ROHDE&SCHWARZ

Test and Measurement
Division

Operating Manual

RADIOCOMMUNICATION SERVICE MONITOR CMS 50 / 52 / 54 / 57

840.0009.50 /.52 /.54 /.57

Printed in the Federal
Republic of Germany

Contents

Index

Grouped Safety Messages

Make sure to read through and observe the following safety instructions!

All plants and locations of the Rohde & Schwarz group of companies make every effort to keep the safety standard of our products up to date and to offer our 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. The product described here 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, the Rohde & Schwarz group of companies 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, if expressly permitted, also 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 product documentation and within its performance limits (see data sheet, documentation, the following safety instructions). Using the product requires technical skills and a basic knowledge of English. It is therefore essential that only skilled and specialized staff or thoroughly trained personnel with the required skills be allowed to use the product. If personal safety gear is required for using Rohde & Schwarz products, this will be indicated at the appropriate place in the product documentation. Keep the basic safety instructions and the product documentation in a safe place and pass them on to the subsequent users.

Symbols and safety labels

							
Observe product documentation	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

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 relevant parts of the product documentation. In these safety instructions, the word "product" refers to all merchandise sold and distributed by the Rohde & Schwarz group of companies, including instruments, systems and all accessories.

Tags and their meaning

DANGER	DANGER indicates a hazardous situation which, if not avoided, will result in death or serious injury.
WARNING	WARNING indicates a hazardous situation which, if not avoided, could result in death or serious injury.
CAUTION	CAUTION indicates a hazardous situation which, if not avoided, may result in minor or moderate injury.
NOTICE	NOTICE indicates a property damage message.
	In the product documentation, the word ATTENTION is used synonymously.

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 in other economic areas or military applications. It is therefore essential to make sure that the tags described here are always used only in connection with the related product documentation and the related product. The use of tags in connection with unrelated products or documentation can result in misinterpretation 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 2000 m above sea level, max. transport altitude 4500 m above sea level.
   A tolerance of ±10% shall apply to the nominal voltage and of ±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.
4. If products/components are mechanically and/or thermically 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/operator 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 (corresponding to the 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. Check the power cable on a regular basis to ensure that it is in proper operating condition. 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 (higher fuse only after consulting with the Rohde & Schwarz group of companies).
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_{rms} > 30 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. Unless expressly permitted, never remove the cover or any part of the housing while the product is in operation. Doing so will expose circuits and components and can lead to injuries, fire or damage to the product.
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 license 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 liquids, unless otherwise specified (see also safety instruction 1.). If this is not taken into account, there exists the danger of electric shock for the user 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. Do not short-circuit batteries and storage batteries.
    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 must be recycled and kept separate from residual waste. Batteries and storage batteries that contain lead, mercury or cadmium are hazardous waste. Observe the national regulations regarding waste disposal and recycling.
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. The product can be very heavy. Be careful when moving it to avoid back or other physical injuries.
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 product 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.
34. Prior to cleaning, disconnect the product from the AC supply. Use a soft, non-linting cloth to clean the product. Never use chemical cleaning agents such as alcohol, acetone or diluent for cellulose lacquers.

Informaciones elementales de seguridad

¡Es imprescindible leer y observar las siguientes instrucciones e informaciones de seguridad!

El principio del grupo de empresas Rohde & Schwarz consiste en tener nuestros productos siempre al día con los estándares de seguridad y de ofrecer a nuestros 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. El presente 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 estándares técnicos de seguridad. Para poder preservar este estado y garantizar un funcionamiento libre de peligros, el usuario deberá atenerse a todas las indicaciones, informaciones de seguridad y notas de alerta. El grupo de empresas 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 está destinado exclusivamente al uso en la industria y el laboratorio o, si ha sido expresamente autorizado, para aplicaciones de campo y de ninguna manera deberá ser utilizado de modo que alguna persona/cosa pueda sufrir daño. 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 mal uso del producto.

Se parte del uso correcto del producto para los fines definidos si el producto es utilizado dentro de las instrucciones de la correspondiente documentación de producto y dentro del margen de rendimiento definido (ver hoja de datos, documentación, informaciones de seguridad que siguen). El uso del producto hace necesarios conocimientos profundos y conocimientos básicas del idioma inglés. Por eso se debe tener en cuenta que el producto sólo pueda ser operado por personal especializado o personas minuciosamente instruidas con las capacidades correspondientes. 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. Guarde bien las informaciones de seguridad elementales, así como la documentación del producto y entréguela a usuarios posteriores.

Símbolos y definiciones de seguridad

							
Ver documen-tación de producto	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 electroestática

					
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

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 el capítulo correspondiente de la documentación de producto y que también son obligatorias de seguir. En las informaciones de seguridad actuales hemos juntado todos los objetos vendidos por el grupo de empresas 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	Identifica un peligro directo con riesgo elevado de provocar muerte o lesiones de gravedad si no se toman las medidas oportunas.
ADVERTENCIA	Identifica un posible peligro con riesgo medio de provocar muerte o lesiones (de gravedad) si no se toman las medidas oportunas.
ATENCIÓN	Identifica un peligro con riesgo reducido de provocar lesiones de gravedad media o leve si no se toman las medidas oportunas.
AVISO	Indica la posibilidad de utilizar mal el producto y a consecuencia dañarlo. En la documentación del producto se emplea de forma sinónima el término CUIDADO.

Las palabras de señal corresponden a la definición habitual para aplicaciones civiles en el área económica europea. Pueden existir definiciones diferentes a esta definición en otras áreas económicas o en aplicaciones militares. Por eso se deberá tener en cuenta que las palabras de señal aquí descritas sean utilizadas siempre solamente en combinación con la correspondiente documentación de producto 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 por principio 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, transporte hasta 4.500 m sobre el nivel del mar.
   Se aplicará una tolerancia de ±10% sobre el voltaje nominal y de ±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 especializado 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. Después de cada recambio de partes elementales para la seguridad deberá ser efectuado un control de seguridad (control a primera vista, control de conductor protector, medición de resistencia de aislamiento, 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 producieran 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 (polvos 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 radiocomunicación RF, 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/usuario está comprometido a valorar y señalar áreas de trabajo en las que se corra un riesgo aumentado de exposición a radiaciones 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 producto.
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. 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 (según la 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 bastidores o instalaciones, se deberá instalar el interruptor al nivel de la instalación.

12. No utilice nunca el producto si está dañado el cable eléctrico. Compruebe regularmente el correcto estado de los cables de conexión a red. 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 (utilización de fusibles de mayor amperaje sólo previa consulta con el grupo de empresas Rohde & Schwarz).
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 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 del estándar IEC950/EN60950.
18. A menos que esté permitido expresamente, no retire nunca la tapa ni componentes de la carcasa mientras el producto esté en servicio. 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, el circuito de suministro de corriente deberá estar protegido de manera que usuarios y productos 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 cortocircuitos 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 líquidos 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 para el usuario 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.

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. No cortocircuitar baterías ni acumuladores. Si las baterías o los acumuladores no son cambiados con la debida atención existirá peligro de explosión (atención células de litio). Cambiar las baterías o los acumuladores solamente por los del tipo R&S correspondiente (ver lista de piezas de recambio). Las baterías y acumuladores deben reutilizarse y no deben acceder a los vertederos. Las baterías y acumuladores que contienen plomo, mercurio o cadmio deben tratarse como residuos especiales. Respete en esta relación las normas nacionales de evacuación y reciclaje.
28. 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.
29. El producto puede poseer un peso elevado. Muévalo con cuidado para evitar lesiones en la espalda u otras partes corporales.
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 sujeción 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 observadas. 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. El fabricante no asumirá ninguna clase de responsabilidad por accidentes o colisiones.
33. Dado el caso de que esté integrado un producto de láser en un producto R&S (por ejemplo CD/DVD-ROM) no utilice otras instalaciones o funciones que las descritas en la documentación de producto. De otra manera pondrá en peligro su salud, ya que el rayo láser puede dañar irreversiblemente sus ojos. Nunca trate de descomponer estos productos. Nunca mire dentro del rayo láser.
34. Antes de proceder a la limpieza, desconecte el producto de la red. Realice la limpieza con un paño suave, que no se deshilache. No utilice de ninguna manera agentes limpiadores químicos como, por ejemplo, alcohol, acetona o nitrodiluyente.

Certified Quality System

DIN EN ISO 9001 : 2000
DIN EN 9100 : 2003
DIN EN ISO 14001 : 2004

DQS REG. NO 001954 QM UM

QUALITÄTSZERTIFIKAT

Sehr geehrter Kunde,
Sie haben sich für den Kauf eines Rohde&Schwarz-Produktes entschieden. Hiermit erhalten Sie ein nach modernsten Fertigungsmethoden hergestelltes Produkt. Es wurde nach den Regeln unseres Managementsystems entwickelt, gefertigt und geprüft.
Das Rohde&Schwarz Managementsystem ist zertifiziert nach:

DIN EN ISO 9001:2000
DIN EN 9100:2003
DIN EN ISO 14001:2004

CERTIFICATE OF QUALITY

Dear Customer,
you have decided to buy a Rohde&Schwarz product. You are thus assured of receiving a product that is manufactured using the most modern methods available. This product was developed, manufactured and tested in compliance with our quality management system standards.
The Rohde&Schwarz quality management system is certified according to:

DIN EN ISO 9001:2000
DIN EN 9100:2003
DIN EN ISO 14001:2004

CERTIFICAT DE QUALITÉ

Cher Client,
vous avez choisi d'acheter un produit Rohde&Schwarz. Vous disposez donc d'un produit fabriqué d'après les méthodes les plus avancées. Le développement, la fabrication et les tests respectent nos normes de gestion qualité.
Le système de gestion qualité de Rohde&Schwarz a été homologué conformément aux normes:

DIN EN ISO 9001:2000
DIN EN 9100:2003
DIN EN ISO 14001:2004

ROHDE&SCHWARZ

1171.0200.11-02.00

Customer Support

Technical support – where and when you need it

For quick, expert help with any Rohde & Schwarz equipment, contact one of our Customer Support Centers. A team of highly qualified engineers provides telephone support and will work with you to find a solution to your query on any aspect of the operation, programming or applications of Rohde & Schwarz equipment.

Up-to-date information and upgrades

To keep your instrument up-to-date and to be informed about new application notes related to your instrument, please send an e-mail to the Customer Support Center stating your instrument and your wish.
We will take care that you will get the right information.

USA & Canada

Monday to Friday (except US public holidays)
8:00 AM – 8:00 PM Eastern Standard Time (EST)

Tel. from USA	888-test-rsa (888-837-8772) (opt 2)
From outside USA	+1 410 910 7800 (opt 2)
Fax	+1 410 910 7801
E-mail	CustomerSupport@rohde-schwarz.com

East Asia

Monday to Friday (except Singaporean public holidays)
8:30 AM – 6:00 PM Singapore Time (SGT)

Tel.	+65 6 513 0488
Fax	+65 6 846 1090
E-mail	CustomerSupport@rohde-schwarz.com

Rest of the World

Monday to Friday (except German public holidays)
08:00 – 17:00 Central European Time (CET)

Tel. from Europe	+49 (0) 180 512 42 42*
From outside Europe	+49 89 4129 13776
Fax	+49 (0) 89 41 29 637 78
E-mail	CustomerSupport@rohde-schwarz.com

* 0.14 €/Min within the German fixed-line telephone network, varying prices for the mobile telephone network and in different countries.

ROHDE&SCHWARZ

1171.0200.22-02.00

Address List

Headquarters, Plants and Subsidiaries

Headquarters

ROHDE&SCHWARZ GmbH & Co. KG
Mühldorfstraße 15 · D-81671 München
P.O.Box 80 14 69 · D-81614 München

Phone +49 (89) 41 29-0
Fax +49 (89) 41 29-121 64
info.rs@rohde-schwarz.com

Plants

ROHDE&SCHWARZ Messgerätebau GmbH
Riedbachstraße 58 · D-87700 Memmingen
P.O.Box 16 52 · D-87686 Memmingen

Phone +49 (83 31) 1 08-0
+49 (83 31) 1 08-1124
info.rsmb@rohde-schwarz.com

ROHDE&SCHWARZ GmbH & Co. KG
Werk Teisnach
Kaikenrieder Straße 27 · D-94244 Teisnach
P.O.Box 11 49 · D-94240 Teisnach

Phone +49 (99 23) 8 50-0
Fax +49 (99 23) 8 50-174
info.rsdts@rohde-schwarz.com

ROHDE&SCHWARZ závod
Vimperk, s.r.o.
Location Spidrova 49
CZ-38501 Vimperk

Phone +420 (388) 45 21 09
Fax +420 (388) 45 21 13

ROHDE&SCHWARZ GmbH & Co. KG
Dienstleistungszentrum Köln
Graf-Zeppelin-Straße 18 · D-51147 Köln
P.O.Box 98 02 60 · D-51130 Köln

Phone +49 (22 03) 49-0
Fax +49 (22 03) 49 51-229
info.rsdc@rohde-schwarz.com
service.rsdc@rohde-schwarz.com

Subsidiaries

R&S BICK Mobilfunk GmbH
Fritz-Hahne-Str. 7 · D-31848 Bad Münder
P.O.Box 20 02 · D-31844 Bad Münder

Phone +49 (50 42) 9 98-0
Fax +49 (50 42) 9 98-105
info.bick@rohde-schwarz.com

ROHDE&SCHWARZ FTK GmbH
Wendenschloßstraße 168, Haus 28
D-12557 Berlin

Phone +49 (30) 658 91-122
Fax +49 (30) 655 50-221
info.ftk@rohde-schwarz.com

ROHDE&SCHWARZ SIT GmbH
Am Studio 3
D-12489 Berlin

Phone +49 (30) 658 84-0
Fax +49 (30) 658 84-183
info.sit@rohde-schwarz.com

R&S Systems GmbH
Graf-Zeppelin-Straße 18
D-51147 Köln

Phone +49 (22 03) 49-5 23 25
Fax +49 (22 03) 49-5 23 36
info.rssys@rohde-schwarz.com

GEDIS GmbH
Sophienblatt 100
D-24114 Kiel

Phone +49 (431) 600 51-0
Fax +49 (431) 600 51-11
sales@gedis-online.de

HAMEG Instruments GmbH
Industriestraße 6
D-63533 Mainhausen

Phone +49 (61 82) 800-0
Fax +49 (61 82) 800-100
info@hameg.de

Locations Worldwide

Please refer to our homepage: www.rohde-schwarz.com

- Sales Locations
- Service Locations
- National Websites

ROHDE&SCHWARZ

EC Certificate of Conformity

CE

Certificate No.: 9502178

This is to certify that:

Equipment type	Order No.	Designation
CMS50	0840.0009.50	Radiocommunic. Service Monitor
CMS52	0840.0009.52	"
CMS54	0840.0009.54	"
CMS57	0840.0009.57	"

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)

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 1995

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

Munich, 01.12.95

Central Quality Management FS-QZ / Becker

ROHDE&SCHWARZ

EC Certificate of Conformity

CE

Certificate No.: 9502172

This is to certify that:

Equipment type	Order No.	Designation
CMS-B1	0840.9406.02	OCXO Reference Oscillator
CMS-B13	0841.1009.02	Signalling Unit
CMS-B2	1001.6809.02	OCXO Reference Oscillator
CMS-B20	0841.1209.02	U/I DC Meter
CMS-B21	1001.6509.02	Programmable Modem
CMS-B22	1001.6750.02	10 MHz Ref. Frequency Inp./Outp.
CMS-B27	1032.1250.02	ATIS/CDCSS Coder and Decoder
CMS-B30	1001.6909.02	RS 232-Interface
CMS-B31	1001.7005.02	Additional RF In/Output
CMS-B32	1001.7905.02	100 W RF Power Meter
CMS-B33	1032.0290.02	300 Hz Lowpass Filter
CMS-B34	1032.1350.02	13 dBm Output
CMS-B35	1075.5441.02	RF Millivoltmeter
CMS-B38	1065.5003.02	Autopilot Generator
CMS-B39	1032.0090.02	600 Ohm AF Transf.

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 electromagnetic compatibility
  (89/336/EEC revised by 91/263/EEC, 92/31/EEC)

Conformity is proven by compliance with the following standards:

EN50081-1 : 1992
EN50082-1 : 1992

Affixing the EC conformity mark as from 1995

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

Munich, 02.04.96

Central Quality Management FS-QZ / Becker

ROHDE&SCHWARZ

EC Certificate of Conformity

CE

Certificate No.: 9502181

This is to certify that:

Equipment type	Order No.	Designation
CMS-B5	0841.0502.xx	Control Interface
CMS-B53	1032.0890.02	Signalling Unit
CMS-B54	1032.0748.02	IEC/IEEE Bus Interface
CMS-B55	1032.0790.02	Centronics Interface
CMS-B59	1032.0990.02	Duplex Modulation Meter
CMS-B60	1075.5006.02	Protection for Input 2
CMS-B9	0840.9506.02	Duplex Modulation Meter

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 electromagnetic compatibility
  (89/336/EEC revised by 91/263/EEC, 92/31/EEC)

Conformity is proven by compliance with the following standards:

EN50081-1 : 1992
EN50082-1 : 1992

Affixing the EC conformity mark as from 1995

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

Munich, 29.11.95

Central Quality Management FS-QZ / Becker

Radiocommunication Service Monitor
CMS50 / CMS52 / CMS54 / CMS57

Operating Manual

Edition 04 / June 1997

REVISION STATE OF PAGES

Order number / Page number		Revision index / Date of edition		Order number / Page number	Revision index / Date of edition
1078.1953.12	1	04	06 / 97		
840.0009.52	0	E-11	06 / 97		
840.0009	CE	E-2	12 / 95		
840.0009	CE.1	E-1	04 / 96		
840.0009	CE.2	E-1	11 / 95		
840.0009.52	1	E-11	06 / 97		
840.0009.52	3 ... 7	E-11	06 / 97		
840.0009.52	I.1 ... I.2	E-2	06 / 97		
1007.8690	1 ... 8	E-2	02 / 96		
840.0009.52	2.1 ... 2.124	E-9	06 / 97		
840.0009.52	3.1	E-9	06 / 97		
840.0009.52	2.200	D/E-1	10 / 92		
840.9306.02	1, 3 ... 29	E-5	06 / 97		
840.0009.57	1, 3 ... 31	E-7	06 / 97		

ROHDE&SCHWARZ

Test and
Measurement Division

Basic Instrument and Options

Printed in the Federal
Republic of Germany

Contents

Index

S

T

V

W

Z

ROHDE&SCHWARZ

Test and Measurement
Division

Supplement to Manual (Basic Instrument)

Testing of ERMES Receivers with the CMS

This test requires a CMS software ≥ V4.95!

Printed in the Federal
Republic of Germany

1 ERMES Main Menu with Controls

The ERMES main menu can be entered by pressing the ERMES key in the selection menu.

In the ERMES main menu, the CMS simulates an ERMES base station. At the socket RF IN/OUT, an RF signal is generated to which ERMES receivers can synchronize. The user can set various signalling parameters, send messages to the receiver under test and check its reaction. Depending on the type of pager, the message sent is signalled optically, acoustically or by vibration on correct reception.

The ERMES service (**E**uropean **R**adio **Me**ssage **S**ystem) is a radio paging service which permits to transmit tone sequences, numeric and alphanumeric messages from a base station to the subscribers. The ERMES networks of different European countries are to be combined to a common network.

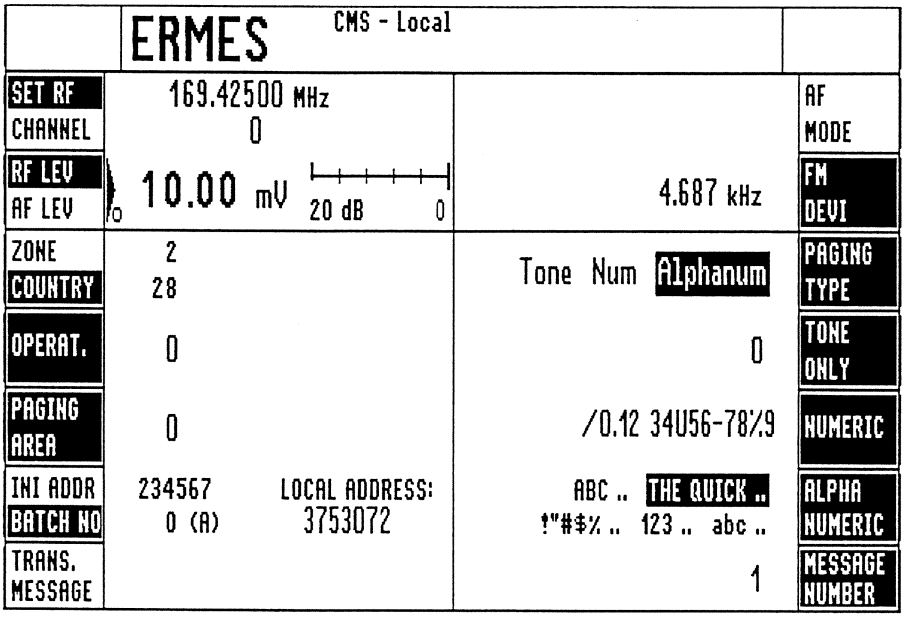
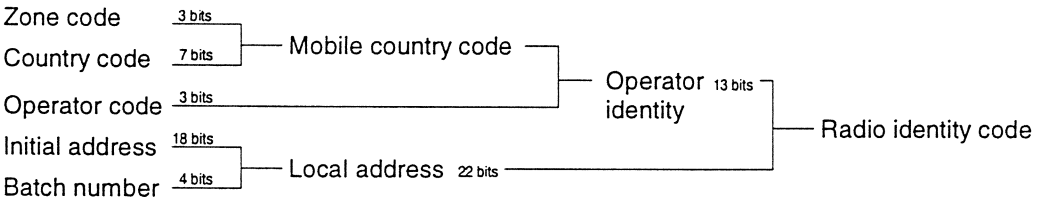


Fig. 1-1: ERMES main menu

The following address and identity codes are defined for the system information contained in the ERMES messages:



The radio identity code is used by the system on the radio path to identify the receiver(s) for which a paging message is intended. It consists of the mobile country code (10 bits), the operator code (3 bits) and the local address (22 bits).

The mobile country code (3 decimal digits) is defined in Annex A to ETS 300 133-4. The first decimal digit of the mobile country code (zone code) is made up of 3 bits and sent in the supplementary system information. The second and the third decimal digit are made up of 7 bits and sent as country code in the system information word.

3 bits (operator code) are used for encoding up to 8 operators per country. The 22 bits of the local address enable up to 4.2 million (2^{22} = 4.194.304) subscribers per operator to be encoded.

After the ERMES main menu has been entered, the CMS starts to issue messages with the ERMES system information. It will take some time for the receiver to synchronize to the signal. If a receiver is taken into operation again for the first time (eg after exchanging the battery), the date and time of day will not be indicated until the receiver is ready for operation. The information on the system time sent as part of the system information can take two forms depending on the channel number set on entering the main menu:.

a) Even channel numbers:

The system information (SI) sent contains in the supplementary system information field (SSIF) the value 0000 and thus the parameters

ZONE (for description see softkey ZONE/-COUNTRY)

HOUR (the time transmitted is 1 o'clock plus the time elapsed since the ERMES main menu was entered)

DATE (the date transmitted is "13", ie the thirteenth day of a month)

b) Odd channel numbers:

The system information (SI) sent contains in the supplementary system information field (SSIF) the value 0001 and thus the parameters

DAY (the day transmitted is "5", ie Friday)

MON. (the month transmitted is "8", ie August)

YEAR (the year transmitted is "9", ie the year 1999).

ERMES receivers can then synchronize to the ERMES signal sent.

For this purpose, the following parameters must be set:

- The RF frequency must correspond to one of the 16 ERMES channels. According to the ERMES specification, ERMES receivers scan all 16 channels to detect the ERMES signal. The parameter FSI is for this purpose set to a fixed value of 30.
- The RF transmitter level must be set to a sufficiently high value. For radiation, an antenna should be connected to the socket RF IN/OUT.

Set the following signalling parameters according to the receiver data:

- Zone number
- Country code
- Operator number
- Paging area

Before sending a message, the LOCAL ADDRESS must be set to that of the receiver (see INITIAL ADDRESS / BATCH NUMBER function).

The individual parameters will be explained in the following:

Function SET RF / CHANNEL

The function SET RF sets the RF frequency of the CMS. The entry is made using
Softkey SET RF/numerical value/unit or ENTER.
Permissible units are MHz, kHz and Hz.

The ERMES signalling covers the frequency range from 169.425 MHz to 169.800 MHz on 16 channels with a channel spacing of 25 kHz. The data rate is 6250 bits/s.

Table 1-1: Assignment of RF frequencies to ERMES channel numbers

Frequency [MHz]	Channel number
169.425	0
169.450	1
169.475	2
169.500	3
169.525	4
169.550	5
169.575	6
169.600	7
169.625	8
169.650	9
169.675	10
169.700	11
169.725	12
169.750	13
169.775	14
169.800	15

The ERMES standard defines 16 RF frequencies for the signal transmission. Table 1-1 shows the assignment of RF frequencies to ERMES channel numbers.

The functions SET RF and CHANNEL are coupled to each other. If the function SET RF is used to set a frequency that corresponds to an ERMES channel number, this channel number will be read out in the display next to the text CHANNEL. If the frequency does not comply with any ERMES channel number, the display indicates ---.

When entering the channel number via the function CHANNEL, the associated RF frequency is always indicated next to the text SET RF.

In addition to direct numerical entries, the rotary knob VAR can also be used to vary the functions SET RF and CHANNEL.

Using the key combination
Softkey SET RF/VAR/numerical value/unit or ENTER
the increment/decrement for variation with the rotary knob VAR can be set.

The key combination Softkey SET RF/REF/ENTER defines the current frequency to be the reference-frequency. The frequency indication in the display is then referred to the reference frequency. The key combination SET RF/REF/CLEAR permits to leave this operating mode again.

Using the key combination
Softkey SET RF/REF/numerical value/unit or ENTER
any frequencies can be defined as the reference frequency.

Function RF LEV / AF LEV

These functions define the output socket of the CMS, where the ERMES signal is output. The respective numbers indicate the level value.

If the function RF LEV is active, the ERMES signal is internally modulated in the CMS upon the RF signal at the socket RF IN/OUT.

The numerical value next to the text RF LEV indicates the RF transmitter level. The function RF LEV is identical with the function of the same name in the receiver test main menu.

The numerical entry is made using
Softkey RF LEV/numerical value/unit or ENTER.

If the function AF LEV is active, the ERMES signal is output as audio signal at the socket MOD GEN and can be used for external modulation upon an RF signal.

The numerical value indicates the level value in volts. A maximum of 5 volts is possible.

The entry is made using
Softkey AF LEV/numerical value/unit or ENTER.
Possible units are µV, mV and V.

The functions RF LEV and AF LEV can be switched on or off using the keys ENTER or CLEAR.

In addition to direct numerical entries, the rotary knob VAR can also be used to vary the functions RF LEV and AF LEV.

As in the case of the function SET RF, the increment/decrement for the rotary knob can also be set using the VAR key in the case of AF LEV, and settings can be defined as reference values using the REF key.

Function ZONE/COUNTRY

The ZONE function is used to set the zone number of the receiver. The ERMES standard defines 8 different zones.

Table 1-2: Definition of zone numbers in ERMES standard.

Zone	Zone number
not used	0
not used	1
Europe	2
North and Central America	3
Asia	4
Australia and Oceania	5
Africa	6
South America	7

The zone numbers are entered using
Softkey ZONE/numerical value/ENTER.

The COUNTRY function permits to set the country code of the receiver. Entries from 0 to 99 are possible.

Table 1-3: Definition of some European country codes in the ERMES standard.

Country	Country code
Greece	02
Netherlands	04
Belgium	06
France	08
Monaco	12
Spain	14
Hungary	16
Italy	22
Romania	26
Switzerland	28
Austria	32
Great Britain	34
Denmark	38
Sweden	40
Norway	42
Finland	44
Poland	60
Germany	62
Gibraltar	66
Portugal	68
Luxembourg	70
Ireland	72
Iceland	74
Albania	76
Malta	78
Cyprus	80
Bulgaria	84
Turkey	86

The country codes of the European countries not listed above as well as those of the non-European countries can be obtained from the ERMES

standard description ETS 300 133-4 of the European Telecommunication Standards Institute (ETSI).

The country code is entered using
Softkey COUNTRY/numerical value/ENTER.

Function OPERATOR

This function is used to set the network operator. According to the ERMES standard, there are up to 7 possible different network suppliers for each country. The respective operator number of the receiver under test is to be set as numerical value. The entry is made using
Softkey OPERATOR/numerical value/ENTER.

Function PAGING AREA

An ERMES network can be divided into up to 64 paging areas. The paging area of the receiver under test is to be set as numerical value using this function.

The entry is made using
Softkey PAGING AREA/numerical value/ENTER.

Function INI ADDR/BATCH NO

This function indicates the individual address (call number) of the receiver. The ERMES standard defines 22 bits for the LOCAL ADDRESS in the system information. This corresponds to 4.193.304 subscribers per network operator.

The LOCAL ADDRESS consists of the Initial Address and the Batch Number.

Bit No.	21	20	.....	5	4	3	2	1	0
	Initial Address					Batch Number			

Fig.1-2: Arrangement of Initial Address and Batch Number in the LOCAL ADDR.

The call number is entered by means of
Softkey INITIAL ADDRESS/numerical value/ENTER and
Softkey BATCH NUMBER/numerical value/ENTER.

The entry and the readout in the display are in the decimal format.

To set the batch number, the last hexadecimal digit of the LOCAL ADDRESS is therefore varied. Following ETS 300 133-4, the batch number is additionally given in the form of a letter (A to P) indicated in brackets.

Function TRANS. MESSAGE

This function is used to transmit a message from the CMS. The type of message is selected using the function PAGING TYPE.

After pressing the key, it is displayed on black background. After the message has been issued, the key automatically changes to white again.

The time elapsing until the message is sent depends on how far the ERMES signalling has proceeded at the time of the keystroke. The following scheme explains this relationship:

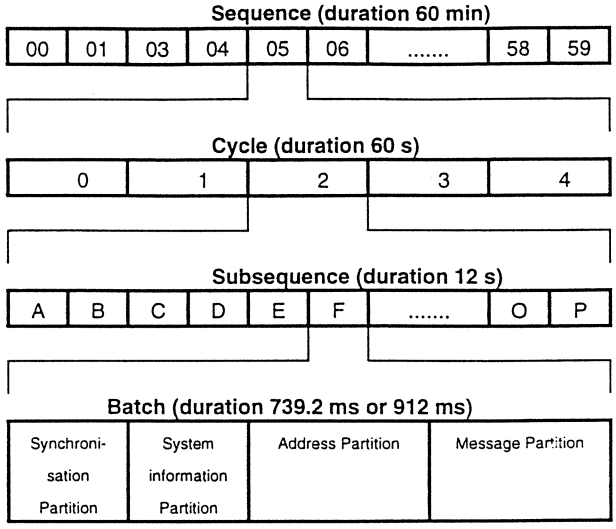


Fig. 1-3: Structure of ERMES transmission protocol for channel 0

16 batches (A to P) are combined to form a subsequence. 15 of the 16 batches take 739.2 ms, and one of the 16 batches 912 ms. The latter may be one of batches A to P, depending on the channel selected. If channel 0 is selected (see Fig. above), batch P takes 912 ms. A subsequence thus has a duration of 12 seconds. 5 subsequencies form a cycle, and 60 cycles constitute a sequence with a duration of one hour.

Synchronization Partition:

Is used to synchronize the receiver to the received ERMES signal.

System Information Partition:

Contains information such as zone, country and operator number, paging area, current sequence, cycle, subsequence and batch number and system time.

Address Partition:

Contains the call number (LOCAL ADDRESS) of the receiver for whom the message in the Message Partition is intended.

Message Partition:

Contains the actual information of the message for the user. It remains unused if paging type 0 (TONE ONLY) is used.

Every ERMES receiver is assigned a batch number (A to P or 0 to 15) which cannot be varied by the user and which results from the 4 least significant bits of the LOCAL ADDRESS.

ERMES receivers only respond to messages featuring their own batch number.

Fig. 1-3 shows that it may take up to 12 seconds until a message with a particular batch number can be sent.

To facilitate operation, the function MESSAGE NUMBER is automatically incremented after the message has been sent.

Function AF MODE

This function permits to open a submenu containing the measuring functions AF voltmeter, DC voltage measurement (only with built-in Option CMS-B20) and the oscilloscope.

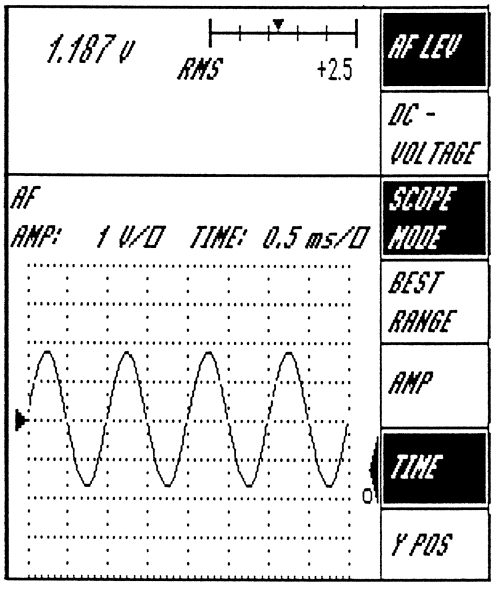


Fig. 1-4: AF submenu

The oscilloscope is operated as in the operating mode transmitter or receiver test. However, the submenu of the function SCOPE MODE cannot be selected.

The input socket AF/SCOPE is set as signal source of the oscilloscope.

If the function SCOPE MODE is active, the CLEAR key permits to stop recording of the signal. The text FREEZE is then indicated in the display. The ENTER key permits to continue the recording again.

Function FM DEVIATION

This function is used to set the FM deviation with which the ERMES signal is modulated upon the RF carrier signal.

The ERMES standard defines a standard deviation of 4.687 kHz.

The numerical entry is made using
Softkey FM DEVIATION/num. value/unit or ENTER.
Permissible units are kHz and Hz.

In addition to direct numerical entries, the rotary knob VAR can also be used to vary the function FM DEVIATION.

As in the case of the function SET RF, the increment/decrement for the rotary knob can also be set using the VAR key, and settings can be defined as reference values using the REF key.

The function is only effective if the function RF LEV is also active, since only then is the ERMES signal modulated upon the RF carrier and output at the socket RF IN/OUT.

Function PAGING TYPE

This function selects the type of message to be sent.

The ERMES standard defines 3 different types of messages which are also referred to as paging types:

TONE ONLY (paging type 0):

This is a tone-only message that releases a particular receiver-dependent tone sequence in the receiver. Eight different tones are possible at two priority levels.

With this type of message, the Message Partition is not used. The message information is encoded with 4 bits in the Address Partition.

NUMERIC (paging type 1):

With this type of message, up to 20 digits and certain special characters can be transmitted. They are shown in the display of the receiver and may represent a telephone number, for example.

ALPHANUMERIC (paging type 2):

Alphanumeric messages with up to 400 characters and special characters can be transmitted. Receivers of paging type 2 can also receive messages of the two other paging types.

Function TONE ONLY

This functions is used to determine the tone to be sent. The entry is made using
Softkey TONE ONLY/numerical value/ENTER.
Numerical values from 0 to 15 are possible.

The function is only effective if the function PAGING TYPE is set to TONE.

Function NUMERIC

This function is used to determine the numeric message to be sent. The entry is made using
Softkey NUMERIC/string/ ENTER.

The ERMES standard defines the following characters for numeric messages:

Table 1-4: Assignment of the numeric characters to the CMS keys.

Character	CMS key
1	1
2	2
3	3
4	4
5	5
6	6
7	7
8	8
9	9
0	0
%	MHz, kHz, %, A
/	kHz, µV, W, B
U	Hz, dBµV, C
Space	dB, dBm, rad, D
- (hyphen)	-
. (full stop)	.

The function is only effective if the function PAGING TYPE is set to NUM.

Function ALPHA NUMERIC

This function permits to select one out of 5 predefined alphanumeric messages. The CMS offers the following messages:

- All upper-case letters of the alphabet

  ABCDEFGHIJKLMNOPQRSTUVWXYZ

- All lower-case letters of the alphabet

  abcdefghijklmnopqrstuvwxyz

- All digits

  1234567890

- All special characters defined in the ERMES standard

  !\"#$%@£¥§&/?+-.=,; :*

- A text containing all letters of the alphabet

  THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG

The function is only effective if the function PAGING TYPE is set to ALPHANUM.

Function MESSAGE NUMBER

The messages regarding a particular ERMES receiver can be assigned a continuous number. Thus a receiver is able to determine whether one or several messages have not been received, for example because it has been out of operation for some time.

The numerical entry is made using
Softkey MESSAGE NUMBER /numerical value/ENTER.
Numbers from 1 to 32 are possible.

When pressing the key TRANS. MESSAGE, the function MESSAGE NUMBER is automatically incremented by the CMS.

2 IEC Remote-control Commands

Command Syntax	Data (number range)	Unit	Description
DISPLAY:MENU	25,00	---	Entering the ERMES main menu without submenu
DISPLAY:MENU	25,66	---	Entering the ERMES main menu with audio submenu
ERMES:RF:CHANNEL	Number (0-15)	---	ERMES channel number
ERMES:AF	Number ON OFF	V MV UV	Numerical value for AF level • Switch on AF level • Switch off AF level
ERMES:AF:VARIATION	Number	V MV UV	Step size of rotary knob for AF level
ERMES:AF:REFERENCE	Zahl ON OFF	V MV UV	Reference input for AF level • Switch on reference display • Switch off reference display
ERMES:ZONE	Number (0 - 7)	---	Zone number
ERMES:COUNTRY	Number (0 - 99)	---	Country code
ERMES:OPERATOR	Number (0 - 7)	---	Number of network operator
ERMES:INIT:ADDRESS	Number (0 - 262143)	---	Upper 18 bits of call number
ERMES:BATCH	Number (0 - 15)		Lower 4 bits of call number
ERMES:PAGING:AREA	Number (0 - 63)	---	Number of paging area
ERMES:TRANSMIT	ON	---	Transmission of ERMES message
ERMES:MODULATION	Number ON OFF	MHZ KHZ HZ	Numerical value for modulation deviation • Switch on modulation • Switch off modulation
ERMES:MODULATION:VARIATION	Number	MHZ KHZ HZ	Step size of rotary knob for modulation deviation
ERMES:MODULATION:REFERENCE	Number ON OFF	MHZ KHZ HZ	Ref. input for mod. deviation • Switch on reference display • Switch off reference display
ERMES:PAGING:TYPE	TONE NUM ALPHANUM	---	Selection of type of message • Tone-only message • Numeric message • Alphanumeric message
ERMES:TONE	Number (0 to 15)	---	Tone-only number
ERMES:NUMERIC	String (max. length: 20 characters)	---	Numeric message
ERMES:ALPHA:NUMERIC	THE_QUICK CAPITAL SMALL NUMBERS SPECIAL	---	Selection of alphanum. message • Text with all letters of the alphabet • all upper-case letters • all lower-case letters • all digits • all special characters
ERMES:MESSAGE:NUMBER	Number (1-32)	---	Number of the message to be sent

The syntax for the functions AF LEV, DC VOLTAGE and the oscilloscope control in the ERMES submenu is identical with that in the transmitter and receiver test and can be obtained from the respective chapter.

2 Operation

The values stated in this section are not guaranteed; only the technical data on the data sheet are binding.

The numbers printed in bold type and italics refer to the controls shown in the front and rear views Figs. 2-1 and 2-2.

2.1 Explanation of Front and Rear Views

2.1.1 Front Panel

(see Fig. 2-1 in appendix)

1

Display

All information for the user is output on the display. It contains a menu heading and status line, describes the functions of the softkeys and indicates the set and measured values in digital and analog form. The information shown on the display changes depending on the selected menu.

2

Softkeys

16 softkeys with alternating functions. The respective function is output on the display directly next to the softkey.

Numbers have been assigned to the softkeys for referencing in the text:

Left-hand softkey column		Right-hand softkey column	
☐	0	☐	8
☐	1	☐	9
☐	2	☐	10
☐	3	☐	11
☐	4	☐	12
☐	5	☐	13
☐	6	☐	14
☐	7	☐	15

3

Numeric keypad 0 to 9

For entering values.

4

Dimension key with ENTER function

Frequency	MHz
Level	mV
Modulation(AM), distortion	%
With tone sequences: numeric value	A

5

Dimension key with ENTER function

Frequency, modulation(FM)	kHz
Level	µV
Power	W
With tone sequences: numeric value	B

6

Dimension key with ENTER function

Frequency, modulation (FM)	Hz
Level	dBµV
With tone sequences: numeric value	C

7

Dimension key with ENTER function

Quasi-dimension for relative settings, SINAD, S/N	dB
Level, power	dBm
Modulation (φM)	rad
With tone sequences: numeric value	D

8

Minus sign

Every number is positive unless a minus sign is entered.
Input of tone sequences:

With DTMF	#
With all other codes	F

9

Decimal point

Input of tone sequences:

with DTMF	*
with all other codes	E

10

ENTER
ON

- Terminating key for all inputs which do not have or require a dimension or quasi-dimension.
- Switching-on the functions which were switched off by OFF.

11

CLEAR
OFF

- Abortion of commenced input strings.
- Switching-off of functions
- Switching-off of functions such as REF, RANGE, VAR, TOL.
- Deletion of a deletable message in the 2nd status line.

12

VAR

Settings can be varied using this spinwheel. The step size and the assignment of the parameter can be defined using the function key VAR.

13

SHIFT

The keys ***14*** to ***20*** have dual functions. The SHIFT key must be pressed to reach the function printed in the top line. The softkeys ***0*** to ***15*** also have a dual function depending on the menu. The second function (top or bottom) is made accessible by first pressing the SHIFT key. The status line indicates when the SHIFT function is active.

14

H.COPY *)
START

H.COPY: Output hardcopy of screen on a printer.
START: Execution of autorun control program (one of the most important functions).

15

RETURN *)
STOP

STOP: Transfer from IEC bus mode to manual mode.

The following applies in autorun control mode:

RETURN: Transfer from IEC bus mode to manual mode.
Transfer from autorun control mode to manual mode.

STOP: Stop current autorun control program.

16

RECALL
STORE

RECALL: Recall instrument settings.
STORE: Store instrument settings.

*) depending on model or option

17

RESET
MENU ↓

RESET: Set instrument to its factory-setting. Autorun control programs are not cleared in this way.
Menu ↓: Enables searching for submenus together with the active cursor in the display

18

REF
MENU ↑

REF: Entered or measured values are declared as reference values.
MENU ↑: Transfer to higher-level menu.

19

RANGE
VAR

RANGE: Storing of full-scale value with analog display.
VAR: Definition of setting increment when using VAR spinwheel.

20

- TOL
+ TOL

Definition of upper and lower limits. The tolerance markers are set in the analog display, and the tolerance evaluation is defined in the autorun control.

21

CONTRAST

Adjustment of screen contrast.

22

VOLUME

Adjustment of loudspeaker volume.

23

MEMORY

Plug-in for the chip card CMS-Z1 or CMS-Z2.

24

AF/SCOPE*)
INPUT
1 MΩ

Input for all AF and DC measurements. The signals connected here can be evaluated by the AF and DC measurement points or displayed on the scope. Input resistance depends on the model or option.

25

MOD GEN*)
OUTPUT

Output of AF generator. Output resistance depends on the model or option.

26

MOD EXT
INPUT
1 MΩ

Input for external modulation signals, also second input for the scope.

27

DEMOD*) **RF*)**
OUTPUT **OUT2**

(If RF OUT2 is at the front, DEMOD OUTPUT is provided at the rear).

Output for the demodulated signal.

*) depending on model or option

28

RF IN 2

⚠ 1 V_{MAX}
~50 Ω

Second RF input; high sensitivity, therefore suitable for remote measurements.

29

RF IN/OUT (optional 80/100 W)

⚠ 50 W_{MAX}
50 Ω

RF power input, also output for RF signals of instrument. This connector is usually linked to the antenna connector of the radiotelephone.

2.1.2 Rear Panel

(see Fig. 2-2 in appendix)

40

F2: T10.0D/250 V DIN 41571

Fuse for battery operation.

41

L I N E — O F F — B A T T

This switch has 3 positions:
Line mode ON
Line and battery modes OFF
Battery mode ON

42

11...30 V DC

Connection of external DC source to instrument.

45

Blower

The blower and the vents in the instrument housing must not be covered since both the power loss of the instrument and the output power of the radiotelephone are discharged via this blower.

46

PRINTER PARALLEL INTERFACE *)

Printer output (Centronics).

47

Alternatively, depending on the model and/or option fitted:

CONTROL

Multifunction input/output with relay connections, TTL inputs / outputs and further functions (Option CMS-B5).

DC MEASUREMENT

Connector for voltage and current measurements.

48

IEC 625 *)
IEC/IEEE bus connection

49

AC supply voltage selector and fuse holder
100/120 V: DIN 41571 - T 1.6 D/250 V
220/240 V: DIN 41662 - T 800/250 V

50

AC power connection

47 to 420 Hz

*) depending on model or option

2.2 Preparation for Use

Unpack the instrument and check that the listed accessories are present. Before switching on for the first time, refer to Sections 2.2.1 and 2.2.2.

2.2.1 AC Power Mode

Setting the AC Supply Voltage

The instrument is designed for rated AC voltages of 100 V, 120 V, 220 V or 240 V (frequency 47 to 420 Hz). Before switching on the instrument for the first time, check that the correct AC supply is set. With new instruments, the set voltage is printed on the yellow label on the AC connector. If this does not agree with the local voltage, convert as follows:

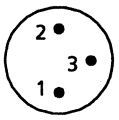
- Unscrew fuse holder ***49*** by $^1/_2$ rotation to the left and remove.
- Remove fuse from fuse holder.
- Set desired voltage (arrow). For this purpose, insert voltage selector switch and rotate.
- Insert fuse with required rating (fuses included in accessories).
  A fuse T 1.6 D is required for 100/120 V,
  a fuse T800 for 220/240 V.
- Insert fuse holder and lock by $^1/_2$ rotation to the right.

Once the AC cable has been inserted into the connector ***50***, the instrument can be switched on using the rocker switch ***41*** on the rear panel (LINE position). The instrument is switched off when in the OFF position, even if the AC cable is connected (no standby mode). The power consumption with the basic configuration is approx. 50 VA.

2.2.2 Battery Mode

An external DC supply can be connected to the connector 11 ... 30 V DC ***42***. The DC battery socket CMS-Z7 can be purchased using the ordering code 841.1350.02. The connection is made as follows:

(viewed onto soldered side)



1 Instrument ground
2 +
3 free

Note:

Connector 42 can only be inserted in one position and thus prevents incorrect polarity. The instrument is not protected against incorrect polarity, however, e.g. when soldering the battery socket.

Spare fuses for battery mode are included in the accessories.

Once the connection to the DC supply has been made, the instrument can be switched on using the rocker switch ***41*** on the rear panel (BATT position). The instrument is switched off when in the OFF position, even if the battery cable is connected (no standby mode). The power consumption is approx. 40 W.

2.3 Operation

The instrument functions are possible in three main operating modes:

- Manual operation
- Autorun control
- Remote control via IEC/IEEE bus.

2.3.1 Power-Up Status

A selftest including various internal operating point adjustments is carried out following power-up. The selection menu is output in the display if no errors are detected, otherwise the corresponding error message is output (cf. Section 2.14.11).

The instrument is equipped with a back-up battery so that the set parameters and measured values are retained when the instrument is switched off or in the event of a power failure. Only the settings for the selection menu and RF and AF levels do not correspond to the status prior to switch-off. This is for reasons of clarity as well as for the safety of devices-under-test and the instrument itself.

A status independent of the previous settings is achieved using the keys SHIFT RESET. Apart from data entered by the user (such as e.g. tone sequence frequencies), this state corresponds to the state when delivered.

If the RESET key is actuated and retained during switch-on, all data entered - except for the autorun control programs - are reset (factory-setting).

2.3.2 Controls

The instrument controls comprise the keys and the VAR spinwheel ***12***.

All instrument outputs with respect to manual operation are on the display ***1***.

2.3.2.1 Softkeys

The softkeys have alternate functions. The respective function is output on the display directly next to the softkey. Together with the display, the softkeys are the main elements for menu operation.

Maximally two functions are output on the display next to a softkey depending on the menu.

The function indicated in inverted form (light characters on dark background) is applicable; the other function can be selected using the SHIFT key ***13*** or by pressing again the same softkey.

2.3.2.2 Hardkeys

2.3.2.2.1 Function-based Hardkeys

An active cursor on the display (▸) indicates the current function. The hardkeys refer to this function.

Function-based hardkeys:

RANGE, VAR, REF, -TOL, +TOL, MENU ↓ (DOWN), dimension keys, ENTER, CLEAR

Examples of hardkey applications:

RANGE

The full-scale value of the analog display usually matches itself to the measured value (auto-ranging). It is sometimes necessary to fix this value during adjustments.

RANGE/ENTER
The full-scale value is held at the current value.

RANGE/CLEAR
Autoranging becomes active again.

RANGE/number/ENTER
The full-scale value is the entered number or next higher number in steps of 1-2-5. The dimension corresponds to that in the display.

RANGE/number/dimension
The full-scale value is the entered number or next higher number in steps of 1-2-5 with the selected dimension.

To indicate that the RANGE HOLD function is switched on, the full-scale value on the analog display is inverted.

VAR

The VAR spinwheel can be used to vary set parameters. The VAR function is used to define the variation increment and the associated function.

Unless a specific VAR operation is made, the function of the spinwheel always corresponds to the current setting parameter with display of VAR symbol ∘ (see Fig. 2.3-1).

VAR ENTER
The VAR spinwheel is assigned the selected function; it can only be changed by VAR or VAR ENTER with another function. At the same time, the VAR symbol ∘ is changed to •.

VAR/CLEAR
Cancellation of fixed assignment.

VAR/number/ENTER
Sets a desired variation increment. The dimension corresponds to that in the display.

VAR/number/dimension
Sets a desired variation increment. The dimension corresponds to that in the display.

VAR/0/ENTER
Selection of minimum increment.

Exceptions:

- In the case of a frequency setting on the modulation generators 1 and 2, the VAR spinwheel is used to vary frequencies from a fixed series.
- The VAR function is automatically assigned to certain functions (time, amp. and Y pos. on the scope) without the user having to press the VAR key.

The assignment of the VAR function is identified in the display by a symbol.

If a parameter which is assigned the VAR function is switched off using OFF, rotating of the VAR spinwheel has no effect.

REF

The output of measured values or settings on the display can be absolute or referred to a reference value.

Measurements which are always relative values (SINAD, S/N) cannot be referred even further to a reference value. Frequencies are indicated as a frequency difference relative to the reference value. All other relative displays are in dB.

REF/ENTER
The current value is defined as reference value.

REF/number/ENTER
The number is defined to be the reference value. The dimension of the reference value corresponds to that in the display.

REF/number/dimension
The number with the dimension is defined to be the reference value.

REF/CLEAR
Return to absolute dimension.

Identification of relative displays:

The quasi-dimension dB is a relative display. In the case of frequencies, the sign (also +) shows that relative frequencies are displayed.

The analog display has a special feature in the case of relative dimensions or quasi-dimensions:

The 0 point is always on the left.

Either the right-hand half of the axis is shown with a positive full-scale value or the left-hand half of the axis with a negative full-scale value depending on the current measured value. The full-scale value is always displayed on the right, however.

TOL

Entered tolerance values have two effects:

- Limits are entered on the scale of the analog display. They serve for optical orientation during adjustments.
- They enable an evaluation during autorun control depending on the result: tolerance in or tolerance out.

`+/- TOL/ENTER`
The current measured value becomes the tolerance limit.

`+/- TOL/number/ENTER`
The entered number is defined to be the tolerance limit. The dimension corresponds to that in the display.

`+/- TOL/number/dimension`
The entered number with dimension becomes the tolerance limit.

`+/- TOL/CLEAR`
Deletion of tolerance markers.

Special features:

The two tolerance markers are not always visible.

A tolerance marker is not displayed if it is above the full-scale value. If one tolerance limit is above 0 and the other below 0 in the case of a relative display, not more than one tolerance marker will be visible on the screen because only one of the two branches (either above 0 or below 0) can be displayed depending on the measured value.

Take care with the sign when selecting the tolerance marker if a relative dimension is present:

e.g. -105 dBm is smaller (-TOL) than -95 dBm (+TOL).

MENU ↓ (DOWN)

If the function which the active cursor points to in the display has a submenu, this is indicated in the status line by an arrow pointing downwards. The corresponding submenu is selected by pressing the MENU ↓ key, and a further submenu can be called if present by pressing again. (MENU ↑ (UP): return to status existing before MENU ↓ (DOWN) was entered).

Dimension keys

For settings:

`Number/dimension`
Setting of value including dimension.

`Dimension`
Conversion of set value into selected dimension.

With measurements:

`Dimension`
Representation of measured value in selected dimension.

Entered dimensions are modified by the instrument automatically if the desired dimension is not compatible with the display format.

Exception:

When entering tone sequences, the dimension keys have the significance of digits. The termination function is also cancelled in this context. Tone sequence entries are terminated by the ENTER key.

ENTER, ON

The ENTER key terminates input strings.

These can be commands (`REF/ENTER`), or also inputs. The ENTER key is used if the dimension is to remain unchanged or if the entered value has no dimension. ENTER can also be used to restore set values previously switched off by CLEAR.

CLEAR, OFF

The 4 functions of CLEAR are:

- Abortion of a commenced input string.
- Switching-off of hardkey functions such as REF, RANGE, VAR or TOL.
- Switching-off of set values; particularly suitable for relative settings with a logarithmic scale since the number "0" has the meaning "Reference value" in this case and not the meaning "Off".
- Deletion of a deletable message in the second status line.

2.3.2.2.2 Mode-related Hardkeys

The instrument can be operated in 6 different modes:

Manual operation mode
IEC/IEEE bus mode (remote) *)
Autorun control RUN mode
Autorun control HOLD mode
Autorun control LEARN mode
Autorun control AUTORUN menu

The functions of the hardkeys START, RETURN and STOP correspond to the instrument mode selected.

IEC/IEEE-bus mode (remote) *)

STOP
Allows for entering the manual mode providing RWLS (remote with lockout state) was not set. (Meaning : local).

Autorun control: RUN mode

STOP
Results in leaving the RUN mode and entering the HOLD mode.

Autorun control: HOLD mode

START
The autorun control enters the RUN mode and continues the program. (Meaning: continue).

STOP
Change from HOLD mode to manual operation. (final stop)

RETURN
Entering the AUTORUN menu of autorun control.

Autorun control: LEARN mode

START
Start of LEARN mode.

Learn mode commences in the selection menu when it is called for the first time. It commences in the last processed menu if it is called again.

Autorun control: AUTORUN menu

START
Start of selected program (new start in contrast to continue).

2.3.2.2.3 Independent Hardkeys

The hardkeys described here always have the same meaning.

SHIFT
A key pressed upon entering SHIFT selects the second function. This is the function indicated in the top line on the hardkeys. With the softkeys, this is the function with the non-inverted label, which can be output in the display next to the corresponding softkey in the top or bottom line.

CLEAR
Cancels an unintentional input of SHIFT.

RESET
Sets the instrument to a defined initial status. Only user-specific parameters such as the assignment of tone frequencies to digits or programs are retained.

*) depending on model or option

MENU ↑ (UP)
Return to next higher menu. This key has no effect in the selection menu.

STORE
This key has 2 functions:

- In the autorun control (LEARN mode), completely entered commands are stored in autorun control programs. The STORE key has a terminating function in this case.
- In addition, instrument states are transferred to the memory using the STORE key.

  Syntax: `STORE/number/ENTER`

  Numbers 1, 2 or 3:
  Internal storage of complete instrument settings.

  Frequencies for AF1 are stored only if the function AF COUPL (submenu DIST/SINAD, DIST) is off.

  Numbers 4 to 9:
  Storage of instrument settings on the chip card.

  Numbers 20 to 39 (two-digit):
  Storage of RF frequencies.

RECALL
The RECALL function corresponds to the STORE function.

- The internally-stored instrument status is set by entering
  `RECALL/number (single-digit)/ENTER`
- The stored frequency is output in the status line by entering
  `RECALL/number (two-digit)`
  and can be accepted using ENTER or deleted using CLEAR.

The STORE and RECALL functions can also be integrated in an autorun control program.

Example:

`10/MHz`	`STORE`	`STORE/3/ENTER`	`STORE`
Set 10 MHz	Imple-mentation in an autorun control program	Store RF setting in memory 13	Imple-mentation of storage pro-cedure in the autorun con-trol program

H.COPY *)
Produce hard copy of current display on a printer.

2.3.2.3 VAR Spinwheel

In contrast to specific entry of parameters using the keys, the VAR spinwheel is used for parameter variation. Its function is very similar to that of the VAR key (see function-based hardkeys (VAR), Section 2.3.2.2.1). The VAR spinwheel can either be specifically assigned to a desired function or can be assigned to the current function. The variation is possible in any step sizes, also logarithmic. The setting values are increased by rotating clockwise and decreased by rotating counterclockwise. The VAR spinwheel is automatically assigned to the scope functions amplitude, time and Y-position.

Special features of VAR spinwheel:

The input `VAR/0/ENTER` does not lead to the minimum increment in the case of a frequency setting on modulation generators 1 and 2. In this case, frequencies from a fixed series are varied using the spinwheel:

0.3 /0.6 / 1 / 1.25 / 2.7 / 3 / 6 / 10 kHz
(default settings)

The VAR spinwheel has no effect (even in background mode) if it is used on a set value which has been switched off using OFF.

*) depending on model or option

If RF levels are reduced using the VAR spinwheel, these settings differ from the corresponding direct key entries in the following manner:

The spinwheel variation utilizes the interruption-free, electronic reduction in level as far as possible (-19.9 dB with FM and ϕM, -4.9 dB with AM), whereas the mechanically switched attenuators are used as far as possible to set the level with a key input.

Entry of level via keys:
Best possible broadband S/N ratio, but interruption in level when changing (audible switching of attenuator set).

