RF POWER METER

6960B

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Contents

Precautions

WARNING **CAUTION** **Note**

These terms have specific meanings in this manual:

WARNING **information to prevent personal injury.**

CAUTION **information to prevent damage to the equipment.**

Note **important general information.**

Symbols

The meaning of the safety related symbols appearing on the equipment and in the documentation are as follows:-

Symbol	Description
	Refer to the instruction manual when this symbol is marked on the instrument. Familiarise yourself with the nature of the hazard and the actions which may have to be taken.
	Dangerous voltage
	Toxic hazard

General conditions of use

This product is designed and tested to comply with the requirements of IEC/EN61010-1 'Safety requirements for electrical equipment for measurement, control and laboratory use', for Class I portable equipment and is for use in a pollution degree 2 environment. The equipment is designed to operate from an installation category I or II supply.

Equipment should be protected from the ingress of liquids and precipitation such as rain, snow, etc. When moving the equipment from a cold to a hot environment, it is important to allow the temperature of the equipment to stabilise before it is connected to the supply to avoid condensation forming. The equipment must only be operated within the environmental conditions specified in Chapter 1 'Performance data' in the Operating manual, otherwise the protection provided by the equipment may be impaired.

This product is not approved for use in hazardous atmospheres or medical applications. If the equipment is to be used in a safety-related application, e.g. avionics or military applications, the suitability of the product must be assessed and approved for use by a competent person.

WARNING

Electrical hazards (AC supply voltage)

This equipment conforms with IEC Safety Class I, meaning that it is provided with a protective grounding lead. To maintain this protection the supply lead must always be connected to the source of supply via a socket with a grounded contact.

Be aware that the supply filter contains capacitors that may remain charged after the equipment is disconnected from the supply. Although the stored energy is within the approved

safety requirements, a slight shock may be felt if the plug pins are touched immediately after removal.

Do not remove instrument covers as this may result in personal injury. There are no user-serviceable parts inside.

Refer all servicing to qualified personnel. See list of Service Centers at rear of manual.

Fuses

Note that there are supply fuses in both the live and neutral wires of the supply. If only one of these fuses should rupture, certain parts of the equipment could remain at supply potential.

WARNING

Fire hazard

Make sure that only fuses of the correct rating and type are used for replacement.

If an integrally fused plug is used on the supply lead, ensure that the fuse rating is commensurate with the current requirements of this equipment. See under 'Performance data' in Chapter 1 for power requirements.

WARNING

Toxic hazards

Some of the components used in this equipment may include resins and other materials which give off toxic fumes if incinerated. Take appropriate precautions, therefore, in the disposal of these items.

WARNING

Lithium

A Lithium battery (or a Lithium battery contained within an IC) is used in this equipment.

As Lithium is a toxic substance, the battery should in no circumstances be crushed, incinerated or disposed of in normal waste.

Do not attempt to recharge this type of battery. Do not short circuit or force discharge since this might cause the battery to vent, overheat or explode.

WARNING

Tilt facility

When the equipment is in the tilt position, it is advisable, for stability reasons, not to stack other equipment on top of it.

CAUTION

LCD handling

When operating or servicing this equipment take care not to depress the front or rear faces of the display module as this may damage the liquid crystal display elements.

CAUTION

Static Sensitive Components

This equipment contains static sensitive components which may be damaged by handling - refer to the Maintenance part of the Service Manual for handling precautions.

CAUTION

Suitability for use

This equipment has been designed and manufactured by Aeroflex to make RF power measurements.

If the equipment is not used in a manner specified by Aeroflex, the protection provided by the equipment may be impaired.

Aeroflex has no control over the use of this equipment and cannot be held responsible for events arising from its use other than for its intended purpose.

Précautions

WARNING **CAUTION** **Note**

Les termes suivants ont, dans ce manuel, des significations particulières:

WARNING contient des informations pour éviter toute blessure au personnel.

CAUTION contient des informations pour éviter les dommages aux équipements.

Note contient d'importantes informations d'ordre général.

Symboles

La signification des symboles liés à cet équipement est la suivante:

Symbole	Nature du risque
	Reportez-vous au manuel d'utilisation quand ce symbole apparaît sur l'instrument. Familiarisez-vous avec la nature du danger et la conduite à tenir.
	Tension dangereuse
	Danger produits toxiques

Conditions générales d'utilisation

Ce produit a été conçu et testé pour être conforme aux exigences des normes CEI/EN61010-1 : 2001 "Règles de sécurité pour appareils électriques de mesurage, de régulation et de laboratoire", pour des équipements Classe I portables, qui tiennent dans la main> et pour une utilisation dans un environnement de pollution de niveau 2. Cet équipement est conçu pour fonctionner à partir d'une alimentation de catégorie I ou II.

Cet équipement doit être protégé de l'introduction de liquides ainsi que des précipitations d'eau, de neige, etc... Lorsqu'on transporte cet équipement d'un environnement chaud vers un environnement froid, il est important de laisser l'équipement se stabiliser en température avant de le connecter à une alimentation afin d'éviter toute formation de condensation. L'appareil doit être utilisé uniquement dans le cadre des conditions d'environnement spécifiées au chapitre 1 "Performance data" du manuel d'utilisation, toute autre utilisation peut endommager les systèmes de protection.

Ce produit n'est pas garanti pour fonctionner dans des atmosphères dangereuses ou pour un usage médical. Si l'équipement doit être utilisé pour des applications en relation avec la sécurité, par exemple des applications militaires ou aéronautiques, la compatibilité du produit doit être établie et approuvée par une personne compétente.

WARNING

Sécurité électrique (tension d'alimentation alternative)

Cet appareil est protégé conformément à la norme CEI de sécurité Classe 1, c'est-à-dire que sa prise secteur comporte un fil de protection à la terre. Pour maintenir cette protection, le câble d'alimentation doit toujours être branché à la source d'alimentation par l'intermédiaire d'une prise comportant une borne de terre.

Notez que les filtres d'alimentation contiennent des condensateurs qui peuvent encore être chargés lorsque l'appareil est débranché. Bien que l'énergie contenue soit conforme aux exigences de sécurité, il est possible de ressentir un léger choc si l'on touche les bornes sitôt après débranchement.

Ne démontez pas le capot de l'instrument, car ceci peut provoquer des blessures. Il n'y a pas de pièces remplaçables par l'utilisateur à l'intérieur.

Faites effectuer toute réparation par du personnel qualifié. Contacter un des Centres de Maintenance Internationaux dans la liste jointe à la fin du manuel.

Fusibles

Notez qu'il y a deux fusibles, l'un pour la phase et l'autre pour le neutre du câble d'alimentation. Si un seul fusible est coupé, certaines parties de l'appareil peuvent rester au potentiel d'alimentation.

WARNING

Risque lié au feu

Lors du remplacement des fusibles vérifiez l'exactitude de leur type et de leur valeur.

Si le câble d'alimentation comporte une prise avec fusible intégré, assurez vous que sa valeur est compatible avec les besoins en courant de l'appareil. Pour la consommation, reportez-vous au "Performance data" dans le chapitre 1.

WARNING

Danger produits toxiques

Certains composants utilisés dans cet appareil peuvent contenir des résines et d'autres matières qui dégagent des fumées toxiques lors de leur incinération. Les précautions d'usages doivent donc être prises lorsqu'on se débarrasse de ce type de composant.

WARNING

Lithium

Une pile au Lithium ou un CI contenant une pile au Lithium est utilisé dans cet équipement.

Le Lithium étant une substance toxique, il ne faut en aucun cas l'écraser, l'incinérer ou le jeter avec des déchets normaux.

N'essayez pas de recharger ce type de pile. Ne court-circuitez pas ou ne forcez pas la décharge de la pile car cela pourrait causer une fuite, une surchauffe ou une explosion.

WARNING

Position inclinée

Lorsque l'appareil est dans une position inclinée, il est recommandé, pour des raisons de stabilité, de ne pas y empiler d'autres appareils.

CAUTION

Utilisation

Cet équipement a été conçu et fabriqué par Aeroflex pour effectuer des mesures de puissance RF

La protection de l'équipement peut être altérée s'il n'est pas utilisé dans les conditions spécifiées par Aeroflex.

Aeroflex n'a aucun contrôle sur l'usage de l'instrument, et ne pourra être tenu pour responsable en cas d'événement survenant suite à une utilisation différente de celle prévue.

Vorsichtsmaßnahmen

WARNING **CAUTION** **Note**

Diese Hinweise haben eine bestimmte Bedeutung in diesem Handbuch:

WARNING dienen zur Vermeidung von Verletzungsrisiken.

CAUTION dienen dem Schutz der Geräte.

Note enthalten wichtige Informationen.

Symbole

Die Gefahrensymbole auf den Geräten sind wie folgt:

Symbol	Gefahrenart
	Beziehen Sie sich auf die Bedienungsanleitung wenn das Messgerät mit diesem Symbol markiert ist. Machen Sie sich mit der Art der Gefahr und den Aktionen die getroffen werden müssen bekannt.
	Gefährliche Spannung
	Warnung vor giftigen Substanzen

Allgemeine Hinweise zur Verwendung

Dieses Produkt wurde entsprechend den Anforderungen von IEC/EN61010-1 “Sicherheitsanforderungen für elektrische Ausrüstung für Meßaufgaben, Steuerung und Laborbedarf”, Klasse I transportabel zur Verwendung in einer Grad 2 verunreinigten Umgebung, entwickelt und getestet. Dieses Gerät ist für Netzversorgung Klasse I oder II zugelassen.

Das Gerät sollte vor dem Eindringen von Flüssigkeiten sowie vor Regen, Schnee etc. geschützt werden. Bei Standortänderung von kalter in wärmere Umgebung sollte das Gerät wegen der Kondensation erst nach Anpassung an die wärmere Umgebung mit dem Netz verbunden werden. Das Gerät darf nur in Umgebungsbedingungen wie in Kapitel 1 "Leistungsdaten (Performance data)" der Bedienungsanleitung beschrieben, betrieben werden; ansonsten wird der vom Gerät vorgesehene Schutz des Anwenders beeinträchtigt.

Dieses Produkt ist nicht für den Einsatz in gefährlicher Umgebung (z.B. Ex-Bereich) und für medizinische Anwendungen geprüft. Sollte das Gerät für den Einsatz in sicherheitsrelevanten Anwendungen wie z.B. im Flugverkehr oder bei militaerischen Anwendungen vorgesehen sein, so ist dieser von einer für diesen Bereich zuständigen Person zu beurteilen und genehmigen.

WARNING

Elektrische Schläge (Wechselspannungsversorgung)

Das Gerät entspricht IEC Sicherheitsklasse 1 mit einem Schutzleiter nach Erde. Das Netzkabel muß stets an eine Steckdose mit Erdkontakt angeschlossen werden.

Filterkondensatoren in der internen Spannungsversorgung können auch nach Unterbrechung der Spannungszuführung noch geladen sein. Obwohl die darin gespeicherte

Energie innerhalb der Sicherheitsmargen liegt, kann ein leichter Spannungsschlag bei Berührung kurz nach der Unterbrechung erfolgen.

