer for measurements in a frequency range in which it cannot be used.

Up to 22 different factors can be defined and stored permanently. They are assigned a number (1 to 22) and a name that can be specified by the user so that they can be told from each other.

Since, in practice, the required number of sampling points varies for the various coupling networks, the maximum possible number of values is grouped according to the following table, depending on the number of the transducer:

Table 4-1

Transducer-number	Number of points
1 to 10	10
11 to 20	20
21, 22	50

These 22 factors can be combined to form sets. Maximally 5 sets are possible. As a prerequisite, all factors involved must have either the same unit or the unit "dB". The definition range of a set is divided into subranges. Various factors can be activated for each subrange. The subranges must be continuous, i.e. the stop frequency of a subrange must be equal to the start frequency of the following subrange.

The definition range of the transducer factors used in a subrange must cover it completely.

It is recommended to define a transducer set if different coupling networks are used in the frequency range to be measured or if cable attenuation or an amplifier are also to be considered.

If a transducer set is defined, a frequency scan is stopped at the intersection between two subranges and the user is requested to change the coupling network (transducer). The following prompt appears on the screen:

Connect Transducer
<Transd. Name>.

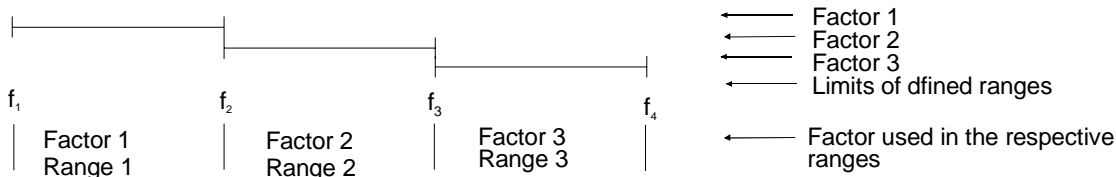
If the beeper is activated, a short beep can be heard.

The rules according to which the transducer factors can be combined to sets are summarized with the help of the following examples. The rules are implemented in the ESCS so that the user need not care whether the transducer set entered is valid.

Only a single transducer factor active:

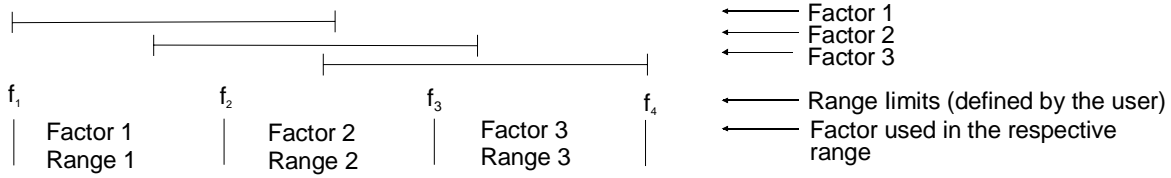


Transducer set with several factors lined up in a row:



The set is valid from f_1 to f_4 . The units of the individual factors are the same. The individual factors cover a continuous range.

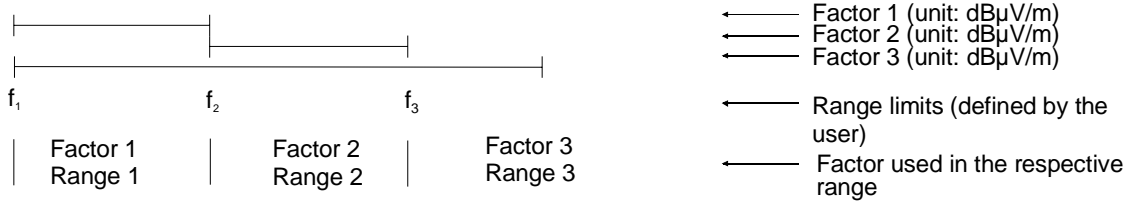
Transducer set with several overlapping factors:



With overlapping factors only those factors can be activated that cover a subrange completely. The set is valid from f_1 to f_4 with the above mentioned subranges.

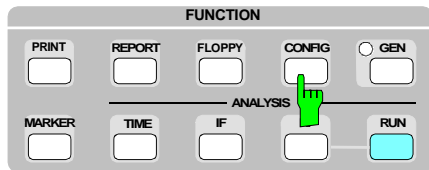
Several factors are simultaneously valid:

(transducers defined from f_1 to f_3)

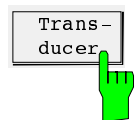


Two factors can be activated simultaneously if the unit of one factors is dB or both factors have the same unit. Factor 3 is added to factor 2 or factor 1 in their valid range.

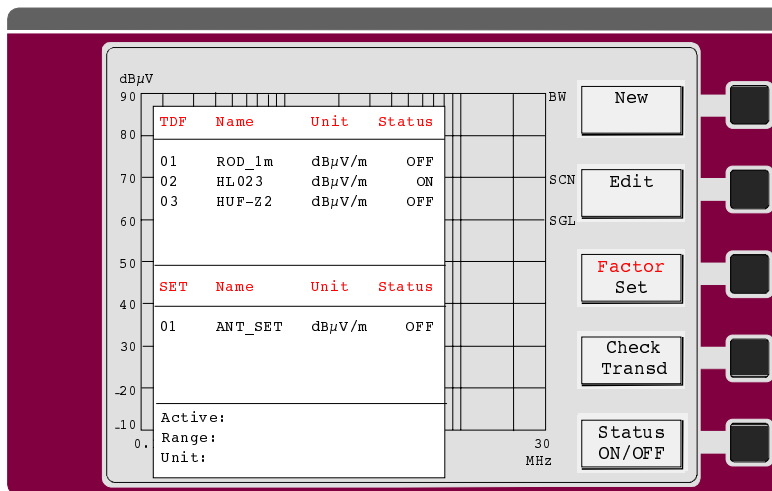
Operation:



- Press the CONFIG key.
 The screen displays the softkey menu for the configuration of the receiver and, in a table, the setup settings.



- Press the *Transducer* softkey.
 The submenu for editing the transducer factors and sets appears on the screen.



The table lists all defined factors and sets.

When the menu is called, the cursor points to the currently active factor or set or, if none is active, to the factor with the lowest number.

The softkey *Factor Set* permits to change the cursor between the factor and the set table. The operation is the same for the factor and the set table.

With the function *Check Transd* activated, the LEVEL display does not indicate the measured value, but the transducer value with the unit calculated at the set receiver frequency. No level measurement is performed. In the case of transducer output, the LEVEL display does not indicate any value for the ZERO SCALE DEFLECTION, ATTENUATION and MODE, and the FREQUENCY display does not indicate anything for bandwidth, detector and measuring time. Thus, the transducer selected can be manually checked by tuning the frequency of the receiver. It can also be output in graphical mode on the printer or plotter. The frequency and level axes are determined by the values defined in the scan data set (see section 4). The output is started using the PLOT or PRINT key (see section 4 Setting the Test Report).

The cursor is set to the factor or set to be edited using the keys \uparrow and \downarrow or by entering the two-digit number.

The softkey *Status ON/OFF* permits to activate or deactivate the factor or set at the cursor position. Since only one factor or set can be active at a time, an already activated one is automatically switched off when a transducer is switched on.

The menu is exited using the EXIT key. The configuration main menu is then displayed.

Entering Transducer Factors

A transducer factor is characterized by
sampling values with frequency and transducer factor (Values)
the unit of the transducer factor (Unit) and
the name to distinguish between the different factors.

During the input the ESCS checks the transducer factor according to particular rules that are to be observed to ensure proper operation.

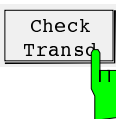
- The frequencies for the sampling values are to be entered in increasing order. If this is not the case, the input will not be accepted, and the status line of the screen will display the following message
- *Frequency Sequence*
- The entered frequencies must also be settable on the receiver. Otherwise, the screen will display the following messages:
- *Max Freq 2750 MHz* if the frequency is too high or
- *Min Freq 200 Hz* if it is too low.
- The minimum or maximum value for a transducer factor is -200 dB or 200 dB, respectively. The unit "dB" only means that the transducer factor is always logarithmic and actually has nothing to do with the physical transducer factor that establishes e.g. the connection between field strength and voltage at 50 Ω . If the minimum or maximum value is exceeded, the receiver signals:

Min Level -200 dB or

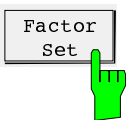
Max Level 200 dB.

- Amplifiers feature a negative transducer factor, attenuation values are to be entered as positive transducer factor.

Operation:



The softkey *Check Transd* is used to switch on and off the transducer value calculated at the set receiver frequency. The function is displayed to the right of the diagram with the red text *CHK*. All displays except for level and frequency are deleted in the level and frequency display.



The *Factor/Set* softkey is used to select the list of transducer factors in the Transducer menu.



The *New* softkey is used to enter a new factor or delete and redefine an existing factor.

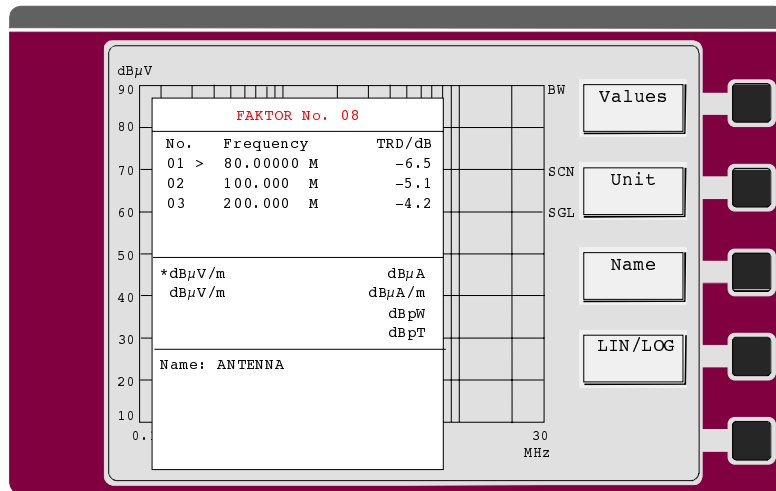


The *Edit* softkey is used to change an existing data set.
After pressing one of the two softkeys enter the number of the desired factor in the status line.

Example: *Edit Factor No. (1..22) 8*

The number of the factor is offered at the current cursor position. It can be directly confirmed by pressing the ENTER key, or a different number can be selected using the cursors \uparrow and \downarrow or via the numeric keypad. After selection of the desired

transducer factor, a submenu appears with the sampled values, the unit and the name of the factor. In the case of a new input, all table fields are empty.

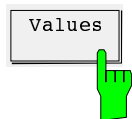


When a transducer factor is edited, a sampling point can be deleted, a new one inserted or a frequency or transducer value can simply be varied. Insertion or deletion is possible if the cursor points to the respective sampling value. The *DELETE* key permits to delete the respective sampling value, and the following values are shifted accordingly. *INSERT* is used to create an empty space at the cursor position, and all following values are increased by one. A frequency or a transducer value can be varied by shifting the cursor to the respective position and entering the new value via the numeric keypad.

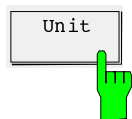
If the factor already has the maximum possible number of sampling values, no more can be entered.

If the last sampling value or the maximum possible frequency has been entered, the cursor remains positioned at the last frequency in the table.

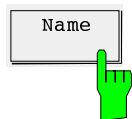
After pressing of the *New* softkey and input of the desired factor number, an empty value table appears, the cursor is positioned to the frequency of the first value, which can be entered directly. Already defined factors are deleted using *New*, but are still available in the memory of the ESCS until the first sampling value is entered. Thus it is possible to restore the values before the first sampling value is entered. In this case, the menu can be left using *EXIT* and the values can be listed using *Edit*.



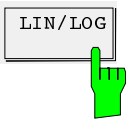
This softkey permits to return to the value table from the unit or name menu. By pressing *Values* the cursor > is faded in at the position of the first sampled value.



In the table *Transducer Unit* the already defined unit of the transducer factor is marked by an asterisk (*). The unit can be newly determined by pressing the softkey, varying the cursor and confirming the new unit using *ENTER*.



The transducer factor can be assigned a name with up to 8 characters. The name permits identification of the factors in lists and is used as file name when it is stored on floppy disk. It is entered via the auxiliary-line editor or via the external keyboard. Impermissible characters are ignored when the file name is stored on floppy disk.



The interpolation between the sampled values is possible with logarithmic or linear frequency axis. The function is of importance if there are only little sampled values over a wide frequency range. It may be useful to get a detailed impression of the interpolation characteristic using the function *Check Transducer*.

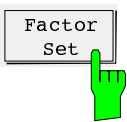
EXIT terminates the input of the transducer factor and returns to the next higher main menu.

Entering a Transducer Set

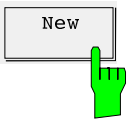
A transducer set is characterized by:

- up to 5 ranges in which various transducer factors can be active
- the combination of several transducer factors per range (*Factor*)
- a transducer set name (max. 8 characters)

Transducer sets can be created using *New* or edited using *Edit*. After one of the two functions has been selected and the desired number entered, the table for determination of the unit of the set appears first.



Use the *Factor Set* softkey in the transducer menu to select editing of a transducer set.



Use *New* to select new input or *Edit* to select editing of a set.

or



Enter the number of the set to be entered or edited in the status line.

In the case of new input, the selection list for the input of the unit of the transducer set appears on the screen.

>dB	dB μ A
dB μ V	dB μ A/m
dB μ V/m	dBpW
	dBpT

- Select the unit of the transducer set using the cursors of the EDIT keypad and activate by pressing the *Select* softkey. The selected unit is preceded by a (*). The table for definition of the transducer set now appears on the screen. It is empty in the case of a new input. For editing, the existing set is displayed.

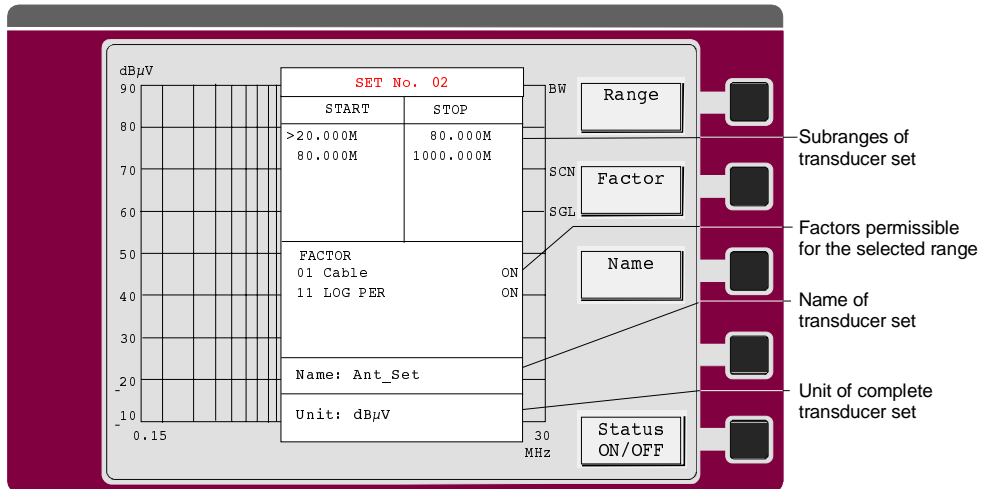
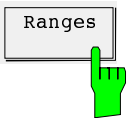


Fig. 4-1 Input menu for the transducer set

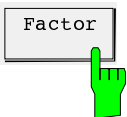
After the menu has been called, the cursor is positioned at the start frequency for the first range.



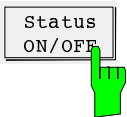
The *Ranges* softkey permits to return to the table for the subranges of the set from the factor or name menu. By pressing the softkey, the cursor > is positioned to the last active frequency field.

In the field for the subranges of the set, the frequency limits are defined. Since the individual subranges must form a continuous frequency range, the frequency limit is already defined starting from the second subrange (= stop frequency of the preceding range). When a stop frequency is changed, the start frequency of the next range is changed as well.

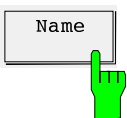
When a set is edited, a frequency range can be deleted, a new one inserted or a frequency can simply be varied. By pressing the DELETE key, the subrange where the cursor > is positioned is deleted, the following ranges are shifted accordingly. INSERT shifts all ranges after the cursor position one position down. In both cases, the ESCS checks that there are no gaps between the ranges. The frequencies at the cursor position can be varied by numeric input. In this case, the same rules are valid as with entering of a transducer factor.



The *Factor* softkey permits to switch to the selection list for the factors that are permissible in the respective range. The list only offers factors that suit with the unit of the set and completely cover the subrange. The list of factors only appears when a range has been completely defined. Each time the range limits have been changed, the ESCS therefore checks the list of factors and updates it, if necessary.



The factors desired in a subrange of the transducer set are selected using the cursor and switched on or off using *Status ON/OFF*.



The *Name* softkey activates the name field for the set. Using the external keyboard or the auxiliary line editor a name with a maximum of 8 characters can be entered. Input of the name is important so that the different transducer sets can be told from one another at a later point of time. It is also used as file name when storing the set on floppy disk. Impermissible names are therefore ignored when storing on a floppy disk.

Entering Limit Lines

The various regulations covering interference measurements include limit lines that must not be exceeded. Irrespective of the frequency display (linear or logarithmic), the limit values are composed of straight lines. In some regulations, several limit values are specified, e.g. a limit value for quasi-peak and a limit value for average measurement.

The ESCS permits to define up to 22 different limit lines and permanently store them in a battery-backed RAM. They are assigned a number (1 to 22) and a user-definable name so that they can be told from one another.

Since, in practice, the necessary number of sampled values for the limit values differs in the various standards, the maximum possible number of values is grouped according to the following table, depending on the number of the limit line:

Table 4-2

No. of limit value	Max. sampled values
1 to 10	10
11 to 20	20
21, 22	50

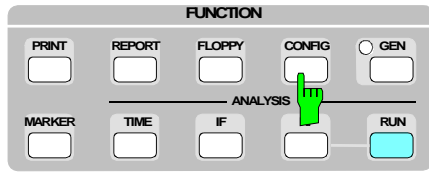
Two of these 22 limit lines can be activated for the measurement. If a name is defined for the limit value (max. 8 characters), it is also output in the diagram.

The defined limit lines are stored in the battery-backed RAM and can be activated or deactivated if required.

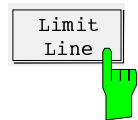
Activated limit lines are used to determine out-of-limit values in final measurements of RF analysis. If bargraph display is activated, the color of the bars changes to red when the associated limit value is exceeded. In the case of dual measurement modes, the test receiver automatically assigns the detector to the reference limit line. The detector that measures the higher level refers to the limit line with the higher value.

Operation:

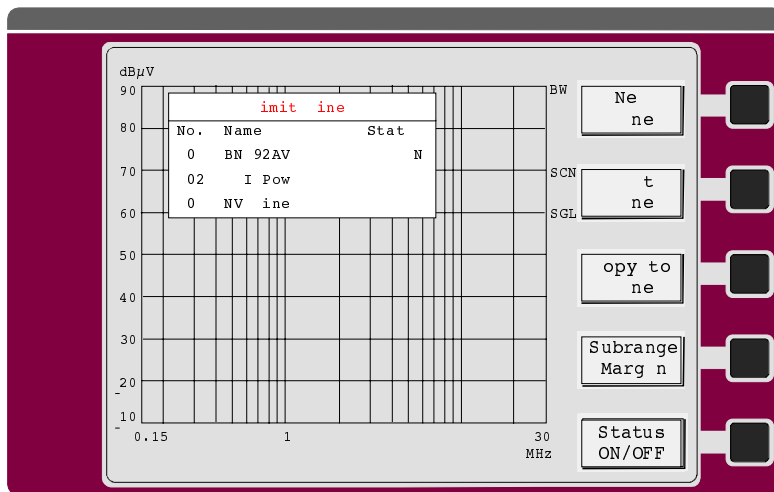
Switching on and off of limit lines:



- Press the CONFIG key.
The CONFIG menu appears on the screen.



- Press the *Limit Lines* softkey.
A list with all defined limit lines and their status (*ON* or *OFF*) appears on the screen.

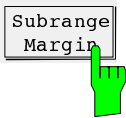


The associated submenu permits to select between new entry (*New Line*), editing (*Edit Line*) and switching on or off (*Status ON/OFF*) of limit lines.

If no limit line is defined, the list indicates *None defined*. In this case, the *Copy to Line* and *Status ON/OFF* softkey are not labeled.

When the menu is called, the cursor points to the first activated limit line in the list, or, if none is active, the list with the lowest number. The cursor is set to the line to be edited using the keys \uparrow and \downarrow or by entering a two-digit number and switched over using the *Status ON/OFF* softkey.

Only two limit lines can be active at the same time. The attempt to activate a third one causes the message *Max 2 Limits active* to be output in the status line. Before switching on the desired limit line, an already active one must be switched off in this case.



This function is used in connection with the options. It determines the number of subranges (*SUBR(AN)GE(S)*) at the level maximum of which a final measurement is to be performed and the level spacing (*Acc Margin*) from the limit line at the respective frequency starting from which the measurement is performed.

Operation:

Default	ON
>No of Subrges:	8
Acc Margin/dB	6

When the function is called, a submenu appears which permits to enter the desired number of subranges and the spacing from the limit line starting from which a weighted measurement is to be performed. In the default status, the default values (25 subranges and 6-dB limit-line spacing) are entered. New values are entered by shifting the cursor to the desired line and entering a value.

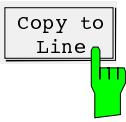
Permissible values for the number of subranges are 8, 16, 25, 50, 100, 200, 400. If another value is entered, it is rounded to the next possible one. All values between -200 dB and +200 dB are permissible as spacing from the limit line. A positive value causes a less stringent limit line.

If no limit line is defined in a frequency subrange, the final measurement is performed at all subrange maxima irrespective of their levels.

EXIT is used to exit the menu.

Copying limit lines

In the field of interference measurements, parallel limit lines are often used. An already entered limit line can be shifted by copying a limit value to a different data set using the softkey *Copy to Line*. The maximum number of sampled values is to be noted.



- Set the cursor to the line to be copied.
- Press softkey *Copy to Line*.
- Enter the number of the data set to be generated in the status line.
Copy line <nn> to line _

The new data set is indicated in the list of limit lines. Parallel shifting of the line is effected under *Edit Line* using the function *Shift Level*.

Entering a new limit line or editing an existing one

A limit line is characterized by:

- sampled values with frequency and level
- name of limit line (max. 8 characters)

The frequency for a sampled value must be at least as high as that of the preceding value. Otherwise, the entry is not accepted and the following message is output in the status line:

Frequency Sequence!

When a frequency is entered which cannot be set on the ESCS, the following error message appears:

Max Freq 2750 MHz or

Min Freq 200 Hz.

Values from -200 dB to +200 dB are permissible for the level value. If a level value greater than 200 dB or smaller than -200 dB is entered, the status line displays the following message:

Min Level -200 dB or Max Level 200 dB.



The *New Line* softkey permits to delete an existing limit line and define a new one.

When the softkey is pressed, the status line displays a prompt to enter the number of the limit line.

New Line No. (1 to 22)

If limit values are already defined, the number is offered at the current cursor position. This number can be confirmed using ENTER, or a new number can be entered via the numerical keypad.

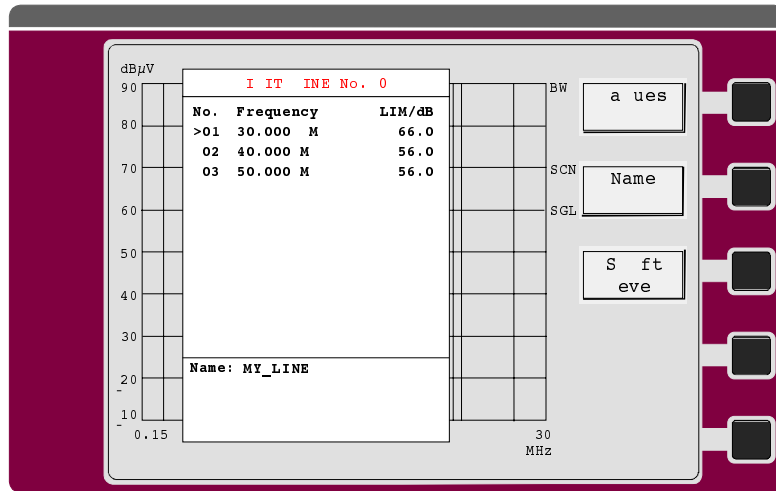
After entering the limit line number, an empty sampled value table is displayed, and the first sampled value can be entered. Already defined limit values are deleted, but are still internally stored until the first sampled value is entered. When the menu is immediately left using EXIT, they are restored.



The *Edit Line* softkey permits to modify the data set of an existing limit line.

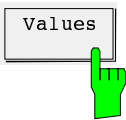
When the softkey is pressed, the status line displays a prompt to enter the number of the limit line:

Edit Line No. (1 to 22):

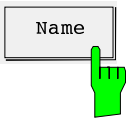


After the number has been entered, the list of sampled values appears.

The cursor is positioned at the first sampled value. The list can immediately be edited.



The *Values* softkey is used to return from the name menu into the value table.



The limit line can be assigned a name consisting of a maximum of 8 characters. The name serves for differentiation between the limit lines. The name can also be used when storing the data set on floppy disk and for labeling the limit value for plotter or printer output. The entry is made via the external keyboard or the auxiliary line editor. Note the restrictions for file names.



The *Shift Level* function permits parallel shifting of limit lines. After copying a data set first (see *Copy to Line*), this function permits to produce a second limit line that is parallel to the first one. After pressing the softkey, the following prompt is output in the status line:

Level Offset:

Note the level limits of ± 200 dB.

Calling up the Selftest (Service Menu)

The ESCS is equipped with a wide variety of self-test functions that can detect an instrument error even down to module level. The selftest runs automatically, starting at the lowest function level and checking the functions one after the other. When a faulty function is detected, it is indicated on the screen display with a hint to the respective module (ERR: <Module>). Only one fault can be detected as, in the case of a fault, the following tests can no longer be carried out correctly. To avoid unfounded error messages the selftest is aborted after detection of the first fault. Complete instrument settings can be called up to allow for convenient setting of the modules in the case of replacement.

The run of the self-test, possible error messages and replacement of modules are described in detail in service manual.

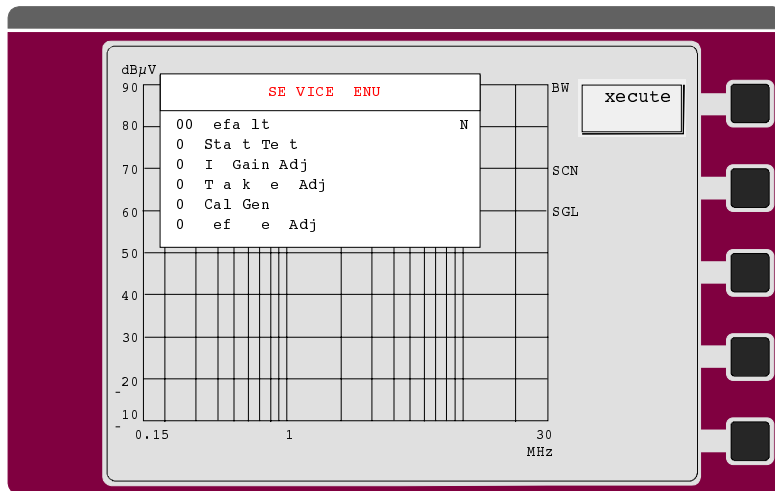


Fig. 4-2 Service menu

Operation:

The selftest menu is called up using the SELFTEST softkey. The desired function is called up either by entering the appertaining number of by way of the cursor.

Function	Meaning
00	Reset of the service function to the default status
01	Performing the instrument self-test
03	Determination of the most favorable gain adjustment on module replacement
04	Switching on the internal calibration source
05	Adjustment of the internal reference oscillator

Automatic Test Runs (RF Spectrum and Time Domain)

In addition to the manual measurement, the ESCS also permits to perform automatic measurement runs in the frequency or time domain. Three different automatic test runs are available in the frequency domain:

- The operating mode **Spectrum Overview** is used to obtain a fast overview of the frequency range. For reasons of speed, the RF attenuation must be fixed in this case. The step size is coupled with the bandwidth.
- In the **scan** the step size is freely selectable. The RF attenuation can be predefined or is automatically set depending on the input signal (autoranging).
- The operating mode **Channel** permits to measure at up to 400 discrete frequencies from a freely definable list.

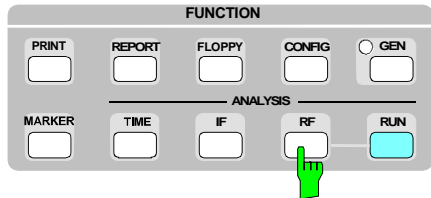
2 detectors may be active at a time, eg for the detection of narrowband and broadband interference of peak and average detector.

Clicks can best be analyzed in the **Time Domain** analysis. This mode permits to use a maximum of three detectors at a time with different measuring times.

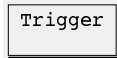
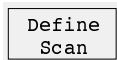
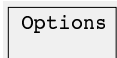
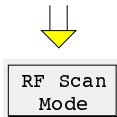
The measurement result can be output in a diagram and/or table either on a plotter, a printer or both. Limit lines can be defined and output according to the specifications valid for the respective measurement. The frequency scan can be matched to the particular measurement problem using various analysis options.

The Operating Modes Spectrum Overview, Scan and Channel

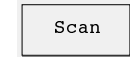
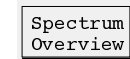
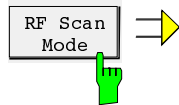
Operation:



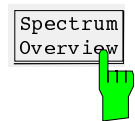
- Press the RF key.
The RF menu appears.



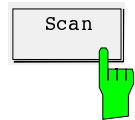
The softkeys lead to the individual input menus and tables used to determine the scan.



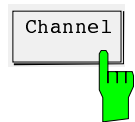
- Press the *RF Scan Mode* softkey.
The submenu for selecting the scan mode appears.



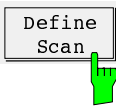
- Press the softkey *Spectrum Overview*,
- *Scan*
- *Channel*.



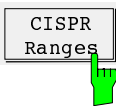
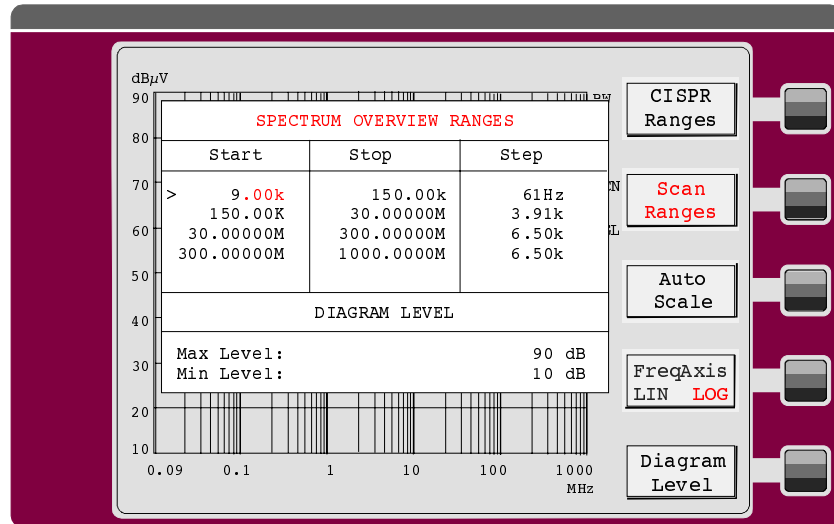
The selected operating mode is switched on, and the menu *Define Scan* for selection of the scan settings will be displayed.



Editing the scan data in the operating mode Spectrum Overview



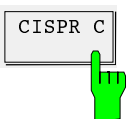
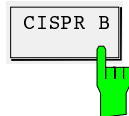
- If, with the scan mode already selected, only one setting is to be changed, e.g. the sweep time, the start frequency, the submenu can be immediately accessed from the RF main menu via the *Define Scan* softkey.
- Press the softkey *Define Scan*.
The table and the softkey menu for entering the scan data will appear.



- **Softkey *CISPR Ranges*:**
This submenu permits to select the frequency ranges for the measurement. All parameters are predefined according to the following table:

Table 4-6 Presettings in the operating mode Spectrum Overview

	CISPR A	CISPR B	CISPR C	CISPR D
Start frequency	9 kHz	150 kHz	30 MHz	300 MHz
Stop frequency	150 kHz	30 MHz	300 MHz	1000 MHz
Step size	61 Hz	3.91 kHz	62.5 kHz	62.5 kHz
IF bandwidth	200 Hz	9 kHz	120 kHz	120 kHz
Attenuation	10 dB	10 dB	10 dB	10 dB
Measuring time	50 μs	50 μs	50 μs	50 μs



- For an RFI power measurement in bands C and D, e.g., press the softkeys *CISPR C* and *CISPR D*.

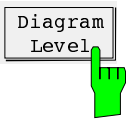
**Scan Ranges softkey:**

If settings are to be used that deviate from the predefined values of the CISPR menu, the scan subranges can be selected using the cursor keys \uparrow and \downarrow , and the start and stop frequency eg can be varied.

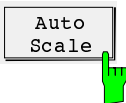
At the same time, the assigned parameters such as bandwidth and RF attenuation can be varied. The subranges must be continuous so that the start frequency of a subrange always corresponds to the stop frequency of the preceding one. All entries are immediately stored.

The step size is coupled with the bandwidth and cannot be edited.

For each scan subrange there is a set of receiver data. These data are entered on the receiver, eg IF bandwidth, RF attenuation and preamplifier setting. They are always valid for the subrange marked in red color in the table of scan data.

**Diagram Level:**

The level display range in the diagram depends on the RF attenuation set if the autoscale function is switched on. If different level limits are desired, e.g. in order to enable expanded display of a level range, min and max level can be entered manually. The limits can be varied even after a scan; the scale of the curves is then changed automatically.