Entry of level using the VAR spinwheel:
Interruption-free level variation, e.g. for squelch measurements.

In contrast to all other settings, an analog display is also provided for the RF level setting. This represents the interruption-free level fine variation (when reducing from right to left).

In the case of the two-function softkeys (e.g. COUNT/SET RF), when the VAR spinwheel can only be used for one of the softkey functions, the activated VAR symbol is displayed also if the softkey function without possible VAR operation is selected.

2.3.2.4 Display

The functions of the display are to indicate user inputs, to display setting and measured values in analog and digital form and to describe the respective function of the softkeys.

Status lines

The operating mode of the instrument is described in the top status line. The second status line contains messages.

Softkey inscriptions

The respective function of the softkeys is output at the right-hand and left-hand margins of the display, directly next to the softkeys. The function displayed in inverted form is currently active. If the softkey is assigned two functions, the second function can be activated using the SHIFT key. The active cursor is positioned next to one of these fields (see Fig. 2.3-1). It marks the function which can be manipulated by entering values or by using the function-based hardkeys (see Section 2.3.2.2.1).

The VAR symbol ∘ is changed to • if the adjacent parameter has been set for VAR spinwheel variation.

Representation of measured and set values

Measured and set values are output in the centre of the display. Set values are usually displayed in digital form only (exception: RF level setting with VAR spinwheel). Measured values are displayed in digital and analog form. Attributes such as RMS or PK refer to the nature of the measured value. The analog displays may be provided with tolerance markers (see function-based hardkeys (TOL), Section 2.3.2.2.1).

The submenus at the lowest position in the hierarchy usually fill a small section of the display only. These display fields overwritten by the submenu are emphasized by italic lettering.

The display can also copy the oscilloscope or spectrum monitor display in addition to the digital and analog outputs of individual measured values. It is only used as an editing or displaying tool in certain menus.

The display characteristics are described in detail in the individual menus.

If the CMS is not operated on for some time, the display will become dark so as to save energy (which is of particular importance when the CMS is operated from battery). It will be bright again by pressing any key. This keystroke does not have any other function then.

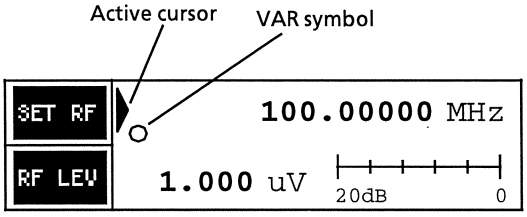
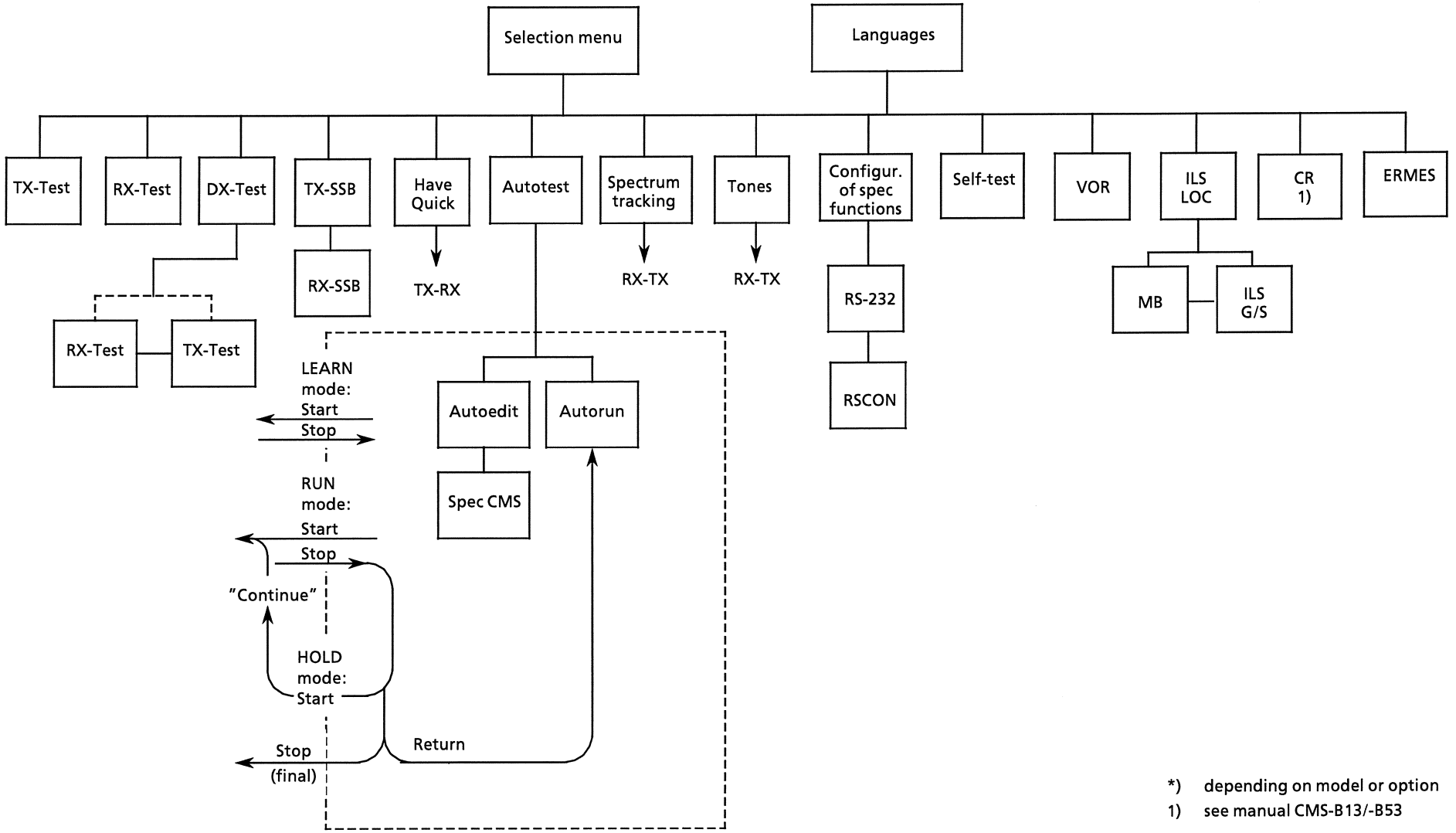


Fig. 2.3-1 Active cursor and VAR symbol

2.3.3 Menu Structure*)

Fig. 2.3-2 illustrates the menu structure of the instrument without consideration of lower hierarchical levels.



*) depending on model or option
1) see manual CMS-B13/-B53

Fig. 2.3-2 Menu structure

2.3.4 Error Reaction

If erroneous operation occurs, the instrument outputs an error message in the status line and produces an audible signal, and rejects the setting. Range violations beyond the minimum value are replaced by the minimum value. Range violations above the maximum value are rejected in order to protect the connected device-under-test. The instrument also reacts to faulty test routines by display of a message and by an audible signal.

2.3.5 Connection of Device-under-Test (DUT)

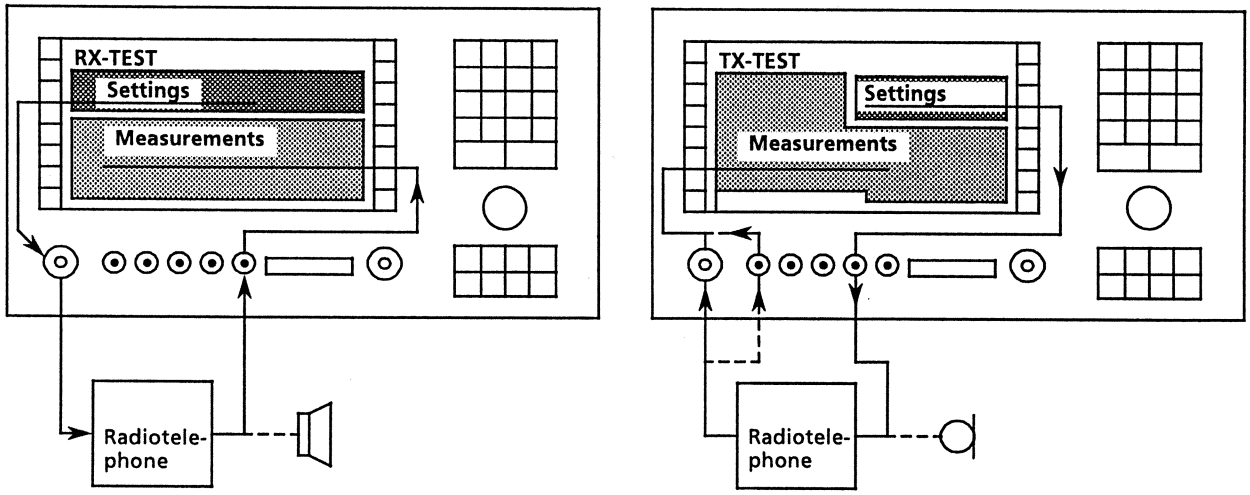


Fig. 2.3-3 Connection of the device-under-test

2.3.6 Selection Menu

After switching on the instrument the selection menu offers all main menus.

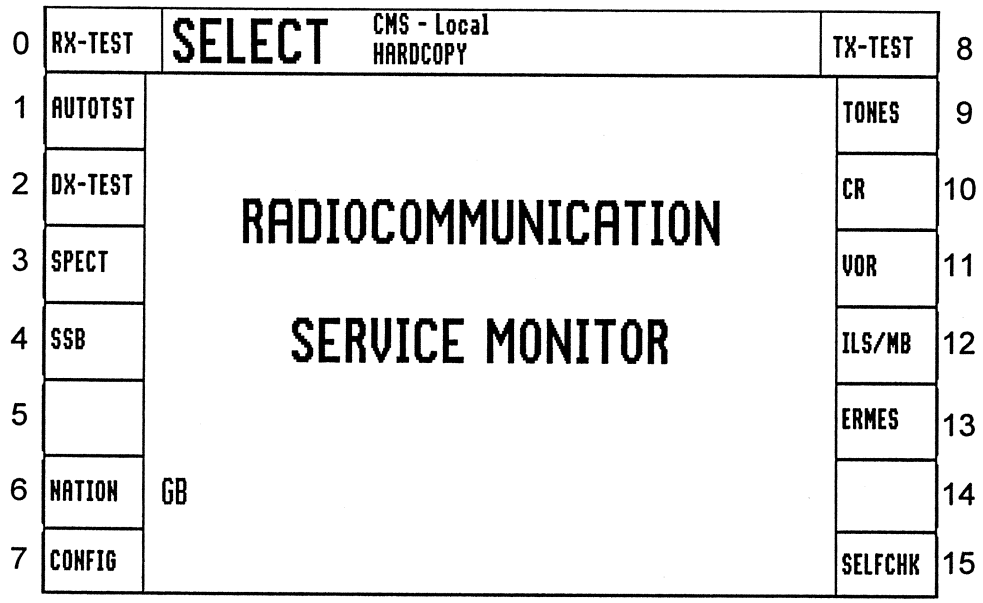


Fig. 2.3-4 Selection menu

2.4 Transmitter Test (TX-Test)

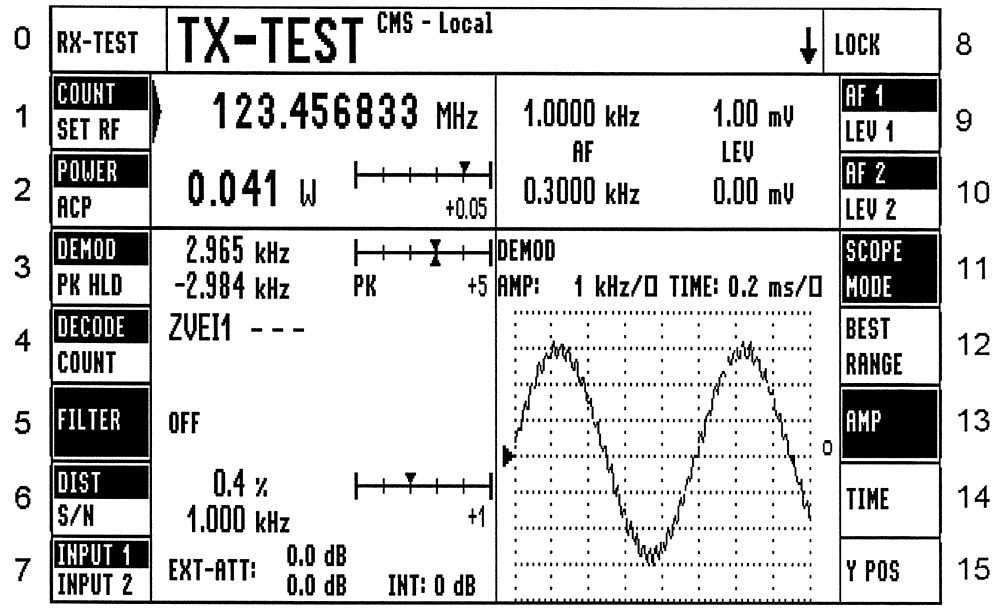


Fig. 2.4-1 Main menu TX-TEST

Starting with the main menus of the selection menu, the main menu TX-TEST (transmitter test) can be entered by pressing the softkey TX-TEST.

This menu contains all controls required to carry out a standard transmitter test. Almost every function contains submenus. These provide controls for more transmitter test functions, which are less often required.

Softkey 0 can be used to directly branch to the main menu for the receiver test (RX-TEST).

2.4.1 RF Measurement

In the case of simple transmitter tests the instrument measures the transmitter frequency and sets the demodulators to this frequency. The receiver frequency of the instrument can also be preset if the device under test outputs several carrier frequencies or if the time for counting is insufficient for the demodulator to respond rapidly (demodulation of a fast acknowledgement).

COUNT Function

The count function is constantly active if the COUNT field is shown in inverted form.

The normal count function only operates at the connector RF IN/OUT. Depending on the model, the direct RF count also operates at the sensitive input (input 2).

The counter resolution can be set using the following input sequence: `softkey COUNT/number 1 or 10/terminating key Hz` or `ENTER`. Thus 1 Hz (slow) or 10 Hz (fast) is selected as the counter resolution.

The sensitivity of the RF counter in particular with frequencies < 1 MHz can be enhanced by switching the IF filter on (FILTER submenu 2, softkey 6: IF-NARROW).

Relative counting

There are two possibilities for selecting a reference frequency for relative counting.

Input of softkey `COUNT/REF/ENTER` declares the frequency just measured as the reference frequency; input of `softkey COUNT /REF /number /termination key dimension` or `ENTER` declares the entered frequency as the reference frequency.

A sign in front of the result indicates that a relative frequency count is being carried out. Absolute frequency counting can be reselected by entering `softkey COUNT/REF/OFF`.

The dimensions MHz, kHz or Hz can be selected for direct or relative counting, e.g. `softkey COUNT/Hz`.

COUNT Function: Submenu

The function COUNT has a submenu which is output in the display fields next to softkeys 3, 4 and 5.

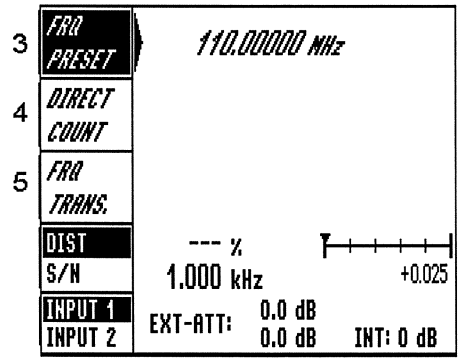


Fig. 2.4-2 COUNT submenu

The normal count function comprises a coarse direct broadband count and a subsequent exact narrowband IF count. The direct count is possible only at the connector RF IN/OUT, the IF count is possible at both inputs (RF IN/OUT and RF IN 2).

Softkey 3: FRQ PRESET (IF count)

A frequency count can be initiated in a narrowband range (approx. 100 kHz) by entering a frequency.

Switch-on: `Softkey3/number/dimension or ENTER`
The entered frequency replaces the coarse count.

Switch-off: `Softkey3/OFF`

Applications:

The IF count method can also be used at the input RF IN 2. If a source outputs several carrier frequencies with a sufficiently large spacing (approx. > 1.5 MHz), this method can be used to select a carrier frequency and to selectively count it. (Method of selection: see softkey 5 (FILTER:IF NARROW) in the main menu).

Note: ***If the squelch function of the CMS is deactivated (submenu DEMOD), only a restricted COUNT function is possible:***
OFF: ***no function***
ON: ***first apply the RF signal to be measured, then press softkey COUNT.***

Softkey 4: DIRECT COUNT

Switch-on: `Softkey 4/number 100 or 1000/dimension Hz or ENTER`. Direct counting is carried out with a resolution of 100 or 1000 Hz, but only via the connector RF IN/OUT.

Switch-off: `Softkey 4/OFF`

Applications:

Measurements can be performed on relay stations even if the instrument is not equipped with a duplex modulation meter. The signal generator of the instrument stimulates the receiver of the relay station, while the direct counter determines the frequency of the relay station transmitter, which may also be in a completely different frequency band.

Softkey 5: FRQ TRANS (transfer function)

Actuating this softkey once transfers the measured frequency as CMS receiver frequency.

In the main menu, this action switches from the COUNT function to the SET function.

Application:

Softkey 5 facilitates operation with regard to the entry of multi-digit and often unknown transmitter frequencies as CMS receiver frequency.

SET RF Function

The receiver frequency of the instrument is fixed using the SET RF function. It is not based on the counter result. If the SET RF function is not already active (displayed in inverted form), it can be activated by entering SHIFT/softkey SET RF. The CMS receiver frequency is usually entered and displayed as a frequency value.

The CMS receiver frequency is entered using softkey SET RF/number/dimension or ENTER.

The receiver frequency setting can be varied using the VAR function and the VAR spinwheel. The receiver frequency setting can also be relative.

The reference frequency can be entered using sofkey SET RF/REF/ENTER if the current frequency is to become the reference frequency, or using the softkey SET RF/REF/number/dimension or ENTER if a frequency is to be set different from the reference frequency.

SET RF Function: Submenu

The SET RF function has a submenu which is output in the display fields next to softkeys 3 to 7.

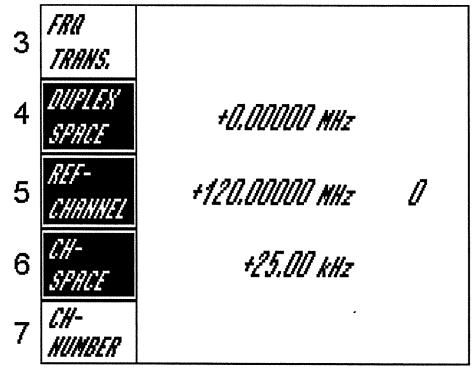


Fig. 2.4-3 SET RF submenu

Softkey 3: FRQ TRANS (frequency transfer function)

Actuating this softkey switches the frequency transfer function on or off.

An activated transfer function has the following effects:

- At the point of switchover from TX→RX, the RX RF frequency is calculated from the RF frequency set or counted in the TX test and the duplex spacing.
- At the point of switchover from RX→TX, the TX RF frequency is calculated from the RF frequency set in the RX test and the duplex spacing, if the RF counter in the TX test is off.
- When the RX RF frequency in the duplex menu is changed, the TX RF frequency continuously follows displaced by the duplex spacing, if the RF counter is off.
- When the TX RF frequency is changed (by RF counter or setting), the RX RF frequency follows displaced by the duplex spacing.

Softkey 4: DUPLEX SPACE

The duplex spacing is entered by sequence sign/ number/(dimension or ENTER).
Values between -500MHz and +500MHz are possible.
The duplex spacing is positively counted if the RX RF frequency is larger than the TX RF frequency.

Softkeys 5, 6 and 7 serve to define the channel numbers.

Softkey 5: REF CHANNEL (reference channel)

The reference channel is entered by number/ ENTER.
Values between 0 and 9999 are possible.
Entries are permissible only if the channel number mode is off (softkey 7).
This entry establishes reference between frequencies and channel numbers. In addition to the reference channel entry, also the respective reference frequency is displayed.
At a duplex spacing not equal to zero, the reference frequency in the TX and RX test is different. In the DX test, the reference frequency is always referred to the RX frequency.

Softkey 6: CH-SPACE (defining channel spacing)

The channel spacing is entered by sequence sign/ number/(dimension or ENTER).
Values between -1MHz and +1MHz are possible.
Entries are permissible only if the channel number mode is off (softkey 7).

A positive sign means that higher channel numbers correspond to higher frequencies.

Softkey 7: CH NUMB. (channel number)

Actuating softkey 7 switches the channel number mode on or off.

When channel number mode is on, frequencies are only displayed as channel numbers plus offset. Reference between channel numbers and frequencies is made when the reference channel is entered.

If the channel number mode is activated in the RX or DX test, the RX RF frequency is assigned to the reference channel selected by softkey 5. The TX channel number is calculated from the TX RF frequency and the duplex spacing and displayed if present in the menu.

If the channel number mode is activated for the TX test, the TX RF frequency is assigned to the reference channel selected by softkey 5.

With VAR spinwheel variations, also the frequencies are varied in the channel number mode. This gives the offset to the channel number.

Offset also occurs if the RF counter counts frequencies that are not exactly in line with the channel spacing.

Frequencies with channel numbers below 0 or above 9999 are not indicated as channel number plus offset, but by normal frequency display.

2.4.2 Power Measurement

POWER Function

The broadband RF power measurement can only be performed at the RF IN/OUT socket; the selective RF power measurement can also be carried out at the RF IN 2 socket (input 2). The dimensions of the broadband RF power measurement are W or dBm, those of the selective RF power measurement are mV, W, dBµV or dBm.

A logarithmic relative display based on a reference value can be selected. Tolerance markers can be set on the analog bar for the dimensions mentioned above; Autorange or Range Hold can be selected on the analog display for the full-scale value.

Selective power measurement:
In this measurement mode the CMS is automatically operated in the mode BEAT mode with an IF of 2 kHz (LO frequency of the local oscillator is 2 kHz **below** the frequency indicated).

The demodulator is switched off. The test bandwidth is approximately the set receiving frequency ± 50 kHz.

The dynamic range is dependent on the input:
RF IN/OUT: ca.125 µV (-65 dBm) to 50 V (47 dBm)
RF IN 2 : ca. 22 µV (-80 dBm) to 4mV (-35 dBm)

Measurement sensitivity can be increased by reducing the test bandwidth using the filters available in the CMS.

The use of the CCITT filter may cause problems as, in accordance with the definition, it features no constant attenuation characteristic in the pass band.

In contrast to the broadband RF power measurement, the selective RF power measurement also includes the Peak Envelope Power (=PEP). With AM results that are up to 6 dB higher (100%) are therefore obtained. Calibration of the selective RF power measurement is not required.

Note: ***Limiting sensitivity may be reduced as a result of strong signals outside the measuring bandwidth. If the frequency of the device-under-test strongly deviates from the nominal frequency, the measurement may be impaired.***

Remedy: ***Monitoring the 2-kHz beat signal by way of the loudspeaker or scope.***

POWER Function: Submenu 1

Pertaining to the POWER function a submenu is available, which is assigned to the fields beside the softkeys 3 to 6 in the display.

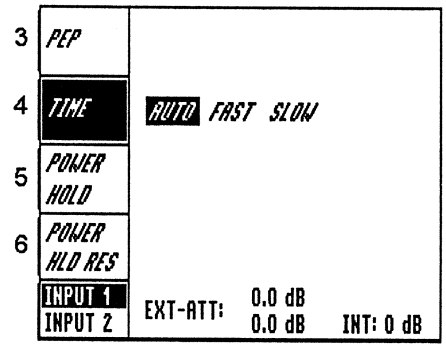


Fig. 2.4-4 POWER submenu 1

Softkey 3: PEP
The type of RF power measurement (selective or broadband) is selected using this softkey.

ON: Selective RF power measurement
OFF: Broadband RF power measurement

Softkey 4: TIME
With broadband RF power measurements a low-pass filter in the measurement path is switched on (SLOW) or off (FAST) using this function. With the setting AUTO the lowpass is switched on during AM modulation; otherwise the lowpass is off. Its cutoff frequency is about 4 Hz.

Softkey 5: POWER HOLD
Storage of the maximum value is switched on when actuating this softkey, i.e. the highest measured value of each RF power measurement (selective or broadband) is stored until deletion. The maximum value is deleted by pressing the softkey 6 (POWER HLD RES) or softkey 2 (POWER).

Softkey 6: POWER HLD RES
The maximum value of RF power measurement currently stored is deleted provided that softkey 5 (POWER HOLD) is activated.

POWER Function: Submenu 2 *)

VSWR - Voltage Standing Wave Ratio. A second submenu with softkeys 3 to 7 assigned is available for this measurement.

VSWR measurement comprises the determination of the forward and reflected power and the calculation of their ratios (VSWR).

VSWR measurement is effected using a measuring head (NAS-Z1, Z3, Z5, Z6, Z7) which is connected at the rear of the CMS via a sub-D cable at the 50-contact connector.

The measuring head, which is inserted between transmitter and antenna, determines the forward and reflected voltage. An analysis of the data supplied by the measuring head is effected in the CMS, with an additional indication of the ratios of the two voltages.

VSWR measurement is executed by opening the 2nd submenu under the <POWER> softkey and by connecting the measuring head. In some models the start in the TX menu is then automatic *).

After the VSWR measurement has started, the values of the forward and reflected voltage as well as the ratio of these two values are indicated one below the other. These values are indicated in digital form with an additional representation on the analog bar.

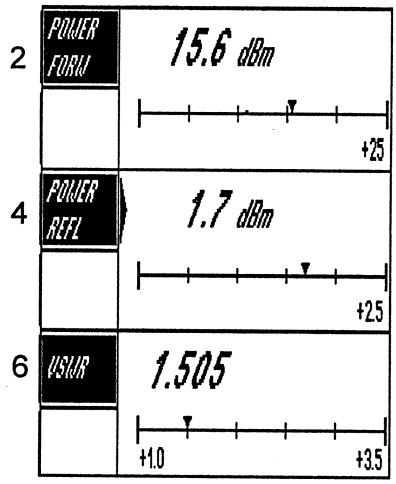


Fig. 2.4-5 POWER submenu 2
Functions "TOL" and "REF" cannot be used for the indication of the VSWR value. A change of unit is neither possible in the indication of this value which has no unit. Further, the analog bar scaling of the VSWR result always starts with 1.

*) depending on model or option

The VSWR function (softkey 6) allows the entry of a correction factor for the forward and reflected wave in the range from 1 to 100. The selected correction factor is always linear and matches the CMS with the measuring head used. If the factor is ≠1, ! is displayed in front of the measured value.

ACP Function *)

Adjacent Channel Power Measurement (ACP)

The desired channel and the adjacent channel are measured using the filters described in the specifications (FT 17 TR 2049, ETS 300086) and set in relation to each other.

Measured value (dB) = 10 x log (power of used channel / power of adjacent channel)

The following values are specified for the CMS:

Channel spacing 25 kHz
ACP filter bandwidth 16 kHz
Required spacing 70 dB

Before switching on the adjacent channel power measurement, the desired reference frequency must be entered using the softkey "SET RF". If this frequency is omitted, a warning is displayed in status line 2.

ACP Function : Submenu 1

The ACP function has a submenu which appears in the display adjacent to the softkeys 3 to 6.

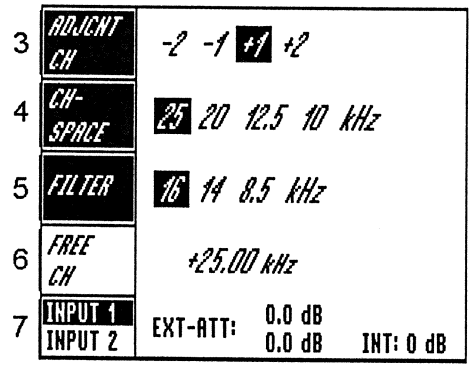


Fig. 2.4-6 ACP submenu 1

Softkey 3: ADJCNT CH
Channel select for the first/second and upper/lower adjacent channel.

Softkey 4: CH SPACE
Selecting specified channel spacing with automatic filter switching.

Softkey 5: FILTER
Filter selection when choosing "free" channel spacing.

Softkey 6: FREE CH
Selecting a user-defined channel spacing up to1000 kHz in 10-Hz steps.

ACP Function : Submenu 2

Harmonic Measurement (not for CMS 50)

This submenu of the ACP measurement has softkeys 2 to 6 assigned. The harmonic measurement permits to determine the power of the first to fourth harmonic of an RF carrier. The frequency of the nth harmonic is equal to n times the frequency of the RF carrier.

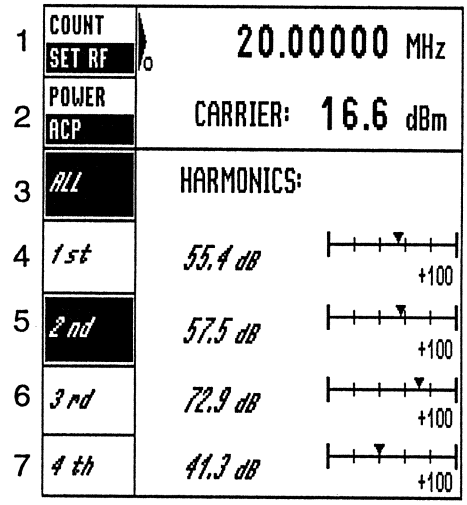


Fig. 2.4-7 ACP submenu 2

The harmonic measurement is to be found in the second submenu of the ACP measurement. Before entering the harmonic submenu, COUNT must be switched to SET RF and the RF frequency of the carrier to be examined set.

After opening the menu, the measurement is started automatically. The absolute power of the RF carrier is indicated opposite to the ACP key.

There are two possible ways of measuring harmonics:

1. If the key ALL is active, the four harmonics are measured cyclically one after the other.
2. If the key ALL is not active, only the power of the currently selected harmonic is measured.

*) depending on model or option

The power unit of the harmonic is determined by the unit of the fundamental. This can be selected by pressing a unit key if the active cursor is positioned on the ACP key.

The following units are possible for the harmonic measurement:

Table 2.4-1

Unit of fundamental	Unit of harmonics
mV/V µW/mW/W dBµV dBm	mV/V µW/mW/W dBµV dB

2.4.3 Demodulation

Softkey 3 is assigned two functions:

DEMOD (continuous demodulation)
PK HLD (demodulation with peak hold function)

The first or second function is selected using the SHIFT key.

DEMOD Function

The instrument is able to demodulate the transmitter signal according to AM, FM or ϕM. One of the three demodulation modes is selected by the following input:

`softkey DEMOD/dimension`. FM demodulation is then used for the dimensions Hz and kHz, AM demodulation for % and ϕM demodulation for rad.

Different weighting modes can be selected in the submenu. If peak weighting is selected, the positive and negative peaks are displayed at the same time. Tolerance markers and decision criteria such as e.g. branching in the autorun control program always refer to the positive peak value, however. The RMS weighting generates only one measured value.

Modulation sensitivity

The modulation sensitivity is integrated in a search routine, which varies the AF voltage of the modulation generator at the transmitter input until a predefined modulation depth, frequency deviation or phase deviation is attained as transmitter modulation.

The entry is made using:
`Softkey DEMOD/number/dimension.`
The number corresponds to the entered modulation value and the dimension to the demodulation mode of the CMS.

If the demodulation mode output in the display is to be retained, ENTER can be input instead of the dimension.

The analog display can be assigned a full-scale value depending on the measured value or a fixed full-scale value (see function-based hardkeys (RANGE), Section 2.3.2.2.1). The positive peak value applies if the fixed full-scale value is to be derived from the currently measured value.

Tolerance markers can be entered in the analog display (see function-based hardkeys (TOL), Section 2.3.2.2.1). In the event of two measured values it is again the positive peak value which is used for the tolerance weighting.

DEMOD Function: Submenu

The DEMOD function has a submenu which is output in the fields in the display next to softkeys 4 to 7.

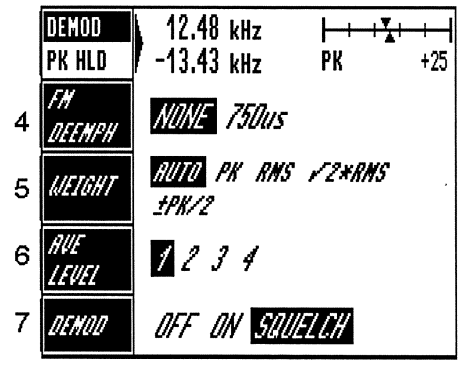


Fig. 2.4-8 DEMOD submenu

Softkey 4: FM DEEMPH (deemphasis)

Softkey 4 can be used to switch on or off a 750-µs-deemphasis. This function is only of significance with FM selected.

Softkey 5: WEIGHT (rectifier)

Softkey 5 is used to select the detector. There are five different possibilities:

AUTO: Noise signals are RMS weighted and wanted signals are peak weighted. Small signals are automatically considered to be noise signals and large signals to be wanted signals.

The limit (RMS) is
200 Hz frequency deviation for FM
0.2 rad phase deviation for ϕM
1 % modulation depth for AM.

PK: Simultaneous positive and negative peak-value measurements.

RMS: Real RMS measurement.

$\sqrt{2}$ * RMS: Real RMS measurement multiplied by 1.41.

This measurement is used for determination of the peak value when modulating with sinewave signals, and the integrating effect of the RMS detector is to be used at the same time (e.g. with noisy signals).

$\pm$ PK/2: Average of positive and negative peak-value measurement.

Softkey 6: AVE LEVEL (averaging factor)

Softkey 6 can be used to select an averaging factor for RMS and 1.41 RMS measurements. Four averaging possibilities are provided.

1: One measurement determines the result.

2: The result is the average of two measurements.

3: The result is the average of three measurements.

4: The result is the average of four measurements.

Each single measurement corresponds to the average of 5 AD measurements.

in IEC-bus mode, the single measurements are repeated following a delay time in the case of large changes in signal level.

The peak-value measurement is always performed with one cycle only.

Averaging factors are selected if reproducible results or a constant analog display are desired despite noise. The repetition rate of the measurements is of course reduced with high averaging factors.

Softkey 7: DEMOD (demodulator)

Softkey 7 offers the following alternatives:

OFF: Switching off demodulator
ON: Switching on demodulator
SQUELCH: Activation of squelch

The squelch switches on the demodulator with a sufficiently high IF level and switches it off at a low level.

Applications:

It is recommended to have the demodulator continuously switched on for remote measurements. The squelch function is activated if the noise of the uncontrolled demodulator results in interferences (e.g. before and after a transmitter burst of limited duration).

The OFF function (demodulator off) is provided as a precautionary measure for switching off e.g. a high-level signal at the output of the demodulator to prevent interference with other sensitive measurements in the CMS.

PK HLD Function

The demodulation mode for the PEAK HOLD function is based on the DEMOD function. Pressing the PK HLD softkey resets the display and stores the largest measured value of the positive peak-value meter until cleared again.

It is also possible with PEAK HOLD to program the full-scale value of the analog display just as with DEMOD. The setting of tolerance markers is also possible.

Using the functions "750-µs deemphasis" and "Squelch" of the demodulator from the DEMOD submenu with the PEAK HOLD function is also advantageous.

Nevertheless, a submenu has not been produced for PEAK HOLD so that functions from the main menu which are used particularly frequently together with the PEAK HOLD function, e.g. decoding of a tone sequence, are not covered by the submenu. If these functions are required, they can be set in the DEMOD submenu and used for the PEAK HOLD function.

See Section 2.12 for further special functions.

2.4.4 AF Measurement

Softkey 4 is assigned two functions:

DECODE (tone sequence decoding)
COUNT (frequency measurement of demodulated or beat signal)

The shift key is used to select between first and second function.

DECODE Function

The tone sequence decoder is activated following actuation of `Softkey4/ENTER`. A decoding result is deleted if present in the display and the tone sequence decocde expects a sequence for decoding. Once this has arrived, it is output in two lines on the display together with the designation of the standard.

The digits 0 to 9 and possibly the special characters A to F are displayed, and also * and # with dual-tone sequences. X indicates a non-decodable frequency and P indicates a pause. The PEAK HOLD function is activated together with the decoding function since the modulation is usually also of interest in addition to the contents of the tone sequence.

DECODE Function : Submenu 1

The function DECODE branches into two submenus, which are output in the display fields next to softkeys 3 to 7. By pressing ENTER, the decoder can also be started from this menu.

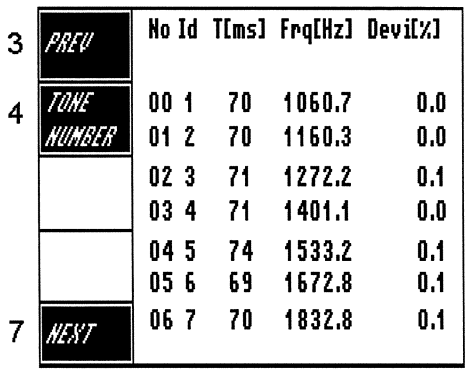


Fig. 2.4-9 DECODE submenu 1

This submenu reads out the contents of the decoded telegram in more detail. Each entry in the measurement buffer is identified by a sequential number starting with "0".

The column "T" gives the measured duration of each displayed tone.

With the tone sequence standards 1 to 9, additionally the frequency measured for each received tone is displayed in the column "FRQ [Hz]", as well as the deviation from the rated frequency in percent in the column "Devi [%]". No information will be shown for invalid tones or tone pauses or, as the case may be, dual tones. Restarting the decoder in submenu 1 causes the data of the new telegram to be output sequentially - beginning with "0" - when the tone sequence has been received completely.

Softkey 3: PREV (page down)

The display pages down to the previous page. This softkey has no function when the first page is already displayed.

Softkey 4: TONE NUMBER *)
(printing of individual lines)

By programming <TONE:NUMBER value>, the contents of a respective line can be printed in the report. If no value is entered, all the lines are printed in form of a table.

Softkey 7: NEXT (page up)

The display pages up to the next page. This softkey has no function if the last tone that was decoded is already shown.

Note: *Submenu 1 is of no significance for standards 15 and 16 (CDCSS, ATIS)*

*) depending on model or option

DECODE Function: Submenu 2

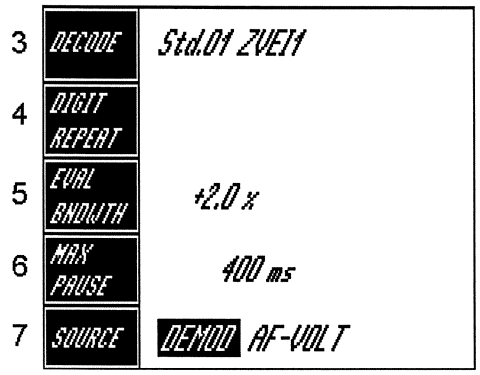


Fig. 2.4-10 DECODE submenu 2

Softkey 3: DECODE (tone sequence standard)

Softkey 3 is used to select the tone sequence standard. The entry is made using softkey `3/number/ENTER` where each number is assigned a tone sequence standard.

Table 2.4-2

Standard number	Unmodified	Modified
0	Std.0 fixed frequencies	Std.0
1	Std.1 ZVEI 1	Std.1
2	Std.2 ZVEI 2	Std.2
3	Std.3 CCIR	Std.3
4	Std.4 EEA	Std.4
5	Std.5 EIA	Std.5
6	Std.6 VDEW	Std.6
7	Std.7 EURO	Std.7
8	Std.8 CCITT	Std.8
9	Std.9 NATEL	Std.9
10	Std.10 DTMF	Std.10
11	Std.11 VDEW direct dial	-------

Standards 1 to 9 are the most common single-tone sequences. To differentiate between unmodified and modified tone sequences, the CMS outputs the standard number and name in the display or, with modified tone sequences, only the standard number.

The assignment of frequencies to numbers is displayed in the definition menu for tones and can also be modified. Standard 0 reacts like a completely normal tone sequence standard. In this case the frequencies are the fixed frequencies for the AF generators. Standard 10 is the dual-tone standard and cannot be modified for evaluation purposes.

Softkey 4: DIGIT REPEAT

Softkey 4 can be used to switch on/off the digit repeat. Since tone length information cannot be used for evaluation purposes, a double digit is not represented by an extra-long tone but by a tone followed by a further tone (tone E) as the repeat tone. The double digit appears with the digit repeat function switched on, the digit and the special character E appear with the digit repeat function switched off.

Softkey 5: EVAL BNDWTH (evaluation bandwidth)

The evaluation bandwidth of the decoder is programmed by entering softkey `5/number/ENTER`. The number should be selected as the magnitude in % which is permissible as a positive or negative deviation from the rated frequencies. Frequencies within this window are decoded as valid. Frequencies outside this window are marked by X.

The tolerance window should not be extended too far, especially in the case of tone sequences with narrow frequency steps, since this could lead to overlapping of the tolerance ranges and thus ambiguous decoding results.

Softkey 6: MAX PAUSE (tolerable pause)

The decoder waits for brief pauses and then continues decoding. The tone sequence is considered to be terminated if the pauses are too long, then the result is displayed. This time limit can be defined using softkey `6/number/ENTER`. The dimension of the number is ms.

This pause definition must not be confused with the pause between two tones which is defined in the standard and which can be influenced in the definition menu for tones. The latter is smaller than the previously defined time limit. A "P" is set during the evaluation if only the intertone pause is exceeded.

Softkey 7: SOURCE (signal source)

Softkey 7 is used to select either the demodulator or the AF voltmeter socket (AF/SCOPE) as the decoder source.

Option CMS-B27 serves to select standard 15 for CDCSS decoding or standard 16 for ATIS decoding using softkey DECODE under function DECODE in submenu 2.

Further details and applications of the decoder function are to be found in section 2.10.

COUNT Function

The frequency of the demodulated signal or the beat signal is counted by pressing softkey 4.

A relative measurement can be made in two different ways:

- The currently measured frequency is selected as the reference frequency by entering softkey `4/REF/ENTER`.
- The frequency corresponding to the number is selected as the reference frequency by entering `REF/number/dimension` or `ENTER`.

The relative result is the difference from the reference frequency. Relative measurements are identified by a sign in front of the result.

COUNT Function: Submenu

The COUNT function has a submenu which is output in the fields in the display next to softkeys 5 and 6.

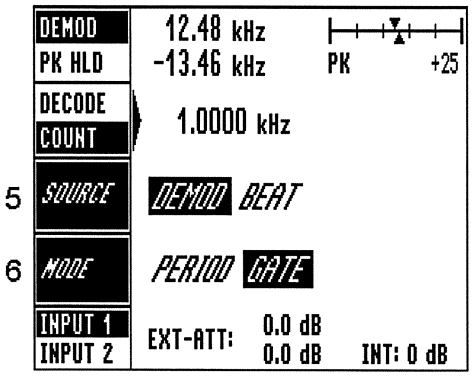


Fig. 2.4-11 COUNT submenu

Softkey 5: SOURCE (Signal source)

Softkey 5 can be used to switch between the signal sources DEMOD (demodulated signal) and BEAT (beat signal).

Since the beat measurement is usually carried out with an unmodulated signal, the AF generator of the CMS is switched off following the activation of softkey 4 (COUNT) provided that BEAT is selected.

Softkey 6: MODE (operating mode and resolution of counter)

There are two alternatives:

1. Period counting
2. Gate time counting

Period counting has a resolution of 0.1 Hz up to 100 kHz; the resolution is 1 Hz at frequencies above this value. Period counting is fast but requires a signal without noise.

Gate time counting is less sensitive to noisy signals.

2.4.5 Filter Selection

FILTER Function

Various AF filters can be switched on or off using softkey `5/ON` or `OFF`. The IF and AF filters and their characteristic frequencies can be selected in two submenus.

FILTER Function: Submenu 1

The FILTER function branches to two submenus, which are both output in the display fields next to softkeys 4 and 7.

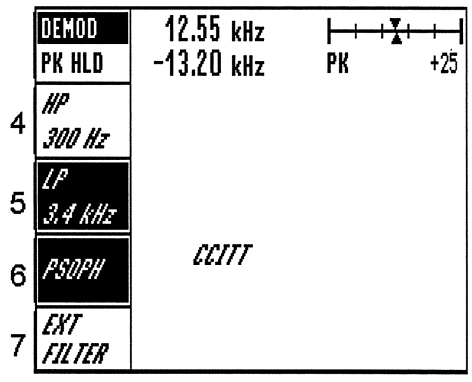


Fig. 2.4-12 FILTER submenu 1

Softkey 4: HP 300 Hz (300-Hz highpass)

Switching the 300-Hz highpass on and off.

Softkey 5: LP 3.4 kHz (3.4-kHz lowpass)

Switching the 3.4-kHz lowpass filter on and off.

Softkey 6: PSOPH (psophometric filter, option CMS-B5 or CMS-B39 or CMS-B20)*)

Switching the psophometric filter on and off. The psophometric filter is a CCITT filter or a C-message filter.

Softkey 7: EXT FILTER *)

Switching the external filter on and off. An input and output for the external filter are fitted to the rear of the device (CONTROL socket ***47***; pin 10 = input/pin 42 = output).

With the option CMS-B33*) installed, the same is activated and deactivated using EXT FILTER. In this case there is no longer any input and output for the external filter at the rear of the device.

The FILTER submenu 2 can be called by pressing the MENU ↓ (DOWN) key.

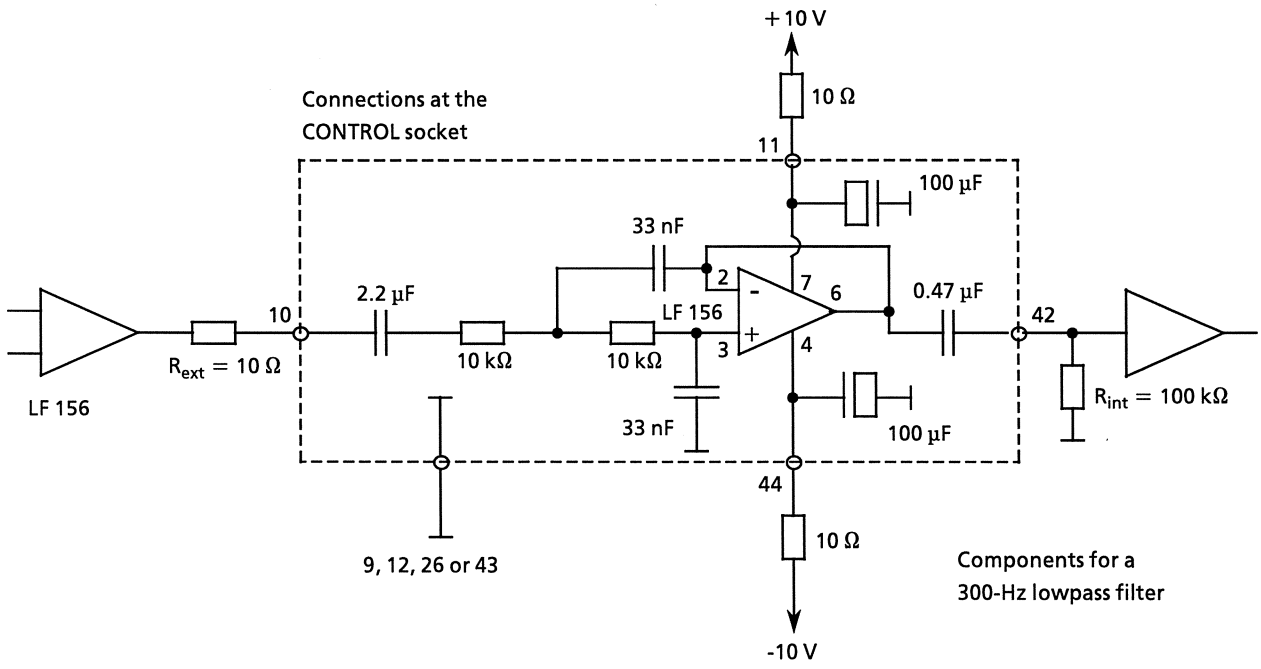


Fig. 2.4-13 Example of an external filter

*) depending on model or option

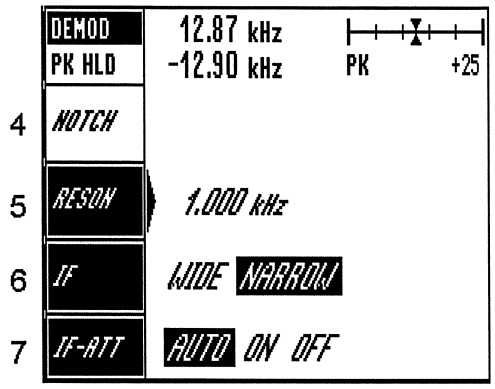


Fig. 2.4-14 FILTER submenu 2

Softkey 4: NOTCH (notch filter)

The notch filter is switched on using softkey `4/ON` and off using `softkey 4/OFF`.

Stop frequency of notch filter:
The stop frequency of the notch filter is also selected using softkey 4. The entry is made using softkey `4/number/dimension` or `ENTER`.

Since the resolution of the set frequencies cannot always be set as required, the actually set frequency is output in the display.

Softkey 5: RESON (resonance filter)

The resonance filter is switched on using `softkey 5/ON` and off using `softkey 5/OFF`.

Resonance frequency of resonance filter:
Softkey 5 is used to select the resonance frequency of the filter. The entry is made using `softkey 5/number/dimension` or `ENTER`. The actually set frequency is displayed as with the notch filter.

Filter combinations*)

For better understanding all filters can be envisaged as a series connection of three filter groups:

- Highpass filter - lowpass filter
- Psophometric filter - external filter
- Notch filter - resonance filter

Highpass and lowpass filters can be combined independently into four different filter configurations.

*) depending on model or option

The psophometric filter and the external filter cannot be combined, the same applies to the notch filter and the resonance filter. Since the notch filter is used for distortion and SINAD measurements, the last filter group cannot be used for evaluation during a distortion or SINAD measurement.

Notch filter and resonance filter are also being switched off when quitting or selecting a new RX test and TX test, since in this case SINAD or DIST measurements automatically continue to run.

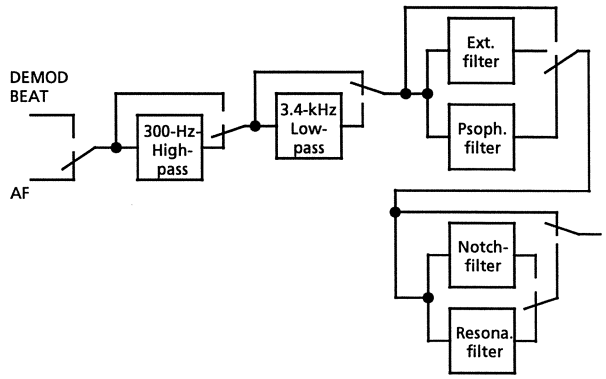


Fig. 2.4-15 Signal paths

Softkey 6: IF (IF filter)

The IF filter can be switched on and off using softkey 6. The IF bandwidth is limited to approx. 25 kHz by the NARROW filter. This improves the S/N ratio, especially when receiving small RF levels, but also results in a distortion at higher deviations and/or modulation frequencies.

Softkey 7: IF-ATT (IF attenuation)

The attenuator of the IF control can be switched on or off (important with AM demodulation). Also an automatic function is available.

The softkeys 6 and 7 are not displayed in the receiver test.

2.4.6 Distortion and S/N Measurements

Softkey 6 is assigned two functions:

DIST (distortion measurement)
S/N (S/N measurement)

The SHIFT key is used to select between first and second function.

DIST Function

The distortion measurement can be performed with the dimension % or dB. The test frequency may vary between 100 Hz and 4 kHz.

Dimension

The measurement is performed in dB by entering `softkey 6/dimension/dB` and in % by entering `softkey 6/dimension/%`.

Test frequency

The test frequency is defined using `softkey 6/number/dimension/Hz` or `kHz`.

The full-scale value can also be influenced in the analog display for the distortion measurement:

The currently measured value is used to define the full-scale value by entering `softkey 6/RANGE/%` or `dB` or `ENTER`.

A number is used to define the full-scale value by entering `Softkey 6/RANGE/number/%` or `dB` or `ENTER`.

Tolerance markers can be set in the analog display using the same syntax: `softkey 6/TOL/number/% or dB or ENTER`.

DIST Function: Submenu

The DIST function branches into one submenu, which is ouput in the display fields next to softkeys 5 and 7. Softkey 6 is assigned to the main menu.

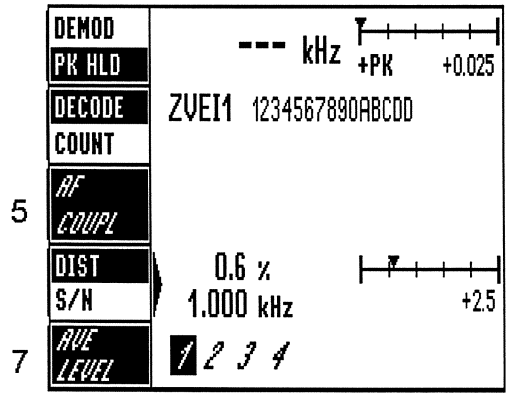


Fig. 2.4-16 DIST submenu

Softkey 5: AF COUPL (test frequency)

Softkey 5 can be used to define whether the test frequency selected in the main menu under distortion is also to define the frequency of the modulation generator or not.

Application:

Generally, coupling offers advantages. The modulation generator supplies the signal to be measured by the distortion meter following the device-under-test. However, coupling is switched off if the radiotransmitter has a scrambler, and the modulation generator signal is set independently of the distortion test frequency.

Softkey 7: AVE LEVEL (averaging factors)

Softkey 7 selects four averaging factors:

1: One measurement determines the result.

2: The result is the average of two measurements.

3: The result is the average of three measurements.

4: The result is the average of four measurements.

Each single measurement corresponds to the average of five AD measurements.

In IEC-bus mode, the single measurements are repeated after a delay time in the case of large changes in signal level.

S/N Function

Whereas the wanted signal is masked out by a filter in the case of a distortion measurement, it is switched off with the S/N measurement.

This measurement can also be performed in two dimensions; the dimensions are selected by entering `softkey 6/dimension %` or `dB`.

The current measured value is used to define the full-scale value in the analog display by entering `softkey 6/RANGE/%` or `dB` or `ENTER`.

The entered numeric value is used to define the full-scale value by entering softkey 6/RANGE/ number/% or dB or ENTER.

Tolerance markers can be set in the analog display by entering softkey 6/TOL/number/% or dB or ENTER.

S/N Function: Submenu

The S/N function branches to one submenu which is output in the display fields next to softkeys 5 and 7. Softkey 6 remains assigned to the main menu.

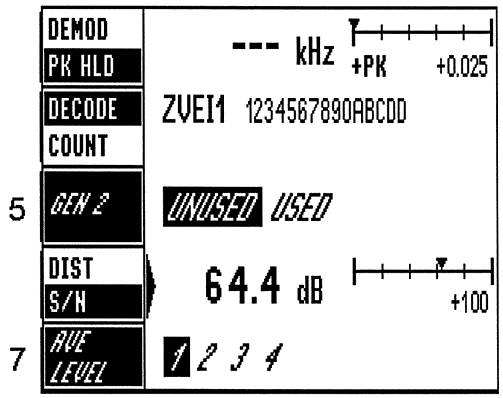


Fig. 2.4-17 S/N submenu

Softkey 5: GEN 2 (modulation generator 2)

The wanted modulation signal is switched on and off alternately in the course of the S/N measurement. Softkey 5 is used to select whether the modulation generator 2 is to to follow this rythm or not.

Softkey 7: AVE LEVEL (averaging factors)

Softkey 7 selects four averaging factors:

1: The result is the average of one signal measurement and two noise measurements.
2: The result is the average of one signal measurement and three noise measurements.
3: The result is the average of two signal measurements and four noise measurements.
4: The result is the average of two signal measurements and five noise measurements.

Each single measurement corresponds to the average of five AD measurements.

In manual operation and IEC-bus mode, the single measurements are repeated after a delay time in the case of large changes in signal level. Different S/N ratios (measurement times) may result.

2.4.7 Input Switchover

INPUT 1/INPUT 2 Function

The selected RF input (RF IN/OUT or RF 2) is shown in inverted form. The other input can be selected by entering SHIFT/ softkey 7. It is possible to inform the CMS of the attenuation value connected prior to the associated input. By entering softkey 7/number/dB or ENTER the CMS takes into account the entered attenuation for the level with RF measurement and setting.

INPUT 2 Function: Submenu *)

An additional internal 24-dB attenuator can be cut in for measurements via the connector RF IN 2.

The attenuator is switched on/off manually in a submenu which can be opened via the INPUT 2 softkey in the TX test.

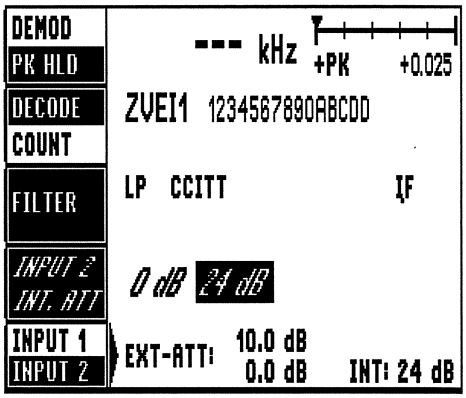


Fig. 2.4-18 INPUT2 submenu

The attenuator status is indicated adjacent to the INPUT 2 softkey in the TX and DX main menu.

*) depending on model or option

2.4.8 Lock

LOCK Function

Softkey 8 is assigned a simple changeover key function.

If the LOCK mode is active, TX test can only be reached by operation in the RX test. With the LOCK function deactivated the switchover from RX test to TX test is only possible by applying an RF power to the RF IN/OUT socket ***29.*** The RX test is automatically activated again by an RF voltage drop. This return to RX test can, however, be eliminated when switching over to the TX test via keys or by calling a submenu in the TX test.

Application:

The LOCK status is used if discontinuous transmitter tests are performed, e.g. power pulses of limited duration with superimposed modulated data messages. The LOCK function prevents the CMS from returning to the receiver test following each pulse. A typical example is an acknowledge call. The LOCK function is automatically switched on in this case and with certain other measurements such as e.g. cellular radio.

2.4.9 Modulation Generators

Softkey 9 is assigned all functions of the first modulation generator, softkey 10 those of the second modulation generator. The frequency is the first function and the level of the modulation generator is the second. Switching between the two functions is possible by entering SHIFT/softkey 9 or 10.