Öffnen Sie niemals das Gehäuse der Geräte das dies zu ernsthaften Verletzungen führen kann. Es gibt keine vom Anwender austauschbare Teile in diesem Gerät.

Lassen Sie alle Reparaturen durch qualifiziertes Personal durchführen. Eine Liste der Servicestellen finden Sie auf der Rückseite des Handbuches.

Sicherungen

Es ist zu beachten, daß es Sicherungen in beiden (spannunsführenden und neutralen) Zuleitungen gibt. Wenn nur eine von diesen Sicherungen schmilzt, so bleiben einige Geräteteile immer noch auf Spannungspotential.

WARNING

Feuergefahr

Es dürfen nur Ersatzsicherungen vom gleichen Typ mit den korrekten Spezifikationen entsprechend der Stromaufnahme des Gerätes verwendet werden. Siehe hierzu die Leistungsdaten (Performance data) in Kapitel 1.

WARNING

Warnung vor giftigen Substanzen

In einigen Bauelementen dieses Geräts können Epoxyharze oder andere Materialien enthalten sein, die im Brandfall giftige Gase erzeugen. Bei der Entsorgung müssen deshalb entsprechende Vorsichtsmaßnahmen getroffen werden.

WARNING

Lithium

Eine Lithium Batterie oder eine Lithium Batterie innerhalb eines IC ist in diesem Gerät eingebaut.

Da Lithium ein giftiges Material ist, sollte es als Sondermüll entsorgt werden.

Diese Batterie darf auf keinen Fall geladen werden. Nicht kurzschließen, da sie dabei überhitzt werden und explodieren kann.

WARNING

Schrägstellung

Bei Schrägstellung des Geräts sollten aus Stabilitätsgründen keine anderen Geräte darauf gestellt werden.

CAUTION

Eignung für Gebrauch

Dieses Gerät wurde von Aeroflex entwickelt und hergestellt um HF Leistungsmessungen durchzuführen

Sollte das Gerät nicht auf die von Aeroflex vorgesehene Art und Weise verwendet werden, kann die Schutzfunktion des Gerätes beeinträchtigt werden.

Aeroflex hat keinen Einfluß auf die Art der Verwendung und übernimmt keinerlei Verantwortung bei unsachgemässer Handhabung.

Precauzioni

WARNING **CAUTION** **Note**

Questi termini vengono utilizzati in questo manuale con significati specifici:

WARNING riportano informazioni atte ad evitare possibili pericoli alla persona.

CAUTION riportano informazioni per evitare possibili pericoli all'apparecchiatura.

Note riportano importanti informazioni di carattere generale.

Simboli

Significato dei simboli di pericolo utilizzati nell'apparato:

Simbolo	Tipo di pericolo
	Fare riferimento al manuale operativo quando questo simbolo è riportato sullo strumento. Rendervi conto della natura del pericolo e delle precauzioni che dovrete prendere.
	Tensione pericolosa
	Pericolo sostanze tossiche

Condizioni generali d'uso

Questo prodotto è stato progettato e collaudato per rispondere ai requisiti della direttiva IEC/EN61010-1 'Safety requirements for electrical equipment for measurement, control and laboratory use' per apparati di classe I portatili e per l'uso in un ambiente inquinato di grado 2. L'apparato è stato progettato per essere alimentato da un alimentatore di categoria I o II.

Lo strumento deve essere protetto dal possibile ingresso di liquidi quali, ad es., acqua, pioggia, neve, ecc. Qualora lo strumento venga portato da un ambiente freddo ad uno caldo, è importante lasciare che la temperatura all'interno dello strumento si stabilizzi prima di alimentarlo per evitare formazione di condense. Lo strumento deve essere utilizzato esclusivamente nelle condizioni ambientali descritte nel capitolo 1 'Performance data' del manuale operativo, in caso contrario le protezioni previste nello strumento potrebbero risultare non sufficienti.

Questo prodotto non è stato approvato per essere usato in ambienti pericolosi o applicazioni medicali. Se lo strumento deve essere usato per applicazioni particolari collegate alla sicurezza (per esempio applicazioni militari o avioniche), occorre che una persona o un istituto competente ne certifichi l'uso.

WARNING

Pericoli da elettricità (alimentazione c.a.)

Quest 'apparato è provvisto del collegamento di protezione di terra e rispetta le norme di sicurezza IEC, classe 1. Per mantenere questa protezione è necessario che il cavo, la spina e la presa d'alimentazione siano tutti provvisti di terra.

Il circuito d'alimentazione contiene dei filtri i cui condensatori possono restare carichi anche dopo aver rimosso l'alimentazione. Sebbene l'energia immagazzinata è entro i limiti di sicurezza, purtuttavia una leggera scossa può essere avvertita toccando i capi della spina subito dopo averla rimossa.

Non rimuovete mai le coperture perché così potreste provocare danni a voi stessi. Non vi sono all'interno parti di interesse all'utilizzatore.

Tutte gli interventi sono di competenza del personale qualificato. Vedi elenco internazionale dei Centri di Assistenza in fondo al manuale.

Fusibili

Notare che entrambi i capi del cavo d'alimentazione sono provvisti di fusibili. In caso di rottura di uno solo dei due fusibili, alcune parti dello strumento potrebbero restare sotto tensione.

WARNING

Pericolo d'incendio

Assicurarsi che, in caso di sostituzione, vengano utilizzati solo fusibili della portata e del tipo prescritti.

Se viene usata una spina con fusibili, assicurarsi che questi siano di portata adeguata ai requisiti di alimentazione richiesti dallo strumento. Tali requisiti sono riportati nel cap. 1 "Performance data".

WARNING

Pericolo sostanze tossiche

Alcuni dei componenti usati in questo strumento possono contenere resine o altri materiali che, se bruciati, possono emettere fumi tossici. Prendere quindi le opportune precauzioni nell'uso di tali parti.

WARNING

Litio

Quest 'apparato incorpora una batteria al litio o un circuito integrato contenente una batteria al litio.

Poiché il litio è una sostanza tossica, la batteria non deve essere mai né rotta, né incenerita, né gettata tra i normali rifiuti.

Questo tipo di batteria non può essere sottoposto né a ricarica né a corto-circuito o scarica forzata. Queste azioni possono provocare surriscaldamento, fuoriuscita di gas o esplosione della batteria.

WARNING

Posizionamento inclinato

Quando lo strumento è in posizione inclinata è raccomandato, per motivi di stabilità, non sovrapporre altri strumenti.

CAUTION

Caratteristiche d’uso

Questo strumento è stato progettato e prodotto da Aeroflex eseguire misure di potenza in RF

Se lo strumento non è utilizzato nel modo specificato da Aeroflex, le protezioni previste sullo strumento potrebbero risultare inefficaci.

Aeroflex non può avere il controllo sull’uso di questo strumento e non può essere ritenuta responsabile per eventi risultanti da un uso diverso dallo scopo prefisso.

Precauciones

WARNING **CAUTION** **Note**

Estos términos tienen significados específicos en este manual:

WARNING contienen información referente a prevención de daños personales.

CAUTION contienen información referente a prevención de daños en equipos.

Note contienen información general importante.

Símbolos

Los significados de los símbolos de peligro que aparecen en los equipos son los siguientes:

Símbolo	Naturaleza del peligro
	Vea el manual de funcionamiento cuando este símbolo aparezca en el instrumento. Familiarícese con la naturaleza del riesgo y con las acciones que deban de tomarse.
	Voltaje peligroso
	Aviso de toxicidad

Condiciones generales de uso

Este producto ha sido diseñado y probado para cumplir los requerimientos de la normativa IEC/EN61010-1 “Requerimientos de la normativa para equipos eléctricos de medida, control y uso en laboratorio”, para equipos clase I portátiles y para uso en un ambiente con un grado de contaminación 2. El equipo ha sido diseñado para funcionar sobre una instalación de alimentación de categorías I o II.

Debe protegerse el equipo de la entrada de líquidos y precipitaciones como nieve, lluvia, etc. Cuando se traslada el equipo de entorno frío a un entorno caliente, es importante aguardar la estabilización el equipo para evitar la condensación. Sólo debe utilizarse el aparato en las condiciones ambientales especificadas en el capítulo 1 “Especificaciones” o “Performance data” del Manual de Operación/Funcionamiento, en caso contrario la propia protección del equipo puede resultar dañada.

Este producto no ha sido aprobado para su utilización en entornos peligrosos o en aplicaciones médicas. Si se va a utilizar el equipo en una aplicación con implicaciones en cuanto a seguridad, como por ejemplo aplicaciones de aviónica o militares, es preciso que un experto competente en materia de seguridad apruebe su uso.

WARNING

Nivel peligroso de electricidad (tensión de red)

Este equipo cumple las normas IEC Seguridad Clase 1, lo que significa que va provisto de un cable de protección de masa. Para mantener esta protección, el cable de alimentación de red debe de conectarse siempre a una clavija con terminal de masa.

Tenga en cuenta que el filtro de red contiene condensadores que pueden almacenar carga una vez desconectado el equipo. Aunque la energía almacenada está dentro de los requisitos de seguridad, pudiera sentirse una ligera descarga al tocar la clavija de alimentación inmediatamente después de su desconexión de red.

No retire las cubiertas del chasis del instrumento, ya que pudiera resultar dañado personalmente. No existen partes que puedan ser reparadas en su interior.

Deje todas las tareas relativas a reparación a un servicio técnico cualificado. Vea la lista de Centros de Servicios Internacionales en la parte trasera del manual.

Fusibles

Se hace notar que el Equipo está dotado de fusibles tanto en el activo como el neutro de alimentación. Si sólo uno de estos fusibles fundiera, existen partes del equipo que pudieran permanecer a tensión de red.

WARNING

Peligro de incendio

Asegúrese de utilizar sólo fusibles del tipo y valores especificados como repuesto.

Si se utiliza una clavija con fusible incorporado, asegúrese de que los valores del fusible corresponden a los requeridos por el equipo. Ver sección de especificaciones del capítulo 1 para comprobar los requisitos de alimentación.

WARNING

Aviso de toxicidad

Alguno de los componentes utilizados en este equipo pudieran incluir resinas u otro tipo de materiales que al arder produjeran sustancias tóxicas, Por tanto, tome las debidas precauciones en la manipulación de esas piezas.

WARNING

Litio

En este equipo se utiliza una batería de litio (o contenida dentro de un CI).

Dada que el litio es una substancia tóxica las baterías de este material no deben ser aplastadas, quemadas o arrojadas junto a basuras ordinarias.

No trate de recargar este tipo de baterías. No las cortocircuite o fuerce su descarga ya que puede dar lugar a que la esta emita gases, se recaliente o explote.

WARNING

Tener en cuenta con el equipo inclinado

Si utiliza el equipo en posición inclinada, se recomienda, por razones de estabilidad, no apilar otros equipos encima de él.

CAUTION

Idoneidad de uso

Este equipo ha sido diseñado y fabricado por Aeroflex para realizar medidas de potencia de RF

Si el equipo fuese utilizado de forma diferente a la especificada por Aeroflex, la protección ofrecida por el equipo pudiera quedar reducida.

Aeroflex no tiene control sobre el uso de este equipo y no puede, por tanto, exigirsele responsabilidades derivadas de una utilización distinta de aquellas para las que ha sido diseñado.