**Auto Scale :**

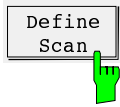
In the operating mode Spectrum Overview, the scaling of the level axis can be matched to the receiver settings using the *Auto Scale* function. The diagram is selected such that the dynamic range of the receiver can always be displayed. Various scan subranges with different operating ranges, curves of transducer factors and coding connectors are taken into account.

**Freq Axis LIN LOG:**

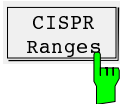
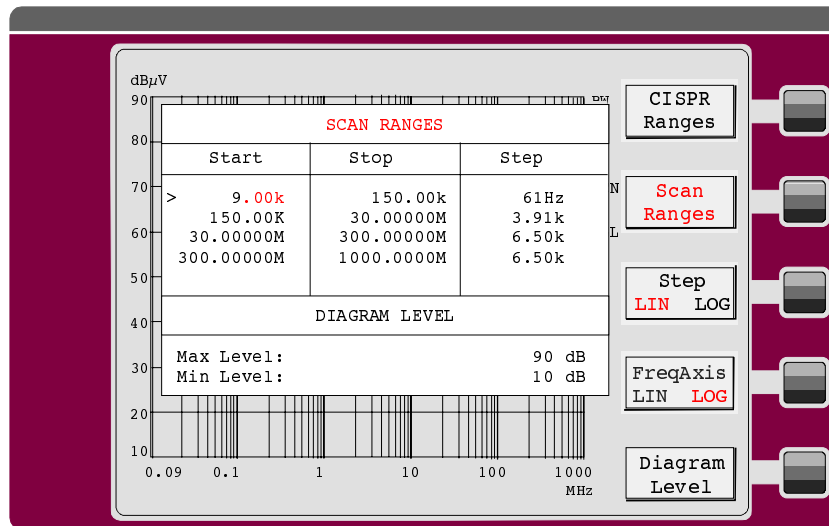
The display of the measurement results is possible either with linear or logarithmic scaling of the frequency axis. This setting is independent of the frequency step size of the scan.

The ratio between stop frequency of the scan and start frequency of the scan must be at least 1.5 to allow the logarithmic frequency axis to be switched on.

Editing the scan data in the operating mode Scan



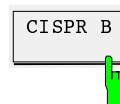
- Press the softkey *Define Scan*.
The *Define Scan* menu will appear.



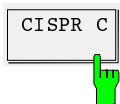
- Press the softkey *CISPR Ranges*:
This submenu permits to select the frequency ranges for the measurements. All parameters are preset according to the following tables:

Table 4-7 Presettings in the operating mode Scan

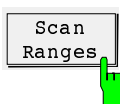
	CISPR A	CISPR B	CISPR C	CISPR D
Start frequency	9 kHz	150 kHz	30 MHz	300 MHz
Stop frequency	150 kHz	30 MHz	300 MHz	1000 MHz
Step size	100 Hz	5 kHz	50 kHz	50 kHz
IF bandwidth	200 Hz	9 kHz	120 kHz	120 kHz
Attenuation	10 dB	10 dB	10 dB	10 dB
Measuring time	100 ms	20 ms	1 ms	1 ms



The input of scan data for the operating mode Scan differs in some aspects from that for the operating mode Spectrum Overview described further above.



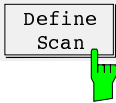
For an RFI power measurement in the bands C and D press eg the softkeys *CISPR C* and *CISPR D*.



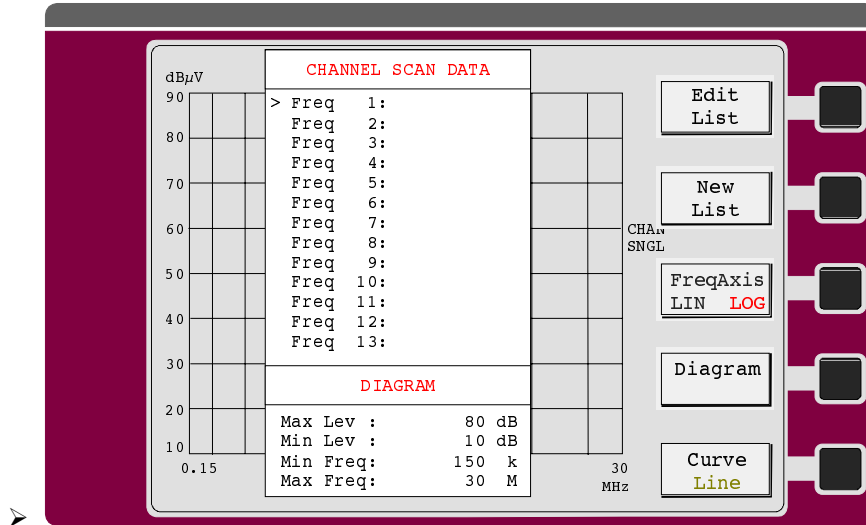
Scan Ranges:
In the operating mode Scan, the step size can additionally be entered.

**Step LIN LOG:**

It is possible to switch between linear and logarithmic frequency steps for the scan. If logarithmic step size is selected, the step size must be entered in per cent in all subscreens. The value range for the step size is 0.1 to 100 % (100 %, 50 %, 25 %, 12.5 % ... 0.1 %). If other step sizes are entered, the next lower one will automatically be used.

Editing the scan data in the operating mode Channel

- Press the softkey *Define Scan*. The table and the softkey menu for entering the channel scan data will appear.

**Edit List:**

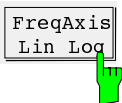
An already existing list of frequencies can be varied. The cursor keys \uparrow and \downarrow can be shifted within the frequency list. The keys INSERT and DELETE permit to insert a new frequency at the cursor position and delete the frequency at the cursor position. All frequencies are to be entered in increasing order. The maximum number of values is 400.

The data set for the Channel Scan does not include any receiver settings, i.e. the measurement is always made with the receiver settings set on the ESCS when the Channel Scan is started.

**New List:**

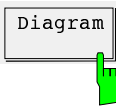
This softkey is used to delete the existing list and enter a new list. The ESCS stores the deleted list until the first new frequency has been entered. If the *New List* softkey has been pressed unintentionally, it is sufficient to press the EXIT key in order to leave the editor and restore the original list.

Editing of the frequencies is possible as described for the *Edit List* softkey.

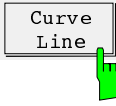
**Freq Axis****Lin Log:**

The measurement results can be displayed either with linear or logarithmic scaling of the frequency axis.

The ratio between stop frequency of the diagram and start frequency of the diagram must be at least 1.5 to enable the logarithmic frequency axis to be switched on.

*Diagram:*

The diagram limits can be entered here. The scaling of level and frequency axis in the operating mode Channel Scan is independent of the scaling in other operating modes. The values for the frequency axis are independent of the frequencies at which the measurements are made, which is why e.g. a larger frequency range can be displayed.

*Curve Line :*

The measured values can be displayed in two ways:

- *Curve* The measured values are connected to form a curve.
- *Line* Each measured value is represented by a vertical line.

The Operating Mode Time Domain

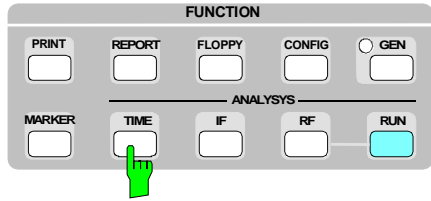
Thermostatically controlled, program-controlled and other electrically controlled devices produce **discontinuous interference**. CISPR 14 or EN 55014, respectively, include limit values of the RFI voltage with click rate weighting in the range from 0.15 to 30 MHz. Clicks are usually measured using click rate analyzers. A critical problem of click rate measurements often consists in successive pulses the pulse height of which cannot be exactly assigned by the time constants of quasi-peak weighting and may therefore produce out-of-limit values.

The **time domain analysis of the ESCS** can determine pulse height and pulse duration and thus be helpful in such cases. It meets the requirements of CISPR 16-1 with respect to the accuracy of the pulse duration measurement for pulse durations of 10 ms and above. Triggering can be made internally (level set with display line) or externally with TTL level. Up to 30,000 measured values can be stored and then zoomed using the marker and analyzed.

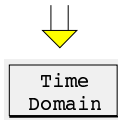
The measurement of the interference timing is preferably performed using the peak-value detector. By way of continuous recording in intervals of the measuring time, the duration of the interference is correctly recorded. In addition, the measuring time of the quasi-peak or average-value detector can be set irrespective of the measuring time of the peak value. Thus it is possible e.g. to determine the pulse duration of a 100-ms interference and **simultaneously** perform a standard quasi-peak measurement with a measuring time of 1 s. Graphic (bargraph) and numeric display are used. With the peak-hold function switched on, the highest measured value is stored until the following sweep is started.

The time domain analysis is also used for analysis of the timing of interference. In order **to set the measuring time of the receiver correctly**, it is helpful to examine the directional voltage using the oscilloscope to determine whether and to which extent a narrowband interference fluctuates, whether it is amplitude-modulated or pulsed. Besides, the pulse rate of a broadband interference can be determined. The measuring time can then be set to a value greater or equal to the reciprocal value of the pulse rate.

Operation:

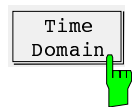
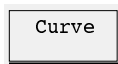
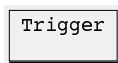


- Press the TIME key.
The main menu for the time domain analysis appears.



The softkeys permit to open menus where:

- scan parameters,
 - the trigger modes and
 - the type of curve display
- can be set.



- Press *Time Domain* softkey.
The diagram for entering the parameters for time domain analysis is displayed.

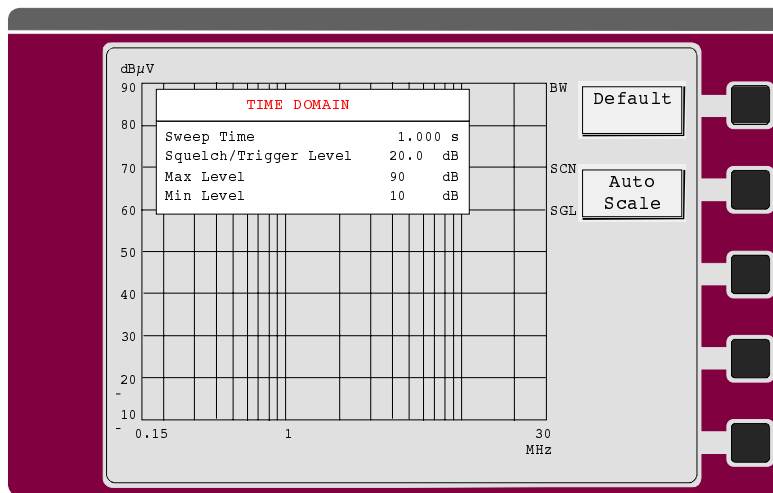
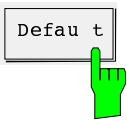


Fig. 4-5 Screen for entering the parameters for the time domain analysis

Squelch/Trigger Level Setting of trigger and squelch level. A red dashed level line is visible in the diagram. The trigger level is numerically displayed at the top right in the field SQUELCH/TRIG LEVEL.

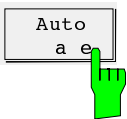
Max Level Maximum level of displayed diagram
 The two level values are only relevant to the graphical display. They do not affect the dynamic range. Like the frequency axis via the zoom function, they can subsequently be changed in order to enable better investigation of the signal characteristic.

Min Level Minimum level of displayed diagram



By pressing the *Default* softkey the ESCS sets the default for the time domain analysis:

Sweep time	1 s
Squelch/trigger level	50 dB μ V
Auto scale	On
Active detectors	Peak, quasi-peak, average
Meas. time peak detector	1 ms
Meas. time QP detector	1 s
Bargraph display	Peak Hold
RF attenuation	20 dB
Preamplifier	off
Trigger	internal
Demodulation	AM
Scanning	continuous



With the autoscale function switched on, the ESCS automatically sets the level limits in the diagram and in the bargraph display. In addition to the set RF attenuation, the detector, the IF bandwidth, the transducer, if applicable, and the operating mode (Low Noise or Low Distortion) determine the diagram limits.

Display of Measurement Results

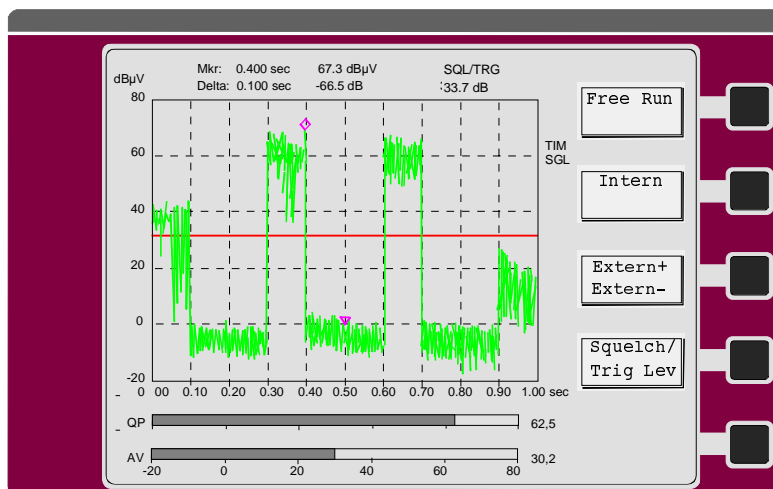
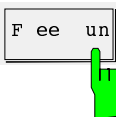


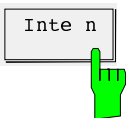
Fig. 4-6 Screen display with timing analysis with peak-hold function switched on

Triggering of the Measurement

The measurement can be triggered in several ways:

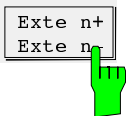


The level measurement is free-running and the scans start immediately after pressing the RUN key.

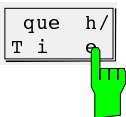


With internal triggering, the level is monitored at the set frequency after pressing the RUN key until it exceeds the set trigger threshold. Then the measurement run is started.

The measurement exceeding the threshold first is already part of the measurement run so that no response time of the internal trigger is produced. The internal triggering is only effective for time domain analysis.

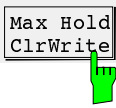


An edge-triggered TTL signal at the user port of the receiver can be used to control the measurement run. The user may choose between positive and negative edge. The external trigger is effective for single measurements and for the time domain analysis.



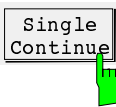
Setting of the trigger and squelch level. A red dashed level line is visible in the diagram. The trigger level can be displayed numerically at the top right in the field SQUELCH/TRIG LEVEL.

Display Modes of the Curves

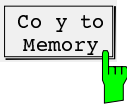


The softkey *Max Hold Clr Write* is visible if the scan has been set to *Continue*. By repeatedly pressing the softkey, the settings *Max Hold*, *Clr Write* and *Max Hold Clr Write* can be activated.

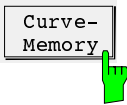
- *Clr Write*
The frequency scan is repetitive. The measured values are continuously updated.
- *Max Hold*
The maximum measured value of successive scans is displayed. In the case of modulated signals, the *Max Hold* curve of the spectrum is gradually filled up until all spectral maxima are achieved. Even pulse-shaped signals fill up the *Max Hold* curve until the pulse spectrum is completely displayed.
- *Max Hold Clr Write* is the combination of the two types of display and is indicated with two curves. In this display mode, only one detector can be used for the measurement.



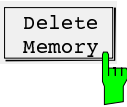
The softkey *Single Continue* switches between single and continuous scanning.



Copy to Memory permits to copy the last measured curve to a reference memory. The reference curve is maintained for new scans and can be used for comparison with new measurements. The receiver copies the complete result memory with up to 30000 measured values, ie the reference curve can be zoomed. It is also stored on floppy disk. The reference curve is deleted as soon as scan data are changed that in turn change the frequency assignment, eg step sizes, and when a scan is started with double detectors. The softkey is only visible when scan results are available.



The function *Curve - Memory* constitutes and displays the difference between reference curve and last measured curve. The softkey is only visible if a reference curve is available.



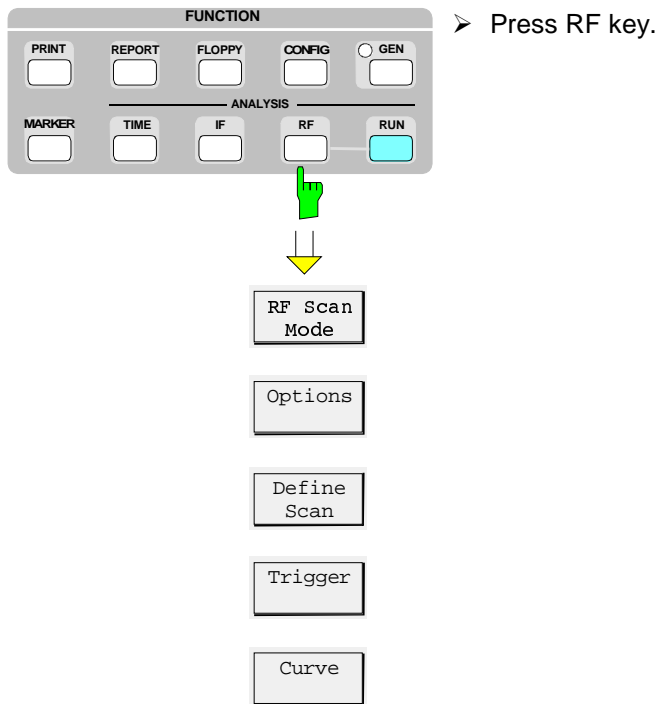
Delete Memory deletes the reference curve. The softkey is only visible if a reference curve is available.

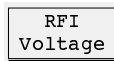
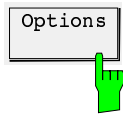
Extended Functions of RF Analysis (OPTIONS)

With the options, the ESCS offers functions which match the RF analysis to specific measurement problems or optimize test runs for the various applications. Data reduction is an important feature in this connection. It is achieved by dividing the frequency range into subranges. The maximum of the interference is searched for in a subrange in a prescan measurement. Then, a measurement is immediately performed at this maximum in the desired indication mode - usually quasi-peak or average. This makes sure that the highest interference levels are measured with weighting. The relatively lengthy measurement procedures, however, need only be performed at a limited number of frequencies so that the total measuring time is considerably shorter. The user may to a large extent determine the test run himself by combining the various options. Thus he can freely determine the number of subranges (max. 400), the parameters of the prescan, the type of weighted measurement and its measuring time as well as the threshold value for which a weighted measurement is to be performed.

With the function *Fixed Final*, the ESCS also permits to perform final measurements at self-defined frequencies.

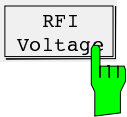
Operation:





- Press the **OPTIONS** softkey.
The **OPTIONS** menu appears on the screen.

The functions are activated by pressing the respective softkey. The active option is displayed in red color. Some scan options require further entries. In this case, a submenu is called on switching-on, in which the necessary values can be entered. The main menu is left by calling any other menu or using the **EXIT** key.

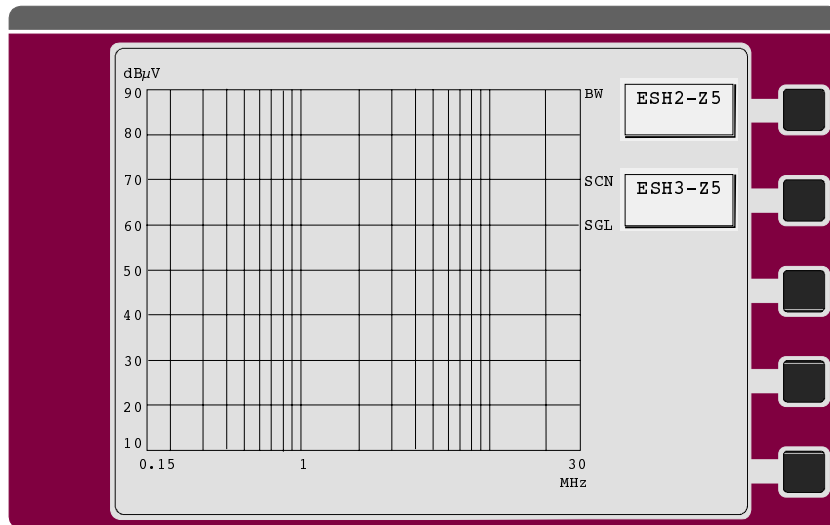


This functions permits to perform a complete RFI voltage measurement with documentation of the measurement results using the ESCS, an artificial mains network ESH2-Z5 or ESH3-Z5 as well as a plotter and/or printer.

When the phase is switched on in the submenu *PRESCAN/MANUAL* a connected artificial mains network is switched at the same time. This enables manual selection of the phases from the receiver. When the artificial mains network is switched off using *OFF*, remote-control operation is no longer possible.

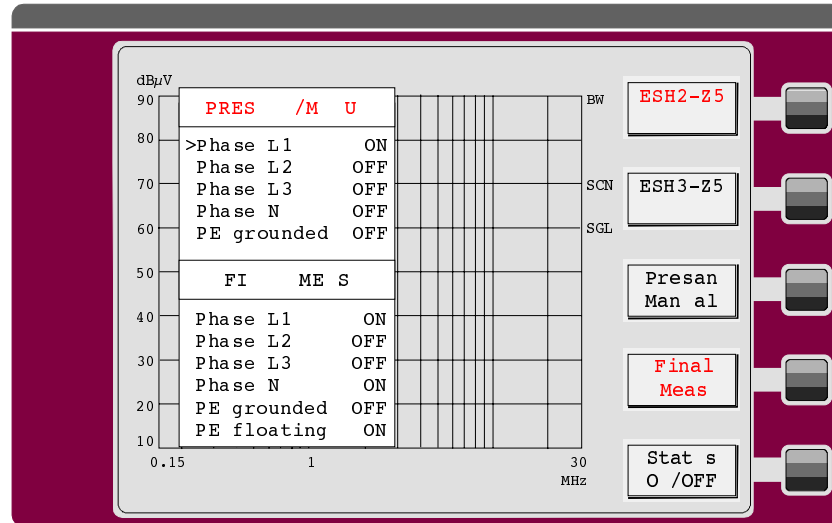
Operation

- Press the *RFI Voltage* softkey.
The *RFI Voltage* softkey turns red; the function is activated.



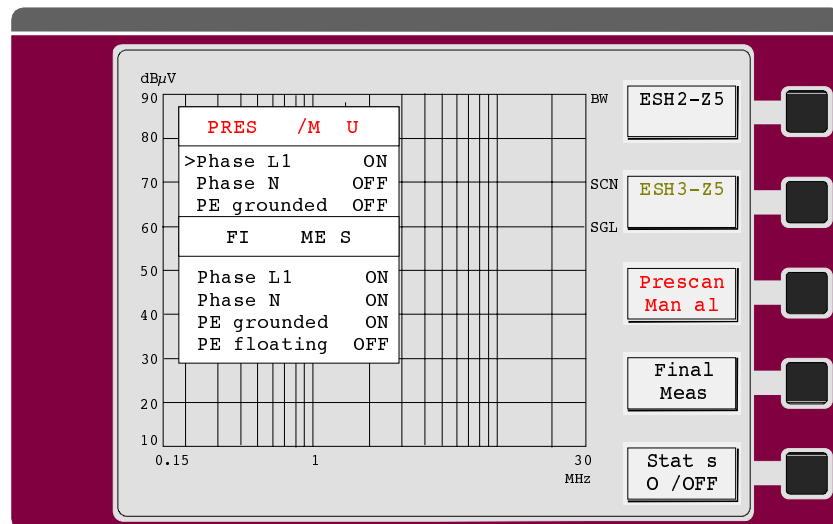
- Press the *ESH2-Z5* or *ESH3-Z5* softkey.
The first menu is called up.
If both LISNs are **OFF**, the RFI voltage measurement is made on one line only. This is to be determined if a probe, a single-phase LISN (*ESH3-Z4*, *ESH3-Z6*) or an RF probe is to be used for the measurement. Only one LISN can be selected at a time. If the other one is switched on, the first one is turned **OFF**. The next menu appears if one of the two LISNs is selected.

- **With the ESH2-Z5:**



Only one phase can be switched on. If "PE grounded" is set to OFF, the PE choke is switched on.

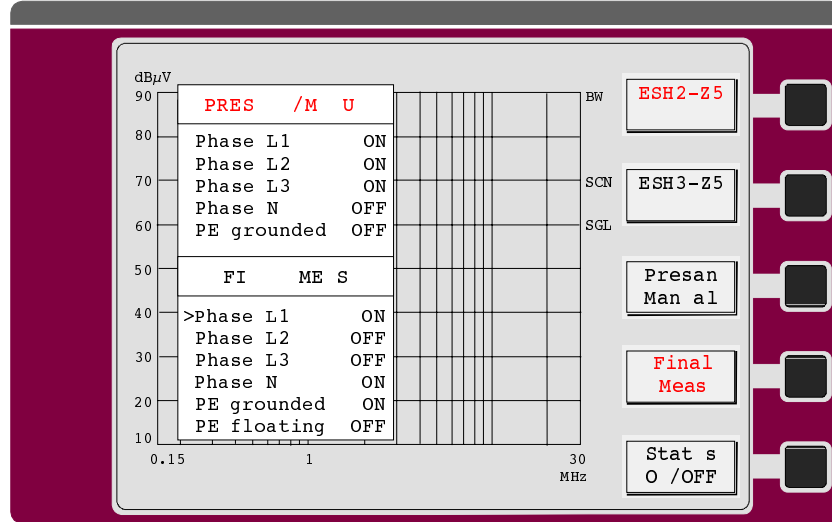
- **With the ESH3-Z5:**



Only one phase can be switched on. If „PE grounded“ is set to OFF, the PE simulating network is switched on.

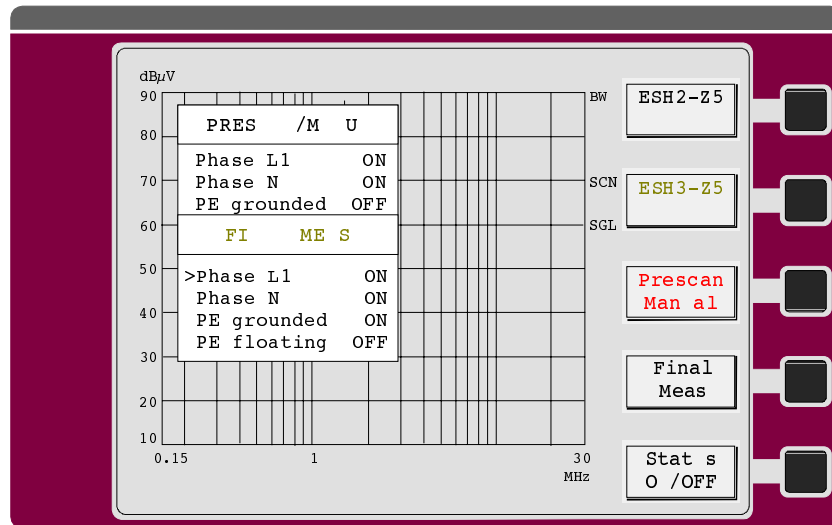
- Press the *Final Meas* softkey.
The next menu is called up, the test configuration for the final measurement is determined as follows:

- **With the ESH2-Z5:**

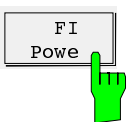


With this setting, only one phase is used for the final measurement. If both *PE grounded* and *PE floating* are set to *ON*, four measurements are performed at each of the frequencies determined by means of data reduction for determining the configuration with the highest interference voltage. According to a decision of CISPR/G, a PE simulating network is used for measurements on both phases, i.e. *PE grounded OFF* and *PE floating ON*.

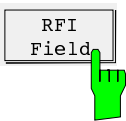
- **With the ESH3-Z5:**



In this example the measurement is made on both phases.



This function permits to perform a complete RFI power measurement in interactive mode with documentation of the measurement results using the ESCS, an absorbing clamp as well as a plotter and/or printer.



This function supports the prescan measurement of the interference field strength in a shielded room and the subsequent free-field measurement.



The *Fixed Final* function permits to perform the final measurements at self-defined frequencies. They are not determined by the receiver itself. A maximum of 400 frequencies can be defined. The frequency list is identical with the list of the Channel Scan. Only the frequencies lying within the defined scan range are used for the final measurement.

Using the Marker in RF Analysis and Time Domain

For analysis of the displayed curve(s) markers are available which permit to determine frequencies and levels on the curve. The main marker is used to digitally output absolute frequency and test level, the delta marker frequency and level spacing from the main marker on the screen above the diagram. The functions *Marker* → *Peak* and *Tune to Marker* allow for analysis of the displayed measured value in the receive channel of the ESCS with only a few keystrokes. By switching over to IF analysis, the spectrum in the vicinity of the marker can immediately be examined.

Two markers are available at the same time. If two curves are shown in one graph, one marker is located on each curve in the default setting. The delta marker can be used to measure frequency and level differences. In this case, the two markers are situated on the same curve.

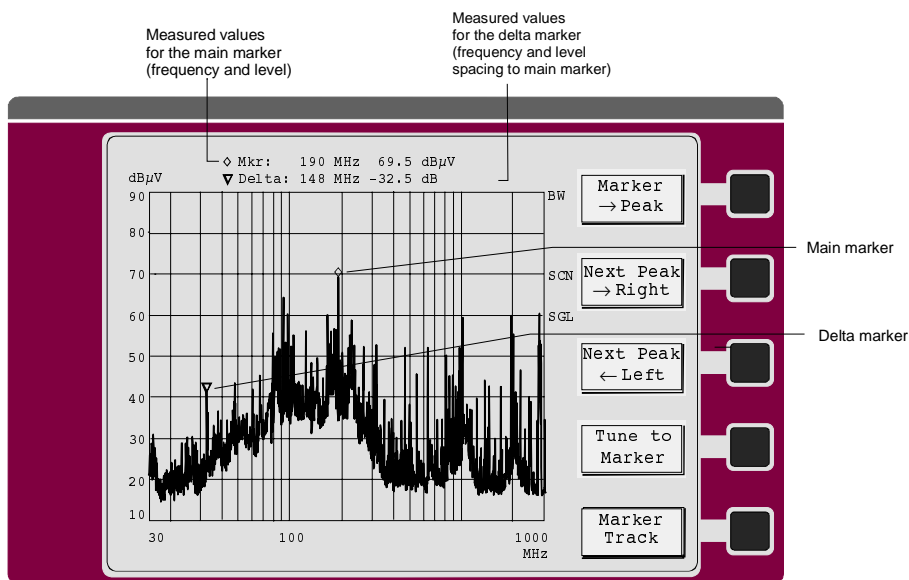
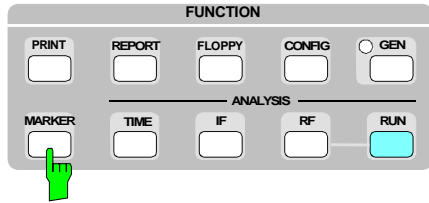


Fig. 4-7 Marker in RF analysis

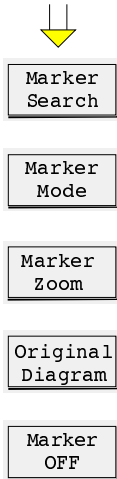
The frequency and the level of the markers are updated after each frequency scan. The two markers are maintained after the marker menu has been left.

If two curves are simultaneously displayed, one marker appears on each curve at first (◇ on curve 1 and ▽ on curve 2). They are both located at the same frequency and are simultaneously shifted.

Operation:



- Press the MARKER key.
Instead of the RF analysis menu, the marker menu will appear on the screen with the marker in the default setting or in the setting in which it has been left before. Only the main marker is provided in the default setting (operating mode *Normal*). The softkeys *Marker Zoom* and *Original Diagram* only appear if a curve with measured values is already displayed on the screen.



Although only 400 measured values are displayed in the diagram on the screen, the ESCS internally stores all measured values (max. 30000 per curve). The displayed diagram can therefore be expanded subsequently, eg in order to increase the resolution of frequency ranges with a large number of signals.



The softkey *Marker Zoom* expands the curve depending on the marker mode set. For zooming the curve(s), the marker is used. The type of zoom depends on the marker mode set:

- Normal marker:
Based on the current marker frequency, 10 % of the diagram are zoomed to fill the complete frequency display range. The frequency axis is automatically matched.
- Delta marker:
The area for the zoomed display is determined by the two markers.

Zooming can be continued until the resolution of the curve has reached a minimum of 3 measured values.

Zoomed curves are not stored on floppy disk; the original curve is always stored.

If a curve consists of more than 30,000 measured values, the zoomed curve will end at the right-hand edge.

In the zoomed display, the diagram can be horizontally scrolled. If the marker is situated at the edge of the diagram and the respective cursor key is pressed in the EDIT keypad, the curve is shifted to the left or right.

A zoomed diagram is characterized by dashed representation of the left and right diagram limit. Zoomed diagrams can also be output to a plotter or printer.

Original
Diagram

The softkey *Original Diagram* permits to restore the complete diagram.

Marker
SearchMarker
→ Peak

The softkey *Marker Search* permits to call up the submenu of the marker search functions.

NextPeak
→ RightNextPeak
← LeftTune to
MarkerPeak Ex-
cursionMarker
→ Peak

The softkey *Marker → Peak* sets the active marker or delta marker to the highest display value of the associated curve.

NextPeak
→ Right

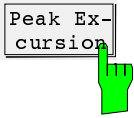
The softkey *NEXT PEAK → RIGHT* sets the active marker to the next signal maximum to the right of the current marker position.

NextPeak
← Left

The softkey *Next Peak ← Left* sets the active marker to the next signal maximum to the left of the current marker position.

Tune to
Marker

The softkey *Tune to Marker* tunes the receiver to the frequency at the marker position.



The softkey *Peak Excursion* activates the input of the minimum step by which a signal must drop or increase in order to be detected as maximum by the search functions. The following appears in the data input field:

Peak Excursion: 6 dB

Permissible input values are 0 dB to 200 dB, the resolution is 0.1 dB. The peak excursion is preset to 6 dB.

The functions *Next Peak ← Left* and *Next Peak → Right* search for the next relative maximum irrespective of the current signal amplitude. The following example illustrates the effect of various settings of PEAK EXCURSION.