AF1/AF2 Function

The frequency is entered using softkey 9 or 10/number/dimension or ENTER. The modulation generator is switched off by entering softkey 9 or 10/OFF. This switch-off function for the level with a frequency entry has the following purpose:

The levels of tone sequences generated naturally by modulation generators are set using the level function. If the modulation generator is not switched off using the above-mentioned method, the valid continuous tone is output before and after the tone sequence. The modulation generator can be switched on again using softkey 9 or 10/ON.

Variation function

The variation increment for the VAR spinwheel can be entered using softkey 9 or 10/VAR/number/dimension or ENTER. In contrast to usual operation, VAR/0/ENTER does not set the minimum increment but leads to variation with the fixed frequency series (see VAR function, Section 2.3.2.2.1 and definition menu for tones, Section 2.10).

Reference function

The selected frequency is defined to be the reference by entering REF/number/dimension or ENTER. The set frequencies must be understood as a difference from the reference frequency (see REF function, Section 2.3.2.2.1).

LEV1/LEV2 Function

Since the source impedance*) of the modulation generator is very low (approx. 2 Ω), the set level is to be understood as the EMF.

The modulation generator level is entered using softkey 9 or 10/number/dimension or ENTER. The power is referred to 600 Ω when the dimension dBm is selected. The level is switched off using softkey 9 or 10/OFF, and the previously valid level is switched on again using softkey 9 or 10/ON (a special method for switching off the level is described with the AF1/AF2 function). Calling the beat frequency measurement automatically switches off the two modulation generators.

Variation function

The variation increment on the VAR spinwheel can be set using softkey 9 or 10/VAR/number/dimension or ENTER.

Application:
The modulation signal must be overloaded by 20 dB in the case of certain measurements. It is recommendable to enter softkey 9 or 10/VAR/

*) depending on model or option

20/dB in this case. One step on the VAR spinwheel switches the 20-dB overload on and off independent of the selected level.

Reference function

The variation increment for the level on the VAR spinwheel can be set using softkey 9 or 10/REF/number/dimension or ENTER.

2.4.10 Oscilloscope / DC Measurement

The scope mode is activated by means of the softkey SCOPE MODE. If the active cursor is located at this position, a submenu may be called for handling the signal sources for the scope and activating the DC measurement.

If the active cursor is located at this position, it can also mean when entering

<CLEAR> : Switching on the FREEZE mode. Signal recording is stopped. "FREEZE" appears in the display.

<ENTER>: Switching off the FREEZE mode. Signal recording continues.

Quitting the current main menu leads to deactivation of the FREEZE mode.

SCOPE MODE Function

Softkey 12: BEST RANGE

The automatic amplitude scaling can be switched on and off using this softkey. With the automatic amplitude setting switched on, the best gain (filling the complete format) is set in steps of 1-2-5. The associated scale is displayed on the scope screen.

Softkey 13: AMP (amplitude setting)

With softkey 13 activated (active cursor), the gain setting can be selected manually in steps of 1-2-5 using the VAR spinwheel.

Softkey 14: TIME (time scaling)

If softkey 14 is activated, the time scale can be varied using the VAR spinwheel in steps of 1-2-5.

If the active cursor is on softkey 13 or 14, values can be directly entered. Assignments can be looked up in Table 2.4-3.

Table 2.4-3

Input value	Scope		Settling		
			AMP		
	AMP kHz/□	TIME ms/□	Power dB□	Frequency kHz□	TIME ms/□
0	-	50	-	-	-
1	50	20	1	5	0.05
2	20	10	2	1	0.1
3	10	5	5	2	0.2
4	5	2	10	5	0.5
5	2	1	20	10	1
6	1.0	0.5	-	20	2
7	0.5	0.2	-	50	5
8	0.2	0.1	-	-	10
9	0.1	0.05	-	-	20
10	0.05	-	-	-	50
11	-	-	-	-	100
12	-		-	-	200
13	-	-	-	-	500
14	-	-	-	-	1000
15	-	-	-	-	-
16	-	-	-	-	-

Softkey 15: Y POS (Y-position)

Activating softkey 15 allows for shifting the position of the displayed signal in the vertical direction using the VAR spinwheel.

SCOPE MODE Function: Submenu 1

The SCOPE MODE function has a submenu which is displayed in the fields next to softkeys 11 to 15.

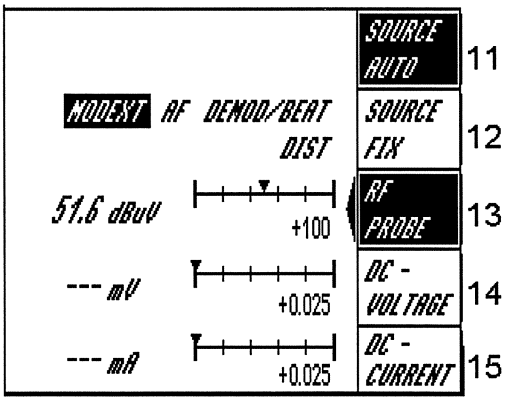


Fig. 2.4-19 SCOPE MODE submenu

Softkey 11: SOURCE AUTO (automatic signal source selection)

If softkey 11 is used to switch on the automatic source selection, the demodulated signal is automatically displayed in the transmitter test and the signal at the AF/SCOPE connector in the receiver test.

Softkey 12: SOURCE FIX (manual selection of signal source)

AF: AF signal at AF/SCOPE connector

DEMOD/BEAT: Selection of demodulated signal or beat signal. The beat signal is displayed on the scope screen.

MOD EXT: Modulation input for external signals.

DIST: When this softkey is activated, the signal path SOURCE DIST shown in Fig. 2.4-20 will be applied to the scope.

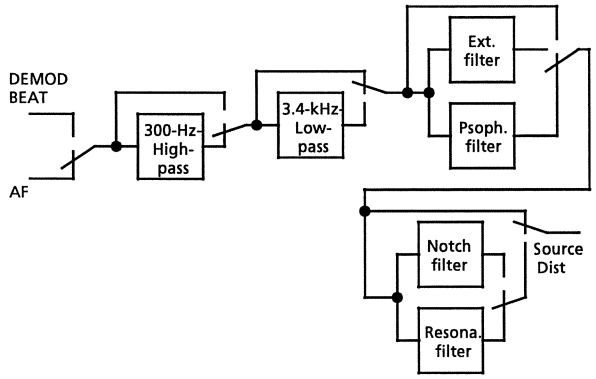


Fig. 2.4-20 Signal paths

Softkey 13: RF PROBE *)

Softkey 13 starts and stops the RF-PROBE measurement. Possible display units are mV as well as dBµV, W and dBm. It should be noted, however, that the latter two units refer to the probe being terminated by 50 Ohms only, since the RF-probe measures voltages, not power. As a result, a probe not being terminated would lead to a 6 dB increase in power. Further on this issue, setting signal source and CMS in W or dBm might lead to overloading the probe if executing measurements at the limit of the chosen RF probe type (i. e. if a terminator is removed).

Input of a value between 0 and 60 dB followed by ENTER allows an external attenuation to be accounted for in the measurement result. In the display this is marked by a "!" leading the result, as well as a display of the chosen attenuation beneath the analogue range bar. These markings are removed as soon as an external attenuation of 0 dB is entered.

Softkey 14: DC-VOLTAGE *)

The DC voltage measurement is initiated by pressing softkey 14. The voltage between the V_{DC} connectors on the rear panel is displayed in digital as well as analog form. The measurement is stopped by pressing the CLEAR key or again the softkey 14.

Softkey 15: DC-CURRENT *)

The DC current measurement is initiated by pressing softkey 15. The current is determined using a shunt of 50-mΩ between the I_{DC} connectors on the rear panel and displayed in digital as well as analog form.
The measurement is stopped by pressing the CLEAR key or again the softkey 15.

Note: ***DC voltage and DC current measurements are possible simultaneously. Measurement errors can occur in case of RF fields >0.5 V/m.***

2.4.11 Settling Option *)

SCOPE MODE Function: Submenu 2 *)

The settling option permits to record the behaviour of a mobile phone with respect to power and frequency while being switched on/off and over.

The settling submenu can be reached as the second submenu via the key SCOPE MODE in the TX test main menu.

2.4.11.1 Description of Controls and Display Elements

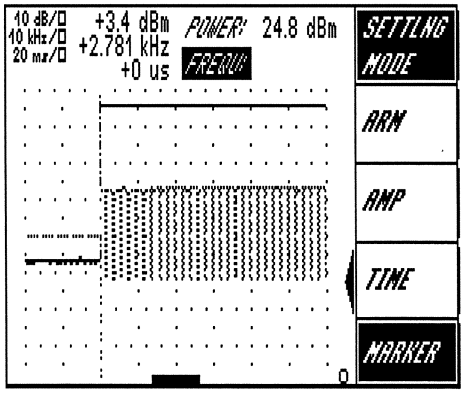


Fig. 2.4-21

The settling submenu consists of five softkeys: SETTLING MODE, ARM, AMP, TIME and MARKER.

*) depending on model or option

Softkey 11: SETTLING MODE

Selection between power and frequency recording. After entering the Settling submenu, POWER is always set if a power ramping has not yet been recorded. If FREQU is active when opening the menu, the unit is automatically set to FM.

Softkey 12: ARM

By pressing this key, the CMS is set to the ready status. The key is shaded, and the occurrence of the trigger event is waited for. A message in the status line indicates the trigger threshold required for triggering the event. By pressing the key again, the ready status can be cancelled. The status line displays the message 'Settling cancelled'.

Softkey 13: AMP

This key is used to set the amplitude scale for recording. It can be varied using the rotary knob.

Depending on the setting of the SETTLING MODE key, the amplitude is varied for recording power or frequency.

After a curve has been recorded, it can be zoomed in the y-direction using the rotary knob, provided that the active cursor is positioned on this key.

Softkey 14: TIME

This key permits to set the time scale for recording. It can be varied using the rotary knob.

The setting applies to power and frequency recording and is therefore independent of the setting of the SETTLING MODE key.

After a curve has been recorded, it can be zoomed in the x-direction using the rotary knob, provided that the active cursor is positioned on this key.

If the active cursor is on softkey 13 or 14, values can be directly entered. Assignment can be looked up in Table 2.4-3.

Softkey 15: MARKER

This key permits to vary the marker position within a recorded curve using the rotary knob. The x and y-value of the marker position is indicated in the display.

The following display elements are provided in the Settling submenu:

- Amplitude scale in dB/div for recording the power
- Amplitude scale in kHz/div for recording the frequency
- Time scale in s/div. This applies to the power and frequency curve.
- Marker position. The amplitude values are indicated for the power and the frequency curve separately. The x-position of the marker (time) applies to both curves. As long as no curve has been recorded yet, --- is indicated as the marker position.
- Setting of the SETTLING MODE key. Possible settings are POWER and FREQU.

2.4.11.2 Power Measurement

This measurement uses a change of the RF level as trigger event.

Before entering the settling menu, switch from COUNT to SET RF and set the RF frequency of the test item.

When the settling menu is entered, all data recorded before are deleted and the SETTLING MODE key is set to the POWER position.

The measurement can be made both via RF input 1 and via RF input 2.

The measurement is started by pressing the ARM key. The softkey is shaded, and the 2nd status line displays a message, indicating the RF level used for initiating the trigger event. The CMS automatically detects whether RF power is applied to the connector and decides whether to measure settling or decaying of power.

The trigger level is determined as follows:

Table 2.4-4

Type of meas	Power settling	Power decay
RF Input 1	5 dBm	Measured power -20 dB
RF Input 2	-70 dBm	Measured power -20 dB

In order for the trigger level not to be too far in the noise when the power decays, it cannot become smaller than -1 dBm for measurements via RF input 1 and smaller than -76 dBm for measurements via RF input 2.

As long as the trigger event has not yet occurred, the CMS is in the free-running mode, ie the signal curve at the RF connector is indicated in the display of the oscilloscope without trigger.

After the trigger event has occurred, the message 'Trigger found' is output in the 2nd status line.

The end of recording is indicated by the message 'End of sampling'. Its duration depends on the setting of the time scale and may be up to 40 seconds with 1s/div.

With the message 'End of sampling', the ARM key is unshaded, and the marker line is positioned in the first third, in the middle or in the last third of the curve, depending on the mode of measurement settling or decaying. The rotary knob symbol is set to the MARKER key. It is then possible to follow the recorded curve using the rotary knob and read off the respective marker values in the display.

Besides, it is possible to expand the recorded curve by varying the amplitude or time scale. The amplitude scale can be zoomed at will in the y-direction, whereas, in the x-direction, two steps up and down are possible starting from the setting during recording.

The user can abort recording at any time by pressing the ARM key again, leaving the Settling menu or actuating any other function which is not associated with the Settling measurement. The message 'Settling cancelled' is produced and the already recorded data are cleared.

A recorded curve can be cleared by pressing the CLEAR key if the active cursor is positioned on the keys AMP, TIME or MARKER.

2.4.11.3 Frequency Measurement

With this measurement, a change of the RF frequency is used as the trigger event. The measurement sequence is similar to that of the power measurement.

The SETTLING MODE key must be set to the FREQU. position.

The trigger level is set to ±8 kHz by the CMS irrespective of the power applied to the RF connector.

2.4.11.4 Combined Power and Frequency Measurement

To enable simultaneous indication of the power and frequency curve in the display, two measurements must be recorded. A combined measurement is automatically performed when a curve is already visible which was recorded before switching over the SETTLING MODE key.

The following combined measurement sequences are possible:

Table 2.4-5

SETTLING MODE 1st measurement	Power is applied to CMS	Type of 2nd measurement	Trigger level of 2nd measurement	
			Input 1	Input 2
FREQU FREQU	no yes	Settling Switchover	±8 kHz ±8 kHz	±8 kHz ±8 kHz
POWER POWER	no yes	Settling Decay	5 dBm Power at CMS -20 dBm	-70 dBm Power at CMS -20 dBm

The setting of the SETTLING MODE key for the first measurement determines whether power or frequency variation is used as trigger event. After recording of the curve, the SETTLING MODE key must be actuated to enable the second measurement to be performed. The trigger level of the second measurement is always equal to the trigger level of the first measurement. This is necessary for the two records to feature a time relationship to each other. Therefore, the test item must be equally operated for both records.

The power curve is indicated by a continuous line, whereas the frequency curve is represented by a dotted line.

The two curves can be cleared simultaneously by pressing the CLEAR key, if the active cursor is set to the MARKER key. The SETTLING MODE key automatically changes to the POWER position.

If the active cursor is positioned on the AMP or TIME key, only one of the two curves can be cleared by pressing the CLEAR key depending on the setting of the SETTLING MODE key.

If the message 'End of sampling' is displayed in the status line at the end of recording, this message must be cleared first by pressing the CLEAR key before a curve can be cleared.

Clearing the curves:

Table 2.4-6

Key	Active cursor	SETTLING MODE	Cleared curves
clear	MARKER	---	both
clear	AMP/TIME	POWER	power curve
clear	AMP/TIME	FREQU.	frequency curve

Input value ranges are shown in Table 2.4-7. Entries for the AMP and TIME parameters are converted to the nearest setting in accordance with Table 2.4-3.

Table 2.4-7

	Default	Maximum value	Minimum value
SETTLING MODE	POWER	---	---
Amplitude scale: **Power measurement** **Frequency measurement**	10 dB/Div 10 kHz/Div	20 dB/Div 50 kHz/Div	1 dB/Div 500 Hz/Div
Time scale	5 ms/Div	1 s/Div	0.05 ms/Div

Note:
After sending an ARM command via IEEE bus or AUTORUN control, synchronization needs to be provided by the user. This way, it is possible to enable the push-to-talk function of a mobile through a remote command, for example by using one of the CMS relais or TTL-lines *). A command of this kind might then be followed by a function like HOLD, PAUSE or WAIT FOR KEY (SPEC 2 menu) to ensure synchronization.

*) depending on model or option

2.5 Receiver Test (RX-Test)

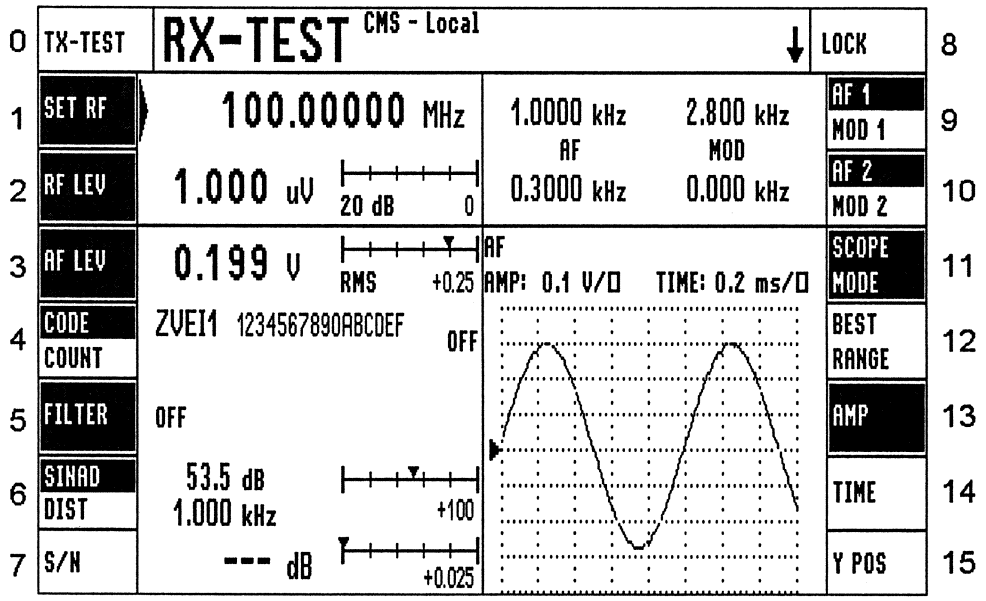


Fig. 2.5-1 Main menu RX test

Starting with the main menus of the selection menu, the main menu RX-TEST (receiver test) can be reached by pressing the softkey RX-TEST.

It contains all controls required to carry out a standard receiver test. Almost every function contains submenus. These contain controls which can be used for more seldom receiver test functions.

Softkey 0 can be used to directly branch to the main menu for the transmitter test (TX-TEST).

2.5.1 RF Frequency Setting

SET RF Function

The signal generator frequency of the instrument can be set using the SET RF function. This function is entered by means of sequence `SET RF/number/dimension` or `ENTER`.

The signal generator frequency setting can be varied using the VAR function and the VAR spinwheel.

The signal generator frequency setting can also be made in relative mode.

The reference frequency is entered using `softkey SET/REF/ENTER`, if the current frequency is to become the reference frequency, or using `softkey SET REF/number/dimension` or `ENTER` if another frequency is to be set as the reference frequency.

SET RF Function: Submenu 1

This menu is described in the TX test (see Section 2.4.1).

SET RF Function: Submenu 2

The second submenu SET RF offers an automatic change of the RF frequency. This can be done step by step but also continuously, similar to a sweep generator.

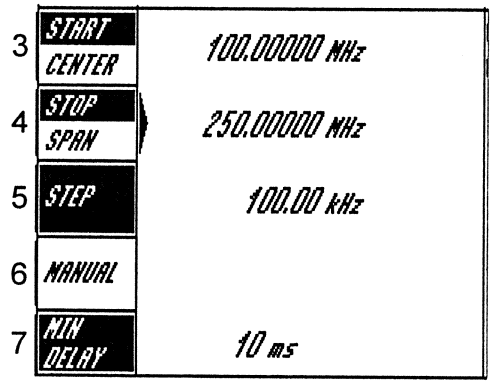


Fig. 2.5-1a SET RF Submenu 2

Softkey 3: START / CENTER
This key either allows the entry of a start frequency (if the upper half of the softkey is shown in inverse video) or the entry of a center frequency for the span covered by the RF generator. The other half of the key results in a switchover to softkey 4. If the main menu RX test is opened from menu SPECTRUM, it has to be noted that the functions on softkey 3 correspond to those on softkey 7 in the spectrum mode and that they influence each other. In this case, values set in menu SPECTRUM do not have to be entered again. With a negative step width (function STEP) set, the upper half of the key (START) represents the maximum final value of the sweep.

Softkey 4: STOP / SPAN
The stop frequency of the range to be covered or - with the lower half of the softkey being activated - the frequency span can be entered here. For switchover to the CENTER/SPAN display press softkeys 3 or 4 a second time. If the main menu RX test is opened from menu SPECTRUM, it has to be noted that the functions on softkey 4 correspond to those on softkey 15 in the spectrum mode and that they influence each other. In this case, values set in menu SPECTRUM do not have to be entered again. With a negative step width (function STEP) selected, the upper half of the key (STOP) represents the start value of the sweep.

Softkey 5: STEP
The step width of the RF transmit frequency can be set by means of this function. The resolution corresponds to that of SET RF (softkey 1). The selected unit can but does not have to correspond to the units of softkey 3 or 4. By entering a negative number, the RF generator of CMS can be made to run from high to low frequencies. If this is the case, the sweep starts at the STOP frequency (softkey 4) and goes down towards the START frequency defined by the upper half of softkey 3. The start frequency of a sweep is always set, the stop frequency of a sweep only if it matches with the spacing defined by STEP. If this is not the case, the current start frequency is continued before the end of the sweep is attained.

Softkey 6: MANUAL
This softkey switches between the continuous and single-step mode of the sweep generator. If the key is in inverse video, the frequency selected and displayed under SET RF is only changed if the ENTER/ON key is pressed. The RF frequency is varied in this single-step mode until softkey 6 is pressed. The key will no longer be in inverse video but be white again. If the active cursor is already on this key, the MANUAL function can also be switched on/off using ENTER/ON and CLEAR/OFF.

Softkey 7: MIN DELAY
This key allows to determine the delay between subsequent frequencies set by the unit. With softkey 6 activated (ie in inverse video), this entry will not be taken into account. It has to be noted that a minimum delay is obtained when varying the RF synthesizer. The magnitude of this delay depends on the step width for the SET RF frequency set under STEP (softkey 5). Waiting periods of 30 ms have to be reckoned with at the switchover points (110, 375 and 750 MHz) of the CMS synthesizer to allow for a complete settling. The entry - always without the unit - and the display are generally based on milliseconds (ms). Moreover, entered values are to be considered as minimum delays as mentioned above.

2.5.2 RF Level Setting

RF LEV Function

The signal generator level can be set using the RF LEV function. The entry is made using `softkey 2/number/dimension` or `ENTER`. If a number is not entered, this sequence can be used to convert the dimension of the set level.

The RF level can be switched off temporarily using softkey 2/OFF. The previously valid level can be switched on again using softkey 2/ON.

If the option CMS-B34 is fitted, higher output levels are output at the connector RF OUT 2. This is indicated in the display as follows: "OUT 2".

Whereas directly entering parameters or varying parameters using the VAR spinwheel are simply different methods of operation which lead to the same result, adjustment of the RF level using keys or the VAR spinwheel leads to different results.

The interrupt-free electronic level fine variation is used for varying the level to smaller values by means of the VAR spinwheel. The level can be reduced interruption-free by 19.9 dB in FM and ΦM modes, and by 4.9 dB in AM mode. The range used by the electronic level fine variation for the reduction in level is indicated in the analog display (in the field next to softkey 2) by a marker leading from right to left. On the other hand, setting the level using the digital keypad mainly uses the mechanical attenuators (audible switching).

Note: ***Frequent level variations in automatic test systems might reduce the service lifetime of the attenuator. It is therefore recommended to carry out the level settings in few steps only, using the electronic level variation if possible.***

Application:

The interrupt-free electronic level fine variation is used to search for the squelch point and the squelch hysteresis of the radio receiver. On the other hand, entering the level on the digital keypad always results in the optimum broadband S/N ratio of the CMS signal generator, increased level accuracy and a reduced AM distortion factor.

The variation increment can be set using softkey SET RF/VAR/number/dimension or ENTER (see function-based hardkeys (VAR), Section 2.3.2.2.1 and spinwheel, Section 2.3.2.3).

The signal generator level setting can also be made in relative mode.The reference level can be entered using softkey SET/REF/ENTER if the current level is to become the reference level, or using softkey SET/REF/number/dimension or ENTER if a different level is to be set as the reference level.

RF LEV Function: Submenu

The RF LEV function has a very important submenu which contains the automatic test routines of the receiver test. The RF LEV submenu is output in the display fields next to softkeys 3 to 5 and 7.

It is important with the automatic test routines to ensure that the radiotelephone is completely connected to the CMS. The connectors RF IN/OUT and AF/SCOPE are used for this purpose.

Since the automatic test routines may require a lengthy period of time, they can be aborted during the measurement by pressing the RF/LEV softkey.

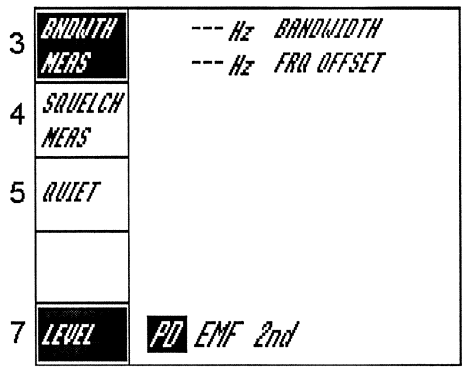


Fig. 2.5-2 RF LEV submenu

Softkey 3: BNDWTH MEAS (bandwidth measurement)

Softkey 3 starts the bandwidth measurement.

The measurement is run as follows:

1. Initial setting: RF frequency = nominal receiver center frequency. The receiver squelch is switched off.
2. Definition of the AF noise level with RF level switched off.
3. Increase in RF level until the AF noise level has decreased by 10 dB. Storage of AF noise level.
4. Increase in RF level by further 6 dB.

*) depending on model or option

5. Offset of RF frequency to higher frequencies until the AF noise level of point 3 is obtained again.
6. Offset of RF frequency to lower frequencies until the AF noise level of point 3 is obtained again.
7. The receiver band limits defined under points 5 and 6 serve for determining the receive bandwidth and the center frequency offset. These two values are displayed.

Softkey 4: SQUELCH MEAS (squelch measurement)

Softkey 4 starts the squelch measurement.

The measurement is run as follows:

1. Initial setting: The RF level is set to the minimal value. The receiver squelch is switched on.
2. The RF level is increased interrupt-free until the AF level is switched on on the radiotelephone. This is the squelch switch-off point.
3. The RF level is decreased until the AF level on the radiotelephone is switched off again. The squelch hysteresis is the difference between the two RF levels.
4. Squelch inset and squelch hysteresis are displayed.

Softkey 5: QUIET (quieting measurement)

The quieting measurement is initiated via `Softkey 5/number/dimension dB or ENTER`. The number in dB corresponds to the quieting criterion.

The measurement is run as follows:

1. Initial setting: RF frequency = receiver center frequency. RF level = off. The receiver squelch is switched off.
2. The AF noise level is measured.
3. The RF level is increased until the AF noise level has decreased by the number specified as the quieting criterion.
4. This RF level is displayed as result.

Softkey 7: LEVEL (EMF-PD switchover)

Softkey 7 can be used to select whether the output RF voltage is to be displayed as a no-load voltage (EMF) or as a terminal voltage (PD) accross a 50-Ω load.

2.5.3 AF Level Measurement

AF LEV Function

The AF level measurement is selected by pressing softkey 3. The dimension can be selected by subsequently pressing a dimension key; the dimensions mV, W, dBµV and dBm are possible. Measurements in W and dBm are usually based on a load resistance of 600 Ω. This can be changed, however, in the definition menu for special functions. (Section 2.12).

Tolerance markers can be set in the analog display using `softkey 3/TOL/number/dimension` or `ENTER`.

The currently measured value is used to define the full-scale value on the analog display using `softkey 3/RANGE/dimension` or `ENTER`. The value corresponding to the number is used to define the full-scale value using `softkey 3/RANGE/number /dimension` or `ENTER`.

The current measured value is defined as the reference value using `softkey 3/REF/dimension` or `ENTER`, and the subsequent measurements are made in dB referred to this value. A reference value can be defined using `softkey 3/REF/number/dimension` or `ENTER`. An integer multiplier, which is then part of the AF-LEV result, can be specified using `Softkey 3/number/ENTER`.

AF LEV Function: Submenu

The AF LEV function has a submenu which is output in the fields in the display next to softkeys 4 to 7.

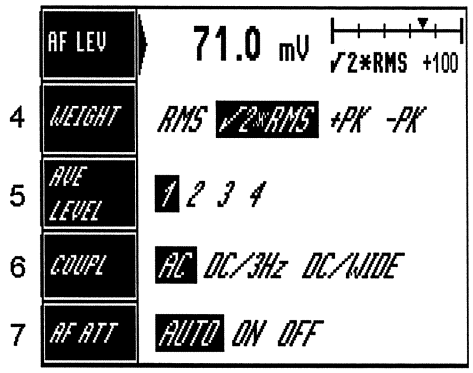


Fig. 2.5-3 AF LEV submenu

Softkey 4: WEIGHT

Softkey 4 can be used to select four different types of weighting.

RMS: Real RMS weighting

$\sqrt{2}$ * RMS: Real RMS weighting multiplied by 1.41.

This weighting is used if the peak value is to be determined when modulating with sinewave signals, and the integrating effect of the RMS detector is to be used at the same time (e.g. with noisy signals).

+PK: Positive peak weighting

- PK: Negative peak weighting

Softkey 5: AVE LEVEL (averaging factor)

Softkey 5 can be used to select an averaging factor for RMS and $\sqrt{2}$ * RMS weighting. Four averaging possibilities are provided.

1: One measurement determines the result.

2: The result is the average of two measurements.

3: The result is the average of three measurements.

4: The result is the average of four measurements.

Each single measurement corresponds to the average of 5 AD measurements.

In IEC-bus operation, the single measurements are repeated with high changes in signal level following a delay time.

Application:

A higher averaging factor results in more reproducible results compared to a single measurement especially in the case of noisy signals. An average measurement takes longer, however. The AF voltmeter is often used in the receiver test to measure the AF noise of the receiver which is not supplied with an RF signal. The reproducibility of these noise measurements is improved by averaging.

Averaging is not carried out for peak weighting.

Softkey 6: COUPL (AC/DC coupling)

Softkey 6 can be used to couple the detectors to the signal source in three different manners:

AC coupling: Only AC voltages ≥50 Hz are measured.

DC / 3Hz: Pure DC measurement. AC components above 3 Hz are suppressed.

DC / WIDE: AC and DC components are RMS or peak weighted together.

Softkey 7: AF ATT (input divider)

The CMS has a selectable input voltage divider in order to expand the dynamic range of the measurement points at higher values. This is usually switched on or off automatically depending on the measured value.

If the automatic feature does not meet all requirements, it can be switched off (e.g. to save time).

Selection is possible using softkey 7 between:

AUTO: Automatic adaptation to measured value

ON: A dynamic range of 24 dB is lost at small measured values.

OFF: Top limit of measuring range approx. 1.4 V.

2.5.4 Code, Count

Softkey 4 is assigned two functions:
CODE (Code outputs)
COUNT (AF frequency counting)

The first or second function is selected using the SHIFT key.

CODE Function

An already stored selective call can be sent to the radiotelephone via the RF path using `softkey 4/ENTER`.

A new call number can be entered and sent using `softkey 4/number/ENTER`. The digits can be 0 to 9 and A to F, and also * and # with dual-tone sequences. A sequence with up to 30 digits can be entered.

A tone sequence can be incorporated in a continuous tone of constant modulation or output as a modulation burst. Section 2.5.9 describes the setting of the two modes.

Code Function: Submenu 1

The CODE function has two submenus which are output in the fields in the display next to softkeys 3 to 7.

These submenus are used for the most significant configurations in conjunction with code transmissions.

Other configurations which are required less often, but then for longer periods, are set up in the "Definition menu for tones" (Section 2.10).

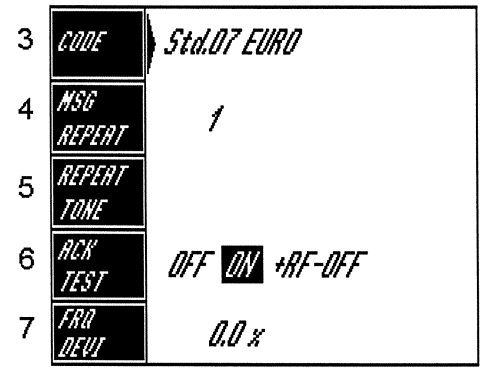


Fig. 2.5-4 CODE submenu 1

Softkey 3: CODE (selection of standard)

One of 16 standards can be selected using `softkey 3/number/ENTER`. A number is assigned to each standard.

Section 2.4.4 explains the meaning of the numbers in more detail. Two standards are described below because of their special feature.

Standard 15 for CDCSS coding or standard 16 for ATIS coding can be selected using the CODE softkey under function CODE in submenu 1, the latter requiring option CMS-B27. The only key used for the two standards in submenu 1 is the CODE softkey.

a) Function CODE CDCSS (Standard 15)

After activating softkey CODE, a 3-digit octal number which has to correspond to one of the 83 CDCSS codes can be entered. Prefix # has to be put in front of the octal number for inverted codes. Acknowledgement using the ENTER key effects a cyclic transmission of the CDCSS code via modulation generator 2 whose deviation can be selected as already known.

Pressing key CLEAR effects the generation of the turn-off code and the subsequent cutting off of the RF power (cf. submenu 2).

b) Function CODE ATIS (Standard 16): Requires Option CMS-B27 *)

After the CODE softkey has been activated, a 10-digit decimal number can be entered as an ATIS self-identification code. The entire ATIS message including error check signal is added to the above entry.

Pressing the ENTER key effects a single transmission of the ATIS message as an FSK modulation via the RF output, with the modulation index of 2 rad stipulated in the ATIS regulation being preselected automatically (independently of the value displayed).

For further explanations on standards 0 to 16 refer to Section 2.10.

Softkey 4: MSG REPEAT (Message Repeat)

`Softkey 4/number/ENTER` is used to define how often the message is to be repeated. A value of 1 corresponds to the normal setting.

*) depending on model or option

Larger numbers are entered if the response sensitivity of a radiotelephone to the telegram is to be determined. The RF level is then varied whilst the telegrams are sent until the receiver responds. Uninterrupted repetition of telegrams can be stopped by pressing the OFF key.

Softkey 5:REPEAT TONE

The digit repeat function can be switched on or off using softkey 5.

With the digit repeat switched on, the second digit of a double digit is replaced by the repeat digit (E). With the digit repeat switched off, the second digit is repeated, which usually leads to an extra-long tone. The digit repeat of the decoder is coupled to this function (see Section 2.4.4).

Softkey 6: ACK TEST (acknowledgement test)

The automatic sequence "Acknowledgement call test" is started by pressing softkey 6; it is then started by activating softkey 4 CODE in the main menu RX-test. The sequence comprises the following steps:

1. Transmission of previously selected tone sequence.
2. Following the last tone in the sequence, the CMS is transferred to the transmitter test with all settings belonging to this test. Note in particular that the transmitter test operating frequency must still be set in the transmitter test to the frequency at which the reply from the radiotelephone is expected. In the position + RF OFF the RF-carrier of the CMS is additionally switched off after the last tone of the tone sequence, since some radio-telephones only reply without input signal.
3. The result of the acknowledgement test is the decoded tone sequence and the modulation.

Softkey 7: FRQ DEVI (frequency deviation)

In order to carry out frequency limit tests on the selective call evaluator, a relative frequency deviation of up to ±10 % can be selected uniformly for all tones in the sequence.

This is entered using `softkey 7/number` with or without `sign/ENTER`. The number corresponds to the frequency deviation in %.

CODE Function: Submenu 2

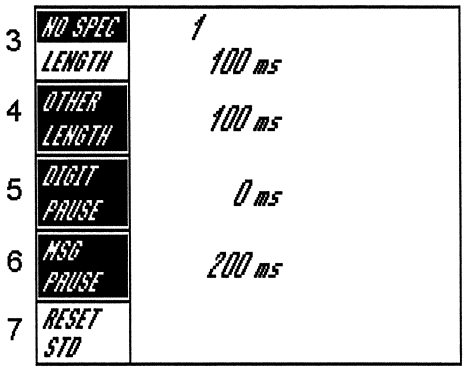


Fig. 2.5-5 CODE submenu 2

Softkey 3 is assigned two functions. The SHIFT key is used for selecting first or second function.

Softkey 3: NO SPC

This function is used to select a tone of the selective-call sequence which is to be subjected to extended tone duration. This is normally the first tone of extended duration compared to the other tones. The entry is made using `Softkey 3 (NO SPC)/number (tone duration in ms)/ENTER`.

Softkey 3: LENGTH

Certain selective call principles can also address receivers with sleep mode. An extended tone in the selective call sequence then bridges the "sleeping pause" of the receiver. The duration of the first tone can be set using `softkey 3 LENGTH/number/ENTER` and corresponds to the number in ms.

Softkey 4:OTHER LENGTH (duration of other tones)

The duration (in ms) of the following tones can be uniformly set by entering `softkey 4/number/ENTER`.

Softkey 5: DIGIT PAUSE

Pauses can be defined between the tones (in ms) uniformly for a tone sequence by entering `softkey/5/ number/ENTER`.

The tone and pause durations need only be selected if values different from the standard are required. These values are components of the standard and can be assigned to the individual standards in the "Definition menu for tones" (Section 2.10).

Softkey 6: MSG PAUSE (message pause)

The pause (in ms) between two messages is defined by entering `softkey 6/number/ENTER`.

Softkey 7: RESET STD

The original parameters, modified by softkeys 3 to 6 can be reset using this softkey.

Submenu 2 has no significance for standard 16 (ATIS).

For standard 15 submenu 2 has a modified appearance:

CDCSS: Submenu 2
Softkey TRN-OFF-CODE can be used to set the length of the turn-off code effecting the turn off of the squelch function of the test object connected.

Softkey TRANSM END serves to set the time between the start of the turn-off code and the cutting off of the transmitter.

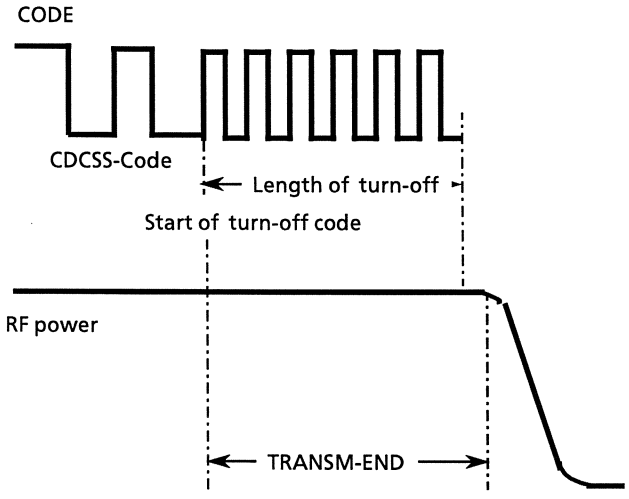


Fig. 2.5-6 Time diagram

COUNT Function

This function is used to determine the frequency of the signal connected to the AF/SCOPE connector ***24***.

A reference frequency can be entered using `softkey 4/REF/number/dimension` or `ENTER` and is always subtracted from the absolute counter result. The currently measured frequency is set as the reference frequency using `softkey 4/REF/dimension` or `ENTER`.

COUNT Function: Submenu

The COUNT function has a submenu which is output in the display field next to softkey 5.

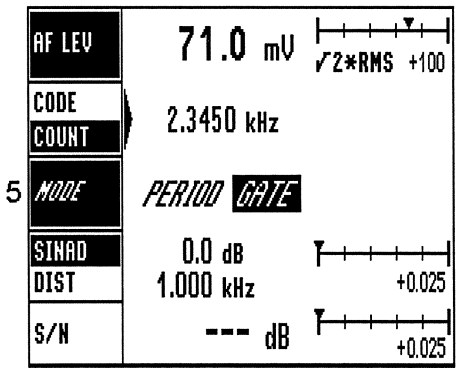


Fig. 2.5-7 COUNT submenu

Softkey 5: MODE (operating mode and resolution of counter)

Selection between 2 modes is possible:

1. Period counting
2. Gate time counting 1 Hz

Period counting has a resolution of 0.1 Hz up to 100 kHz; the resolution is 1 Hz at frequencies exceeding this value. Period counting is fast but requires a signal without noise.

Gate time counting is less sensitive to noisy signals.

2.5.5 Filter Selection

FILTER Function

Various AF filters can be switched on or off using `softkey 5/ON` or `OFF`. The AF filters and their characteristic frequencies can be selected in two submenus.

FILTER Function: Submenu 1

The FILTER function has two submenus. The first submenu is output in the display fields next to softkeys 4 and 7, the second submenu in the fields next to softkeys 4 to 5.

The operation of softkeys 4 to 7 is analogous to that described in Section 2.4.5.

The FILTER submenu 2 is called by pressing the MENU ↓ (DOWN) key.

FILTER Function: Submenu 2

The operation of softkeys 4 and 5 is analogous to that described in 2.4.5 for the transmitter test. Softkeys 6 and 7 are however not displayed.

2.5.6 SINAD and Distortion Measurements

Softkey 6 is assigned two functions:

SINAD (S/N measurement)
DIST (distortion measurement)

The SHIFT key is used to select either the first or second function.

SINAD/DIST Function

The two measurements are performed using the same method. The result is displayed in dB for SINAD and in % for distortion.

Test frequency

The test frequency is defined via `softkey 6/number/dimension Hz` or `kHz`. It is possible to select in the submenu whether the modulation generator is to be set to this frequency or not.

Automatic search routine

The automatic search routine is started using `softkey 6/number/dimension %` (distortion) `or dB` (SINAD). The routine is run as follows: The RF level is modified until the measured value corresponding to the number is reached. The RF level obtained at the end of the search routine corresponds to the receiver sensitivity. The search routine can be aborted by pressing softkey 6.

The full-scale value can also be influenced in the analog display for the SINAD or DIST measurement.

When `softkey 6/RANGE/% or dB or ENTER` are pressed, the currently measured value is used for defining the full-scale value.

When `softkey 6/RANGE/number/% or dB or ENTER` are pressed, the entered number is used for defining the full-scale value.

Tolerance markers can be set in the analog display using the same syntax: `softkey 6/TOL/number/% or dB or ENTER.`

SINAD/ DIST Function: Submenu

A submenu is available for the SINAD/DIST function, which is output in the display fields next to softkeys 3 to 5 and 7. Softkey 6 remains assigned to the main menu.

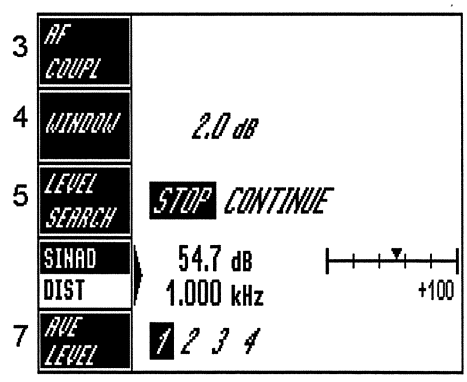


Fig. 2.5-8 SINAD/DIST submenu

Softkey 3: AF COUPL (test frequency)

Softkey 3 can be used to define whether the test frequency selected for the distortion is also to define the frequency of the modulation generator 1 or not.

Application:

Coupling usually has advantages. The modulation generator supplies the signal, which is to be measured by the distortion meter or the SINAD meter following the device-under-test. However, if the radio receiver has a scrambler, the coupling is switched off and the modulation generator signal is set independently of the distortion/SINAD test frequency.

Softkey 4: WINDOW (abort window)

Softkey 4 can be used to define a criterion for aborting the automatic search routine. The range around the target value to be measured is determined by entering `softkey 4/number/dB or %`. The entered number defines the magnitude in % or dB around the target value as the abort window. When a measured value from this range is reached in the search routine for the first time, the search routine is aborted.

Softkey 5: LEVEL SEARCH (stop/continue search routine)

Softkey 5 selects whether the RF level variation is to be stopped when the abort window is reached or not.

Application:

If the receiver sensitivity is to be determined by a measurement, the "stop" position is selected. The "continue" position is selected if the receiver sensitivity is to be set to a maximum during the search routine.

Softkey 7: AVE LEVEL (averaging factors)

Four averaging factors are available to be selected via softkey 7.

1: One measurement determines the result.

2: The result is the average of two measurements.

3: The result is the average of three measurements.

4: The result is the average of four measurements.

Each single measurement corresponds to the average of 5 AD values.

In IEC-bus operation, the single measurements are repeated with large changes in signal level following a delay time.

2.5.7 S/N Measurement

S/N Function

The S/N measurement is very similar to the distortion or SINAD measurement except that the wanted modulation is switched off during the noise measurement and not eliminated by a filter.

Dimension

The S/N ratio is displayed either in % or dB by entering `softkey 7/dimension %` or `dB`.

The full-scale value can also be influenced in the analog display for the S/N measurement.

The currently measured value is used to define the full-scale value by entering `softkey 7/RANGE/%/` or `dB` or `ENTER`.

The number is used to define the full-scale value by entering `softkey 7/RANGE/number/%/` or `dB` or `ENTER`.

Tolerance markers can be set in the analog display with the same syntax: `softkey 7/TOL/number/%` or `dB` or `ENTER`.

Automatic search routine

An automatic search routine is initated via softkey 7/number/dimension % or dB. The routine is executed as follows:

The RF level is modified until the measured value corresponding to the number is reached. The RF level at the end of the search routine corresponds to the receiver sensitivity.

The search routine can be aborted by pressing softkey 7.

S/N Function: Submenu

A submenu is available for the S/N function, which is output in the display fileds next to softkeys 3 to 7.

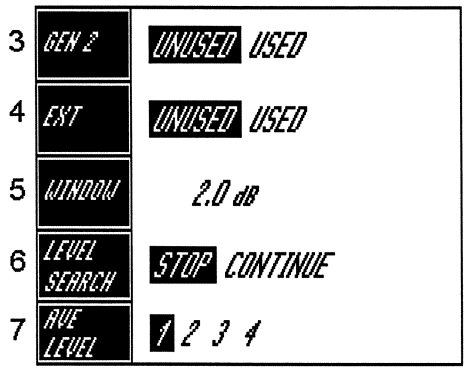


Fig. 2.5-9 S/N submenu

Softkey 3: GEN2 (modulation generator 2)

The modulation is switched on and off by modulation generator 1. Softkey 3 can be used to select whether the modulation generator 2 is to follow this rythm or not.

Softkey 4: EXT (external modulation)

Softkey 4 can be used in the same manner as described above to select whether the external modulation applied to the MOD EXT connector is to follow this rythm or not.

Softkey 5: WINDOW (abort window)

Softkey 5 can be used to define a criterion for aborting the automatic search routine. The range around the target value to be measured is determined by entering `softkey 5/number/dB or %`.The entered number determines the magnitude in % or dB around the target value as the abort window. When a measured value from this range is reached in the search routine for the first time, the search routine is aborted.

Softkey 6: LEVEL SEARCH (stop/continue search routine)

Softkey 6 selects whether the RF level variation is to be stopped when the abort window is reached or not.

Application:

If the receiver sensitivity is to be determined by a measurement, the "stop" position is selected. The "continue" position is selected if the receiver sensitivity is to be set to a maximum during the search routine.

Softkey 7: AVE LEVEL (averaging factors)

Four averaging factors can be selected using softkey 7:

1: The result is the average of one signal measurement and two noise measurements.

2: The result is the average of one signal measurement and three noise measurements.

3: The result is the average of two signal measurements and four noise measurements.

4: The result is the average of two signal measurements and five noise measurements.

Each single measurement corresponds to the average of five AD measurements.

In local and IEC-bus mode, the single measurements are repeated following a delay time in case of large changes in signal level. (Different S/N ratios (measurement times) may result.)

2.5.8 Lock

LOCK Function

Softkey 8 is assigned the function of a simple changeover key.

If the LOCK mode is active, TX test can only be reached by operation in the RX test. With the LOCK function deactivated the switchover from RX test to TX test is only possible by applying an RF power to the RF IN/OUT socket ***29.***

The RX test is automatically actuated again by an RF voltage drop. This return to RX test can, however, be eliminated when switching to the TX test via keys or by calling a submenu in the TX test.

Application:

The LOCK status is used if discontinuous transmitter tests are carried out, e.g. power pulses of limited duration with superimposed modulated data messages. The LOCK function prevents the CMS from returning to the receiver test following each pulse. A typical example is a acknowledgement call. The LOCK function is switched on automatically in this case and with certain other measurements such as e.g. cellular radio.

2.5.9 Modulation Generators

Softkey 9 is assigned all functions of the first modulation generator, softkey 10 those of the second modulation generator. Each softkey is assigned the frequency as first function and the modulation as the second. Switching between the two functions is possible by entering SHIFT/softkey 9 or 10.

AF1/AF2 Function

The frequency is entered using softkey 9 or 10/number/dimension or ENTER. The modulation generator is switched off by entering softkey 9 or 10/OFF. This switch-off function for the level when making a frequency entry has the following function:

The modulation of tone sequences generated naturally by modulation generators are set using the MOD function. If the modulation generator is not switched off using the above-mentioned method, the valid continuous tone is output before and after the tone sequence. The modulation generator can be switched on again using softkey 9 or 10/ON.

Variation function

The variation increment for the VAR spinwheel can be entered using softkey 9 or 10/VAR/number/dimension or ENTER. In contrast to usual operation, VAR/0/ENTER does not set the minimum increment but leads to variation with the fixed frequency series (see VAR function, Section 2.3.2.2.1 and definition menu for tones, Section 2.10).

Reference function

The selected frequency is defined to be the reference by entering REF/number/dimension or ENTER. The set frequencies are to be understood as a difference from the reference frequency (see REF function, Section 2.3.2.2.1).

MOD1/MOD2 Function

The modulation is entered using softkey 9/number/dimension or ENTER. The operating mode of the instrument is determined by the dimension selected for the 1st modulation generator.

Selection of the dimension % sets the CMS to AM mode, selection of the dimension kHz or Hz to FM mode and selection of the dimension rad to ϕM mode.

The modulation mode of the 2nd modulation generator follows that of the 1st (dual-tone modulation).

(An external modulation source is used for dual-tone modulation.)

The modulation can be switched off using softkey 9 or 10/OFF, and the previously valid modulation can be switched on again using softkey 9 or 10/ON.

MOD1/MOD2 Function: Submenu

There is a submenu for the MOD1/MOD2 function which is output in the fields in the display next to softkeys 11 to 14. This submenu can be selected by means of softkey 9 or softkey 10.

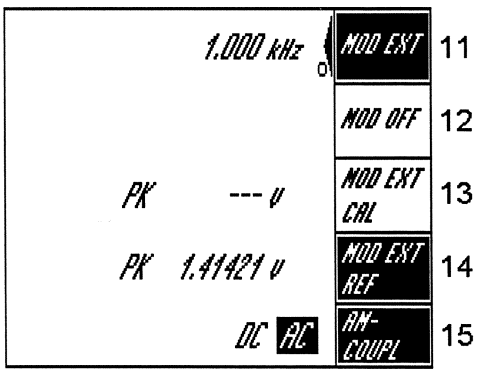


Fig. 2.5-10 MOD1/MOD2 submenu

Softkey 11: MOD EXT (external modulation)

An external modulation signal can be connected to the MOD EXT connector and can be entered using `softkey 11/number/dimension` or `ENTER`. Modulation mode AM (multi-tone) is possible via the external input if the instrument is in AM mode. The dimensions used are %, kHz or Hz.

Further FM modulation (multi-tone) is possible via the external input if the instrument is in FM mode.

Softkey 12: MOD OFF (switching off modulation)

All modulation is switched off by pressing softkey 12; the modulation modes are retained.

Softkey 13: MOD EXT CAL (external calibration)

Softkey 13 should be pressed if the voltage applied to the MOD EXT connector is unknown. The instrument then measures this voltage (output in the display) and takes it into account when setting the modulation. (Subsequent changes in voltage are not taken into account.)

Softkey 14: MOD EXT REF (input of modulation voltage)

`Softkey 14/number/dimension` or `ENTER` can be used to inform the instrument of the voltage applied to the MOD EXT connector which is to be used as the basis for the external modulation setting. The number corresponds to the peak voltage; input ranges between 50 mV and 2 V with DC coupling and between 5 mV and 2 V with AC coupling can be taken into account, otherwise a message is output in the display.

Softkey 15: AM-COUPL

This softkey is used to select AC or DC coupling with external AM modulation. DC coupling is selected when the RF signal amplitude is to be varied using an external DC voltage, e.g. for simulation of a fading signal.

2.5.10 Oscilloscope / DC Measurement

Operation and use of the oscilloscope and the DC measurement feature are analogous to that as described in Section 2.4.10 for the transmitter test.

The settling measurement *) can however not be called in the RX test menu.

*) depending on model or option

2.6 Duplex Test (DX-Test) *)

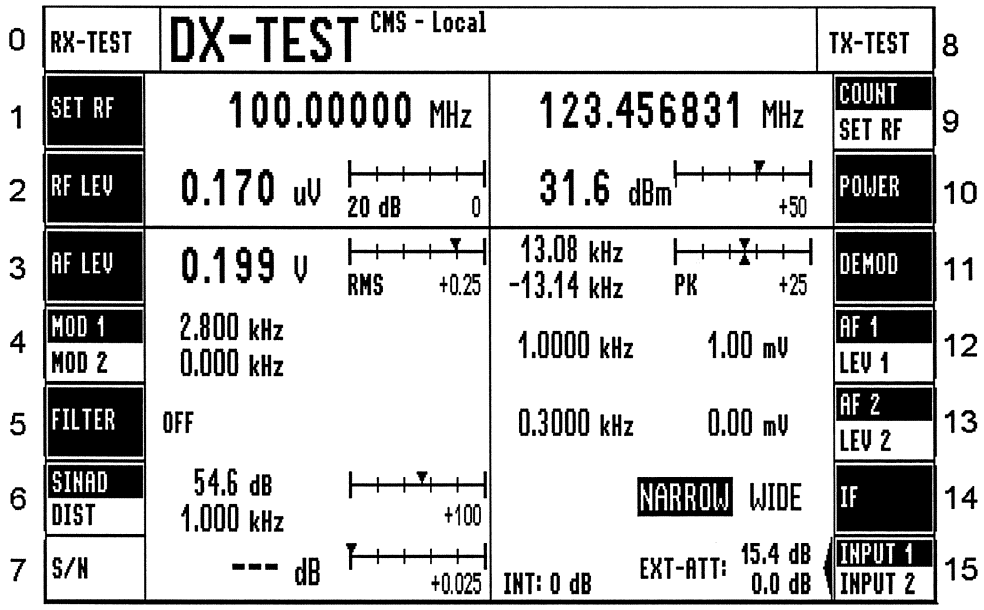


Fig. 2.6-1 Main menu DX test

Starting with the main menu of the selection menu, the main menu DX-TEST (duplex test) can be entered by pressing the softkey DX-TEST.

This menu contains all controls required to carry out a normal duplex test. Almost every function offers submenus. These provide controls for duplex test functions that are required less often.

Softkey 0 may be used to branch directly to the main menu of the receiver test (RX-TEST), softkey 8 to the main menu of the transmitter test (TX-TEST).

The duplex test is a combination of the most important transmitter and receiver test functions. The following sections serve to provide an overview of the interdependencies, e. g. the effect of the transmit power on the receiver sensitivity.

2.6.1 RF Frequency Setting

SET RF Function

This function is described in the RX test (see Section 2.5.1).

2.6.2 RF Level Setting

RF LEV Function

This function is described in the RX test (see Section 2.5.2).

2.6.3 AF Level Setting

AF LEV Function

This function is described in the RX test (see Section 2.5.3).

*) depending on model or option

2.6.4 Modulation

Softkey 4 is used to select the modulation generators. The active modulation generator is displayed in inverse video. The SHIFT key allows to switch between modulation generator 1 and 2.

MOD1/MOD2 Function

The modulation is entered using `softkey 4/number/dimension` or `ENTER`. The operating mode of the instrument is determined by the dimension selected for the 1st modulation generator.

Selection of the dimension % sets the CMS to AM mode, selection of the dimension kHz or Hz to FM mode and selection of the dimension rad to ϕM mode.

The modulation mode of the 2nd modulation generator follows that of the 1st (dual-tone modulation). Modulation 2 is therefore simply acknowledged with ENTER.

The modulation can be switched off using `softkey 4/OFF`, and the previously valid modulation can be switched on again using `softkey 4/ON`.

Variation function (MOD1 only)

The variation increment for the spinwheel VAR is entered by means of
softkey `4/VAR/number/dimension or ENTER`.

Reference function (MOD1 only)

The selected modulation can be chosen as reference using
softkey `4/REF/number/dimension or ENTER`.

2.6.5 Filter Selection

FILTER Function

Various AF filters can be switched on or off using `softkey 5/ON` or `OFF`. The AF filters and their characteristic frequencies can be selected in two submenus.

The filters are switched as in the RX test. Their operation is exactly the same as in the RX test and, apart from differences with softkeys 6 and 7, explained in submenu 2 of Section 2.4.5 (TX test).

FILTER Function: Submenu 1

The FILTER function has two submenus. The first submenu is output in the display fields next to softkeys 4 and 7, the second submenu in the fields next to softkeys 4 to 5.

The operation of softkeys 4 to 7 is analogous to that described in Section 2.4.5.

FILTER Function: Submenu 2

The FILTER submenu 2 is called by pressing the MENU ↓ (DOWN) key.

The operation of softkeys 4 and 5 is analogous to that described in 2.4.5 for the transmitter test. Softkeys 6 and 7 are however not displayed.

2.6.6 SINAD and Distortion Measurements

Softkey 6 is assigned two functions:

SINAD (S/N measurement)
DIST (distortion measurement)

The SHIFT key is used to select either the first or second function.

SINAD/DIST Function

The two measurements are performed using the same method. The result is displayed in dB for SINAD and in % for distortion.

Test frequency

The test frequency is defined via `softkey 6/number/dimension Hz` or `kHz`. It is possible to select in the submenu whether the modulation generator is to be set to this frequency or not.