Chapter 1
GENERAL INFORMATION

Contents

INTRODUCTION

The 6960B is a microprocessor controlled RF power meter which combines high accuracy with fast, easy, flexible operation and simple calibration and maintenance.

With the IFR 6910, 6920 and 6930 series of power sensors, the 6960B can be used to measure powers from +35 dBm (3 W) down to -70 dBm (0.1 nW) over a wide range of frequencies.

FEATURES

Accuracy

- The instrumentation error of the 6960B is no more than 0.5% in Watts mode or 0.02 dB in dB mode.
- The AUTOZERO function automatically zeros each of the instrument's five ranges and stores the data so that zero carry-over error is less than 0.03%.
- The AUTOCAL key automatically calibrates the instrument to an internal 50 MHz, 1 mW power reference. Calibration factor data supplied with each sensor ensures that highest accuracy is maintained across the whole of the sensor's frequency range.
- Power sensors are provided with individual linearity factor data. When entered into the 6060B, errors from this source are reduced to less than ±0.5% for full-scale on range 5.

Speed and ease of use

- Typical response time is 250 ms for manual operation, with fastest response of 25 ms when using the optional GPIB interface. Response time and resolution can be automatically optimized for each range.
- In normal operation the instrument will 'auto-range'. Any range may be 'held', however, to facilitate 'peaking' adjustments.
- A 'max-hold' function allows only the maximum measured power value to be displayed.
- Manual control is through a calculator-type keypad, which allows rapid selection of instrument settings and entry of data.
- The main display is a large four-digit LCD with a variety of annunciators (see Fig. 1-1). An additional analogue meter gives a display relative to the top of the current range.

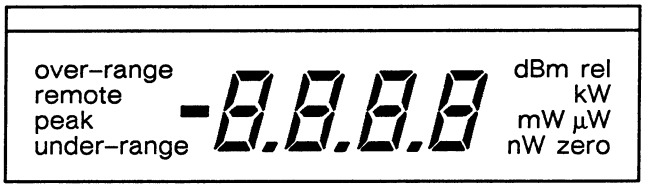


Fig. 1-1 : Liquid crystal display (LCD)

- Ten non-volatile memories, which can each store complete instrument settings for up to 10 years, further reduce test time and operator effort. The power-down settings can be automatically recalled at power-up if required.

Flexibility

- Measurements can be displayed in either logarithmic (dBm) or linear (nW, µW, mW, W, kW) units.
- Offsets can be entered using the dB REL key to allow for attenuation or amplification of power, or to measure drift.
- For pulse systems, direct readings of peak pulse power can be made by entering the appropriate duty cycle.
- The automatic setting of response time/resolution can be overridden to increase resolution, giving maximum displayed resolution of 0.001 dB.
- With the optional interface fitted (Option 001), the 6960B is fully programmable via the General Purpose Interface Bus (GPIB). Service requests (SRQs) are used to signal to the controller that the 6960B requires service, thus avoiding unnecessary delays in bus operation which may occur with a structured reading sequence.
- An optional external DC supply input is available. Any voltage within the range 11 to 32 V can be accepted, such as from a vehicle DC supply.

Ease of calibration, fault-diagnosis and maintenance

- A 'self-check' is performed at each power-up.
- Routine pre-measurement calibration is achieved by two key presses (AUTO ZERO AND AUTO CAL).
- Displayed error codes help to indicate the nature of any faults. The TEST mode allows the service engineer to test the operation of the D-A converters and digital circuits from the keyboard.
- Having isolated the area of a fault, 6960B's modular construction allows easy access to all components.
- Internal tests require only a standard DVM and counter/timer.

RF power sensors

Table 1-1 below summarizes he characteristics of the power sensors currently available or use with the 6960B. All sensors have a 50 dB dynamic range. The type of sensor in use is automatically recognized by the 6960B and ranges are set accordingly.

TABLE 1-1: GENERAL CHARACTERISTICS OF 6910, 6920 AND 6930 SERIES POWER SENSORS WHEN USED WITH 6970

Sensor	Frequency range	Power range	Connector
6910	10 MHz to 20 GHz	-30 to +20 dBm	N type (m)
6911	10 MHz to 20 GHz	-30 to +20 dBm	APC 7
6912	30 kHz to 4.2 GHz	-30 to +20 dBm	N type (m)
6913	10 MHz to 26.5 GHz	-30 to +20 dBm	3.5 mm (m)
6914	10 MHz to 40 GHz	-30 to +20 dBm	PC 2.92 mm (m)
6914S	10 MHz to 46 GHz	-30 to +20 dBm	PC 2.92 mm (m)
6919	30 kHz to 3 GHz	-30 to +20 dBm	N type (75 Ω)
6920	10 MHz to 20 GHz	-70 to -20 dBm	N type (m)
6923	10 MHz to 26.5 GHz	-70 to -20 dBm	3.5 mm (m)
6924	10 MHz to 40 GHz	-70 to -20 dBm	PC 2.92 mm (m)
6924S	10 MHz to 46 GHz	-70 to -20 dBm	PC 2.92 mm (m)
6930	10 MHz to 18 GHz	-15 to +35 dBm	N type (m)
6930-002	10 MHz to 18 GHz	-5 to +44 dBm	N type (m)
6932	30 kHz to 4.2 GHz	-15 to +35 dBm	N type (m)
6932-002	30 kHz to 4.2 GHz	-5 to +44 dBm	N type (m)
6934	10 MHz to 40 GHz	-15 to +30 dBm	PC 2.92 mm (m)
6934S	10 MHz to 46 GHz	-15 to +30 dBm	PC 2.92 mm (m)

The maximum safe input power for the power sensors is as follows:-

6910 series:	+25 dBm (300 mW) continuous, +42 dBm (15 W) for 2 µs.
6920 series:	+26 dBm (400 mW) continuous, +30 dBm (1 W) for 2 µs.
6930, 6932	+37 dBm (5W) continuous, +50 dBm (100 W) for 2 µs.
6930-002, 6932-002	45 dBm (30 W) continuous, 60 dBm (1 kW) for 2 µs.
6934	+33 dBm (2W) continuous, +45 dBm (32 W) for 2 µs.

Full details on the characteristics, operation and maintenance of the sensors are contained in the instruction manual which accompanies each sensor.

PERFORMANCE DATA

General

Display

Four digit LCD with floating decimal point. Contains the following annunciators:

Over-range, Remote, Peak, Under-range, dB, dBm, dB rel, nW, µW, mW, W, kW, Zero.

Keys

UNITS

Changes the displayed units between log (dB) and linear (mW).

dB REL

Enables dB offsets (+ve or -ve) to be made in either dB or mW units. Depressing the key displays the current offset which may then be entered or changed.

STORE

9 non-volatile stores (10 year storage time). Each store may hold complete instrument settings. The instrument state at power down is also saved.

AVERAGE

Enables any integer in the range 1 to 254 to be set. In AUTO mode the instrument automatically selects an average appropriate to range, i.e.:

Range	Average no.	Response time
1	50	12.5 s
2	20	5 s
3	4	1 s
4	1	0.25 s
5	1	0.25 s

Average number may be changed from front panel or GPIB.

RANGE

5 ranges provided. Depressing the RANGE key displays the current range automatically selected. Any other range may be selected by pressing the appropriate numeric key. In AUTO mode the instrument automatically selects the appropriate range. RANGE "9" initiates max hold, RANGE "8" turns the function off. When enabled the units flash.

RECALL

Selecting this function followed by a numeric key (0 to 9) recalls a previously stored instrument setting from non-volatile memory. Store 0 contains the instrument state at power down.

POWER UP	Pressing this key displays the current power up mode, PU 1 or PU 2. PU 1 sets all parameters to default on power up, i.e. Cal Factor 100, Linearity Factor 8, Duty Cycle 100%. PU 2 powers up the instrument with the settings that were used at power down.
LINEARITY FACTOR	Numeric entry to correct for power non-linearities of individual power sensors. Pressing the key displays the current setting which may then be entered or changed with the numeric keys.
CAL FACTOR	Pressing this key displays the current setting which may then be entered or changed with the numeric keys. Cal factors may be entered in the range 100% to 0.001%.
DUTY CYCLE	Enables entry of the duty cycle of a pulsed signal in the range 100% to 0.001%. The 6960B calculates the peak value of the pulsed signal from average power measured by the sensor. Selecting a value of <100% causes the "peak" annunciator to be displayed.
POWER REFERENCE	Pressing this key turns on the 0 dBm, 50 MHz power reference and illuminates the adjacent LED. The key has a toggle action.
AUTO ZERO	Initiates the auto zero routine. During operation the zero annunciator is displayed with five bars (–) which are progressively removed as the zero offset for each range is stored. It also turns off the power reference if this was on and restores it at completion.
AUTO CAL	Causes the 0 dBm, 50 MHz power reference to be turned on and "CAL" to be displayed while the auto cal function is performed. If a 6930 power sensor is connected appropriate averaging is also selected.
LOCAL	In manual operation, pressing the key once causes the GPIB address to be displayed. In GPIB operation pressing this key returns the instrument to manual operation.

Power-on display Software issue number, power up mode and GPIB address are each displayed for 2 seconds.

Frequency range Dependent on RF power sensor (see Table 1-1).

Power range Dependent on RF power sensor (see Table 1-1).

Power reference

Frequency:	50 MHz ±0.25 MHz.
Power:	1 mW.
Uncertainty:	±0.7%, traceable to national standards.
Accuracy:	±1.2% worst case for 1 year.

Instrumentation accuracy

Watts mode:	±0.5%.
dBm mode:	±0.02% dB.
dB REL mode:	±0.02% dB.

Zero

Set:	±1% of full scale on most sensitive range (range 1).
Carry over:	±0.03% of full scale (when zeroed on range 1).
Drift: (Over 1 h at constant temperature after 24 h stabilization)	±0.01% of full scale (±2% for 6920 series) on range 1, decreasing by a factor of 10 for each higher range.

Noise

Less than 1% of full scale (2% for 6920 series) on the most sensitive range with an average factor greater than 19 over a 10 s period.

Outputs

Fast levelling:	Proportional to indicated power. For external levelling of an RF source. 0 to 1 V, each range. 1 kΩ output impedance. (Excludes Cal. Factor, Linearity Factor and Average Number).
Recorder:	Proportional to indicated power. ±1.0%. In dB mode: 1 V/decade, 7 V max on range 5. In Watts mode: 0 to 5 V linear, each range.
Blanking:	Max voltage: 25 V Max current: 50 mA open collector, short circuit for blanking during AUTO ZERO.

Response time:

Range 1 (most sensitive):	1 second, selectable.
Ranges 2 to 5:	250 ms (display update). 25 ms selectable using GPIB.

GPIB interface (Option 001)

All front panel functions are remotely programmable except for test modes. Complies with the following sub-sets of IEEE 488-1978: SH1, AH1, T5, L4, SR1, RL1, DC1, DT1, E1.

Limit range of operation

Temperature: 0°C to 55°C.

Conditions of storage and transport

Temperature: -40°C to +70°C.

Humidity: Up to 95% RH at 35°C.