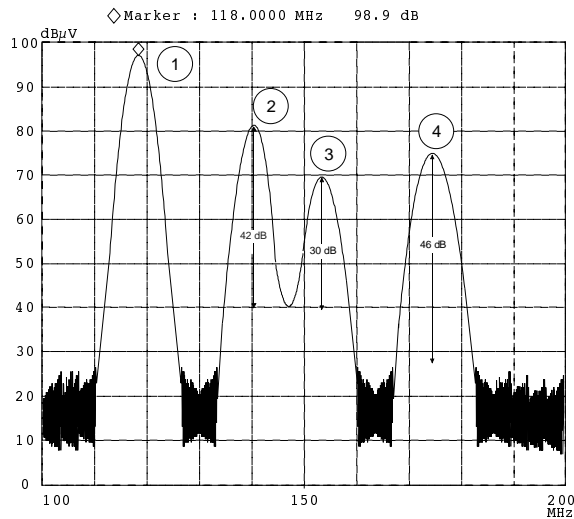


Fig. 4-8 Example of various settings of Peak Excursion

Maximum relative level change of the signals measured:

Signal 2: 42 dB

Signal 3: 30 dB

Signal 4: 46 dB

The setting **Peak Excursion 40 dB** causes the signals 2 and 4 to be found with *Next Peak → Right*. Signal 3 is not found, since the signal is only reduced by 30 dB before the level increases again.

Order of signals found:

PEAK: Signal 1

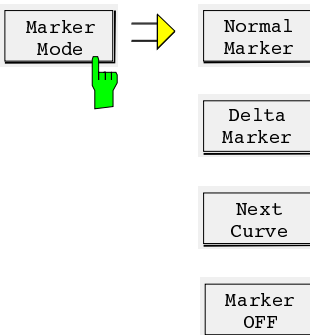
NEXT PEAK RIGHT: Signal 2

NEXT PEAK RIGHT: Signal 4

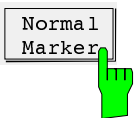
The setting **Peak Excursion 20 dB** causes signal 3 to be found as well, because its biggest level change of 30 dB is now greater than the Peak Excursion set.

Order of signals found:

PEAK: Signal 1
 NEXT PEAK RIGHT: Signal 2
 NEXT PEAK RIGHT: Signal 3
 NEXT PEAK RIGHT: Signal 4



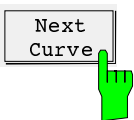
The softkey *Marker Mode* permits to call up the submenu of the marker mode functions.



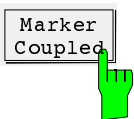
With *Normal Marker*, the frequency field in the result output of the main marker (◊) is unblanked and a new frequency can be entered. After termination of the entry, the marker jumps to the new frequency. The input is limited to the displayed frequency range. If the delta marker is switched on, it will be switched off.



The second marker (=delta marker) is faded in. If two curves are displayed, both markers jump to the same curve. Below the result output for the normal marker, a second line with the value for the frequency spacing and the level spacing to the main marker appears. The frequency spacing is displayed in red, indicating that a frequency spacing (positive or negative) to the main marker can be entered. If the delta marker is already activated, the softkey is only used for frequency input.



The softkey *Next Curve* only appears if, with two curves, the delta marker is switched on. Both marker symbols are thus set to the other curve.



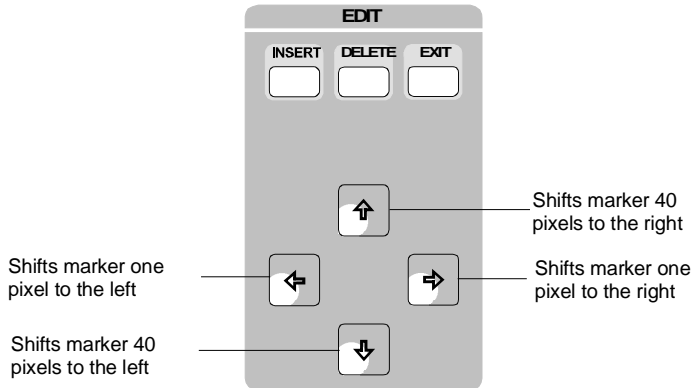
The softkey *Marker Coupled* couples the marker frequency to the receiver frequency and vice versa. If the frequency is tuned eg using the rotary knob, the marker is shifted accordingly within the diagram limits. Vice versa, the marker can be shifted along a measured curve using the Next Peak function and the receiver frequency automatically follows.



The marker(s) are blanked using *Marker OFF* and the softkey labeling changes to *Marker ON*.

Shifting of the Marker

After calling up the marker function, the marker can immediately be shifted using the cursor keys in the EDIT keypad. To ensure unambiguous function of the controls, the marker can only be moved using these cursor keys; the rotary knob is always reserved for frequency tuning. However, if the function *Marker Coupled* has been activated, the marker always moves with the frequency tuning, ie it can be shifted indirectly with the rotary knob.



Longer pressing of the key accelerates the marker movement so that fast setting of the marker to the desired position is ensured.

Leaving the marker menu: The marker menu is left by pressing a key which leads to another display or using EXIT. Only *Marker OFF* permits to switch off the marker(s), otherwise they are retained.

IF Spectrum Analysis

In IF spectrum analysis, the spectrum of the RF input signal is displayed in the vicinity of the receiver frequency. The center frequency of the displayed spectrum is always the current receive frequency.

The IF analysis provides a fast overview of the assignment of the spectrum adjacent to the measuring channel proper, or, with a large IF bandwidth, the spectral distribution of a modulated signal in the channel. Interference of the received useful signal can also be detected quickly, whether it is CW interference appearing as unmodulated carrier or pulse-like interference which is represented in the form of narrow horizontal lines on the screen.

The IF spectrum analysis is a very comfortable means for exact frequency tuning of the receiver and for identification of signals and of their bandwidth. The accuracy of the frequency axis corresponds to the reference used (internal or external). The frequency display range (span) can be selected between 10 kHz and 10 MHz in steps of 1, 2 and 5. With the bandwidths 1, 3 and 10 kHz the frequency resolution can be matched to the span. All filters feature a flat group delay in their passband so that they fully settle with a high sweep rate. The sweep rate (*Sweep Time*) is always optimally set depending on the display width and the resolution bandwidth. The minimum sweep time is 50 ms. In conjunction with the fast graphics (approx. 15 pictures per second), this high sweep rate contributes to the fact that quickly changing signals can be observed quasi in real time. If required by the receive signal, e.g. for better recording of pulse-like signals, the sweep time can be prolonged to up to 10 s.

The level indication has a dynamic range of 80 dB. A switchable 20-dB attenuator pad permits to shift the display range towards higher levels. The level measurement at the center frequency in the test channel is performed in parallel and indicated on the LEVEL display. The level display of IF analysis is unweighted, ie it is not affected by the set detector, eg average or quasi-peak. It is also independent of the set IF bandwidth and measuring time of the receiver. The IF analysis does not reach the accuracy of the receiver channel. Levels adjacent to the center frequency can be fast and easily measured using the marker. The function *Tune to Marker* - (set marker to center frequency) automatically varies the receiver frequency such that the desired signal remains at the center frequency. The level can be read on the digital level display LEVEL.

IF spectrum analysis permits to display maximally two separate curves at the same time in an independent display mode.

Clr Write: The frequency scan is repeated. The measured values of the current scan overwrite the curve of the preceding scan. If, because of the set bandwidth and the display range, more measured values are obtained than can be displayed on the screen (max. 401 values), several measured values are combined to form one display value, and the maximum and minimum are connected.

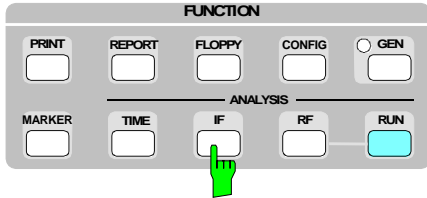
Average: Several curves are digitally averaged. In the case of time-varying signals, the average value is represented versus time. Signals whose level lies in the vicinity of noise or which are heavily superimposed by pulse-like interference, can thus be better identified. Averaging is performed until it is aborted by the user.

Max Hold/Min Hold: The maximum or minimum measured value of successive measurement runs is displayed. With modulated signals, the spectrum is gradually filled up in the Max Hold curve until all occurring spectral maxima are reached. Pulse-shaped signals also fill up the Max Hold curve until the pulse spectrum is completely displayed. With Min Hold representation, on the other hand, pulse-shaped signals are suppressed, whereas sinusoidal signals can be displayed unchanged. The combination of both types of representation (one curve Max Hold, the other Min Hold) permits e.g. CW interference with very low levels to be easily identified within a TV signal.

View: A measured curve is frozen. This permits to easily view variations in the spectrum if the second curve is represented with *Clr Write*.

Blank: The curve is blanked. However, it is maintained in the background and can be displayed again at any time using View.

Operation:



➤ Press IF key.

The diagram of the IF spectrum analysis appears on the screen. Labeling and subdivision of the screen are shown in the following figure.

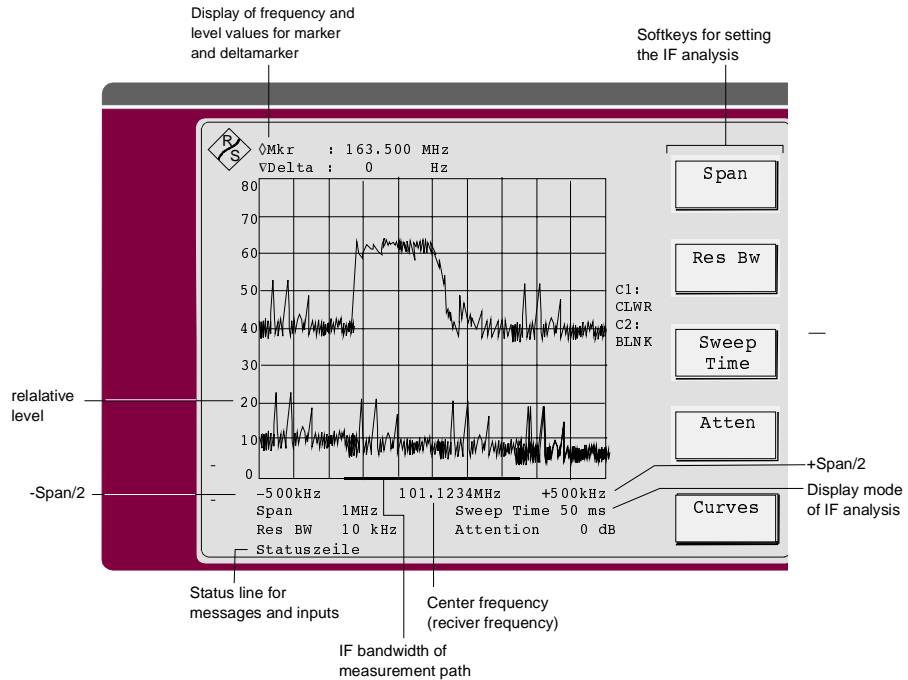


Fig. 4-9 Screen display of IF spectrum analysis

The frequency axis is labeled with the center frequency (= set receiver frequency) and the display width (minus half span (-span/2) and plus half span (+span/2)). The center frequency is continuously updated during frequency tuning of the receiver. The red bar on the frequency axis indicates the bandwidth of the measuring path. Thus it is possible to quickly determine the signal components of the displayed spectrum which lie inside the bandwidth of the receiver.

The level axis is marked by the relative level and the unit. Below the level axis, the settings span, resolution bandwidth (RBW), sweep time (SWT) and input attenuation of IF analysis (ATT) are indicated. If the marker is used, frequency and level of the marker and of the delta marker are output in the two lines at the top of screen.

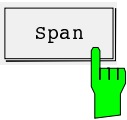
The right edge of the screen shows the softkey labelings and the status displays. Thus, the currently set display mode of the two curves (C1 and C2) is indicated.

Default setting: After Recall 0, the IF spectrum analysis in the default setting with the following values for the test parameters:

Table 4-8 Default setting of IF spectrum analysis

Test parameters	Default setting
Span	1 MHz
Resolution bandwidth (RBW)	10 kHz
Sweep time (SWT)	100 ms
Attenuation (ATT)	0 dB
Operating mode (Mode)	Normal

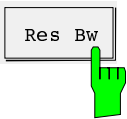
All test parameters are set via the softkeys. After pressing the respective softkey, the associated input field is displayed in red color. The selected parameter can be increased or decreased using the keys \uparrow and \downarrow of the EDIT keypad or varied by entering a number together with the desired unit. The attenuation can only be switched over by pressing the *Atten* softkey.



The *Span* softkey is used to determine the display range of the IF analysis spectrum. A new value can be selected using the keys \uparrow and \downarrow of the EDIT keypad or via numerical entry. Values between 10 kHz and 10 MHz in steps of 1/2/5 can be set for the span.

The entry is terminated with the unit (ENTER) or by pressing any softkey or hardkey that causes a prompt.

After termination of the entry, the frequency sweep of IF analysis is aborted and restarted with the modified setting.



The *Res BW* softkey is used to determine the resolution bandwidth of the IF analysis spectrum. A new value can be selected using the keys \uparrow and \downarrow of the EDIT keypad or via numerical entry. IF analysis contains the bandwidths 10 kHz (default), 3 kHz and 1 kHz.

When entering another numerical value, the next possible bandwidth is selected. The entry is terminated with the unit (ENTER) or by pressing any softkey or hardkey that causes a prompt.

After termination of the entry, the frequency sweep of IF analysis is aborted and restarted with the modified setting.

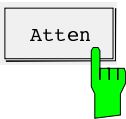


The *Sweep Time* softkey determines the sweep time for a sweep. A new value can be entered using the keys \uparrow and \downarrow of the EDIT keypad or via numerical entry. For any combination of span and resolution bandwidth, the sweep time is automatically set to the minimum possible value which ensures complete settling of the IF filter. A smaller value cannot be set. It is underlined in the display field for the sweep time.

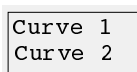
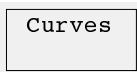
Table 4-9 Minimum (optimum) sweep times

Span	RBW		
	1 kHz	3 kHz	10 kHz
10 MHz	10 s	1 s	500 ms
5 MHz	10 s	1 s	500 ms
2 MHz	5 s	0,5 s	100 ms
1 MHz	2 s	200 ms	50 ms
500 kHz	1 s	100 ms	50 ms
200 kHz	0,5 s	50 ms	50 ms
100 kHz	200 ms	50 ms	50 ms
50 kHz	100 ms	50 ms	50 ms
20 kHz	50 ms	50 ms	50 ms
10 kHz	50 ms	50 ms	50 ms

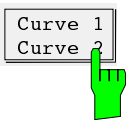
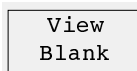
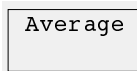
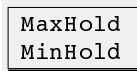
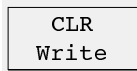
Sweep times between 50 ms and 100 s in steps of 1, 2 and 5 are possible. When entering other numerical values, the next possible sweep time is selected. The entry is terminated with the unit (ENTER) or by pressing any softkey or hardkey that causes a prompt. After termination of the entry, the frequency sweep of IF analysis is aborted and restarted with the modified setting.



The *Atten* softkey is used to switch over the input attenuation of IF analysis. By pressing this key, the attenuation is switched from 0 to 20 dB or from 20 to 0 dB. The default setting is 0 dB.



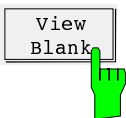
The *Curves* softkey permits to call a submenu in which the display mode for the two curves can be selected. The currently selected display mode for curve 1 and 2 (C1 and C2) is output above the softkey.



The *Curve 1/ Curve 2* softkey is used to switch to the second curve. *Curve 2* is a switch for selecting the curve to which the remaining softkeys refer. One display mode can be selected for each of the two curves. When a new display mode is selected, the previous one is automatically switched off.



The softkey *MaxHold MinHold* changes between two display modes. Of two successive measurement runs, the maximum and minimum measured value is displayed.



The softkey *View Blank* freezes the current curve or totally switches it off.

Using the Marker in IF Analysis

For analysis of the displayed curve(s) markers are provided, which permit to determine frequencies and relative levels on the curve. Using the main marker, absolute frequency and relative level, using the delta marker frequency and level spacing from the main marker are digitally output on the screen above the diagram. The marker search functions permit to analyze the spectrum with only a few keystrokes.

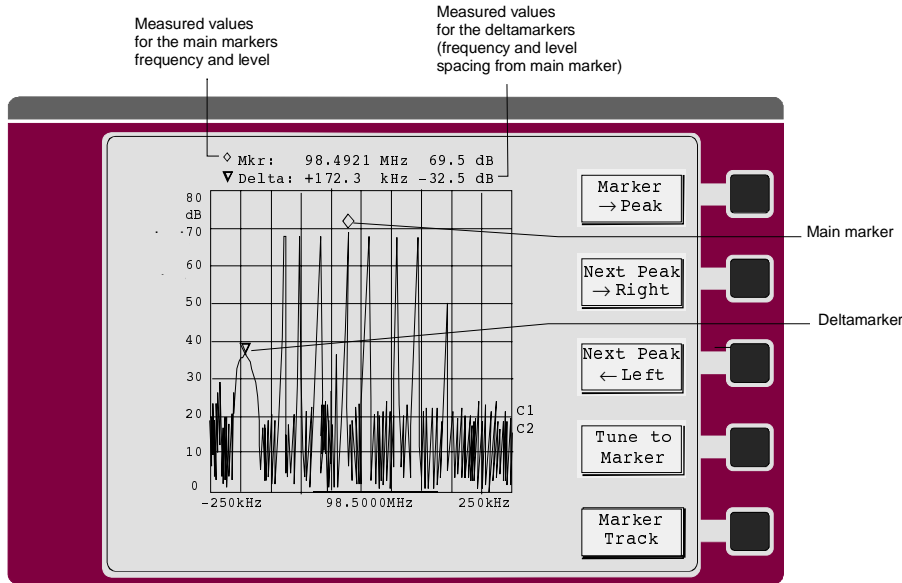
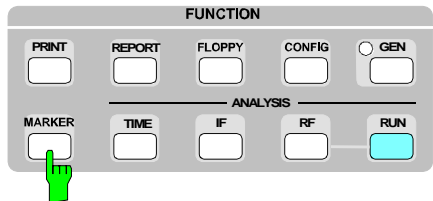


Fig. 4-10 Marker in IF spectrum analysis

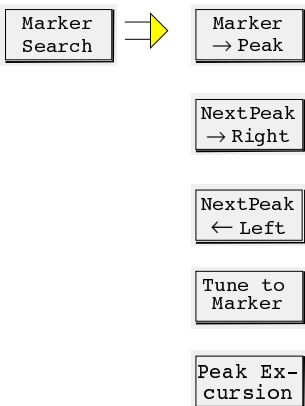
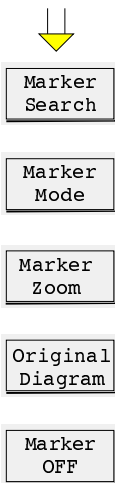
The frequency and the level of the markers are updated after each frequency scan. When the marker menu is left, the markers are preserved.

If two curves are displayed at the same time, a marker appears on each curve (◇ on curve 1 and ▽ on curve 2). Both are always located at the same frequency and are also shifted parallel to each other.

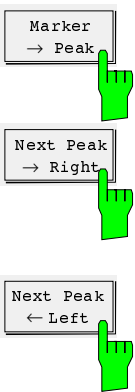
Operation:



- Press the MARKER key. Instead of the IF spectrum analysis menu, the marker menu is displayed on the screen with the marker in the default setting or in the previously valid setting. In the default setting, only the main marker is available (operating mode *Normal*). It is located at the center frequency of the curve.



The *Marker Search* softkey is used to call the submenu of the marker search functions.



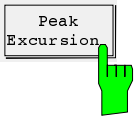
The *Marker -> Peak* soft key sets the active marker/delta marker to the maximum displayed value on the associated curve.

The *Next Peak -> Right* softkey sets the active marker/delta marker to the next lower peak value on the corresponding curve.

The *Next Peak -> Left* softkey sets the active marker to the next peak to the right of the current marker position.



The softkey *Tune to Marker* tunes the receiver to the frequency at the marker position.



The softkey *Peak Excursion* activates input of the minimum step by which a signal must drop or increase in order to be detected as peak by the search functions. The following appears in the data input field:

Peak Excursion: 6 dB

Permissible input values are 0 dB to 2000 dB, the resolution is 0.1 dB. The presetting of the Peak Excursion is 6 dB.

The functions *Next Peak ← Left* and *Next Peak → Right* search for the next relative peak, irrespective of the current signal amplitude. The following example explains the effect of various PEAK EXCURSION settings.

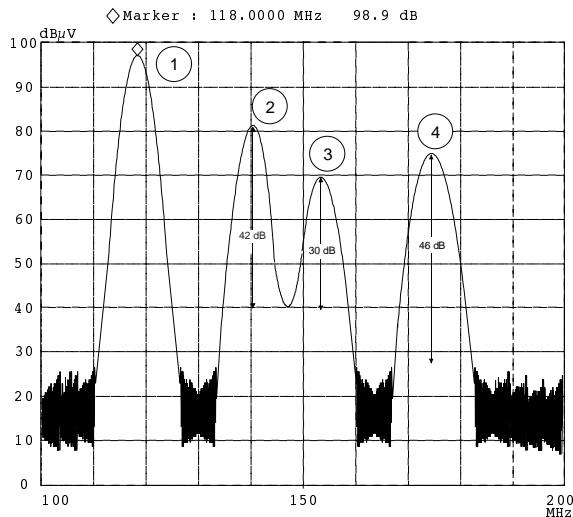


Fig. 4-11 Example of different peak excursion settings

Maximum relative level change of the measured signals:

- Signal 2: 42dB
- Signal 3: 30dB
- Signal 4: 46dB

The setting **Peak Excursion 40 dB** causes the signals 2 and 4 to be detected with *Next Peak → Right*. Signal 3 is not found, since in this case the signal only decreases by 30 dB before the level rises again.

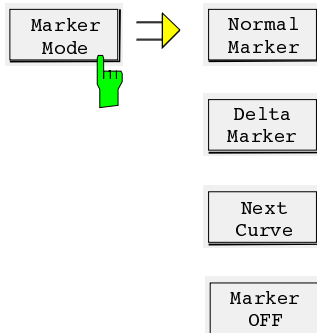
Order of signals found:

- PEAK: Signal 1
- NEXT PEAK RIGHT: Signal 2
- NEXT PEAK RIGHT: Signal 4

Setting **Peak Excursion 20 dB** causes signal 3 to be detected since its highest level change of 30 dB is now higher than the set peak excursion.

Order of signals found:

PEAK: Signal 1
 NEXT PEAK RIGHT: Signal 2
 NEXT PEAK RIGHT: Signal 3
 NEXT PEAK RIGHT: Signal 4



The *Marker Mode* softkey is used to call the submenu of the marker mode functions.



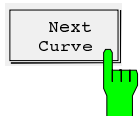
Normal Marker is used to unblank the frequency field in the output of measured values of the main marker (◇), and a new frequency can be entered. After termination of the entry, the marker jumps to the new frequency. The entry is limited to the displayed frequency range. If the delta marker is switched on, it is switched off.



The second marker (= *delta marker*) is faded in. If two curves are displayed, both markers jump to the same curve. Below the measured value output for the normal marker, a second line appears with the value for frequency spacing and level spacing from the main marker. The frequency spacing is displayed in red, indicating that a frequency spacing (positive or negative) from the main marker can be entered. If the delta marker is already activated, the softkey is only used for frequency input.



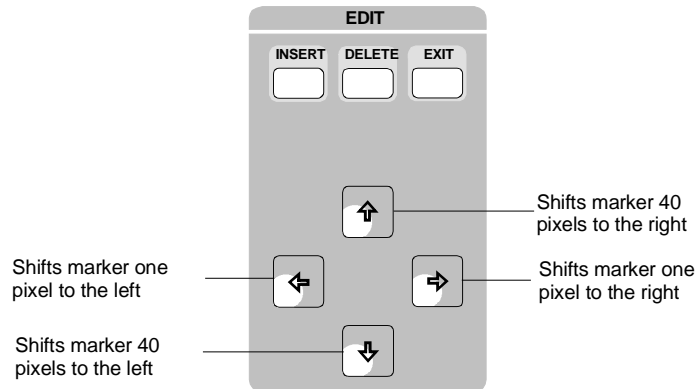
The marker(s) is (are) switched off using *Marker OFF* and the marker menu is left. The main menu of IF analysis appears.



The *Next Curve* softkey only appears if the delta markers is switched on when two curves are displayed. The two marker symbols are thus set to the other curve.

Shifting the marker:

After the marker function has been called up, the marker can immediately shifted using the cursor keys in the EDIT keypad:



Longer pressing of the key accelerates the movement of the marker.

Leaving the marker menu: The marker menu is left using *Marker OFF*, by pressing a hardkey which causes a different screen display or using EXIT. Only *Marker OFF* permits to switch off the marker(s), otherwise they are retained.

Output of Measurement Results on Plotter or Printer

Introduction The result of a frequency scan of RF analysis or the displayed spectrum of the IF analysis can be output to a printer with Centronics interface or via IEC bus to a plotter with the language standard HP-GL. The contents of printer or plotter output is freely selectable. The following outputs are possible:

- User-definable labeling of test report (*Title*)
- Test settings of receiver (*Scan Table*)
- *Diagram* with limit lines
- List output of *final results*. After the prescan, the subrange maxima are output.
- List output of all measured values in tables (*Scan Res List*). With the limit line activated, only the measured values exceeding the limit line are output.
- Numbering of pages (*Page Count*)

In the case of IF spectrum analysis, the diagram is always output and only the *title* can be added.

Date and time at the beginning of the measurement are always output, too.

Note: *The ESCS supports the printer types Laser Jet II, Desk Jet, Desk Jet Color (according to standard PCL4) and the EPSON 24-needle printer. Many other printers are compatible to these types and can therefore be driven by the ESCS, too. The corresponding printer manual informs about the supported operating modes.*

Printer

Introduction The result of a frequency scan of the RF analysis or the displayed spectrum of the IF analysis can be output on a printer with Centronics interface or via IEC bus to a plotter with language standard HP-GL. The contents of the printer- or plotter output is freely selectable. The following outputs are possible:

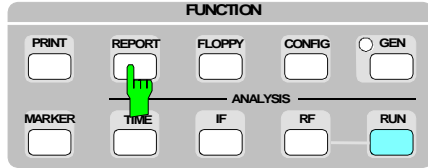
- *Diagram* with limit lines
 - Test settings of receiver (*Scan Table*)
 - User-definable labeling of the test report (*Title*)
- List output of measured values in tables (*Meas Values*)

Note: The ESCS supports the printer types Laser Jet, Desk Jet, Desk Jet Color and Epson 24-needle. There is a large number of other compatible printer types, which can also be addressed by the ESCS. The supported operating modes can be obtained from the respective printer manual.

Presetting of the Printer

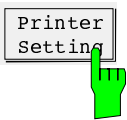
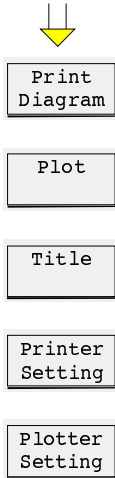
Introduction The type of result output (diagram or list) and the components of the printer report can be selected with the printer presetting. The printer presettings are stored in the battery-backed RAM of the ESCS and usually are to be performed only once. They are maintained even after calling up the default setting of the ESCS using RCL 0. When a complete instrument configuration is stored on floppy disk, the settings are also stored.

Operation:



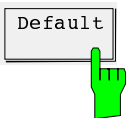
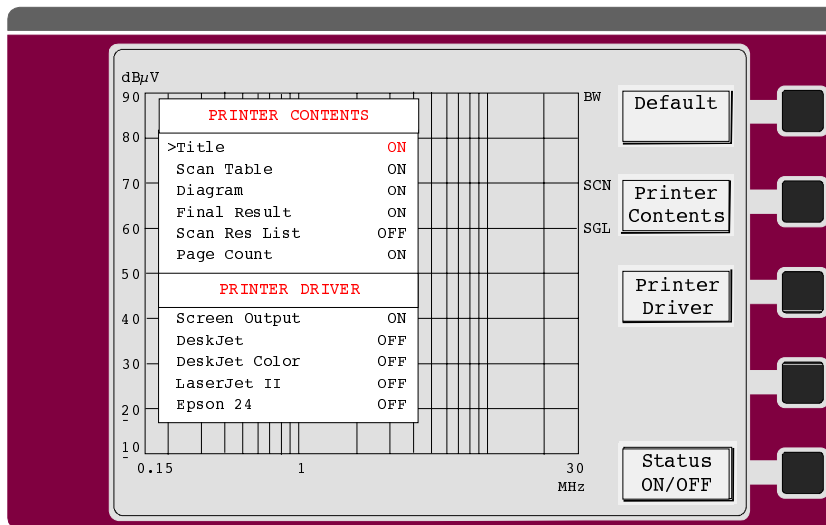
Press the REPORT key.

The screen shows the REPORT menu with the softkeys for configuration of the test report and for triggering the printer and plotter output.



➤ Press the *Printer Setting* softkey.

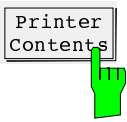
A list with the possible components of the printer report appears on the screen.



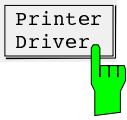
The *Default* softkey permits to set the default for the table PRINTER CONTENTS. The settings are as follows:

- Title* ON
- Scan Table* ON
- Diagram* ON
- Final Results* ON
- Scan Res List* OFF
- Page Count* ON

The selected printer (*printer driver*) remains unchanged.

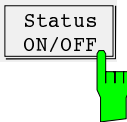


Printer Contents sets the select cursor into the table PRINTER CONTENTS. The cursor keys \uparrow and \downarrow permit to shift the cursor within the table. The softkey *Status ON/OFF* is used to switch the individual elements on and off.



Printer Driver sets the select cursor into the table PRINTER DRIVER. The cursor keys \uparrow and \downarrow permit to shift the cursor within the table. The softkey *Status ON/OFF* is used to switch the individual printers on and off.

Screen Output diverts the output of the tables *Final Results* and *Scan Res List* into a window on the screen.



The *Status ON/OFF* softkey is used to switch on or off the various components of the report for printer output.

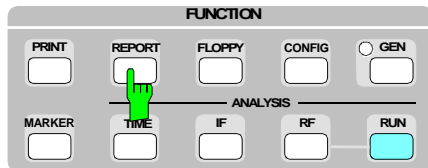
The EXIT key can be used to leave the menu for the printer presetting.

Presetting of the Plotter

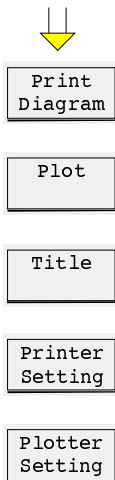
Introduction: The plotter presetting permits to select measured value output, the components of the plotter report and the plotter pens.

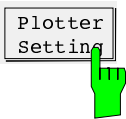
The plotter settings are stored in the battery-backed RAM of the ESCS so that they usually need only be performed once. They are maintained even after calling the default setting of the ESCS using RCL 0. When storing a complete instrument configuration on floppy disk, the settings are also stored.

Operation:

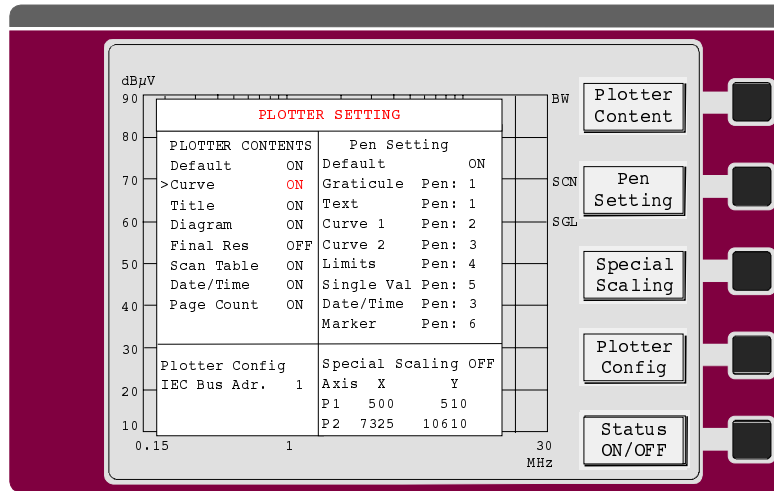


- Press the REPORT key .
- The screen shows the report menu with the softkeys for configuration of the test report and for triggering the printer and plotter output.





- Press the *Plotter Setting* softkey.
A list with the possible components of a plotter report appears on the screen:



The list *Plotter Contents* shows the components of the report. The list *Pen Settings* permits to assign the plotter pens to the components of the report. The plotter address is set in the *IEC Bus Address* field. The size of the plot can be matched to the needs of the user in the field *Special Scaling*.

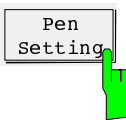
The individual fields are selected using the softkey menu.



By pressing the softkey *Plotter Content* the cursor > is displayed in the list for the *Plotter Contents*. The default setting can be selected in the first line (Default ON). The following lines list the selectable components:

- the curve(s) (*Curve*),
- the user-defined heading (*Title*),
- the grid with labeling of the frequency and level axis and, if defined, the limit lines (*Diagram*),
- the list of receiver settings in the various subranges during the frequency scan (*Scan Table*) and
- date and time (*Date/Time*).

The desired elements of the report are selected using the cursor and switched over using the *Status ON/OFF* softkey (OFF → ON, ON → OFF).



The softkey *Pen Setting* is used to assign the plotter pens to the individual components of the report. In the default setting, the pens are selected as shown in the illustration. To change the assignment, the cursor is set to the respective line and the desired pen number is entered. The numbers 0 to 8 are permissible as pen numbers. With "0" no pen is selected, i.e. the respective pixel is not written.

If a scaling of the test report other than given with the default setting of the plotter used is desired, the softkey *Special Scaling* can be used to individually set the bottom left (P1) and the top right corner (P2) of the test report. The softkey *Status ON/OFF* switches the special scaling on or off. With *Special Scaling ON*, the table with the values for the X and Y-coordinates of points P1 and P2 appears. Shift the cursor to the respective position and enter the new value. Values from -32768 to +32768 are permissible. Illegal values are not accepted. The values of the coordinates depend on the plotter used and are to be obtained from the respective manual.