Automatic search routine

The automatic search routine is started using `softkey 6/number/dimension %` (distortion) `or dB` (SINAD). The routine is run as follows: The RF level is modified until the measured value corresponding to the number is reached. The RF level obtained at the end of the search routine corresponds to the receiver sensitivity. The search routine can be aborted by pressing softkey 6.

The full-scale value can also be influenced in the analog display for the SINAD or DIST measurement.

When `softkey 6/RANGE/% or dB or ENTER` are pressed, the currently measured value is used for defining the full-scale value.

When `softkey 6/RANGE/number/% or dB or ENTER` are pressed, the entered number is used for defining the full-scale value.

Tolerance markers can be set in the analog display using the same syntax: `softkey 6/TOL/number/% or dB or ENTER`.

SINAD/ DIST Function: Submenu

A submenu is available for the SINAD/DIST function, which is output in the display fields next to softkeys 3 to 5 and 7. Softkey 6 remains assigned to the main menu.

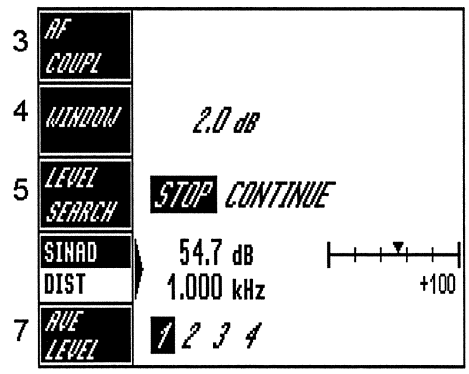


Fig. 2.6-2 SINAD/DIST submenu

Softkey 3: AF COUPL (test frequency)

Softkey 3 can be used to define whether the test frequency selected for the distortion is also to define the frequency of the modulation generator 1 or not.

Application:

Coupling usually has advantages. The modulation generator supplies the signal, which is to be measured by the distortion meter or the SINAD meter following the device-under-test. However, if the radio receiver has a scrambler, the coupling is switched off and the modulation generator signal is set independently of the distortion/SINAD test frequency.

Softkey 4: WINDOW (abort window)

Softkey 4 can be used to define a criterion for aborting the automatic search routine. The range around the target value to be measured is determined by entering `softkey 4/number/dB or %`. The entered number defines the magnitude in % or dB around the target value as the abort window. When a measured value from this range is reached in the search routine for the first time, the search routine is aborted.

Softkey 5: LEVEL SEARCH (stop/continue search routine)

Softkey 5 selects whether the RF level variation is to be stopped when the abort window is reached or not.

Application:

If the receiver sensitivity is to be determined by a measurement, the "stop" position is selected. The "continue" position is selected if the receiver sensitivity is to be set to a maximum during the search routine.

Softkey 7: AVE LEVEL (averaging factors)

Four averaging factors are available to be selected via softkey 7.

1: One measurement determines the result.

2: The result is the average of two measurements.

3: The result is the average of three measurements.

4: The result is the average of four measurements.

Each single measurement corresponds to the average of 5 AD values.

In IEC-bus operation, the single measurements are repeated with large changes in signal level following a delay time.

2.6.7 S/N Measurement

S/N Function

The S/N measurement is very similar to the distortion or SINAD measurement except that the wanted modulation is switched off during the noise measurement and not eliminated by a filter.

Dimension

The S/N ratio is displayed either in % or dB by entering `softkey 7/dimension %` or `dB`.

The full-scale value can also be influenced in the analog display for the S/N measurement.

The currently measured value is used to define the full-scale value by entering `softkey 7/RANGE/%/` or `dB` or `ENTER`.

The number is used to define the full-scale value by entering `softkey 7/RANGE/number/%/` or `dB` or `ENTER`.

Tolerance markers can be set in the analog display with the same syntax: `softkey 7/TOL/number/%` or `dB` or `ENTER`.

Automatic search routine

An automatic search routine is initated via softkey 7/number/dimension % or dB. The routine is executed as follows:

The RF level is modified until the measured value corresponding to the number is reached. The RF level at the end of the search routine corresponds to the receiver sensitivity.

The search routine can be aborted by pressing softkey 7.

S/N Function: Submenu

A submenu is available for the S/N function, which is output in the display fileds next to softkeys 3 to 7.

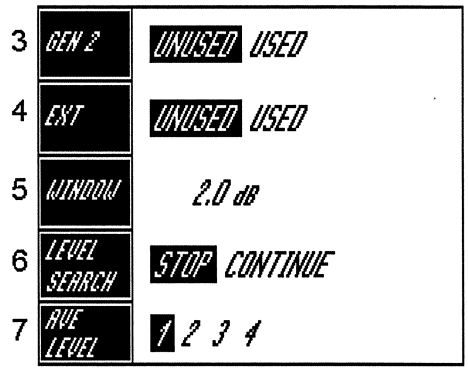


Fig. 2.6-3 S/N submenu

Softkey 3: GEN2 (modulation generator 2)

The modulation is switched on and off by modulation generator 1. Softkey 3 can be used to select whether the modulation generator 2 is to follow this rythm or not.

Softkey 4: EXT (external modulation)

Softkey 4 can be used in the same manner as described above to select whether the external modulation applied to the MOD EXT connector is to follow this rythm or not.

Softkey 5: WINDOW (abort window)

Softkey 5 can be used to define a criterion for aborting the automatic search routine. The range around the target value to be measured is determined by entering `softkey 5/number/dB or %`.The entered number determines the magnitude in % or dB around the target value as the abort window. When a measured value from this range is reached in the search routine for the first time, the search routine is aborted.

Softkey 6: LEVEL SEARCH (stop/continue search routine)

Softkey 6 selects whether the RF level variation is to be stopped when the abort window is reached or not.

Application:

If the receiver sensitivity is to be determined by a measurement, the "stop" position is selected. The "continue" position is selected if the receiver sensitivity is to be set to a maximum during the search routine.

Softkey 7: AVE LEVEL (averaging factors)

Four averaging factors can be selected using softkey 7:

1: The result is the average of one signal measurement and two noise measurements.

2: The result is the average of one signal measurement and three noise measurements.

3: The result is the average of two signal measurements and four noise measurements.

4: The result is the average of two signal measurements and five noise measurements.

Each single measurement corresponds to the average of five AD measurements.

In local and IEC-bus mode, the single measurements are repeated following a delay time in case of large changes in signal level. (Different S/N ratios (measurement times) may result.)

2.6.8 RF Count Measurement

In the case of simple transmitter tests the instrument measures the transmitter frequency and sets the demodulators to this frequency. The receiver frequency of the instrument can also be preset if the device under test outputs several carrier frequencies (off-air measurement) or if the time for counting is insufficient for the demodulator to respond rapidly (demodulation of a fast acknowledgement).

COUNT Function

The count function is constantly active if the COUNT field is shown in inverted form.

The normal count function operates at the connector RF IN/OUT, depending on the model, it also operates at input 2.

The counter resolution can be set using the following input sequence: `softkey COUNT/number 1 or 10/terminating key Hz` or `ENTER`. Thus 1 Hz (slow) or 10 Hz (fast) is selected as the counter resolution.

The sensitivity of the RF counter in particular with frequencies < 1 MHz can be enhanced by switching the IF filter on.

Relative counting

There are two possibilities for selecting a reference frequency for relative counting.

Input of softkey COUNT/REF/ENTER declares the frequency just measured as the reference frequency; input of softkey COUNT /REF /number /dimension or ENTER declares the entered frequency as the reference frequency.

A sign in front of the result indicates that a relative frequency count is being carried out. Absolute frequency counting can be reselected by entering softkey COUNT/REF/OFF.

The dimensions MHz, kHz or Hz can be selected for direct or relative counting, e.g. softkey COUNT/Hz.

SET RF Function

The receiver frequency of the instrument is fixed using the SET RF function. It is not based on the counter result. If the SET RF function is not already active (displayed in inverted form), it can be activated by entering SHIFT/softkey SET RF. The CMS receiver frequency is usually entered and displayed as a frequency value.

The CMS receiver frequency is entered using softkey SET RF/number/dimension or ENTER.

The receiver frequency setting can be varied using the VAR function and the VAR spinwheel. The receiver frequency setting can also be relative.

The reference frequency can be entered using sofkey SET RF/REF/ENTER if the current frequency is to become the reference frequency, or using the softkey SET RF/REF/number/dimension or ENTER if a frequency is to be set different from the reference frequency.

SET RF Function: Submenu

This submenu is identical with that assigned to softkey 1 and has been described in Section 2.4.1 (TX test).

2.6.9 Power Measurement

POWER Function

The broadband RF power measurement can only be performed at the RF IN/OUT socket. The dimensions of the measurement are W or dBm. Tolerance markers can be set on the analog bar for both W and dBm.

A logarithmic relative display based on a reference value can be selected.

Autorange or Range Hold can be selected on the analog display for the full-scale value.

2.6.10 Demodulation

DEMOD Function

The instrument is able to demodulate the transmitter signal according to AM, FM or ϕM. One of the three demodulation modes is selected by the following input:

softkey DEMOD/dimension. FM demodulation is then used for the dimensions Hz and kHz, AM demodulation for % and ϕM demodulation for rad.

Different weighting modes can be selected in the submenu. If peak weighting is selected, the positive and negative peaks are displayed at the same time. Tolerance markers and decision criteria such as e.g. branching in the autorun control program always refer to the positive peak value, however. The RMS weighting generates only one measured value.

Modulation sensitivity

The modulation sensitivity is integrated in a search routine, which varies the AF voltage of the modulation generator at the transmitter input until a predefined modulation depth, frequency deviation or phase deviation is attained as transmitter modulation.

The entry is made using:
Softkey DEMOD/number/dimension.

The number corresponds to the entered modulation value and the dimension to the demodulation mode of the CMS.

If the demodulation mode output in the display is to be retained, ENTER can be input instead of the dimension.

The analog display can be assigned a full-scale value depending on the measured value or a fixed full-scale value. The positive peak value applies if the fixed full-scale value is to be derived from the currently measured value.

Tolerance markers can be entered in the analog display. In the event of two measured values it is again the positive peak value which is used for the tolerance weighting.

2.6.11 Modulation Generators

Softkeys 12 and 13 are assigned the frequency as the first function and the level as the second function of the corresponding modulation generators. Switching between the two functions is possible using the SHIFT key.

AF 1/AF 2 Function

The frequency is entered using softkey 12 or 13/number/dimension or ENTER. The modulation generator is switched off by entering softkey 12 or 13/OFF, and switched on again using softkey 12 or 13/ON.

Variation function

The variation increment for the VAR spinwheel can be entered using softkey 12 or 13/VAR/number/ dimension or ENTER. In contrast to usual operation, VAR/0/ENTER does not set the minimum increment but leads to variation with the fixed frequency series (300 Hz, 600 Hz to 10 kHz).

Reference function

The selected frequency is defined to be the reference by entering REF/number/dimension or ENTER. The set frequencies must be understood as a difference from the reference frequency.

LEV1/LEV2 Function

Since the source impedance*) of the modulation generator is very low (approx. 2 Ω), the set level is to be understood as the EMF.

The modulation generator level is entered using softkey 12 or 13/number/dimension or ENTER. The power is referred to 600 Ω when the dimension dBm is selected. The level is switched off using softkey 12 or 13/OFF, and the previously valid level is switched on again using softkey 12 or 13/ON.

Variation function

The variation increment on the VAR spinwheel can be set using softkey 12 or 13/VAR/number/ dimension or ENTER.

Reference function

The variation increment for the level on the VAR spinwheel can be set using softkey 12 or 13/REF/number/dimension or ENTER.

2.6.12 IF Filter

The IF filter can be switched on and off using softkey 14. The IF bandwidth is limited to approx. 25 kHz by the NARROW filter. This improves the S/N ratio, especially when receiving small RF levels, but also results in a distortion at higher deviations and/or modulation frequencies.

2.6.13 Input Switchover

INPUT 1/INPUT 2 Function

The selected RF input (RF IN/OUT or RF 2) is shown in inverted form. The other input can be selected by entering SHIFT/ softkey 15. It is possible to inform the CMS of the attenuation value connected prior to the associated input. By entering softkey 15/number/dB or ENTER the CMS takes into account the entered attenuation for the level with RF measurement and setting.

*) depending on model or option

2.7 SSB Transmitter Test (TX-SSB)

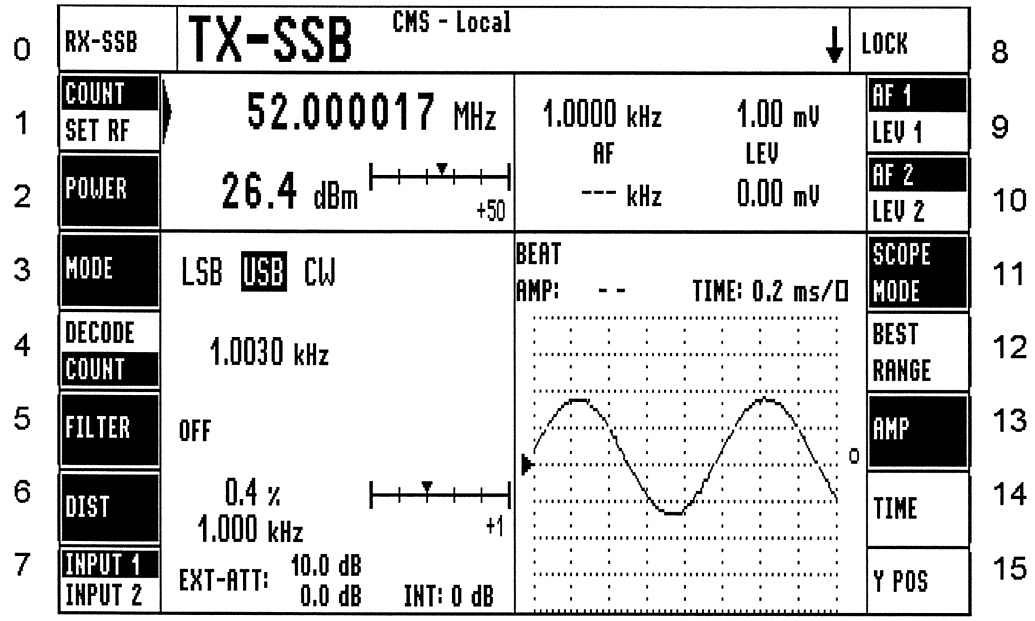


Fig. 2.7-1 Main menu TX-SSB

Starting with the main SSB menu accessible from the selection menu, the main menu TX-SSB (transmitter test) can be entered by pressing the softkey SSB. In SSB mode the CMS is switched to Beat mode and AM modulation permanently.

This menu contains all controls required to carry out a single side band transmitter test. Almost every function offers submenus. These provide controls for additional transmitter test functions that are required less often.

Softkey 0 may be used to branch to the receiver test (RX-SSB) main menu.

2.7.1 RF Count Measurement

With simple transmitter tests (only one RF frequency present), the instrument will show the frequency of the suppressed carrier. If the device under test outputs several strong RF frequencies, the receiver frequency should be preset by toggling to SET RF.

COUNT Function

The count function is constantly active if the COUNT field is shown in inverted form.

The normal count function only operates at the connector RF IN/OUT.

The count measurement is executed in BEAT mode only.

The carrier frequency value shown depends on

- the measured RF frequency
- the value of the chosen AF frequency and
- the setting of the ssb mode toggle (LSB, USB, CW).

In case of LSB and USB a suppressed carrier is assumed. Depending on the operating mode the following formulas apply:

LSB (lower side band): $F_{sc} = F_m + F_{af}$

USB (upper side band): $F_{sc} = F_m - F_{af}$

CW (continuous wave): $F_c = F_m$

with F_{sc}, F_c being the value of the (suppressed) carrier, Fm the measured RF frequency. Faf represents the AF generator frequency output by CMS (please refer to description of softkey 9 or 10 for further details).
In case AF1 and 2 are active simultaneously, a warning is issued; the value for Faf will correspond to AF1 in that case.

The local oscillator is set to Fsc in case of LSB and USB. In continuous wave mode, however, the LO frequency is as follows:

$F_{lo} = F_m - ITF$

where ITF is the international telegraph standard frequency of 800 Hz.

The counter resolution can be set using the following input sequence: `softkey COUNT/number 1 to 10/terminating key Hz` or `ENTER`. Thus 1 Hz (slow) or 10 Hz (fast) is selected as the counter resolution.

Relative counting

There are two possibilities for selecting a reference frequency for relative counting.

Input of softkey `COUNT/REF/ENTER` declares the frequency just measured as the reference frequency; input of `softkey COUNT /REF /number /unit key` or `ENTER` declares the entered frequency as the reference frequency.

A sign in front of the result indicates that a relative frequency count is being carried out. Absolute frequency counting can be reselected by entering `softkey COUNT/REF/OFF`.

The dimensions MHz, kHz or Hz can be selected for direct or relative counting, e.g. `softkey COUNT/Hz`.

COUNT Function: Submenu

The function COUNT has a submenu which is output in the display fields next to softkeys 3, 4 and 5.

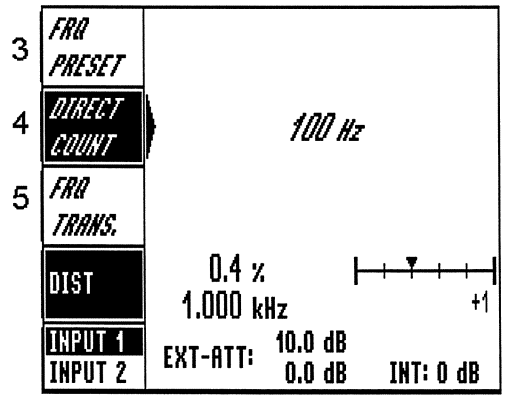


Fig. 2.7-2 COUNT submenu

The normal count function comprises a coarse direct broadband count and a subsequent exact AF count.

Softkey 3: FRQ PRESET (IF count)

This setting is of no consequence in SSB mode.

Softkey 4: DIRECT COUNT

Switch-on: `Softkey 4/number 100 or 1000/ dimension Hz or ENTER`. Direct counting is carried out with a resolution of 100 or 1000 Hz.

Switch-off: `Softkey 4/OFF`

Softkey 5: FRQ TRANS (transfer function)

Actuating this softkey once transfers the measured frequency as CMS receiver frequency.

In the main menu, this action switches from the COUNT function to SET RF.

Application:

Softkey 5 facilitates operation with regard to entry of multi-digit or unknown transmitter frequencies as CMS receiver frequency.

SET RF Function

The receiver frequency of the instrument is fixed using the SET RF function. It is not based on the counter result. If the SET RF function is not already active (displayed in inverted form), it can be activated by entering SHIFT/softkey SET RF. The CMS receiver frequency is usually entered and displayed as a frequency value using softkey SET RF/number/dimension or ENTER.

The receiver frequency setting can be varied using the VAR function and the VAR spinwheel. The receiver frequency setting can also be relative.

The reference frequency can be entered using sofkey SET RF/REF/ENTER if the current frequency is to become the reference frequency, or using the softkey SET RF/REF/number/dimension or ENTER if a reference frequency is to be set to a different value.

SET RF Function: Submenu

This submenu has been described in the TX test section of this manual. Please refer to section 2.4.1.

2.7.2 Power Measurement

POWER Function

The broadband RF power measurement can only be performed at the RF IN/OUT socket; the selective RF power measurement can also be carried out at the RF IN 2 socket (input 2). The dimensions of the broadband RF power measurement are W or dBm, those of the selective RF power measurement are mV, W, dBµV or dBm.

A logarithmic relative display based on a reference value may be selected. Tolerance markers can be set on the analog bar for the dimensions mentioned above. Autorange or Range Hold for the full-scale value can be selected on the analog display.

POWER Function: Submenu

This submenu has been described in the TX test section of this manual. Please refer to section 2.4.2.

2.7.3 MODE Function

MODE Function

The DUT's SSB transmission mode is set using softkey 3. Three different settings may be selected:

- LSB (Lower Side Band)
- USB (Upper Side Band)
- CW (Continuous Wave).

In order to correctly measure the frequency of the suppressed carrier, the transmission mode of the DUT must be known to the CMS (RF measurement: COUNT function).

2.7.4 AF Measurement

This mode is described in the TX test (see Section 2.4.4).

COUNT Function

The frequency of the demodulated signal or the beat signal is counted by pressing softkey 4.

A relative measurement can be made in two different ways:

- The currently measured frequency is selected as the reference frequency by entering softkey 4/REF/ENTER.
- An arbitrary frequency value is selected as the reference frequency by entering REF/number/dimension or ENTER.

The relative result is the difference to the reference frequency. Relative measurements are identified by a sign in front of the result.

COUNT Function: Submenu

The COUNT function has a submenu which is output in the field of the display next to softkey 6.

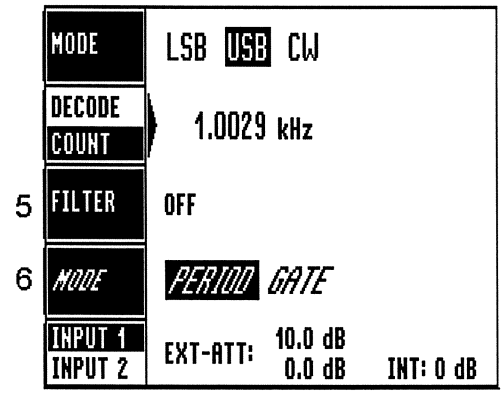


Fig. 2.7-3 COUNT submenu

Softkey 6: MODE (operating mode and resolution of counter)

There are two alternatives:

- Period counting
- Gate time counting

Period counting has a resolution of 0.1 Hz up to 100 kHz; the resolution is 1 Hz at frequencies above this value. Period counting is fast but requires a signal without noise.

Gate time counting is slower but less sensitive to noisy signals.

2.7.5 Filter Selection

FILTER Function

Various AF filters can be switched on or off using softkey `5/ON` or `OFF`. The AF filters and their characteristic frequencies can be selected in two submenus.

FILTER Function: Submenu 1

This submenu has been described in the TX test section of this manual. Please refer to section 2.4.5.

FILTER Function: Submenu 2

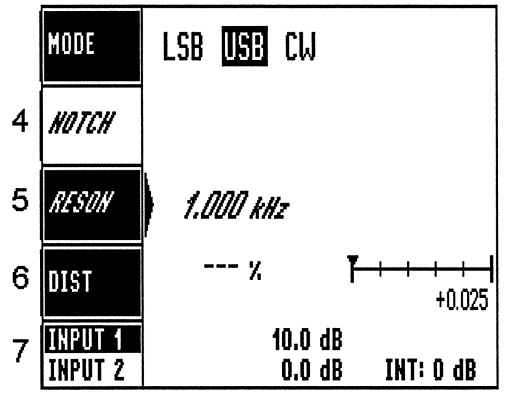


Fig. 2.7-4 FILTER submenu 2

Softkey 4: NOTCH (notch filter)

The notch filter is switched on using softkey `4/ON` and off using `softkey 4/OFF`.

Stop frequency of notch filter:
The stop frequency of the notch filter is also selected using softkey 4. The entry is made using softkey `4/number/dimension` or `ENTER`.

Since the frequencies cannot always be set exactly as required, the frequency actually set is output in the display.

Softkey 5: RESON (resonance filter)

The resonance filter is switched on using `softkey 5/ON` and off using `softkey 5/OFF`.

Resonance frequency of resonance filter:
Softkey 5 is used to select the resonance frequency of the filter. The entry is made using `softkey 5/number/dimension` or `ENTER`. The actually set frequency is displayed as with the notch filter.

Filter combinations*)

For better understanding all filters can be envisaged as a series connection of three filter groups:

- Highpass filter - lowpass filter
- Psophometric filter - external filter
- Notch filter - resonance filter

Highpass and lowpass filters can be combined independently into four different filter configurations.

*) depending on model or option

The psophometric filter and the external filter cannot be combined, the same applies to the notch filter and the resonance filter. Since the notch filter is used for distortion and SINAD measurements, the last filter group cannot be used for evaluation during a distortion or SINAD measurement.

Notch filter and resonance filter are also being switched off when quitting or selecting RX-test and TX-test, since in this case SINAD or DIST measurements automatically continue to run.

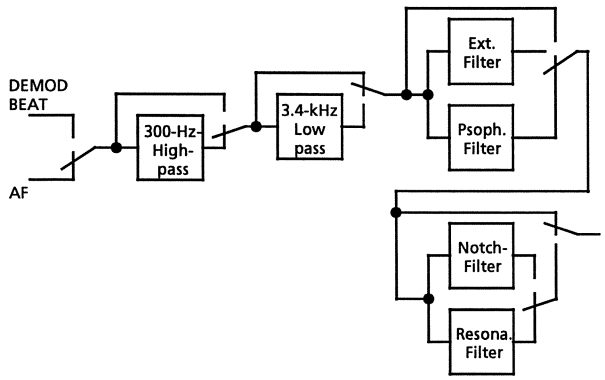


Fig. 2.7-5 Signal paths

2.7.6 Distortion Measurement

DIST Function

This funciton has been described in the TX test section of this manual. Please refer to section 2.4.6.

2.7.7 Input Switchover

INPUT 1/INPUT 2 Function

This function has been described in the TX test section of this manual. Please refer to section 2.4.7.

2.7.8 Lock

LOCK Function

This function has been described in the TX test section of this manual. Please refer to section 2.4.8.

2.7.9 Modulation Generators

AF1/AF2 Function

This function has been described in the TX test section of this manual. Please refer to section 2.4.9.

LEV1/LEV2 Function

This function has been described in the TX test section of this manual. Please refer to section 2.4.9.

2.7.10 Oscilloscope Settling Measurement *)

SCOPE MODE Function

This function has been described in the TX test section of this manual. Please refer to section 2.4.10. Settling measurement is not possible in SSB mode*).

*) depending on model or option

2.8 SSB Receiver Test (RX-SSB)

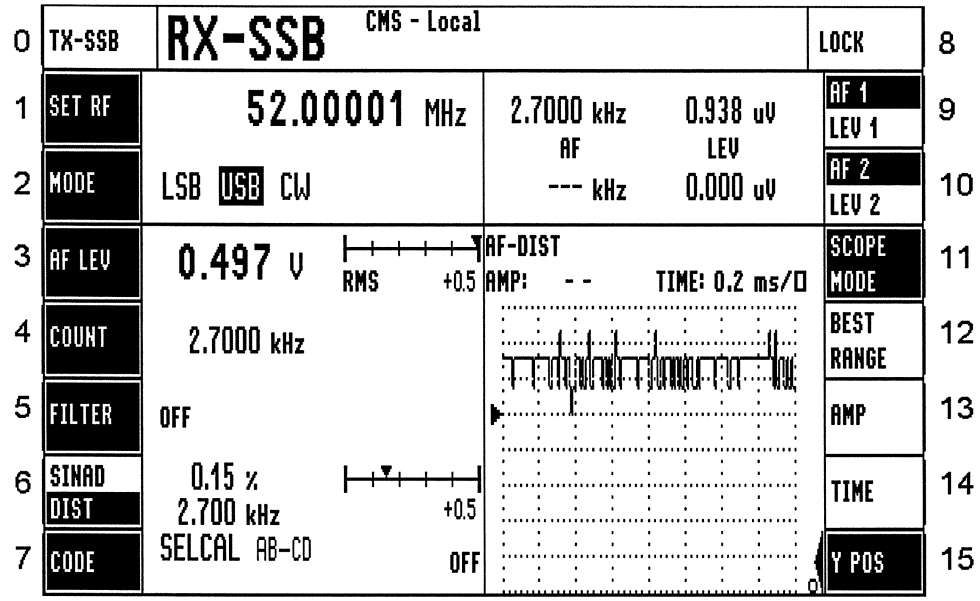


Fig. 2.8-1 Main menu RX-SSB

The main menu RX-SSB (receiver test) can be accessed by pressing the softkey RX-SSB in the upper left corner of the SSB transmitter test menu TX-SSB.

It contains all controls required to carry out a single side band receiver test. Almost every function contains submenus. These contain controls which can be used for more seldom receiver test functions.

Softkey 0 may be used to branch to the main menu for the transmitter test (TX-SSB).

In SSB mode, single or two-tone modulation is permissible. The kind of modulation depends on the number of AF generators used. To switch off an AF generator, press the OFF key after selecting the frequency of either AF1 or AF2 with the active cursor.

Note: *Since for SSB a suppressed RF carrier is simulated, the RF level is set by means of softkeys 9 and 10, i. e. via the modulation.*

Input of LEV1/OFF or LEV2/OFF has no influence on single/two-tone modulation.

a) Single tone
In case modulation is supplied by a single tone, complete carrier and residual sideband suppression is employed.

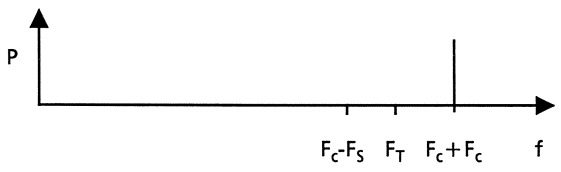


Fig. 2.8-2

Example:
USB mode (Upper Side Band): Complete absence of carrier Fc and residual sideband Fc-Fs (lower sideband in this example).

b) Two-tone

In case of two-tone modulation, CMS will not suppress the spurious spectral components. Instead, the carrier as well as the modulation signals will be offset by 10 kHz, respectively. As a result, unwanted spectral components will come to rest in a position further away from the side band under analysis and thus not influence measurement results.

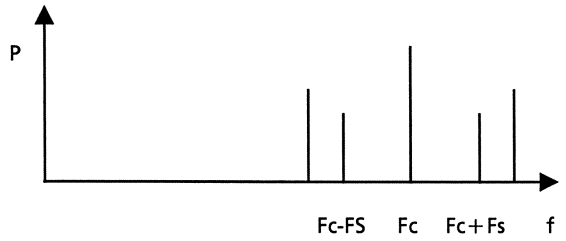


Fig. 2.8-3 Spectral components of an unmodified AM signal

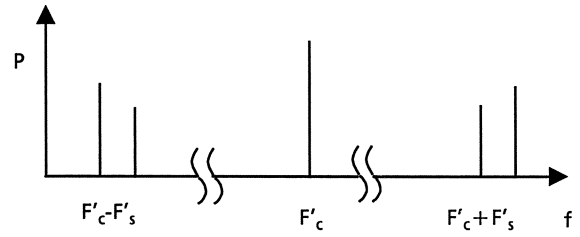


Fig. 2.8-4 Spectral components of the modified AM signal

Example: Mode USB, modified AM signal

F'c = Fc - 10kHz
F's = Fs + 10kHz

By simultaneous modification of the carrier and unwanted sideband frequency, the wanted sideband frequency (USB in above example) remains unaffected while the disturbing components of the carrier and sideband are shifted far way away from their original frequencies and thus without affecting the DUT.

Note: *Since the frequency offset of both carrier and unwanted sideband is achieved through the AF generator, the upper frequency limit of AF1 and AF2 is lowered to 20kHz. For the same reason, the frequency output at the MOD GEN socket is 10 kHz higher then displayed.*

2.8.1 RF Frequency Setting

Please refer to corresponding section 2.5.1 (RX test).

2.8.2 Mode Function

MODE Function

The SSB transmission mode is set using the MODE function.

Three different settings may be selected:

- LSB (Lower Side Band)
- USB (Upper Side Band)
- CW (Continuous Wave).

With settings LSB and USB carrier and residual sideband will either not appear or be shifted a distant frequency range depending on type of modulation (single or two-tone).

In CW mode, the carrier that is typically suppressed in SSB will be transmitted; this carrier is defined by the frequency value supplied by the SET RF function and the RF level displayed next to softkey LEV1.

Both AF generators are switched off in CW mode, entry of AF frequency values is not possible.

2.8.3 AF Level Measurement

AF LEV Function

Please refer to corresponding section 2.5.3 (RX test).

2.8.4 AF Count Measurement

COUNT Function

This function has been described in the RX test section of this manual. Please refer to section 2.5.4.

2.8.5 Filter Selection

FILTER Function

Please refer to corresponding section 2.5.5 (RX test).

2.8.6 SINAD and Distortion Measurements

SINAD/DIST Function

Please refer to corresponding section 2.5.6 (RX test).

2.8.7 Code

CODE Function

An already stored selective call can be sent to the radiotelephone via the RF path using `softkey 7/ENTER`.

On entry into the SSB-RX menu code standard 13 (SELCAL) with be pre-selected.

A new call number can be entered and sent using `softkey 7/number/ENTER`. Depending on the tone standard selected, tone sequences of differing length may be issned; the keypad may assume different meanings (see RX test function CODE and section 2.11).

A tone sequence can be incorporated in a continuous tone of constant modulation or output as a modulation burst. Section 2.5.9 describes the setting of the two modes.

CODE Function: Submenu 1

Please refer to corresponding section 2.5.4 (RX test).

CODE Function: Submenu 2

This function has been described in the RX test section of this manual. Please refer to section 2.5.4.

2.8.8 Lock

LOCK Function

This function has been described in the RX test section of this manual. Please refer to section 2.5.8.

2.8.9 Modulation Generators

Softkey 9 is assigned all functions of the first modulation generator, softkey 10 those of the second modulation generator. Each softkey is assigned the frequency as first function and RF Level as the second. Switching between the two functions is possible by entering `SHIFT/softkey 9` or `10`.

AF1/AF2 Function

The frequency is entered using `softkey 9` or `10/number/dimension` or `ENTER`. The modulation generator is switched off by entering `softkey 9` or `10/OFF`. The modulation generator can be switched on again using `softkey 9` or `10/ON`.

Variation function

The variation increment for the VAR spinwheel can be entered using `softkey 9` or `10/VAR/number/dimension` or `ENTER`. In contrast to usual operation, `VAR/0/ENTER` does not set the minimum increment but leads to variation with the fixed frequency series (see VAR function, Section 2.3.2.2.1 and definition menu for tones, Section 2.10).

Reference function

The selected frequency is defined to be the reference by entering REF/number/dimension or ENTER. The set frequencies are to be understood as a difference from the reference frequency (see REF function, Section 2.3.2.2.1).

LEV1/LEV2 Function

Input of RF levels (determined by build-in modgen) may be accomplished through softkeys 9 or 10/number/unit or ENTER. If unit dBm is selected, power refers to 50 Ohms. Using softkey 9 or 10 followed by OFF will switch off the RF output assigned to LEV1 or LEV2, respectively. Softkey 9 or 10/ON switches on the level set previously (a method to switch on or off RF level and change between single and two-tone modulation as well is described with function AF1 and AF2).

Variation function

The variation increment for the VAR spinwheel is set using softkey 9 or 10/VAR/number/dimension or ENTER.

Reference function

The variation increment for the VAR spinwheel is set using softkey 9 or 10/REF/number/dimension or ENTER.

2.8.10 Oscilloscope / DC Measurement

Operation and use of the oscilloscope and the DC measurement feature are analogous to that as described in section 2.4.10.

2.9 RF Spectrum Analyzer

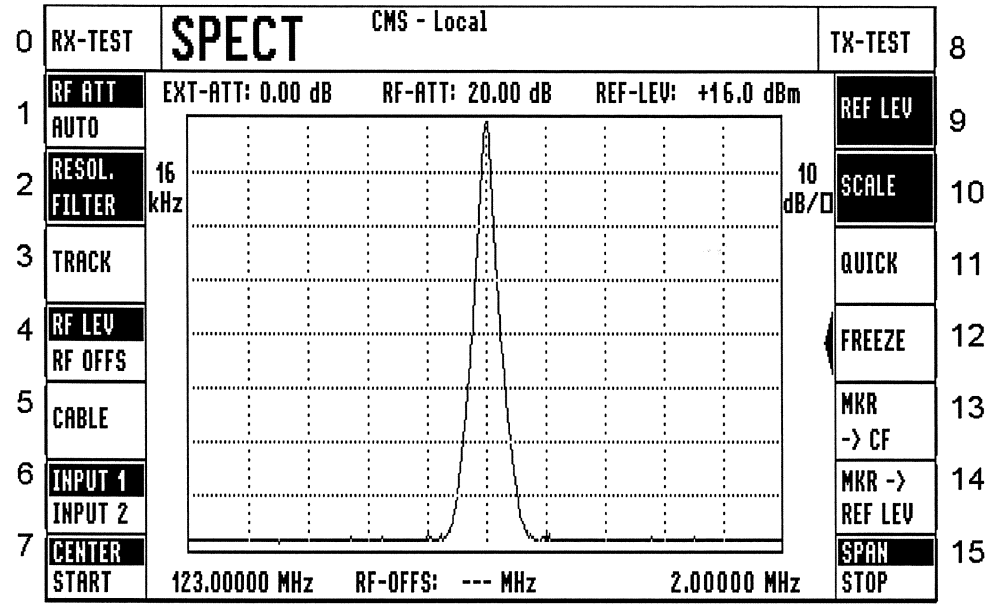


Fig. 2.9-1 Main menu of RF spectrum analyzer

The main menu of the RF spectrum analyzer can be selected from the selection menu by pressing the SPECT key.

In this menu, the CMS permits to display modulation spectra within one or a few channels as well as observe the complete frequency spectrum in the range from 10 MHz to 1 GHz.

The softkey 0 permits to branch directly into the main menu for the receiver test, softkey 8 into the main menu for the transmitter test.

In operating mode RF spectrum analyzer, all RF functions of the instrument are made use of, even if the duplex synthesizer is installed. Thus no duplex operation is possible.

2.9.1 Attenuation Setting

RF ATT/AUTO Function

For measurements via the connector RF IN/OUT, the spectrum analyzer is provided with switchable input attenuator pads in the range from 0 to 112.5 dB. This input attenuation can be selected manually, or it is set automatically depending on the power measured by the power meter and on the reference level set. The set value is indicated in the upper display area.

Changing from automatic setting to manual setting and vice versa is effected by pressing softkey 1.

For measuring small voltages via the sensitive input connector RF IN 2, RF level matching is not possible. The functions RF ATT and AUTO are at no significance in this case. The 2nd RF input attenuation (0 or 24 dB) is displayed next to softkey 6. *)

Manual attenuation setting:

In the position RF ATT, the user can set the attenuation himself in the range from 0 to 112.5 dB. Since the total attenuation is obtained by series-connection of single attenuator pads of fixed attenuation, not all values can be implemented. The CMS therefore rounds the entry to the next possible value. Note that a 20-dB power attenuator pad is automatically cut in when a high RF power (approx. >13 dBm) is applied.

*) depending on model or option

Automatic attenuation setting:

In the AUTO position, the power at the connector RF IN/OUT is measured internally in the CMS prior to each build-up of the display, which permits the optimum setting of the input attenuation to be determined automatically.

2.9.2 Resolution Filter Selection

RESOLUTION FILTER Function

This key is used to select the bandwidth of the resolution filter via which the frequency spectrum is weighted. The CMS provides 7 resolution filters with bandwidths from 150 Hz to 3 MHz. The set filter bandwidth is indicated opposite to the key.

Since, depending on the settings of the frequency span, not all filters allow for a useful display, their selection is restricted.

Table 2.9-1 Settable resolution filters depending on the frequency span set

Span	Resolution filters				
2,4 kHz...30 kHz	150 Hz	6 kHz	16 kHz	50 kHz	
30 kHz...1,2 MHz	6 kHz	16 kHz	50 kHz	300 kHz	1 MHz
1,2 MHz...3,2 MHz	16 kHz	50 kHz	300 kHz	1 MHz	3 MHz
3,2 MHz...10 MHz	50 kHz	300 kHz	1 MHz	3 MHz	
10 MHz...50 MHz	300 kHz	1 MHz	3 MHz		
50 MHz...1 GHz	1 MHz	3 MHz			*)

2.9.3 Function Tracking Mode (only if fitted with CMS-B9/-B59) *)

TRACK Function

Softkey 3 permits to activate and deactivate the tracking mode (tracking generator). In this operating mode, an RF signal is output at the connector RF IN/OUT according to the span selected and the signal at the input connector RF IN 2 is displayed in the spectrum analyzer display. In this way, filter frequency responses can be recorded, for example.

*) depending on model or option

Tracking mode is only possible if the CMS is provided with a duplex synthesizer. Besides, RF input 2 must be selected, because the test signal is generated at the connector RF IN/OUT.

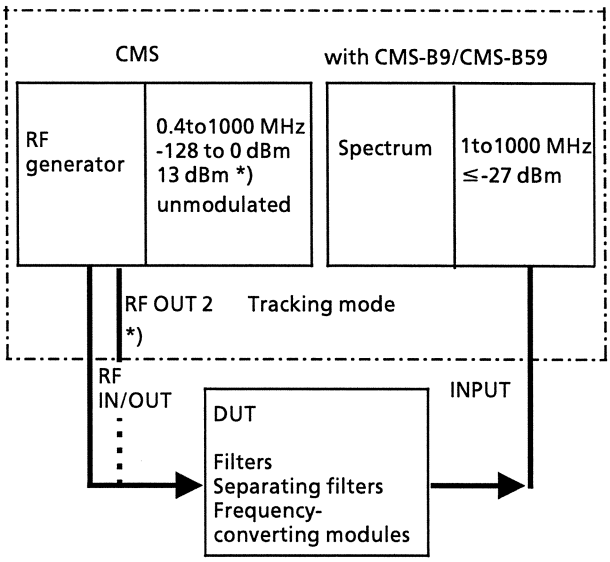


Fig. 2.9-2 Tracking mode

The frequency offset between the RF generator and the spectrum evaluation filter is user-definable from 0 to max. ± 999 MHz (dependent upon selected center frequency and display width).

Evaluation dynamic range: 50 dB (1 to 500 MHz)
45 dB (500 to 1000 MHz)

As in spectrum mode, various evaluation filters are available.

If the option CMS-B34 is fitted, higher output levels are output at the connector RF OUT 2. This is indicated in the display as follows: "!". *)

2.9.4 RF Level and RF Offset

RF LEV/RF OFFS Function

Softkey 4 is used to set the level at the RF IN/OUT socket.
The RF OFFS function allows to define the difference in frequency between the RF IN/OUT socket and the RF IN2 socket, eg for measurements on frequency-converting modules. The measured value may either be positive or negative.

The settings for the RF level and offset frequency are shown in the upper part of the display as soon as the tracking key is active.

2.9.5 Detection of Short-Circuits and Open-Circuits (Cable Fault Test) *)

CABLE Function *)

This function can be used to detect short circuits or open circuits in RF lines. To carry out the measurement, connect the CMS as shown in Fig. 2.9-3.

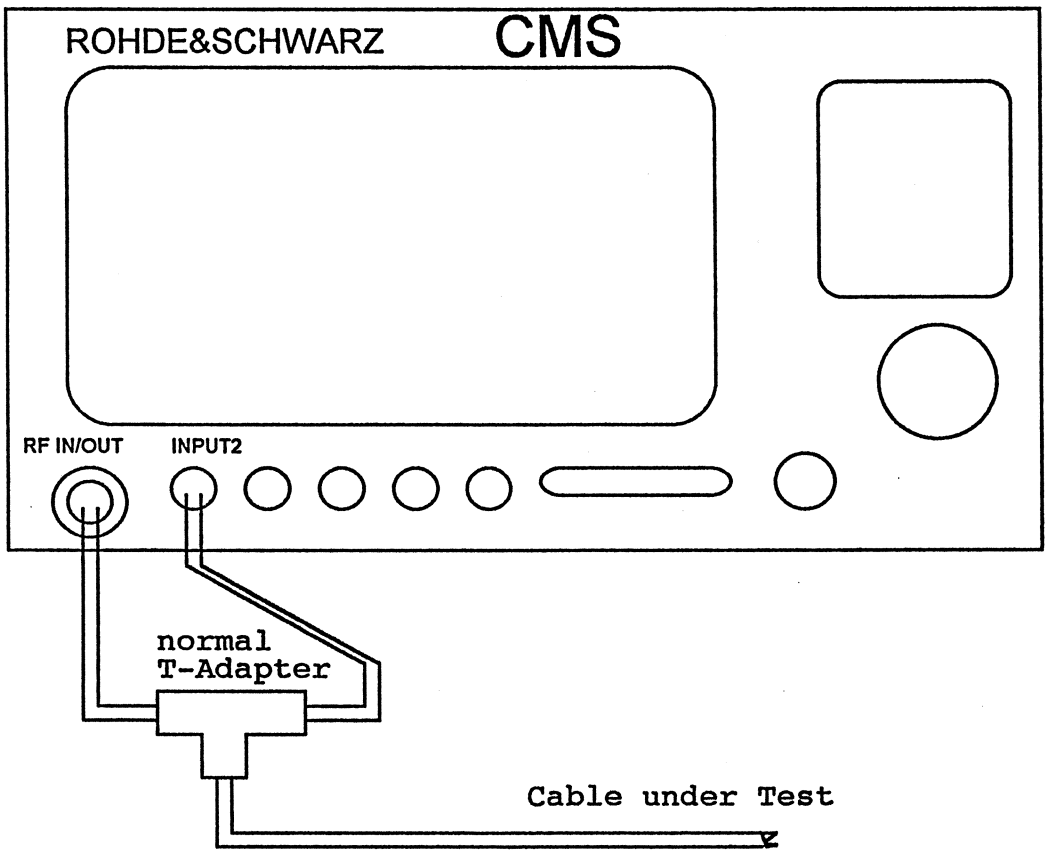


Fig. 2.9-3 Connection of the CMS for cable fault test

After the CABLE softkey has been pressed, the CMS activates the tracking mode and the following presettings are made:

starting frequency:	0.4 MHz
stop frequency:	200 MHz
RF input:	INPUT2
reference level:	-27 dBm
RF transmitter level:	-37 dBm

To obtain correct measurement results the parameter RF OFFS must be kept at 0.

In addition, the FREEZE key is activated so that recording is stopped after the first build-up of the display and the picture can be analyzed by the user.

Depending on whether there is a short circuit or an open circuit, different curves are obtained:

*) depending on model or option

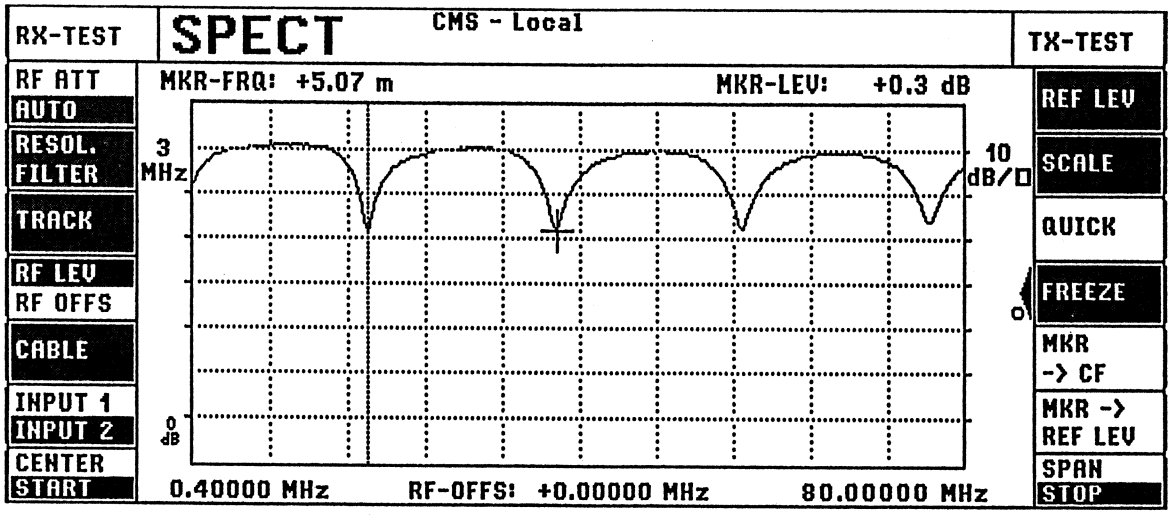


Fig. 2.9.4 Short -circuit at a distance of 5 m

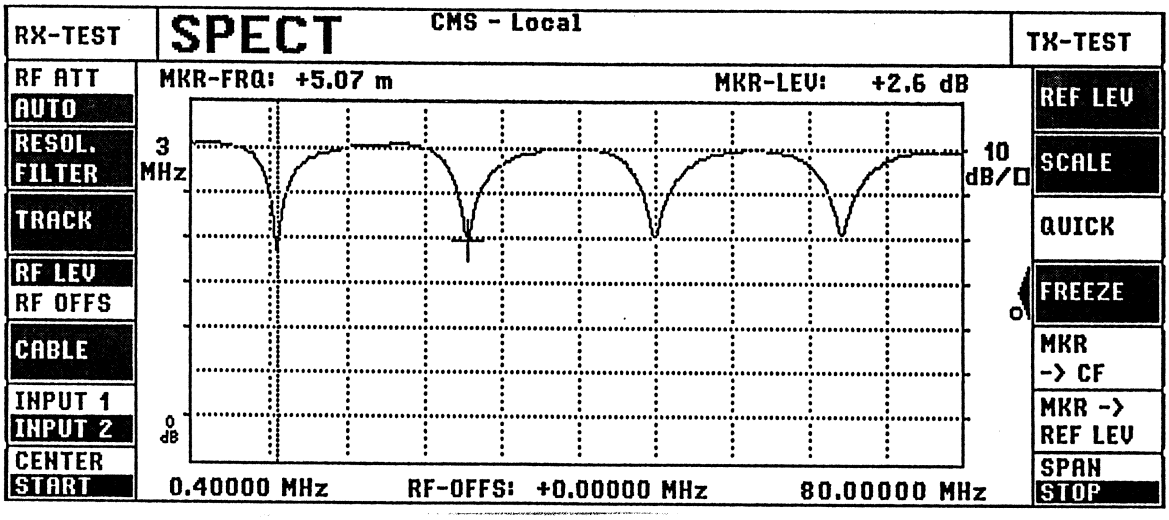


Fig. 2.9-5 Open-circuit at a distance of 5 m

In the case of a short-circuit, the recording shows a notch near the zero frequency (Fig. 2.9-4), while in the case of an open circuit the first notch only occurs in the half-distance frequency range (Fig. 2.9-5).

The distance to the open-circuit or the short-circuit is determined by placing the reference marker in a notch using the VAR rotary knob and hardkeys SHIFT/REF/ENTER. Now an adjacent notch is approached using the VAR rotary knob. The distance can be read in the upper area of the display in the unit meters.

If the active cursor is set on the softkey CABLE, the shortening factor can be entered on the keyboard. This factor is the ratio of the propagation speed of EM waves in a cable of a specific material to that in air. Reducing the propagation speed has the effect of shortening the wavelength.

Shortening factor values occuring in practise lie between 0.5 and 0.95. The value range of the CMS is 0.01 to 1.

The table below lists the shortening factor for common cable types:

Cable type	Shortening factor
RG 58C	0,66
RG 400	0,66
RG 142	0,69
RG 402	0,69
RG 214	0,66
RG 393	0,69
RG 401	0,69
RG 196	0,7
AGSC 3008	0,7
Pair of coax. CCI cable, small	0,95
Pair of coax. CCI cable, normal	0,95

2.9.6 Test Input Selection

INPUT 1 / INPUT 2 Function

This key permits to select the RF input via the connectors RF IN/OUT or RF IN 2. An external attenuation in the range from 0 to 100 dB can be entered for the two inputs. The numerical value is indicated in the upper display area with EXT ATT: -- dB.

2.9.7 RF Range Setting

CENTER / START / SPAN / STOP Function

These keys permit to define the RF frequency range, in which the RF input signal is analyzed.

The user may select between display with center and span frequency or with start and stop frequency. Switchover is possible by actuating one of the two keys CENTER / START or SPAN / STOP.

The selected settings are also valid for the RX test, submenu 2 of the SET RF function. Thus, an RF generator can be operated even if the option Duplex modulation tester is not fitted.

If entries are made for one of these functions, the CMS automatically selects a resolution filter depending on the set span so as to guarantee useful recording.

Table 2.9-2 Selection of the optimum resolution filter depending on the frequency span entered

Span			Resolution filter
1.2 kHz	to	30 kHz	150 Hz
30 kHz	to	1.2 MHz	6 kHz
800 kHz	to	3.2 MHz	16 kHz
2.5 MHz	to	10 MHZ	50 kHz
8 MHz	to	50 MHz	300 kHz
50 MHz	to	1 GHz	1 MHz

In order to avoid unintentional, frequent variation of the resolution filters, Table 2.9-2 features hysteresis. A resolution filter setting is maintained as long as the frequency span is within the range of a row.

2.9.8 Reference Level Setting

REFLEV Function

The reference level indicates the level of the upper edge of the display. Thus, the level of the recorded signal can easily be determined at any point.

The limit values for the numerical entries of the reference level are dependent on the selection of the RF input. The RF attenuator pads or the pads connected at the RF IN/OUT or RF IN2 test inputs are taken into account for the limit values.

If signals are recorded via the connector RF IN/OUT, the reference level can be set at will in the range from -47 dBm to +47 dBm (+50 dBm with CMS-B32).

For RF input 2, the reference level can be set in the range from -67 dBm to -27 dBm.

Possible units for the reference level are W, V and dBUV.

2.9.9 Amplitude Resolution

SCALE Function

This function permits to vary the scale in the y-direction. Settings of 2, 5 and 10 dB/division are possible. The set value is indicated to the left of the key.

2.9.10 Sweep Rate

QUICK Function

This softkey can be used to affect the beam sweep rate. In default state (QUICK not active), 400 pixels (corresp. to 400 testpoints) are formed in a single sweep of the beam while with softkey QUICK active only 200 pixels are generated. The sweep time is thus reduced to roughly half of its previous value.

2.9.11 Freeze Function

FREEZE Function

Softkey 12 switches on and off the FREEZE function.

The Freeze function permits to stop the continuous build-up of the display. After pressing the key, the current build-up is finished and the curve then "freezed". A marker shaped as a cross appears at the maximum point of the curve. The frequency and level of the marker are indicated in the display. The marker can then be moved at will on the curve using the rotary knob VAR.

During Freeze mode, FM-modulated signals can be demodulated at the frequency defined by the marker.

The settings for AM, FM, ϕM demodulation, IF filter (WIDE/NARROW), the demodulator status (ON/OFF/SQUELCH), and the setting of the loudspeaker (AMP softkey) are taken from the TX test.

A reference marker can be set at the position of the marker positioned before using keys SHIFT/REF/ENTER. The active cursor must be on the FREEZE key.

The reference marker is displayed in the form of a vertical line. If the reference marker is activated, the marker frequency and the marker level are displayed as a deviation from the reference position.

The reference marker function can be deactivated by keys SHIFT/REF/CLEAR. It is also cancelled with every new build-up of the display. The marker frequency displayed can be defined as centre frequency by way of softkey 13 (MKR → CF). Softkey 14 (MKR → REFLEV) serves to turn the indicated marker level into the reference level.

Thus the user is allowed to position a part of the recorded curve that is important to him into the middle of the picture with only a few keystrokes.

Both keys can only be operated if FREEZE has been activated. Pressing of these keys initiates a new build-up of the display.

These actions lead again to a sweep in order to show the modified display.

If the TX test is activated in the Freeze function after the marker appears, the current marker frequency is accepted as the value for the SET RF function of menu TX test (softkey 1).

2.10 Definition Menu for Tones

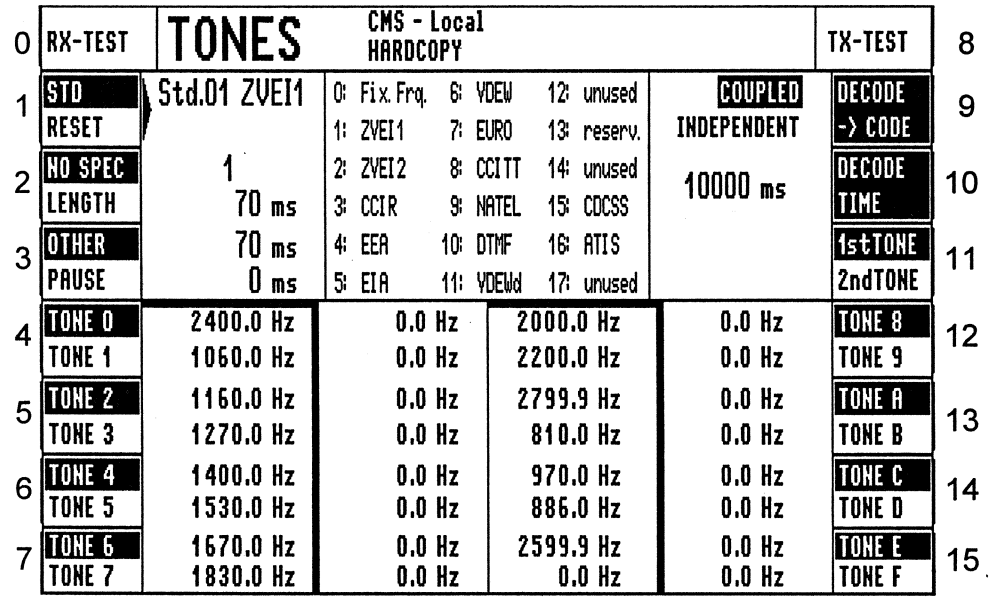


Fig. 2.10-1 Main menu TONES

Starting with the main menus of the selection menu the main menu TONES (definition menu for tones) is reached by pressing the softkey TONES.

It contains all controls required to define parameters such as frequency, tone duration, pause duration and further parameters for output of the tone sequence and evaluation. The parameters are used in the transmitter and receiver test menus.

Softkey 0 allows for direct branching to the main menu for the receiver test and softkey 8 for branching to the transmitter test.

2.10.1 Selection of Standard

STD/RESET Function

The standards are named and called by numbers. These can be used according to the original standard or be modfied as required.

Number (= Std.No.)	Unmodified	Modified
0	Std.0 Fixed Frequencies	Std.0
1	Std.1 ZVEI 1	Std.1
2	Std.2 ZVEI 2	Std.2
3	Std.3 CCIR	Std.3
4	Std.4 EEA	Std.4
5	Std.5 EIA	Std.5
6	Std.6 VDEW	Std.6
7	Std.7 EURO	Std.7
8	Std.8 CCITT	Std.8
9	Std.9 NATEL	Std.9
10	Std.10 DTMF *)	Std.10

Standards 1 to 9 represent the usual single-tone sequences. For differentiation of unmodified and modified tone sequences the CMS displays standard number and name for unmodified tone sequences, but only the standard number for modified tone sequences.