Altitude: Up to 2500 m (pressurized freight at 27 kPa differential, i.e. 3.9 lbf/in^2

Electromagnetic compatability

Conforms with the protection requirements of the EEC Council Directive 89/336/EEC.
Conforms with the limits specified in the following standards:
IEC/EN61326-1 : 1997, RF Emission Class B, Immunity Table 1, Performance Criterion B

Safety

Conforms with the requirements of EEC Council Directive 73/23/EEC and Standards IEC/EN 61010-1 : 2001 + C1 : 2002 + C2 : 2003.

This instrument is designed to comply with the requirements of IEC/EN61010-1 for Class I portable equipment and is for use in a pollution degree 2 environment. The equipment is designed to operate from installation supply categories I or II.

Power requirements

AC supply: Switchable voltage ranges:

105 V - 120 V~ (limit 90 - 132 V~)
210 V to 240 V~ (limit 188 - 264 V~)

Frequency: 50 Hz to 400 Hz (Limit 45 - 440 Hz).

Power consumption: 50 VA maximim.

DC supply (Option 004): Input voltage: Operates from 11 V to 32 V DC. The instrument resets below 11 V

Power consumption: 20 W maximum.

Dimensions and weight:

Height:	108 mm (including feet), 88 mm (excluding feet).
Width:	256 mm (including handle), 216 mm (excluding handle).
Length:	369 mm (overall).
Weight:	3.3 kg.

VERSIONS, ACCESSORIES AND ASSOCIATED EQUIPMENT

Options

GPIB	Option 001
Rear panel sensor input	Option 002
Top cover mounted storage pouch	Option 003
External DC operation	Option 004

Supplied accessories

	Order code
Operating manual	46882/124
Operating summary card	46882/123
AC supply lead	-
2 metre power sensor cable	06950/081
DC supply lead (DC input versions)	43138/154

Optional accessories

	Order code
GPIB manual (details of general GPIB protocols)	46881/365
Maintenance manual for 6960B	46882/125
GPIB IEEE/IEC connector adapter	46883/408
5 metre power sensor cable	06950/086
15 metre power sensor cable	06950/087
50 metre power sensor cable	06950/088
Rack mounting kit (double unit - 3 U high)	46884/501
Rack mounting kit (single unit - 2 U high)	46884/500
Stowage cover	54124/022

Associated equipment

RF Power Sensors 6910, 6920 and 6930 Series. See Table 1-1.

EC Declaration of Conformity

Certificate Ref. No.: DC217

The undersigned, representing:

Manufacturer:	**Aeroflex International Ltd.**
Address:	**Longacres House, Six Hills Way,** **Stevenage, Hertfordshire, UK SG1 2AN**

Herewith declares that the product:

Equipment Description:	RF Power Meter
Model No.	6960B
Options:	1, 2, 4

is in conformity with the following EC directive(s)
(including all applicable amendments)

Reference No.	Title:
73/23/EEC	Low Voltage Directive
89/336/EEC	EMC Directive

and that the standards and/or technical specifications referenced below have been applied:

Safety:
IEC/EN61010-1 : 2001 + C1 : 2002 + C2 : 2003

EMC:
IEC/EN 61326-1:1997 + A1 : 1998 + A2 : 2001
RF Emission Class B, Immunity Table 1 and Performance Criterion B

Qualifying Notes:

Aeroflex Stevenage (Place) 23 December 2003 (Date)

(Signature)

Robert Trott — Director of Product Assurance

Chapter 2

INSTALLATION

Contents

UNPACKING AND REPACKING

Retain the packing materials and the packing instructions note (if included) in case it is necessary to reship the instrument.

If the instrument is to be returned for servicing attach a label indicating the service required, type or model number (on rear label), serial number and your return address. Pack the instrument in accordance with the general instructions below or with the more detailed information in the packing instruction note.

(1) Place a pad in the bottom of the container.

(2) Place pads in the front and rear ends of the container with the plywood load spreader(s) facing inwards.

(3) Put the polythene over the instrument and place it in the container with the front handles and rear projections (where applicable) against the plywood load spreaders.

(4) Place pads in the two sides of the container with cushioning facing inwards.

(5) Place the top pad in position.

(6) Wrap the container in waterproof paper and secure with adhesive tape.

(7) Mark the package FRAGILE to encourage careful handling.

Note ...

If the original container or materials are not available, use a strong double-wall carton packed with a 7 to 10 cm layer of shock absorbing material around all sides of the instrument to hold it firmly. Protect the front panel controls with a plywood or cardboard load spreader; if the rear panel has guard plates or other projections a rear load spreader is also advisable.

MOUNTING ARRANGEMENTS

Excessive temperatures may affect the instrument's performance, therefore, completely remove the plastic cover, if one is supplied over the case. Avoid standing the instrument or associated sensors in the vicinity of large transformers or other possible magnetic fields or where X-rays are present. If the source of such fields cannot be isolated Mumetal shields should be used to provide the necessary screening.

CLASS I POWER CORDS (3-CORE)

General

This instrument is a Safety Class 1 product and therefore must be earthed. Use the supplied power cord or an appropriate replacement. Make sure the instrument is plugged into an outlet socket with a protective earth contact.

The detachable power cord is the instrument's disconnecting device, but if the instrument is integrated into a rack or system, an external power switch or circuit breaker is required. Whichever is the disconnecting device, make sure it can be easily reached by the operator and that it is accessible at all times.

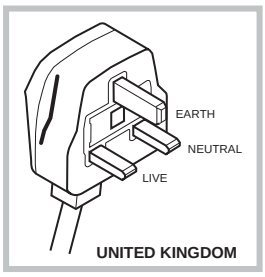
When the equipment has to be plugged into a Class II (ungrounded) 2-terminal socket outlet, the cable should either be fitted with a 3-pin Class I plug and used in conjunction with an adapter incorporating a ground wire, or be fitted with a Class II plug with an integral ground wire. The ground wire must be securely fastened to ground. Grounding one terminal on a 2-terminal socket will not provide adequate protection.

In the event that a moulded plug has to be removed from a lead, it must be disposed of immediately. A plug with bare flexible cords is hazardous if engaged in a live socket outlet.

Power cords with the following terminations are available from Aeroflex. Please check with your local sales office for availability.

British

Country	IEC 320 plug type	Part number
United Kingdom	Straight through	23422/001
United Kingdom	Right angled	23422/002



C3510

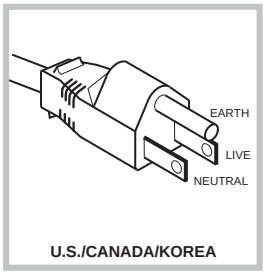
The UK lead is fitted with an ASTA approved moulded plug to BS 1363.

A replaceable 13 A fuse to BS 1362 is contained within the plug. This fuse is only designed to protect the lead assembly. Never use the plug with the detachable fuse cover omitted or if the cover is damaged.

The fuse(s) or circuit breaker to protect the equipment is fitted at the back of the equipment.

North American

Country	IEC 320 plug type	Part number
North American	Straight through	23422-004
North American	Right angled	23422-005

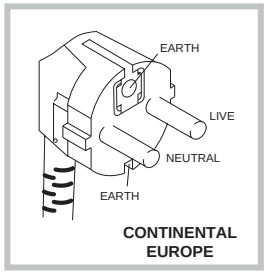


C3511

The North American lead is fitted with a NEMA 5-15P (Canadian CS22.2 No 42) plug and carries approvals from UL and CSA for use in the USA and Canada.

Continental Europe

Country	IEC 320 plug type	Part number
Europe	Straight through	23422-006
Europe	Right angled	23422-007



C3512

The Continental European lead is fitted with a right angle IEC83 standard C4 plug (CEE 7/7) which allows it to be used in sockets with either a male earth pin (standard C 3b) or side earth clips (standard C 2b) the latter is commonly called the German ‘Schuko’ plug. In common with other Schuko style plugs, the plug is not polarized when fitted into a Schuko socket. The lead carries approvals for use in Austria, Belgium, Finland, France, Germany, Holland, Italy, Norway and Sweden. Note that this plug will not fit Italian standard CEI 23-16 outlets. The lead should not be used in Denmark given that the earth connection will not be made.

Français

Le câble d'alimentation d'Europe Continentale est muni d'un connecteur mâle à angle droit type CEI83, standard C4 (CEE 7/7), qui peut être utilisé dans une prise femelle à ergot de terre (standard C 3b) ou à clips latéraux (standard C 2b), cette dernière étant communément appelée prise “Schuko” allemande. De la même façon que les autres connecteurs de type Schuko, celui-ci n'est pas polarisé lorsqu'il s'adapte à une prise femelle Schuko. Ce câble d'alimentation est homologué en Allemagne, Autriche, Belgique, Finlande, France, Hollande, Italie, Norvège et Suède. A noter que ce connecteur n'est pas compatible avec les prises de courant italiennes au standard CEI 23-16. Ce câble ne doit pas être utilisé au Danemark à cause du défaut de connexion de masse.

Deutsch

Das kontinentaleuropäische Netzkabel ist mit einem rechtwinkeligen Stecker nach IEC83 C4 (CEE7/7) Standard versehen, welcher sowohl in Steckdosen mit Erde-Stift (Standard C 3b) oder seitlichen Erdeklemmen, im allgemeinen “Schukosteckdose” genannt, paßt. Üblicherweise ist der Schukostecker bei Verwendung in Schukosteckdosen nicht gepolt. Dieses Netzkabel besitzt Zulassung für Österreich, Belgien, Finnland, Frankreich, Deutschland, Holland, Italien, Norwegen und Schweden.

Hinweis: Dieser Schukostecker paßt nicht in die italienischen Standardsteckdosen nach CEI 23-16 Norm. Dieses Netzkabel sollte nicht in Dänemark verwendet werden, da hier keine Erdeverbindung hergestellt wird.

Español

El cable de alimentación tipo Europeo Continental dispone de una clavija C4 normalizada IEC83 (CEE 7/7) que permite su utilización tanto en bases de enchufe con toma de tierra macho (tipo C 3b) o con toma de tierra mediante contactos laterales (tipo C 2b) que, en este último caso, suele denominarse “Schuko”. Al igual que cualquier otra clavija tipo Schuko, las conexiones a red no están polarizadas cuando se conectan a una base tipo Schuko. El cable lleva autorización para su uso en Austria, Bélgica, Finlandia, Francia, Alemania, Holanda, Italia, Noruega y Suecia. Observe que este cable no se adapta a la norma italiana CEI 23-16. El cable no debe utilizarse en Dinamarca en el caso de no efectuarse conexión a tierra.

Italiano

I cavi d'alimentazione per l'Europa continentale vengono forniti terminati con una spina ad angolo retto del tipo C4 secondo lo standard IEC83 (CEE 7/7) che può essere usato in prese in cui la terra può essere fornita o tramite connettore maschio (C 3b) o tramite clips laterali (C 2b), quest'ultima comunemente detta di tipo tedesca “Schuko”. Questa spina, quando collegata ad una presa Schuko, non è polarizzata.

Il cavo può essere usato in Austria, Belgio, Finlandia, Francia, Germania, Olanda, Norvegia, Svezia ed Italia. E' da notare che per l'Italia questo non risponde allo standard CEI 23-16.