The following table gives the favorable coordinate settings for a few plotters.

Table 4-8

Plotter	P1/X	P1/Y	P2/X	P2/Y
DOP (R&S)	600	610	7320	10610
R 9833 (Advantest)	650	610	7200	10610
HP 7475	Default			
HP Color Pro	Default			



The softkey *Plotter Config* permits the IEC-bus address of the plotter to be set in the range between 0 and 30.

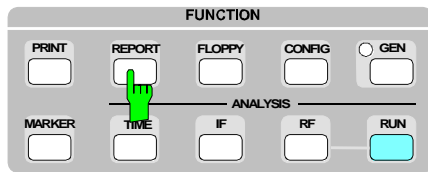
EXIT can be used to leave the menu for presetting the plotter.

Input of Labeling

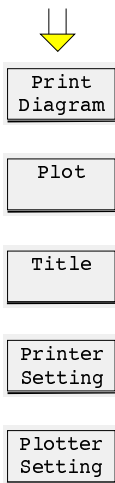
To provide complete documentation of the measurement results, the printer or plotter report can be labeled individually. The following entries can be made:

- Heading
- Measurement Type
- Equipment under test (*Eut*)
- *Manufacturer* of the test item
- Operator
- Test specifications (*Test Spec*)
- 2 lines with 60 characters each with freely selectable text (*Comment 1* and *Comment 2*)

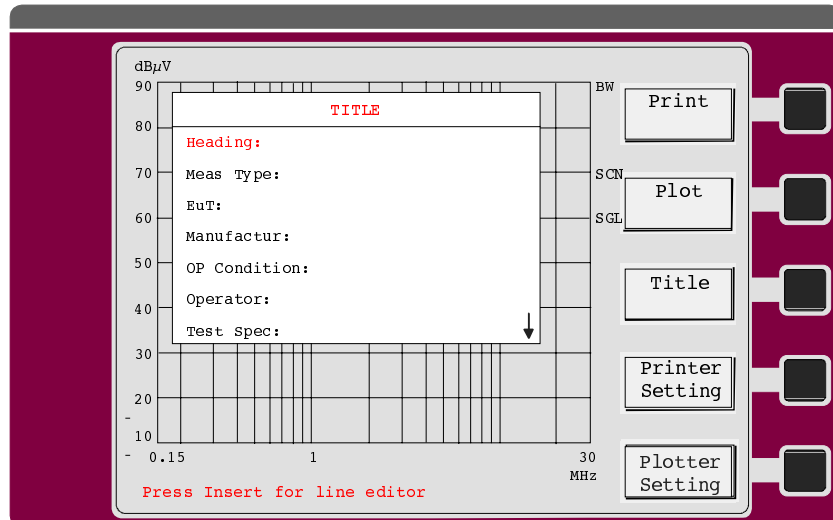
Operation:



➤ Press the REPORT key.
The screen shows the REPORT menu with the softkeys for configuration of the test report and for triggering the printer and plotter output.



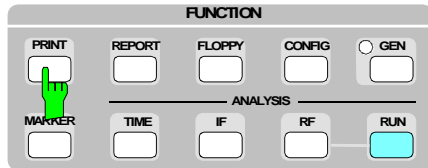
Using the softkey *Title* the input mask for labeling the report output is set up on the screen:



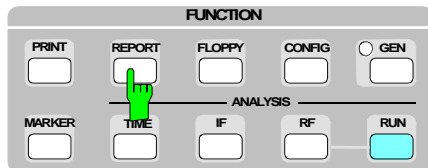
The cursor permits to select the desired line for labeling. This line is displayed in red color. The arrow ▼ in the bottom right corner of the screen indicates that it is still possible to enter more lines (*Comment 1* and *Comment 2*).

The text is entered either via the external keyboard or, if none is connected, via the auxiliary line editor which is automatically faded in (see section 3 "Operation of Auxiliary Line Editor").

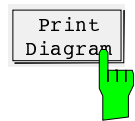
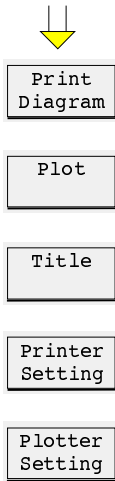
Output of Measurement Results on the Printer



- Press the PRINT key.
The measurement results are immediately printed in the format defined in the menus *Printer Settings* and *Title*. The menu for the report output appears on the screen.



- or
- Press the REPORT key.
The menu for the report output appears on the screen.

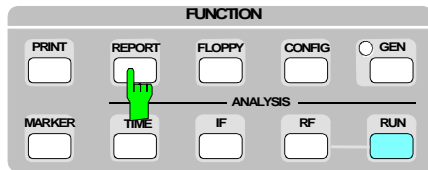


- Press the *Print Diagram* softkey.
The diagram is immediately printed together with the heading and the scan table. The running printing procedure is indicated in the status line by the message *Printing....*

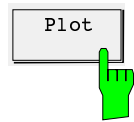
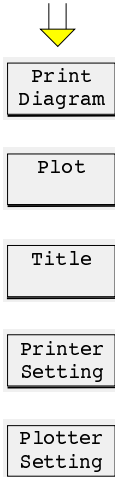
During the printing procedure, the *Abort Print* softkey appears, allowing the printing to be stopped. Printing is performed in the background, i.e. the receiver can still be operated immediately after beginning of the printing procedure. The level measurement remains switched off during printing.

Message: If no printer is connected, the message *Connect Printer!* is output in the status line. After connecting a printer, printing must be restarted.

Output of Measurement Results on a Plotter



- Press the REPORT key.
The menu for the report output appears on the screen.



- Press the *Plot* softkey.
The measurement results are immediately plotted in the format defined in the menus *Plotter Setting* and *Title*. The running plotting procedure is indicated in the status line by the message *Plotting.....* If the output of a diagram and a table is specified, the diagram is plotted on the first page and the table on the following pages. The labeling is repeated on all pages.

During plotting, the *Abort Plot* softkey appears, allowing for the plotting to be stopped. Plotting is performed in the background, i.e. the receiver can still be operated immediately after the beginning of plotting. Fast measurements, however, take more time as long as the ESCS transfers data to the plotter.

Messages:

- If no plotter is connected or the connected plotter has an IEC-bus address different from that indicated in the *Plotter Setting* menu, the message "*Connect Plotter!*" is output in the status line of the screen. Plotting must be started again after connecting a plotter or changing the IEC-bus address of the plotter.
- The message "*Err:No Bus Control*" indicates that a controller is connected to the IEC bus of the ESCS. This prevents the ESCS from actively transmitting data to the plotter. The simplest remedy is to remove the IEC-bus connection between controller and ESCS and restart plotting.
- If a plotter output is started although a plotter procedure has not been terminated yet, the ESCS will output the following message:
- *WARN: Plotter active" WARN: Plotter active"*.
- A new plotter output can only be started after the currently running plotting procedure has been terminated and the warning has disappeared.

If pen number 0 is selected for an element, the output "*WARN: No Pen selected*" will appear.

Storing and Recalling of Settings and Measurement Results

Internal Memories

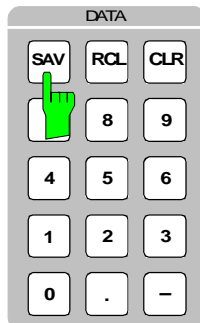
The ESCS can store 9 complete instrument setups (1 to 9) in the internal battery-backed RAM. The setting 0 contains the default setting of the receiver and cannot be modified. It can be used to set all instrument setups to their default.

The following settings are stored in memories 1 to 9:

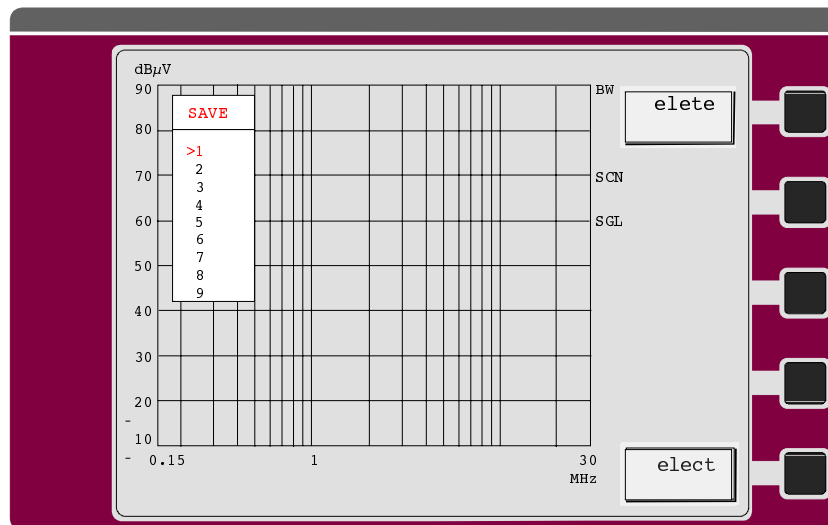
- All current receiver settings, such as frequency, attenuation, operating range, detector, etc.
- the special functions activated,
- the currently valid transducer settings,
- the scan data set,
- the activated limit lines,
- the activated scan options,
- the marker settings and
- the settings of the IF analysis.

Note: *Since the limit lines and the transducer in turn contain extensive data sets, they are saved completely only once. The stored data set only contains a hint as to the respective limit values and transducers. If they are changed subsequently, it may occur that the initial transducer or limit value cannot be restored when recalling an instrument setting.*

Operation:



- Press the SAV key.
The following menu appears on the screen:

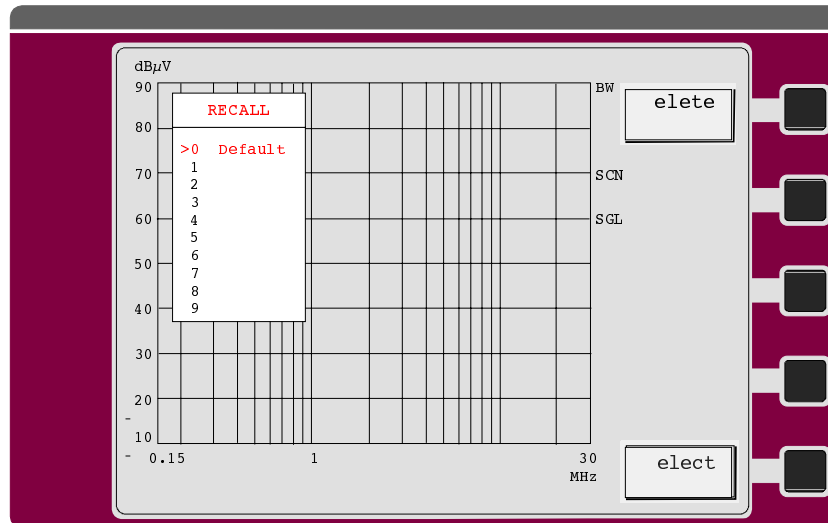
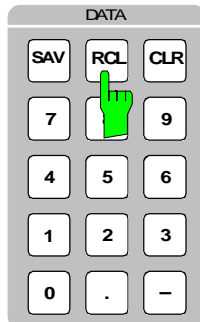


- Use the arrow keys to select the desired memory location and press the *Select* softkey.
- or:
- Select the memory location by directly entering a number between 1 and 9.
- Enter the file name with the line editor or via the external keyboard.

- Press one of the *Enter* keys.
- If the memory selected is already occupied, a message is displayed:
Overwrite Register *ENTER/EXIT*
- Press one of the *Enter* keys to store the instrument setting.

Note: If no name is attributed to the stored file, it will be marked by an asterisk **** in the list.

- Press the *Delete* softkey to delete the selected file.
- Press the RCL key.
The following menu appears on the screen:



- Use the arrow keys to select the desired memory location and press the *Select* softkey or one of the *Enter* keys.

or:

- Select the memory location by directly entering a number between 1 and 9.
The stored instrument settings are displayed on the screen.

Floppy Disk Drive

The 3½" floppy disk drive of the ESCS is used as a mass storage unit for instrument settings, transducer factors, limit lines, measurement results and graphics in HP GL file format. Furthermore, the ESCS permits to format floppy disks, list floppy disk contents on the screen and delete individual files.

Floppy disk format The 3½" floppy disks are formatted in a format that is PC-compatible so that the floppy disk can be used both for personal computers and for the ESCS. The floppy disks can be formatted either in the high-density format (1.44 Mbyte) or in the double-density format (720 kbyte).

File organization: Each data set is stored in its own file on the floppy disk. The file name entered by the user consists of a maximum of 8 characters. The extension is automatically appended to the file name by the receiver when the file is stored.

Table 4-9

Data set	Extension
Complete instrument setup (without measurement results)	.SPC
Complete instrument setup (with measurement results)	.RES
Limit lines	.LLI
Transducer factor	.TDF
Transducer Set	.TDS
Diagrams in HP-GL format	.GRA

The files are always stored in the main directory in the ESCS. A maximum of 224 files can be generated. Except for the graphics in HP-GL format which are provided as ASCII files, they are all stored in the receiver-internal binary format.

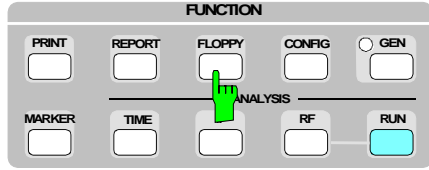
The compiler program ESXS2ASC.EXE permits to convert the binary files on a PC into ASCII files. These data can then be further edited eg using a spreadsheet.

The compiler program can be obtained free of charge.

File names: Each file which is to be stored on floppy disk must be assigned a name consisting of a maximum of 8 characters. For easy distinction of the floppy disks, a floppy disk can be given a name consisting of a maximum of 11 characters (*volume name*) when it is formatted.

The name is entered via an external keyboard of, if none is connected, via the automatically displayed auxiliary line editor.

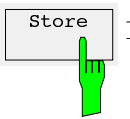
Operation:



- Press the FLOPPY key.
The screen displays the opposite menu, the Floppy menu with the possibilities Store, Load and Disk Service functions.

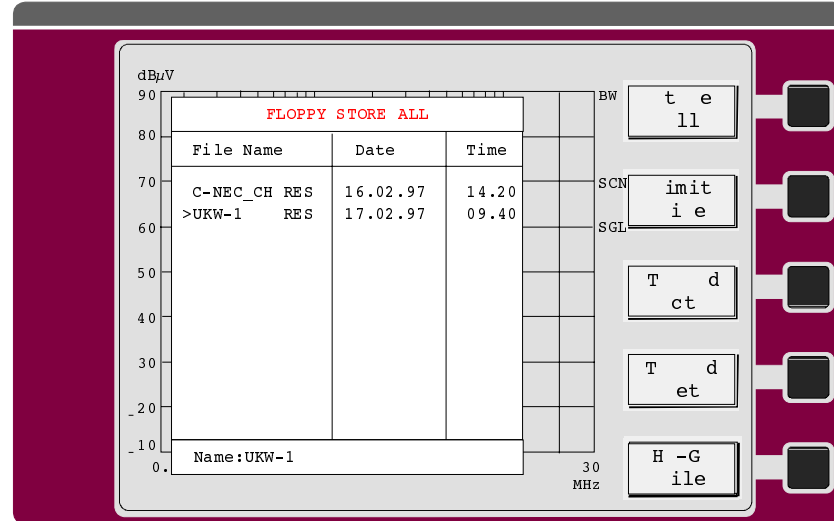


Storing on Floppy Disk



The *Store* softkey calls a submenu which contains the data sets that can be stored.

After pressing of the desired storage functions, the receiver checks the installed floppy disk for the files with the respective extensions and lists them.



If there is no file on the floppy disk, the table remains empty. The file name under which the file is to be stored on floppy disk can be entered in the status line. An already existing file can be overwritten by selecting an already existing name using the keys \uparrow and \downarrow and pressing ENTER. The status line displays the prompt

Overwrite existing file?

This prompt is also displayed if the file is found to already exist on the floppy disk when a name is directly entered. The file is stored by pressing the ENTER key. If the file is not to be overwritten, the function can be aborted using EXIT.

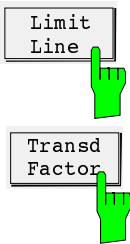
The softkeys described above are used to store the following data:

Store all is used to store the complete instrument settings. If measurement results from a frequency scan are available they are also stored. The following data are stored:

- all receiver settings (including special functions)
- the selected type of analysis (RF or IF analysis),
- the configuration for measured value output on printer or plotter,
- activated limit lines,
- activated transducer factors,
- if available, measurement results from a preceding frequency scan
- the data sets for the set frequency scan,
- marker settings and
- all settings of IF analysis

Complete storage of the receiver settings with the measurement results avoids problems when loading the data with the current settings. Data sets loaded from the floppy disk can be subsequently processed as if they were only just measured (zoom, marker, output, etc.)

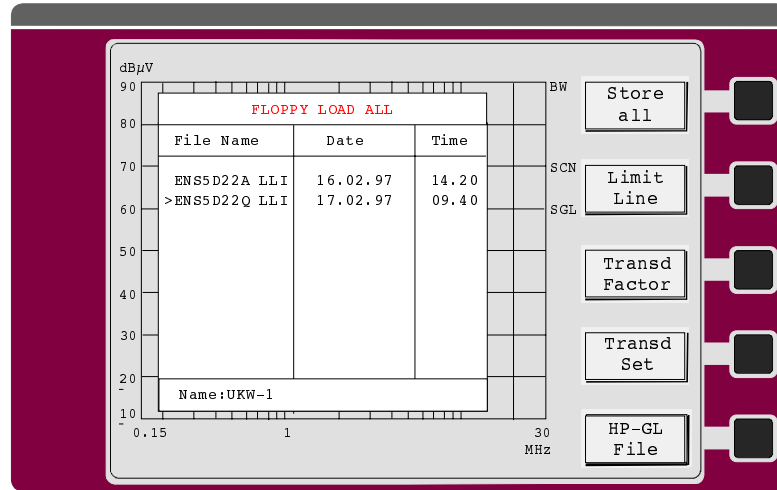




Limit lines and transducer factors can be stored separately and also loaded separately later. All data sets defined at this point in time can be stored on floppy disk, irrespective of whether the data set is currently activated. The status (ON/OFF) is not stored.

After pressing one of the 5 softkeys, the associated list is displayed on the screen.

Example:



A data set to be overwritten can be selected from the list (set cursor to data set + ENTER) or a name for a new data set can be entered in the status line. ENTER is used to store the data set on floppy disk. The extension .LLI, .TDF or .TDS is automatically appended.

After the storage function has been executed, the screen contents and the softkey menu are maintained in order to allow further data sets to be immediately stored. By pressing the EXIT key or a function key, the menu can be left and a different menu displayed on the screen.

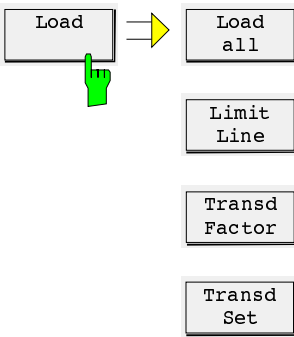


This softkey permits to store a complete graphics as ASCII file in the HP-GL-format on floppy disk. The ESCS behaves as if a plotter output had been started, however, the output is not made to the plotter, but to a floppy disk. Depending on the presetting of the plotter output, the file contains:

- Title
- Scan Table
- Diagram
- Curves
- Tabular measurement results as well as
- Date and time.

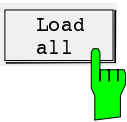
Note: *The files stored like this cannot be reloaded into the ESCS. They are only used for further processing on a PC. Text processing and graphics programs which can import HP GL files can be used. In the easiest case, the file can be output to a plotter via the respective PC interface.*

Loading from the Floppy Disk



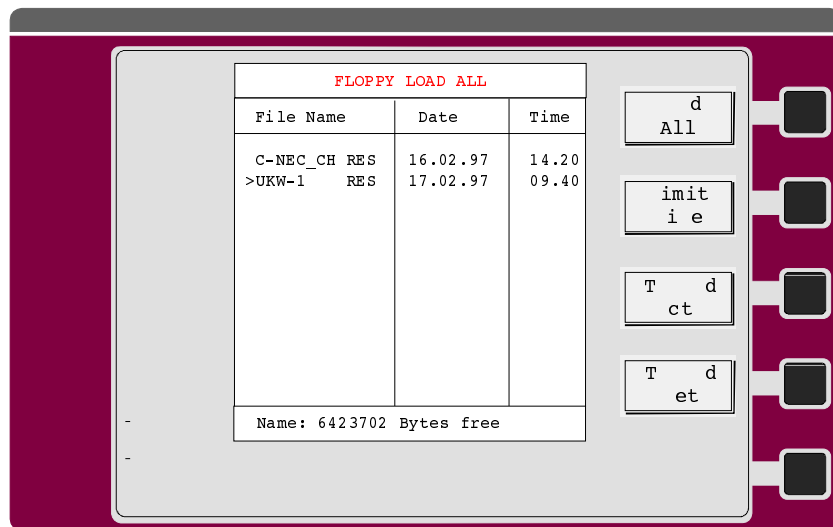
The *Load* softkey calls a submenu which determines the data set to be loaded from the floppy disk into the receiver.

Operation and procedure when loading the data sets largely correspond to storing.



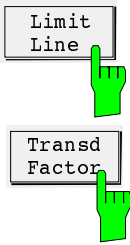
Load all is used to load a complete setting of the ESCS and, if available, measurement results, into the receiver. All files with the extension .SPC (only settings) or .RES (settings and measurement results) are listed on the screen. If no such file is stored on the floppy disk, the list remains empty.

Example:



The desired data set is selected using the cursor and loading is started using the ENTER key. After loading, the floppy menu is left and the receiver changes to the loaded setting. Stored measurement results are displayed on the screen.

Note: *The loaded data set overwrites all instrument settings.*



Limit lines or a transducer factor can be loaded into the ESCS using the softkeys *Limit Line* and *Transd. Factor*. They are not automatically switched on after loading in order to avoid a conflict with already active limit values or transducers.

After pressing one of the four softkeys, the appropriate list is displayed on the screen. The desired file is selected by entering the file name or using the keys or directly from the list. After confirmation of the file name using ENTER, the number of the data set into which the data are to be loaded is requested:

Load into factor No. (1...22): (Example of a transducer factor)

After the data set number has been entered correctly, the data are loaded. After loading, the screen contents and the softkey menu are maintained to allow for immediate loading of further data sets. The menu is left using the EXIT key or any function key.

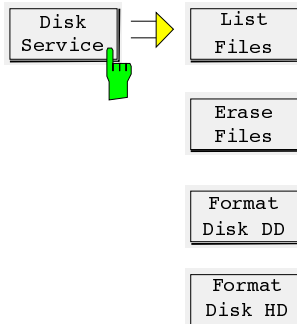
Note: *Existing data sets are overwritten if new data sets are loaded with the same number.*

Floppy Disk Operations

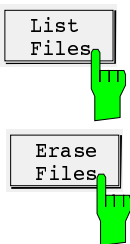
The menu *Disk Service* is used to

- format floppy disks,
- list files and
- delete files.

After pressing the *Disk Service* Softkey, the following submenu is displayed:



List Files causes all files on the floppy disk to be listed on the screen. Subdirectories produced eg on a PC are not displayed. The list can be scrolled using the cursor keys ↑ and ↓.

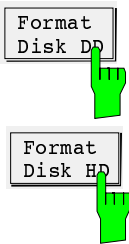


Erase Files causes all files on the floppy disk to be listed. The file to be deleted is selected using the cursor keys ↑ and ↓ or by entering the file name in the status line and confirming the entry using ENTER.

Before the file is definitely deleted, the following prompt appears in the status line:

Press Enter to erase file.

Note: *In the event that a file is unintentionally deleted, there are utility programs for personal computers, which are able to restore the deleted file. However, no further file may be stored on the floppy disk in the meantime.*



Before data can be stored on a new floppy disk, it must be formatted. In the ESCS, floppy disk are formatted in the MS-DOS PC-compatible format. Both files with 720 kbytes ("Double Density" DD) and 1.44 Mbytes ("High Density" HD) can be formatted. After the appropriate softkeys have been pressed, the following prompt appears in the status line:

Insert disk and press ENTER

Enter the floppy disk to be formatted into the drive and press the ENTER key.

Prior to formatting, it is possible to assign a name (volume name) to the floppy disk with max. 11 characters:

Volume name _

Then starts formatting of the disk. During the formatting procedure, all receiver functions are disabled.

Note: *In the case of used floppy disks, all data are deleted by formatting.*

Messages during Floppy Disk Operations

Floppy disk operations are commented by the messages and error messages listed below. If an error occurs, it must be eliminated by the user and the desired functions must be called up again subsequently.

<i>Storing <filename> on disk</i>	Message while data are stored on floppy disk
<i>Loading <filename> from disk</i>	Message while data are read from floppy disk
<i>Reading disk, please wait...</i>	Each time the floppy disk is changed, the file management system of the ESCS must reorganize the floppy disk. During this procedure, the above message is displayed.
<i>Overwrite existing file?</i>	The file name entered for storage already exists. By pressing ENTER, the file is overwritten. EXIT is used to abort the storage procedure.
<i>Drive not ready</i>	The drive is not ready for read or write accesses, e.g. because no floppy disk is inserted or the floppy disk is not formatted.
<i>Write protect error</i>	The floppy disk is write-protected which is why no write access is possible.
<i>Insufficient disk space</i>	The floppy disk does not provide enough space to store the file.
<i>Invalid file name</i>	An invalid file name has been entered.
<i>Invalid floppy disk</i>	The floppy disk cannot be read because it is faulty.

5 Remote Control - Fundamentals

This chapter describes the fundamentals of programming the instrument. The device-specific commands are to be found in chapter 6, the program examples in R&S-BASIC can be obtained from chapter 7.

The test receiver ESCS features an IEC-bus device as standard equipment. The interface complies with the standards IEEE 488.1 and IEC 625-1. The ESCS furthermore considers the standard "IEEE Standard Codes, Formats, Protocols, and Common Commands ANSI/IEEE Std 488.2 - 1987" also approved of by the IEC commission. The standard IEEE 488.2 describes common commands, data transfer formats, terminator definitions, protocols of passing control.

The IEC-bus connection socket is situated on the rear panel of the ESCS. It is a 24-contact Amphenol connector complying with the IEEE 488 standard. The interface contains three groups of bus lines:

1. Data bus with 8 lines DIO1 to DIO8

Data transmission via these lines is bit-parallel and byte-serial with the characters in ISO 7-bit code (ASCII code). (see table 5-4)

2. Control bus with 5 lines

ATN (Attention)

becomes active low when addresses, addressed or universal commands are transmitted to the connected devices.

REN (Remote Enable)

enables the device to be switched to the remote state.

SRQ (Service Request)

enables a device connected to the bus to send a service request to the controller by activating this line.

IFC (Interface Clear)

can be activated by the controller in order to set the IEC interfaces of the connected devices to a pre-defined state.

EOI (End or Identify)

can be used to identify the end of data transfer and is used with a parallel poll.

3. Handshake bus with 3 lines

It is used to control the data transfer timing via the IEC bus.

NRFD (Not Ready For Data)

A low level on this line signals to the talker/controller that at least one of the connected devices is not ready to accept data present on the data bus.

DAV (Data Valid)

This line is held at low level by the talker/controller after a new data byte has been applied to the bus and signals that this data byte is valid.

NDAC (Not Data Accepted)

This line is held at low level until the connected devices have accepted the data byte present on the bus.

According to the IEC 625-1 standard, IEC-bus compatible devices can be equipped with different interface functions. The following interface functions are implemented in the ESCS:

Table 5-1 Interface function

Control character	Interface function
SH1	Source handshake, full capability
AH1	Acceptor handshake, full capability
L4	Listener function, full capability, unaddress if MTA
T6	Talker funktion, full capability, unaddress if MLA
SR1	Service Request, full capability
RL1	Remote/Local switchover function, local lockout (LLO), full capability
PP1	Parallel Poll, remote-controlled setting, full capability
DC1	Device Clear, full capability
DT1	Device Trigger, full capability
C1 C2 C3 C11	Controller function (system control) transmits IFC transmits REN takes and passes control (RLC),

Setting the Device Address

The IEC-bus address of the receiver is set in the SETUP menu (see section 4). The address can be entered using the numerical keypad in the range from 0 to 30 and remains stored in the non-volatile memory when the test receiver is switched off. The address is factory-set to 18 (upon delivery, cold start or firmware update).

The controller uses the IEC-bus address to address the ESCS as IEC-bus talker or listener. "Talk Only" is not provided in the case of the ESCS.

LOCAL / REMOTE Switchover

At power-up, the receiver is always in the local state (manual operation). If the ESCS is addressed as listener by a controller (e.g. using the R&S BASIC commands "IECOUT" or "IECLAD"), the receiver enters the remote state and remains in this state after data transfer has been completed. This is indicated by the "REMOTE" LED on the front panel.

In the "Remote" mode, the receiver cannot be manually operated via the front panel. The rotary knob and the keys (except for the "LOCAL" key) are disabled, no menu is displayed. There are two methods to return to local mode:

- By the controller issueing the addressed command "Go To Local" (GTL).
- By pressing the LOCAL key.
Data output from the controller to the ESCS should be completed before, since otherwise the ESCS will immediately enter the remote state again. The controller can disable the LOCAL key using the universal command "Local Lockout" (LLO) in order to prevent unintentional switchover to the local state. The GTL command permits the receiver to be switched to manual operation in the disabled state. When entering the remote state again, the Local Lockout function is again effective. Activation of the Remote Enable line (REN) by the controller definitely renders LLO ineffective. In R&S BASIC a combination of the commands IECNREN and IECREN may be used, for example.

Interface Messages

The controller transmits this group of messages to a device via the eight data lines, the ATN line being active, i.e. low. Only an active controller is able to transmit interface messages. A differentiation is made between universal commands and addressed commands.

Universal Commands

Universal commands act on all devices connected to the IEC bus without previous addressing.

Table 5-2 Universal commands

Command	BASIC command with R&S controllers	Function
DCL (Device Clear)	IECDCL	Aborts processing of the currently received commands and sets the command processing software to a pre-defined state. This command does not affect the device settings.
LLO (Local Lockout)	IECLLO	The LOCAL key is disabled.
SPE (Serial Poll Enable)	IECSPE	Ready for serial poll.
SPD (Serial Poll Disable)	IECSPD	End of serial poll.

Addressed Commands

The addressed commands act only on those devices that have been addressed as listeners before by the controller (e.g. R&S BASIC command "IECLAD").

Table 5-3 Addressed commands

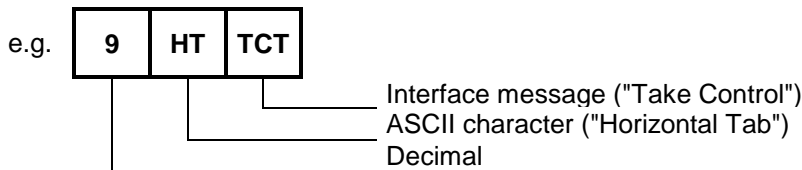
Command	BASIC command with R&S controllers	Function
SDC (Selected Device Clear)	IECSDC	Aborts processing of the currently received commands and sets the command processing software to a pre-defined state. This command does not affect the device settings.
GTL (Go to Local)	IECGTL	Change to local mode (manual operation)
GET (Group Execute Trigger)	IECGET	Start measurement

A device is addressed as listener until it is unaddressed by the controller (R&S BASIC command: IECUNL).

Table 5-4 ASCII/ISO and IEC character set

Control characters					Numbers and special characters				Upper-case letters				Lower-case letters				
0	NUL		16	DLE		32	SP	48	0	64	@	80	P	96	'	112	p
1	SOH	GTL	17	DC1	LLO	33	!	49	1	65	A	81	Q	97	a	113	q
2	STX		18	DC2		34	"	50	2	66	B	82	R	98	b	114	r
3	ETX		19	DC3		35	#	51	3	67	C	83	S	99	c	115	s
4	EOT	SDC	20	DC4	DCL	36	\$	52	4	68	D	84	T	100	d	116	t
5	ENQ	PPC	21	NAK	PPU	37	%	53	5	69	E	85	U	101	e	117	u
6	ACK		22	SYN		38	&	54	6	70	F	86	V	102	f	118	v
7	BEL		23	ETB		39		55	7	71	G	87	W	103	g	119	w
8	BS	GET	24	CAN	SPE	40	(	56	8	72	H	88	X	104	h	120	x
9	HT	TCT	25	EM	SPD	41	)	57	9	73	I	89	Y	105	i	121	y
10	LF		26	SUB		42	*	58	:	74	J	90	Z	106	j	122	z
11	VT		27	ESC		43	+	59	;	75	K	91	[	107	k	123	{
12	FF		28	FS		44	,	60	_	76	L	92	\	108	l	124	|
13	CR		29	GS		45	-	61	=	77	M	93	]	109	m	125	}
14	SO		30	RS		46	.	62	_	78	N	94	^	110	n	126	~
15	SI		31	US		47	/	63	? / UNL	79	O	95	-	111	o	127	DEL
Addressed commands			Universal commands			Listener addresses				Talker addresses				Secondary addresses and commands			

Code for control characters:



Device Messages

Device messages (to IEC 625-1) are transmitted via data lines, in which case the ATN line is not active, i.e. high. The ASCII code (ISO 7-bit code) is used. A differentiation is made between:

- device-independent commands (Common Commands, s. chapter „Common Commands“)
- device-specific commands (s. chapter 6)

Commands with a "?", such as FREQUENCY? are referred to as "query messages" and request the ESCS to output the respective value, the same format as in the command table being used. The data and values read in by the controller can thus be directly returned to the ESCS. In this example, a possible output of the test receiver is "FREQUENCY 9000" where the basic unit (here: Hz) is always valid.

Commands Received by the Test Receiver in Listener Mode (Controller to Device Messages)

Input buffer:

All the commands and data sent to the receiver are temporarily stored in a 4096-byte input buffer. It is however also possible to process longer command lines, in which case the part received before is processed internally in the receiver.