The assignment of frequencies to numbers is displayed in the main menu for tones and can be modified. Standard 0 reacts like a completely normal tone sequence standard. In this case the frequencies are the fixed frequencies for the AF generators. Standard 10 is the dual-tone standard; it cannot be modified for evaluation purposes.

Softkey 1 allows for calling any standard in order to modify it (STD) or to reset the original parameters for the selected standard (RESET). The SHIFT key is used to select between these two possibilities.

*) depending on model or option

The standard is called by entering `softkey 1(STD)/number/ENTER`. A standard is reset to the original state by entering `softkey 1(RESET)/number/ENTER`.

Note: *Std. 11 (VDEW d) consists of the data records of Std. 1 (ZVEI 1) and STD. 10 (DTMF) and therefore cannot be selected in this menu, but only from the CODE submenu 1 or DECODE submenu 2.*

Hinweis zu ATIS / CDCSS:

The generation and decoding of following tone sequences is implemented in addition to the standard ones:

- CDCSS coding
- CDCSS decoding: *)
  requires option CMS-B27 and CMS-B33
- ATIS coding: *)
  requires option CMS-B27
- ATIS decoding: *)
  requires option CMS-B27

Function description

- **ATIS**
  ATIS is an automatic transmitter identification system, i.e. after the transmission key of the mobile phone has been released, an identification message is sent. This identification message must be repeated at least once every 5 minutes with longer transmissions.
  Data message: 360 Bit
  Data modulation: FSK with a baud rate of 1200 Bit/s
  0 corresponds to 2100 Hz; 1 corresponds to 1300 Hz
  RF modulation: phase modulation with a modulation index of 2.0 rad

- **CDCSS**
  CDCSS is a digital code parallel to speech whose identification is used by an addressed mobile phone to make itself ready to receive information. The end of the transmit mode is announced by sending a turn-off code so that the receiver can turn off without disturbing noise effects.
  Data message: 23 bits with continuous repetition
  Bit length: 7.44 ms
  Modulation: Direct carrier shift keying with a settable deviation, depending on the class of mobile phone.

The following 83 octal codes are permissible

023	072	152	244	343	432	606	723
025	073	155	245	346	445	612	731
026	074	156	251	351	464	624	732
031	114	162	261	364	465	627	734
032	115	165	263	365	466	631	743
043	116	172	265	371	503	632	754
047	125	174	271	411	506	654	
051	131	205	306	412	516	662	
054	132	223	311	413	532	664	
065	134	226	315	423	546	703	
071	143	243	331	431	565	712	

2.10.2 Tone Duration

NO SPEC/LENGTH Function

Softkey 2 is assigned two functions. The SHIFT key is used to select the first or second function.

Softkey 2: NO SPEC

This function is used to define, which tone of the selective-call sequence is to be subjected to special tone duration.

Normally this is the first tone of extended tone duration compared to the other tones. The entry is made using `softkey 2 (No SPC)/number (tone duration in ms)/ENTER`.

Softkey 2: LENGTH

Each individual standard is assigned a tone duration, which can, however, also be influenced using softkey 2 (LENGTH). The duration can be selected independent of the other tones. It is entered using `softkey 2 (LENGTH)/number (tone duration in ms)/ENTER`.

*) depending on model or option

2.10.3 Pause

OTHER/PAUSE Function

Softkey 3 is assigned two functions. The SHIFT key is used for selecting the first or second function.

Softkey 3: OTHER

This softkey is used for determining the tone duration of the other tones by entering `softkey 3 (OTHER)/number (tone duration in ms)/ENTER`.

Softkey 3: PAUSE

The pause duration between the tones defined by entering `softkey 3 (PAUSE)/number (tone duration in ms)/ENTER`.

2.10.4 Frequency Definition

TONE Function

The complete lower half of the screen is available for definition of frequencies. 8 softkeys with dual function (4 to 7, 12 to 15) are provided for the entry of 16 different frequencies or frequency pairs. The tone numbers correspond to the numbers (incl. A to F) of the "dialling number". The digits * and# are used for standard 10 (DTMF) instead of E and F. Again, `SHIFT/softkey..` is used for switching between first and second function of a softkey.

A frequency or frequency pair can be entered for each digit, i.e. standards can consist of single or dual tones or even be mixed of single and dual tones. Single tones are produced by selecting 0 in the right softkey column. The selection of right or left column is made by pressing softkey 11. Again, `SHIFT/softkey 11` is used to select the first function (left softkey column) or the second function (right softkey column) or vice versa.

The frequencies are entered by `softkey../number/ENTER`. The frequencies are displayed in Hz.

The range for standard 0 is 100 Hz to 20 kHz and for standards 1 to 10 it is 300 Hz to 4 kHz.

The frequencies thus defined are valid for standards 0 to 10 (modified or unmodified) for output of tone sequences. For evaluation the frequencies of the first softkey column apply (modified or unmodified), however, only for standards 0 to 9. The lower tone number (digit) is decoded in case of frequency repeats. With standard 10 selected, the double tones of the unmodified standard are decoded.

2.10.5 Coupling of Standards

DECODE → CODE Function

Softkey 9 is used to determine, whether coder and decoder work with the same standard or not. In the first case a change of standard for the coder automatically leads to a change of standard with the decoder and vice versa (normal operation). In the other case coder and decoder can be set individually.

2.10.6 Decoding Time

DECODE TIME Function

This function is especially of interest in automatic operation (IEC/IEEE bus and autorun control). The decoding time set here causes abortion of decoding after this time elapsed, independent of tones following or not.

The decoding time is entered using `softkey 10/number (decoding time in ms)/ ENTER`.

Application:

With acknowledgement call operation the CMS sends out a call, then evaluates the reply. Or the transceiver first sends a call; starting with this call the CMS first waits until the decoding time set via softkey 10 has passed, then continues the program by a reply selective call or any other action. This function is required for the signalling operation within the Swiss mobile telephone system NATEL B.

2.11 Special Signalling *)
(with option CMS-B27 and B33 only)

2.11.1 ATIS

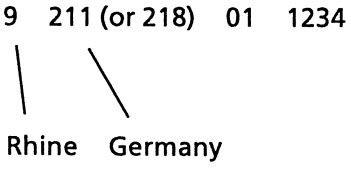
ATIS is an automatic transmitter identification system, i.e. after the transmission key of the mobile phone has been released, an identification message is sent. This identification message must be repeated at least once every 5 minutes with longer transmissions.

- Data message: 360 bit
- Data modulation: FSK with a baud rate of 1200 Bit/s
  0 corresponds to 2100 Hz; 1 corresponds to 1300 Hz
- RF modulation: phase modulation with a modulation index of 2.0 rad

DECODE ATIS (standard 16) function:

The ATIS code is decoded by pressing the DECODE/ENTER key. A single signalling telegram in line with ATIS regulation (BAPT 225 ZV 4-1/53A) is expected. The ATIS self-identification decoded from the received telegram is shown as a 10-digit decimal number.

This value is split up into several blocks that are separated by blank spaces. It is made up of the following components: waterway code (1 digit), nationality code (3 digits), the second letter of the selective-call number (2 digits) and the remaining numbers (4 digits). An example of the identification code:



The following error messages can additionally be displayed in the status line:

- ATIS-MESSAGE FAIL (bit error in the telegram).
- PARITY CHECK ERROR (error check character not completely correct).
- ATIS-TIMEOUT.

If no signal is received within the ATIS timeout of 6 min., the symbol – – – appears on display.

- Decode ATIS: Submenu 1
  Submenu 1 is of no significance for ATIS.
- Decode ATIS: Submenu 2
  Softkeys EVAL BNDWTH and MAX PAUSE are not relevant.

2.11.2 CDCSS

CDCSS is a digital code parallel to speech whose identification is used by an addressed mobile phone to make itself ready to receive information. The end of the transmit mode is announced by sending a turn-off code so that the receiver can turn off without disturbing noise effects.

- Data message: 23 bits with continuous repetition
- Bit length: 7.44 ms
- Modulation: Direct carrier shift keying with a settable deviation, depending on the class of mobile phone.

The following 83 octal codes are permissible:

023	072	152	244	343	432	606	723
025	073	155	245	346	445	612	731
026	074	156	251	351	464	624	732
031	114	162	261	364	465	627	734
032	115	165	263	365	466	631	743
043	116	172	265	371	503	632	754
047	125	174	271	411	506	654	
051	131	205	306	412	516	662	
054	132	223	311	413	532	664	
065	134	226	315	423	546	703	
071	143	243	331	431	565	712	

DECODE CDCSS (standard 15) function:

The CDCSS code is decoded by pressing the DECODE/ENTER key. A cyclically repeated CDCSS signalling telegram in the subaudio band is expected. If one of the 83 permissible message is received, it will be displayed as a 3-digit octal number. In addition, any inverted message is displayed with the prefix #
(example: 023 = #047).

If none of the defined 83 CDCSS codes is received, the decoded bit sequence will be displayed as a 3-digit hexa-decimal number prefixed with !.

*) depending on model or option

If no signal is received within the timeout, the symbol – – – appears on display.

Note:
The CDCSS signal can be evaluated via the AF/SCOPE input for AF measurement or via INPUT 1 or INPUT 2 as a FM-demodulated signal.

- Decode CDCSS: Submenu 1
  Submenu 1 is of no significance for CDCSS.
- Decode CDCSS: Submenu 2
  Softkeys EVAL BNDWTH and MAX PAUSE are not relevant.

2.12 Definition menu for Special Functions

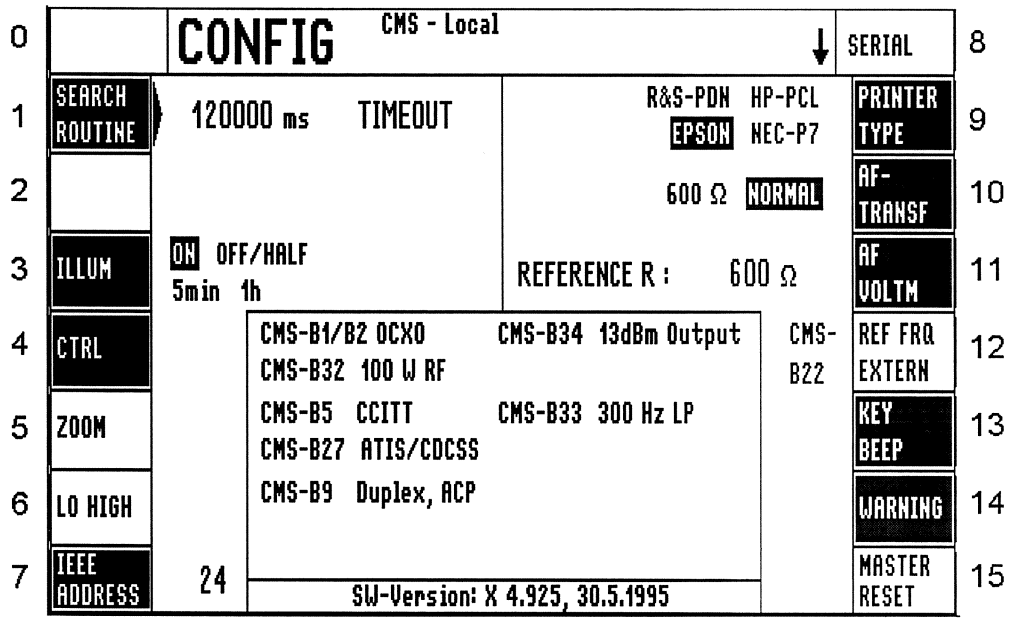


Fig. 2.12-1 Main menu CONFIG (special functions)

Starting with the main menus of the selection menu the main menu CONFIG (definition menu for special function) is entered by pressing the softkey CONFIG.

2.12.1 Search Routines

SEARCH ROUTIN Function

The timeout value can be determined for the search routines using this function.

SEARCH ROUTIN Function: Submenu

A submenu is available for the SEARCH ROUTIN function, which is output in the display fields next to the softkeys 2 to 7.

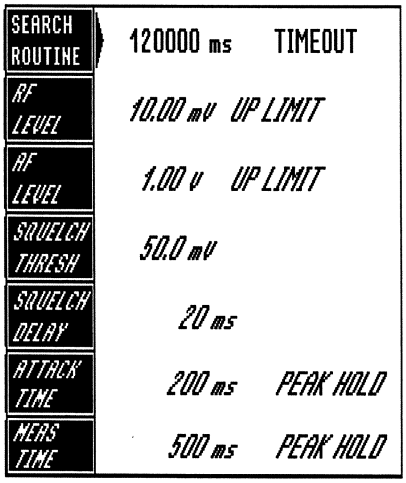


Fig. 2.12-2 SEARCH ROUTIN submenu

Softkey 2: RF LEVEL

Softkey 2 can be used to define the upper RF level limit with search routines.

Softkey 3: AF LEVEL

Softkey 3 can be used to define the upper AF level limit with search routines.

Softkey 4: SQUELCH THRESH

Softkey 4 can be used to define the threshold value for squelch on or squelch off with AF level measurements.

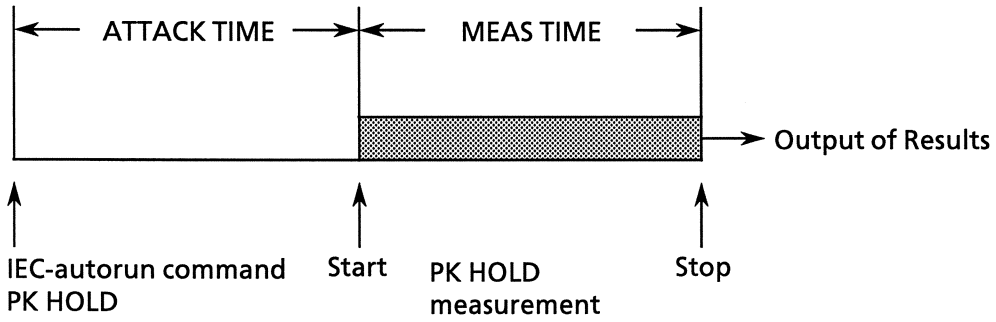
Softkey 5: SQUELCH DELAY

Using softkey 5, the delay time for slowing down the test cycle with the squelch measurement can be defined.

Softkey 6/7: ATTACK TIME/MEAS TIME

In IEC-bus or autorun mode the PK HOLD measurement is a single, time-limited process.

MEAS TIME means the time during which the peak value meter evaluates all the voltage peaks occurring. ATTACK TIME is the time by which evaluation is delayed after command execution.



2.12.2 Display Illumination

ILLUM Function

Illumination of the display can be switched on and off using softkey 3 (ILLUM).

ON: Illumination of the CMS remains activated.

OFF/HALF: Illumination of the CMS is deactivated or switched to half brightness.

5 min:
1 h: After 5 min/1 h the CMS switches illumination off or to half brightness, if no key was activated during this time.

2.12.3 Relay and TTL Interface *)

(Cf. also Fig. 2.12-4: pin assignment of the CONTROL connector)

CTRL Function

Pressing the CTRL softkey calls the submenu CTRL.

CTRL Function: Submenu

The CTRL function has a submenu, which is output in the display fields next to softkeys 2 to 7.

*) depending on model or option

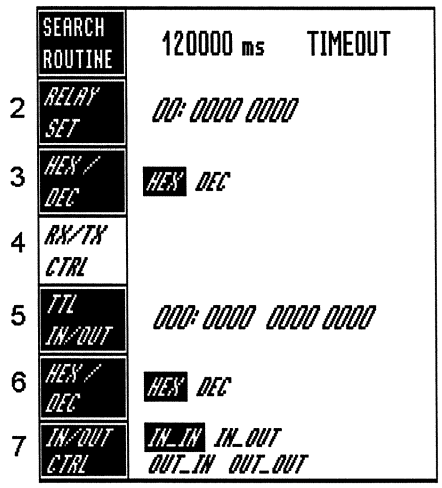


Fig. 2.12-3 CTRL submenu

Softkey 2: RELAY SET

All relays can be set and reset individually or jointly. The two least significant hexadecimal positions determine which relay is influenced.

1. Setting all relays: range of values between 0 and 255 (0 and FF Hex)

   All relays are set irrespective of the previous setting in accordance with the binary number.

   e.g. setting all relays:

previous setting:	55 Hex	=	0101 0101 B
entered value:	0 0F Hex	=	0000 1111 B
new setting:	0F Hex	=	0000 1111 B

   relays are set
   all relays are to be set

2. Setting individual relays: range of values between 0 and 255 + 256 (100 and 1FF Hex)

   All indicated relays with the binary number "1" are set, relays with binary value "0" are not influenced.

   e.g.: setting all less significant relays, leaving the more significant relays unaffected.

previous setting:	55 Hex	=	0101 0101 B
entered value:	1 0F Hex	=	0000 1111 B
new setting:	5F Hex	=	0101 1111 B

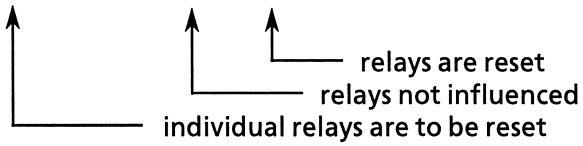
   relays are set
   relays not influenced
   individual relays are to be set

3. Resetting individual relays: range of values between 0 and 255 + 512 (200 and 2FF Hex)

   All indicated relays with the binary number "1" are reset, relays with binary value "0" are not influenced.

e. g.: resetting all less significant relays, leaving the more significant relays unaffected.

previous setting: 55 Hex = 0101 0101 B
entered value: 2 0F Hex = 0000 1111 B
new setting: 5F Hex = 0101 0000 B



Note: ***Some options do not have 8 relays. In this case relays not available are marked by X.***

Softkey 3: HEX / DEC

Softkey 3 can be used to select whether the relay position is to be entered in decimal or hexadecimal form.

Softkey 4: RX / TX CTRL

When softkey 4 is pressed, the most significant relay is switched off with menu changeover to the RX test, and switched on with menu changeover to the TX test. An RX-TX switchover with the RF power does not change the relay.

Softkey 5: TTL IN / OUT

Softkey 5 can be used to have the TTL interface read and/or written to. All TTL lines can be set and reset individually or jointly. The three least significant hexadecimal positions and the respective programming of the TTL interface by softkey 7 determine which TTL lines are influenced.

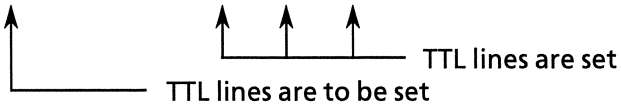
Example for TTL IN/OUT (IN/OUT CTRL = OUT_OUT)

1. Setting all TTL lines: range of values between 0 and 4095 (0 and FFF Hex)

   All TTL lines are set irrespective of the previous setting in accordance with the binary value.

   e. g.: setting all TTL lines.

   previous setting: 255 Hex = 0010 0101 0101 B
   entered value: 0 00F Hex = 0000 0000 1111 B
   new setting: 25F Hex = 0000 0000 1111 B

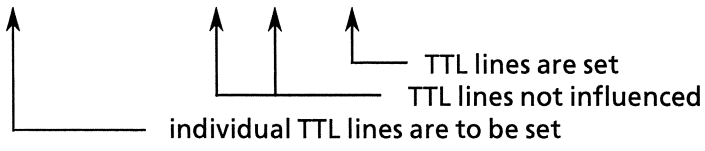


2. Setting individual TTL lines: range of values between 0 and 4095 + 4096 (1000 and 1FFF Hex)

   All indicated TTL lines with the binary number "1" are set, TTL lines with binary value "0" are not influenced.

   e. g.: setting all less significant 4 TTL lines, leaving all more significant lines unaffected.

   previous setting: 255 Hex = 0010 0101 0101 B
   entered value: 1 00F Hex = 0000 0000 1111 B
   new setting: 25F Hex = 0010 0101 1111 B



3. Resetting individual TTL lines: range of values between 0 and 4095 + 8192 (2000 and 2FFF Hex)

   All indicated TTL lines with the binary number "1" are reset, TTL lines with binary value "0" are not influenced.

   e. g.: resetting all less significant 4 TTL lines, leaving all more significant lines unaffected.

   previous setting: 255 Hex = 0010 0101 0101 B
   entered value: 2 00F Hex = 0000 0000 1111 B
   new setting: 25F Hex = 0010 0101 0000 B

   TTL lines are reset
   TTL lines not influenced
   individual TTL lines are to be reset

Softkey 6: HEX / DEC

Softkey 6 can be used to select whether the TTL lines are to be entered in decimal or hexadecimal form.

Softkey 7: IN / OUT CTRL

This functions sets the TTL interface to input or output.

IN_IN: All TTL lines are set to input. 12 external TTL lines are read.

IN_OUT: The upper four TTL lines are set to input and are read, the internal eight TTL lines are written to.

OUT_IN: The upper four TTL lines are set to output and are written to, the lower eight TTL levels are read.

OUT_OUT: All TTL lines are set to output and are written to.

The upper four TTL lines in the setting IN-IN or IN-OUT can be used to control AUTOTEST programs. The line at D12 has the symbolic name "BCD-3", D9 "BCD-0".

Note: *CMS frames for options do not all have 12 TTL lines. If there are less than 12 lines, the non-existing lines are marked with an X. In this case, lines D1 to D4 in the settings IN-IN and OUT-IN can be used to control AUTOTEST events BCD-0 (D1) to BCD-3 (D4).*

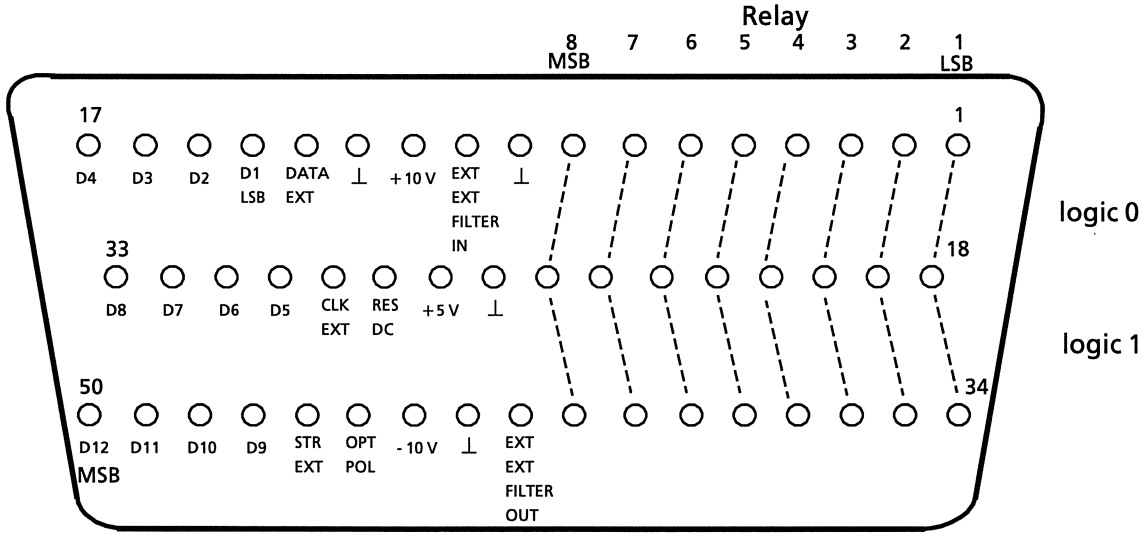


Fig. 2.12-4 Pin assignment of connector CONTROL

2.12.4 ZOOM

ZOOM Function

The ZOOM function is switched on (light characters on a dark background) and off (dark characters) using softkey 5 (ZOOM). With the ZOOM function switched on, analog indications in the TX-test menu and RX-test menu are shown in magnified display; the oscilloscope is switched off in this operating mode.

2.12.5 LO Frequency LO/HIGH

LO HIGH Function

This softkey is used to set the LO frequency for conversion into the internal IF frequency of 455 kHz above or below the carrier frequency (standard setting is LO HIGH invers: LO frequency below carrier frequency).

2.12.6 IEC/IEEE Bus *)

IEEE ADDRESS Function

This function serves for setting the IEC/IEEE-bus address. The value range of the address is 0 to 30. The address is entered using `softkey 2/number/ENTER`. The default address setting is 24.

2.12.7 SERIAL *)

This softkey allows branching to the RS232 main menu provided the option is built in.

2.12.8 Selection of Printer

PRINTER TYPE Function

Various printer types may be selected on actuation of softkey 9 (toggle function).

2.12.9 600-Ω AF Transformers*)

AF-TRANSF Function

A 600-Ω transformer can be connected each into the AF voltmeter input (AF/SCOPE) and modulation generator output (MOD GEN), using softkey 10 (AF-TRANSF) (with setting "600 Ω" selected). The level indications of AF voltmeter and modulation generator are appropriately corrected in this mode.

2.12.10 AF Voltmeter (Reference Resistance)

AF VOLTM Function

The AF level measurement normally refers to a load resistance of 600 Ω.

Another load resistance can be selected using this function. The entry is made using `softkey 11/number/ENTER`, the number representing the reference resistance in Ω.

2.12.11 External Reference Frequency*)

REF FRQ EXTERN Function

Actuating softkey 12 switches off the internal 10-MHz reference frequency. This means that all frequencies of the CMS are inaccurate if option CMS-B22 is not fitted or no 10-MHz input signal is available.

*) depending on model or option

2.12.12 Acoustic Acknowledgement

KEY BEEP Function

The softkey KEY BEEP is used for selecting whether each keystroke is to be acoustically acknowledged or not.

2.12.13 Warnings

WARNING Function

The WARNING softkey is used to select whether warning messages are displayed by the CMS or not. These warning messages are hints to possible erroneous operation. Hints on real conflicts are always indicated in the status line.

2.12.14 Master Reset

MASTER RESET Function

The instrument is set to the factory setting using the softkey MASTER RESET. A request to acknowledge safeguards the operator from inadvertent action.

2.13 Remote Control*)

The IEC/IEEE bus interface corresponds to the IEC 625-1 or IEEE 488.1 standard and to IEEE 488.2 also approved of by the IEC commission. This standard describes data transfer formats and common commands etc.

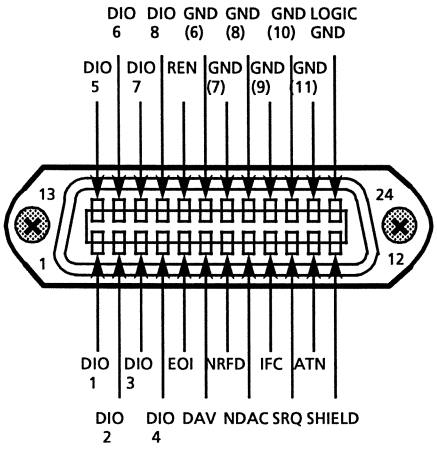


Fig. 2.13-1 Pin assignment of socket ***48***

The bus connection socket ***48*** is fitted to the rear of the instrument. The instrument is equipped with the 24-contact socket according to the IEEE 488 standard. The interface contains three groups of bus lines:

1. **Data bus with 8 lines DIO 1 to DIO 8**

   Data transmission is bit-parallel and byte-serial with the characters in ISO 7-bit code (ASCII code).

   DIO 1 represents the least significant bit and DIO 8 the most significant bit.

2. **Control bus with 5 lines**

   This is used to transmit control functions:

   ATN (Attention)
   becomes active Low when addresses, universal commands or addressed commands are transmitted to the connected devices.

   REN (Remote Enable)
   enables the device to be switched to the remote status.

   SRQ (Service Request)
   enables a connected device to send a Service Request to the controller by activating this line.

   IFC (Interface Clear)
   is activated by the controller in order to set the IEC interfaces of the connected devices to a defined status.

   EOI (End or Identify)
   is used to identify the end of data transfer and is used with a parallel poll.

3. **Handshake bus with 3 lines**

   Used to control the data transfer timing.

   NRFD (Not Ready For Data)
   an active Low on this line signals to the talker/controller that one of the connected devices is not ready to accept data.

   DAV (Data Valid)
   is activated by the talker/controller shortly after a new data byte has been applied to the data bus.

   NDAC (Not Data Accepted)
   is held at active Low by the connected device until it has accepted the data present on the data bus

Detailed information on the data transfer timing is available in the IEC 625-1 standard.

According to the IEC 625-1 standard, devices controlled via the IEC bus can be equipped with different interface functions. Table 2-13-1 lists the interface functions applicable to the instrument:

*) depending on model or option

Table 2.13-1 Interface functions

Control characters	Interface function
SH1	Source Handshake function, complete capability
AH1	Acceptor Handshake function, complete capability
L4	Listener function,complete capability, unaddress if MTA
T6	Talker function,complete capability, capability to reply to serial poll, unaddress if MLA
SR1	Service Request function, complete capability
PP1	Parallel Poll function, complete capability
RL1	Remote/Local switchover function, complete capability
DC1	Device Cleart function, complete capability
DT0	Device Trigger function, no Device Trigger
C0	Controller function, no controller function

2.13.1 Setting the Device Address

The device address can be set in the CONFIG menu using the IEEE ADRESS function. The address between 0 and 30 is entered using the numeric keys and remains stored when the device is switched off. The instrument is factory-set to address 24.

The address is the decimal equivalent of bits 1 to 5 of the Talker or Listener address. This form is also used with the IEC-bus command of the controller.

2.13.2 Local/Remote Switchover

The device is in the Local state (manual mode) when switched on.

If the instrument is addressed as a Listener by a controller, it enters the Remote state in line with the standard and remains in this state after data transfer has been completed. All controls on the front panel except the STOP(LOCAL) key are disabled.

There are two methods to return to the "Local" state:

- by the addressed command GTL (Go to Local) from the controller.
- by pressing the STOP key. Data output from the controller to the instrument should be stopped before pressing the STOP key for otherwise the instrument will immediately enter the Remote state again. The function of the STOP key can be disabled by the controller by sending the universal command LLO (Local Lockout).

The other device settings are not changed when switching from Remote to Local state or vice versa.

When the CMS is switched to the Local state, the respective main menu of the current operating mode is indicated.

2.13.3 Interface Messages

Interface messages (according to IEC 625-1/IEEE 488 standard) are transmitted to the device on the data lines where the Attention line ATN is active (low).

2.13.3.1 Universal Commands

The universal commands have codes between 10 and 1F hexadecimal (see Table 2.13-4). They act, without previous addressing, on all devices connected to the bus.

Table 2.13-2 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 defined initial status. The device setting is not changed.
LLO (Local Lockout)	IECLLO	The STOP key is disabled.
SPE (Serial Poll Enable)	IECSPE *	Ready for serial poll.
SPD (Serial Poll Disable)	IECSPD *	End of serial poll.

* The BASIC command "IECSPL adr, status" contains the commands "IECSPE" and "IECSPD" and additionally reads the status of the device with address "adr" and stores this in the integer variable "status".

2.13.3.2 Addressed Commands

The addressed commands have codes between 00 and 0F hexadecimal (see Table 2.13-4). They only act on devices addressed as Listeners (by the BASIC command "IECLAD addr").

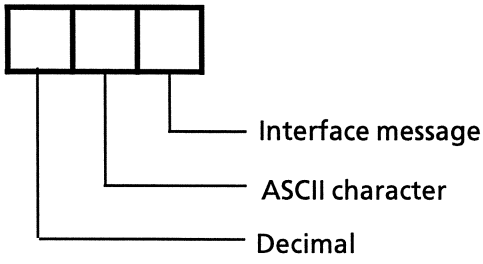
Table 2.13-3 Addressed commands

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 defined initial status. The device setting is not changed.
GTL (Go To Local)	IECGTL	Change to Local state (manual operation)

Table 2.13-4 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:



2.13.4 Device Messages

Device messages (in line with IEC 625-1) are transmitted on the data lines, in which case the Attention line is High, i.e. not active. The ASCII code (ISO 7-bit code) is used (see Table 2.13-4).

As can be seen in Table 2.13-5, the device messages can be grouped according to two different aspects.

Table 2.13-5 Grouping of device messages

Type of commands	Direction of transfer	
	Messages received by the CMS	Messages sent by the CMS
Common device-independent commands (in line with the IEEE 488.2 standard)	cf. Table 2.13-6	cf. Table 2.13-7
Device-specific commands (dependent on the device characteristics)	cf. Table 2.13-8	cf. Table 2.13-8

In the following text, device messages received by the CMS are referred to as commands.

Commands with a "?", such as "COUNT:RF?" request the CMS to output a measured value where the same format is used as in the command table. For the given example, this is:

"COUNT:RF 20 000 000",

when always the basic unit applies (Hz in this case).

Commands with a "?" and subsequent data give a specific setting value to the CMS and request the CMS to output the measured value. In the case of a search routine, this would be:

S_N:RX TEST? 20 DB

2.13.4.1 Commands Received by the CMS in Listener Mode (Controller to Device Messages)

Input buffer:

All commands received are buffered in a memory of max. 256 bytes; it is also possible to process command lines which are longer. In this case, the part of the command line which was first received is already processed in the device.

Command syntax:

Fig. 2.13-2 shows the syntax of a command line (program message). Every command line must end with a terminator.

Terminators:

- New line (ASCII code 10 decimal)
- End (EOI line active) together with the last useful character of the command line or the new line character.

Since the carriage return character (ASCII code 13 decimal) is permissible as a filler without effect before the terminator, the combination of carriage return + new line is permissible.

All IEC-bus controllers from Rohde & Schwarz send terminators accepted by the device as standard. A command line may require more than one line on the controller screen since it is only limited by the terminator. The terminator is automatically added to the end of command text with most IEC-bus controllers.

Separators:

A command line may contain several commands (program message units) separated by semicolons (;).

Command structure:

A command may consist of the following parts:

- Only a header
  Example: **RST*

- Header and question mark
  (Query)
  Example: *POWER:RF?*

This combination requests the CMS to transfer the desired data to an output buffer in order to transfer them via the IEC bus as soon as it is addressed as a Talker (see Section 2.13.4.2).

- Header and number

  Examples: *FREQUENCY:RF:TXTEST 20E6*
  FREQUENCY:RF:TXTEST 20 MHz

To remain in accordance with the IEEE 488.2 standard, the header and number(s) 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.

- Header and string

  Example: *FREQUENCY:AF:I1 ON*

The headers and their meanings are explained in Sections 2.13.4.3 and 2.13.4.4.

Lower case/upper case letters:

Lower case letters are permissible and are equivalent to the corresponding upper case letters. Thus units can be used in the usual form (e.g.: dBm) instead of the notation using upper case letters which is also permissible (e.g. DBM).

Spaces:

Additional spaces may be inserted at the following points:

- before a header;
- between header and number;
- before and after commas (,) and semicolons (;)
- before the terminator.

Decimal numbers:

The following notations are permissible for decimal numbers:

- With and without sign
  e. g. *5, +5, -5*

- With and without decimal point, any position of decimal point is permissible.
  e. g. *1.234, -100.5, .327*

- With or without exponent to base 10, "E" or "e" is used as the exponent character.

  e. g. *.451, 451E-3, +4.51e-2*

- The exponent is permissible with or without a sign, also a space is permissible instead of the sign.
  e. g. *1.5E+3, 1 .5E-3, 1.5E 3*

- Leading zeros are permissible in the mantissa and exponent.
  e. g. *+0001.5, -01.5E-03*

- The length of the number, including the exponent, may be up to 30 characters. The number of digits for the mantissa and exponent is only limited by this condition. Digits which exceed the resolution of the device are rounded up or down; they are always considered for the order of magnitude (power of ten).
  e. g. *150000000, 0.00000032*

If two numeric entries are permissible with one command, they are separated by comma, e.g. DISPLAY: MENU 2,0

Note: Specification of the exponent alone (e.g.: E-3) is not permissible, 1E-3 is correct).

Hexadecimal and binary numbers:

Hexadecimal numbers and binary numbers are permissible only without exponent and unit, the following notations are permissible:

Hexadecimal number
e.g. #H12ffab, #h12FFAB, #HFf19a

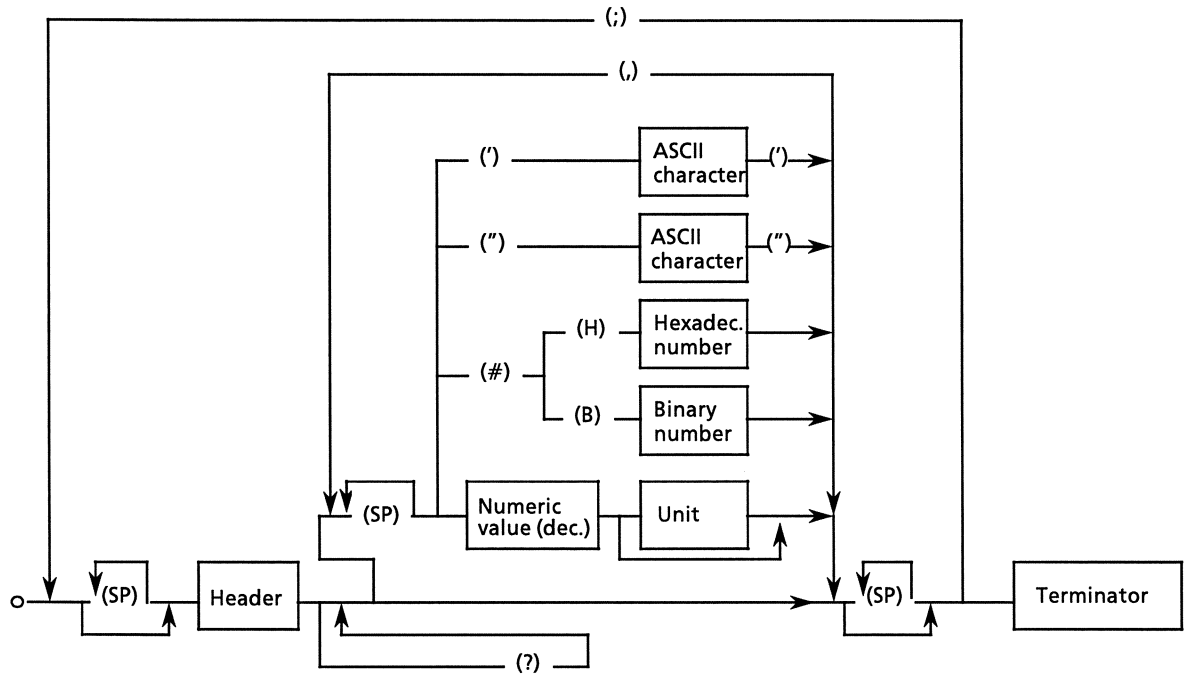
Binary number
e.g. #b101011, #B11001

String entries:

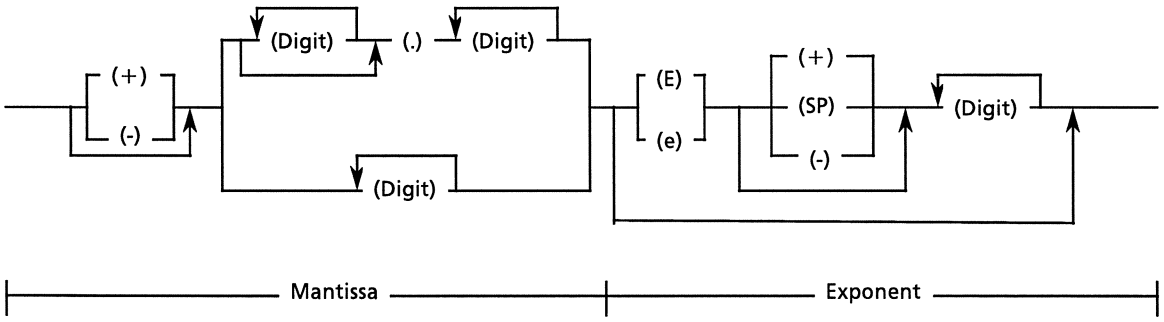
The following notations are permissible for string entries:

e.g. CODE '01234567890abcdef'
CODE '0123456789abCDEF'
CODE "01234567890abcdef"
CODE "0123456789AbcdEF"

Command line



Numeric value (decimal)



SP: Any character with ASCII code 0 to 9 and 11 to 32 decimal, especially space.

Fig. 2.13-2 Syntax diagram of a command line

2.13.4.2 Messages Sent by the CMS in Talker Mode (Device to Controller Messages)

The CMS sends messages via the IEC bus if it

- 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 (message available) in the status byte that the requested data are now present in the output buffer (see also Section 2.13.5), and
- has been addressed as a talker

Note that the command line with the data request must be transmitted directly before the talker is addressed. If another command line is present in between, the output buffer is cleared.

The maximum length of the output buffer is 256 bytes.

A query message is formed by adding a question mark "?" onto the header of Table 2.13-8, e.g. "COUNT: RF?".

If the CMS is addressed as a Talker directly after the query message, the bus handshake is disabled until the requested data are available. This simple synchronization procedure is certainly meaningful with the CMS if the execution of a query message can take place independent of the execution and termination of a test run.

The syntax of the messages sent by the CMS is shown in Fig. 2.13-3. The syntax is similar to that for commands received by the CMS.

A new line (ASCII code 10 decimal) together with end (line EOI active) is used as terminator.

The transmission of "header and numbers" makes it possible that the messages sent by the CMS can again be returned to the CMS in the same form, without any amendments as setting commands. Thus a setting made on the keyboard can be read, stored in the controller and repeated later via the IEC bus.

- If the CMS receives several query messages, it also returns several messages within one line separated by semicolons (;).
- Several numbers can be sent as a reply to certain query messages, they are separated by commas (,).
- Header and numbers are always separated by spaces.
- Headers only consist of upper-case letters and the characters ":", "_" and "*".
- The syntax of the numbers is described in Fig. 2.13-3. The exact form of the numbers of each message is described in Tables 2.13-7 and 2.13-8.
- Messages sent by the CMS do not contain units. In the case of physical variables, the numbers are referred to the basic unit of the units specified in Table 2.13-8 (V, A, W, OHM, S, Hz, RAD, PCT, DB).

Special Cases in the Talker Mode

In the Talker mode one result is usually output. There are however the following exceptions, where several values separated by commas are output:

- Demodulation: DEMODULATION?

  Two results are output. However, the second result makes only sense with peak weighting of the demodulated signal. Otherwise a zero is output as second result.

- Search Routines

  In the case of all search routines two results in accordance with the following table are output.

Search R2utine	1st Result	2nd Result
Bandwidth Measurement	Actual value of bandwidth	Actual value of delta frequency
Squelch	Act. value of Switch Off RF	Actual value of Squelch Hysteresis
Quieting	Actual value of Quiet	Actual value of RF Level
Sinad/Dist/SN	Actual value of Sinad/SN	Actual value of RF Level
Modulation Sensitivity	Nominal value of Demod	Actual value of AF Level1

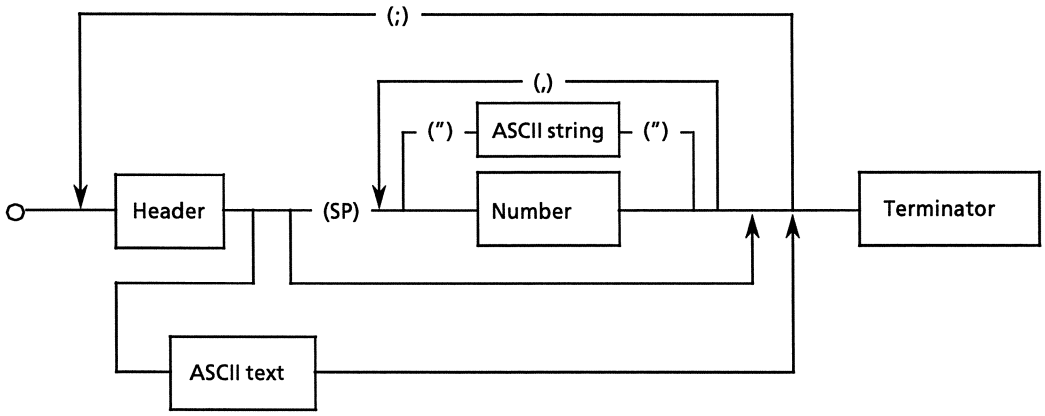
- Read out contents of decoded telegram: DECODE:NUMBER?

  The contents of the decoded telegram can be output using DECODE:NUMBER? 0 to 40. The number specifies which entry in the measurement buffer is to be output. Each entry in the buffer consists of three values:

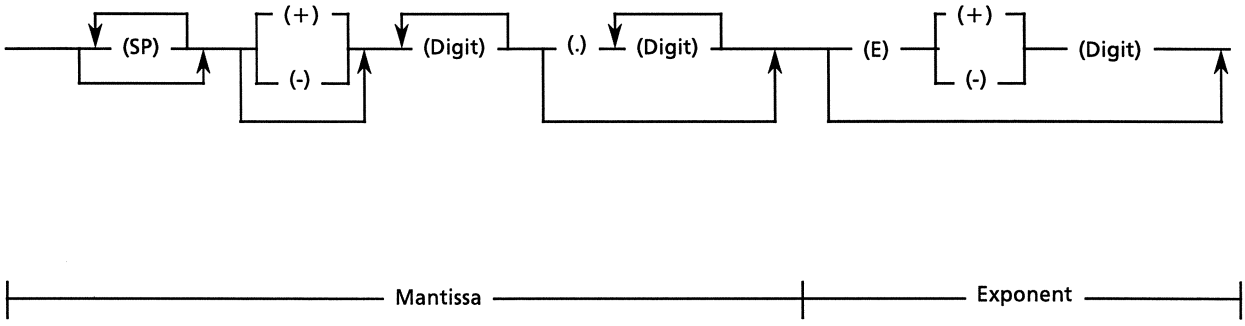
  1st Time in second2
  2nd Frequency in Hz
  3rd Deviation in percent from the nominal value

If the decoded telegram of an acknowledgement test (CODE function, Section 2.5.4) is to be read out, commands CODE:ACKTEST ON and either CODE<transmit string> or CODE? have to precede the command DECODE:NUMBER? value.

Output message line



Number



SP: Space (ASCII code 32 decimal)
ASCII text: Reply to command *IDN? (see table 2.13-7)

Fig. 2.13-3 Syntax diagram of messages sent by the CMS

2.13.4.3 Device-independent Commands (Common Commands)

These commands are listed in Tables 2.13-6 and 2.13-7 and can be split up into the following groups:

- Commands which refer to the Service Request function with the associated status and mask registers
- Commands for device identification
- Commands which refer to the Parallel Poll function
- Commands for device-internal sequences (reset, calibrate) and for synchronizing sequences.

These are taken from the IEEE 488.2 standard, which ensures that these commands have the same effect in different devices.

The headers of these commands consist of a star (*) followed by three letters.

Table 2.13-6 Device-independent commands (common commands) received by the CMS

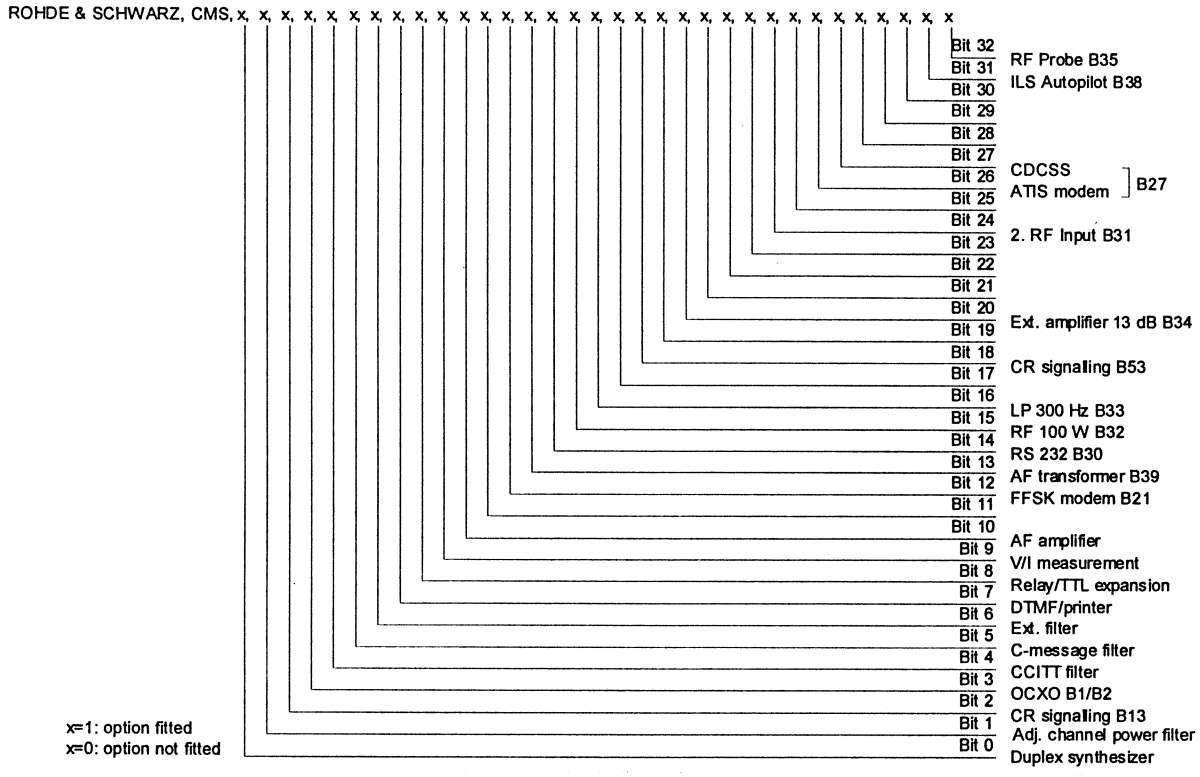
Command	Number, range	Meaning
***RST**	---	**Reset** Acts on the instrument setting like the RESET key. This command does not change the status of the IEC-bus interface, the set IEC-bus address, the mask register of the Service Request function and the output buffer. A current Service Request is only reset if it has not been produced by a message in the output buffer.
***PSC**	0 to 65535	**Power On Status Clear** (reset on power-up) If >0: with power-up, the Service Request Enable mask register (SRE) and the Event Status Enable mask register (ESE) are cleared in addition. If 0: the above-mentioned registers retain their contents when the device is switched on and off. This enables a Service Request when the device is switched on.
***OPC**	---	**Operation Complete** (ready signal) Sets bit 0 (Operation Complete) in the ESR, if all previous commands have been processed (see Section 2.13.7).
***CLS**	---	**Clear Status** • Sets the status registers (ESR and STB) to zero. The mask registers of the Service Request function (ESE and SRE) are not changed. • Clears the output buffer. A present Service Request is cleared (see Section 2.13.5).
***ESE**	0 to 255	**Event Status Enable** The ESE mask register is set to the specified value which is interpreted as a decimal number (see Section 2.13.5).
***SRE**	0 to 255	**Service Request Enable** The SRE mask register is set to the specified value which is interpreted as a decimal number (see Section 2.13.5).

Command	Number, range	Meaning
*PRE	0 to 255	**Parallel Poll Enable** The Parallel Poll Enable mask register is set to the specified value which is interpreted as a decimal number (see Section 2.13.5).
*WAI	---	**Wait To Continue** Only process the subsequent commands when all previous commands have been completely executed (see Section 2.13.7).

Table 2.13-7 Device-independent commands sent by the CMS

Command	Output message Data value		Meaning
	No. of digits	Range	
*IDN?	23	alphanume-ric	**Identification Query** The following identification text is sent via the IEC/IEEE bus as a reply to the IDN? command. Example: Rohde&Schwarz, CMS,0,X.XX Rohde&Schwarz = manufacturer CMS = model 0 = reserved for serial number, (not used with CMS) X.XX = firmware version (e.g. V1.00)
*PSC?	1	0 or 1	**Power On Status Clear Query** To read the status of the Power On Clear Flags, see *PSC in Table 2.13-6
*OPC?	1	1	**Operation Complete Query** (ready message) The message "*OPC 1" is entered into the output buffer and bit 4 (message available) set in the status byte if all previous commands have been completely executed. Bit 0 (operation complete) is also set in the ESR (see Section 2.13.7).
*ESR?	1 to 3	0 to 255	**Event Status Register Query** The contents of the ESR are output in decimal form and the register then set to zero.

Command	Output message Data value		Meaning
	No. of digits	Range	
*ESE?	1 to 3	0 to 255	**Event Status Enable Query** The contents of the ESE mask register are output in decimal form.
*STB?	1 to 3	0 to 255	**Status Byte Query** The contents of the status byte are output in decimal form.
*SRE?	1 to 3	0 to 255	**Service Request Enable Query** The contents of the SRE mask register are output in decimal form.
*TST?	1	0 to 255	**Self-Test Query** The output value "0" indicates the duly completion of the self-test.
*IST?	1	0 or 1	For reading the actual instrument status (see section 2.13.5)
*PRE?	1 to 3	0 to 255	The contents of the Parallel Poll Enable register are output in decimal form.
*OPT?	2	0 to 255 (alpha-numeric)	**Option Identification Query** The following text is sent via IEC bus in response to the OPT? command (see table below)



Meaning of the CMS Option Bits Not Documented

Bit	Meaning
10	Autorun control/printer control (B15) incorporated as standard
16	VOR/ILS generator (model 57)
18	Software-dependent flag
20	Harmonics measurement
21	Software-dependent flag
22	At least 50 MHz span in RF spectrum
24	Software-dependent flag
27	RF count via RF IN2
28	Software-dependent flag
29	For future applications
33	Software-internal flag
34	Have-Quick (special software required)
35	RDKS (special version of software required)

2.13.4.4 Device-specific Commands

All CMS functions which can be set using the keyboard can also be controlled via the IEC bus. The effect of the setting commands is the same as the corresponding entry via the keyboard.

According to the output in the display, the values of all setting parameters can also be read out via the IEC bus, especially the marker frequency and marker level values.

Table 2.13-8 shows the setting commands and the data request commands with the associated messages sent by the CMS.

The headers are the same as the key designations or similar to them. This results in easy-to-read (self-documenting) programs.

The headers can be abbreviated by omitting any characters at the end. The shortest possible notation is shown in Table 2.13-8 in bold print.

Many headers consist of several parts separated by colons (:). The abbreviations can be used in each part of the header (e.g. FR:R:TX instead of FREQUENCY:RF:TXTEST).

Certain headers contain the underline character (ASCII code 95 decimal) to facilitate reading.

All setting commands which must be assigned values are listed in Table 2.13-8 in the column "Data". Certain commands may also have a character string as the data, e.g. FREQUENCY:RF:TXTEST ON.

A unit can be added directly to the numbers in the setting commands. The permissible units are listed in Table 2.13-8. They may also be abbreviated and written with lower-case or upper-case letters. If no unit is used, the respective default unit applies (V, A , OHM, S, HZ, RAD, PCT, DB).

Table 2.13-8 Device-specific setting commands

IEC-bus commands for common device functions

Command	Data	Units	Function
X:VARIATION	no. **ON OF**F	---	Step size of set values
X:REFERENCE	no. **ON OF**F	---	Measured or set value becomes reference
X:TOLERANCE:**U**PPER **X:TO**LERANCE:**L**OWER	no. **ON OF**F	---	Output of tolerance markers in the analog display
X:RANGE	no. **ON OF**F	---	Full-scale value of analog display

X corresponds to any command, e. g. "COUNT:RF".