Questa spina non dovrebbe invece essere usata in Danimarca in quanto non realizza il collegamento di terra.

CONNECTING TO AC SUPPLY

Before connecting the instrument to the AC supply, check the position of the voltage selector switch. The range selected can be seen on the side of the switch protection plate situated on the rear panel.

The instrument is normally dispatched selected to the 210-240 V range. To select the 105-120 V range remove the protection plate, switch ranges and change the value of the AC supply fuses to that shown below, reverse and refit the protection plate.

Fuses are 20 mm x 5 mm cartridge type.

115 V range: T500mAL250V
230 V range: T250mAL250V

ROUTINE SAFETY TESTING AND INSPECTION

In the UK, the ‘Electricity at Work Regulations’ (1989) section 4(2) places a requirement on the users of equipment to maintain it in a safe condition. The explanatory notes call for regular inspections and tests together with a need to keep records.

The following electrical tests and inspection information is provided for guidance purposes and involves the use of voltages and currents that can cause injury. It is important that these tests are only performed by competent personnel.

Prior to carrying out any inspection and tests, the instruments must be disconnected from the mains supply and all external signal connections removed. All tests should include the instrument’s own supply lead, all covers must be fitted and the equipment supply switch must be in the ‘ON’ position.

The recommended inspection and tests fall into three categories and should be carried out in the following sequence:-

1. Visual inspection
2. Earth bonding tests
3. Insulation resistance test

1. Visual inspection

A visual inspection should be carried out on a periodic basis. This interval is dependent on the operating environment, maintenance and use, and should be assessed in accordance with guidelines issued by the Health and Safety Executive (HSE). As a guide, this instrument when used indoors in a relatively clean environment would be classified as 'low risk' equipment and hence should be subject to safety inspections on an annual basis. If the use of the equipment is contrary to the conditions specified, you should review the safety re-test interval.

As a guide, the visual inspection should include the following where appropriate:

Check that the equipment has been installed in accordance with the instructions provided (e.g. that ventilation is adequate, supply isolators are accessible, supply wiring is adequate and properly routed).

The condition of the mains supply lead and supply connector(s).

Check that the mains supply switch isolates the instrument from the supply.

The correct rating and type of supply fuses.

Security and condition of covers and handles.

Check the supply indicator functions (if fitted).

Check the presence and condition of all warning labels and markings and supplied safety information.

Check the wiring in re-wireable plugs and appliance connectors.

If any defect is noted this should be rectified before proceeding with the following electrical tests.

2. Earth bonding tests

Earth bonding tests should be carried out using a 25 A (12 V maximum open circuit voltage) DC source. Tests should be limited to a maximum duration of 5 seconds and have a pass limit of 0.1 Ω after allowing for the resistance of the supply lead. Exceeding the test duration can cause damage to the equipment. The tests should be carried out between the supply earth and exposed case metalwork, no attempt should be made to perform the tests on functional earths (e.g. signal carrying connector shells or screen connections) as this will result in damage to the equipment.

3. Insulation tests

A 500 V DC test should be applied between the protective earth connection and combined live and neutral supply connections with the equipment supply switch in the 'on' position. It is advisable to make the live/neutral link on the appliance tester or its connector to avoid the possibility of returning the equipment to the user with the live and neutral poles linked with an ad-hoc strap. The test voltage should be applied for 5 seconds before taking the measurement.

Aeroflex employs reinforced insulation in the construction of its products and hence a minimum pass limit of 7 MW should be achieved during this test.

Where a DC power adapter is provided with the equipment, the adapter must pass the 7 MΩ test limit.

We do not recommend dielectric flash testing during routine safety tests. Most portable appliance testers use AC for the dielectric strength test which can cause damage to the supply input filter capacitors.

4. Rectification

It is recommended that the results of the above tests are recorded and checked during each repeat test. Significant differences between the previous readings and measured values should be investigated.

If any failure is detected during the above visual inspection or tests, the equipment should be disabled and the fault should be rectified by an experienced Service Engineer who is familiar with the hazards involved in carrying out such repairs.

Safety critical components should only be replaced with equivalent parts, using techniques and procedures recommended by Aeroflex.

The above information is provided for guidance only. aeroflex designs and constructs its products in accordance with International Safety Standards such that in normal use they represent no hazard to the operator. Aeroflex reserves the right to amend the above information in the course of its continuing commitment to product safety.

Cleaning

Before commencing any cleaning, switch off the instrument and disconnect it from the supply. The exterior surface of the case may be cleaned using a soft cloth moistened in water. Do not use aerosol or liquid solvent cleaners.

Cleaning the LCD Window

To prevent damage to the LCD window, care should be taken not to scratch the surface during use and also when cleaning. The LCD window should be cleaned by wiping a slightly damp, soft, lint-free cloth gently over the surface. To remove grease or smears, use a clean cotton cloth moistened with Heptane. No other cleaning agents should be used. Clean the window using either horizontal or vertical strokes, NEVER a circular action.

GPIB INTERFACE

The GPIB interface module is available as an optional accessory (no. 03964-650E). This consists of a kit of parts, complete with fitting instructions.

RACK MOUNTING KITS

(1) For rack mounting the 6960B on its own, a single unit rack mounting kit (no. 46884-500K) is available. This contains a pair of side angle plates wide enough to allow the instrument o sit centrally within the rack frame.

(2) For rack mounting the 6960B on its own, a single unit rack mounting kit (no. 46884-501A) is available. This kit contains fixings for joining the two instruments together and for attaching the twinned unit to the rack. A blanking plate is also supplied for one half of the kit, allowing the 6960B to be mounted alone while retaining the option of mounting a second instrument beside it.

(3) Rack mounting instructions are supplied with the kits.

Chapter 3

OPERATION

Contents

FRONT PANEL CONTROLS AND CONNECTORS

[1] **SUPPLY** switch. Applies mains supply to the instrument.

[2] **SENSOR INPUT**. Accepts multipin connector from the sensor input cable.

[3] **POWER REFERENCE** output. 50 Ω, N (f) connector accepts the power sensor for calibration to the internal 50 MHz, 1 mW reference signal.

Note...

Adapters are provided with the 6913 and 6923 (SMA type connector) and 6919 (75 Ω impedance) sensors, and a 30 dB attenuator is provided with the 6920 series (low power) sensors to allow calibration to the internal calibrator.

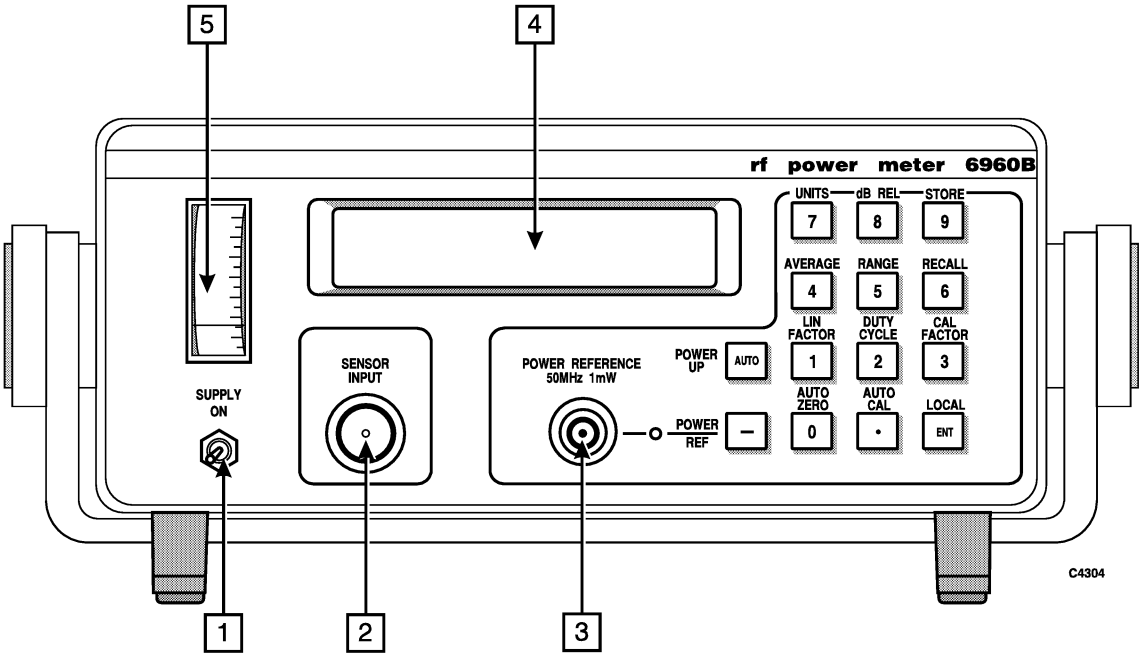


Fig. 3-1 Front panel controls and connectors

4 **LCD display.** Large 4 digit LCD display with comprehensive annunciators which indicate units, over-range and under-range conditions, autozeroing and remote operation.

5 **Analogue 'peaking' meter**. Displays a level relative to the top of the current range. Used with the range hold function to determine the trend of the changing power level. Especially useful when devices must be adjusted for maximum or minimum output power.

KEYPAD

The keypad consists of 14 keys, all with dual functions. The primary functions are indicated by the labels *above* each key, the secondary functions (the numeric keypad, ENTer and AUTO functions) by the labels *on* the keys.

After selection of a primary function the numeric keys and ENT or AUTO are normally enabled to allow numerical change to that function.

The primary functions of all 14 keys are summarized below. Secondary functions are shown in brackets:

STORE (9). Used to store current instrument settings (LINEARITY FACTOR, CAL FACTOR, DUTY CYCLE etc.) to non-volatile memory. Pressing one of the digits 1 to 9 after [STORE] defines the memory to which the settings are stored. Memory 0 cannot be written to as it is reserved for the power-down settings of the instrument : these may be automatically recalled at power-up or by using the RECALL or POWER UP keys.

dB REL (8). Used to enter an offset into the 6960B's power reading. The general formula for measurement display in the dB REL mode is:

Measured power (dBm or W) - Offset (dB) = Displayed power (dBm rel or W rel).

UNITS (7). Toggles between logarithmic (dBm) or linear (kW, W, mW, μW, nW) measurement units.

RECALL (6). Recalls the contents of memories 0 to 9.

RANGE (5). Allows auto-ranging to be overridden so that any one of ranges 1 to 5 can be held.

AVERAGE (4). Allows entry of an average factor which is a number from 1 to 254. Increasing the average factor value improves the display resolution and also determines the settling time. The default value is automatically selected according to the range but may be changed by the user to allow fast response on range 1 for example.

CAL FACTOR (3). Allows entry of a sensor calibration factor appropriate to the frequency of measurement (given on the side of the sensor or from the calibration data chart).

DUTY CYCLE (2). Allows the entry of the duty cycle of a pulse waveform so that peak pulse power is displayed. Duty cycles as low as 0.001% can be accommodated. The 'peak' annunciator indicates that a value of <100% has been selected.

LIN FACTOR (1). Allows entry of sensor linearity factor (given on the side of the sensor or from its calibration data chart).

AUTO ZERO (0). Initiates auto-zeroing of the instrument's five ranges. The power reference is turned off during AUTO ZERO and on completion is returned to its state prior to AUTO ZERO.