Terminators:

Each command line must be terminated by a terminator (exception: continued command lines). Permissible terminators are:

- <New Line> (ASCII-Code 10 decimal)
- <End> (EOI line active) together with the last useful character of the command line or the character <New Line>.

The terminator is set using the device-specific commands TERMINATOR LFEOI - <New Line> together with <EOI> - and TERMINATOR EOI - only <EOI> for transmission of binary data blocks. (s. chapter 6)

As the <Carriage Return> character (ASCII code 13 decimal) is permissible as a filler without effect before the terminator, the combination of <Carriage Return> and <New Line> that is for example used by R&S BASIC is also permissible.

A command line may require more than one line on the controller screen, since the end of the command line is only determined by the terminator. Most controllers automatically add a terminator to the transmitted data.

Separators:

A command line may contain several commands (program message units) which must be separated from each other by a semicolon (;).

Command syntax:

A command may consist of the following parts:

- Only a header
Example: *RST
- Combination of headers
Example: PRINTER:START
- Header and question mark ("Query")
Example: UNIT?

These queries cause the test receiver to provide the requested data in its output buffer. As soon as the device is addressed as talker, these data can be read in by the controller.

- Header and numerical value
Example: MEAS:TIME 50 MS
FREQUENCY 1.045E4

According to the IEC-bus standard IEEE488.2, the header and the numerical value must be separated by at least one space (ASCII code 32 decimal). In the case of device-specific commands, the number can be supplemented by a unit (e.g. "MHZ", "S", etc.).

- Header and numerical value
Example: DETECTOR AVERAGE
- Header and string
Example: LIMIT:TEXT 'VFG 1046'
or LIMIT:TEXT "VFG 1046"

The two different types of notation permit convenient use in different programming languages. The character ' is preferably used in R&S BASIC.

The headers and their meanings are explained in section 6. Lower-case letters are permissible as equivalents to the corresponding upper-case letters. Thus units can be used in the usual form, e.g. dBm instead of the upper-case notation DBM.

The IEC-bus syntax permits to insert additional spaces at the following places:

- before a header
- between header and number, mnemonic or string
- between number and unit
- before and after commas (,) and semicolons (;)
- before the terminator.

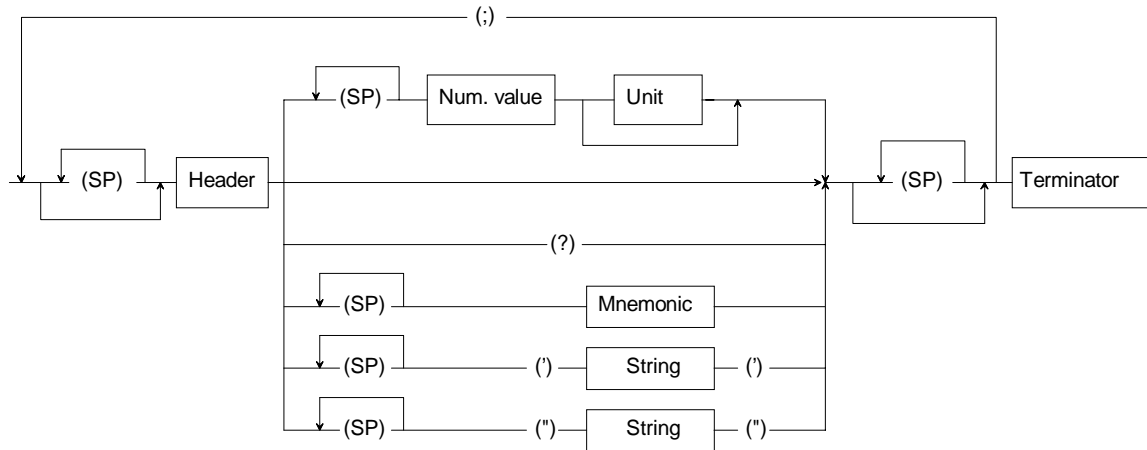
Numbers:

Only decimal numerical values are allowed in the following permissible notations:

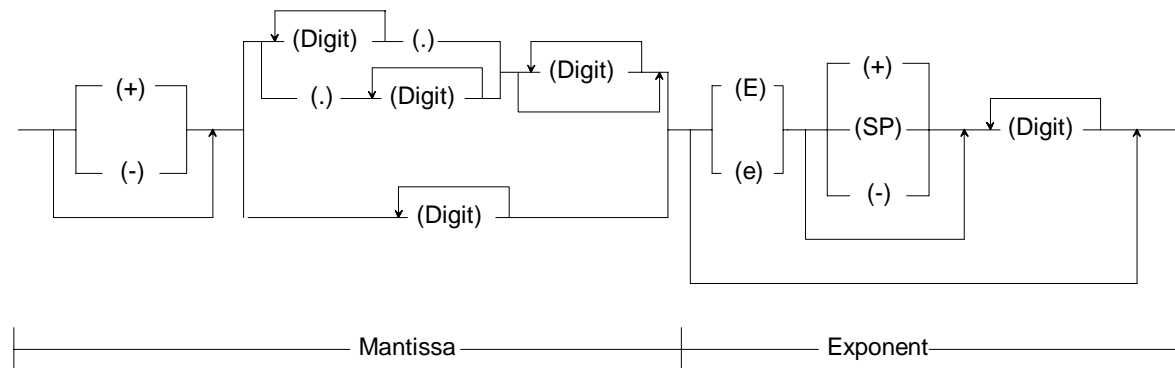
- With and without sign
Example: 10, +10, -10
- With and without decimal point, any position of the decimal point is permissible.
Example: 1.234 -200.5 .123
- With or without exponent to base 10, "E" or "e" can be used as the exponent character.
Example: 451 451E-3 +4.51e-2

- The exponent is permissible with or without a sign, a space is also permissible instead of the sign.
Example: 1.5E+3 1.5e-3 1.5E 3
- Specification of the exponent alone (e.g. E-3) is not permissible, 1E-3 is correct.
- Leading zeros are permissible in the mantissa and exponent.
Example: +0001.5 -03.7E-03
- The length of the numerical value, including the exponent, may be up to 20 characters. The number of digits for the mantissa and exponent is only limited by this condition. Digits that exceed the resolution of the device are rounded up or down; they are, however, always considered for the order of magnitude.

Command line



Numerical value



SP: Any character with ASCII code 0 to 9 and 11 to 32 decimal, especially space.

Fig. 5-1 Syntax diagramm of a command line

Messages Sent by the Test Receiver in Talker Mode (Device to Controller Messages)

The ESCS send messages via the IEC bus if they

- has been requested to provide data in its output buffer by one or more query messages with a question mark within one command line,
- indicates by setting bit 4 in the status byte (Message Available) that the requested data are now available in the output buffer,
- has been addressed as talker (e.g. by the R&S BASIC command "IECIN")

It is necessary for the command line with the data requests to be transmitted directly before talker addressing; if another command line is entered in between, the output buffer is cleared and bit 2 in the event status register is set (query error; see section 6 „Service Request and status register).

The output buffer has a capacity of 4096 bytes.

A query message is formed by adding a question mark to the respective header, e.g. FREQUENCY?.

If the ESCS is addressed as talker directly following the query message, the bus handshake is disabled until the requested data are available. This may take several seconds in the case of *CAL? since a calibration is performed before. In this case it is advisable to wait for the MAV bit (see section 6 „Service Request and Status Registers“).

The syntax for data output is exactly the same as for commands received by the ESCS. <New Line> together with END (EOI active) is always used as terminator. The transmission of header and numerical value enables the messages sent by the ESCS as a talker to be returned unchanged from the controller to the test receiver. It is thus possible to read a setting performed via the front panel, store it in the controller and return it later to the receiver via the IEC bus.

Note: *If the receiver receives several query messages, it also returns several messages separated by semicolons (;) within one line.*

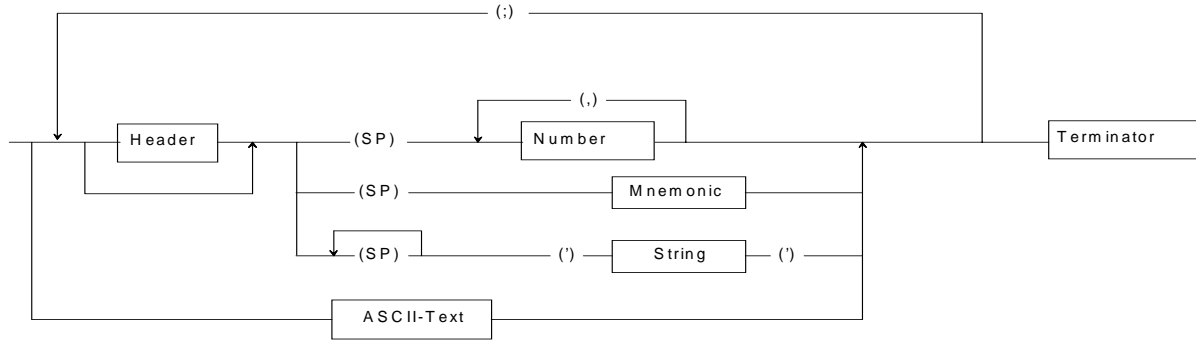
Several numerical values (day, month and year) can be sent as a reply to certain query messages. They are separated by commas (,)(e.g. SYSTEM:DATE 24,07,89)..

Headers and numerical values are always separated by spaces. Headers only consist of upper-case letters and the characters ":" "_" and "".*

The messages sent by the ESCS do not contain units. In the case of physical variables, the numerical values are referred to the basic unit (see section 6).

Output of the header can be switched on or off using the commands "HEADER ON" and "HEADER OFF".

Output message line



Numerical value

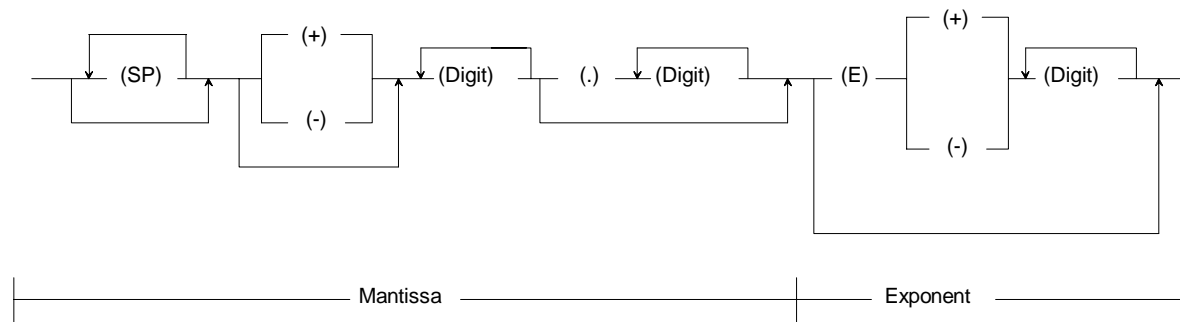


Fig. 5-2 Syntax diagram of messages sent by the receiver

Common Commands

The common, device-independent commands are grouped as follows:

- Commands referring to the Service Request function with the associated status and mask registers.
- Commands for device identification
- Commands referring to the Parallel Poll function.
- Commands for triggering sequences
- Commands for device-internal sequences (reset, calibration, selftest) and for synchronization of sequences.

The common commands are taken from the new IEEE488.2 (IEC 625-2) standard. This makes sure that these commands have the same effect on different devices. The headers of these commands consist of an asterisk "*" followed by three letters.

Table 5-5 Device-independent commands (common commands) received by the ESCS

Command	Number, Range	Meaning
*RST	---	Reset The receiver is set to its default status as it is possible with RCL0 on the front panel. This command does not change the status of the IEC-bus interface, the set IEC-bus address, the mask register of the Service Request function and the output buffer.
*PSC	0 to 65535	Power On Status Clear (reset on power-up) If the value is unequal to 0, the Service Request Enable mask register (SRE) and the Event Status Enable mask register (ESE) as well as enable registers ERAE, ERBE, ERCE and ERDE are cleared for the extended event status registers on power-up. If the value is equal to 0, these registers remain unchanged when the device is switched off and on. Bit 7 in the Event Status register is set when switching on the test receiver. If the Event Status and Service Request Enable registers have the appropriate configuration prior to switch-off, a service request can thus be triggered (see section 6 „Service Requests and status register“)
*OPC	---	Operation Complete (ready signal) Bit 0 (Operation Complete) in the Event Status register (ESR) is set if all previous commands have been processed and executed.
*CLS	---	Clear Status The status registers ESR and STB and the extended status registers ERA, ERB, ERC and ERD are set to zero. The mask registers of the Service Request function (ESE and SRE) are not changed. This command does not change the status of the IEC-bus interface and the set IEC-bus address.

Command	Number, Range	Meaning
*ESE	0 to 255	Event Status Enable The Event Status Enable mask register is set to the specified value which is interpreted as decimal number (see section 6 „Service Requests and status register“).
*SRE	0 to 255	Service Request Enable The Service Request Enable mask register is set to the specified value which is interpreted as decimal number (see section 6 „Service Requests and status register“).
*PRE	0 to 65535	Parallel Poll Enable The Parallel Poll Enable mask register is set to the specified value which is interpreted as decimal number.
*PCB	0 to 30	Pass Control Back The numerical value specifies the address of the controller to which the IEC-bus control is to be passed back after completion of a corresponding function.
*TRG	---	Trigger Level measurement of the ESCS is restarted, a current measurement is aborted. This command corresponds to the GET message. However, no measured value is provided for output, since the IEC-bus standard permits output only following a query command. The device-specific commands are provided for this purpose: <ul style="list-style-type: none"> • LEVEL:LASTVALUE? The value of the last level measurement, which was triggered by "TRG", for example, is provided in the output buffer. • LEVEL? A level measurement is started and the measured value is subsequently provided in the output buffer. • LEVEL:CONTINUE? The value of the last measurement is provided in the output buffer and a new level measurement is started. This corresponds to a sequence consisting of the commands: LEVEL:LASTVALUE? and *TRG.
*RCL	0 to 9	Recall Recalls a stored device setting. *RCL 0 sets the ESCS to its default status analog to the command *RST. The command has the same function as the RCL key.
*SAV	1 to 9	Save Saves a current device setting. Same function as the SAVE key.
*WAI	---	Wait To Continue Only processes the subsequent commands when all previous commands have been completely executed (see section 6 „command processing sequence and synchronization“).

Table 5-6 Common commands, leading to data output

Command	Output message Data value		Meaning
	No. of digits	Range	
*IDN?	30	alphanumeric	<p>Identification Query</p> <p>The ESCS sends the following identification text via the IEC bus as a reply to the *IDN? command (always without header).</p> <p>Example: Rohde&Schwarz,ESCS,0,1.10 01.00 02.00</p> <p>Rohde&Schwarz = manufacturer ESCS = model 0 = reserved for serial number (not used) 1.10 = Version of main-firmware 01.00 = Version of graphics firmware 02.00 = OTP-Firmware-Version</p>
*PSC?	1	0 or 1	<p>Power On Status Clear Query</p> <p>Reading the status of the Power On Clear Flag (see *PSC)</p>
*OPC?	1	0 or 1	<p>Operation Complete Query (ready message)</p> <p>The message "1" is entered into the output buffer and bit 4 (message available) is set in the status byte when all previous commands have been completely executed. Bit 0 (operation complete) is also set in the Event Status Register (see section 6).</p>
*ESR?	1 to 3	0 to 255	<p>Event Status Register Query</p> <p>The contents of the Event Status Register is output in decimal form and the register then set to zero.</p>
*ESE?	1 to 3	0 to 255	<p>Event Status Enable Query</p> <p>The contents of the Event Status Enable mask register is output in decimal form. The gap in the range of values results from the fact that bit 6 (rsv) cannot be set. The value results from ORing of the other bits</p>
*STB?	1 to 3	0 to 255	<p>Status Byte Query</p> <p>The contents of the status byte is output in decimal form, this does not change the status byte.</p>
*SRE?	1 to 3	0 to 63 and 128 to 191	<p>Service Request Enable Query</p> <p>The contents of the Service Request Enable mask register is output in decimal form. The gap in the range of values results from the fact that bit 6 (rsv) cannot be set. The value results from ORing of the other bits.</p>
*TST?	1 to 3	s. Tab 3-9	<p>Self-Test Query</p> <p>A device self-test is executed. The output value "0" indicates proper termination of the self-test. Values > "0" signal faults in the respective module(s)</p>
*IST?	1	0 or 1	<p>Individual Status Query</p> <p>The instrument status „IST“ is output (parallel poll message according to IEEE488.1). "0" means "IST" FALSE, "1" means "IST" TRUE.</p>
*PRE?	1 to 3	0 to 255	<p>Parallel Poll Enable Query</p> <p>The contents of the Parallel Poll Enable register is output in decimal form.</p>
*CAL?	1 to 3	s. Tab. 3-9	<p>Calibration Query</p> <p>The receiver is calibrated. If the calibration is completed successfully, "0" is output as a reply; otherwise a number between 25 and 613, the meaning of which is to be obtained from table 4-6.</p>
*OPT?	---	alphanumeric	<p>Option Query</p> <p>The configuration of the test receiver fitted can be queried.</p> <p>ESCS-B4 IF Spectrum Analysis ESCS-B5 Tracking Generator ESCS-B9 RMS Detector</p>

Table 5-7 Meaning of the error messages during calibration

Output value	Meaning
06	An error has occurred during calibration of the IF bandwidth
25	The gain at the reference frequency 5.9 MHz cannot be stabilized.
65	The IF gain switch is faulty so that its gain error can no longer be corrected.
81	The 30-dB operating range is faulty and cannot be calibrated.
103	The quasi-peak weighting in band A is faulty.
105	The quasi-peak weighting in band B is faulty.
107	The quasi-peak weighting in band C/D is faulty.

Table 5-8 A filter range of the preelection is defective; frequency response at the respective frequency is more than 6 dB:

Output value	Frequency	Output value	Frequency	Output value	Frequency
129	100 kHz	183	70.9 MHz	231	290.9 MHz
131	200 kHz	185	79.9 MHz	233	300.9 MHz
133	500 kHz	187	80.4 MHz	235	310.9 MHz
135	1 MHz	189	90.9 MHz	237	320.9 MHz
137	1.8 MHz	191	100.9 MHz	239	330.9 MHz
139	1.9 MHz	193	110.9 MHz	241	340.9 MHz
141	2.4 MHz	179	50.9 MHz	229	280.9 MHz
143	2.9 MHz	181	60.9 MHz	243	350.9 MHz
145	3.9 MHz	195	120.9 MHz	245	360.9 MHz
147	5.9 MHz	197	130.9 MHz	247	370.9 MHz
149	7.9 MHz	199	140.9 MHz	249	380.9 MHz
151	8.4 MHz	201	150.9 MHz	251	390.9 MHz
153	8.9 MHz	203	160.9 MHz	253	400.9 MHz
155	9.9 MHz	205	170.9 MHz	255	410.9 MHz
157	14.9 MHz	207	180.9 MHz	257	420.9 MHz
159	19.9 MHz	209	190.9 MHz	259	430.9 MHz
161	24.9 MHz	211	199.9 MHz	261	440.9 MHz
163	25.4 MHz	213	200.4 MHz	263	450.9 MHz
165	25.9 MHz	215	210.9 MHz	265	460.9 MHz
167	27.9 MHz	217	220.9 MHz	267	470.9 MHz
169	30.9 MHz	219	230.9 MHz	269	480.9 MHz
171	40.9 MHz	221	240.9 MHz	271	490.9 MHz
173	50.9 MHz	223	250.9 MHz	273	499.9 MHz
175	60.9 MHz	225	260.9 MHz	275	500.4 MHz
177	40.9 MHz	227	270.9 MHz	277	510.9 MHz

Output value	Frequency	Output value	Frequency	Output value	Frequency
279	520.9	333	790.9	387	1250.9
281	530.9	335	800.9	389	1300.9
283	540.9	337	810.9	391	1350.9
285	550.9	339	820.9	393	1400.9
287	560.9	341	830.9	395	1450.9
289	570.9	343	840.9	397	1500.9
291	580.9	345	850.9	399	1550.9
293	590.9	347	860.9	401	1600.9
295	600.9	349	870.9	403	1650.9
297	610.9	351	880.9	405	1700.9
299	620.9	353	890.9	407	1750.9
301	630.9	355	900.9	409	1800.9
303	640.9	357	910.9	411	1850.9
305	650.9	359	920.9	413	1900.9
307	660.9	361	930.9	415	1959.9
309	670.9	363	940.9	417	1960.9
311	680.9	365	950.9	419	2000.9
313	690.9	367	960.9	421	2050.9
315	700.9	369	970.9	423	2100.9
317	710.9	371	980.9	425	2150.9
319	720.9	373	990.9	427	2200.9
321	730.9	375	999.9	429	2250.9
323	740.9	377	1000.4	431	2300.9
325	750.9	379	1050.9	433	2350.9
327	760.9	381	1100.9	435	2400.9
329	770.9	383	1150.9	437	2450.9
331	780.9	385	1200.9	439	2499.9

Table 5-9 Meaning of the return values of the selftest

Value	Meaning
0	Selftest has been completed without an error
1	+5-V supply voltage out of tolerance
2	+10-V supply voltage out of tolerance
3	-10-V supply voltage out of tolerance
4	+28-V supply voltage out of tolerance
15	Any other defect of the module CPU-board
18	Component of the real-time clock is defective
19	Serial bus is defective
99	Synthesizer is defective
100	Frontend is defective
106	IF selection board is defective
107	2nd mixer is defective
111	Detektor Board is defective

6 Device-specific Commands

The query messages are identified by an added "?". They enable the ESCS to transmit device settings or measured values to the controller. The structure of the data output format is the same as that of data input thus making it possible that the data read by the controller can be returned to the test receiver without further processing in the controller. If no unit is stated, the respective basic unit is used (Hz, s, dB, %). The used syntax is in accordance with the new standard "IEEE 488.2" that has been valid since 11/87. Program examples concerning IEC-bus programming are stated in section 7.

Note: *When reading the data in the controller please do make sure that the settings of the terminators are correct. The R&S-BASIC command for ASCII-texts is IEC TERM 10; for binary data IEC TERM 1.*

Some headers can be abbreviated. The shortest possible notation is marked by bold letters in the tables 6-1 to 6-10

Table 6-1 Receiver Functions

Command	Data	Unit	Meaning
ATTENUATION ATTENUATION? :AUTO :AUTO? :MODE :MODE? :PREAMPLIFIER :PREAMPLIFIER? :ZSD?	0 to 60 dB INCREMENT DECREMENT ON OFF LOWNOISE LOWDISTORTION ON OFF ---	dB --- ---	Set RF attenuation Increase RF attenuation by 5 dB Decrease RF attenuation by 5 dB Auto-Ranging on Auto-Ranging off IF attenuation (mode) The preamplifier is also integrated in the auto-ranging. It is used only if the minimum RF and IF attenuation is reached. Zero Scale Deflection
BANDWIDTH :IF :IF?	200 Hz 10 kHz 120 kHz 1 MHz	HZ KHZ MHZ GHZ	IF bandwidth of receiver
CALIBRATION :CORRECTION	ON OFF	---	Considering the calibration correction values during level measurement on/off
DEMODULATION DEMODULATION?	FM AM A0 OFF	---	AF demodulation modes: Frequency modulation Amplitude modulation Zero beat
DETECTOR DETECTOR?	AVERAGE PEAK QUASISPEAK	---	Weighting mode (Detector)

Command	Data	Unit	Meaning
FREQUENCY FREQUENCY?	9 kHz to 2750 MHz INCREMENT DECREMENT	HZ KHZ MHZ GHZ ---	Receiver frequency. Step up Step down
:STEPSIZE :STEPSIZE?	0 Hz to 2750	HZ KHZ MHZ GHZ	Step size of frequency variation
:VARIATION :VARIATION?	STEP COARSE FINE LOCK	---	Step size of frequency variation using rotary knob
:EXTREF? :EXTREF?	ON OFF	---	Switching on/off external reference
GENERATOR GENERATOR?	ON OFF	---	Switching on/off the internal tracking generator (option ESCS-B5).
LEVEL?	---	---	Level measurement is started and measured value provided
:CONTINUE?	---	---	The value of the last level measurement is provided in the output buffer and a new measurement is started.
:LASTVALUE?	---	---	The value of the last level measurement is provided in the output buffer.
:FORMAT :FORMAT?	ASCII BINARY	---	Output of measured value in ASCII format. Output of measured value in binary format.
MEASUREMENT:TIME MEASUREMENT:TIME?	1 ms to 100 s	S MS	Measuring time of level measurement, values smaller than 1 ms are possible for time domain.
:SINGLE :SINGLE?	ON OFF	---	If this function is switched off, the level is measured continuously. It doesn't have to be started explicitly.
PREAMPLIFIER PREAMPLIFIER?	ON OFF	---	Switching on/off the internal preamplifier.

Command	Data	Unit	Meaning
SPECIALFUNC SPECIALFUNC?	Number, ON/OFF (,Number, ON/OFF to) 1 3 12 13 17 18 20 21 30 32 33 50 51 52	---	Special functions: CISPR-bandwidths 10 dB minimum attenuation Coding socket Beeper Transducer check Transducer switch Unit dBm Absolute level indication with tracking generator Double measurement modes: Peak + AV Peak + Quasipeak Quasipeak + AV Internal trigger External trigger positive edge External trigger negative edge
UNIT?	---	---	Polling the level unit
MODE MODE?	RF IF	---	Selecting a type of analysis. The receiver switches to RF analysis (with time-domain analysis) or to IF analysis. The corresponding diagram is displayed.

Table 6-2 RF-analysis

Command	Data	Unit	Meaning
GRID :FREQAXIS GRID :FREQAXIS?	LIN LOG	---	Pitch of axes of the diagram of RF-analysis
: MINLEVEL : MINLEVEL ?	-200 to+200	dB	Minimum level of the diagram of RF-analysis
: MAXLEVEL : MAXLEVEL ?	-200 to+200	DB	Maximum level of the diagram of RF-analysis
SCAN SCAN ?	1 to 5	---	Selection of a partial scan
: RUN	[n] n: 0 to 65535	---	Starting a scan. The optional parameter defines the number of runs for repeating scan.
: INTERRUPT	---	---	Interrupting a scan
: CONTINUE	---	---	Continuing an interrupted scan
: STOP	---	---	Stopping a scan
: MODE : MODE	CHANNEL NORMAL OVERVIEW TDOMAIN		Selecting the scan mode.
: RANGES : RANGES ?	1 to 5	---	Number of scans to be executed
: FREQUENCY:START : START ?	Receiver frequency range,	HZ, KHZ, MHZ, GHZ	Start frequency of partial scan
: STOP : STOP ?	Receiver frequency range,	HZ, KHZ, MHZ, GHZ	Stop frequency of partial scan
: STEPMODE : STEPMODE ?	LIN LOG	---	Type of step size, the same for all partial scans
: STEPSIZE : STEPSIZE ?	0 to 1000 (2050, 2750) MHz 0 to 100 %	HZ, KHZ, MHZ, GHZ PCT	Step size, in Hz for linear steps, in % for logarithmic frequency switching
: SAVE	---	---	The scan settings for the start and stop frequency as well as the step size are adopted and checked whether they are consistent using this command. Error messages refer to the previous settings for the partial scan ranges.
: TIME	5 ms ... 10000 sec	S Ms	Scan time in time-domain analysis mode.

Command	Data	Unit	Meaning
SCAN:RECEIVER:MEASUREMENT:TIME :MEASUREMENT:TIME?	1 ns to 100s	S Ms	Measuring time per measured value of partial scan
:DETECTOR :DETECTOR?	AVERAGE PEAK QUASISPEAK	---	Weighting mode for partial scan
:BANDWIDTH:IF :BANDWIDTH:IF?	200 Hz to 1 20 kHz	Hz, KHZ, MHZ, GHZ	IF-bandwidth for partial scan
:ATTENUATION :ATTENUATION?	0 to 65dB	dB	RF-attenuation for partial scan
:ATTENUATION:AUTO :ATTENUATION:AUTO? :	ON OFF	---	Auto-range on/off
:ATTENUATION:MODE :ATTENUATION:MODE?	LOWNOISE LOWDISTORTION	---	IF-attenuation for partial scan
:PREAMPLIFIER :PREAMPLIFIER?	ON OFF	---	Switching on/off the internal preamplifier for partial scan.
SCAN:OPTION :SUBRANGES :SUBRANGES?	8 16 25 50 100 200 400		Special functions of RF-analysis Number of subranges
:FASTSCAN	ON OFF	---	Fast Scan with fixed RF attenuation synonymous to SCAN:MODE OVERVIEW
:MARGIN :MARGIN?	-200 to 200dB	DB	Margin from acceptance line to limit line
:GATEDSCAN :GATEDSCAN?	ON OFF		Option Gated Scan
:SPECIALSCAN :SPECIALSCAN?	ON OFF		Switching on/off the option Special Scan. synonymous to SCAN:MODE CHANNEL.
:STYLE :STYLE?	CURVE LINE		The measurement curves can be represented either in the form of a closed curve (CURVE) or vertical lines (LINE).
:MAXLEVEL :MAXLEVEL?	-200 to. 200 dB	DB	Maximum level of the RF analysis diagram.
:MINLEVEL :MINLEVEL?	-200 to 200 dB	DB	Minimum level of the RF analysis diagram
:MAXFREQ :MAXFREQ?	Receiver frequency range		Maximum frequency of the RF analysis diagram.
:MINFREQ :MINFREQ?	Receiver frequency range	Hz, KHZ, MHZ, GHZ	Minimum frequency of the RF analysis diagram.
:FREQUENCIES :FREQUENCIES?	Number, Frequency1, Frequency2, to,	Hz, KHZ, MHZ, GHZ	Frequency values for the option Special Scan; max. 400 values in increasing sequence
:REPETITIVE :REPETITIVE?	CLRWRITE MAXHOLD MAXCLR OFF	---	Repetitive Scan: repeat drawing the diagram record maximum value combine the two previous actions switch off

Command	Data	Unit	Meaning
SCAN:BLOCK?		---	Output of the scan results in the form of blocks (cf. section 6 „output of measurement via IEC bus“)
:COUNT :COUNT?	Number	---	Number of the measured values that are transmitted in a block (the max. number depends on the structure of the data). The value 0 means: measured value output during scan is switched off.
	MAX		The output buffer is used to its maximum. Max. number of block elements.
	SUBRANGE		All the measured values of a subrange are combined to form a block, if the size of the output buffer is sufficient.
:ELEMENT	COMBINED	---	All level values of subrange are combined to form a block, if the size of the size of the output buffer is sufficient.
	TRACE		Only the results of the 400 subrange maximal are transmitted.
	SUBMAX		Only the results of the user subranges defined with SCAN:OPTION:SUBRANGE are transferred.
	DET1	---	Level values detector 1
	DET2	---	Level values detector 2
	VALID	---	Validity bytes
:FORMAT :FORMAT?	ASCII BINARY DUMP SDUMP	---	Output format for scan results (cf. section. 6 „output of measurement via IEC bus“)
:SIZE?	---	---	Size of a block element when the measured values are output in the form of bytes (this size is variable for output in ASCII format)
:TEMPLATE?	---	---	Composition of the individual components of a block element (cf. section 6 „output of measurement via IEC bus“).
:RESULTS	---		Using this command, scan results can be output at a later date. This command sets the appropriate bits in the ERD register, however does not make available the data in the output buffer.
:CLEAR	---		Clearing the memory with measured values.
:CURVE			
:CALCULATE	---	---	Calculating and representing the difference between the reference trace and the last measured trace
:COPY	---	---	Copying the last measured trace to a reference memory. The reference trace is retained while new scans are performed and may be used for a simple comparison with new measurements. It is deleted as soon as scan data that modify the frequency assignment are changed (eg step widths). It is deleted as well if a scan with double detectors is started.
:DELETE	---	---	Deletes the reference trace.

Table 6-3 Limit lines

Command	Data	Unit	Meaning
LIMIT	1 to 22 [ON]	---	Selecting and switching on or off limit lines
LIMIT?	1 to 22 [OFF]	---	
:TEXT	"ASCII-text"	---	Name of limit line
:TEXT?	max. 8 characters	---	
:DEFINE	Number,	HZ	Definition of limit line by frequency-level pairs in increasing order
:DEFINE?	Frequency 1, Level 1,	KHZ	
	Frequency 2,	MHZ	
	Level 2,..	GHZ	
:VALUE?	n[,limit 1[,limit 2]] n: number of limit lines, 0 to 2 limit 1: 1 st limit limit 2: 2 nd limit	DB	Output of interpolated intermediate values at the current receiver frequency. The value 0 is returned if no limit lines have been switched on.