Command	Data	Units	Function
X:	---	<desired display unit>	Conversion of the display unit for the CMS display

Command	Data	Units	Function
RESET	---	---	Reset to original state
PRESET	---	---	Reset to a defined state
STORE:**S**TATE	number (1-3)	---	Storing of device state
STORE:**F**REQUENCY	number (10-29)	---	Storing of RF frequency
RECALL:**S**TATE	number (1-3)	---	Recall of device state
RECALL:**F**REQUENCY	number (10-29)	---	Recall of RF frequency
HARDCOPY	---	---	Hardcopy of screen contents
DISPLAY:**M**ENU	number number	---	Direct selection of a menu. The first number selects the main menu, the second number the associated submenu (see table below).
HEADER	**ON OF**F	---	Output of the IEC-bus header is switched on or off.
UNIT	---	---	Set unit
LANGUAGE	**E**NGLISH **D**EUTSCH **I**TALIAN **F**RENCH **SP**ANISH	---	Language selection

Main menu		Submenu			
Index	Name	Index	Name	Index	Name
0	Selection menu	0	no submenu	20	RX-CODE 1
1	TX-Test menu	1	TX-SET-RF 1	21	RX-CODE 2
2	RX-Test menu	2	TX-POWER 1	22	RX-FILTER 1
3	Duplex-Test	3	TX-COUNT	23	RX-FILTER 2
4	TONES menu	4	ACP1 (ACP)	24	RX-SINAD
5	TONES AF1/AF2	5	ACP2 (HARMONICS)	25	RX-S/N
6	SPECTRUM menu	6	DEMOD	26	RX-MOD 1
7	CONFIG menu	7	TX-AF-COUNT	27	Reserved
13	SELFCHECK menu	8	DECODE1	28	CONFIG-Search-Routine
14	CR-SEL menu	9	DECODE2	29	TX-POWER 2 (VSWR)
15	CR main menu	10	TX-FILTER 1	30	CONFIG-Control
16	Modem menu	11	TX-FILTER 2	66	VOR/ILS-SCOPE
17	VOR	12	DISTORTION	67	Settling
18	ILS-LOC	13	TX-S/N	68	Reserved
19	ILS-GS	14	TX-INPUT	69	SSB-TX-FILTER 2
20	Marker Beacon	15	TX-SCOPE	70	SSBTX-AF COUNT
21	R232	16	CODE-CDCSS	71	Have-Quick-Rollover
22	R232 Config.	17	RX-RF-LEVEL	72	TX-SET-RF2
25	ERMES	18	RX-AF-LEVEL		
26	SSB-TX-Test	19	RX-AF-COUNT		
27	SSB-RX-Test				
28	Audio-I / F				
29	Have-Quick				
30	RDKS				

IEC-bus commands for TX and RX test

Command	Data	Units	Function
FREQUENCY:RF:TXTEST	no.	MHZ KHZ HZ	RF frequency input in TX-Test
FREQUENCY:RF:TXTEST	?	MHZ KHZ HZ	Query of the setting
FREQUENCY:RF:TXTEST:VARIATION	no. ON OFF	MHZ KHZ HZ	
FREQUENCY:RF:TXTEST:REFERENCE	no. ON OFF	MHZ KHZ HZ	
FREQUENCY:RF:RXTEST	no.	MHZ KHZ HZ	RF frequency input in TX-Test
FREQUENCY:RF:RXTEST	?	MHZ KHZ HZ	Query of the setting
FREQUENCY:RF:RXTEST:VARIATION	no. ON OFF	MHZ KHZ HZ	
FREQUENCY:RF:RXTEST:REFERENCE	no. ON OFF	MHZ KHZ HZ	
FREQUENCY:RF:TRANSFER	ON OFF	---	Channel numbering
FREQUENCY:RF:DUPLEXSPACE	no.	MHZ KHZ HZ	
FREQUENCY:RF:REFCHANNEL	no.	---	
FREQUENCY:RF:CHANNELSPACE	no.	MHZ KHZ HZ	
FREQUENCY:RF:NUMBERING	ON OFF	---	
FREQUENCY:AF:I1	no. ON OFF	MHZ KHZ HZ	AF frequency of modulation generator 1
FREQUENCY:AF:I1	?	MHZ KHZ HZ	Query of the setting
FREQUENCY:AF:I1:VARIATION	no. ON OFF	MHZ KHZ HZ	
FREQUENCY:AF:I1:REFERENCE	no. ON OFF	MHZ KHZ HZ	

Command	Data	Units	Function
FREQUENCY:AF:I2	no. ON OFF	MHZ KHZ HZ	AF frequency of modulation generator 2
FREQUENCY:AF:I2	?	MHZ KHZ HZ	Query of the setting
FREQUENCY:AF:I2:VARIATION	no. ON OFF	MHZ KHZ HZ	
FREQUENCY:AF:I2:REFERENCE	no. ON OFF	MHZ KHZ HZ	
COUNT:RF	no.	MHZ KHZ HZ	Counting of RF frequency
COUNT:RF	?	MHZ KHZ HZ	<Measured value>
COUNT:RF:REFERENCE	no. ON OFF	MHZ KHZ HZ	
COUNT:RF:TOLERANCE:UPPER	no. ON OFF	MHZ KHZ HZ	
COUNT:RF:TOLERANCE:LOWER	no. ON OFF	MHZ KHZ HZ	
COUNT:RF:PRESET	no. ON OFF	MHZ KHZ HZ	Presetting RF frequency for counting
COUNT:RF:DIRECTCOUNT	no. ON OFF	MHZ KHZ HZ	Direct coarse RF counting
COUNT:RF:TRANSFER	---	---	Transfer of counted frequency as working frequency
COUNT:AF:TXTEST	no.	MHZ KHZ HZ	Counting of AF frequency in TX-Test
COUNT:AF:TXTEST	?	MHZ KHZ HZ	<Measured value>
COUNT:AF:TXTEST:REFERENCE	no. ON OFF	MHZ KHZ HZ	
COUNT:AF:TXTEST:SOURCE	DEMOD BEAT	----	Selection of Demod or Beat
COUNT:AF:TXTEST:TOLERANCE:LOWER	ON OFF	MHZ KHZ HZ	
COUNT:AF:TXTEST:TOLERANCE:UPPER	ON OFF	MHZ KHZ HZ	
COUNT:AF:TXTEST:PERIOD	PERIOD GATE	---	Operating mode of AF counter
COUNT:AF:RXTEST	no.	MHZ KHZ HZ	Counting the AF frequency of the AF voltmeter
COUNT:AF:RXTEST	?	MHZ KHZ HZ	<Measured value>
COUNT:AF:RXTEST:REFERENCE	no. ON OFF	MHZ KHZ HZ	
COUNT:AF:RXTEST:TOLERANCE:LOWER	ON OFF	MHZ KHZ HZ	
COUNT:AF:RXTEST:TOLERANCE:UPPER	ON OFF	MHZ KHZ HZ	
COUNT:AF:RXTEST:PERIOD	PERIOD GATE	---	Operating mode of the AF counter

Command	Data	Units	Function
POWER:RF	---	**W DBM**	Power measurement
POWER:RF	?	**W DBM**	<Measured value>
POWER:RF:TOLERANCE:UPPER	no. **ON OFF**	**W DBM**	
POWER:RF:TOLERANCE:LOWER	no. **ON OFF**	**W DBM**	
POWER:RF:REFERENCE	no. **ON OFF**	**W DBM**	
POWER:RF:RANGE	no. **ON OFF**	**W DBM**	
POWER:RF:TIME	**AUTO FAST SLOW**	---	Measurement speed
POWER:RF:HOLD	**ON OFF**	---	Hold function
POWER:RF:RESET	---	---	Basic setting
POWER:RF:PEP	**ON OFF**	---	
POWER:RF:FORWARD	---	**W DBM**	Selection of unit
POWER:RF:FORWARD	?	**W DBM**	<Measured value>
:TOLERANCE:LOWER	no. **ON OFF**	**W DBM**	
:TOLERANCE:UPPER	no. **ON OFF**	**W DBM**	
POWER:RF:FORWARD:RANGE	no. **ON OFF**	**W DBM**	
POWER:RF:FORWARD:REFERENCE	no. **ON OFF**	**W DBM**	
POWER:RF:REFLECTED	---	**W DBM**	Selection of unit
POWER:RF:REFLECTED	?	**W DBM**	<Measured value>
:TOLERANCE:LOWER	no. **ON OFF**	**W DBM**	
:TOLERANCE:UPPER	no. **ON OFF**	**W DBM**	
POWER:RF:REFLECTED:RANGE	no. **ON OFF**	**W DBM**	
POWER:RF:REFLECTED:REFERENCE	no. **ON OFF**	**W DBM**	
POWER:RF:VSWR	?	---	<Non-dimensional measured value>
:TOLERANCE:LOWER	**ON OFF**	---	
:TOLERANCE:UPPER	**ON OFF**	---	

Command	Data	Units	Function
ACP	---	**V MV UV W DBUV DBM DB**	Selection of unit
ACP	?	**V MV UV W DBUV DBM DB**	<Measured value>
ACP:TOLERANCE:LOWER	no. **ON OFF**	**V MV UV W DBUV DBM DB**	Setting lower tolerance markers for adjacent channel measurement
ACP:TOLERANCE:UPPER	no. **ON OFF**	**V MV UV W DBUV DBM DB**	Setting upper tolerance markers for adjacent channel measurement
ACP:RANGE	no. **ON OFF**	**V MV UV W DBUV DBM DB**	Selecting measurement range
ACP:ADJACENT:CHANNEL	**PLUS_2 PLUS_1 MINUS_1 MINUS_2**	---	Selection of channel for the first/second and upper/lower adjacent channel
ACP:CHANNELSPACE	**SEL_25**KHZ **SEL_20**KHZ **SEL_12**_5KHZ **SEL_10**KHZ	---	Selecting specific channel spacings
ACP:FILTER	**ON OFF SEL_16**KHZ **SEL_14**KHZ **SEL_8**_5KHZ	---	Filter selection when choosing any channel spacing
ACP:FREECHANNEL	no. **ON OFF**	**MHZ KHZ HZ**	Selecting any channel spacing
ACP:HARM:FIRST	---	---	The harmonic which will be measured is determined by selecting one of these four commands.
ACP:HARM:SECOND	---	---	
ACP:HARM:THIRD	---	---	
ACP:HARM:FOURTH	---	---	

Command	Data	Units	Function
DEMODULATION	no.	**P**CT **M**HZ **K**HZ **H**Z **R**AD	Selection of demodulation type DEMOD measurement and search routine
DEMODULATION	?	**P**CT **M**HZ **K**HZ **H**Z **R**AD	<Measured value>
DEMODULATION:**T**OLERANCE:**UP**PER	no. **ON OF**F	**P**C T**M**HZ **K**HZ **H**Z **R**AD	
DEMODULATION:**T**OLERANCE:**LOW**ER	no. **ON OF**F	**P**CT **M**HZ **K**HZ **H**Z **R**AD	
DEMODULATION:**RA**NGE	no. **ON OF**F	**P**CT **M**HZ **K**HZ **H**Z **R**AD	
DEMODULATION:**RE**FERENCE	no. **ON OF**F	**P**CT **M**HZ **K**HZ **H**Z **R**AD	
DEMODULATION:**D**EEMPHASIS	**N**ORMAL **S**EL_750	---	Deemphasis: no deemphasis or 750 µs
DEMODULATION:**W**EIGHTING	**A**UTO **PK RMS RMS_S**QRT 2 **PK2**	---	Weighting: peak, RMS RMS· √2, average of pos. and negative peak
DEMODULATION:**A**VERAGING	**SEL_1 SEL_2 SEL_3 SEL_4**	---	Averaging
DEMODULATION:**C**ONTROL	**S**QUELCH **ON OF**F	---	Demodulation: Squelch on, off
PEAKHOLD	no.	**P**CT **M**HZ **K**HZ **H**Z **R**AD	Selection of demodulation mode and retaining max. value
PEAKHOLD	?	**P**CT **M**HZ **K**HZ **H**Z **R**AD	<Measured value>
PEAKHOLD:**T**OLERANCE:**U**PPER	no. **ON OF**F	**P**CT **M**HZ **K**HZ **H**Z **R**AD	
PEAKHOLD:**T**OLERANCE:**L**OWER	no. **ON OF**F	**P**CT **M**HZ **K**HZ **H**Z **R**AD	
PEAKHOLD:**RE**FERENCE	no. **ON OF**F	**P**CT **M**HZ **K**HZ **H**Z **R**AD	
PEAKHOLD:**RA**NGE	no. **ON OF**F	**P**CT **M**HZ **K**HZ **H**Z **R**AD	

Command	Data	Units	Function
DECODE	---	---	Decoding of selective call
DECODE	?	---	Received value
DECODE:**ST**ANDARD	no.	---	Selection of standard (see Section 2.4.4)
DECODE:**D**IGITREPEAT	**ON OF**F	---	Digit repeat
DECODE:**B**ANDWIDTH	no.	**P**CT	Evaluation bandwidth
DECODE:**P**AUSE	no.	**S MS US**	Tolerable pause
DECODE:**SO**URCE	**D**EMOD **A**FVOLT	---	Selection of source
DECODE:**N**UMBER	no.	---	Tone number
CODE	String	---	Transmitting of selective call
CODE	?	---	Query of the string
CODE:**ST**ANDARD	no.	---	Selection of standard (see Section 2.4.4)
CODE:**MSGR**EPEAT	no.	---	Number of telegrams to be transmitted
CODE:**REP**EATTONE	**ON OF**F	---	Tone repetition
CODE:**A**CKTEST	**ON OF**F **RF_OFF**	---	Acknowledgement test
CODE:**F**R_TUNE	no.	**P**CT	Frequency deviation
CODE:**SP**ECIAL:**N**UMBER	no.	---	Selection of extra tone
CODE:**SP**ECIAL:**L**ENGTH	no.	**S MS US**	Length of extra tone
CODE:**O**THER:**L**ENGTH	no.	**S MS US**	Duration of other tones
CODE:**D**IGITPAUSE	no.	**S MS US**	Time elapsing between the tones
CODE:**MSGP**AUSE	no.	**S MS US**	Time elapsing between the telegrams
CODE:**RES**ET	---	---	Resetting the original prameters
FILTER:**T**XTEST	**ON OF**F	---	Switching on/off the selected filters in TX-Test
FILTER:**T**XTEST:**H**P	**ON OF**F	---	High pass filter in TX-Test
FILTER:**T**XTEST:**L**P	**ON OF**F	---	Low pass filter in TX-Test
FILTER:**T**XTEST:**P**SOPHOMETRIC	**ON OF**F	---	Psophometric filter in TX-Test
FILTER:**T**XTEST:**N**OTCH	no. **ON OF**F	**MHZ KHZ HZ**	Notch filter in TX-Test
FILTER:**T**XTEST:**R**ESONANCE	no. **ON OF**F	**MHZ KHZ HZ**	Resonance filter in TX-Test
FILTER:**T**XTEST:**E**XTERNAL	**ON OF**F	---	External filter in TX-Test
FILTER:**T**XTEST:**I**F	**WI**DE **NA**RROW	---	IF filter

Command	Data	Units	Function
FILTER:RXTEST	ON OFF	---	Switching on/off the selected filters in RX-Test
FILTER:RXTEST:HP	ON OFF	---	High pass filter in RX-Test
FILTER:RXTEST:LP	ON OFF	---	Low pass filter in RX-Test
FILTER:RXTEST:PSOPHOMETRIC	ON OFF	---	Psophometric filter in RX-Test
FILTER:RXTEST:NOTCH	no. ON OFF	MHZ KHZ HZ	Notch filter in RX-Test
FILTER:RXTEST:RESONANCE	no. ON OFF	MHZ KHZ HZ	Resonance filter in RX-Test
FILTER:RXTEST:EXTERNAL	ON OFF	---	External filter in RX-Test
ATTENUATION:IF	ON OFF AUTO	---	Attenuation of IF control
DISTORTION:TXTEST	no.	PCT MHZ KHZ HZ DB	Distortion measurement of demodulated signal
DISTORTION:TXTEST	?	PCT MHZ KHZ HZ DB	<Measured value>
:TOLERANCE:UPPER	no. ON OFF	PCT MHZ KHZ HZ DB	
:TOLERANCE:LOWER	no. ON OFF	PCT MHZ KHZ HZ DB	
:RANGE	no. ON OFF	PCT MHZ KHZ HZ DB	
DISTORTION:TXTEST:AFCOUPLED	ON OFF	---	The frequency of the modulation generator is identical with the distortion measurement frequency.
DISTORTION:TXTEST:AVERAGING	SEL_1 SEL_2 SEL_3 SEL_4	---	Averaging
DISTORTION:RXTEST	no.	PCT MHZ KHZ HZ DB	Distortion measurement of the signal applied to the AF voltmeter
DISTORTION:RXTEST	?	PCT MHZ KHZ HZ DB	<Measured value>
:TOLERANCE:UPPER	no. ON OFF	PCT MHZ KHZ HZ DB	
:TOLERANCE:LOWER	no. ON OFF	PCT MHZ KHZ HZ DB	
:RANGE	no. ON OFF	PCT MHZ KHZ HZ DB	
SINAD:RXTEST	no.	PCT MHZ KHZ HZ DB	SINAD measurement of the signal applied to the AFvoltmeter
SINAD:RXTEST	?	PCT MHZ KHZ HZ DB	<Measured value>
SINAD:RXTEST:TOLERANCE:UPPER	no. ON OFF	PCT MHZ KHZ HZ DB	SINAD search routine
SINAD:RXTEST:TOLERANCE:LOWER	no. ON OFF	PCT MHZ KHZ HZ DB	
SINAD:RXTEST:RANGE	no. ON OFF	PCT MHZ KHZ HZ DB	
SINAD_DISTORTION:AFCOUPLED	ON OFF	---	The frequency of the modulation generator is identical with the meas. frequ.
SINAD_DISTORTION:AVERAGING	SEL_1 SEL_2 SEL_3 SEL_4	---	Averaging
SINAD_DISTORTION:WINDOW	no.	PCT DB	Window of SINAD search routine
SINAD_DISTORTION:WINDOW	?	PCT DB	Query of the setting

Command	Data	Units	Function
S_N:TXTEST	no.	PCT DB	S/N measurement of demodulated signal
S_N:TXTEST	?	PCT DB	<Measured value>
S_N:TXTEST:TOLERANCE:UPPER	no. ON OFF	PCT DB	
S_N:TXTEST:TOLERANCE:LOWER	no. ON OFF	PCT DB	
S_N:TXTEST:RANGE	no. ON OFF	PCT DB	
S_N:TXTEST:GEN2	USED UNUSED	---	2nd modulation generator is also used for S/N meas.
S_N:TXTEST:AVERAGING	SEL_1 SEL_2 SEL_3 SEL_4	---	Averaging
S_N:RXTEST	no.	PCT DB	S/N meas. of the signal applied to the AF voltm.
S_N:RXTEST	?	PCT DB	<Measured value>
S_N:RXTEST:TOLERANCE:UPPER	no. ON OFF	PCT DB	S/N search routine
S_N:RXTEST:TOLERANCE:LOWER	no. ON OFF	PCT DB	
S_N:RXTEST:RANGE	no. ON OFF	PCT DB	
S_N:RXTEST:EXTERNAL	USED UNUSED	---	External modulation is also used
S_N:RXTEST:AVERAGING	SEL_1 SEL_2 SEL_3 SEL_4	---	Averaging
S_N:RXTEST:GEN2	USED UNUSED	---	2nd modulation generator is also used
S_N:RXTEST:WINDOW	no.	PCT DB	Window of SINAD search routine
S_N:RXTEST:WINDOW	?	PCT DB	Query of the setting
INPUT:ONE	no.	DB	Selection of input and external attenuation
INPUT:TWO	no.	DB	Selection of input and external attenuation
INPUT:TWO:ATTENUATION	SEL_0DB SEL_24DB		Set the attenuation
LEVEL:RF	no. ON OFF	MV UV DBUV DBM	Level setting of RF synthesizer
LEVEL:RF	?	MV UV DBUV DBM	Query of the setting
LEVEL:RF:VARIATION	no. ON OFF	V MV UV DB	
LEVEL:RF:REFERENCE	no. ON OFF	MV UV DBUV DBM	
LEVEL:RF:FINE	no. ON OFF	MV UV DBUV DBM	Level sett. via fine level var.
LEVEL:RF:BANDWIDTH	---	---	Bandwidth measurement
LEVEL:RF:SQUELCH	---	---	Squelch routine
LEVEL:RF:QUIETING	no.	DB	Quieting measurement
LEVEL:RF:RXTEST:LEVEL	PD EMF	---	Level output

Command	Data	Units	Function
LEVEL:AF:I1	no. ON OFF	V MV UV DBUV DBM	Level setting of first modulation generator
LEVEL:AF:I1	?	V MV UV DBUV DBM	Query of the setting
LEVEL:AF:I1:VARIATION	no. ON OFF	V MV UV DB	
LEVEL:AF:I1:REFERENCE	no. ON OFF	V MV UV DBUV DBM	
LEVEL:AF:I2	no. ON OFF	V MV UV DBUV DBM	Level setting of second modulation generator
LEVEL:AF:I2	?	V MV UV DBUV DBM	Query of the setting
LEVEL:AF:I2:VARIATION	no. ON OFF	V MV UV DB	
LEVEL:AF:I2:REFERENCE	no. ON OFF	V MV UV DBUV DBM	
LEVEL:AF:RXTEST	no.	V MV UV W DBUV DBM	Level setting of AF voltmeter
LEVEL:AF:RXTEST	?	V MV UV W DBUV DBM	Query of the setting
:TOLERANCE:UPPER	no. ON OFF	V MV UV W DBUV DBM	
:TOLERANCE:LOWER	no. ON OFF	V MV UV W DBUV DBM	
:REFERENCE	no. ON OFF	V MV UV W DBUV DBM	
:RANGE	no. ON OFF	V MV UV W DBUV DBM	
LEVEL:AF:RXTEST:WEIGHTING	PLUS_PK MINUS_PK RMS RMS_SQRT2	---	Weighting the AF voltmeter: pos. peak, neg. peak, RMS, RMS · $\sqrt{2}$, average of pos. and neg. peak
LEVEL:AF:RXTEST:AVERAGING	SEL 1 SEL_2 SEL_3 SEL_4	---	Averaging
LEVEL:AF:RXTEST:COUPLING	AC DC3HZ DCWIDE	---	Cut-off frequency of the AF voltmeter
LEVEL:AF:RXTEST:ATTENUATION	AUTO ON OFF	---	Internal attenuator
MODE:TXRX:LOCK	ON OFF	---	LOCK function
MODULATION:AF:I1	no. ON OFF	PCT MHZ KHZ HZ RAD	Modulation of the RF signal generator with the first modulation generator
MODULATION:AF:I1	?	PCT MHZ KHZ HZ RAD	Query of the setting
MODULATION:AF:I1:VARIATION	no. ON OFF	PCT MHZ KHZ HZ RAD	
MODULATION:AF:I1:REFERENCE	no. ON OFF	PCT MHZ KHZ HZ RAD	

Command	Data	Units	Function
MODULATION:**A**F:**I2**	no. **ON OF**F	**P**CT **M**HZ **K**HZ **H**Z **R**AD	Modulation of the RF signal generator with the second modulation generator
MODULATION:**A**F:**I2**	?	**P**CT **M**HZ **K**HZ **H**Z **R**AD	Query of the setting
MODULATION:**A**F:**I2:VAR**IATION	no. **ON OF**F	**P**CT **M**HZ **K**HZ **H**Z **R**AD	
MODULATION:**A**F:**I2:RE**FERENCE	no. **ON OF**F	**P**CT **M**HZ **K**HZ **H**Z **R**AD	
MODULATION:**E**XTERNAL	no. **ON OF**F	**P**CT **M**HZ **K**HZ **H**Z	External modulation of the RF signal generator
MODULATION:**E**XTERNAL	?	**P**CT **M**HZ **K**HZ **H**Z	Query of the setting
:VARIATION	no. **ON OF**F	**P**CT **M**HZ **K**HZ **H**Z	
:REFERENCE	no. **ON OF**F	**P**CT **M**HZ **K**HZ **H**Z	
:CALIBRATION	---	---	Modulation: ext. calibration
:VOLTAGE	no.	**V M**V **U**V	Input of external modulation voltage
MODULATION:**C**OUPLING	AC **D**C	---	Set the coupling
MODULATION:**O**FF	---	---	
DC:VOLTAGE	no.	**M**V **V**	DC voltage measurement
DC:VOLTAGE	?	**M**V **V**	<Measured value>
DC:VOLTAGE:**RE**FERENCE	no. **ON OF**F	**M**V **V D**B	
DC:VOLTAGE:**RA**NGE	no. **ON OF**F	**M**V **V D**B	
DC:VOLTAGE:**T**OLERANCE:**U**PPER	no. **ON OF**F	**M**V **V D**B	
DC:VOLTAGE:**T**OLERANCE:**L**OWER	no. **ON OF**F	**M**V **V D**B	
DC:CURRENT	no.	**M**A **A**	DC current measurement
DC:CURRENT	?	**M**A **A**	<Measured value>
DC:CURRENT:**RE**FERENCE	no. **ON OF**F	**M**A **A D**B	
DC:CURRENT:**RA**NGE	no. **ON OF**F	**M**A **A D**B	
DC:CURRENT:**T**OLERANCE:**U**PPER	no. **ON OF**F	**M**A **A D**B	
DC:CURRENT:**T**OLERANCE:**L**OWER	no. **ON OF**F	**M**A **A D**B	

IEC-bus-commands for the SCOPE mode

Command	Data	Units	Function
SCOPE:CONTINUE	ON OFF	---	ON: Activation of the scope OFF: FREEZE mode
SCOPE:CONTINUE:AUTO	---	---	Automatic selection of source
SCOPE:CONTINUE:SOURCE	MODEXT DEMOD-BEAT AF DIST	---	Defined selection of source
SCOPE:BESTRANGE	ON OFF	---	Selection of best measuring range
SCOPE:AMPLITUDE	no.	---	Amplitude setting
SCOPE:TIME	no.	---	Time setting
SCOPE:YPOSITION	no.	---	Y position
SCOPE:PROBE:RF	no. ON OFF	V MV UV DBUV DBM	Selection of unit and external attenuation, switches measurement on/off
SCOPE:PROBE:RF	?	V MV UV DBUV DBM	<Measured value>
SCOPE:PROBE:RF:REFERENCE	---	V MV UV DBUV DBM DB	
:TOLERANCE:LOWER	---	V MV UV DBUV DBM DB	
:TOLERANCE:UPPER	---	V MV UV DBUV DBM DB	
SCOPE:PROBE:RF:RANGE	---	V MV UV DBUV DBM DB	
SETTLING:ARM	ON OFF	---	
SETTLING:MODE	POWER FREQUENCY	---	
SETTLING:MARKER	no. ON OFF	---	
SETTLING:TIME	no. ON OFF	---	
SETTLING:AMP	no. ON OFF	---	

IEC-bus commands for selective call generation

Command	Data	Units	Function
TONES:STANDARD	no.	---	Calling of standard (see Section 2.10)
TONES:RESET	no.	---	Resetting of original parameters
TONES:SPECIAL:NUMBER	no.	---	Selection of extra tone
TONES:SPECIAL:LENGTH	no.	S MS US	Duration of extra tone
TONES:OTHER:LENGTH	no.	S MS US	Duration of other tones
TONES:DIGITPAUSE	no.	S MS US	Time elapsing between the tones
TONES:COUPLING:STANDARDS	COUPLED INDEPENDENT	---	Coupling of standards
TONES:DECODE:TIME	no.	S MS US	Decoding time
TONES:SELECT:FREQUENCY:ONE	---	---	Selection of tones for generator 1
TONES:SELECT:FREQUENCY:TWO	---	---	Selection of tones for generator 2
TONES:TONE0	no.	MHZ KHZ HZ	Assignment of tones to frequencies
TONES:TONE1	no.	MHZ KHZ HZ	
TONES:TONE2	no.	MHZ KHZ HZ	
TONES:TONE3	no.	MHZ KHZ HZ	
TONES:TONE4	no.	MHZ KHZ HZ	
TONES:TONE5	no.	MHZ KHZ HZ	
TONES:TONE6	no.	MHZ KHZ HZ	
TONES:TONE7	no.	MHZ KHZ HZ	
TONES:TONE8	no.	MHZ KHZ HZ	
TONES:TONE9	no.	MHZ KHZ HZ	
TONES:TONEA	no.	MHZ KHZ HZ	
TONES:TONEB	no.	MHZ KHZ HZ	
TONES:TONEC	no.	MHZ KHZ HZ	
TONES:TONED	no.	MHZ KHZ HZ	
TONES:TONEE	no.	MHZ KHZ HZ	
TONES:TONEF	no.	MHZ KHZ HZ	
TONES:AF:I10	no.	MHZ KHZ HZ	Assignment of tones to frequencies for standard 0 (variation series for modulation generators 1 and 2)
TONES:AF:I11	no.	MHZ KHZ HZ	
TONES:AF:I12	no.	MHZ KHZ HZ	
TONES:AF:I13	no.	MHZ KHZ HZ	
TONES:AF:I14	no.	MHZ KHZ HZ	
TONES:AF:I15	no.	MHZ KHZ HZ	
TONES:AF:I16	no.	MHZ KHZ HZ	
TONES:AF:I17	no.	MHZ KHZ HZ	
TONES:AF:I20	no.	MHZ KHZ HZ	
TONES:AF:I21	no.	MHZ KHZ HZ	
TONES:AF:I22	no.	MHZ KHZ HZ	
TONES:AF:I23	no.	MHZ KHZ HZ	
TONES:AF:I24	no.	MHZ KHZ HZ	
TONES:AF:I25	no.	MHZ KHZ HZ	
TONES:AF:I26	no.	MHZ KHZ HZ	
TONES:AF:I27	no.	MHZ KHZ HZ	

IEC-bus commands for SSB

Command	Data	Units	Function
SSB:LEVEL:I1	---	**V MV UV DBUV DBM**	RF output level
SSB:LEVEL:I1:VARIATION	---	**V MV UV DB**	
SSB:LEVEL:I1:REFERENCE	---	**V MV UV DBUV DBM**	
SSB:LEVEL:I2	---	**V MV UV DBUV DBM**	RF output level
SSB:LEVEL:I2:VARIATION	---	**V MV UV DB**	
SSB:LEVEL:I2:REFERENCE	---	**V MV UV DBUV DBM**	
SSB:MODE	**SEL_SSB_LSB SEL_SSB_USB SEL_SSB_CW**	---	Selection of the RF offset
SSB:STATUS	**ON OFF**	---	Switches the SSB transmission mode on/off

IEC-bus commands for the self-test

Command	Data	Units	Function
CALIBRATION:CYCLIC	**ON OFF**	---	Cyclic calibration
CALIBRATION:DISTORTION	---	---	Distortion calibration
CALIBRATION:DETECTOR:RMS	---	---	Calibration of RMS detector
CALIBRATION:MODULATION:FILTER	---	---	Calibration of AF synthesizer filters
CALIBRATION:MODULATION:GENERATOR	---	---	Calibration of offset and amplitude of the AF synthesizers
CALIBRATION:POWER	---	---	Calibration of power meter
CALIBRATION:PEAK	---	---	Calibration of peak meter
CALIBRATION:SYNTHESIZER	---	---	Calibration of synthesizer deviation
SERVICE:BATTERY	**ON OFF**	---	Battery voltage measurement

IEC-bus commands for configuration

Command	Data	Units	Function
CONFIGURATION:AF:TRANSFORMER		SEL_600_OHM	NORMAL
CONFIGURATION:R_REFERENCE	no.	OHM	Reference resistance of AF voltmeter
CONFIGURATION:KEYBEEP	ON OFF	---	Acoustic key acknowledgement
CONFIGURATION:WARNING	ON OFF	---	Warning in case of erroneous operation
CONFIGURATION:ZOOM	ON OFF	---	
CONFIGURATION:CLOCK:EXTERNAL	ON OFF	---	Switching to ext. reference
CONFIGURATION:PRINTER:TYPE	NECP6,7 EPSON PDN CM-Z22	---	Printer type
CONFIGURATION:SCREEN:LIGHTING	ON OFF SEL_5_MIN SEL_1_H	---	Lighting of the CMS is switched on/off or switched on for 5/60 min
CONFIGURATION:ROUTINE:LIMIT:TIMEOUT	no.	S MS US	Timeout value for search routines
CONFIGURATION:ROUTINE:LIMIT:DELAY	no.	S MS US	Wait time for slowing down the test cycle with squelch measurement
CONFIGURATION:ROUTINE:LIMIT:THRESHOLD	no.	MV UV W DBUV DBM	AF level (measurement): threshold value for squelch on/off
CONFIGURATION:ROUTINE:LIMIT:AF LEVEL	no.	MV UV W DBUV DBM	Upper AF level limit for search routines
CONFIGURATION:ROUTINE:LIMIT:RF LEVEL	no.	MV UV W DBUV DBM	Upper RF level limit for search routines
CONFIGURATION:ROUTINE:LIMIT:MEASURE	no.	S MS US	Measuring time
CONFIGURATION:ROUTINE:LIMIT:ATTACKTIME	no.	S MS US	Wait time until meas. start
CONFIGURATION:CONTROL:TTL	no.	---	Input and/or output of the TTL interfaces
CONFIGURATION:CONTROL:TTL	?	---	<Received value>
CONFIGURATION:CONTROL:TTL:VARIATION	no.	---	
CONFIGURATION:CONTROL:RELAYS CONFIGURATION:CONTROL:RELAYS: :VARIATION	no. no.	--- --- 	Programming of the relays
CONFIGURATION:CONTROL:INOUT	IN_IN IN_OUT OUT_IN OUT_OUT	---	Programming of the TTL interface
CONFIGURATION:CONTROL:RX TX	ON OFF	---	Setting most significant relays via RX - TX switchover
CONFIGURATION:LO:HIGH	ON OFF	---	LO frequency

IEC-bus commands for the SPECTRUM operation

Command	Data	Units	Function
SPECTRUM:ATTENUATION **SPECTRUM:AUTOATTENUATION**	no.	**DB**	<Attenuation dB>
SPECTRUM:FILTER	**SEL_150HZ** **SEL_6KHZ** **SEL_16KHZ** **SEL_50KHZ** **SEL_300KHZ** **SEL_1MHZ** **SEL_3MHZ**		
SPECTRUM:TRACKING	**ON OFF**		(only if CMS-B9/-B59 is fitted)
SPECTRUM:TRACKING:OFFSET	no.	**MHZ KHZ HZ**	<OffsetFreq Hz> "
SPECTRUM:TRACKING:OFFSET	?		<Query of the setting>
SPECTRUM:QUICK	**ON OFF**		
SPECTRUM:CABLE:FAULT	no. **ON OFF**		<Cable fault test, shortening fault>
SPECTRUM:CENTER	no.	**MHZ KHZ HZ**	<CenterFreq Hz>
SPECTRUM:CENTER	?		<Query of the setting>
SPECTRUM:SPAN	no.	**MHZ KHZ HZ**	<SpanFreq Hz>
SPECTRUM:SPAN	?		<Query of the setting>
SPECTRUM:START	no.	**MHZ KHZ HZ**	<StartFreq Hz>
SPECTRUM:START	?		<Query of the setting>
SPECTRUM:STOP	no.	**MHZ KHZ HZ**	<StopFreq Hz>
SPECTRUM:STOP	?		<Query of the setting>
SPECTRUM:REFERENCE:LEVEL	no.	**V MV UV W** **DBUV DBM**	<RefLevel W>
SPECTRUM:REFERENCE:LEVEL	?	**V MV UV W** **DBUV DBM**	<Query of the setting>
SPECTRUM:SCALE	**SEL_2DB** **SEL_5DB** **SEL_10DB**		
SPECTRUM:FREEZE	**ON OFF**		
SPECTRUM:MARKER	no.	**MHZ KHZ HZ**	---
SPECTRUM:MARKER	?		<MKr Level W> <MkrFreq Hz>
SPECTRUM:MARKER:REFERENCELEVEL	**ON OFF**		
SPECTRUM:MARKER:CENTERFREQUENCY	**ON OFF**		

IEC-bus commands for options *)

Command	Data	Units	Function
MODEM	**OFF ENTER**	---	Switch on FFSK transmitter
MODEM:ZERO:FREQUENCY	no.	**MHZ kHz Hz**	Frequency which results in a log of 0
MODEM:ONE:FREQUENCY	no.	**MHZ kHz Hz**	Frequency which results in a log of 1
MODEM:BIT:FREQUENCY	no.	---	Transmission speed
MODEM:MODULATION	no. **ON OFF**	**MHZ kHz Hz**	Deviation setting
MODEM:LEVEL	no. **ON OFF**	**V MV UV W DBUV DBM**	Output level
MODEM:SQUELCH	no.	**DB**	
MODEM:IO:LEVEL	**TTL RS232**	---	Selection of the modulation sensitivity
MODEM:SLOPE	**RISE FALL**	---	
SERIAL:NULINE	**AUTO CR CRLF OFF**	---	Selection of string terminator
SERIAL:RX:TIMEOUT	no.	---	Waiting period in ms after reception of the last character until abortion of the SEND function
SERIAL:RX:DISABLE	**ON OFF**	---	Disabling reception of data
SERIAL:PARITY	**OFF SEL_0 SEL_1 EVEN ODD**	---	Selection of parity bit with transmission and reception
SERIAL:BAUD:RATE	**SEL_19200 BD SEL_9600 BD SEL_4800 BD SEL_2400 BD SEL_1200 BD SEL_600 BD SEL_300 BD SEL_150 BD**	---	Setting the baud rate
SERIAL:ECHO:CANCEL	**ON OFF**	---	Activating/Deactivating the ECHO CANCEL function
SERIAL:BITS	**SEL_8_1 SEL_8_2 SEL_7_1 SEL_7_2**	---	Determination of the data format for transmission
SERIAL:SEND	no. **ON OFF**	---	Send string via the serial interface
SERIAL:SEND:IMMEDIATELY	**ON OFF**	---	Setting: Send individual characters
SERIAL:SOFTWARE:HANDSHAKE	**OFF ETX_ACK XON_XOFF**	---	Selection of software-handshake protocol
SERIAL:HARDWARE:HANDSHAKE	**OFF SEL_2_WIRE SEL_4_WIRE**	---	Selectuion of hardware-handshake protocol

*) depending on model or option

Command	Data	Units	Function
CDCSS:TURN_OFF	ON OFF SEL_100 MS SEL_150 MS SEL_200 MS SEL_250 MS	---	
CDCSS:TRANSM_END	SEL_100 MS SEL_150 MS SEL_200 MS SEL_250 MS SEL_300 MS SEL_350 MS SEL_400 MS	---	
AUDIO_IF:CONNECTION	SEL_UNBALAN SEL_BALAN	---	Set the connection
AUDIO_IF:INPUT:AF	TEL_1 TEL_2	---	Input selection
AUDIO_IF:IMPED:BALANCED	SEL_150_OHM SEL_300_OHM		Only with SEL_BALAN
AUDIO_IF:IMPED:MEAS	ON OFF	OHM	Measure the load impedance
AUDIO_IF:IMPED:MEAS	?	OHM	<Measured value>
:TOLERANCE:LOWER	no. ON OFF	---	
:TOLERANCE:UPPER	no. ON OFF	---	
AUDIO_IF:IMPED:MEAS:RANGE	no. ON OFF	---	
AUDIO_IF:IMPED:MEAS:REFERENCE	no. ON OFF	---	
AUDIO_IF:IMPED:MATCH	ON OFF	---	Match the voltage to the last IMPED result

Function Keyboard Lock

The CMS permits to lock the keyboard using an IEC-bus command. This serves to prevent an unauthorized user from intervening in the measurement or changing preset parameters.

The IEC-bus command for locking the keyboard reads as follows:

"KEYBOARD:LOCK ON".

The following message appears in the first status line:

"REMOTE with Lockout"

If an IEC-interface command (goto local - GTL) is used to switch to manual operation, the keyboard is locked as well. The message

"CMS - Local with Lockout"

is displayed in the first status line.

This state permits observing measurement sequences (e.g. with zoom function activated) at the display without settings at the CMS being able to be changed.
This state can only be canceled by sending the unlocking command via the IEC-bus controller or by switching off/on the CMS.

The IEC-bus command for unlocking the keyboard reads as follows:

"KEYBOARD:LOCK OFF".

The following message appears in the first status line:

"REMOTE-Local by <STOP>".

Remark: After switching on the CMS, the keyboard is always unlocked.

Setting Units

The IEC-bus command "UNIT<unit>" makes it possible to select the unit of the results which are sent from the CMS to the controller. The CMS attempts to convert each result into the selected unit. If this is not possible, the result is returned in the default IEC unit. The command "UNIT" remains valid until it is cancelled with "UNIT NO_UNIT".

The unit used by the CMS to display the results can be changed by sending the command, followed by the desired unit.

Example:

"POWER: RF DBM"

2.13.5 Service Request and Status Registers

The following Fig. shows the status registers and the effective links between them. To remain in accordance with the IEEE 488.2 standard, the Status Byte (STB) and its associated mask register (SRE), which are also present with older devices, have been supplemented by the Event Status Register (ESR) and its Event Status Enable Mask Register (ESE).

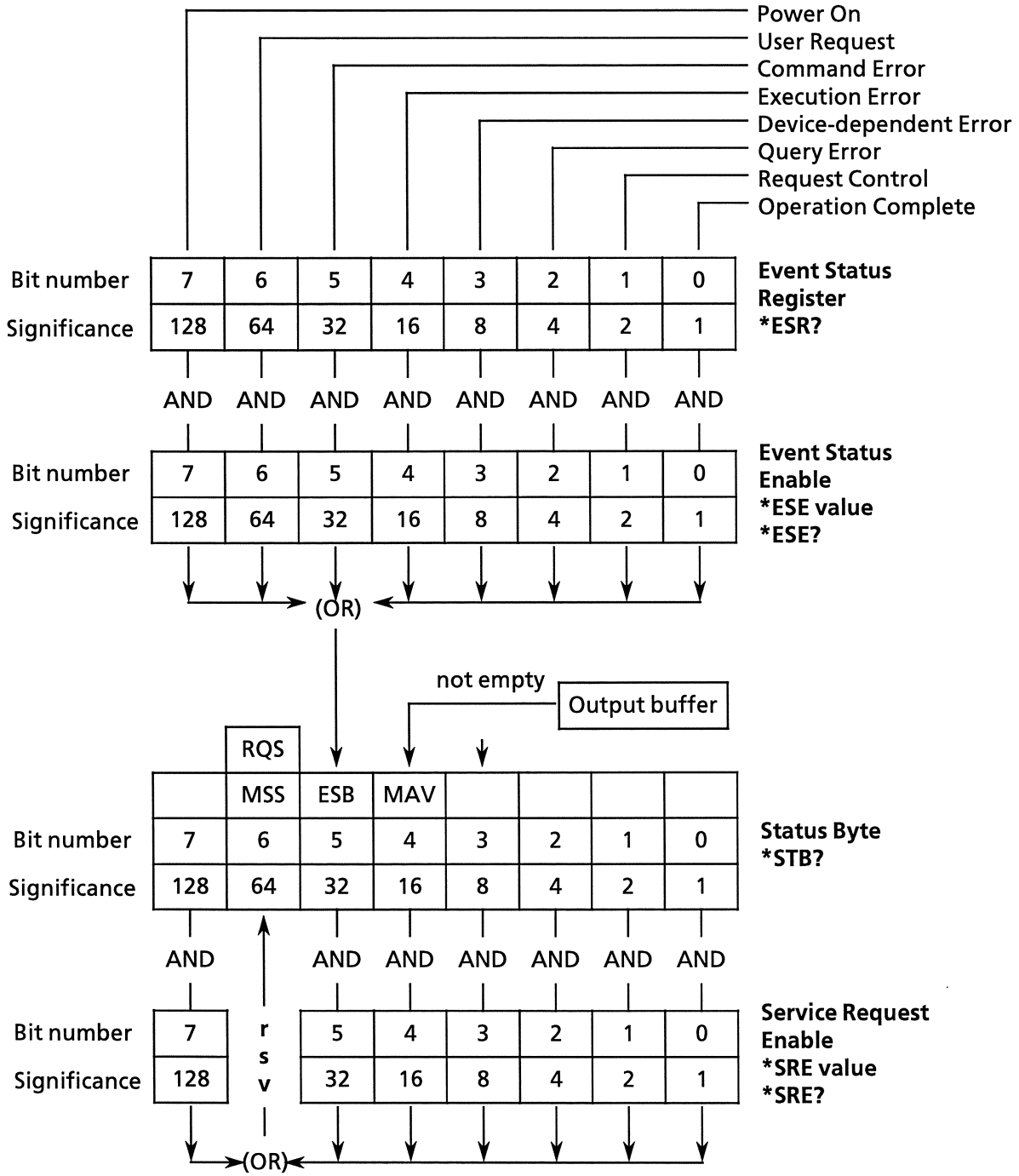


Fig. 2.13-4 Status registers

A bit is set to "1" in the ESR in the case of certain events (e.g. fault, ready signal), see Table 2-13-10. These bits remain set until they are cleared by reading the ESR (by the command *ESR?) or by the following conditions:

- The commands *RST or *CLS
- Switching on the AC supply (the power-on bit is, however, set in this case).

Using the ESE mask register, the user can select the bits in the ESR which also set the sum bit ESB (bit 5 in the status byte) via which a service request can be triggered. The sum bit is therefore only set if at least one bit in the ESR and the corresponding bits in the ESE are set to "1". The sum bit is automatically cleared again if the previous condition is no longer fulfilled, e.g. if the bits in the ESR have been cleared by reading the ESR or if the ESE has been modified.

The ESE mask register is written by the command "*ESE value" ("value" is the contents in decimal form) and can be read again by the command *ESE?. It is set to "0" when the AC power is switched on if the power on status clear flag is "1" (*PSC1).The ESE mask register is not changed by other commands or interface messages (DCL, SDC).

The bits listed in Table 2.13-9 are used in the status byte (STB):

Table 2-13-9 Bit allocation of status byte

Bit number	Bus line	Designation	Meaning
4	DIO 5	MAV	Message Available Indicates that a message, which can be read, is present in the output buffer. The bit is "0" if the output buffer is empty.
5	DIO 6	ESB	Sum bit of the Event Status Register
6	DIO 7	RQS	Request Service

Note that the status register bits are numbered from 0 to 7 in compliance with the standard, but the bus data lines are designated DIO1 to DIO8.

Table 2.13-10 Bit allocation of ESR

Bit Number	Meaning
7	**Power On** Is set when the instrument is switched on or if the power returns following a failure.
6	**User Request** This function is not implemented in the CMS.
5	**Command Error** Is set if one of the following faults is detected in the received commands: • Syntax error • Illegal unit • Illegal header • A number has been combined with a header where no number is allowed.
4	**Execution Error** Is set if one of the following errors was detected during execution of the received commands • A number is outside the permissible range (for the respective parameter). • A received command is not compatible with the current device setting.
3	**Device-dependent Error** Is set if functional errors occur.
2	**Query Error** This bit is set: • If the controller wishes to read data from the CMS but no query message has previously been output. • If the data present in the output buffer of the CMS have not been read out and a new command was sent to the instrument instead. The output buffer is cleard in this case.
1	**Request Control** This function is not implemented in the CMS.
0	**Operation Complete** This bit is set by the commands *OPC and *OPC? if all previous commands have been executed.

Using the SRE mask register, the user can determine whether the ESB, and/or MAV bits of the status byte are set, and whether a Service Request is sent to the controller by activating the SRQ line. Since each bit in the SRE mask register is assigned to the corresponding bit in the status byte, the following possibilities result (see Table 2.13-11), and the combinations thereof.

Table 2.13-11 Bit allocation of the SRE

Contents of SRE (decimal)	Set bit No. in SRE	Effect
0	--	No Service Request
16	4	Service Request if MAV bit is set (message in output buffer)
32	5	Service Request if ESB bit is set (at least 1 bit set and not masked in the ESR)

The Service Request Enable mask register (SRE) is written by the command "*SRE value" ("value" is the contents in decimal form) and can be read again by the command *SRE?. It is set to "0" when the AC power is switched on, if the power-on clear flag is "1"; the Service Request function of the CMS is thus disabled. The SRE mask register is not changed by other commands or interface messages (DCL, SDC).

Several devices can trigger a Service Request simultaneously, the open collector drivers generate an OR function on the SRQ line. The controller must read the status bytes of the devices in order to identify the device which has triggered the Service Request. A set RQS bit (bit 6/DIO7) indicates that the device is sending a Service Request.

The status byte of the CMS can be read in the following manner:

- By the command *STB?.

  The contents are then output in decimal form. The status byte is not changed by reading out, and the Service Request is not cleared.

- By a Serial Poll.

  The contents are transferred in binary form as one byte. The RQS bit is then set to "0" and the Service Request becomes inactive; the other bits of the status byte are not changed.

The status byte is cleared:

- By the command *CLS.

  This command clears the ESR and the output buffer; the ESB and MAV bits in the status byte are also set to "0". This in turn clears the RQS bit and the Service Request.

- By reading the ESR (*ESR? command) or setting the ESE mask register to "0" (*ESE command) and by reading the contents of the output buffer.

2.13.6 Resetting of Device Functions

The following table lists the various commands and events which cause individual device functions to be reset.

Table 2.13-12 Resetting of various device functions

Event	Power on		DCL, SDC (Device Clear, Selected Device Clear)	Commands	
	Power-on-clear flag			*RST	*CLS
	0	1			
Basic device setting	--	--	--	Yes	--
Set Event Status Register ESR to zero	Yes	Yes	--	Yes	Yes
Set mask registers ESE and SRE to zero	--	Yes	--	--	--
Clear output buffer	Yes	Yes	Yes	--	Yes
Clear Service Request	Yes	1)	2)	3)	Yes
Reset command processing and input buffer	Yes	Yes	Yes	--	--

1) Yes, but "Service Request on power on" is possible.
2) Yes, if only caused by message in output buffer.
3) Yes, if not caused by message in output buffer.

2.13.7 Command Processing Sequence and Synchronization

The commands received by the CMS are first stored in an input buffer which can accommodate up to 256 characters. Once the terminator has been received, the commands are processed in the sequence in which they were sent. During this time, the IEC 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.

OPERATION COMPLETE:

The commands *OPC and *OPC? (operation complete) are used as feedbacks to inform on the time at which processing of the received commands was terminated and a measurement (if any) has been completely performed.

*OPC sets bit 0 in the ESR, and a Service Request can then be triggered 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.

WAIT:

The 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. This may be favourable in the case of very short measuring times.

Program example:

A program example of an RF counter measurement is given in the following, where a Service Request is triggered in the case of error. The type of error generated is specified in detail.

(The command set of the IEC-bus controllers PCA is used; the IEC bus address of the CMS has been taken as 24.)

```
10 IEC TERM 10                                          : REM input terminator LF
20 ON SRQ1 GOSUB 300
30 IEC OUT 24, "*CLS; *ESE 60; *SRE 32"
40 REM
50 REM                                                  for Service Request in case
60 REM                                                  of error
70 IEC OUT 24, "HEADER ON"                              : REM header output as well
80 REM
90 IEC OUT 24, "DISPLAY: ME 1,0"                        : REM TX-Test menu
100 REM
110 IEC OUT 24, "COUNT : RF?"                           : REM counting of RF
120 IEC IN 24, HFCOUNT$
130 PRINT HFCOUNT$
140 END
300 REM ------------------------------------------------
310 REM              SERVICE REQUEST ROUTINE
320 REM ------------------------------------------------
330 IEC SPL 24,S%                                       : REM Serial Poll
340 IF (S% AND 64)=0 THEN GOTO 420                      : REM SRQ not from CMS?
350 IEC OUT 24, "*ESR?"                                 : REM Event Status Register
360 IEC IN 24, X$                                       : REM read
370 B=VAL (X$)
380 IF (B AND 032) <>0 THEN PRINT "COMMAND ERROR"
390 IF (B AND 016) <>0 THEN PRINT "EXECUTION ERROR"
400 IF (B AND 008) <>0 THEN PRINT "DEVIVE DEPENDENT ERROR"
410 IF (B AND 004) <>0 THEN PRINT "QUERY ERROR"
420 ON SRQ1 GOSUB 300
430 RETURN
500 REM ------------------------------------------------
510 REM      SERVICE REQUEST FROM OTHER DEVICE
520 REM ------------------------------------------------
530 REM....
540 REM....
620 ON SRQ1 GOSUB 300
630 RETURN
```

2.13.8 Error Handling

All errors detected by the CMS in connection with operation via the IEC bus are indicated in the ESR by setting a bit (bit 2, 4 or 5, see Table 2.13-10). Function faults are signalled by setting of bit 3. These bits remain set until the ESR is read or is cleared by the commands *RST or *CLS. This is in line with the standard IEEE 488.2 and enables triggering of a Service Request and program-controlled evaluation of the type of error.

2.14 Self-Test

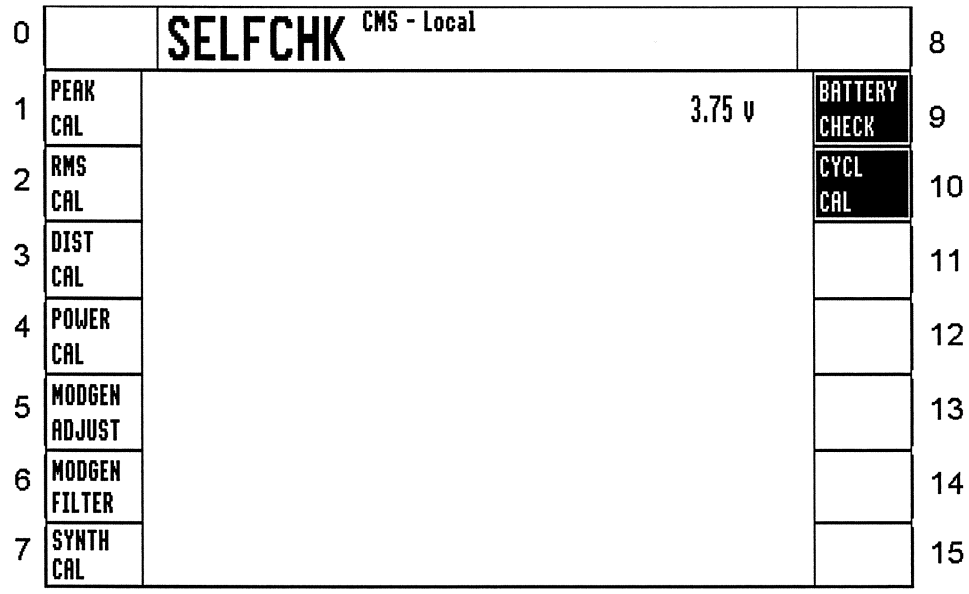


Fig. 2.14-1 Main menu SELFCHK (self-test)

Starting with the main menus of the selection menu, the main menu SELF CHK (self-test) is reached by pressing the softkey SELFCHK. Several internal measuring facilities are checked and evaluated.

2.14.1 Calibration of PEAK Meter

PEAK CAL Function

The PEAK meter in the CMS is adjusted by pressing the softkey PEAK CAL.

2.14.2 Calibration of RMS Meter

RMS CAL Function

The RMS meter in the CMS is adjusted by pressing th softkey RMS CAL.

2.14.3 Calibration of Distortion Meter

DIST CAL Function

The RMS meter of the distortion meter / SINAD meter is adjusted by pressing the softkey DIST CAL.

2.14.4 Power Calibration

POWER CAL Function

This test can be carried out only if the RF IN/OUT socket ***29*** is free.

The POWER CAL softkey is pressed for once adjusting the offset for power measurement at the respective measuring facilities.

2.14.5 Calibration of Modulation Generator

MODGEN ADJUST Function

An offset adjustment of the modulation generator output voltage is carried out by pressing the softkey MODGEN ADJUST.
The following text
"MOD GEN adjust completed? <ENTER>"
is read out in the status line.
A hardware offset adjustment (see CMS Service Manual) can then be internally performed in the instrument.

When the ENTER key is pressed, the measurement of the respective calibration data is carried out.

2.14.6 Adjustment of the Modulation Generator Filter

MODGEN FILTER Function

The frequency response caused by the ouput filters of the modulation generator is adjusted using the softkey MODGEN FILTER.

2.14.7 Synthesizer Calibration

SYNTH CAL Function

The deviation of the signal generator in the CMS is adjusted by pressing the softkey SYNTH CAL. This procedure takes some soconds and is output in the status line when completed.

2.14.8 Battery Check

BATT CHECK Function

The softkey BATT CHECK is pressed for once measuring the battery of the RAM with backup. The result is displayed next to the softkey, the evaluation is read out in the status line.

2.14.9 Cyclic Calibration

CYCL CAL Function

The following measuring facilities or generator functions are calibrated cyclically by pressing the softkey CYCL CAL: modulation generator offset, RMS meter, peak-value meter and A/D converter.

If measuring sequences are required at a defined point in time (especially in automatic operation), this function should better be switched off in order to prevent that asynchronous calibration measurements interfere with the time scale.

2.14.10 Limits of Calibration Values

Calibration	Calibration value	Min.	Max.	Unit
PEAK CAL	Output offset	- 20	+ 20	mV
	Gain	0.9	1.1	./.
	Input offset			
	(Path AF AC)	- 30	+ 30	mV
	(Path Demod)	- 30	+ 30	mV
	(Path Dist)	- 30	+ 30	mV
	(Path Psoph)	- 30	+ 30	mV
	(Path Hp)	- 30	+ 30	mV
	(Path Lp Demod)	- 30	+ 30	mV
	(Path Lp AF AC)	- 30	+ 30	mV
RMS CAL	Output offset	- 20	+ 20	mV
	Gain	0.9	1.1	./.
	Input offset			
	(Path AF AC)	- 50	+ 50	mV
	(Path Demod)	- 50	+ 50	mV
	(Path Dist)	- 50	+ 50	mV
	(Path Psoph)	- 50	+ 50	mV
	(Path Hp)	- 50	+ 50	mV
	(Path Lp Demod)	- 50	+ 50	mV
	(Path Lp Af AC)	- 50	+ 50	mV
DIST CAL	Offset	- 40	+ 40	mV
	Gain	0.9	1.1	./.
POWER CAL	Offset	- 20	+ 20	mV
MODGEN ADJUST	Offset	- 270	+ 270	mV
	Amplitude	125	1550	mV
MODGEN FILTER	Min/max filter Correction value at internal modulation (GEN)	4152	7118	./.
	for f > 20 kHz		14236	./.
	Min/max filter Correction value at MODGEN output	4152	7118	./.
	for f > 20 kHz		14236	./.
SYNTH CAL	Min/max deviation Correction value at Oscillator 1	5	254	./.
	Min/max deviation Correction value at Oscillator 2	5	254	./.
BATT CHECK	Voltage	3.0	5.0	V

2.14.11 Error Messages

Battery Check

- error 1 : Voltage error - falling below
- error 2 : Voltage error - exceeding
- error : General error

ADC Calibration

- error 1 : Offset error
- error 2 : Gain error
- error 3 : Offset error of DC amplifier
- error : General error

Peak Detector Calibration

- error 1 : Offset error
- error 2 : Gain error
- error 3 : Offset error in AF AC path
- error 4 : Offset error in Demod path
- error 5 : Offset error in Dist. path
- error 6 : Offset error in CCITT path
- error 7 : Offset error in Hp path
- error 8 : Offset error in Lp Demod path
- error 9 : Offset error in Lp AF AC path
- error : General error

Modgen Filter Calibration

- error 1 : Freq. response error Modgen 1 - falling below
- error 2 : Freq. response error Modgen 1 - exceeding
- error 3 : Freq. response error Modgen 2 - falling below
- error 4 : Freq. response error Modgen 2 - exceeding
- error : General error

Modgen Generator Calibration

- error 1 : Offset error
- error 2 : Amplitude error
- error : General error

RMS Detector Calibration

- error 1 : Offset error
- error 2 : Gain error
- error 3 : Offset error in AF AC path
- error 4 : Offset error in Demod path
- error 5 : Offset error in Dist path
- error 6 : Offset error in CCITT path
- error 7 : Offset error in Hp path
- error 8 : Offset error in Lp Demod path
- error 9 : Offset error in Lp AF AC path
- error : General error

Distortion Detector Calibration

- error 1 : Offset error
- error 2 : Gain error
- error : General error

Power Meter Calibration

- error 1 : Offset error - exceeding
- error 2 : Offset error - falling below
- error : General error

RF-Synthesizer Deviation Calibration

- error 1 : Deviation corr. value Osc. 1 - falling below
- error 2 : Deviation corr. value Osc. 1 - exceeding
- error 3 : Deviation corr. value Osc. 2 - falling below
- error 4 : Deviation corr. value Osc. 2 - exceeding
- error : General error

3 Maintenance

3.1 Electrical Maintenance

The self-test initiated in the CMS each time it is switched on informs the user on the occurrence of any faults.

Various calibration routines can be started in the self-check menu. Calibration routines and self-tests which do not lead to an error message indicate that no errors are detected and the CMS functions properly.
The user may request readout of the battery voltage in the self-check menu to know exactly when the batteries need be replaced.

Readjustment of the reference frequency is recommended once a year (for adjustment see section 4 in the CMS Service Manual).

3.2 Mechanical Maintenance

No mechanical maintenance is required under normal operating conditions.