AUTO CAL (·). Switches on the internal 50 MHz, 1 mW power reference against which the sensor is calibrated, and initiates auto-calibration. When auto-calibration is completed, the power reference returns to the state prior to AUTO CAL.

POWER REF (-). Toggles the internal power reference on/and off. Allows visual confirmation that auto-calibration has been successful : display shows 0 dBm (1 mW) with the 6910 series sensor connected to the power reference, -30 dBm with 6920 series (when using 30 dB attenuator) and -15 dBm with 6930.

LOCAL (ENT). Returns the instrument to keyboard control from GPIB operation (unless local lockout has been selected). Displays GPIB address when in local mode.

POWER UP. Selects power-up modes PU1 and PU2. PU1 sets the instrument to the standard (default) settings. PU2 sets the instrument to the settings in use before power down.

(AUTO). Selects auto RANGE and auto AVERAGE. Also sets default values of LINearity FACTOR, DUTY CYCLE and CAL FACTOR.

REAR PANEL CONTROLS AND CONNECTORS

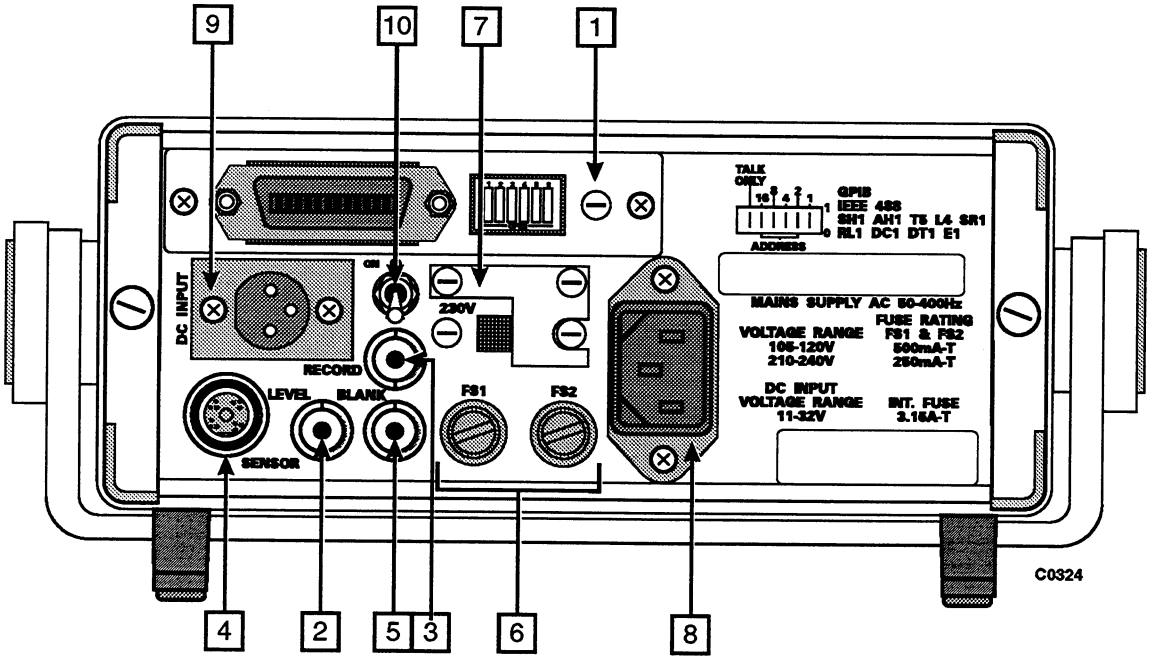


Fig. 3–2 : Rear panel controls and connectors

[1] **GPIB interface.** This is available when Option 001 is fitted, or as an optional accessory (03964–650E). An adapter (46883–408K) is available to convert from the interface's IEEE–488 connector to IEC 625 systems.

[2] **LEVELLING O/P (BNC).** When this socket is connected to the levelling input of a sweep generator, the RF output of the generator can be levelled. A defined portion of the generator's output should be fed to the 6960B's input (via a calibrated coupler). Provided that the power variation falls within one of the 6960B's ranges (that is, ±5 dB of centre–range) fast responding levelling can be achieved. Note that LINEARITY and CAL FACTOR information is not included in the levelling signal.

[3] **RECORDER O/P (BNC).** When this socket is connected to an X–Y recorder a plot can be made over the full dynamic range (50 dB) in either the dBm or W mode. Full correction information (LINEARITY and CAL FACTOR) is included. Disabled when using fast GPIB trigger mode.

[4] **Rear SENSOR I/P** (Option 002). Enables the RF sensor to be connected to the rear of the instrument in rack mounted systems. When fitted, this option disables the front panel sensor input and a blanking plug is provided for the front input connector.

[5] **BLANKING OUTPUT (BNC).** By connecting this output to the RF blanking input of a sweep generator it is possible to turn off the RF output during the 6960B's AUTOZERO function. This facility allows the RF sensor to remain connected to the test system while the instrument autozeros.

[6] **AC supply fuses.** Supply input fuses are rated at 250 mA-T/LAG (time lag) for 210-250 V operation or 500 mA-T/LAG for 105-120 V operation.

WARNING

This instrument employs double fusing. Should the fuse in the neutral line fail, certain areas in the instrument may still be at mains potential.

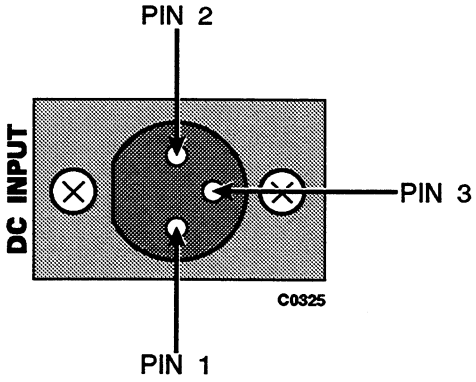
[7] **AC supply locking plate.** The instrument is normally despatched with the the plate locking the supply selector switch to the 210-250 V position. To change to 105-120 V operation, remove the locking plate, adjust the switch, reverse the locking plate and refit.

[8] **AC supply input.** Accepts AC supply input of 210-250 V or 105-120 V at 45-440 Hz. The earth pin is internally connected to the chassis.

[9] **DC supply input** (Option 004). Accepts DC supply input of 11-32 V at 15 W. DC supply fuse is fitted internally and rated at 3.15 A-T/LAG.

Note, the pin connections are as follows:-

Pin 1 +ve
Pin 3 N.C. } See below
Pin 2 -ve



[10] **DC supply switch** (Option 004). Applies DC supply to the instrument

NOTE ON KEYPAD OPERATION AND LCD DISPLAYS

All manual operations (zeroing, calibration, storage, recall etc.) are performed by the fourteen keys on the front panel. All of the keys have two functions: primary and secondary.

Most of the primary functions have numeric values associated with them. When such a 'numerically defined' function is selected, its current value is displayed on the LCD and the secondary functions (the numeric keys and ENT) are enabled to allow the value to be changed.

The procedure for changing the value of a numerically defined function is:

[FUNCTION] [DIGITS] [ENT]

This sequence is used by the following keys:-

STORE	RECALL	AVERAGE	DUTY CYCLE	POWER UP
dB REL	RANGE	CAL FACTOR	LIN FACTOR	

The digits appear on the LCD as they are typed in. If the wrong value is entered, the entry should be completed using the [ENT] key, and the function re-selected. If a value outside the range of the function is entered, an error code (**Er 5**) is displayed and the appropriate limiting value is set.

If it is simply required to view the current value of a function without change, the procedure is:

[FUNCTION] [ENT]

The 'non-numerically' defined primary functions are of two types:

(i) AUTOCAL, AUTOZERO, LOCAL. Selection of one of these functions initiates the appropriate operation.

(ii) UNITS, POWER REF. These keys have a 'toggle' action.

Key-press operations are indicated throughout this chapter by square brackets enclosing the function label. For example:

[LINEARITY FACTOR] [7.5] [ENT]

indicates the procedure for entry of a linearity factor of 7.5. LCD displays (which are either formed by the segments of the main 4 digit display, or are dedicated annunciators) are indicated by bold type in the following text.

To enter a value of zero into the 'dB Rel' store it is necessary to press the decimal point key followed by ENTER.

PREPARATION FOR USE (including LINEARITY FACTOR, AUTO ZERO, AUTO CAL, POWER REF)

Note...

On early instruments, the LCD may indicate a 6960A type number at power-on, rather than 6960B, although the instrument is a 6960B in every other respect.

(1) Check that the rear-panel supply locking plate is correctly set for the supply available. Connect the 6960B to the supply via the supply lead.

(2) Select the appropriate sensor for the power and frequency range to be tested and connect it via the sensor input cable to the SENSOR INPUT connector on the front panel.

(3) Switch the 6960B on. The following sequence of displays should appear on the LCD:

Is n Software issue number.

PU n Power Up mode selected (either 1 or 2).

Ad n GPIB address (if GPIB module is fitted).

Each item is displayed for approximately 2 seconds.

The display then shows either a very low power reading, or five dashes with an "under-range" annunciator, or alternates between these two conditions.

(4) If, however, a fault has been detected during the power-up self-check routine, the error code **Er 1** will be displayed.

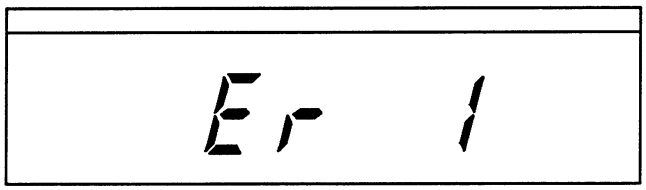


Table 3-1 lists all the displayed error codes. Consult the Service Manual for full information on fault-finding and repair.

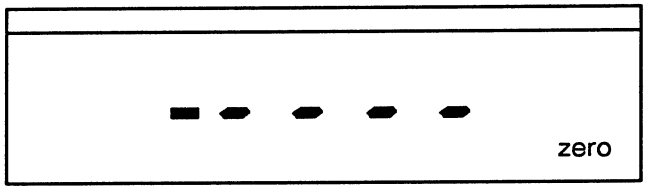
TABLE 3-1: DISPLAYED ERROR CODES

Code	Meaning
Er 1	Power-up fail
Er 2	No RF sensor
Er 3	Auto-zero fail
Er 4	Auto-cal fail
Er 5	Entered number outside function limits (Manual & GPIB operation)
Er 6	Results exceed display capability
Er 12	Store/recall error

(5) Enter the sensor's LINEARITY FACTOR. This is shown on the sensor's label or, more precisely (to two decimal places), on the Calibration Data Chart which accompanies the sensor. The allowed range of LINEARITY FACTOR is 0.1 to 14.99. The default (standard power-up) value is 8. When the new value has been entered, the low power reading/five dashes display reappears.

LINEARITY FACTOR is a correction figure to allow for the non-linearity of the sensor's response to high power levels.

(6) Select [AUTO ZERO]. Five dashes and the zero annunciator are displayed.