Table 6-4 Transducer

Command	Data	Unit	Meaning
TRANSDUCER	OFF	---	Switching off consideration of transducer factors
:FACTOR :FACTOR?	1 to 22	---	Selecting a transducer factor
:TEXT :TEXT?	"ASCII text" max. 8 characters	---	Name of transducer
:DEFINE :DEFINE?	Number, Frequency 1, Level 1, Frequency 2, Level 2, to	HZ, KHZ MHZ GHZ, DB	Definition of transducer factors by frequency-level pairs in increasing order
:VALUE?		---	Output of the interpolated intermediate value at the current receiver frequency
:SELECT :SELECT?	1 to 22, NONE	---	Activating a transducer factor
:UNIT :UNIT?	DB, DBUV, DBUV_M, DBUA, DBUA_M, DBPW,	---	Unit of transducer factor
:INTERPOLATION :INTERPOLATION?	LIN LOG		Linear or logarithmic Frequency axis with transducer interpolation
:SET	1 to 5	---	Selecting a transducer set
:SET:SELECT :SET:SELECT?	1 to 5, NONE	---	Activating a transducer set
:RANGES :RANGES?	1 to 5	---	Number of ranges of a transducer set
:SELECT :SELECT?	1 to 5	---	Selecting a transducer set range
:START :START?	1 to 5	HZ, KHZ, MHZ, GHZ	Start frequency of the selected transducer set range
:STOP :STOP?	Receiver frequency range,	HZ, KHZ, MHZ, GHZ	Stop frequency of the selected transducer set range
:DEFINE :DEFINE?	Receiver frequency range,	HZ, KHZ, MHZ, GHZ	Selecting the transducer factors that are combined in a transducer set range.
:SAVE	Number, Factor1, Factor2, to	---	
:UNIT :UNIT?	---	---	The programmed frequency ranges are tested for consistency and then accepted.
:TEXT :TEXT?	DB, DBUV, DBUV_M, DBUA, DBUA_M, DBPW, "ASCII-text" max. 8 characters	---	Unit of the transducer set Designation of the transducer set

Table 6-5 IF analysis

Command	Data	Unit	Meaning
SWEEP:MODE SWEEP:MODE?	n,mode n: 1 or 2 mode: VIEW BLANK CLRWRITE AVERAGE MAXHOLD MINHOLD	---	Display modes of curves in IF analysis: n selects 1 or 2 The curve is displayed. The curve is blanked. New curve display with each sweep. Subsequent sweeps are averaged. The maximum values of subsequent sweeps are displayed. The minimum values of subsequent sweeps are displayed.
:TIME :TIME?	20 ms...10 s	MS, S	Sweep time in IF analysis
:RUN :STOP	0...65536 ---	--- ---	A number of sweeps is started. If the number is 0, the sweeps are only terminated by switching off IF analysis. Stop IF analysis.
:BLOCK?		---	Readout of the results of the IF analysis (only in binary format) Cf. section 3.3.8
SPAN SPAN?	10 kHz...10 MHz	HZ KHZ MHZ GHZ	Display span
ATTENUATION:IF ATTENUATION:IF?	ON OFF	---	Switch on and off 20-dB input attenuation for IF analysis
BANDWIDTH:RESOLUTION BANDWIDTH:RESOLUTION?	1 kHz...10 kHz	HZ KHZ MHZ GHZ	Resolution bandwidth

Table 6-6 Marker functions

Commands for marker control. They can be used in the RF and IF analysis.

Command	Data	Unit	Meaning
MARKER MARKER?	ON OFF	---	Switching on/off marker function
:DELTA :DELTA?	ON OFF	---	Switching on/off delta marker
:POSITION?	n, frequency, level [,frequency, level]		Polling the current marker position. n indicates the number of markers activated. If the delta marker is switched on, its frequency and level are transmitted after the main marker.
:FREQUENCY	Marker frequency or frequency difference at delta marker	HZ KHZ MHZ GHZ	Setting the marker to a frequency. If switched on, the delta marker is set.
:PEAK	---	---	The main marker is set to the highest level value of the measurement curve.
:NEXTLEFT	---	---	The main marker is set to the next peak on the left.
:NEXTRIGHT	---	---	The main marker is set to the next peak on the right.
:EXCURSION :EXCURSION?	0 ... 200 dB	DB	Criterion for determining the next maximum.
:RECEIVER	---	---	The receiver is set to the frequency at which the main marker is positioned.
:CENTER	---	---	This function is identical to command MARKER:RECEIVER . This designation is oriented according to IF analysis
:ZOOM	---	---	The spectrum is shown in zoomed display: If only the main marker is switched on, 10% of the spectrum is displayed; if the delta marker is switched on, the range between the markers is zoomed and displayed (only in RF analysis).
:ORIGINAL	---	---	The complete spectrum is displayed. (only in RF analysis)
:CURVE	1...2	---	If several curves are displayed ,on which the marker can be moved, this command is used to select the curve.

Table 6-7 Test Report

Command	Data	Unit	Meaning
PLOTTER :START	---	---	Starting plotter output (cf. section 3 „selecting the measuring time“, for program examples see section 7).
:SETUP:ADDRESS :SETUP:ADDRESS?	0 to 30	---	The set IEC-bus address of the plotter is used by the receiver for the output of test reports. It must differ from the IEC-bus address of the receiver.
:SETUP:FORMAT :SETUP:FORMAT?	ON OFF	---	Special scaling of plotter output on/off
:LEFT :LEFT?	-99.999 to 99.999 Plotter Units	---	Definition of the limits P1 and P2:
:RIGHT :RIGHT?	-99.999 to 99.999 Plotter Units	---	Right margin
:TOP :TOP?	-99.999 to 99.999 Plotter Units	---	Top margin
:BOTTOM :BOTTOM?	-99.999 to 99.999 Plotter Units	---	Bottom margin
:SETUP:PEN :SETUP:PEN?	ON OFF	---	Selection of pen for plotter output on/off
:GRID :GRID?	0 to 8	---	Diagram
:LIMIT :LIMIT?	0 to 8	---	Limit line
:MARKER :MARKER?	0..8	---	Marker
:CURVE1 :CURVE1?	0 to 8	---	Measurement curve 1
:CURVE2 :CURVE2?	0 to 8	---	Measurement curve 2
:TEXT :TEXT?	0 to 8	---	Labeling
:SINGLEVALUES :SINGLEVALUES?	0 to 8	---	List of measured values
:DATE :DATE?	0 to 8	---	Data
:CONTENT:DEFAULT :CONTENT:DEFAULT?	ON OFF	---	Elements of a test report: Default setting
:CURVE :CURVE?	ON OFF	---	Measurement curve(s)
:HEADER :HEADER?	ON OFF	---	Header of protocol
:DIAGRAM :DIAGRAM?	ON OFF	---	Diagram
:LIST :LIST?	ON OFF	---	List of measured values
:SCANTABLE :SCANTABLE?	ON OFF	---	Table with scan data
:DATE :DATE?	ON OFF	---	Data
:PAGE :PAGE?	ON OFF	---	Paging

Command	Data	Unit	Meaning
PRINTER PRINTER?	EPSON24 LASERJET DESKJET CDESKJET	---	Selecting of printers, ,EPSON 24-needle Laser Jet II Desk Jet Colorand Desk Jet Color
PRINTER :START :STOP	--- ---	--- ---	Starting printer output Stopping printer output
:CONTENT:DEFAULT :CONTENT:DEFAULT :HEADER :HEADER? :DIAGRAM :DIAGRAM? :LIST :LIST? :PAGE :PAGE? :SCANTABLE :SCANTABLE?	ON OFF ON OFF ON OFF ON OFF ON OFF	--- --- --- --- --- ---	Elements of a test report: Default setting Header of protocol Diagram List of measured values Paging Table with scan data
REPORT:HEADER:COMPANY :COMPANY :PROGAM :PROGAM? :EUT :EUT? :MANUFACTURER :MANUFACTURER? :CONDITION :CONDITION? :OPERATOR :OPERATOR? :SPEC :SPEC? :REMARK1 :REMARK1? :REMARK2 :REMARK2?	"ASCII text" (max. 40 characters) --- "ASCII text" (max. 40 characters) --- "ASCII text" (max. 40 characters) --- "ASCII text" (max. 40 characters) --- "ASCII text" (max. 40 characters) --- "ASCII text" (max. 40 characters) --- "ASCII text" (max. 40 characters) --- "ASCII text" (max. 60 characters) --- "ASCII text" (max. 60 characters)	--- --- --- --- --- --- --- ---	Texts for the protocol header: Test company Measurement program Equipment under test Manufacturer Operating conditions Operator Test specifications Remark/comment Remark/comment

Table 6-8 Disk drive

Command	Data	Unit	Meaning
FLOPPY :INITIALIZE	size, "label" size: DD 720 KB HD 1.44 MB	---	Formatting a floppy disk in the specified size. "label" is the name of the floppy disk. It can consist of max. 11 characters.
:DELETE	"filename.extension"	---	Deleting a file
:CATALOG?	used_space, available_space [file1,size1[,file2, size2 [,filen,sizen]]]	---	List of all files: used_space = memory space used on the floppy disk; available_space = free memory space; filen = file name sizen = file size
:STORE	"filename", type [,n] type: ALL HPGL LIMIT TFACTOR TSET	---	Storing instrument data in a file. "filename" is automatically provided with the correct extension. Data: Receiver settings Report configuration Activated limit lines Activated transducer factor Activated transducer set Measurement results of RF analysis Scan data sets Marker settings Graphics in HPGL format Limit line selected by n Transducer factor selected by n Transducer set selected by n
:LOAD	"filename", type [,n] type: ALL LIMIT TFACTOR TSET	---	Reading and setting instrument data from a file. Complete test receiver setting, which may include results of RF analysis Loading a limit line and storing it internally under number n Loading a transducer factor and storing it internally under number n. Loading a transducer set and storing it internally under number n. Note that with limit lines and transducer factors the number of sampling points is graduated (10, 20 or 50)! If the data set to be loaded has more components than can be stored, an error message is produced.

Table 6-9 Common Commands

Command	Data	Unit	Meaning
DISPLAY	ON OFF	---	Switching on/off LCD display on front panel
ERA?	---	---	Event Status register A for specifying the instrument states
ERAE ERAE?	0 to 65535	---	Event status Enable register A
ERB?	---	---	Event Status register B for indicating synthesizer.
ERBE ERBE?	0 to 65535	---	Event Status Enable register B
ERC?	---	---	Event Status register for specifying the validity of measured value (section „output of measurement via IEC bus“)
ERCE ERCE?	0 to 65535	---	Event Status Enable register C
ERD?	---	---	Event Status register D for specifying the scan states
ERDE ERDE?	0 to 65535	---	Event Status Enable register D
HEADER	ON OFF	---	Switching on and off output of header during poll
LISN :LISN? :PHASE :PE	ESH2Z5 ESH3Z5 N L1 L2 L3 GROUNDED FLOATING		Selecting the LISN to be controlled Setting the phase; with ESHS3-Z5, N and L1 are permissible only Setting the PE
PRESET	---	---	Resetting of device settings without resetting IEC-bus interface. It corresponds to the function RCL0.
SERVICE:SELFTEST:CALGEN	ON OFF		Switching on/off the calibration generator
SYSTEM:ERRORS? :DATE :DATE? :TIME :TIME?	dd,mm,yy hh,mm,ss		Polling device-dependent errors (cf. Table 6-10) Date of real-time clock Time of real-time clock
TERMINATOR	LFEOI EOI	---	Listener terminator: Linefeed (10 decimal) with EOI only EOI for binary data
USERPORT	1 to 6, ON 1 to 6, OFF	---	Setting the user port

Table 6-10 Commands for reading out device configurations

Command	Data	Unit	Meaning
SYSTEM:SETUP?	Block data	---	The complete receiver configurations (without transducer and limit lines) can be read out in the form of arbitrary length block data. The data can be reprogrammed in the same form. Block size approx. 12.5 Kbytes
:BANDWIDTH?	---	---	Polling the bandwidths of the IF filters integrated in the device. Output in ASCII format; the values are separated by commas.
:LIMIT :LIMIT?	Block data	---	All limit lines can be read out in the form of arbitrary length block data. The data can be reprogrammed in the same form. Block size approx. 6 Kbytes
:RECEIVER :RECEIVER?	Block data	---	Complete receiver settings, such as SYSTEM:SETUP?, however without SAVE or RECALL data can be read out in the form of arbitrary length block data. The data can be reprogrammed in the same form.
:TRANSDUCER :TRANSDUCER?	Block data	---	The complete transducer factors and transducer sets can be read out in the form of arbitrary length block data. The data can be reprogrammed in the same form. Block size approx. 11 Kbytes.
:LABEL :LABEL?	n,"label",n,"label", to n: register "label": name of register	---	The names of the SAVE/RECALL registers can be programmed and queried. After the query, the complete list from 1 to 9 is provided. Any combination can be programmed.

Service Request and Status Registers

In line with the new IEC-bus standard, the receiver provides the following registers:

- Event Status (ESR),
- Event Status Enable (ESE),
- Status byte (STB),
- Service Request Enable (SRE) and
- Parallel Poll Enable (PRE).

The individual registers have the following meanings:

a) Event Status (ESR):

The Event Status Register is an extended version of the status byte used in earlier IEC-bus-programmable measuring instruments. In this register the ESCS marks special events that can be polled by the controller. The respective bit associated with the event or status is set to 1. This bit remains set until it is cleared by reading the Event Status Register (command *ESR?) or by one of the following conditions:

- the commands *RST or *CLS
- switching on the power supply voltage (the power-on bit is however set afterwards).

Table 6-11 Meaning of the individual bits in the event status register

Bit-No.	Meaning
7	Power On Is set when the device is switched on or the power returns following a power failure.
6	User Request This bit is set in the ESR by pressing the LOCAL key. If the mask register is set appropriately, the ESCS and the ESCS can request service.
5	Command Error Is set if one of the following errors is detected during analysis of the received commands: <ul style="list-style-type: none"> • Syntax error • Illegal unit • Illegal header • A numerical value has been combined with a header that requires no subsequent numerical value.
4	Execution Error Is set if one of the following errors is detected during execution of the received commands: <ul style="list-style-type: none"> • A numerical value is out of the permissible range (for the respective parameter) • A received command is incompatible with a currently active device setting.
3	Device-dependent Error Is set if function errors occur.
2	Query Error Is set if: <ul style="list-style-type: none"> • the controller attempts to read data from the receiver when no query command has been issued before. • the data provided in the output buffer of the ESCS have not been read and a new command is sent to the ESCS or ESCS instead. The output buffer is cleared in this case.
1	Request Control Is set if the receiver requires IEC-bus control for control purposes (e.g. plotter).
0	Operation Complete Is set in response to the commands *OPC and *OPC? when all preceding commands have been processed and executed.

b) Event Status Enable (ESE):

This register is set by the controller and forms the mask for the Event Status Register. The user can select which bits in the Event Status Register also effect the setting of the sum bit ESR (bit 5 in the status byte), thus triggering a service request. The sum bit is only set if at least one bit in the ESR and the appropriate bit in the ESE are set to 1. The sum bit is automatically cleared when the condition stated above no longer prevails, e.g. when the bits in the ESR have been cleared by reading out the ESR or when the ESE register has been changed. The ESE register is set to zero when switching on the power supply if the power-on status clear flag is 1 (*PSC 1). The command "*ESE value" is used to set the Event Status Enable mask register, with "value" being the contents of the register in decimal form. The current value of the register can be read out again using *ESE?.

c) Status byte (STB):

The status byte can be read as follows:

- By way of the command *STB?
The contents is output in decimal form. The status byte is not changed by the readout and the service request is not cleared.
- By way of a serial poll
The contents is transmitted in binary form. As a result, the RQS bit is set to zero and the service request inactive, the remaining bits of the status byte are not changed.
- The status byte is cleared:
- By way of the command *CLS, provided that the output buffer is empty.
This command clears all event status registers (ESR, ERA, ERB, ERC, ERD), thus setting the sum bits in the status byte to zero. This in turn causes the RQS bit and the service request message to be cleared.
- By setting the Event Status Enable register to zero and reading the contents of the output buffer.

Table 6-12 Meaning of the individual bits in the status byte

Bit	Bus line	Designation	Meaning
0	DIO 1	ERD	Sum bit of event status register D for marking the scan states.
1	DIO 2	ERC	Sum bit of event status register C for marking the validity of a measured value.
2	DIO 3	ERB	Sum bit of event status register B for marking synthesizer loop errors.
3	DIO 4	ERA	Sum bit of event status register A for marking instrument states.
4	DIO 5	MAV	Message available, i.e. output buffer is not empty, an available message, e.g. a measured value, can be read.
5	DIO 6	ESR	Sum bit of event status register
6	DIO 7	RQS	Request service

d) Service Request Enable (SRE)

This mask register for the status byte can be set by the controller. The conditions that trigger a service request can thus be selected. The command SRE 32, for example, sets the mask register such that a service request is only generated when the ESR bit is set. When switching on the power supply, the SRE register is reset (=0) provided that the Power On Clear flag has the value "1". The SRE register is not changed by DCL and SDC.

The bit positions 0 to 3 and 7 can be freely assigned for further events according to the standard. The bits 0 to 3 (ERA, ERB, ERC and ERD) are used to identify certain events and states in the case of the ESCS.

e) Parallel-Poll-Enable-Register

The Parallel Poll Enable register has a capacity of 16 bits. Each bit in this register has a corresponding bit in the status byte or in a device-specific register. If the bit-by-bit operation of the Parallel Poll Enable register with the two other ones does not result in 0, the IST bit (Individual Status) is set to 1. The IST bit is sent as a reply to a Parallel Poll of the process controller, allowing the reason for the service request to be identified. (The IST bit can also be read using "*IST?"). Fig. 6-1 illustrates the Parallel Poll Enable register.

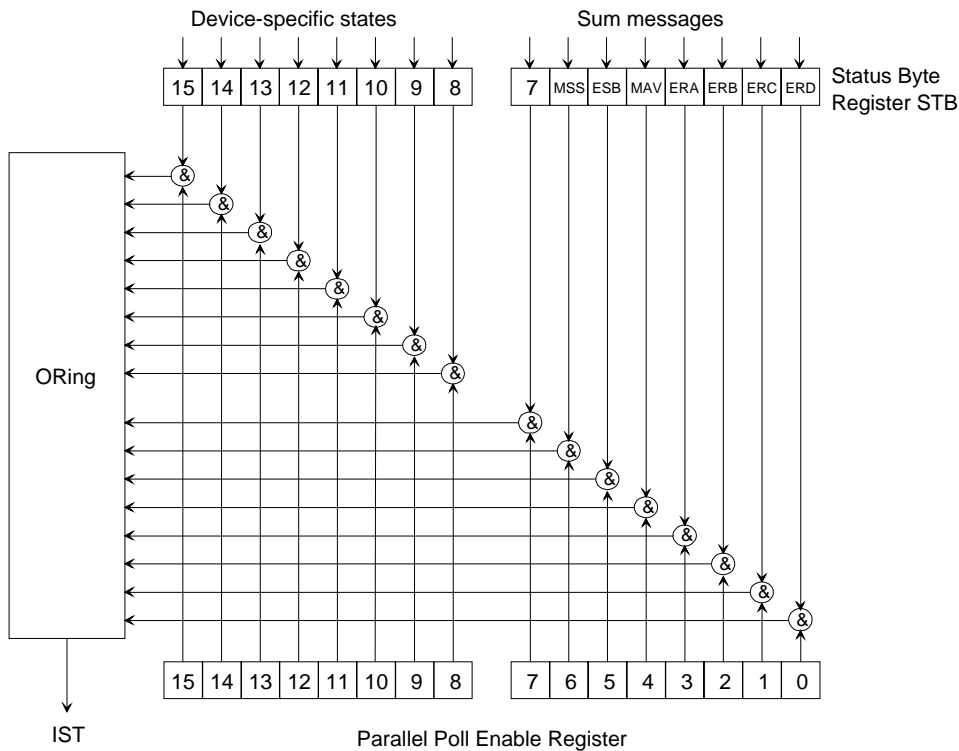


Fig 6-1 Parallel Poll Enable Register PRE

f) Assignment of and relationship between the individual registers

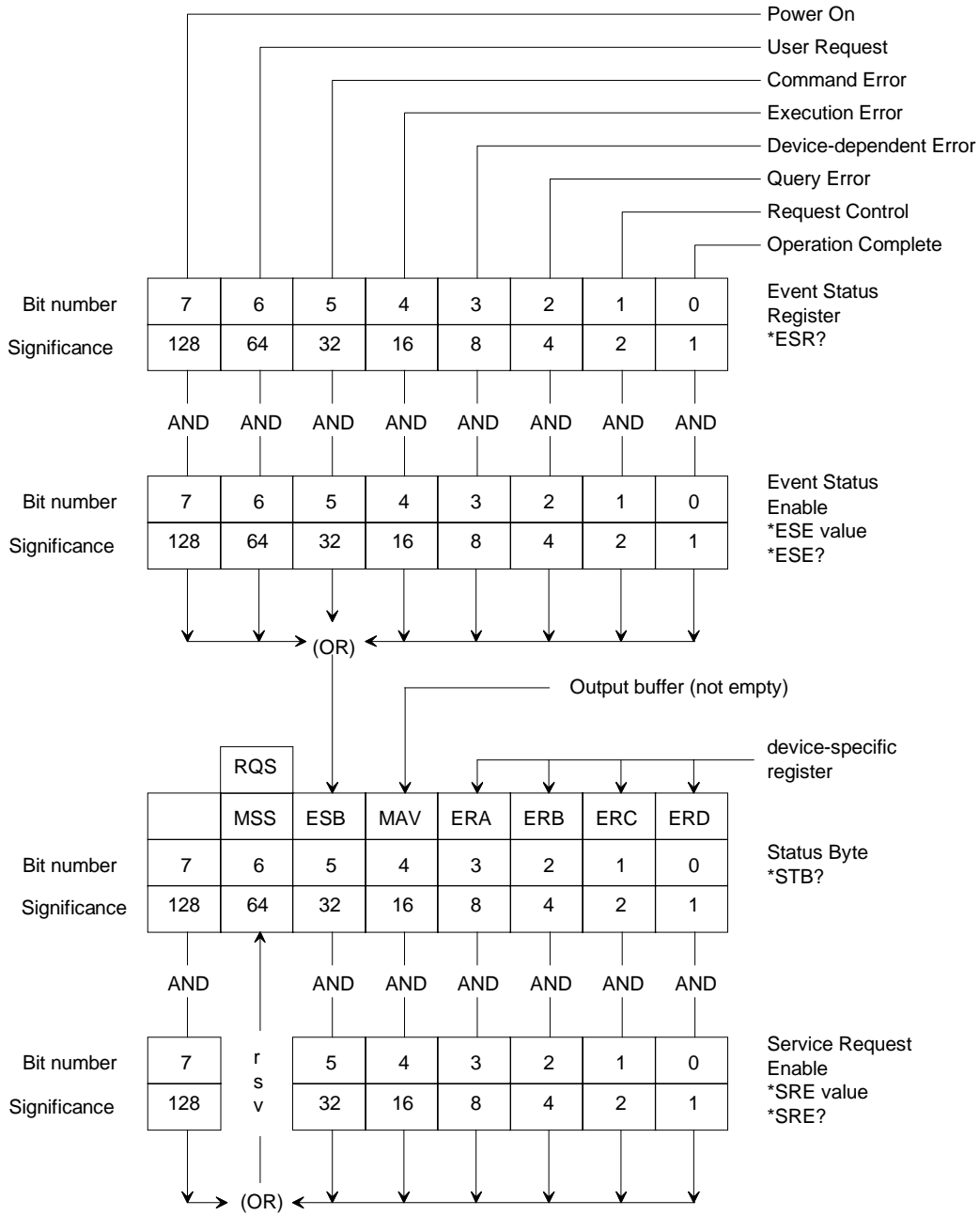


Fig. 6-2 Status registers

g) Event-Status Register A:

The assignment of the extended event register ERA for identification of the instrument states is illustrated by the following diagram:

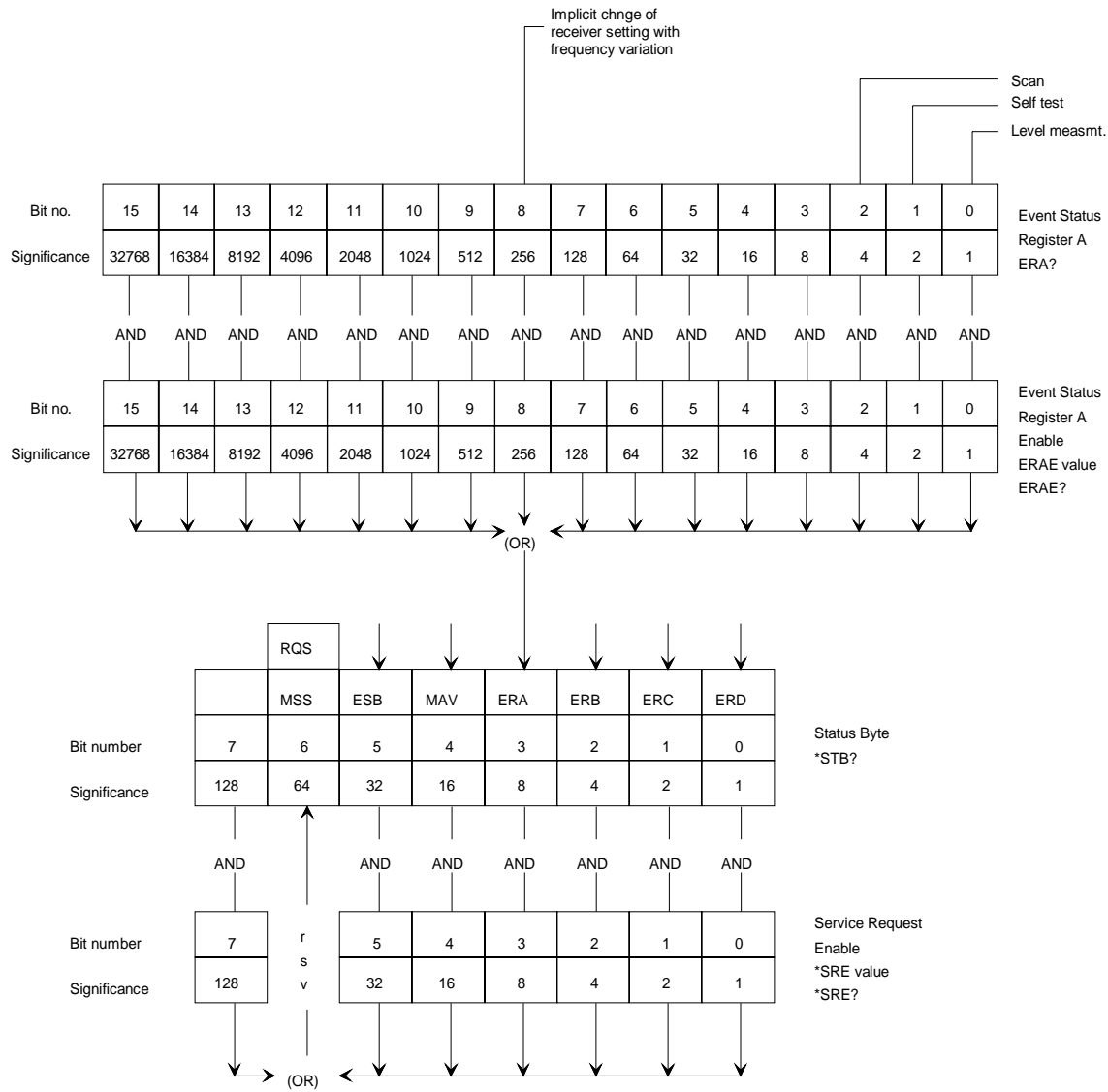


Fig. 6-3 Status register ERA

Bit 8 is set if another receiver setting has been automatically changed by frequency variation. The other bits indicate that certain functions are active. They are reset after completion of these functions.

h) Event-Status Register B:

The assignment of the extended Event Register ERB for indication of the synthesizer loop errors and switching on/off of the external reference are illustrated by the following diagram:

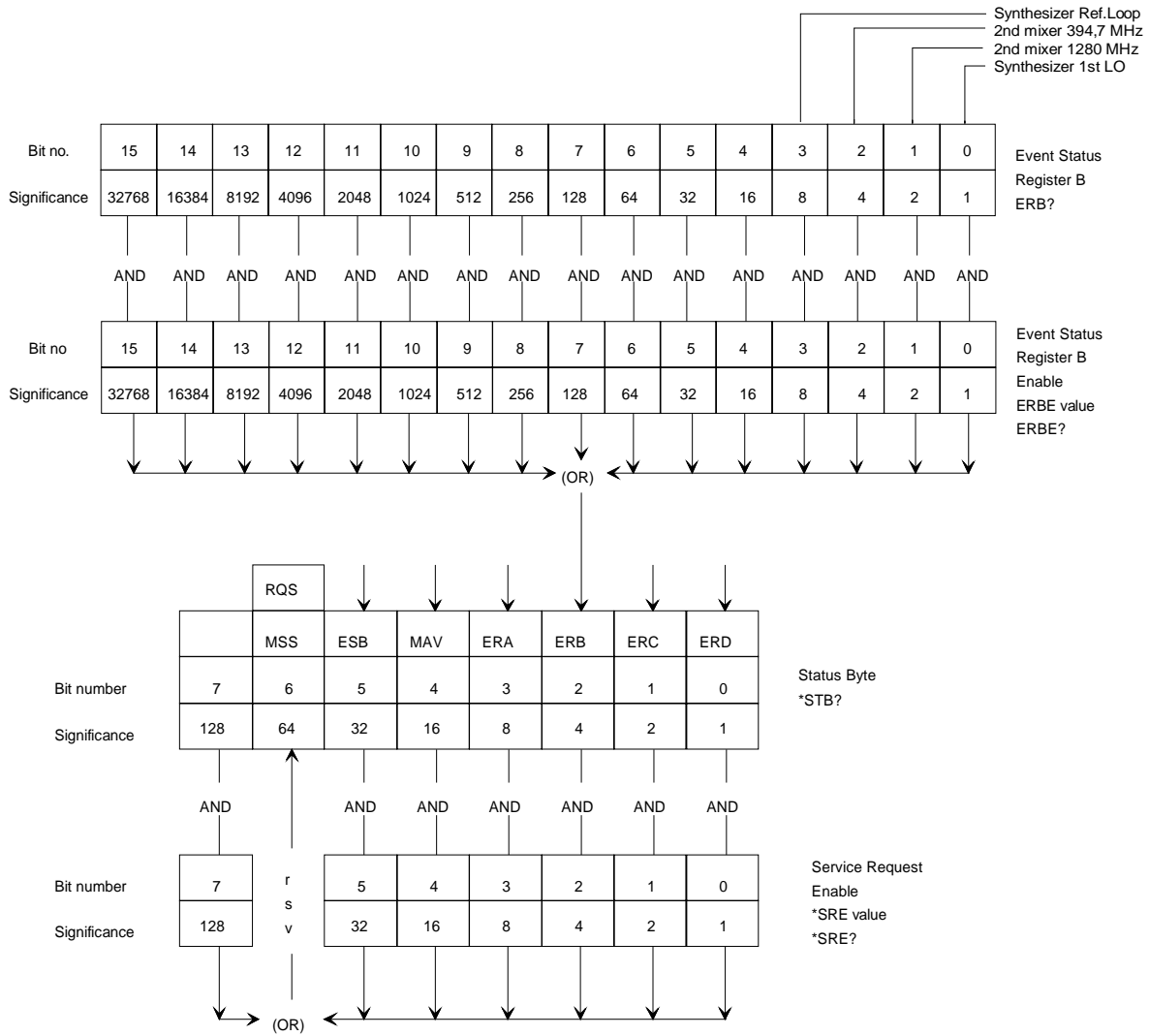


Fig. 6-4 Status register ERB

i) Event-Status Register C:

The assignment of the extended Event Register ERC for indicating the validity of measured values is illustrated by the following diagram:

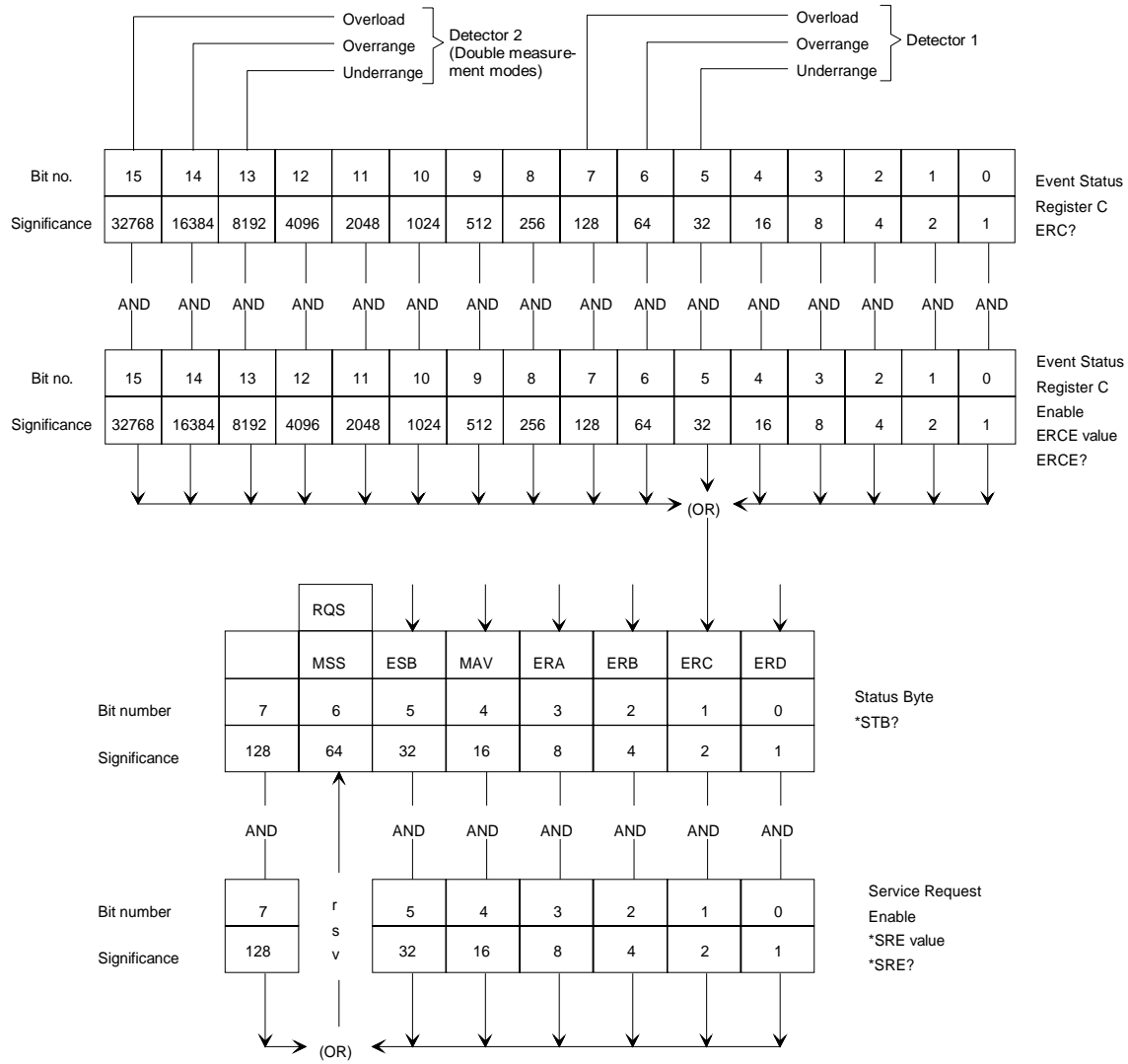


Fig. 6-5 Status register ERC

j) Event-Status Register D:

The assignment of the extended Event Register ERD and marking of the scan states is illustrated by the following diagram:

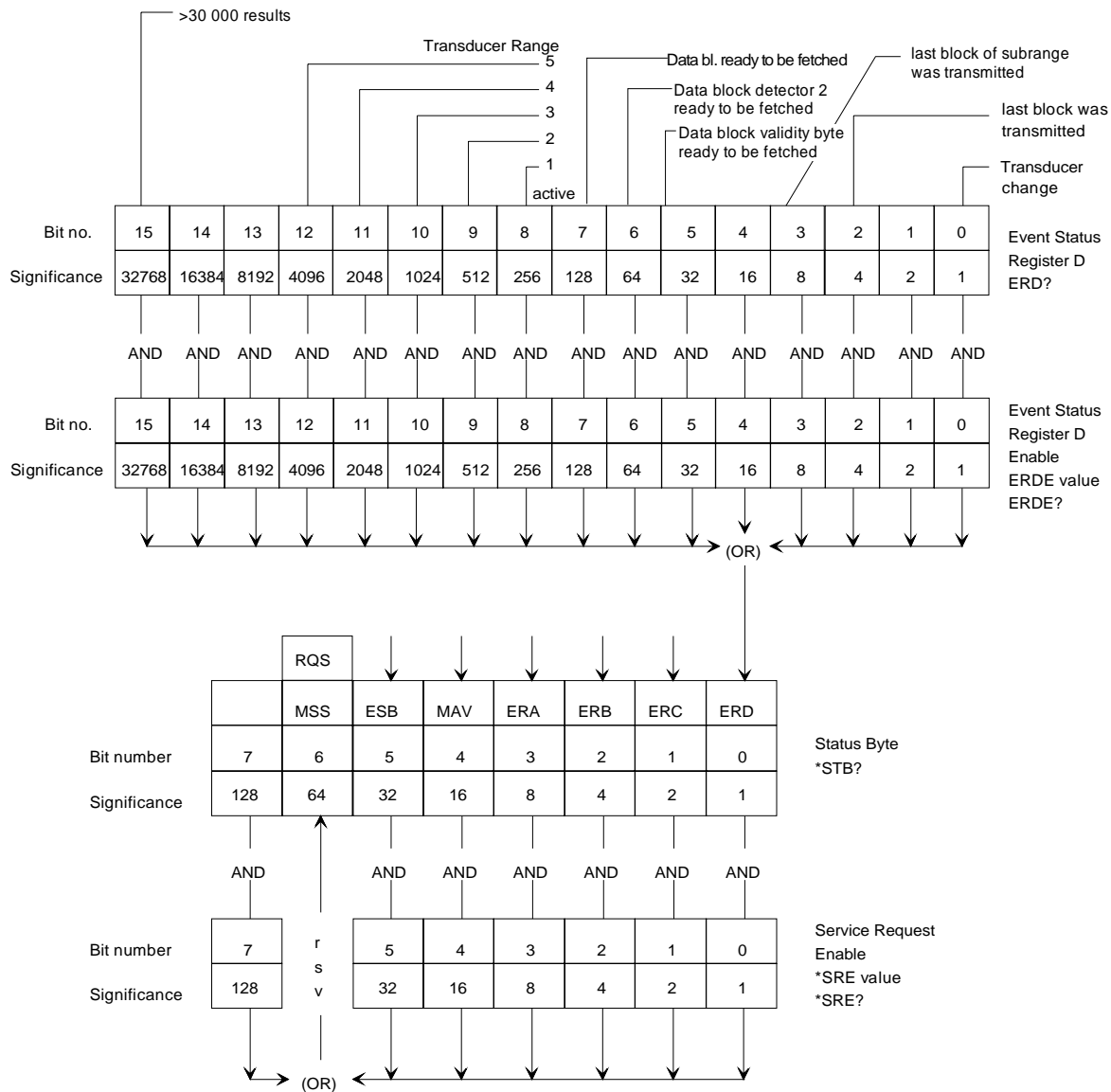


Fig. 6-6 Status register ERD

If an antenna switch-over point is reached during a scan, the "transducer change" bit is set in the event status register D.