3.3 Storage

A storage temperature between - 40 and + 70 °C is allowed. It should be noted that storage at high temperatures reduces the service life of the batteries. Before starting operation of the instrument again the battery charge should be checked (self-check menu).

ROHDE&SCHWARZ

Bilder
Figures
Figures

(R 29500 Bl 1)
095.1000 BL 1

ROHDE&SCHWARZ

Test and
Measurement Division

Autorun
Printer Control

Printed in the Federal
Republic of Germany

Contents

Page

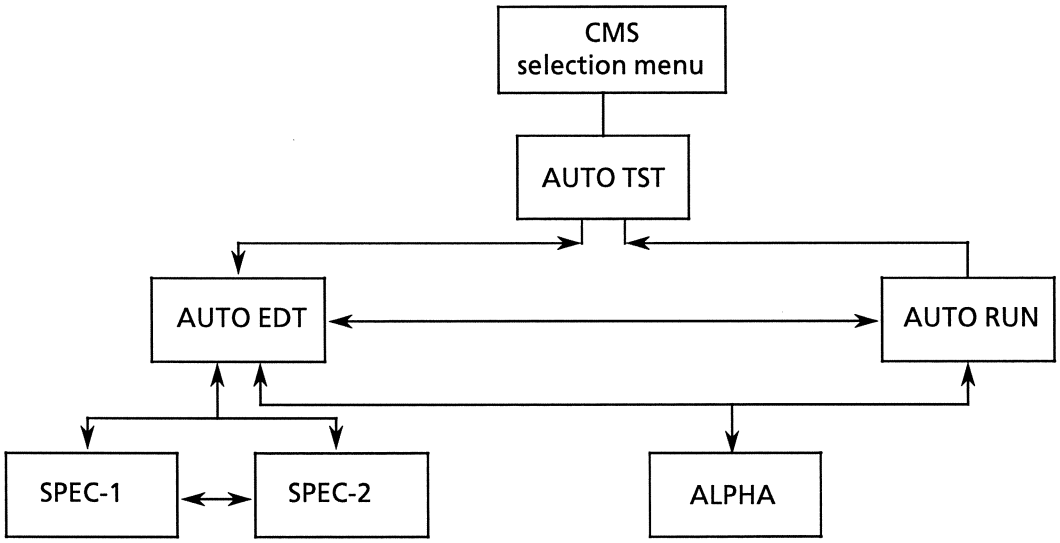
List of Figures

Autorun Control

Note: The electronic components on the memory card are insensitive to discharge pulses, only when R&S cards with protective sheathing are used.

The Autorun Control in the CMS Radiocommunication Service Monitor allows the user to store and execute program sequences entered via front panel controls and to generate test reports printed out on an external printer. Battery-backed memory cards (CMS-Z1 etc.) serve as program library and storage media for test reports.

Menu structure:



1 Generation of Programs on the CMS

Actuation of softkey 1 in the CMS selection menu calls the main menu AUTOTEST (see Fig. 1).

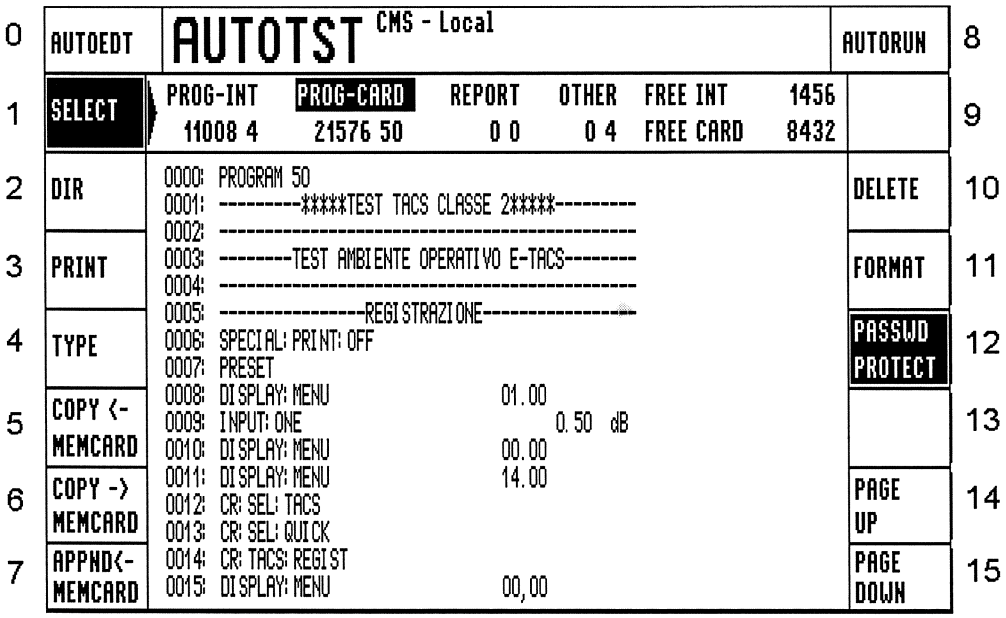


Fig. 1 Main menu AUTOTEST

This menu comprises all the softkeys required for storing, loading and display of programs.

Softkey 1 selects the item that the other softkeys in this program refer to.

The TYPE and PRINT functions allow for the content of programs and reports written to the CMS display or an external printer. The latter, however, will only work as intended if a printer is connected to the CMS printer port and the correct printer type set in the CONFIG menu. The printer port is to be found on the rear of the unit (fig 2-2, 46 in the appendix of this manual's section 1).

Softkeys 5 & 6 allow Programs to be copied from and to memory-card, respectively. If the target program number is already in use, a security message will prompt for further confirmation. The password function (softkey 12) allows a further increase in security, if desired.

The APPEND function of softkey 7 allows to append memory-card programs to existing programs in CMS memory. This function is identical to softkey 5, if the target location is still unused. A more in-depth description of the COPY and APPEND commands may be found in chapter 3.

The DELETE key serves to erase the single item chosen with the SELECT softkey. Softkey 11 (FORMAT) allows to delete a whole group of items in a single, convenient step. A security prompt will ensure operation only if intended. Further security against FORMAT and DELETE commands is gained for programs under password protection; in that case the operator will be prompted for the current password before operation is resumed.

Softkey 12 of menu AUTOTEST covers the function allowing to protect internal AUTORUN programs as well as programs stored on memory-card. This is accomplished by setting individual passwords for both types of program. A password is defined by entry of a variable length string of numeric characters in the range from 1 to 60000 (an easy reminder being that valid values correspond to the maximum integer range of milliseconds in a minute). Entry is done via the numeric keypad 3 (see front view, fig 2-1 in the appendix to section 1).

Pressing softkey 0 (AUTOEDT) gives access to submenu AUTOEDIT (see Fig. 2).

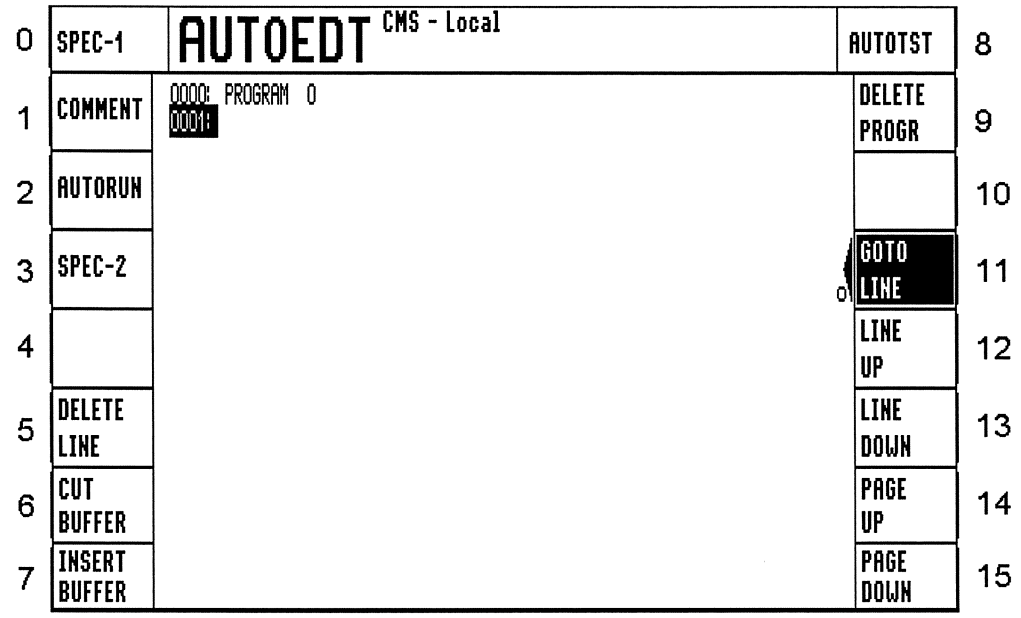


Fig. 2 Submenu AUTOEDIT

Programming is initated by pressing the START hardkey, and the CMS switches back to the selection menu (or the menu selected last in the LEARN mode). Any command entered then and stored via hardkey STORE corresponds to one program line for the started sequential program. The individual commands are commented in the first status line as IEC bus commands. Actuation of hardkey STOP permits the user to leave the LEARN mode, i.e. programming is stopped and the CMS returns to the AUTOEDIT menu. The programmed commands are then listed in the display in the same sequence as entered. Each command line is preceded by a number.

Example: Following power-up the CMS is set to the selection menu

AUTOTST		→	Select Autorun Control
AUTOEDT		→	Select LEARN mode
START		→	Start programming
TX-TEST	STORE	→	Select transmitter test
AF1		→	Select AF generator 1
1 kHz	STORE	→	Frequency setting 1 kHz
SHIFT AF1		→	Select AF level generator 1
25 mV	STORE	→	Level setting 25 mV
DEMOD		→	Select demodulation
MENU ↓		→	Select submenu DEMOD
WEIGHT		→	Select peak weighting
WEIGHT	STORE	→	Select RMS weighting
MENU ↑		→	Leaving submenu DEMOD
COUNT	STORE	→	Select frequency count
POWER	STORE	→	Select power measurement
DEMOD	STORE	→	Select demodulation measurement
RX-TEST	STORE	→	Select the receiver test
STOP		→	Stop programming

Stop of programming switches the CMS back to the AUTOEDIT menu. All the commands previously entered in LEARN mode are listed in the display of the example program:

```
0000:  PROGRAM  0
0001:  DISPLAY:MENU                  01,00
0002:  FREQUENCY:AF:I1                  1000.00 Hz
0003:  LEVEL:AF:I1                       +25000 uV
0004:  DEMODULATION:WEIGHTING        RMS
0005:  COUNT:RF
0006:  POWER:RF
0007:  DEMODULATION
0008:  DISPLAY:MENU                  02,00
0009:
```

Line 0 always identifies the number of the program. This line is automatically inserted. A maximum of about 1200 lines is possible. The cursor is positioned in the last empty line; respectively marked lines can be deleted or additional lines be inserted.

Maximally 14 lines are read out in the display per display page. Softkeys 14 PAGE UP and 15 PAGE DOWN are used for page turning. These two functions are also available in the AUTOTEST menu using the same softkeys. The softkeys 12 LINE UP and 13 LINE DOWN permit to shift the cursor by one line, respectively. Softkey 11 GOTO LINE moves the cursor to a defined position.

To delete the complete program sequence, the softkey 9 DELETE PROGR is pressed. Before deletion, the CMS prompts the user by the message "ARE YOU SURE?", which is acknowledged for program deletion by pressing hardkey ENTER or aborted using hardkey CLEAR.

1.1 Insertion of Additional Program Lines

The user wishes to activate the lowpass filter of the CMS in the program example of previous Section 1 before performing the measurements. To this end, the cursor is shifted to the command line that is to be preceded by the additional commands (line 5 in this example). Then the hardkey START is pressed to restart programming. The CMS is switched back to the menu which was active on completion of programming or on start-up of the program sequence.

GOTO LINE 5 ENTER		→	Select command line to be preceded by additional commands
START		→	Start programming
TX-TEST		→	Change to transmitter test
FILTER		→	Activate filter selection
MENU ↓		→	Select submenu FILTER 1
LP 3.4 kHz	STORE	→	Select lowpass filter
MENU ↑		→	Leave submenu
STOP		→	Stop programming

The last key actuation which stops programming resets the CMS to the AUTOEDIT menu. The display then shows the following program sequence:

```
0000:  PROGRAM  0
0001:  DISPLAY:MENU                  01,00
0002:  FREQUENCY:AF:I1                  1000.00 Hz
0003:  LEVEL:AF:I1                       +25000 uV
0004:  DEMODULATION:WEIGHTING        RMS
0005:  FILTER:TXTEST:LP              ON
0006:  COUNT:RF
0007:  POWER:RF
0008:  DEMODULATION
0009:  DISPLAY:MENU                  02,00
0010:
```

Line 5 FILTER:TXTEST:LP ON is additionally included in the program sequence and the program has been renumbered. Lines can be inserted as long as the CMS is set to LEARN mode. The cursor is not shifted in this case but remains on the command line to which it is set.

1.2 Clearing and Shifting of Command Lines

To delete a line in the active program sequence, the cursor must be set to the respective line and softkey 5 DELETE LINE is pressed. The line numbers of the following lines are renumbered accordingly and the cursor remains in the same position, i.e. the next command line.

To clear one or more lines, the cursor is set to the beginning of the lines to be deleted and softkey 6 CUT BUFFER is pressed. Then the cursor is moved to the end of the lines to be deleted and softkey 6 CUT BUFFER is actuated again. The selected characters are then highlighted in inverse display. For moving the cursor the softkeys 11 to 15 and the spinwheel can be used. Maximally 42 lines starting from the start position of the cursor can be deleted at a time. If more lines are selected for deletion, the error message "cut buffer full" appears.

When softkey 6 CUT BUFFER is pressed the first time, CUT BUFFER is highlighted in inverse display to indicate that the delete function is active. Actuation of any other key except softkeys 11 to 15 disables the delete function again.

Pressing softkey 6 the second time resets the softkey labelling to normal display, but softkey 7 INSERT BUFFER is shown in inverse display. At the same time, the selected lines disappear from the program and the command sequence is renumbered.

However, the lines disappeared from the screen are not irrevocably lost but are temporarily stored in a buffer. Only by activating the delete function again, i.e. pressing softkey 6 CUT BUFFER again, these lines are cleared from the program for good.

Intermediate storage can also be used for shifting or copying of command lines. Any lines stored in the buffer can be inserted in one or several positions in the program sequence (except before line 0), which must be marked by cursor before.

In the example program from Section 1.1, the user wishes to copy the lines 1 to 4 into the sequence after line 9 and then delete them again:

GOTO LINE 1 ENTER	→	Mark beginning of lines to be copied
CUT BUFFER	→	Activate buffer
GOTO LINE 5 ENTER	→	Mark end of lines to be copied*
CUT BUFFER	→	Fill buffer and clear lines
INSERT BUFFER	→	Resinsert lines
GOTO LINE 10 ENTER	→	Mark line from where to insert the lines
INSERT BUFFER	→	Insert lines

**** Note: For copying n lines, n lines, but n + 1 line numbers must be marked.***

The complete program thus reads as follows:

```
0000:  PROGRAM  0
0001:  DISPLAY:MENU                01,00
0002:  FREQUENCY:AF:I1                1000.00 Hz
0003:  LEVEL:AF:I1                     +25000 uV
0004:  DEMODULATION:WEIGHTING      RMS
0005:  FILTER:TXTEST:LP            ON
0006:  COUNT:RF
0007:  POWER:RF
0008:  DEMODULATION
0009:  DISPLAY:MENU                02,00
0010:  DISPLAY:MENU                01,00
0011:  FREQUENCY:AF:I1                1000.00 Hz
0012:  LEVEL:AF:I1                     +25000 uV
0013:  DEMODULATION:WEIGHTING      RMS
0014:
```

The selected lines can be inserted in the program at other positions as often as required. The respective position where to add the lines is always marked by the cursor.

Lines 10 to 13 are to be deleted again:

GOTO LINE 10 ENTER	→	Mark beginning of lines to be deleted
CUT BUFFER	→	Activate buffer
GOTO LINE 14 ENTER	→	Mark end of lines to be deleted
CUT BUFFER	→	Fill memory

Lines 10 to 13 are thus removed again from the program and the program is reset to its original sequence.

1.3 Adding Comments in the Program

It may be useful in the course of a program run to supply additional information for the user in the second status line, for instance to switch on the radio transmitter of the mobile phone. Softkey 1 COMMENT in the AUTOEDIT menu gives access to submenu ALPHA (see Fig. 3) for input of additional comments for the program.

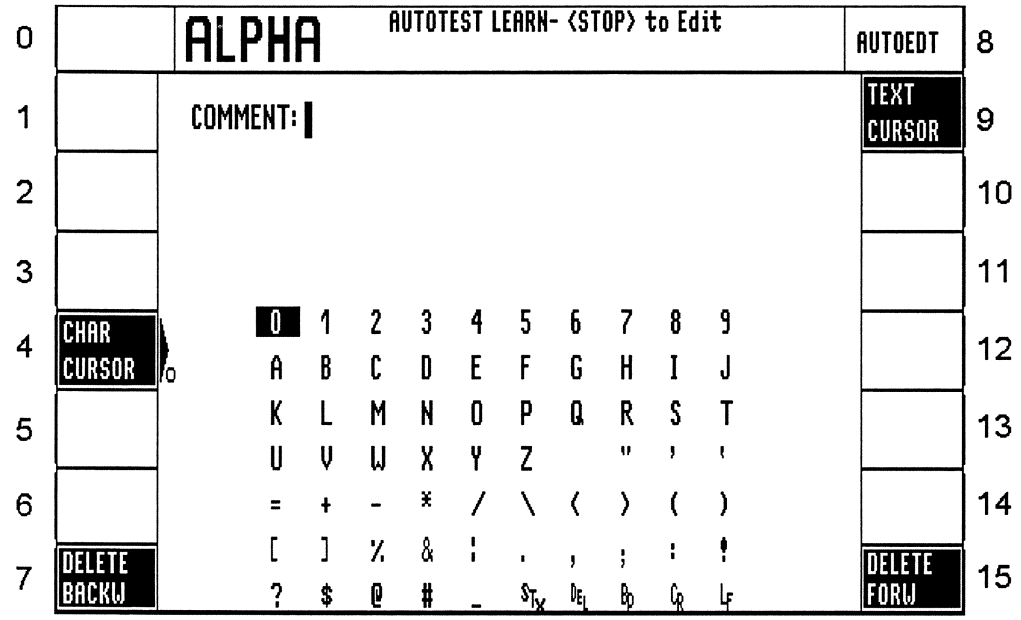


Fig. 3 Submenu ALPHA

For input of characters first the softkey 4 CHAR CURSOR is pressed. The characters required for the comment are selected using the VAR spinwheel and acknowledged by pressing the ENTER key.To modify the entered text (i.e. delete and insert), the softkey 9 TEXT CURSOR is pressed and the TEXT CURSOR (light characters on a dark background) set to the required position using the VAR spinwheel. Then, the letters to the left and the right of the marked location can be deleted by pressing the softkey 7 and softkey 15, respectively. Actuation of CLEAR deletes the complete comment.
To insert a new text in the comment, again as described above the softkey 4 CHAR CURSOR is pressed and the required respective characters are input.

Using the STORE key, the contents of the entered comment line are stored in the program. Also several lines can be stored without leaving the ALPHA menu. Max. 34 characters per line can be entered.

Softkey MENU ↑ or softkey 8 only permit leaving the menu without storing the comment line in the program.

In the example program in Section 1.2, the user wishes to insert the comment "switch on transmitter" before the line 6:

GOTO LINE 6 ENTER	→	Mark the line to be preceded by a comment
COMMENT	→	Access to submenu ALPHA

Select the individual characters of "SWITCH ON TRANSMITTER" using the VAR spinwheel and press the hardkey ENTER after each character to acknowledge entry.

STORE	→	Store the line "SWITCH ON TRANSMITTER"
MENU ↑	→	Return to the AUTOEDIT menu

The program reads as follows:

```
0000:  PROGRAM  0
0001:  DISPLAY:MENU                    01,00
0002:  FREQUENCY:AF:I1                    1000.00 Hz
0003:  LEVEL:AF:I1                         +25000 uV
0004:  DEMODULATION:WEIGHTING          RMS
0005:  FILTER:TXTEST:LP                ON
0006:  ------switch on transmitter-------
0007:  COUNT:RF
0008:  POWER:RF
0009:  DEMODULATION
0010:  DISPLAY:MENU                    02,00
0011:
```

Line 6 reads out the comment "switch on transmitter". Comments are characterized by "--" characters and are always centered. These comments can also be added for better readability of the programs. During the program run they also get displayed in the second status line.

1.4 Delays and Stops in the Active Program Run

For certain measurements, e.g. measurements at mobile phones with compandors, delays must be provided in the program sequence. Also, defined stop pauses are required in the program flow to await user reactions on comments. In this case, the pause is terminated and the program continued again by the user by pressing the hardkey START.

As the Autorun Control operates at high speed, in most cases the user is not always able to clearly follow the sequence. To avoid this, the special function also permits the user to insert defined delays between each individual command line.

The submenu SPEC-1 (see Fig. 4) is reached by pressing softkey 0 (SPEC-1) in the AUTOEDIT menu.

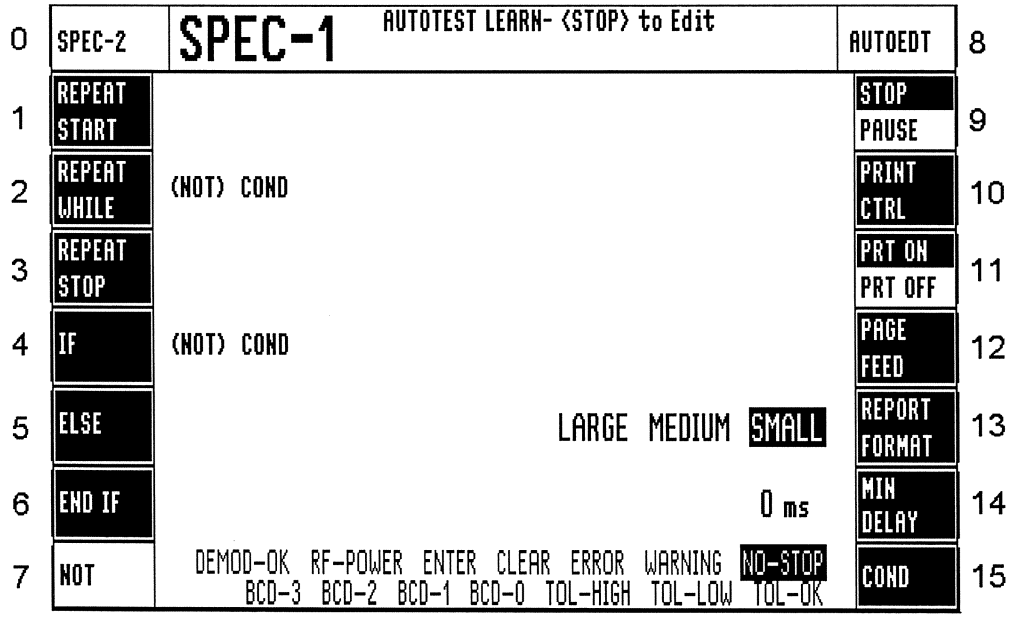


Fig. 4 Submenu SPEC-1

Softkey 9 STOP PAUSE is used to define delays and stops. STOP followed by STORE is entered to set a stop in the program, which is then continued by pressing hardkey START. PAUSE and values between 1 and 10000 followed by STORE serve to effect delays in the program.

Softkey 14 MIN DELAY determines the delays between the execution of the individual commands. Delays of 0 ms (no waiting time) or from 10 ms to 10000 ms can be selected.

No entries are accepted by the CMS during these delays, i.e. the keyboard is disabled.
To return to the AUTOEDIT menu, the softkey 8 AUTOEDT is pressed.

In the program example of Section 1.3, a stop is to be inserted after the comment in line 6. This is to allow the user to selectively continue the program run when the transmitter is switched on. Also, a delay of 100 m is to be defined before the DEMOD measurement in line 9. To allow the user to follow the program, a delay of 500 ms is set between the individual commands.

GOTO LINE 1 ENTER	→	Mark the line from where the delays apply
SPEC-1	→	Access to the SPEC-1 menu
MIN DELAY 500 ENTER STORE	→	Insert delay of 500 ms between the individual commands
AUTOEDT	→	Return to the AUTOEDIT menu
GOTO LINE 8 ENTER	→	Mark the line to be preceded by a stop
SPEC-1	→	Access to the SPEC-1 menu
STOP STORE	→	Insert stop pause
AUTOEDT	→	Return to the AUTOEDIT menu
GOTO LINE 11	→	Mark the line to be preceded by a delay
SPEC-1	→	Access to the SPEC-1 menu
PAUSE 100 ENTER STORE	→	Insert delay of 100 ms
AUTOEDT	→	Return to the AUTOEDIT menu

The program example then reads as follows:

```
0000:  PROGRAM  0
0001:  SPECIAL:MINDELAY                    500
0002:  DISPLAY:MENU                  01,00
0003:  FREQUENCY:AF:I1                  1000.00 Hz
0004:  LEVEL:AF:I1                       +25000 uV
0005:  DEMODULATION:WEIGHTING        RMS
0006:  FILTER:TXTEST:LP              ON
0007:  ------switch on transmitter-------
0008:  SPECIAL:STOP                          0
0009:  COUNT:RF
0010:  POWER:RF
0011:  SPECIAL:PAUSE                   100
0012:  DEMODULATION
0013:  DISPLAY:MENU                  02,00
0014:
```

Each time the CMS returns to the AUTOEDIT menu the command lines are renumbered. However, it is not necessary following each command entered in the SPEC-1 menu to return to the AUTOEDIT menu. As long as commands are entered in the SPEC-1 menu they are inserted in the program sequence in the current cursor position.

1.5 Repetitions of Program Sections

It is often required to have certain program sections repeated in the sequence if the same measurement is to be carried out with different parameters (e.g. frequency response measurements).

Softkeys 1 to 3 in the SPEC-1 menu are available for this purpose (REPEAT START, REPEAT WHILE und REPEAT STOP).

Repetitions of program sections are generally initiated via REPEAT START X or REPEAT WHILE, X being the number of repetitions ranging from 1 to 10000. REPEAT WHILE initiates a repetition of program sections until a pre-defined condition is fulfilled. To terminate the repetition, always the softkey REPEAT STOP is pressed. If no REPEAT STOP is entered, the complete program is fully executed to the end.

Repetitions can be nested to a depth of five. The following is an example for nesting to a depth of two:

```
REPEAT START 100
    further commands
      REPEAT START 10
        further commands
      REPEAT STOP
    further commands
REPEAT STOP
```

The conditions to stop repetitions initiated with REPEAT WHILE can be defined in the SPEC-1 menu via the softkeys 7 NOT and 15 COND. Softkey 15 COND permits to select the condition, softkey 7 NOT can be used to negate the condition if the display of softkey 7 NOT is backlighted. For instance, REPEAT WHILE NOT WARNING means that the program section selected is repeated as long as no warning is given, while REPEAT WHILE WARNING means that the section is repeated as long as warnings are given.

The following conditions can be selected (all conditions are not negated):

DEMOD-OK	Valid value of demodulated signal
RF-POWER	Power available
ENTER	ENTER key was pressed with WAIT FOR KEY
CLEAR	CLEAR key was pressed with WAIT FOR KEY
ERROR	Error messages
WARNING	Warnings
NO-STOP	always fulfilled during program execution
BCD-3	Control line 3 of Control Interface CMS-B5 set to HIGH
BCD-2	Control line 2 of control interface CMS-B5 set to HIGH
BCD-1	Control line 1 of control interface CMS-B5 set to HIGH
BCD-0	Control line 0 of control interface CMS-B5 set to HIGH
TOL-HIGH	Tolerance of measurement value above the set value
TOL-LOW	Tolerance of measurement value below the set value
TOL-OK	Tolerance of measurement value in the set range

REPEAT:WHILE:NO-STOP	opens an endless loop
REPEAT:WHILE:NOT NO-STOP	this loop is executed exactly once

Note: ***If the conditions BCD-0 to BCD-3 are to be used, the lines must be defined as inputs beforehand. For information on the setting of TTL-lines, please refer to that option's manual.***

With the conditions TOL-LOW, TOL-OK and TOL-HIGH, the contents of the loop are executed once in any case, with all other conditions the validity of the condition must be verified before the line REPEAT WHILE.... A loop is to be executed at least once!

In the following sequence, the program example of Section 1.4 is expanded such that by means of a pre-defined repetition the AF frequency response of the transmitter (in dB) is measured until no more RF power is applied to the CMS. To this end, first a repetition block REPEAT WHILE is inserted before line 12 with the condition RF-POWER and terminated again after line 12:

GOTO LINE 12 ENTER	→	Mark the line where to start the repetition block
SPEC-1	→	Access to SPEC-1 menu
COND	→	Actuate until the RF-POWER display is backlighted
NOT RF-POWER	→	Switch on negation to wait for RF power
REPEAT WHILE STORE	→	Insert repetition block
REPEAT STOP	→	Terminate repetition block
NOT	→	Switch off negation
REPEAT WHILE STORE	→	Insert repetition block
AUTOEDT	→	Return to AUTOEDIT menu
GOTO LINE 16 ENTER	→	Mark the line before which to terminate the repetition block
SPEC-1	→	Access to SPEC-1 menu
REPEAT STOP STORE	→	Terminate repetition block

The program now reads as follows:

```
0000:  PROGRAM  0
0001:  DELAY                              500
0002:  DISPLAY:MENU                 01,00
0003:  FREQUENCY:AF:I1                 1000.00 Hz
0004:  LEVEL:AF:I1                      +25000 uV
0005:  DEMODULATION:WEIGHTING       RMS
0006:  FILTER:TXTEST:LP             ON
0007:  ------switch on transmitter-------
0008:  STOP
0009:  COUNT:RF
0010:  POWER:RF
0011:  STOP                               100
0012:  SPECIAL:REPEAT WHILE NOT RF-POWER
0013:  SPECIAL:REPEAT STOP
0014:  SPECIAL:REPEAT WHILE RF-POWER
0015:  DEMODULATION
0016:  REPEAT STOP
0017:  DISPLAY:MENU                 02,00
0018:
```

With the repetition block inserted in program lines 12 to 14, the demodulated signal is then measured until no more RF power is applied to the CMS.

As a next step, the user wishes to measure the frequency response of the demodulated signal of 11 measurement values, starting from 500 Hz in steps of 250 Hz. The reference is 1 kHz.

GOTO LINE 15 ENTER	→	Mark the line where to insert
START	→	Start programming
TX-TEST		
AF1 1000 Hz STORE	→	Frequency of reference measurement
DEMOD STORE	→	Select DEMOD measurement
SHIFT REF ENTER STORE	→	Measured value set as reference
AF1 250 Hz STORE	→	Frequency of modulation generator set to 250 Hz
VAR 250 Hz STORE	→	Select 250 Hz-increment
DEMOD STORE	→	Select DEMOD measurement
STOP	→	Leave LEARN mode
GOTO LINE 19 ENTER	→	Mark the line to be preceded by the repetition block
SPEC-1	→	Access to SPEC-1 menu
REPEAT START 11 ENTER STORE	→	Insert repetition block with 11 repetitions
AUTOEDT	→	Return to AUTOEDIT menu
GOTO LINE 22 ENTER	→	Mark the line where to end the repetition block
SPEC-1	→	Access to SPEC-1 menu
REPEAT STOP	→	End repetition block
AUTOEDT	→	Return to AUTOEDIT menu

The program thus reads as follows:

```
0000:  PROGRAM  0
0001:  DELAY                                500
0002:  DISPLAY:MENU                  01,00
0003:  FREQUENCY:AF:I1                  1000.00 Hz
0004:  LEVEL:AF:I1                       +25000 uV
0005:  DEMODULATION:WEIGHTING        RMS
0006:  FILTER:TXTEST:LP              ON
0007:  ------switch on transmitter-------
0008:  STOP
0009:  COUNT:RF
0010:  POWER:RF
0011:  PAUSE                                100
0012:  SPECIAL:REPEAT WHILE NOT RF-POWER
0013:  SPECIAL:REPEAT STOP
0014:  SPECIAL:REPEAT WHILE RF-POWER
0015:  FREQUENCY:AF:I1                  1000.00 Hz
0016:  DEMODULATION
0017:  DEMODULATION:REFERENCE
0018:  FREQUENCY:AF:I1                      250 Hz
0019:  SPECIAL:REPEAT START 11
0020:  FREQUENCY:AF:I1:VARIATION            250 Hz
0021:  DEMODULATION
0022:  SPECIAL:REPEAT STOP
0023:  SPECIAL:REPEAT STOP
0024:  DISPLAY:MENU                  02,00
0025:
```

The repetition block for frequency response measurement starts from line 15. The start value of 500 Hz results from the AF generator setting plus one increment. The increment must be in the repetition block as the value is increased with each repetition.

1.6 Conditional Statements in the Program

Conditional statements with branching can be incorporated in the program using the function IF-ELSE-END IF. The softkeys 4 to 6 (IF, ELSE, END IF) in the SPEC-1 menu give access to this function.

As a rule, a conditional statement is initiated with the IF condition (with the same conditions valid as in Section 1.5) and terminated by END IF. The command ELSE can be set between these two commands, which is executed if the condition is not fulfilled.

```
IF RF-POWER
 Commands a
ELSE
 Commands b
ENDIF
```

In this example, the commands a are executed if RF power is applied and the commands b if no RF power is present. Nesting to a maximal depth of two is permissible.

Repetition blocks and conditional statements can be interleaved in the program. However, they cannot be freely nested at will:

Permissible examples:

```
IF condition 1
   REPEAT START X
      further commands
   REPEAT STOP
ELSE
   REPEAT WHILE NOT condition 2
      further commands
   REPEAT STOP
END IF
```

```
REPEAT START X
   IF condition
      further commands
   ELSE
      further commands
   END IF
REPEAT STOP
```

Illegal examples are:

```
REPEAT WHILE condition 1
   IF condition 2
      further commands
REPEAT STOP
   ELSE
      further commands
   END IF
```

Repetition blocks and conditional statements must also be completed.

1.6.1 Conditional Execution of Program Sections

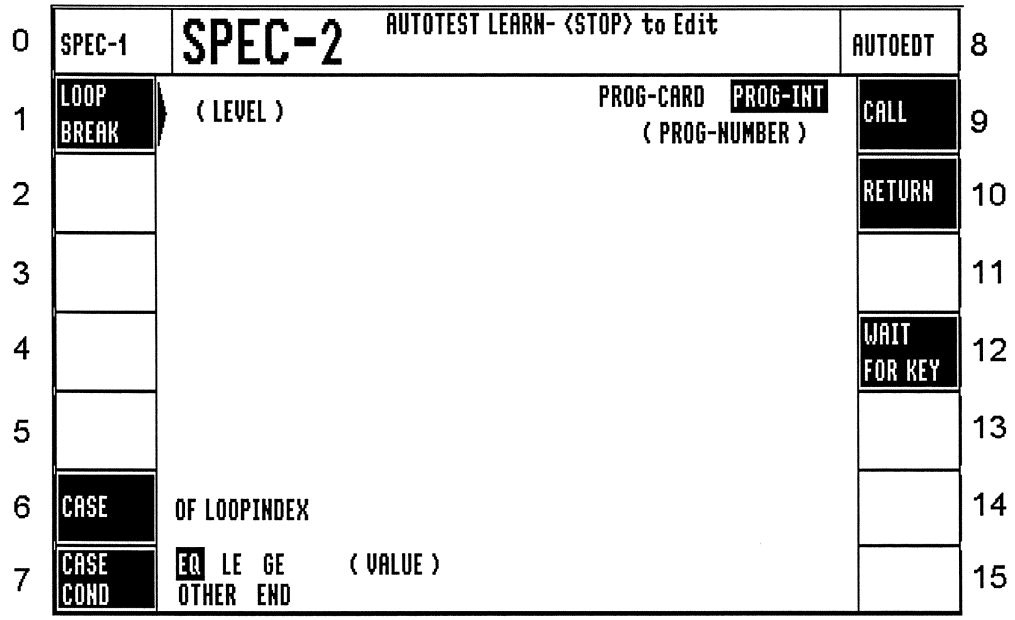


Fig. 5 Submenu SPEC-2

The menu SPEC-2 offers extended possibilities of program generation:

Conditional execution of program sections (depending on the loop counter):

In order to be able to perform different settings when a loop is executed repeatedly, softkey 6 and softkey 7 permit to use a case differentiation of the following type:

REPEAT:START or REPEAT:WHILE Beginning of loop

The commands are always executed in this case.

CASE:OF:LOOP Beginning of case differentiation
CASE:COND EQ 3

The commands are only executed in loop 3.

CASE:COND EQ 7

The commands are only executed in loop 7.

CASE:COND OTHER

The commands are executed in all runs except for loop 3 and 7.

CASE:COND END End of case differentiation

The commands are always executed.

REPEAT:STOP End of loop

After starting a case differentiation, an appropriate case specification is searched for in the following commands until the end of the case differentiation (CASE:COND:END or end of program), i.e. the command CASE:OF:LOOP (softkey 6) must always be followed by a CASE:COND command (softkey 7) in the next line.

If the condition of a CASE:COND line is fulfilled, the following commands are executed.

The subsequent CASE:COND command (independent of a condition) or the program end terminate the command execution.

Possible case specifications:

EQ	number	loop index = number
LE	number	loop index ≤ number
GE	number	loop index ≥ number
OTHER		any loop index unequal to the ones used with EQ, LE or GE!
END		end of case differentiation

Waiting for user entry

If a program run is to depend on decisions of the user, softkey 12 (WAIT FOR KEY) can be used to determine that a user entry is waited for.

During the program run, the user is requested at this place to make an entry, which sets the conditions ENTER and CLEAR as follows:

User entry	Condition	
	ENTER	CLEAR
ENTER	true	false
CLEAR	false	true
Any other key	false	true

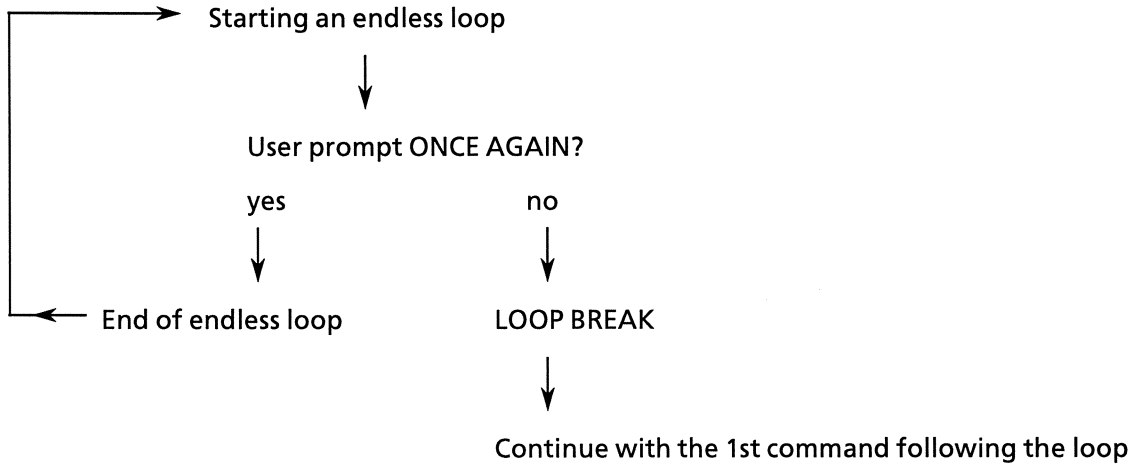
The conditions ENTER and CLEAR can be read out in conditional loops and in IF conditions.

Aborting a loop (softkey 1 : LOOP BREAK)

The LOOP BREAK command allows loop-execution (endless loops or a loop with a high repetition number) to be terminated prematurely when the desired result is obtained.

Normally, the current loop is concerned; however, several nested loops can also be terminated by indicating the appropriate number.

Example:



Calling up programs by other programs

Softkey 9 (CALL) can be used to insert a program call (internal or from memory card) into another program.

When syntax testing, a check is made to see whether the program to be called is available; otherwise, a warning is generated. The program generation itself, however, can be terminated by changing to the AUTOTEST menu.

During the program run, the execution is continued with the first command of the program indicated. A return to the calling program is possible with a RETURN command or at the end of the called program.

Softkey 10 (RETURN) can be used to return to the calling program prematurely. During the program run, the execution is continued with the next command of the calling program after the call. If there is no calling program, the program execution is terminated as with a program end.

1.7 Printer Control during the Program Run

A printer connected to the CMS to give out test reports can be directly controlled from the program sequence. Softkeys 10 to 13 (PRINT CTRL, PRINT ON, PRINT OFF, PAGE FEED, REPORT FORMAT) in the SPEC-1 menu are used for this purpose.

With softkey 10 PRINT CTRL, control characters can be sent to the printer which are normally not included in the printouts but effect switchover of printer functions, e.g. switching on or off of the underline function.

These control characters can be entered only in the HEX code. Maximally 10 characters per command line are permissible.

The control characters are entered via the keypad (0 to 9 and A to F) and each entry is completed by pressing hardkey STORE.

The printer can be switched on or off during the program run using the softkey 11 (PRINT ON, PRINT OFF). Again, these commands are acknowledged by pressing hardkey STORE.

Softkey 12 is used to effect form feed.

The softkey function 13 REPORT FORMAT can be used to select the format of the printout (SMALL, MEDIUM or LARGE) during the program run (see Section 1.7.2).

Note: ***Softkey 5 REPORT TARGET has highest priority in the AUTORUN menu. If the target for the report is set to OFF, all the printer controls in the program are disabled.***

Example: The printer is to be initialized at the beginning of a sequential program (CMS in AUTOEDIT menu (command sequence for this printer HEX: 1B 40), the protocol format be set to LARGE and the printer then be switched on. Following further commands, i.e. measurements, the report is to be generated:

SPEC-1	→	Access to the SPEC-1 menu
PRINT CTRL 1 B 4 0 STORE	→	HEX code for initialization
PAUSE 1000 STORE	→	Insert delay before new commands can be sent to the printer
REPORT FORMAT	→	Press softkey until LARGE display is backlighted
STORE	→	Store function
PRINT ON STORE	→	Switch on printer
AUTOEDT	→	Return to AUTOEDIT menu

The following command lines are displayed:

0006 previous command
0007 PRINT CTRL 1B 40
0008 PAUSE 1000
0009 REPORT FORMAT LARGE
0010 PRINT ON
0011 further commands

If the function PRINTER or MEMCARD is selected in the AUTORUN menu using softkey 5 REPORT TARGET, a report header information is generated at each program start and the subsequent program lines are printed out until PRINT OFF is set.

1.7.1 Printing of Reports

All the parameters measured during the program run can be given out to a printer in form of reports or be stored on a memory card. Test reports are printed out in the following form:

```
REPORT:  26      PROGRAM:  03     20-APR-89 09:24     USER: XXXXXX
DEVICE under TEST IDENTIFICATION:.............................
_____________________________________________________________________
NO         COMMAND          PARAMETER          RESULT          TOL

0001 -------------------TRANSMITTER TEST----------------------
0002 LEVEL:RF               0.1 mV
0003 DEMODULATION                              2.75 kHz         OK
0004 DEMODULATION                              4.45           FAULT
0005 SINAD                  20 dB             20.1 dB
---> RF LEVEL                                 0.5 uV
0006 LEVEL:RF               ::1MV

9999 TOTAL TOLERANCE                                          FAULT
```

Explanations:

NO:	Line number of active program
COMMAND:	IEC bus format of command
PARAMETER:	Preset parameter settings
RESULT:	Measurement results as specified in the display. In the case of two measurement results (SINAD search routine), the second value is indicated in a subsequent line (marked by →).
TOL:	Tolerance evaluations are listed in the report only for those commands which are immediately followed by +TOL and/or -TOL. OK means no violation of the tolerance range, FAULT means that the tolerance limit is exceeded.
::	In the case of setting values, which are stated only in the course of the active program sequence, the entered value is documented after :: .
Report header:	(see Section 2.1.1).

If the program data in the report include tolerance evaluations, the individual tolerance evaluations are automatically summed up at the end of the report, i.e. the section TOTAL TOLERANCE lists if no (OK) or at least one tolerance violation (FAULT) has occurred during the program run.

1.7.2 Report Formats

The format of the report can be defined by the user before starting the program sequence or from the active program using REPORT FORMAT LARGE, REPORT FORMAT MEDIUM or REPORT FORMAT SMALL. If the program sequence is already started, the user can no longer manually modify the format from the active program. It is neither possible to modify the format of already executed reports.

Three report formats are available:

REPORT FORMAT LARGE: Complete logout of program data, i.e. all commands, comments and measurements are documented.

REPORT FORMAT MEDIUM: Commands pertaining to the autorun control (e.g. changing of menus) and all settings are suppressed. However, setting values which are stated only in the course of the program run are included in the report.

REPORT FORMAT SMALL: Only measurement data are reported.

2 Execution of Programs

A program generated in the AUTOEDIT menu can be started from the AUTORUN menu. To access the AUTORUN menu, the softkey 3 AUTORUN is pressed in the AUTOEDIT menu.

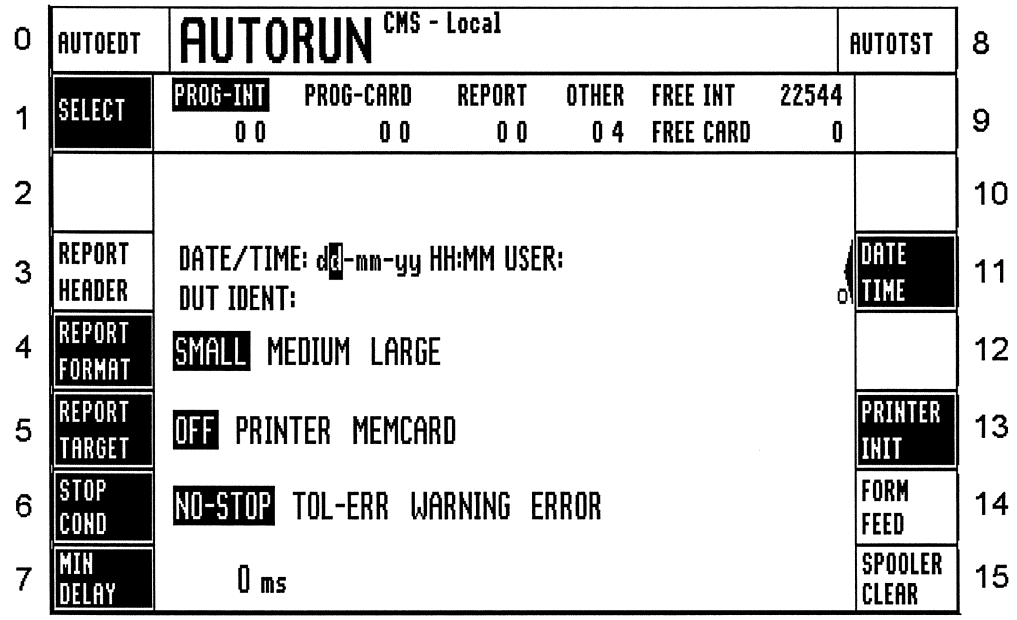


Fig. 6 Submenu AUTORUN

This menu permits to set or modify the parameters required for the program execution. The program execution is started via hardkey START. This can be done in any menu. The currently selected program is started. Moreover, internal programs can be started from any menu by the combination of <START>, program number, <ENTER>.

Once the program sequence is started, the CMS is in AUTOTEST RUN mode. The first status line reads out the message AUTOTEST RUN - HOLD by <STOP>.

In this mode, the CMS executes all the commands stored in the active program in the sequence as entered.

2.1 Parameters for Program Execution

It is possible before starting the program run to set some parameters which are not yet determined in the actual program setup (cf. Sections 2.1.1 to 2.1.8). Other functions such as COPY additionally require the desired program/report number to be entered directly above the number field.

Information on the selected programs and reports is read out in the two lines between softkeys 1 and 9.

In the CMS the following data types in short-form are available in these two lines:

PROG-INT: CMS-internal programs

PROG-CARD: programs on memory card

REPORT: reports on memory card

OTHER: stored instrument states (=PANEL) and other data types on memory card

The left-hand number below each data type indicates the memory occupied by the data type (in characters), the right-hand number specifies the number of the currently selected program/report.

To the right of the abbreviations

FREE INT: internal program memory,
FREE CARD: memory card,

the size of the available (free) memory is indicated.

2.1.1 Report Header

Each report contains a report header at the beginning, which specifies the current date, the user and a DUT identification. On actuation of softkey 3 REPORT HEADER, the menu REPORT (similar to the ALPHA menu) is automatically called up and the user can enter the respective data as described in Section 1.3. To leave the REPORT menu again, the hardkey MENU ↑ is pressed.

In addition, also not the following:
A text can be entered in the fields USER or DUT IDENT or an already existing text be modified by pressing the softkey 9 TEXT CURSOR, if required several times. The field DATE/TIME is selected by pressing softkey 1 DATE/TIME.
In the field DATE/TIME, each numeric value of the date section can be directly set (i.e. incremented or decremented) using the VAR spinwheel. The individual numeric values are selected by pressing the softkey 1 DATE/TIME several times. The softkeys 7, 15 and ENTER have no functions in this case, CLEAR initializes the field.

2.1.2 Report Formats

Softkey 4 REPORT FORMAT is used to select one of the report formats, LARGE, MEDIUM or SMALL (cf. Section 1.7.2). If a format has been selected during program generation, the pre-set format is modified in the program irrespective of the setting of softkey 4 from the position where such a command has been inserted in the active program.

2.1.3 Target Address of Report

Softkey 5 REPORT TARGET selects the target address of the test report, i.e. PRINTER or memory card MEMCARD, or no report (OFF).

In the OFF setting, any printer control commands entered in the program are disabled (cf. Section 1.7).

2.1.4 STOP Conditions

Softkey 6 STOP COND permits to select one of the following conditions: NO STOP, stop in the case of violations of the tolerance range (TOL ERR), stop with warnings (WARNING) or stop of the program with error messages (ERROR).

Irrespective of the setting of softkey 6, any stops entered in the program as commands are executed (cf. Section 1.4).

2.1.5 Delays in the Program

Softkey 7 MIN DELAY has the same function as softkey 14 in the SPEC-1 menu (cf. section 1.4).

The delay set is valid until it is overwritten by a MIN DELAY command stored in the program.

2.1.6 Initialization of the Printer

Softkey 13 PRINTER INIT is used to enter the command sequence for initialization of the connected printer. The characters are entered in the HEX code via the keypad (0 to 9 and A to F). The initialization itself is started using hardkey ENTER.

2.1.7 Form Feed of the Printer

Softkey 14 FORM FEED is used to effect a form feed of the printer, which sets the print head to the next page to the beginning of the first line.

This function is above all useful to coordinate the line counter of the CMS with the connected printer.

2.1.8 Clearing of the Printer Buffer (SPOOLER CLEAR)

All the characters for printout are stored in a buffer (SPOOLER). During printing, these characters are read from the buffer in the sequence as stored. This offers the advantage that no delays are required for printing and that printing is carried out in background mode, i.e. the CMS is immediately ready for user operation again.

To abort printing, the buffer must be cleared using softkey 15 SPOOLER CLEAR.

2.2 Program Suspensions

The active program can be stopped by pressing hardkey STOP, as a result of programmed stops or by one of the stop conditions STOP COND. The first status line displays the message AUTO HOLD - <START><STOP><RETURN>.

The display then shows the menu which was valid before the active program was started, or the menu called up by programming. The CMS is ready for entries of settings, which, however, are not transferred to the program, but still define the setting of the CMS hardware unless modified during further program execution.

To leave the HOLD mode and restart the program, the hardkey START is pressed. The program is continued exactly where it was interrupted.

When hardkey STOP is pressed again, the CMS leaves the AUTOTEST mode and is switched to manual operation in the currently displayed menu.

When hardkey RETURN is pressed in the HOLD mode, the CMS accesses the AUTORUN menu and the report number is incremented by one. This means that the report number must not always be entered before program start. The program can again be executed using hardkey START.

If the user accesses the submenu AUTOEDIT from the AUTORUN menu via the AUTOTEST menu, the first 14 lines of the program are not displayed as is normally the case but the cursor marks the first command in the program sequence that was not yet executed. If the program has been completely executed, the cursor marks the first free line of the program. However, in the case of error it is easier for the user to verify the cause of error if the program is not completely executed.

3 Management of Programs and Test Reports

All the functions required for the management of program and test reports (loading, saving, printing and display) are accessible from the AUTOTEST menu (see Fig. 1). Maximally 100 programs can be stored in the CMS, additional programs must be loaded via memory cards where they are stored.

3.1 Dealing with Programs and Reports from Memory Card

Softkey 1 SELECT in the AUTOTEST menu allows to select a program or a report to be dealt with. The program or report is selected by entering the respective number. Loading is effected by pressing softkey 5 COPY <-MEMCARD.

It is possible only to load programs from the memory card into the CMS, typing or printing of files is possible without loading them into CMS, however.

3.2 Linking of Programs

Several individual programs can be linked to one program. First one program is loaded and the memory card program to be appended selected using softkey 1. Both programs are linked together by means of the softkey function 7 (APPND <-MEMCARD).

3.3 Storing of Programs and Reports

Programs generated in the CMS can be stored on the memory card using softkey 6 COPY -> MEMCARD. For this purpose, first both program numbers must be entered via softkey 1. If a program with the same number already exists on the memory card, the message "DELETE EXISTING PROGRAM?" is given out. Pressing the ENTER key overwrites the already existing program, CLEAR is used for aborting. The same applies if, after a START command is issued, a particular report number is already in use.

3.4 Display of Directory

The programs available in the CMS as well as the programs and test reports stored on the memory card can be displayed via softkey 2 DIR. Via softkey 1 SELECT, the user needs to select if programs in the CMS or on memory card are to be displayed. The same applies for data types REPORT and OTHER, however these are only available on memory card.

The display reads out the number and the first line of the programs. Therefore, when generating a program a comment should always be inserted in the first program line to identify the program.

With reports, the report number and the DUT identification should always be specified (cf. Section 2.1.1).

If more programs or test reports are available than can be displayed, the softkeys 14 PAGE UP and 15 PAGE DOWN are provided to call up the other programs or reports.

3.5 Display and Printing of Programs or Reports

If a program or report is selected by softkey 1, softkey 4 TYPE can be pressed to have its contents displayed. Paging through the contents is possible by means of softkeys 14 PAGE UP and 15 PAGE DOWN.

Using softkey 3 PRINT, the selected program or report can be printed out on a printer connected to the CMS.

3.6 Clearing of Programs and Reports

Programs and reports can be cleared from the memory card or CMS using softkey 10 DELETE. First the program or report to be deleted is selected via softkey 1. Before the program or report is deleted, the user is prompted by "ARE YOU SURE ?". ENTER acknowledges deletion, CLEAR is pressed for aborting.

The entire contents saved on the memory card or all the programs in the CMS can be cleared by means of softkey 11 FORMAT. Again, softkey 1 is used for selecting. The user is prompted again by "ARE YOU SURE ?", which is acknowledged by ENTER or aborted by CLEAR.

3.7 Password protection of programs

On entering the AUTOTEST menu, softkey 12 (PASSWD PROTECT) is either set active (inverted) or toggled off (white background), depending on the state of the toggle SELECT (softkey 1). Since programs may be protected only, softkey 12 will always show protection to be inactive if softkey 1 does not select a program. Deletion of existing reports only happens after an appropriate runtime prompt issued through stateline 2. Protection of programs works in the following pattern:

User action	**CMS response in stateline 2**
a) Select PROG-INT or PROG-CARD	- none -
b) Engage softkey 12	"Please enter password"
c) Value between 1 and 60000 & ENTER	"To verify, please re-enter password"
d) Retype chosen value & ENTER	"Programs now password-protected"
e) - Softkey 12 is in active state -	

Removal of password protection works in similar fashion:

a) Select PROG-INT or PROG-CARD	- none -
b) Engage softkey 12	"Please enter password"
c) Value between 1 and 60000 & ENTER	"Programs now unprotected"
d) - Softkey 12 is toggled inactive -	

An important difference between internal and memory-card protection is that the whole of the memory-card program space is protected through softkey 12, i.e. no transfer of programs to memory-card is possible while protection is active, even if the chosen program number is not in use. With internal protection, new programs may be added despite softkey PASSWD PROTECT being active; however, these new programs will automatically be password-protected the moment they are completely written to CMS internal memory. Password-protection, if set active, affects the commands assigned to softkeys 5, 6, 7, 10 and 11, which is every action that modifies internal programs or writes to memory-card program space respectively.

ROHDE&SCHWARZ

Test and
Measurement Division

VOR/ILS-GENERATOR
(only CMS 57)

Printed in the Federal
Republic of Germany

CERTIFICATE OF TRACEABILITY

The

ROHDE & SCHWARZ Service Monitor
with integrated
VOR/ILS Generator
CMS57
Identity No. 0840.0009.57

has been manufactured and tested at ROHDE & SCHWARZ, MESSGERÄTEBAU GMBH in Memmingen.

The measuring equipment used for pre and final test is calibrated according to ROHDE & SCHWARZ standards.

The accuracy of the measuring equipment is derived from officially recognized standards at PTB (Physikalisch Teschnische Bundesanstalt) or equivalent organizations like DKD (German Calibration Service) or NIST (National Institute of Standards and Technology).

The calibration as well as the procedure for monitoring the accuracy and the traceability of the standards applied correspond to Mil-Std. 45662 and AQAP 6.

The measured values were found to lie within the limits of the equipment specifications.

ROHDE & SCHWARZ
MESSGERÄTEBAU GMBH

i.V. Bechteler

i.A. Baldermann

Supplement to R&S CMS Model 57 Operating Manual

Section 6.2.2: AM Modulation and AM Distortion

Connect the modulation analyzer to the RF IN/OUT socket.

VOR:
-9 dBm (with option CMS-B32: -12 dBm); 113.0 MHz
Switch on the tones 30 Hz VAR, 9960 Hz CARRIER and 1020 Hz AUX separately.
Measure the AM modulation and the AM distortion.