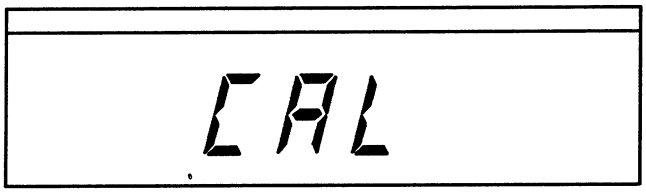


As each range is zeroed, one of the dashes is blanked. When the last dash (representing the most sensitive range) is blanked, the low power reading/five dashes display reappears.

(7) For uiltimate accuracy, the power reference should be switched on (using the [POWER REF] key) for a minimum of 15 minutes before an AUTO CAL is performed. Connect the sensor to the 50 MHz, 1 mW POWER REFERENCE connector.

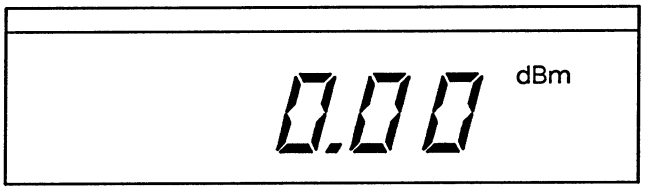
Use the N-type to SMA adapter for 6913/6914/6934.
Use the 75 Ω to 50 Ω adapter for 6919.
Use the 30 dB pad for 6920.
Use the 30 dB pad and N-type to SMA adapter for 6923/6924.

Enter the REFERENCE CAL FACTOR for the sensor. This is given on the side of all sensors except the 6910 and 6913, which always have a cal factor of 100 at 50 MHz. Press [AUTO CAL]. The display shows CAL and the LED adjacent to the POWER REFERENCE connector is illuminated to indicate that the reference signal is switched on.



When calibration is complete, the reference signal is automatically switched off, the LED is extinguished and the low power reading/five dashes display reappears (unless the Power Reference was already on prior to selections Auto Cal, in which case the Power Reference remains on).

(8) The success of the auto-calibration can be confirmed by pressing [POWER REF]. This switches the power reference on again and the display should read 0.00 dBm.



[POWER REF] has a toggle action: reselection will switch the reference signal off.

MANUAL OPERATION

The 6960B is now ready to make power measurements. Remove the sensor from the POWER REFERENCE connector and connect it (via attenuator or matching unit as required) to the source to be measured. A power reading (in dBm) will be obtained.

CAUTION

IFR 6910, 6920 and 6930 series power sensors have precision connectors (N type and 3.5 mm) and APC 7. To avoid damage to these connectors, they should not be mated with non-precision connectors.

KEY FUNCTIONS

The remaining front panel keys allow for a variety of refinements to be made to this basic reading. Each of the keys not already discussed in "Preparation for use" is described below.

CAL FACTOR

CAL FACTOR is a correction figure which takes into account the variation in efficiency of RF to DC conversion in the sensor, including the full effect of VSWR.

If the frequency of the source to be measured is known, the accuracy of the reading can be improved by entering the CAL FACTOR corresponding to this frequency. A graph of CAL FACTOR against frequency is given on the side of each sensor, and the calibration data chart gives CAL FACTOR at appropriate frequency intervals to two decimal places. The maximum CAL FACTOR is 100 (%) and this is also the default (standard power-up mode 1) figure.

AVERAGE (Auto)

If AUTO averaging is selected, the 6960B automatically selects the appropriate average factor which gives optimum resolution with the minimum final display time for the range selected. The 'Auto' average factors selected are as follows:-

Range	Average factor	Final display time (seconds)
1	50	11.5
2	20	4.6
3	4	0.92
4	1	0.23
5	1	0.23

Auto averaging is the default setting.

AVERAGE (Manual)

Response time depends on the rang selected but it can be changed by manually entering an average factor. The higher the average factor value he slower the response time but resolution may be increased. The maximum average actor allowed is 254.

The default (standard power-up) average factor is 1 on ranges 4 and 5. This gives appropriate resolution with a minimum response time that is the time taken for the 6960B to display a power level which is 1 second for range 1 and 250 ms for ranges 2 to 5, see Table 3–2.

Table 3–3 shows the effect of increasing the average factor on range 1. The power levels and resolutions quoted in both tables apply to a 6910 sensor.

TABLE 3–2 : RESOLUTIONS AND RESPONSE TIMES FOR ALL RANGES : AVERAGE FACTOR 1

Average factor	Range	Power level (dBm)*	Resolution (dB)*	Response time
1	5	+10 to +20	0.01	250 ms
1	4	+0 to +10	0.01	250 ms
1	3	−10 to +0	0.01	250 ms
1	2	−20 to −10	0.1	250 ms
1	1	−30 to −20	1	1 s

* 6910 sensor

TABLE 3–3 : RESOLUTIONS AND FINAL DISPLAY TIMES FOR RANGE 1 : AVERAGE FACTOR VARIABLE

Average factor	Range	Power level (dBm)*	Resolution (dB)*	Response time
1	1	−30 to −20	1	1 s
4	1	−30 to −20	0.1	1 s
20	1	−30 to −20	0.01	5 s
50	1	−30 to −20	0.001	12 s

* 6910 sensor

It can be seen from Table 3–3 that increased resolution is achieved at the expense of increased final display time. In general (apart from average factor 1 on RANGE 1):

Final display time = 250 ms x average factor

However, standard resolution is displayed after the minimum response time and the resolution is then progressively improved as the averaging takes effect. Thus, with an average factor of 50 selected on range 1; 0.1 dB resolution is displayed after 1 s, 0.01 dB after 5 s and finally 0.001 dB after 12 s.

Notes ...

(1) When the power level being measured changes appreciably, a faster response time can be obtained by restarting the averaging. This is done by pressing {AVERAGE] [AUTO] when in Auto averaging mode, or [AVERAGE] [ENTER] when in manual averaging mode.

(2) When 'max hold' is selected the average number is set to 1 and can not be changed. On selecting AVERAGE the 1 will be displayed for approximately one second and the 6960B will return to displaying the measurement. Auto average will be selected on turning off the 'max hold' function.

(3) Maximum resolution is 0.001 dB (logarithmic) which corresponds to 0.1 nW for 6910 series sensors or 1.0 pW for the 6920.

(4) In GPIB operation the minimum response time can be up to 10 times faster at 25 ms – see GPIB Operation, Chap. 3–1.

UNITS

The units of measurement may be changed between logarithmic (dBm) and linear (nW, μW, mW, W, kW) by pressing [UNITS]. The key has a 'toggle' action.

Operation of the [UNITS] key cancels dB REL mode.

The units conversion is performed by a numerical algorithm which eliminates the temperature drift errors which can occur with analogue conversion circuits.

dB REL

This function allows an offset to be introduced into the power reading. A typical application is to obtain a true reading of a power level which is too high for the sensor in use, and has therefore had to be attenuated before measurement.

The procedure for entering an offset is:

[dB REL] [DIGITS] [ENT]

where the value entered is the offset in dB.

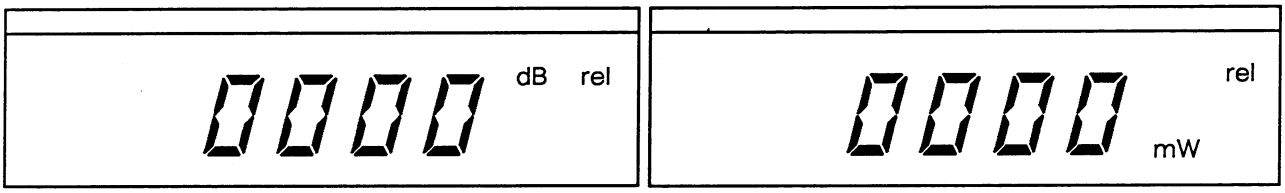
To achieve a reading of pre–attenuated power, the *loss* of the attenuator(in dB) should be entered with a preceding *minus* sign. For a reading of pre–amplified power, the gain (in dB) should be entered directly (no sign). Offsets in the range –100 dB to +100 dB may be entered.

Offsets can be entered when either logarithmic or linear measurement units are in use – but numeric entries must be in dB.

The current power reading can be made a 0 dB reference (to measure drift, for example) by simply pressing:

[dB REL] [AUTO]

When an offset is in use the rel annunciator appears in addition to the units annunciator.



To cancel the offset and dB REL mode press [UNITS]. This gives dBm measurement with no offset.

The current dB offset value can be displayed by pressing dB REL. If this value is still required press ENT otherwise a different value can be entered by the numeric keys then ENT, or the current power reading can be entered by pressing AUTO.

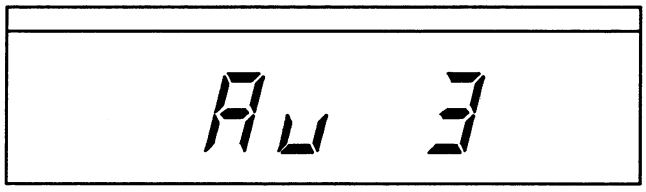
To enter a value of zero use the key sequence below:

[dB REL] [·] [ENT]

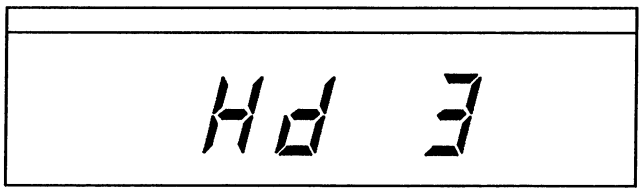
RANGE

Obtaining the maximum power point (using the analogue 'peaking' meter) can be made difficult by the autoranging of the instrument. The RANGE function allows individual ranges to be held to facilitate peaking measurements.

To hold any range (1 to 5), first select [RANGE]. The current range (e.g. range 3) is displayed as **Au 3** to indicate that this range has been automatically selected.



To hold this range press [3]. The display briefly shows **Hd 3** and then returns to the previous power reading.



When the power level is adjusted beyond the nominal limits of a 'held' range an **over-range** or **under-range** annunciator is displayed appropriately.

To restore auto-ranging select [RANGE] [AUTO].

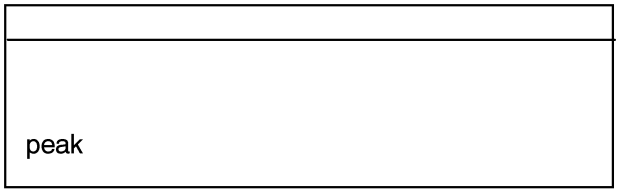
The RANGE key can also be used to enable and disable the 'max hold' function. See Page 3-15.

DUTY CYCLE

The 6960B can be used to display peak pulse power by entering the duty cycle of a pulse waveform. Duty cycles from 0.001% to 100% (CW) can be accommodated. Simply select:

[DUTY CYCLE] [DIGITS] [ENT]

When duty cycle values less than 100% are entered, the peak annunciator is illuminated.



It is not possible to make reliable measurements using a pulse repetition rate (p.r.f.) of less than 40 Hz due to the response time of the powermeter and sensor.

Also avoid p.r.f. of between 830 Hz and 1000 Hz.

For p.r.f. of less than 250 Hz, set the 'AVERAGE FACTOR' to 254 and use the 'RANGE HOLD' on the most appropriate range (see page 3-12).