The index of the active transducer set is marked by setting the associated bit in the register.

If the set number of measured values (SCAN:BLOCK:COUNT) is ready for output during or after a scan, the bit "data block ready to be fetched" is set in the event status register D.

With unformatted output selected ("SCAN:BLOCK:FORMAT DUMP or SDUMP), bit 7 indicates that level measurement results are available whereas bit 5 indicates that validity bytes are ready to be fetched.

Resetting of Device Functions

The following table shows various commands and results that cause individual device functions to be reset:

Table 6-13 Resetting various device functions

Event	Switching on the operating voltage		DCL, SDC (Device Clear, Selected Device Clear)	Commands		
	Power On Clear Flag			*RST	*CLS	RCL 0
	0	1				
Device default setting	--	--	--	yes	--	yes
Set ESR to zero	yes	yes	--	--	yes	--
Set ESE and SRE to zero	--	yes	--	--	--	--
Clear output buffer	yes	yes	yes	--	--	--
Clear service request	yes	1)	2)	--	3)	--
Reset command processing and input buffer	yes	yes	yes	--	--	--

1) Yes, but "Service Request on Power On" is possible.

2) Yes, if only conditioned by a message in the output buffer.

3) Yes, if not conditioned by a message in the output buffer.

Command Processing Sequence and Synchronization

The commands received by the ESCS are first stored in an input buffer which can accommodate up to 4096 characters. Once the terminator has been received, the commands are processed in the sequence in which they were sent. During this time, the IEC/IEEE-bus can be used for communication with other devices. Command lines which exceed the capacity of the input buffer are processed in several sections. The bus is occupied during this time.

The commands *OPC and *OPC? (operation complete) are used as a feedback to inform on the time at which processing of the received commands was terminated and a scan (if any) has been completely executed.

*OPC sets bit 0 in the Event Status register, and a Service Request can then be enabled if all previous commands have been executed.

*OPC? additionally provides a message in the output buffer and sets bit 4 (MAV) in the status byte.

This synchronization can be established within a command line by the command *WAI, i.e. all subsequent commands are only executed when the previous commands have been completely executed.

Output of Measurement Results via IEC-Bus

Single Measurements

The result of a single measurement is provided following a request by one of the device-specific commands LEVEL?, LEVEL:LASTVALUE? or LEVEL:CONTINUE?. The latter is especially suited for time-critical applications since the value of the last measurement can be read in immediately using an IEC bus command and the controller can subsequently process this measured value while the test receiver is already performing a new level measurement. The availability of the measurement result in the output buffer is indicated by setting the MAV bit (message available) in the Event Status register. If the associated mask register has been configured appropriately, a Service Request is thus enabled. (Program example cf. section 7).

The data can be output in binary or ASCII format. Selection is effected by the commands LEVEL:FORMAT BINARY or LEVEL:FORMAT ASCII. Binary output is made with 2 byte where the measured value was multiplied by 100 to obtain an integer. Resolution is 0.01 dB and the output in ASCII format is performed correspondingly e.g. with the header LEVEL 12.56.

With a double measurement mode set the measured value of the second detector is also output. In ASCII format the value is separated from the first value by a decimal point, e.g. LEVEL 12.56,7.98. In binary format two more bytes are added without using any separators. For triple detectors, the third value is treated analogously.

The associated header can be switched on and off using the commands HEADER ON and HEADER OFF.

The validity of a measured value is indicated via the Extended Status register ERC. The individual bits indicate exceeding of the display range or overload of the test receiver. The low-order byte (bits 0-7) is used for detector 1, the high-order byte (bits 8-15) for detector 2 in the case of double measurement modes. If only one detector is switched on, the low-order byte is used.

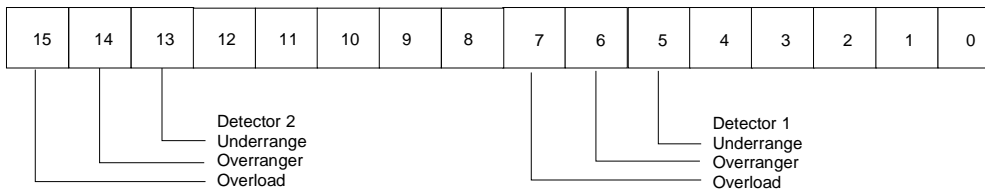


Fig. 6-7 Assignment of the Event Register ERC

The validity of a measured value is indicated using the extended status register ERC. The individual bits indicate violation of the display range or overload of the test receiver. Bit 0 is set if the sum of the individual correction values exceeds the permissible range.

By setting the respective bit in the associated enable register ERCE and bit 3 in the service request enable register SRE, the conditions overload, violation of display range as well as invalid measured value can be used for generating a service request.

Scan

For output of the scan results various formats are available. If complete information on each test point is desired, it is possible to output with each frequency the appertaining level, a status word, the appertaining transducer factor if switched on. This type of output can be selected using the command "SCAN:BLOCK:ELEMENT COMBINED".

If "SCAN:BLOCK:ELEMENT TRACE" has been selected, on the other hand, only information on the highest level values of the 400 scan subranges are output. They correspond to the values contained in a test report output on a printer or plotter. They are suited for graphical representation of the measurement results without loading the evaluation program and the test receiver with the transmission and evaluation of unnecessary data.

The block elements described above can be further distinguished by output in binary format and in ASCII format. The commands "SCAN:BLOCK:FORMAT BINARY" and "SCAN:BLOCK:FORMAT ASCII" are used to select the format. Note that in ASCII format the length of a block element may reach more than twice the size of an element in binary format and that internal data processing takes longer than with binary format.

Another form is the unformatted output described below. Two more types of block elements are available for this kind of output.

Table 6-14 Overview of the assignment of the possible block elements to the formats:

	ASCII	BINARY	DUMP	SDUMP
COMBINED	√	√		
TRACE	√	√		
SUBMAX	√	√		
DET1			√	√
DET2			√	√
VALID			√	√

To ensure that data transmission is as fast as possible and the scan is not slowed down by unnecessary IEC bus traffic, the scan measurement results are output in the form of blocks. The block size can be selected by the user using the command "SCAN:BLOCK:COUNT value" where "value" is the number of individual measurements that can be transmitted together. The output of measurement values is suppressed during a scan using SCAN:BLOCK:COUNT 0. The number of blocks is calculated automatically depending on the output buffer size after having programmed SCAN:BLOCK:COUNT MAX.

SCAN:BLOCK:COUNT SUBRANGE is used to set the number of values to be transmitted such that the "measured value ready" bits (see below) are set only when a complete subrange is ready. In case the number of data appertaining to a subrange exceed the size of the output buffer transmission must be performed in sections. Bit 3 in the extended Event Register ERD is set to indicate complete transmission of a subrange.

Formats ASCII and BINARY

Please note that block size and format must be defined prior to the start of RF analysis.

During a scan the measurement values are stored internally until the selected block size is reached or the output buffer is filled. In this case bit 7 in the Event register ERD is set. This in turn triggers a Service Request of the receiver, if bit 7 in the Event Enable register ERDE is set. The stored results can then be requested using the command SCAN:BLOCK?. The measurement values collected are transmitted at one go.

The space a single measurement requires in the output buffer depends on the measurement mode and the use of transducer factors and limit lines. The elements of the data blocks can be polled using SCAN:BLOCK:TEMPLATE?. A word the respective bits of which represent the components of a block element is returned. If a bit has the value 1, the respective element is contained in the data block.

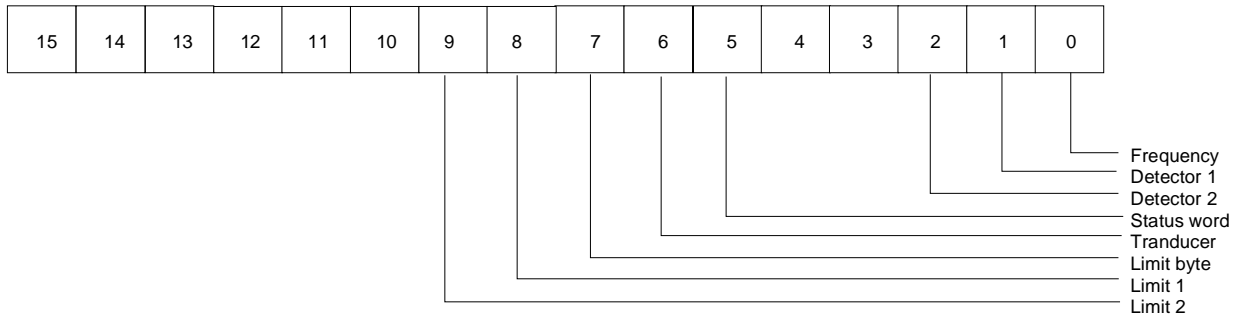


Fig. 6-8 Format of template word

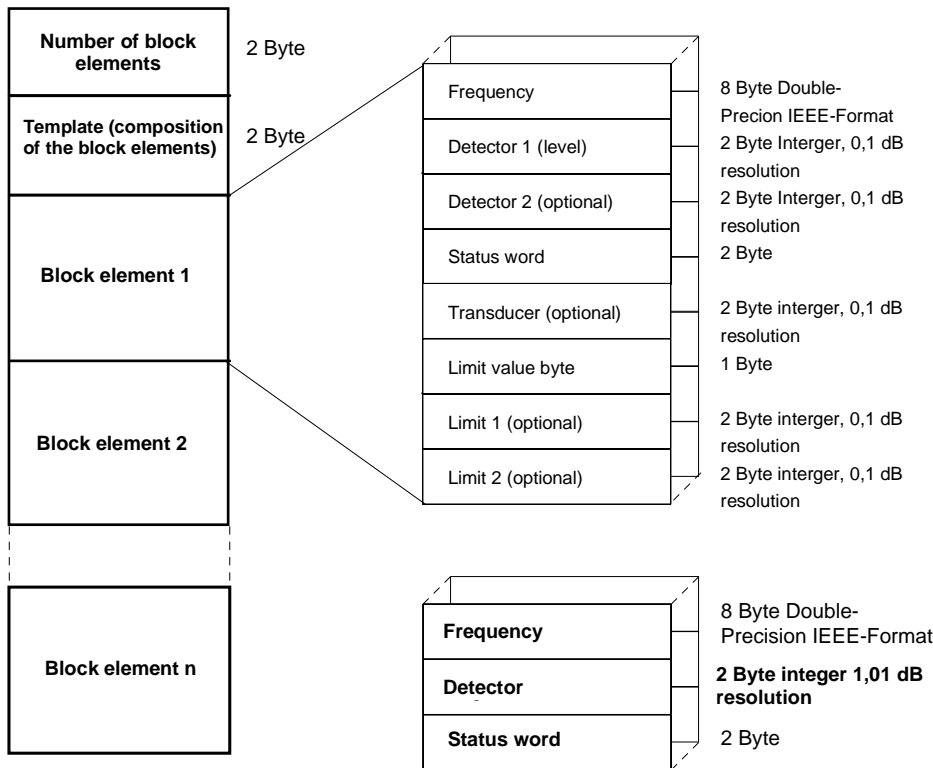


Fig. 6-9 Composition of a Data block in binary format

Fig. 6-10 Examples of block elements in binary format

Since the data can be transferred directly from the measured value memory, only one of the three types of results can be output. The command "SCAN:BLOCK:ELEMENT DET1" is used to select detector 1, "SCAN:BLOCK:ELEMENT DET2" detector 2 and "SCAN: BLOCK:ELEMENT VALID" the validity byte, respectively. It is possible to make a selection while a scan is running.

The number of measured values transferred in one block can also be defined using the command "SCAN:BLOCK:COUNT n". With the number set to the value 0, output is not performed during analysis. Please note in this case that the maximum size a block can reach is not limited by the size of the output buffer, which is 4096 bytes. The limit is however 60,000 bytes as each of the measured value memories has a capacity of 30,000 values each represented by 2 bytes.

Since the output is not performed via the output buffer the command "SCAN:BLOCK?" must not be combined with other polling commands with unformatted output being selected.

As a rule, no header is output.

Users of R&S-BASIC must observe that a string can achieve a maximum length of 32 KBytes. For this reason a maximum of approx. 16,000 values each represented by two bytes can be transferred at one time.

With a corresponding amount of measured values being ready to be fetched a message is given by bits set in the extended Event Register ERD.

Results from detector 1 are indicated by bit 7, results from detector 2 by bit 6 and the validity byte by setting bit 5, respectively. This assignment allows to use a universal program routine during the evaluation of the ERD register contents.

The mechanism of data transfer is not affected by how far RF analysis has proceeded. Even with the scan already terminated the availability of measured values not yet fetched is indicated by repeated setting of the appropriate bits in the ERD register.

Scans providing more results than the measured value memory with a storage capacity of 30,000 values can accept are exceptions. With its capacity exhausted, the measured values are stored in a temporary buffer. If the latter is also fully used, or the configured number of measured values per block is reached, RF analysis can only be continued after all results, i. e. from detector 1, or, as the case may be, from detector 2 and the validity byte have been read out.

With format DUMP, bit 2 is set in the ERD register (last block has been transmitted) either after all measured values from detector 1 or from detector 2 or all validity bytes have been transferred.

With format SDUMP (Synchronized DUMP), bit 2 is set only after all measured values and all validity bytes have been read out.

The status word which is assigned in the same way as in the Event register ERC is saved internally in a byte. With unformatted output, the internal format is output, which is different from the status word in the block formats ASCII and BINARY.

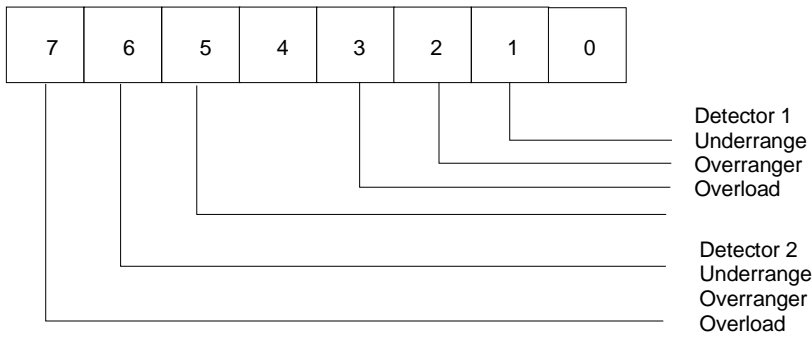


Fig. 6-12 Format of the validity byte with unformatted output of scan results.

The scan results can be queried as often as desired even after termination of scans carried out in LOCAL or REMOTE mode. There are two ways to query the results:

1. Execution of command SCAN:BLOCK?. The presence of measured values causes a data block to be made available and the bits in the ERD register to be set.
2. Execution of command SCAN:RESULTS. Only the bits in the ERD register are set, which has the advantage that afterwards the same mechanism as in a parallel transmission can be applied. Using this command, transmission always starts with the first value in the measured value memory.

Transfer of the IEC-Bus Controller Function

The ESCS must be able to activate the control line ATN (Attention) so that it is possible to send commands to other IEC-bus devices. Only the active IEC-bus controller (Controller in Charge) is entitled to do so. The ESCS needs to be Controller in Charge in order to program IEC-bus controlled plotters and thus output test reports.

The test receiver can obtain the controller function in the following ways:

1. There is no process controller connected to the IEC-bus.

This is recognized by the ATN-line and is usually the case when the ESCS operates in the stand-alone mode.

The ESCS can then configure itself as IEC-bus controller and end the controller function following completed plotter output (Release Control).

2. A process controller is IEC-bus controller.

This is always true, when the ESCS is controlled by a controller connected to the IEC-bus.

In this case IEC-bus control is transferred to the test receiver via talker addressing and passed back to the controller after plotter output has been terminated ("Pass Control Back").

Error Handling

Errors that are detected in connection with IEC-bus operation are indicated by setting a bit in the Event Status register. These are bit 2 for a query error, bit 4 for an execution error and bit 5 for command error. Device-specific errors are signaled by setting bit 3 (device-dependent error).

These bits remain set until the Event Status register is read out or cleared by the commands *RST or *CLS. A Service Request can thus be enabled and the type of error can be evaluated by way of program control.

A more detailed error message can be obtained by way of the command SYSTEM:ERROR?. A decimal value is output, which can be interpreted in accordance with table 6-10

Table 6-15 Error messages

0	no error
-100	internal error
-101	syntax not correct
-102	wrong data type
-113	unknown command or command not clear
-130	wrong or unclear unit
-141	wrong or unclear character data
-161	illegal block data
-221	input not allowed
-222	date is out of the permissible range, if not already specified by error message >0
-400	overflow of output buffer
-410	output data were not read and overwritten
-420	no output data available during the attempt to read them
2	Parameter out of permissible range
3	setting not allowed in this connection
4	date is out of permissible range
9	unit not correct
16	minimum frequency exceeded (e.g. transducer factors)
17	maximum frequency exceeded
18	minimum level exceeded
19	maximum level exceeded
20	wrong order of frequency values
100	no scan defined during the attempt to program scan data

7 Program Examples

The examples given in this section illustrate how to program the test receiver and may be the foundation for the solution of more complex spheres of measurement. The examples are based on each other step by step and each one is explained.

The programming language used is the Rohde & Schwarz-BASIC from version 2.00 onward. It is, however, possible to translate the programs into other languages.

Initialization and Initial State

At the beginning of every program, the IEC-bus and the settings of the receiver should be brought into a defined default status. It is helpful to use subprograms, in this case "Prolog" and "Init_ESCS".

The controller terminator should be set to "linefeed" (decimal 10), which - together with EOI - is the only permissible terminator according to the standard IEEE 488.2 and is also made use of in the ESCS.

```

10000 '
10010Prolog:
10020 '
10030     IEC TERM 10: '           Linefeed
10040     IEC TIME 1000: '       Timeout 1s
10050 '
10060     Escs=18: '             Receiver IEC address
10070 '
10080 '                         other initialization
10090 '
10100 RETURN
10110 '-----

```

Die IEC-Bus-Status-Register und Geräteeinstellungen des Empfängers werden in einem weiteren Unterprogram in den Grundzustand gebracht:

```

11000 '
11010Init_escs:
11020 '
11030 '                         reset status registers
11040     IEC OUT Escs,"*CLS"
11050 '
11060 '                         reset Receiver settings
11070     IEC OUT Escs,"*RST"
11080 '
11090 '                         init other devices
11100 '
11110 RETURN
11120 '-----

```

Sending a Device Setting Command

In this example some settings of the receiver section are made: frequency, RF-attenuation and demodulator.

```

100 '-----
110 '       Send Receiver settings
120 '-----
130 '
140 GOSUB Prolog
150 GOSUB Init_escs
160 '                               send new settings
170 IEC OUT Escs,"FREQUENCY 20 MHZ"
180 IEC OUT Escs,"ATTENUATION 30 DB;DETECTOR PEAK"
190 '
200 END
210 '-----
10000 '
10010Prolog:
10020 '
10030     IEC TERM 10: '           Linefeed
10040     IEC TIME 1000: '       Timeout 1s
10050 '
10060     Escs=18: '             Receiver IEC address
10070 '
10080 '                           other initialization
10090 '
10100 RETURN
10110 '-----
11000 '
11010Init_escs:
11020 '
11030 '                               reset status registers
11040     IEC OUT Escs,"*CLS"
11050 '
11060 '                               reset Receiver settings
11070     IEC OUT Escs,"*RST"
11080 '
11090 '                               init other devices
11100 '
11110 RETURN
11120 '-----

```

The subprograms "Prolog" and "Init_ESCS" still integrated in this example will no longer be part of the following examples.

Reading of the Device Settings

The settings made in the preceding example are read in this program. The commands are used in short form for this purpose.

```
100 '-----
110 '      Read Receiver settings
120 '-----
130 '
140 GOSUB Prolog
150 '
160 '                read settings
170 IEC OUT Escs,"FR?"
180 IEC IN Escs,Frequency$
190 '
200 IEC OUT Escs,"A?"
210 IEC IN Escs,Rf_attenuation$
220 '
230 IEC OUT Escs,"DET?"
240 IEC IN Escs,Detector$
250 '                print settings on screen
260 PRINT Frequency$
270 PRINT Rf_attenuation$
280 PRINT Detector$
290 '
300 END
```

In line with the settings that have been made earlier, the following indication results:

```
FREQUENCY 20000000
ATTENUATION 30
DETECTOR PEAK
```

Triggering a Single Measurement and Synchronization using *WAI

In this case a level measurement at a frequency previously set is started using the common command *TRG. *WAI serves to delay the processing of further commands until all the previous commands - in this case the level measurement - are executed. Only then is the result of the last measurement read in and indicated on the screen. When using *WAI, please note that the set timeout must be longer than the processing time of the commands, as otherwise an error message results. In this example the timeout of 1 s set in the prolog is sufficient for the default measuring time of 100 ms.

```

100 '-----
110 '      Trigger and read result
120 '-----
130 '
140 GOSUB Prolog
150 GOSUB Init_escs
160 '
170 IEC OUT Escs,"FREQUENCY 98.5 MHz"           set frequency
180 '
190 IEC OUT Escs,"*TRG;*WAI"                   Trigger and Wait
200 '
210 IEC OUT Escs,"LEVEL:LASTVALUE?"           get result
220 IEC IN Escs,Level$
230 '
240 PRINT Level$                               print result on screen
250 END

```

The output on the screen might be as follows:

```
LEVEL:LASTVALUE 23.87
```

To simplify this frequently used sequence, the ESVS offers the command LEVEL?, which synchronizes internally level measurement and retrieving of the measured value. It substitutes for the commands *TRG;*WAI;LEVEL:LASTVALUE?

The synchronization mechanism described above can also be applied to all other commands.

Service Request Routine

The smartest and most flexible way of synchronization of sequences is offered by the Service Request.

It requires an interrupt routine being part of the program of the system controller. The routine can be serviced asynchronously to the usual program run, if a Service Request occurs.

In the case of this subprogram the device(s) having sent the Request can be identified by their status bytes when polling the devices that might have sent one. Subsequently the appropriate measures can be taken.

To activate the interrupt capability of the controller, the command

```
nnn  ON SRQ GOSUB label
```

must be added to the main program.

Service Request Routine:

```
12000 '-----
12010 '   Service Request Routine
12020 '-----
12030 Srq_routine:
12040 '           Serial Poll
12050   IEC SPL Escs,Sb%
12060 '           Check SRQ-Bit
12070   IF (Sb% AND 64) THEN
12080 '           SRQ-Flag TRUE
12090   Srq%=1
12100 '           e.g. check registers
12110   ELSE
12120 '           poll other devices
12130   ENDIF
12140 '           enable SRQ Interrupt and return
12150 '           in the same line to avoid nesting!
12160 '
12170 ON SRQ GOSUB Srq_routine: RETURN
```

This very simple Service Request routine can be extended for the respective applications. It includes the operation of other devices connected to the bus or the weighting of additional IEC-bus register or error recoveries.

If a Service Request is to be generated at the end of processing of a command, the Event Status Enable register ESE and Service Request Enable register must be configured correspondingly.

The command *OPC sets the bit 0 in the Event Status register. Analog to this setting, the bit 0 in the Event Status Enable register must be set. Bit 5 in the Service Request Enable register must finally be set to enable a Service Request.

Synchronization with the End of the Scan using *OPC

In this example a scan, the end of which is waited for with the help of the command *OPC, is triggered. The end can be identified by the flag Srq% which is set in the Service Request routine. The registers stated in the before-mentioned example are previously configured.

```

100 '-----
110 '      Execute Scan
120 '-----
130 '
140   GOSUB Prolog
150   GOSUB Init_escs
160 '
170   GOSUB Exec_scan
180 '
190 END
3000 '-----
3010 '      Execute Scan and wait for Operation Complete
3020 '-----
3030 Exec_scan:
3060 '                               Init SRQ-Routine
3070   ON SRQ1 GOSUB Srq_routine
3080 '                               Config Registers
3090   IEC OUT Escs,"*CLS;*ESE 1;*SRE 32"
3100 '                               Init SRQ-Flag
3110   Srq%=0
3120 '                               Start Scan
3130   IEC OUT Escs,"SCAN:RUN;*OPC"
3140 '
3150 '                               Do something useful
3160 '                               while scanning
3170 '
3180   REPEAT
3190 '                               Do something useful too
3200 '                               or just wait
3210   UNTIL Srq%
3220 '                               Scan is completed
3230 RETURN
3240 '

```

Programming a Scan Data Set

In this example a scan data set for RF analysis consisting of two ranges is defined. The appertaining receiver settings are made and the level range displayed in the diagram is set.

```

100 '-----
110 '       Set Scan Data
120 '-----
130 '
140   GOSUB Prolog
150   GOSUB Init_escs
160 '
170   GOSUB Prog_scan
180 '
190 END
2000 '-----
2010 '       Define Settings for RF Analysis
2020 '-----
2030Prog_scan:
2060 '
2070 '                               define grid
2080   IEC OUT Escs,"GRID:FREQAXIS  LOG"
2090   IEC OUT Escs,"GRID:MINLEVEL  -20 dB"
2100   IEC OUT Escs,"GRID:MAXLEVEL  80 dB"
2110 '
2120 '                               2 scan ranges
2130   IEC OUT Escs,"SCAN:RANGES 2"
2140 '
2150 '                               linear steps
2160   IEC OUT Escs,"SCAN:FREQUENCY:STEPMODE LIN"
2170 '
2180 '                               define frequency ranges
2190   IEC OUT Escs,"SCAN 1"
2200   IEC OUT Escs,"SCAN:FREQUENCY:START    20 MHz"
2210   IEC OUT Escs,"SCAN:FREQUENCY:STOP    100 MHz"
2220   IEC OUT Escs,"SCAN:FREQUENCY:STEPsize 10 kHz"
2230 '
2240   IEC OUT Escs,"SCAN 2"
2250   IEC OUT Escs,"SCAN:FREQUENCY:STOP    500 MHz"
2260   IEC OUT Escs,"SCAN:FREQUENCY:STEPsize 100 kHz"
2270 '
2280   IEC OUT Escs,"SCAN:SAVE"
2290 '
2300 '                               define receiver settings
2310   IEC OUT Escs,"DETECTOR                PEAK"
2320   IEC OUT Escs,"SCAN 1"
2330   IEC OUT Escs,"SCAN:RECEIVER:BANDWIDTH:IF    10 kHz"
2340   IEC OUT Escs,"SCAN:RECEIVER:MEASUREMENT:TIME 100 ms"
2350   IEC OUT Escs,"SCAN:RECEIVER:ATTENUATION:AUTO ON"
2360   IEC OUT Escs,"SCAN:RECEIVER:ATTENUATION:MODE LOWNOISE"
2380 '
2390 '
2400 '
2410   IEC OUT Escs,"SCAN 2"
2420   IEC OUT Escs,"SCAN:RECEIVER:DETECTOR                PEAK"
2430   IEC OUT Escs,"SCAN:RECEIVER:BANDWIDTH:IF    120 kHz"
2440   IEC OUT Escs,"SCAN:RECEIVER:MEASUREMENT:TIME 20 ms"
2450   IEC OUT Escs,"SCAN:RECEIVER:ATTENUATION:AUTO ON"
2460   IEC OUT Escs,"SCAN:RECEIVER:ATTENUATION:MODE LOWNOISE"
2480 '
2490 '
2500 '
2510 '
2520 RETURN

```


Programming the Settings for Time Domain Analysis

In this example a dataset for time domain analysis is defined. The corresponding receiver settings are performed, the level range shown in the diagram is set.

```

100 '-----
110 '      Set Scan Data
120 '-----
130 '
140   GOSUB Prolog
150   GOSUB Init_escs
160 '
170   GOSUB Prog_scan
180 '
190 END
2000 '-----
2010 '      Define Settings for Time Domain
2020 '-----
2030Prog_scan:
2060 '
2070 '                                define grid
2090   IEC OUT Escs,"GRID:MINLEVEL -20 dB"
2100   IEC OUT Escs,"GRID:MAXLEVEL  80 dB"
2110 '
2170 '
2180 '                                define sweep time
2200   IEC OUT Escs,"SCAN:TIME          5 s"
2290 '
2300 '                                define receiver settings
2320   IEC OUT Escs,"DETECTOR           PEAK"
2330   IEC OUT Escs,"BANDWIDTH:IF       10 kHz"
2340   IEC OUT Escs,"MEASUREMENT:TIME  1 ms"
2350   IEC OUT Escs,"ATTENUATION        20 dB"
2360   IEC OUT Escs,"ATTENUATION:MODE  LOWNOISE"
2380 '
2500 '
2510 '
2520 RETURN

```

Programming a Transducer Factor

A transducer factor for an antenna is stored as transducer factor No. 1 in this example. The name and unit are additionally specified.

```

100 '-----
110 '      Transducer Factor
120 '-----
130 '
140   GOSUB Prolog
150   GOSUB Init_escs
160 '
170   GOSUB Prog_tfactor
180 '
190 END
1000 '-----
1010 '      Define Transducer Factor and activate
1020 '-----
1030Prog_tfactor:
1040   GOSUB Prolog
1050   GOSUB Init_escs
1060 '
1070 '                                define values
1080 DIM Frequency(10)
1090 DIM Level(10)
1100 '
1110 Frequency(0)=20E6: Level(0)=15.7
1120 Frequency(1)=25E6: Level(1)=17.6
1130 Frequency(2)=30E6: Level(2)=13.6
1140 Frequency(3)=35E6: Level(3)=12.1
1150 Frequency(4)=40E6: Level(4)=12.2
1160 Frequency(5)=45E6: Level(5)=11.2
1170 Frequency(6)=50E6: Level(6)=10.3
1180 Frequency(7)=55E6: Level(7)=9.7
1190 Frequency(8)=60E6: Level(8)=8.2
1200 Frequency(9)=65E6: Level(9)=7.4
1210 '
1220 '
1230 '                                select factor
1240   IEC OUT Escs,"TRANSDUCER:FACTOR 1"
1250 '
1260 '                                transducer name
1270   IEC OUT Escs,"TRANSDUCER:FACTOR:TEXT 'antennal'"
1280 '
1290 '                                transducer unit
1300   IEC OUT Escs,"TRANSDUCER:FACTOR:UNIT DBUV_M"
1310 '
1320 '                                build command string
1330 '
1340   Transducer$="10": '                                number of values
1350   FOR I=0 TO 9 STEP 1
1360     Transducer$=Transducer$+", "+STR$(Frequency(I))+", "+STR$(Level(I))
1370   NEXT I
1380 '
1390 '                                transmit factor
1400   IEC OUT Escs,"TRANSDUCER:FACTOR:DEFINE "+Transducer$
1410 '
1420 '                                activate factor
1430   IEC OUT Escs,"TRANSDUCER:FACTOR:SELECT 1"
1440 '
1450 RETURN
1460 '

```

Programming a Transducer Set

A transducer set consisting of two ranges is created from transducer factors defined before. The transducer factors used must be defined for the frequency range of the selected transducer set range.