ILS-LOC:
-9 dBm (with option CMS-B32: -12 dBm); 110.1 MHz
Switch on the tones 90 Hz, 150 Hz and 1020 Hz AUX separately.
Measure the AM modulation and the AM distortion.

ILS-GS:
-9 dBm (with option CMS-B32: -12 dBm); 332.0 MHz
Switch on the tones 90 Hz, 150 Hz and 1020 Hz AUX separately.
Measure the AM modulation and the AM distortion.

The AM modulation of the VOR and ILS signals must not deviate from nominal values by more than 2 % or 3 %, respectively. The AM distortion must not exceed 2 %.

MB:
-9 dBm (with option CMS-B32: -12 dBm); 70.0 MHz
Switch on the tones 400 Hz, 1300 Hz and 3000 Hz separately. Measure the AM modulation.

The AM modulation must not deviate from the nominal value by more than 5 %.

Section 6.2.3: VOR Phase

VOR AF Phase

- Connect the VOR phase meter to the MOD GEN socket.
- AF REF = 990 mV; MOD FM = 480 Hz
- Switch on the tones 30 Hz VAR and 9960 Hz FM simultaneously.
- Measure the phase at 0 °.
- The deviation must not exceed 0.04 °.

VOR RF Phase

- Connect the VOR phase meter to the RF IN/OUT socket.
- RF LEV = -9 dBm (with option CMS-B32: -12 dBm); SET RF = 108 MHz; PHASE = 0 °
- Switch on the tones 30 Hz VAR and 9960 Hz FM simultaneously.
- Measure the phase at 0 °.
- The deviation must not exceed 0.05 °.

Contents

Page

1 Information on Air Navigation

1.1 Determination of Position Using VOR

The VOR (=VHF Omnidirectional Radio Range) is an omnidirectional beacon in the VHF range enabling the pilot of an aircraft to determine its position in the air. This is achieved by VOR ground stations sited at defined co-ordinates, emitting the same RF carrier via two different antennas. One of the antennas radiates in all directions, the second one emits a rotating beam. This antenna rotates at 30 revolutions per second, thus leading to an amplitude modulation of 30 Hz with the transceiver aboard the aircraft. The same RF carrier is transmitted via the omnidirectional antenna, but it is amplitude-modulated with the frequency 9960 Hz. This subcarrier is again frequency-modulated with a 30-Hz reference signal. Since the phasing of the rotating amplitude-modulated signal depends on the direction it can be used for determining the position of the aircraft. The frequency-modulated 30-Hz signal is referred to as reference phase. The reference signal and the rotating beam are synchronized such that a receiving instrument, which is located in magnetic north direction to the transmitter, receives both with a phase offset of 0° (cf. fig. 1). If, e.g., the position of the aircraft is 90° to the VOR transmitter base, the amplitude-modulated 30-Hz signal is received with a phase offset of 90° to the reference signal.

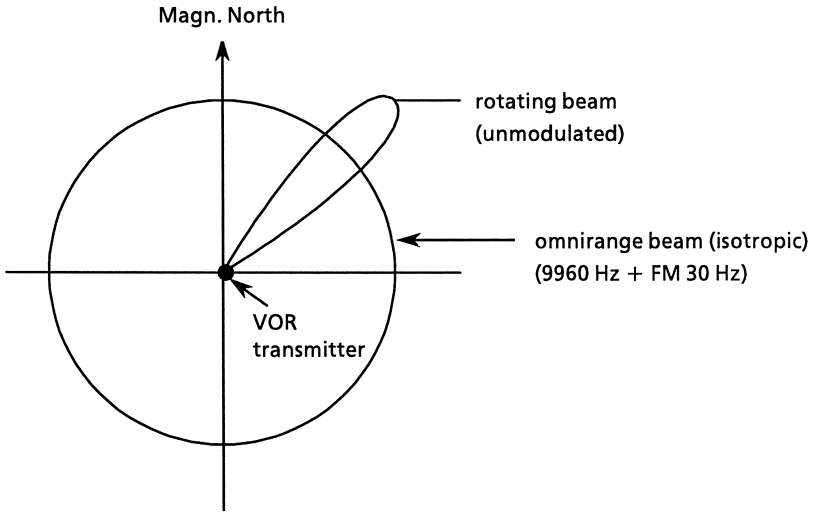


Fig. 1 VOR function principle

1.2 Landing Approach with ILS

The ILS (=Instrument Landing System) is a radio landing system, which allows for an approaching aircraft to be lead in the right angle until touchdown. The ILS consists of two function units. The localizer determines the vertical approach angle whereas the glide slope determines the horizontal angle to the touchdown point. The ILS ground transmitter emits four lobe-shaped beams in the direction of the approach line. The two lobes of the localizer are arranged in parallel, i.e. one on the right and one on the left side, those of the glide slope in vertical order, i.e. as an upper and a lower lobe. The antennas each emit amplitude-modulated RF carriers. The carrier frequencies are different for the glide slope and the localizer (cf. fig. 2).

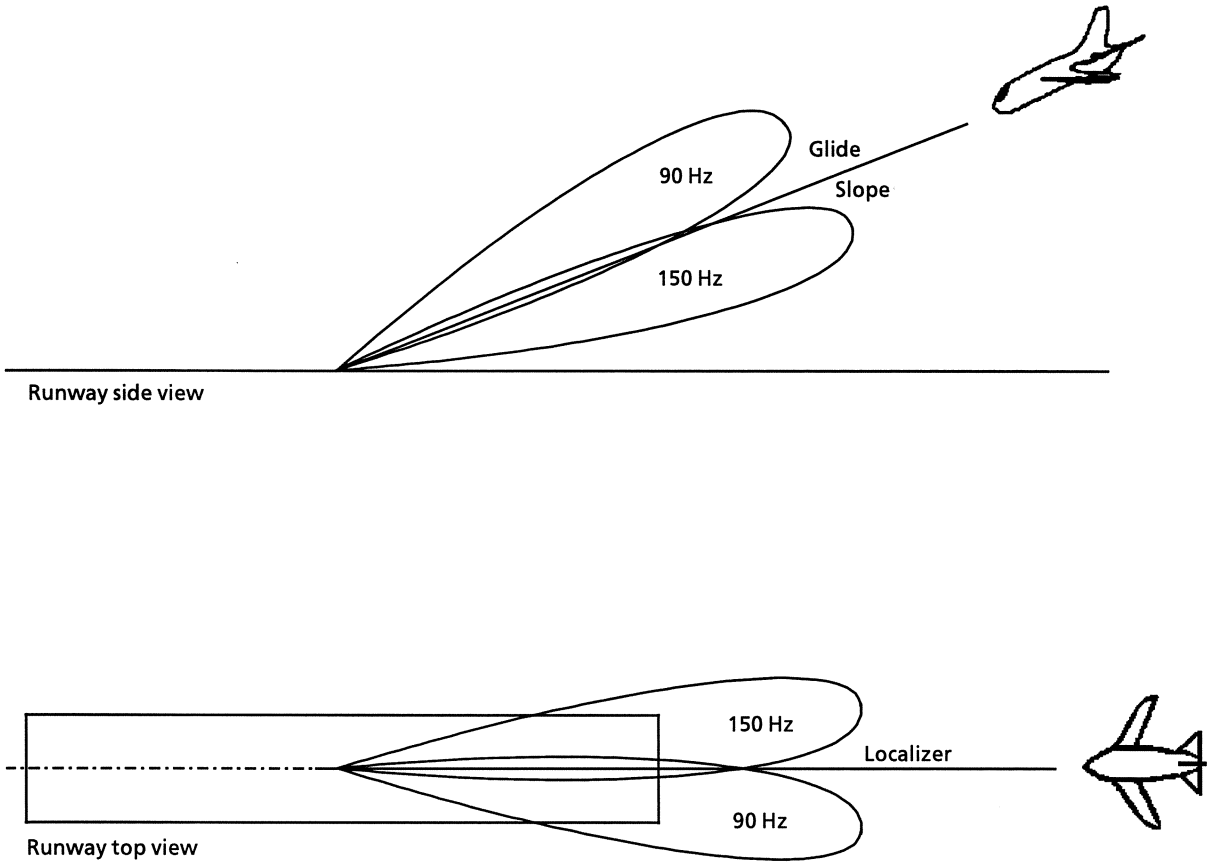


Fig. 2 ILS function principle

1.2.1 Localizer

Looking into approach direction, the left antenna of the localizer emits an RF carrier modulated with 90 Hz, the right one an RF carrier modulated with 150 Hz with a modulation depth of 20 % each. Both radiation fields slightly overlap. The points where both fields can be received with the same strength form a level which corresponds to the correct vertical approach angle. Since the 90-Hz tone and the 150-Hz tone use the same carrier, a different field strength on the receiver causes a different modulation of both tones. The ILS receiver aboard the plane measures and displays the difference of both modulation depths in DDM (= Difference in Depth of Modulation). DDM = 0 thus means that the aircraft is positioned in the right approach angle to the runway.

1.2.2 Glide Slope

The function principle of the glide slope corresponds to that of the localizer. However, the two radiation patterns are arranged in vertical order such that the points of the same field strength form a level which corresponds to the correct glide angle. The lower antenna of the glide slope emits an RF carrier modulated with 150 Hz, the upper one emits an RF carrier modulated with 90 Hz, the modulation depth being 40 % each.

1.3 Marker Beacon

The marker beacon is an RF transmitter within the 75-MHz band located in the approach line to the runway. Its directional antennas radiate the RF power vertically upward. Thus, the receiver aboard the aircraft receives and displays a signal only when flying over the marker beacon. Up to three markers are situated one after the other in the approach lane. The RF carrier of each marker beacon is amplitude-modulated with a different AF frequency.

Outer	Marker	(OM)	=	400 Hz
Middle	Marker	(MM)	=	1300 Hz
Inner	Marker	(IM)	=	3000 Hz

The receiver is enabled to indicate, which marker the aircraft is just passing by means of selection of the individual tones.

2 Application of the Signal Generators

The CMS signal generators for VOR, ILS glide slope, ILS localizer and marker beacon allow for generating the same signals which are transmitted by a VOR/ILS ground station. They are provided at the RF IN/OUT connector and can thus be directly fed to the antenna connector of the VOR/ILS receiver. Optionally, an AF signal can be generated at the MOD GEN output in order to modulate an external RF synthesizer. In addition to the signal generator the CMS provides the measuring functions SCOPE and AF voltmeter.

3 Function Principle of the Signal Generators

3.1 Function Principle of the VOR Signal Generator

The VOR signal generator consists of three AF generators. The first one generates a 30-Hz signal which is varied in phase on the one hand by means of a phase shifter and which is on the other hand frequency-modulated with its fixed phase to the signal of the second generator (9960 Hz), serving as subcarrier. The third generator provides a so-called auxiliary tone of 1020 Hz. All frequencies of the AF generators are default values, which can be varied for test purposes. The amplitudes of the subcarrier, the auxiliary tone and the 30-Hz signal with the variable phase can now be individually attenuated. The three signals are then added up via an adder and either applied to the AF connector MOD GEN via a variable amplifier or modulated to a variable RF carrier by means of an amplitude modulator. The RF signal which can be varied in level over a wide range is output at the RF IN/OUT connector.

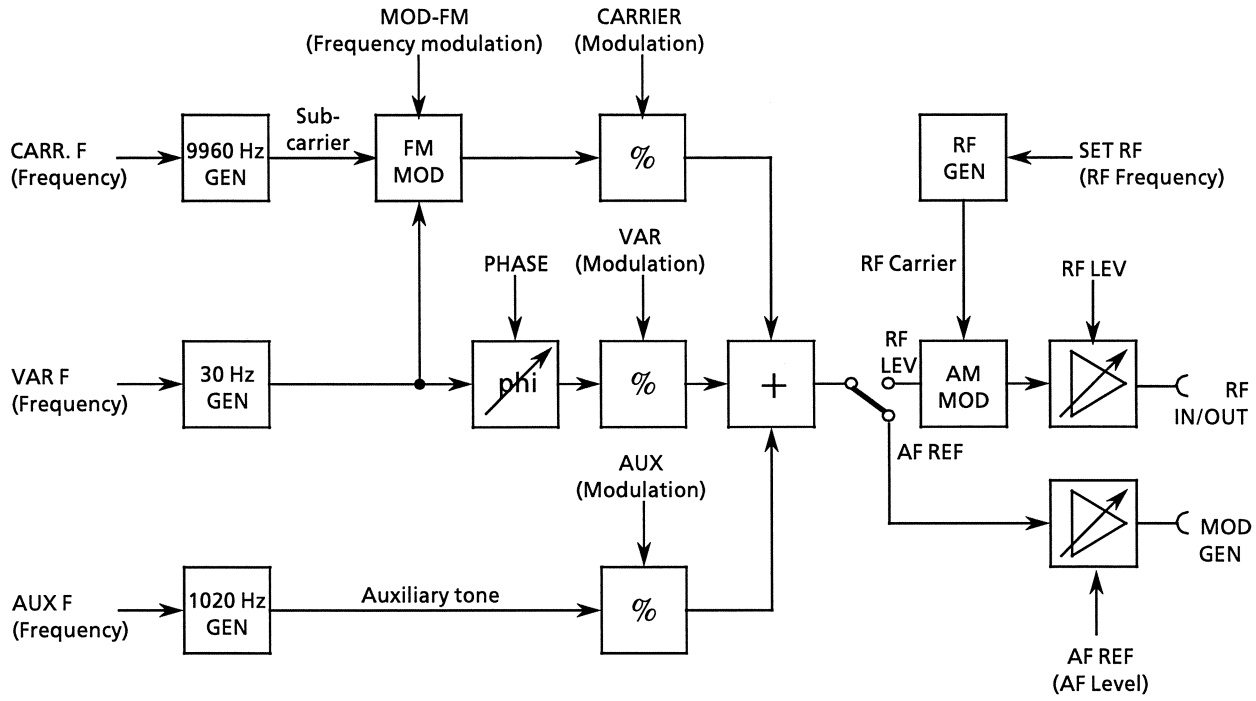


Fig. 3 Block Diagram "VOR Signal Generator"

3.2 Function Principle of the ILS Signal Generator

The ILS signal generator consists of three AF generators. The first two generators supply the 90-Hz signal and the 150-Hz signal. The frequency ratio is 3/5 with the generators being phase-locked. The user can set a phase offset of 0° to 100° relating to the 150-Hz signal. The third generator generates a auxiliary tone of 1020 Hz. All frequencies of the AF generators are default values which can be varied for test purposes. The amplitudes of the 90-Hz tone and the 150-Hz tone as well as that of the auxiliary tone can now be individually attenuated. The three signals are then added and either applied to the AF connector MOD GEN via a variable amplifier or modulated to a variable RF carrier by means of an amplitude modulator. The RF signal which can be varied in level over a wide range is output at the RF IN/OUT connector (cf. fig. 4). This generator is used for glide slope and localizer operation.

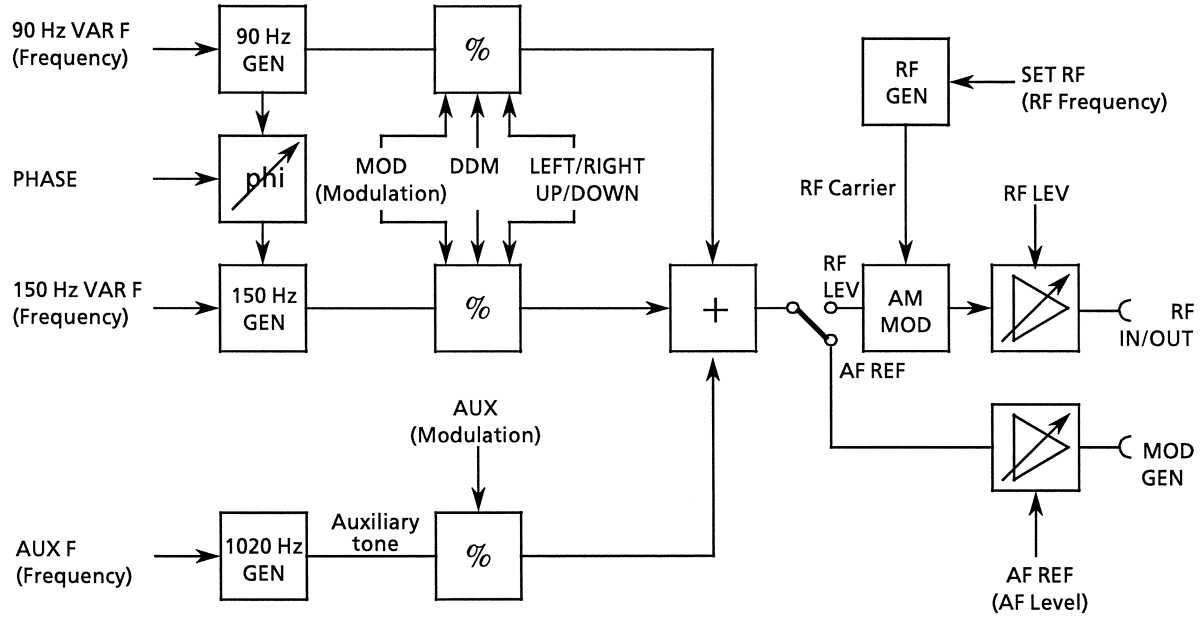


Fig. 4 Block Diagram "ILS Signal Generator"

3.3 Function Principle of the Marker Beacon Signal Generator

The marker beacon signal generator consists of two AF generators. The first one generates a sinewave signal with one of the three specified frequencies (300 Hz, 1300 Hz, 3000 Hz). The second generator provides a auxiliary tone of 1020 Hz with the frequency, however, being variable over a wide range. The amplitudes of both tones can be attenuated individually. They are then added by means of an adder and output to the AF connector MOD GEN via a variable amplifier or modulated to an RF carrier by means of the amplitude modulator. The RF signal which can be varied in level over a wide range is output at the RF IN/OUT connector.

4 Operation of the VOR/ILS Signal Generator

4.1 Menu Structure

Four menus are reserved for the VOR/ILS generator:

- VOR
- ILS-GS (ILS glide slope)
- ILS-LOC (ILS localizer)
- MB (marker beacon)

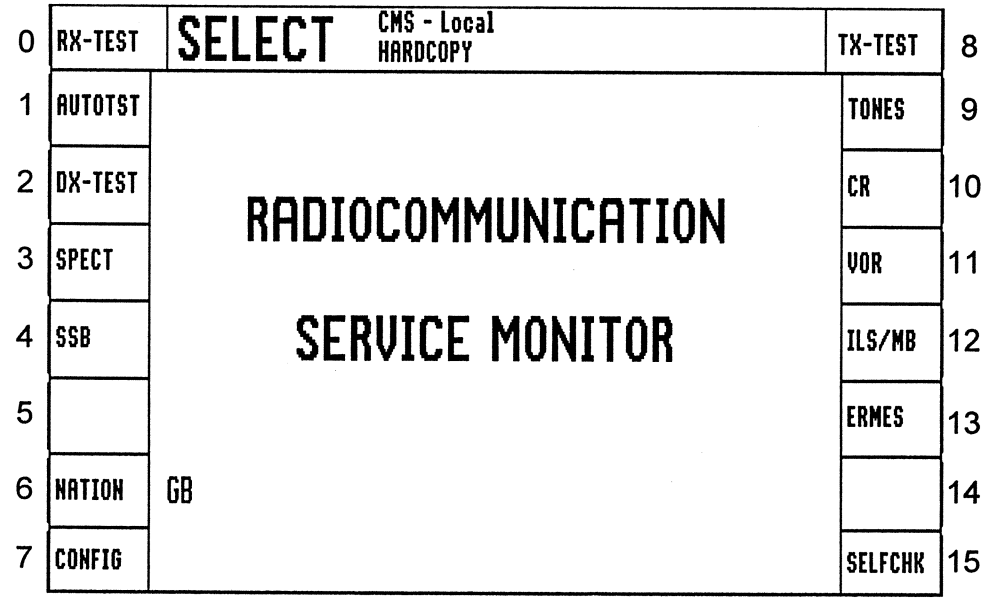


Fig. 5 SELECT menu

The SELECT menu allows for selecting the VOR menu by pressing softkey 11 or for selection of the ILS-LOC menu by pressing softkey 12. The ILS-GS menu can be entered by pressing softkey 0 in the ILS-LOC menu, the MB menu is reached by pressing softkey 8. The softkey MENU UP is used for returning to the SELECT menu from each of the four above-mentioned menus.

The softkey AF MOE (9) can be actuated in the VOR, ILS-GS and ILS-LOC menus for calling a submenu enabling the measuring functions Scope, AF voltmeter and DC voltmeter (only with built-in option CMS-B20). These measuring functions are implemented as a standard in the marker beacon menu MB. Operation of the oscilloscope corresponds to the operating modes transmitter test or receiver test. The submenus of these functions, however, cannot be entered in this application.

The oscilloscope can be set to FREEZE/ CONTINUOUS modes by activating softkey 11 and pressing the CLEAR/ ENTER key.

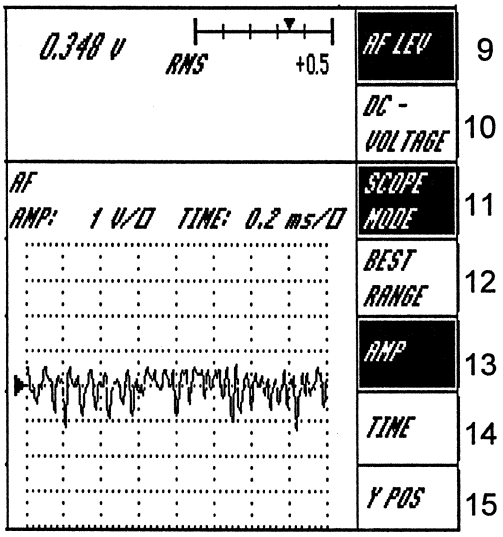


Fig. 6 Submenu AF MODE

4.2 General Operation Features of the Operating Modes VOR, ILS-LOC, ILS-GS and MB

4.2.1 Switchover AF Output or Modulation to RF Carrier

The softkey RF LEV/AF REF (2) is assigned two functions. First, it is used for selecting, whether the AF signals are output at the MOD GEN connector or amplitude-modulated to an RF carrier and output at the RF IN/OUT connector. The second function is the setting of the AF or RF output level. If the RF LEV field is inverted (bright characters on a dark background), the measuring signal is output in modulated form and the value displayed is the RF level. If the active cursor is located at this position, a new RF level can now be entered with the units dBm or µV. If the AF REF field is inverted, the AF signal is directly output. The displayed value then means the reference output level, the proportional modulation values of the individual signals refer to. This level can either be output in V, mV or µV.

4.2.2 RF Frequencies

The SET RF function is used for setting the frequency of the RF carrier. Each of the 4 menus contains an individual table listing the standard frequencies for VOR, ILS and MB (cf. table 1, page 19). The values are called by rotating the VAR spinwheel. The two frequencies for ILS-LOC and ILS-GS are always paired, i.e., in case of a switchover from one menu to the other, the corresponding frequency value is loaded respectively. This does not affect VOR and MB.

4.2.3 VAR Function

The relevant parameters can be varied using the VAR spinwheel. The parameters are preset to the smallest possible step size or, if present, to a table of values (RF, DDM) which are loaded one after the other. If the parameters are varied via the keypad, rotating the VAR spinwheel causes the next values from the table to be loaded. If a new step size is entered, the table cannot be accessed. The table can be activated again by entering a step size of zero. The AF modulations and AF frequencies displayed in each of the four menus are specified standard values which can, however, be varied for simulation of deviations and faults.

4.2.4 Presettings

Varied parameters in the VOR, ILS and MB menus can be reset to their standard values using the key combination SHIFT / RESET (cf. table 2, page 20); however, this effects entering the SELECT menu again.

4.3 VOR Menu

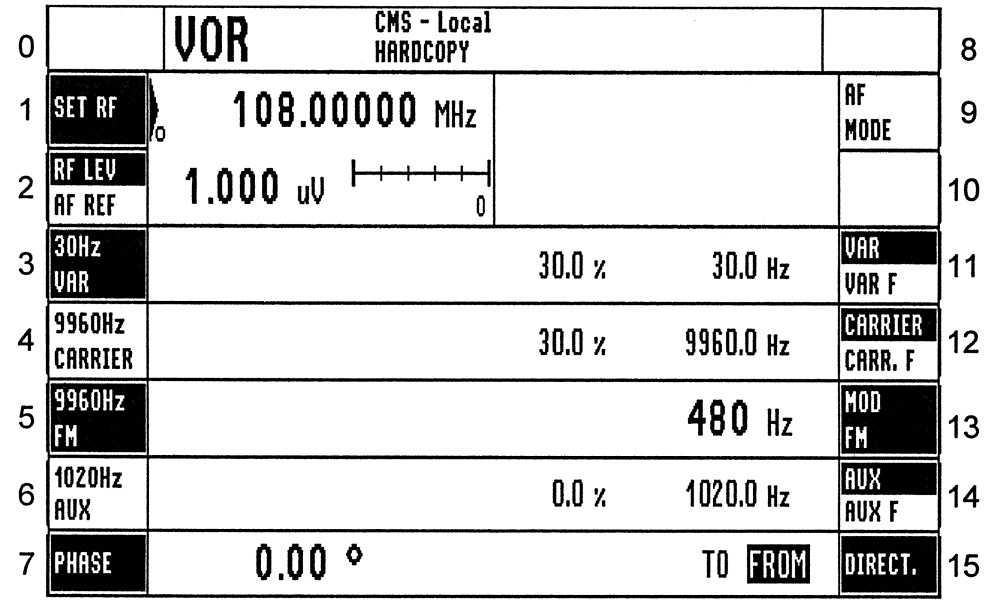


Fig. 7 VOR Menu

Softkey 3: 30 Hz VAR

This softkey activates the phase-variable 30-Hz tone. It is active when the field is inverted.

Softkey 4: 9960 Hz CARRIER

This softkey activates the unmodulated subcarrier. It is active when the field is inverted.

Softkey 5: 9960 Hz FM

This softkey activates the FM-modulated subcarrier. Softkeys 4 and 5 cannot be active simultaneously, i.e. switching on the modulated subcarrier automatically disables the unmodulated carrier. Softkey 5 is active when the field is inverted.

Softkey 6: 1020 Hz AUX

This softkey switches on the auxiliary tone. It is active when the field is inverted.

Softkey 7: PHASE

This function sets the phase of the 30-Hz signal. The entry is made using `Softkey 7/number/ENTER`. The phase value is indicated in degrees. The step size of the VAR spinwheel is preset to 10°.

The softkeys 11 to 14 are used for entering the frequency using `Softkey/number/dimension or ENTER` and for entering the modulation using `Softkey/number/% or ENTER`. The modulation is displayed in percent.

Softkey 11: VAR/VAR F

Dual function for entering the frequency and modulation of the phase-variable 30-Hz signal.

Softkey 12: CARRIER/CARR. F

Dual function for entering the frequency and modulation of the subcarrier.

Softkey 13: MOD FM

Entry of the frequency deviation for the FM modulation of the subcarrier.

Softkey 14: AUX/AUX F

Dual function for entering the frequency and modulation of the auxiliary tone.

Softkey 15: DIRECT.

Softkey with toggle function for switching over the direction TO/FROM. If TO is inverted the internal phase is additionally shifted by 180°. This does not affect display of the phase.

4.4 ILS Menu

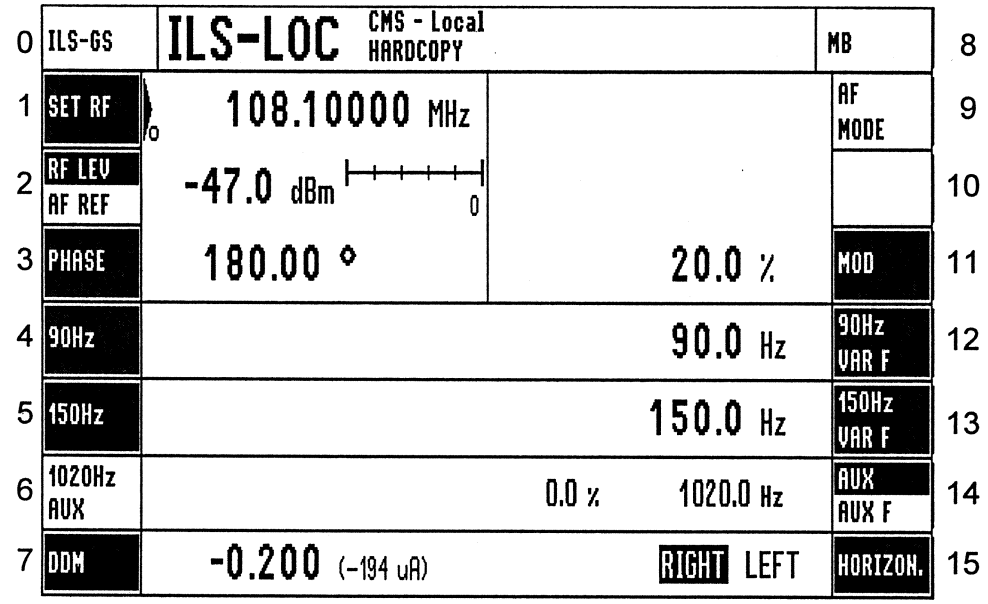


Fig. 8 ILS-LOC Menu

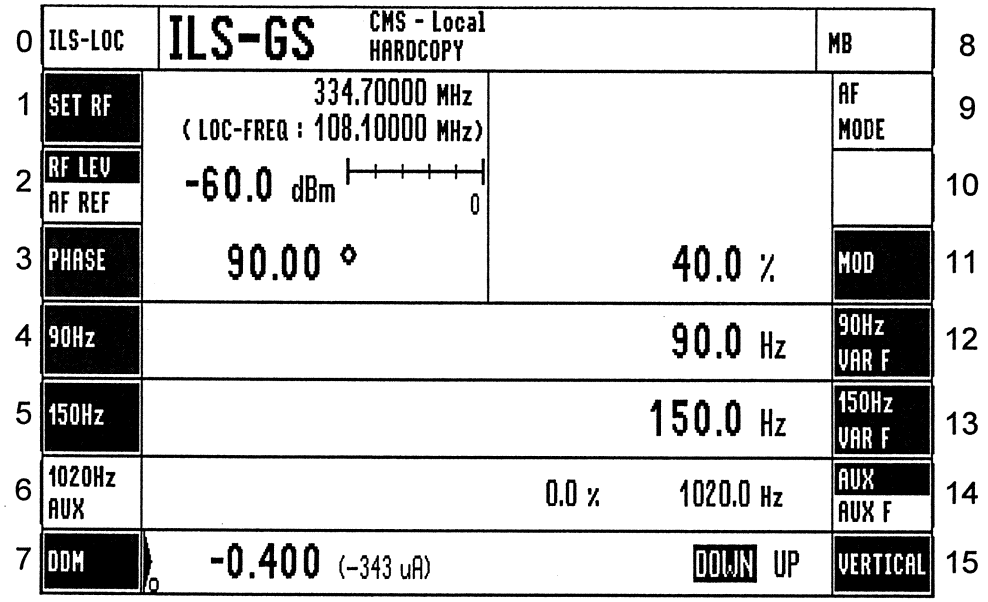


Fig. 9 ILS-GS Menu

The two menus ILS-LOC and ILS-GS are identical concerning arrangement and function, except for softkeys 0 and 15 which are labelled differently. The default parameters are, however, different.

The ILS-LOC and ILS-GS RF frequencies are allocated in pairs (cf. table 1, page 19). When changing these frequencies via softkey 1, the new allocated frequency is used when entering the respective other menu. The allocated LOC frequency is additionally displayed in the ILS-GS menu.

The frequency ratio of the ILS signals "90 Hz" and "150 Hz" is always 3/5. Thus, changing the frequency of one signal automatically changes the frequency of the other signal proportionally. Both signals are phase-locked. The phasing is set using the PHASE parameter.

Softkey 3: PHASE

This function is used for setting the phase between the 90-Hz and the 150-Hz signals. The entry is made using `Softkey 3/number/ENTER`.

Softkey 4: 90 Hz

This softkey enables the 90-Hz tone. It is active, when the field is inverted.

Softkey 5: 150 Hz

This softkey enables the 150-Hz tone. It is active, when the field is inverted.

Softkey 6: 1020 Hz AUX

This softkey enables the auxiliary tone. It is active, when the field is inverted.

Softkey 7: DDM

This function is used for entering the modulation difference between the 90-Hz signal and the 150-Hz signal.

DDM = (90-Hz modulation - 150-Hz modulation) / 100% with RIGHT or DOWN

DDM = (150-Hz modulation - 90-Hz modulation) / 100% with LEFT or UP

Calculation of the modulation of individual tones:

90-Hz modulation = MOD+/(-) DDM/2 * 100 % with RIGHT or DOWN (with LEFT or UP)

150-Hz modulation = MOD-/(+) DDM/2 * 100 %

Rotating the VAR spinwheel calls the subsequent table of values for the localizer and the glide slope, respectively. DDM can be varied in positive and negative direction.

ILS-LOC		ILS-GS	
0.000	(Course Line)	0.000	(Glide Path)
± 0.046		± 0.045	
± 0.093		± 0.091	
± 0.155	(Course Sector)	± 0.175	(Glide Sector)
± 0.200		± 0.400	

Any step width can be set by means of <VAR>, number, <ENTER>.

The current corresponding to the DDM value (in µA), which is used for calibration of conventional moving-coil instruments, is indicated in brackets after the DDM value. Being useful for servicing purposes (adjustment works) only, the current is output exclusively on the display and not via IEC bus or in the autorun report.

Softkey 10: AUTOPILOT (with option CMS-B38 only)

This softkey appears only when the CMS is fitted with a second RF output. On pressing this softkey a modulated glide-slope signal is made available provided option CMS-B38 is built in. In this case, the frequency setting appears next to softkey 10 as shown in Fig. 8. A glide-slope signal is output and displayed only if the localizer frequency to be entered by means of softkey 1 corresponds to a standard value in Table 1. If a new standard frequency is selected with softkey 1 via the rollkey or directly entered, the glide slope frequency varies in line with the standard (Table 1). If a frequency is selected out of the standard range, the glide-slope signal is switched off. This state is indicated on the display by the symbol "----".

The modulation of the glide slope synthesizer is carried out together with the localizer frequency using softkeys 11 to 13. The specifications of the GS synthesizer (as shown on Fig. 9) do not apply to option CMS-B38.

The softkeys 11 to 14 are used for entering the frequency using `Softkey/number/dimension or ENTER` and for entering the modulation using `Softkey/number/% or ENTER`. The modulation is displayed in percent.

Softkey 11: MOD

This function is used for setting the modulations of the 90-Hz signal and the 150-Hz signal. MOD indicates the arithmetic average of the modulation of the two signals.

MOD = (90-Hz modulation + 150-Hz modulation) / 2

Softkey 12: 90 Hz VAR F and Softkey 13: 150 Hz VAR F

These functions are used for changing the frequencies of the 90-Hz and 150-Hz signal.

Softkey 14: AUX/AUX F

Dual function for entering the frequency and the modulation of the auxiliary tone.

Softkey 15: L/R (ILS-LOC) or U/D (ILS-GS)

Softkey with toggle function for converting the modulation of the 90-Hz and the 150-Hz tones.

Menu / Tone	ILS-LOC	ILS-GS
90 Hz	RIGHT	DOWN
150 Hz	LEFT	UP

Assigning the higher modulation to one of the two tones.

4.5 Marker Beacon Menu (MB)

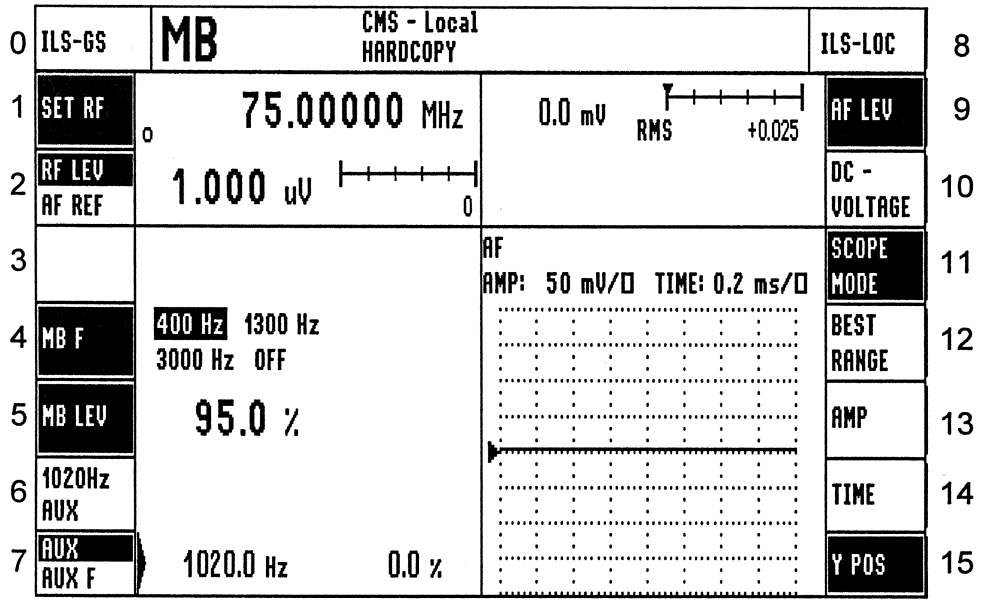


Fig. 10 MB menu

Softkey 4: MB F

This toggle function is used for selecting one of the three AF frequencies for the marker beacon. The tone is switched off in the OFF position.

Softkey 5: MB LEV

This funtion sets the modulation of the marker beacon tones. The entry is made using `Softkey/number/% or ENTER`.

Softkey 6: 1020 Hz AUX

This softkey switches on the auxiliary tone. It is active when the field is inverted.

Softkey 7: AUX/AUX F

This function is used for setting the modulation and frequency of the auxiliary tone. The frequency is entered using `Softkey 7/number/dimension or ENTER`. Entry of modulation is made using `Softkey 7/number/% or ENTER`.

Table 1 Standard frequencies of the RF carriers

VOR frequencies [MHz]			ILS frequencies paired		Marker beacon frequencies [MHz]
			LOCALIZER [MHz]	GLIDESLOPE [MHz]	
108.00	112.70	115.40	108.10	334.70	74.600
108.05	112.75	115.45	108.15	334.55	74.625
108.20	112.80	115.50	108.30	334.10	74.650
108.25	112.85	115.55	108.35	333.95	74.675
108.40	112.90	115.60	108.50	329.90	74.700
108.45	112.95	115.65	108.55	329.75	74.725
108.60	113.00	115.70	108.70	330.50	74.750
108.65	113.05	115.75	108.75	330.35	74.775
108.80	113.10	115.80	108.90	329.30	74.800
108.85	113.15	115.85	108.95	329.15	74.825
109.00	113.20	115.90	109.10	331.40	74.850
109.05	113.25	115.95	109.15	331.25	74.875
109.20	113.30	116.00	109.30	332.00	74.900
109.25	113.35	116.05	109.35	331.85	74.925
109.40	113.40	116.10	109.50	332.60	74.950
109.45	113.45	116.15	109.55	332.45	74.975
109.60	113.50	116.20	109.70	333.20	75.000
109.65	113.55	116.25	109.75	333.05	75.025
109.80	113.60	116.30	109.90	333.80	75.050
109.85	113.65	116.35	109.95	333.65	75.075
110.00	113.70	116.40	110.10	334.40	75.100
110.05	113.75	116.45	110.15	334.25	75.125
110.20	113.80	116.50	110.30	335.00	75.150
110.25	113.85	116.55	110.35	334.85	75.175
110.40	113.90	116.60	110.50	329.60	75.200
110.45	113.95	116.65	110.55	329.45	75.225
110.60	114.00	116.70	110.70	330.20	75.250
110.65	114.05	116.75	110.75	330.05	75.275
110.80	114.10	116.80	110.90	330.80	75.300
110.85	114.15	116.85	110.95	330.65	75.325
111.00	114.20	116.90	111.10	331.70	75.350
111.05	114.25	116.95	111.15	331.55	75.375
111.20	114.30	117.00	111.30	332.30	75.400
111.25	114.35	117.05	111.35	332.15	
111.40	114.40	117.10	111.50	332.90	
111.45	114.45	117.15	111.55	332.75	
111.60	114.50	117.20	111.70	333.50	
111.65	114.55	117.25	111.75	333.35	
111.80	114.60	117.30	111.90	331.10	
111.85	114.65	117.35	111.95	330.95	
112.00	114.70	117.40			
112.05	114.75	117.45			
112.10	114.80	117.50			
112.15	114.85	117.55			
112.20	114.90	117.60			
112.25	114.95	117.65			
112.30	115.00	117.70			
112.35	115.05	117.75			
112.40	115.10	117.80			
112.45	115.15	117.85			
112.50	115.20	117.90			
112.55	115.25	117.95			
112.60	115.30				
112.65	115.35				
VOR menu			ILS-LOC menu	ILS-GS menu	MB menu

Table 2 Presetting standard values

Parameter	Value displayed	Presetting Δ VAR
VOR, ILS-LOC, ILS-GS and MB menu:		
RF LEV	1 uV	0,1 dBm
AF REF	1 mV	0,1 mV
VOR menu:		
30 Hz VAR	ON	--
9960 Hz CARRIER	OFF	--
9960 Hz FM	ON	--
1020 Hz AUX	OFF	--
PHASE	0,00 °	10 °
VAR	30 %	0,1 %
VAR F	30 Hz	0,1 Hz
CARRIER	30 %	0,1 %
CARR. F	9960 Hz	1 Hz
MOD FM	480 Hz	1 Hz
AUX	20 %	0,1 %
AUX F	1020 Hz	1 Hz
DIRECT.	FROM	--
SET RF	108.0 MHz	cf. table 1
ILS-LOC and ILS-GS menu:		
PHASE	0 °	1 °
90 Hz VAR F	90 Hz	0,1 Hz
150 Hz VAR F	150 Hz	0,1 Hz
ILS-LOC menu:		
SET RF	108,10 MHz	cf. table 1
AUTOPILOT	334,70 MHz	with SET RF
90 Hz	ON	--
150 Hz	ON	--
1020 Hz AUX	OFF	--
DDM	0,000	cf. ILS menu, softkey 7 (DDM)
MOD	20 %	0,1 %
AUX	20 %	0,1 %
AUX F	1020 Hz	0,1 Hz
L/R	LEFT	--
ILS-GS menu:		
SET RF	334,70 MHz	cf. table 1
90 Hz	ON	--
150 Hz	ON	--
1020 Hz AUX	OFF	--
DDM	0,000	cf. ILS menu, softkey 7 (DDM)
MOD	40 %	0,1 %
AUX	5 %	0,1 %
AUX F	1020 Hz	0,1 Hz
U/D	UP	--
MB menu:		
SET RF	74,6 MHz	cf. table 1
MB F	400 Hz	--
MB LEV	95,0 %	0,1 %
1020 Hz AUX	OFF	--
AUX	5 %	0,1 %
AUX F	1020 Hz	1Hz

5 IEC-Bus Commands for VOR/ILS Signal Generator

VOR

Command	Data	Units	Function
VOR:AF	number	MV UV V	AF reference level
VOR:AF:VARIATION	number ON OFF	MV UV V	
VOR:AUX:FREQUENCY	number	KHz Hz MHz	Frequency setting of the
VOR:AUX:FREQUENCY:VARIATION	number ON OFF	KHz Hz MHz	auxiliary tone
VOR:AUX:LEVEL	number	PCT	Modulation of the
VOR:AUX:LEVEL:VARIATION	number ON OFF	PCT	auxiliary tone
VOR:AUX:TOGGLE	ON OFF		Auxiliary tone on/off
VOR:MOD:FM	number	KHz Hz MHz	Frequency deviation of subcarrier
VOR:MOD:FM:VARIATION	number ON OFF	KHz Hz MHz	
VOR:CARRIER:FREQUENCY	number	KHz Hz MHz	Frequency of subcarrier
VOR:CARRIER:FREQUENCY:VARIATION	number ON OFF	KHz Hz MHz	
VOR:CARRIER:TOGGLE	ON OFF		Unmodulated subcarrier on/off
VOR:CARRIER:LEVEL	number	PCT	Modulation of subcarrier
VOR:CARRIER:LEVEL:VARIATION	number ON OFF	PCT	
VOR:VAR:LEVEL	number	PCT	Modulation of the phase-variable signal
VOR:VAR:LEVEL:VARIATION	number ON OFF	PCT	
VOR:VAR:FREQUENCY	number	KHz Hz MHz	Frequency of the phase-variable signal
VOR:VAR:FREQUENCY:VARIATION	number ON OFF	KHz Hz MHz	
VOR:VAR:TOGGLE	ON OFF		Phase-variable signal on/off
VOR:MODFM:TOGGLE	ON OFF		Modulated subcarrier on/off
VOR:PHASE	number		Phase shift
VOR:PHASE:VARIATION	number ON OFF		
VOR:DIRECTION	TO FROM		Switchover TO/FROM

ILS Localizer

Command	Data	Units	Function
ILS:LOC:AF	number	MV UV V	AF reference level
ILS:LOC:AF:VARIATION	number ON OFF	MV UV V	
ILS:LOC:PHASE	number		Phase shift
ILS:LOC:PHASE:VARIATION	number ON OFF		
ILS:LOC:F90HZ:TOGGLE	ON OFF		90-Hz tone on/off
ILS:LOC:F90HZ:FREQUENCY	number	KHZ HZ MHZ	Frequency setting for the 90-Hz tone
ILS:LOC:F90HZ:FREQUENCY:VARIATION	number ON OFF	KHZ HZ MHZ	
ILS:LOC:DDM	number		DDM setting
ILS:LOC:DDM:VARIATION	number ON OFF		
ILS:LOC:MODULATION	number	PCT	Modulation of the 90-Hz-/150-Hz tone
ILS:LOC:MODULATION:VARIATION	number ON OFF	PCT	
ILS:LOC:AUTOPILOT	ON OFF		GS synth. on/off
ILS:LOC:F150 HZ:TOGGLE	ON OFF		150-Hz tone on/off
ILS:LOC:F150 HZ:FREQUENCY	number	KHZ HZ MHZ	Frequency setting for the 150-Hz tone
ILS:LOC:F150 HZ:FREQUENCY: VARIATION	number ON OFF	KHZ HZ MHZ	
ILS:LOC:AUX:TOGGLE	ON OFF		Auxiliary tone on/off
ILS:LOC:AUX:FREQUENCY	number ON OFF	KHZ HZ MHZ	Frequency setting for the
ILS:LOC:AUX:FREQUENCY:VARIATION		KHZ HZ MHZ	auxiliary tone
ILS:LOC:AUX:LEVEL	number	PCT	Modulation of the
ILS:LOC:AUX:LEVEL:VARIATION	number ON OFF	PCT	auxiliary tone
ILS:LOC:LEFTRIGHT	LEFT RIGHT		Higher modulation with DDM referred to 150-Hz tone (right) or 90-Hz tone (left)

ILS Glide Slope

Command	Data	Units	Function
ILS:GS:AF	number	MV UV V	AF reference level
ILS:GS:AF:VARIATION	number ON OFF	MV UV V	
ILS:GS:PHASE	number		Phase shift
ILS:GS:PHASE:VARIATION	number ON OFF		
ILS:GS:F90HZ:TOGGLE	ON OFF		90-Hz tone on/off
ILS:GS:F90HZ:FREQUENCY	number	KHZ HZ MHZ	Frequency setting for the 90-Hz tone
ILS:GS:F90HZ:FREQUENCY:VARIATION	number ON OFF	KHZ HZ MHZ	
ILS:GS:DDM	number		DDM setting
ILS:GS:DDM:VARIATION	number ON OFF		
ILS:GS:MODULATION	number	PCT	Modulation of the 90-Hz-/150-Hz tone
ILS:GS:MODULATION:VARIATION	number ON OFF	PCT	
ILS:GS:F150 HZ:TOGGLE	ON OFF		150-Hz tone on/off
ILS:GS:F150 HZ:FREQUENCY	number	KHZ HZ MHZ	Frequency setting for the 150-Hz tone
ILS:GS:F150 HZ:FREQUENCY: VARIATION	number ON OFF	KHZ HZ MHZ	
ILS:GS:AUX:TOGGLE	ON OFF		Auxiliary tone on/off
ILS:GS:AUX:FREQUENCY	number	KHZ HZ MHZ	Frequency setting for the
ILS:GS:AUX:FREQUENCY:VARIATION	number ON OFF	KHZ HZ MHZ	auxiliary tone
ILS:GS:AUX:LEVEL	number	PCT	Modulation of the
ILS:GS:AUX:LEVEL:VARIATION	number ON OFF	PCT	auxiliary tone
ILS:GS:UPDOWN	UP DOWN		Higher modulation with DDM referred to 150-Hz tone (down) or 90-Hz tone (up)

Marker Beacon

Command	Data	Units	Function
MB:AF	number	**MV UV V**	AF reference level
MB:AF:VARIATION	number **ON OFF**	**MV UV V**	
MB:FREQUENCY:TOGGLE	**SEL_400 HZ** **SEL_1300 HZ** **SEL_3000 HZ** **OFF**		AF frequencies of marker beacon (400 Hz, 1.3 kHz, 3 kHz or OFF)
MB:LEVEL	number	**PCT**	Marker beacon modulation
MB:LEVEL:VARIATION	number **ON OFF**	**PCT**	
MB:AUX:TOGGLE	**ON OFF**		Auxiliary tone on/off
MB:AUX:FREQUENCY	number	**KHz Hz MHz**	Frequency setting of the
MB:AUX:FREQUENCY:VARIATION	number **ON OFF**	**KHz Hz MHz**	auxiliary tone
MB:AUX:LEVEL	number	**PCT**	Modulation of the
MB:AUX:LEVEL:VARIATION	number **ON OFF**	**PCT**	auxiliary tone

Main menu		Submenu	
Index	**Name**	**Index**	**Name**
17	VOR menu	65	AF MODE
18	ILS-LOC menu		
19	ILS-GS menu		
20	MB menu		

6 Performance Test

6.1 Required Measuring Instruments and Accessories

Item No.	o Type of Instrument, Required Data • Recommended R&S Instrument	Type	Order No.	Application Section
1	o Modulation analyzer 70 to 350 MHz AM Distortion meter for the demodulated signal and external AF signals • Modulation Analyzer	FMAV	856.4509.52	6.2.2
2	o RMS voltmeter (true RMS) 10 Hz to 20 kHz Resolution = 100 µV • RMS Voltmeter	URE	342.1214.02	6.2.6
3	o ILS test receiver for evaluation of the DDM	FMAV	856.4509.52	6.2.5
4	o VOR phase meter	FMAV	856.4509.52	6.2.3
5	o Oscilloscope			6.2.4

6.2 Testing the Rated Specifications

6.2.1 General Information

All the settings not stated below must be set to their preset values. Reset them by pressing the keys SHIFT and RESET.

6.2.2 AM Modulation and AM Distortion

The modulation analyzer is connected to the RF IN/OUT socket.

VOR:
-9 dBm, 113.0 MHz
Switch on the tones 30 Hz VAR, 9960 Hz CARRIER and 1020 Hz AUX separately. Measure the modulation and AM distortion.

ILS-LOC:
-9 dBm, 110.1 MHz
Switch on the tones 90 Hz, 150 Hz and 1020 Hz AUX separately. Measure the modulation and AM distortion.

ILS-GS:
-9 dBm, 332.0 MHz
Switch on the tones 90 Hz, 150 Hz and 1020 Hz AUX separately. Measure the modulation and AM distortion.

With AM modulation of the VOR- and ILS-signals, deviation from the nominal value must not be higher than 2 % or 3%. AM distortion may be max. 2 %.

MB:
-9 dBm, 70.0 MHz
Switch on the tones 400 Hz, 1300 Hz and 3000 Hz separately. Measure the modulation.

With AM modulation, deviation from the nominal value must not be higher than 5 %.

6.2.3 VOR Phase

The VOR phase meter is connected to the MOD GEN socket.

VOR:
AF REF = 2 V; MOD FM = 480 Hz
The tones 30 Hz VAR and 9960 Hz FM must be switched on. The phase is measured at 0 °. Deviation must not be higher than 0.04 °.

6.2.4 ILS Phase

ILS-GS:
AF REF = 2 V
DDM = 0.000
PHASE = 120.00 °
Connect the oscilloscope to the MOD GEN socket. The input must be d.c. coupled. Set the time base, amplitude excursion and triggering such that the two lower amplitude peaks of the characteristic ILS signal are displayed optimally magnified on the screen (cf. fig. 11). With a phase shift of 0 ° and 120 ° the two peaks must be equally high. Otherwise the peaks can be made equally high by way of fine variation of the phase (VAR 0.1 °). Deviation from 0° and/or 120 ° must not be higher than ±1 °.

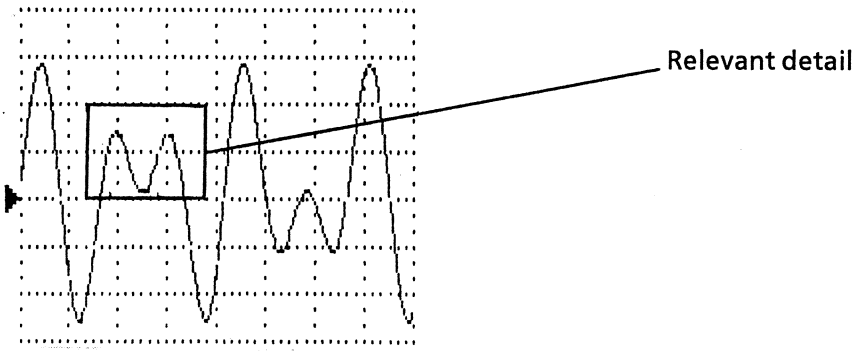


Fig. 11 ILS signal at the AF output (MOD GEN)

6.2.5 DDM Measurement at the RF Output with ILS Signals

RF LEV =-30 dBm
Both modulation tones 90 Hz and 150 Hz are switched on. Depending on the ILS test receiver used the DDM value is either directly measured or calculated using the selectively measured modulation depths of both tones.

The DDM value is obtained using the following formula:

DDM = (90-Hz modulation - 150-Hz modulation)/ 100% if toggle LEFT/RIGHT is set to RIGHT (ILS-LOC) or toggle UP/DOWN to UP (ILS-GS).

ILS-LOC menu:
The DDM value may deviate from the displayed value by ±(2 % + 0.0004 DDM).

ILS-GS menu:
The DDM value may deviate from the displayed value by ±(2 % + 0.001 DDM).

6.2.6 DDM Measurement at the AF Output with ILS Signals

AF REF = 3.5 V
The levels of the individual tones are measured at the MOD GEN output using the RMS voltmeter. The 90-Hz and 150-Hz tone are switched on separately.

The DDM value is obtained using the following formula:

$DDM = (90\text{-}Hz\ level - 150\text{-}Hz\ level) / AF\ REF$ if toggle LEFT/RIGHT is set to RIGHT (ILS-LOC) or toggle UP/DOWN to UP (ILS-GS).

In the ILS-LOC menu and ILS-GS menu the deviation from the displayed DDM value must not be higher than 3 % + 0.0002 DDM.

6.3 Performance Test Report

ROHDE & SCHWARZ Date .....

RADIOCOMMUNICATION SERVICE MONITOR CMS*) Name .....

Order. No. 840.0009*)

F. Nr. ..... *)for certain models

Item no.	Characteristic	Measure-ment to section	Min.	Actual	Max.	Unit
1	**AM modulation**	6.2.2				
	VOR:					
	30 Hz VAR					
	Modulation = 30 %		29.4	.....	30.6	%
	9960 Hz CARRIER					
	Modulation = 30 %		29.4	.....	30.6	%
	1020 Hz AUX					
	Modulation = 20 %		19.4	.....	20.6	%
	Modulation = 10 %		9.7	.....	10.3	%
	ILS-LOC:					
	90 Hz, DDM = 0.0					
	Modulation 20 %		19.6	.....	20.4	%
	150 Hz, DDM = 0.0					
	Modulation = 20 %		19.6	.....	20.4	%
	1020 Hz AUX					
	Modulation = 20 %		19.4	.....	20.6	%
	Modulation = 10 %		9.7	.....	10.3	%
	ILS-GS:					
	90 Hz, DDM = 0.0					
	Modulation = 40 %		39.2	.....	40.8	%
	150 Hz, DDM = 0.0					
	Modulation = 40 %		39.2	.....	40.8	%
	1020 Hz AUX					
	Modulation = 20 %		19.4	.....	20.6	%
	Modulation = 10 %		9.7	.....	10.3	%
	MB:					
	MB = 400 Hz					
	MB modulation = 95 %		90.25	.....	99.75	%
	MB = 1300 Hz					
	MB modulation = 95 %		90.25	.....	99.75	%
	MB = 3000 Hz					
	MB modulation = 95 %		90.25	.....	99.75	%

Item no.	Characteristic	Measure-ment to section	Min.	Actual	Max.	Unit
2	**AM distortion**	6.2.2				
	VOR:					
	30 Hz VAR		---	.....	2	%
	9960 Hz CARRIER		---	.....	2	%
	1020 Hz AUX					
	Modulation 20 %		---	.....	2	%
	Modulation 10 %		---	.....	2	%
	ILS-LOC:					
	90 Hz		---	.....	2	%
	150 Hz		---	.....	2	%
	ILS-GS:					
	90 Hz		---	.....	2	%
	150 Hz		---	.....	2	%
3	**VOR phase (AF)**	6.2.3				
	Phase = 0 °		-0.04	.....	0.04	°
4	**ILS phase (AF)**	6.2.4				
	Phase = 120 °		119	.....	121	°
5	**DDM (RF)**	6.2.5				
	ILS-LOC:					
	DDM = 0.0		-0.0004	.....	+0.0004	---
	DDM = 0.2		0.1956	.....	0.2044	---
	ILS-GS:					
	DDM = 0.0		-0.001	.....	+0.001	---
	DDM = 0.4		0.391	.....	0.409	---
6	**DDM (AF)**	6.2.6				
	ILS-LOC:					
	DDM = 0.0		-0.0002	.....	0.0002	---
	DDM = 0.2		0.1938	.....	0.2062	---
	ILS-GS:					
	DDM = 0.0		-0.0002	.....	0.0002	---
	DDM = 0.2		0.1938	.....	0.2062	---