In this example two factors each are put together to form a set range. These two factors might be an antenna with cable, for example.

The start frequency of the second range is defined by the stop frequency of the first range.

```

100 '-----
110 '      Transducer Set
120 '-----
130 '
140   GOSUB Prolog
150   GOSUB Init_escs
160 '
170   GOSUB Prog_tset
180 '
190 END
1000 '-----
1010 '      Define Transducer Set and activate
1020 '-----
1030Prog_tset:
1040 '
1050 '                select set
1060   IEC OUT Escs,"TRANSDUCER:SET 1"
1070 '
1080 '                transducer set name
1090   IEC OUT Escs,"TRANSDUCER:SET:TEXT 'RFI test'"
1100 '
1110 '                transducer unit
1120   IEC OUT Escs,"TRANSDUCER:SET:UNIT DBUV_M"
1130 '
1140 '                define ranges
1150   IEC OUT Escs,"TRANSDUCER:SET:RANGES 2"
1160 '
1170 '                select transducer factor
1180 '                4 and 7 for range 1
1190   IEC OUT Escs,"TRANSDUCER:SET:RANGES:SELECT 1"
1200   IEC OUT Escs,"TRANSDUCER:SET:RANGES:START 20 MHz"
1210   IEC OUT Escs,"TRANSDUCER:SET:RANGES:STOP 150 MHz"
1220   IEC OUT Escs,"TRANSDUCER:SET:RANGES:DEFINE 2,4,7"
1230 '
1240 '                select transducer factor
1250 '                5 and 9 for range 2
1260   IEC OUT Escs,"TRANSDUCER:SET:RANGES:SELECT 2"
1270   IEC OUT Escs,"TRANSDUCER:SET:RANGES:STOP 500 MHz"
1280   IEC OUT Escs,"TRANSDUCER:SET:RANGES:DEFINE 2,5,9"
1290 '
1300 '                save set
1310   IEC OUT Escs,"TRANSDUCER:SET:SAVE"
1320 '                activate set
1330   IEC OUT Escs,"TRANSDUCER:SET:SELECT 1"
1340 '
1350 RETURN
1360 '

```

Output of a Test Report on Plotter

To enable the receiver to output a test report on plotter via IEC bus, the receiver must be the IEC-bus controller. If output is started by a process controller, the pass-control protocol is used for this purpose.

This means that the receiver is transferred IEC-bus control by the process controller. After completion of plotter output the controller function is returned by the ESCS.

The receiver must previously be told the address of the process controller using pass-control-back command "*PCB address".

While the ESS has the controller function, the process controller is not disabled. IEC-bus functions requiring bus control are the only ones which cannot be performed by the process controller.

It waits for the receiver to return the controller function with the help of command "Wait Take Control" - WTCT.

```

100 '-----
110 '          Plot Test Report
120 '-----
130 '
140   GOSUB Prolog
150   GOSUB Init_escs
160 '
170   GOSUB Plot_report
180 '
190 END
1000 '-----
1010 '          Plot_report
1020 '-----
1030Plot_report:
1120 '                      Controller address
1130   Controller=30
1140 '
1150 '                      configure for Pass Control Back
1160   IEC ADR Controller
1170   IEC OUT Escs,"*PCB "+STR$(Controller)
1180 '
1190 '                      configure Test Report
1200 '                      diagram and heading
1210   IEC OUT Escs,"PLOTTER:CONTENT:DEFAULT ON"
1220 '
1230 '                      select pens
1240   IEC OUT Escs,"PLOTTER:SETUP:PEN ON"
1250   IEC OUT Escs,"PLOTTER:SETUP:PEN:GRID 2"
1260   IEC OUT Escs,"PLOTTER:SETUP:PEN:LIMIT 3"
1270   IEC OUT Escs,"PLOTTER:SETUP:PEN:CURVE1 4"
1280   IEC OUT Escs,"PLOTTER:SETUP:PEN:CURVE2 5"
1290   IEC OUT Escs,"PLOTTER:SETUP:PEN:TEXT 1"
1300   IEC OUT Escs,"PLOTTER:SETUP:PEN:DATE 4"
1310 '
1320 '                      special scaling off
1330   IEC OUT Escs,"PLOTTER:SETUP:FORMAT OFF"
1340 '
1350 '                      header
1360   IEC OUT Escs,"REPORT:HEADER:COMPANY      'Rohde & Schwarz'"
1370   IEC OUT Escs,"REPORT:HEADER:PROGRAM      'Conformance Test'"
1380   IEC OUT Escs,"REPORT:HEADER:EUT          'Machine'"
1390   IEC OUT Escs,"REPORT:HEADER:MANUFACTURER 'No Name'"
1400   IEC OUT Escs,"REPORT:HEADER:CONDITION   'green'"
1410   IEC OUT Escs,"REPORT:HEADER:OPERATOR    'M. Keller'"
1420   IEC OUT Escs,"REPORT:HEADER:SPEC        'internal #23'"

```

```
1430   IEC OUT Escs,"REPORT:HEADER:REMARK1      'comments'"
1440   IEC OUT Escs,"REPORT:HEADER:REMARK2      '"

1450 '
1460 '                                     initiate Plot
1470   IEC OUT Escs,"PLOTTER:START"
1480 '                                     pass control to Receiver
1490   IEC TAD Escs: IEC TCT
1500 '                                     wait for plot complete
1510 '                                     and pass control back
1520   IEC WTCT
1530 '
1540   RETURN
1550 '
```

Block-Serial Output of the Scan Results in ASCII Format

In the following example a block-serial transfer of the measured values, which is proceeding with the measurement being executed, is carried out during the current RF analysis. The number of block elements to be simultaneously transferred is set to 20. "COMBINED" is selected for the type of data to be output, i.e. each level value measured is included in the data block together with all additional information. "ASCII" has been chosen as output format, i.e. the data are transferred in a string which can be read directly, e.g. "SCAN:BLOCK 0002,35,20000000,13.24,0,20100000,14.58,0". The first number indicates the number of following block elements, the second contains information on the composition of the block elements and is designated as template. All further numbers contain the actual measurement results, in this example frequency, level and the validity byte.

This format is most time-consuming in output, as the conversion of binary data into ASCII format requires a high amount of computing.

Extended event-status register ERD is used to indicate that enough new data have been collected. The status registers are set such that the setting of one bit in this register induces a service request. Thus the weighting of all this information is effected in the appertaining service-request routine.

A further bit of this register indicates that the last block has been transferred and thus supplies the signal for terminating the program. As soon as the poll of a block has been initiated using "SCAN:BLOCK?", the data are processed and formatted in the output buffer. In order to have sufficient time for that, the IEC-bus timeout is set to a value of 32 s.

Subroutines Prolog, Init_escs and Prog_scan have already been included in the preceding examples and are not listed here any more.

```

100 '-----
110 '   Transfer of Block Data in ASCII format
120 '-----
130 '
140   GOSUB Prolog
150   GOSUB Init_escs
160 '
170 '           Define settings for RF analysis
180   GOSUB Prog_scan
190 '
200   GOSUB Exec_scan
210 '
220 '
230 END
3000 '-----
3010 '           Execute Scan and wait for last block
3020 '-----
3030 Exec_scan:
3040 '           setup block format
3050   IEC OUT Escs,"SCAN:BLOCK:FORMAT  ASCII"
3060   IEC OUT Escs,"SCAN:BLOCK:ELEMENT COMBINED"
3070   IEC OUT Escs,"SCAN:BLOCK:COUNT  20"
3080 '           config registers
3090   IEC OUT Escs,"*CLS;*ESE 1;*SRE 33"
3100 '           enable all bits
3110   IEC OUT Escs,"ERDE 65535"
3120 '           init variable
3130   Erd=0
3140 '           waste previous results
3150   IEC OUT Escs,"SCAN:RESULTS:CLEAR"
3160 '           Init SRQ-Routine
3170   ON SRQ1 GOSUB Srq_routine
3180 '

```

```

3190   IEC OUT Escs,"SCAN:RUN;*OPC"
3200   PRINT "Scan is running"
3210 '
3220 '
3230   REPEAT
3240 '                               Wait for last block
3250 '                               of scan results
3260   UNTIL Erd AND 4
3270 '
3280   PRINT "Transfer completed"
3290 '
3300 RETURN
4000 '-----
4010 '                               Get data block
4020 '-----
4030Block_query:
4040 '                               data query
4050   IEC OUT Escs,"SCAN:BLOCK?"
4060 '
4070 '                               wait for data processing
4080   IEC TIME 32000
4090 '                               get data
4100   IEC IN Escs,Block$
4110 '
4120 '                               length of data block
4130   Count=LEN(Block$)
4140 '
4150 '
4160 RETURN
12000 '-----
12010 '   Service Request Routine
12020 '-----
12030Srq_routine:
12040 '                               Serial Poll
12050   IEC SPL Escs,Sb%
12060 '                               check SRQ bit
12070   IF (Sb% AND 64) THEN
12080 '----- check ERD bit
12090       IF (Sb% AND 1) THEN
12100 '                               read ERD register
12110           IEC OUT Escs,"ERD?"
12120           IEC IN Escs,Erd$
12130           Erd=VAL(Erd$)
12140           PRINT "ERD: ";Erd
12150 '----- check insufficient RAM bit
12160           IF (Erd AND 16) THEN
12170               PRINT "Insufficient RAM"
12180           ENDIF
12190 '----- check data ready bit
12200           IF (Erd AND 128) THEN
12210 '                               read data block
12220               GOSUB Block_query
12230               Sum=Sum+(Count-1)
12240 '                               print results
12250                   PRINT Block$
12260                   PRINT
12270                   PRINT "-->";Sum;" bytes up to now"
12280           ENDIF
12290       ENDIF
12300 '----- check ESR Bit
12310       IF (Sb% AND 32) THEN
12320           PRINT "Operation complete"
12330 '                               clear enable register

```

```
12340         IEC OUT Escs,"*ESE 0"
12350         ENDIF
12360     ELSE
12370 '----- poll other devices
12380     ENDIF
12390 '             enable SRQ Interrupt and return
12400 '             in the same line to avoid nesting!
12410 '
12420 ON SRQ1 GOSUB Srq_routine: RETURN
```


Block-Serial Output of the Scan Results in Binary Format

In this example the data are output in binary format. Here weighting is somewhat more difficult because the binary data are combined without a significant delimiter. Further, some components of a block element cannot be assigned a fixed position in the data block, as the results can be composed differently depending on the receiver setting.

The routine listed subsequently first evaluates the first two bytes of the data block, they contain the number of block elements in the data string, and then the next two bytes from whose content the parts a block element consists of are evident.

The FOR-NEXT loop, which performs the actual analysis of the block elements, can be made so universal - using these two pieces of information - that it is true of all types of block data possible. The index% variable is a pointer which always points to the date in the result string to be analyzed next and is switched further according to the size of the respective date.

Thus this single procedure in an application program is sufficient to cover all cases. The output of a header is switched off as it is not required and would only make the analysis of the data more complicated.

What is particular is the weighting of the frequency. The receiver transfers the values in IEEE format for floating-point variables at twice the accuracy. The R&S BASIC uses the same internal kind of display of floating-point numbers. Instead of a time-consuming conversion it is thus possible to copy the bytes of the result string directly into BASIC's internal memory of variables using the VARPTR and POKE commands.

This principle can also be used in other programming languages if they themselves or a library, which can be connected in addition, support the IEEE-Double-Precision format.

```

100 '-----
110 '   Transfer of Block Data in binary format
120 '-----
130 '
140   GOSUB Prolog
150   GOSUB Init_escs
160 '
170 '                               Define settings for RF analysis
180   GOSUB Prog_scan
190 '
200   GOSUB Exec_scan
210 '
220 '
230 END
3000 '-----
3010 '       Execute Scan and wait for last block
3020 '-----
3030 Exec_scan:
3040 '                               setup block format
3050   IEC OUT Escs, "SCAN:BLOCK:FORMAT  BINARY"
3060   IEC OUT Escs, "SCAN:BLOCK:ELEMENT COMBINED"
3070   IEC OUT Escs, "SCAN:BLOCK:COUNT  20"
3080 '                               config registers
3090   IEC OUT Escs, "*CLS;*ESE 1;*SRE 33"
3100 '                               enable all bits
3110   IEC OUT Escs, "ERDE 65535"
3120 '                               init variable
3130   Erd=0
3140 '                               waste previous results
3150   IEC OUT Escs, "SCAN:RESULTS:CLEAR"
3160 '                               supress header

```

```

3170   IEC OUT Escs,"HEADER OFF"
3180 '                                     terminator EOI for binary data
3190   IEC TERM 1
3200 '                                     Init SRQ-Routine
3210   ON SRQ1 GOSUB Srq_routine
3220 '
3230   IEC OUT Escs,"SCAN:RUN;*OPC"
3240   PRINT "Scan is running"
3250 '
3260 '
3270   REPEAT
3280 '                                     Wait for last block
3290 '                                     of scan results
3300   UNTIL Erd AND 4
3310 '
3320   PRINT "Transfer completed"
3330 '
3340 RETURN
4000 '-----
4010 '                                     Get data block
4020 '-----
4030Block_query:
4040 '                                     data query
4050   IEC OUT Escs,"SCAN:BLOCK?"
4060 '
4070 '                                     wait for data processing
4080   IEC TIME 32000
4090 '                                     get data
4100   IEC IN Escs,Block$
4110 '
4120 '                                     length of data block
4130   Count=LEN(Block$)
4140 '
4150 '
4160 RETURN
5000 '-----
5010 '                                     Extract results from binary data block
5020 '-----
5030Block_analysis:
5040 '                                     get count of block elements
5050 '
5060   Num_of_elts%=ASC(LEFT$(Dump$,1))+ASC(MID$(Dump$,2,1))*256
5070   PRINT Num_of_elts%;" block elements received"
5080 '
5090 '                                     get template word
5100 '
5110   Template%=ASC(MID$(Dump$,3,1))+ASC(MID$(Dump$,4,1))*256
5120   PRINT "Template ";Template%
5130 '
5140   Index%=5: '                                     pointer to block data
5150 '
5160 '----- single block elements
5170   FOR I=1 TO Num_of_elts%
5180 '                                     8 byte frequency
5190 '----- IEEE format
5200     IF Template% AND 1 THEN
5210       Addr=VARPTR(Freq)
5220       FOR J=0 TO 7
5230         POKE Addr+J,ASC(MID$(Dump$,Index%+J,1))
5240       NEXT J
5250       PRINT Freq,
5260       Index%=Index%+8
5270     ENDIF

```

```

5280 '----- level, detector 1
5290     IF Template% AND 2 THEN
5300
Lev%=ASC(MID$(Dump$,Index%,1))+ASC(MID$(Dump$,Index%+1,1))*256
5310         Levell=Lev%/100
5320         PRINT Levell,
5330         Index%=Index%+2
5340     ENDIF
5350 '----- level, detector 2
5360     IF Template% AND 4 THEN
5370
Lev%=ASC(MID$(Dump$,Index%,1))+ASC(MID$(Dump$,Index%+1,1))*256
5380         Level2=Lev%/100
5390         PRINT Level2,
5400         Index%=Index%+2
5410     ENDIF
5420 '----- status word
5430     State%=ASC(MID$(Dump$,Index%,1))+ASC(MID$(Dump$,Index%+1,1))*256
5440     PRINT State%,
5450     Index%=Index%+2
5460 '----- transducer
5470     IF Template% AND 64 THEN
5480
Lev%=ASC(MID$(Dump$,Index%,1))+ASC(MID$(Dump$,Index%+1,1))*256
5490         Trd=Lev%/100
5500         PRINT Trd,
5510         Index%=Index%+2
5520     ENDIF
5530 '----- limit byte
5540     IF Template% AND 128 THEN
5550
Lim%=ASC(MID$(Dump$,Index%,1))+ASC(MID$(Dump$,Index%+1,1))*256
5560         PRINT Lim%,
5570         Index%=Index%+1
5580     ENDIF
5590 '----- limit 1
5600     IF Template% AND 256 THEN
5610
Lev%=ASC(MID$(Dump$,Index%,1))+ASC(MID$(Dump$,Index%+1,1))*256
5620         Limit1=Lev%/100
5630         PRINT Limit1,
5640         Index%=Index%+2
5650     ENDIF
5660 '----- limit 2
5670     IF Template% AND 512 THEN
5680
Lev%=ASC(MID$(Dump$,Index%,1))+ASC(MID$(Dump$,Index%+1,1))*256
5690         Limit2=Lev%/100
5700         PRINT Limit2,
5710         Index%=Index%+2
5720     ENDIF
5730     PRINT
5740     NEXT I
5750 RETURN
12000 '-----
12010 '     Service Request Routine
12020 '-----
12030Srq_routine:
12040 '                                     Serial Poll
12050 IEC SPL Escs,Sb%
12060 '                                     check SRQ bit
12070 IF (Sb% AND 64) THEN
12080 '----- check ERD bit

```

```

12090     IF (Sb% AND 1) THEN
12100 '                                     read ERD register
12110     IEC OUT Escs,"ERD?"
12120     IEC IN Escs,Erd$
12130     Erd=VAL(Erd$)
12140     PRINT "ERD: ";Erd
12150 '----- check insufficient RAM bit
12160     IF (Erd AND 16) THEN
12170         PRINT "Insufficient RAM"
12180     ENDIF
12190 '----- check data ready bit
12200     IF (Erd AND 128) THEN
12210 '                                     read data block
12220         GOSUB Block_query
12230         Sum=Sum+(Count-1)
12240 '                                     convert binary data
12250         GOSUB Block_analysis
12260 '
12270         PRINT "-->";Sum;" bytes up to now"
12280     ENDIF
12290 ENDIF
12300 '----- check ESR Bit
12310     IF (Sb% AND 32) THEN
12320         PRINT "Operation complete"
12330 '                                     clear enable register
12340         IEC OUT Escs,"*ESE 0"
12350     ENDIF
12360 ELSE
12370 '----- poll other devices
12380 ENDIF
12390 '                                     enable SRQ Interrupt and return
12400 '                                     in the same line to avoid nesting!
12410 '
12420 ON SRQ1 GOSUB Srq_routine: RETURN

```

Block-Serial Output of Scan Results in the Internal Data Format (Dump)

With this format the weighting of results is very easy as the data with increasing frequency are simply sequenced successively.

The appertaining frequency can be calculated from start frequency, stop frequency and step width by the application program if required.

The service-request routine is designed such that it weighs event-status register ERD and can thus respond to which kind of results - detector 1, detector 2 or validity byte - is ready to be fetched. This means that this routine can be applied universally as well.

In comparison to the two others, this format offers the largest advantages as to speed on the receiver side as no formatting has to be performed. Contrary to the two data formats described before, the selection of the date to be transferred is effected immediately before polling the data block. This is necessary to ensure that access to all three kinds of results is possible during the scan. The data block can be fetched immediately after the command "SCAN:BLOCK?".

```

100 '-----
110 '   Transfer of unformatted Block Data
120 '-----
130 '
140   GOSUB Prolog
150   GOSUB Init_escs
160 '
170 '                               Define settings for RF analysis
180   GOSUB Prog_scan
190 '
200   GOSUB Exec_scan
210 '
220 '
230 END
3000 '-----
3010 '       Execute Scan and wait for last block
3020 '-----
3030 Exec_scan:
3040 '                               setup block format
3050   IEC OUT Escs,"SCAN:BLOCK:FORMAT DUMP"
3060   IEC OUT Escs,"SCAN:BLOCK:COUNT 100"
3070 '                               config registers
3080   IEC OUT Escs,"*CLS;*ESE 1;*SRE 33"
3090 '                               enable all bits
3100   IEC OUT Escs,"ERDE 65535"
3110 '                               init variable
3120   Erd=0
3130 '                               waste previous results
3140   IEC OUT Escs,"SCAN:RESULTS:CLEAR"
3150 '                               terminator EOI for binary data
3160   IEC TERM 1
3170 '                               Init SRQ-Routine
3180   ON SRQ1 GOSUB Srq_routine
3190 '
3200   IEC OUT Escs,"SCAN:RUN;*OPC"
3210   PRINT "Scan is running"
3220 '
3230 '
3240   REPEAT
3250 '                               Wait for last block
3260 '                               of scan results
3270   UNTIL Erd AND 4

```

```

3280 '
3290 PRINT "Transfer completed"
3300 '
3310 RETURN
4000 '-----
4010 '           Get data block
4020 '-----
4030Block_query:
4040 '           data query
4050 IEC OUT Escs,"SCAN:BLOCK?"
4060 '
4070 '           get data
4080 IEC IN Escs,Block$
4090 '
4100 '           length of data block
4110 Count=LEN(Block$)
4120 '
4130 '
4140 RETURN
12000 '-----
12010 '   Service Request Routine
12020 '-----
12030Srq_routine:
12040 '           serial poll
12050 IEC SPL Escs,Sb%
12060 '           check SRQ bit
12070 IF (Sb% AND 64) THEN
12080 '----- check ERD bit
12090     IF (Sb% AND 1) THEN
12100 '           read ERD register
12110     IEC OUT Escs,"ERD?"
12120     IEC IN Escs,Erd$
12130     Erd=VAL(Erd$)
12140     PRINT "ERD:";Erd
12150 '----- check insufficient RAM bit
12160     IF (Erd AND 16) THEN
12170       PRINT "Insufficient RAM"
12180     ENDIF
12190 '----- check data ready bit detector 1
12200     IF (Erd AND 128) THEN
12210 '           configure for detector 1
12220       IEC OUT Escs,"SCAN:BLOCK:ELEMENT DET1"
12230       PRINT "Detector 1: ";
12240 '           get data block
12250       GOSUB Block_query
12260       Sum=Sum+Count/2
12270 '           print level values
12280       FOR I=1 TO Count/2
12290
Lev%=ASC(MID$(Block$,I*2-1,1))+ASC(MID$(Block$,I*2,1))*256
12300 '           1/100 dB resolution; signed
12310           Level=Lev%/100
12320           PRINT USING "-###.## ";Level;" ";
12330       NEXT
12340       PRINT
12350       PRINT "-->";Sum;" values up to now"
12360     ENDIF
12370 '----- check data ready bit detector 2
12380     IF (Erd AND 64) THEN
12390 '           configure for detector 2
12400       IEC OUT Escs,"SCAN:BLOCK:ELEMENT DET2"
12410       PRINT "Detector 2: ";
12420 '           get data block

```

```

12430          GOSUB Block_query
12440 '                print level values
12450          FOR I=1 TO Count/2
12460
Lev%=ASC(MID$(Block$,I*2-1,1))+ASC(MID$(Block$,I*2,1))*256
12470 '                1/100 dB resolution; signed
12480          Level=Lev%/100
12490          PRINT USING "-###.## ";Level;" ";
12500          NEXT
12510          PRINT
12520          ENDIF
12530 '----- check data ready bit validity
12540          IF (Erd AND 32) THEN
12550 '                configure for validity byte
12560          IEC OUT Escs,"SCAN:BLOCK:ELEMENT VALID"
12570          PRINT "Validity: ";
12580 '                get data block
12590          GOSUB Block_query
12600 '                print validity bytes
12610          FOR I=1 TO Count
12620          PRINT USING "###";(ASC(MID$(Block$,I,1))); " ";
12630          NEXT
12640          PRINT
12650          ENDIF
12660          ENDIF
12670 '----- check ESR bit
12680          IF (Sb% AND 32) THEN
12690          PRINT "Operation complete"
12700          IEC OUT Escs,"*ESE 0"
12710          ENDIF
12720          ELSE
12730 '----- poll other devices
12740          ENDIF
12750 '                enable SRQ Interrupt and return
12760 '                in the same line to avoid nesting!
12770 '
12780 ON SRQ1 GOSUB Srq_routine: RETURN

```

8 Maintenance

Mechanical Maintenance

The ESCS requires no mechanical maintenance at all. The front panel should be cleaned from time to time preferably using a soft, damp cloth..

Electrical Maintenance

Testing the Level Measuring Accuracy

As it is possible to perform a total calibration with the help of the built-in calibration generators, a high long-term stability of the level measurement characteristics, which exclusively depends on the aging of the calibration generators, is ensured. The measurement accuracy should be checked once every year according to section 1 (service manual). The re-adjustments of the calibration generators required following exceedings of the tolerance limits should be effected by an R&S-service station.

9 Error Messages

Message	Cause
<i>1st LO HF unlock</i>	Hardware error synthesizer
<i>2nd LO UHF unlock</i>	Hardware error synthesizer
<i>Bus control required</i>	Plotter output is not possible since the receiver does not have the bus control.
<i>Connect Plotter!</i>	Plotter output has been started without having connected a plotter; plotter address is faulty
<i>Connect Printer!</i>	Printer output has been started without having connected a printer.
<i>Drive not ready</i>	The drive is not ready for read or write accesses, e.g. because no floppy disk is inserted or the floppy disk is not formatted.
<i>ERR: IEC</i>	Hardware error during selftest; the IEC-bus interface is faulty.
<i>ERR:+5V ERR:+10 V ERR:+28 V ERR:-10 V</i>	Hardware error during selftest; the supply voltage indicated is out of tolerance.
<i>ERR:60 dB Range</i>	Error during calibration; the linearity of the operating range indicated is out of tolerance and cannot be corrected any more
<i>ERR:Detector Board</i>	Hardware error during selftest, the Detector Board is faulty
<i>ERR:Synthesizer</i>	Hardware error during selftest, the Synthesizer is faulty
<i>ERR:Gain at 5.9 MHz</i>	Error during total calibration, the gain in the frequency range above 5.9 MHz cannot be corrected.
<i>ERR:Gain at BW 200 Hz</i>	Error during calibration; the gain at the respective bandwidth cannot be corrected.
<i>ERR:IF Attenuator</i>	Error during total calibration; the IF gain switch is faulty.
<i>ERR:IF Selection Board</i>	Hardware error during selftest; the IF Selection Board is faulty
<i>ERR:Meas uncal</i>	The gain of the receiver cannot be set. The measured values are not exact.
<i>ERR:QP</i>	Error during total calibration; quasi-peak weighting cannot be corrected
<i>ERR:RS232</i>	Hardware error during selftest; the serial interface of the user interface does not work

Message	Cause
<i>Ext Ref</i>	Der Empfänger ist auf externe Referenz synchronisiert.
<i>Frequency Sequence!</i>	Frequencies have not be entered in increasing sequence in the table.
<i>Insufficient disk space</i>	The floppy disk does not provide enough space to store the file.
<i>Invalid file name</i>	An invalid file name has been entered.
<i>Invalid floppy disk</i>	An invalid file name has been entered.
<i>Max 2 Limits</i>	An attempt has been made to activate a third limit line
<i>Max Freq 2750 MHz</i>	A frequency above 2750 MHz has been entered. (transducer factor, limit value).
<i>Max Level 200 dB</i>	A value above 200 dB has been entered when entering a transducer factor or a limit line.
<i>Max xx values (xx = 10, 20 oder 50)</i>	The maximum number of sampled values for the transducer factor or a limit line has been reached, no further value is possible.
<i>Meas invalid, Transd undefined</i>	An active transducer is not defined over the entire scan range. The measured values outside the defined range are illegal.
<i>Min Freq 200 Hz</i>	A frequency below 200 Hz has been entered when entering a transducer factor or a limit line.
<i>Min Level -200 dB</i>	Bei der Eingabe eines Transducerfaktors oder einer Grenzwertlinie wurde ein Wert unter -200 dB eingegeben.
<i>Overwrite existing file?</i>	The file name entered for storage already exists. By pressing ENTER, the file is overwritten. EXIT is used to abort the storage procedure.
<i>CMOS Batt low</i>	RAM battery flat, needs replacement, otherwise data will be lost
<i>Register empty</i>	RCL has been used to call a register which does not contain any setting data
<i>Write protect error</i>	The floppy disk is write-protected which is why no write access is possible.
<i>xx undef</i>	An attempt has been made to activate an undefined transducer or limit value

10 Index

A

Abort Plot 4-53
 Atten 4-39
 Auto Scale 4-18; 4-23
 Average 4-36

B

Blank 4-37

C

Channel 4-15; 4-16
 Check Transd 4-4; 4-5
 CISPR A 4-17; 4-19
 CISPR B 4-17; 4-19
 CISPR C 4-17; 4-19
 CISPR D 4-17; 4-19
 CISPR Ranges 4-17; 4-19
 Clr Write 4-36
 CONFIG 4-3; 4-10
 Configuration 2-44; 2-45; 4-3
 Connecting a Keyboard 1-25
 Copy to Line 4-12
 Copy to Memory 4-25
 Curve 4-48
 Curve - Memory 4-25
 Curve 1 Curve 2 4-39
 Curve Line 4-21
 Curves 4-39

D

date 1-21
 Defaul 4-23
 Default 4-46
 Define Scan 4-17; 4-19; 4-20
 DELETE 4-6; 4-6
 Delete Memory 4-25
 Delta marker 4-30; 4-34; 4-40
 DEMOD 3-24
 DETECTOR 3-21
 Diagram 4-21
 Diagram Level 4-18
 Discontinuous interference 4-21
 Disk
 deleting files 4-62
 Disk Service 4-62
 format 4-62
 Disk drive
 messages 4-63

E

Edit 4-5
 Edit List 4-20
 Enhancement Label 3-6
 External+ External- 4-24

F

Fact 4-8
 Factor 4-7
 Factor Set 4-4; 4-7
 Factor/Set 4-5
 Fixed Final 4-30
 Floppy disk
 file name 4-57
 Format 4-56
 HP-GL format 4-60
 FREQ 3-11
 Freq Axis LIN LOG 4-18; 4-20
 Frequency axis
 labeling 3-5

G

GEN 3-26

H

HP-GL File 4-60

I

IEC-bus address 1-21
 IF 4-37
 IF analysis 4-36
 Indication
 instrument settings 3-6
 INSERT 4-6; 4-6
 Instrument settings
 indication 3-6

L

Limit line
 copy 4-12
 switch on and off 4-10
 Limit Lines 4-10
 input 4-9

M

Main marker 4-30; 4-40
 Marker 4-31; 4-41
 IF analysis 4-40
 Maximum 4-32
 peak 4-41
 RF Analysis 4-30
 Time Domain 4-30
 Marker → Peak 4-32; 4-41
 Marker Coupled 4-34; 4-35
 Marker Mode 4-34; 4-43
 Marker OFF 4-34
 Marker ON 4-34
 Marker Search 4-32; 4-41
 Marker Zoom 4-31
 Max Hold Clr Write 4-25
 Max Hold/Min Hold 4-36
 Max Level 4-23
 MaxHold MinHold 4-39
 Maximum search 4-32
 Measurement results display 4-23
 Min Level 4-23

N

Name	4-6; 4-13
New	4-5; 4-7
New Line.....	4-12
New List	4-20
NEXT.....	4-41
Next Curve.....	4-34; 4-43
Next Peak ← Left.....	4-32
Next Peak → Right	4-32; 4-41
Normal Marker	4-34

O

OPTIONS.....	4-27
Original Diagram	4-31; 4-32

P

Peak	
search.....	4-41
Peak Excursion.....	4-33; 4-42
Plot	4-53
Plotter	
IEC-bus address.....	4-49
output	4-45; 4-53
presetting.....	4-47
scaling	4-49
Plotter Config.....	4-49
Plotter Contents	4-48; 4-48
Printer	
output	4-45; 4-52
Printer Contents.....	4-46
Printer Driver.....	4-47
Printer Setting.....	4-46

R

Ranges	4-8
RBW	4-37
Receiver	
setting up.....	1-16
REPORT.....	4-46; 4-47
labeling.....	4-50
Res BW	4-38
RF.....	4-16; 4-26
RF Analysis.....	4-26
RF Scan Mode.....	4-16
RF Spectrum.....	4-15
RFI Field.....	4-30
RFI Power.....	4-29
RFI Voltage.....	4-27
RMS.....	3-19
RMS value	3-19
RUN.....	4-24

S

Scan.....	4-15; 4-16
Scan Ranges	4-18; 4-19
Scan Table	4-48
Screen	
subdivision	3-5
Search	
Maximum.....	4-32
peak	4-41
PEAK EXCURSION	4-33; 4-42
Selftest.....	4-14
Service menu	4-14
Shift Level	4-13
Single Continue	4-25
Span.....	4-38
Spectrum analysis	4-37
Spectrum overview.....	4-15; 4-16
SQUELCH/TRIG LEVEL.....	4-24
Squelch/Trigger Level.....	4-23
Status ON/OFF.....	4-4; 4-47
Step LIN LOG.....	4-20
Sweep Time	4-36; 4-38
SWT.....	4-37

T

time	1-21; 4-22
Time Domain	4-15; 4-21; 4-22
Time domain analysis.....	4-21
Title	4-50
Transducer	4-3
factor.....	4-5
sampling value	4-5
set.....	4-7
Transducer factor	4-5
Tune to Marker	4-32; 4-36; 4-42

U

Uni.....	4-6
Unit.....	4-5

V

Values	4-6; 4-13
View	4-37
View Blank	4-39