STORE

The STORE key is used to store the current values/states of the functions listed in Table 3-4 to non-volatile memory. Nine memories (numbered 1 to 9) are available, each capable of storing all he listed functions. To store the current settings to a particular memory simply select [STORE] followed by the memory number.

TABLE 3-4 : FUNCTIONS STORABLE TO MEMORY

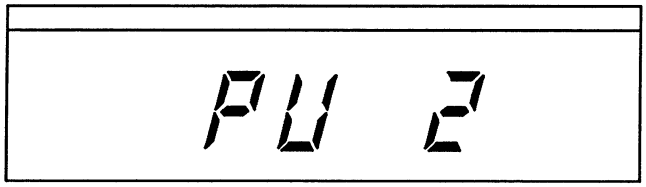
Function	Range/States
LINEARITY FACTOR	0.10 to 14.99
CAL FACTOR	0.001 to 100 (%)
RANGE	1 to 5 or AUTORANGING
AVERAGE	1 to 254 or AUTOAVERAGING
DUTY CYCLE	0.001 to 100 (%)
dB REL	-100 to +100 (dB)
POWER REF	OFF/ON
UNITS	log or linear (dBm, dB REL, W, W REL)
Max Hold	OFF/ON
AUTO ZERO	Current setting
AUTO CAL	Current setting

A tenth memory (memory 0) is reserved for the function settings at power down.

The battery back-up allows non-volatile storage for a minimum of 10 years.

POWER-UP

If the instrument is set to Power-Up Mode 2 by pressing [POWER-UP][2], the Power-down settings (stored in memory 0) will be automatically recalled at the next power-up. The display shows PU 2 (Power-Up Mode 2) for approximately 2 seconds. The power-down settings can also be recalled by pressing [RECALL][0] if the instrument is in Power-Up Mode 1.



This facility is useful in situations where the 6960B is monitoring power in a remote location and there is a temporary break in mains supply.

To restore the instrument to Power-Up Mode 1 (recall of standard settings at power-up) press [POWER-UP][1]. The display shows PU 1 for approximately 2 seconds.

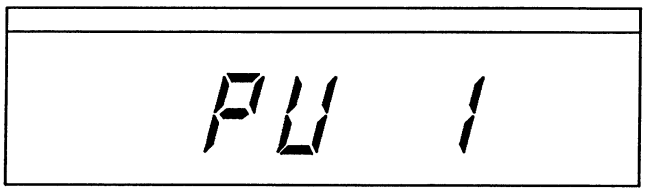


Table 3-5 lists the standard (PU 1) power-up settings.

TABLE 3-5 : STANDARD (PU 1) POWER-UP SETTINGS

Function	Status settings
LINEARITY FACTOR	8
CAL FACTOR	100 (%)
RANGE	AUTORANGING
AVERAGE	AUTOAVERAGING
DUTY CYCLE	100 (%)
dB REL	NO OFFSET
POWER REF	OFF
UNITS	dBm
Max Hold	OFF

RECALL

To recall any stored set of function settings, simply select [RECALL] followed by the appropriate memory number (0 to 9).

LOCAL

This key returns the 6960B to 'local' (manual) operation from 'remote' (GPIB) operation and causes the current GPIB address to be displayed. Does not operate if a "local-lockout" command has been sent by the controller (see GPIB Operation, Chap. 3-1).

Max Hold mode

When enabled, the Max Hold mode allows only the maximum value of a varying power level being measured to be displayed.

Enable Max Hold by pressing [RANGE][9]
Disable Max Hold by pressing [RANGE][8]

When Max Hold is enabled, the currently displayed unit annunciator, e.g. 'mW', is flashed on/off.

Note...

When Max Hold is selected the AVERAGE number is set to 1 and can not be altered.

Test mode

A variety of tests which are used in the calibration/maintenance of the 6960B are available through the Test mode.

To select Test mode, switch SUPPLY OFF and then ON while simultaneously pressing another key until test is displayed.

In the Test mode, specific tests can be initiated y pressing the appropriate attribute key. All available tests are listed in the Maintenance Manual. Two of these tests are described below:-

(1) **Keyboard test** Select [-].

Selection of any key will now result in its secondary (numeric) function being displayed. Note that displayed d = decimal point key pressed, E = "ENT".

(2) **Display test** Select [0].

All LCD segments, annunciators and the power reference LED are flashed to demonstrate correct operation.

To exit from Test mode switch SUPPLY OFF.

MAKING LOW LEVEL POWER MEASUREMENTS

The 6920 sensor when used with the 6960B Power Meter is an extremely sensitive measuring system capable of reading power levels as low as 70 dBm. It is therefore necessary to follow a few simple precautions to ensure an accurate reading at these low levels.

(1) Allow the sensor to stabilize to the ambient temperature before attempting to start the calibration and measurement.

(2) Ensure that the sensor is not subjected to changes of temperature during the calibration and measurement. For example, handle the sensor as little as possible and do not carry out the measurement in a stream of hot air from an instrument.

(3) When zeroing the sensor ensure that it is not receiving radiated power input at its connector.

(4) During the zeroing operation, the internal power reference of the 6960B is automatically switched off to prevent RF radiation being picked up by the power sensor.

(5) Zeroing procedure entails the following functions to be performed immediately prior to the measurement and in the order defined below:-

[AUTO ZERO]	With the sensor connected to 6960B power reference, operate zero control
[AUTO CAL]	With the sensor connected to 6960B power reference, operate cal control. Ensure 50 MHz calibration factor is correctly set.
again [AUTO ZERO]	With the sensor connected to the signal source to be measured, again ensuring no RF power is being applied to the sensor, operate zero control again.

The lowest level of power should be applied first, rather than starting at the highest level and reducing the level.

For optimum accuracy, when making low level power measurements, it is advisable to repeat the zeroing operations every 20 minutes (ensuring that no RF power is applied to the sensor, during this operation).

Chapter 3-1

GPIB OPERATION

Contents

The GPIB (General Purpose Interface Bus) module, either factory fitted or offered as an optional accessory, allows the instrument to be controlled by an external controller.

GPIB FUNCTIONS

The general GPIB functions and mnemonics (those not specific to the 6960B) are described below. Further information on the general features and applications of the GPIB system can be obtained from The "GPIB Manual" offered as an optional accessory (46881-365R).

SH1: Source handshake (complete capability)

The source handshake sequences the transmission of each data byte from the instrument over the bus data lines. The sequence is initiated when the function becomes active, and the purpose of the function is to synchronize the rate at which bytes become available to the rate at which accepting devices on the bus can receive the data.

AH1: Acceptor handshake (complete capability)

The acceptor handshake sequences the reading of the data byte from the bus data lines.

T5: Talker function (talk only function)

The talker function provides the 6960B with the ability to send device dependent messages over the bus to other devices. The ability of any device to talk exists only when it has been addressed as a talker.

L4: Listener function (no listen only function)

The listener function provides a device with the ability to receive device dependent messages over the bus. The capability exists only when the device is addressed to listen via the bus by the controller.

SR1: Service request function (complete capability)

The service request function gives the 6960B the capability to inform the controller when it requires attention.

RL1: Remote/local function (complete capability)

The remote/local function allows the 6960B to be controlled either by the local front panel keys or by device dependent messages over the bus.

DC1: Device clear function (complete capability)

Device clear is a general reset and may be given to all devices in the system (DCL) or only to addressed devices (SDC). On receipt of DCL or SDC the 6960B performs a software reset, returning the instrument to its power-on state, as 'RE' reset command.

Note ...

A self test failure may cause a GPIB interface error condition or suspend GPIB activity. The 6960B must be switched off to clear this condition.

E1: Open collector drives

The GPIB drivers fitted to the 6960B have open-collector, rather than tristate, outputs.

GPIB OPERATING PROCEDURE

The GPIB operation of the 6960B is described below. A summary is contained in the "Operating Summary Card" which accompanies this manual.

Setting the GPIB address

The instrument's talk/listen address is selected by the address switch as shown in Fig. 3-3. The address switch is positioned on the GPIB interface module alongside the GPIB connector on the rear panel. The instrument's internal address register is updated by reading the setting of the address switch, which is done at power-on or on receipt of a device clear (DC1) command. Note, therefore, that simply changing the position of the address switch while the instrument is powered-up will not by itself actually change the address. The current GPIB address is shown on the display at switch-on if the interface is correctly installed.

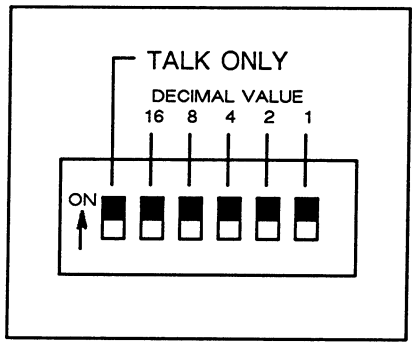


Fig. 3–3 GPIB address switch

Note ...

The valid GPIB address range is 0–30. The 6960B address is preset to 9 at the factory. Before changing this check controller manuals for reserved addresses.

Remote operation

On receipt of an instrument command from the GPIB the 6960B switches to remote operation, indicated by the remote annunciator being displayed. No instrument settings are changed, but all front panel keys except LOCAL are disabled and their functions come under GPIB control.

Unless inhibited by the Local Lockout (LLO) message the instrument can be returned to local control by pressing the LOCAL key or sending a Go to Local (GTL), Interface Clear (IFC) or Not Remote Enable (REN) GPIB message.

GPIB program codes

All valid GPIB program codes are listed in Table 3–6. These include equivalents for all front panel keys (except LOCAL) with additional codes for special functions.

TABLE 3-6 GPIB PROGRAM CODES

Code	Function
UNn	Set displayed units
DRm	Enter dB offset
STn	Store current settings
RLn	Recall stored settings
PUn	Select Power up mode
SRn	Set range
PKn	Set Max Hold mode
AVm	Set average number
LFm	Enter linearity factor
DCm	Enter duty cycle
CFm	Enter sensor calibration factor
PRn	Power reference on/off
AC	Auto calibration
AZ	Auto zero
RE	Reset
TRnn	Trigger mode
RS	Read settings
RC	Read calibration data
SQn	Set SRQ mask
E	Numeric entry terminator

n ..... Single byte number entry, requires no terminator.
m ..... Floating point numeric entry, requires 'E' terminator.

Program codes may be combined in a string without individual terminators, although spaces or commas may be included to improve clarity. These will be ignored by the instrument.

Data entry and terminators

The maximum length of any command string is 78 characters.

There are two forms in which data may be sent to the 6960B – one in which only single numbers are sent and another which accepts data in floating point format. Floating point numbers should be in the form of (i) sign (if negative), (ii) up to 4 digits (plus a decimal point in any position), followed by (iii) the numeric entry terminator 'E', for example:–

123.4 is sent as 123.4E
0 can be sent as 0E, 0.E, 0.0E or 0000E
-10 can be sent as -10E, -10.0E or -10.00E

The type of numeric entry is defined by the particular command being sent.

GPIB error codes

All invalid GPIB operations may be flagged via SRQs. By serial polling, an error code number can be read from the status byte which is explained under 'Serial poll' on page 3-25). The error codes are listed in Table 3-7.

TABLE 3-7 GPIB ERROR CODES

Code	Meaning
Er 06	Entry greater than 9999
Er 07	GPIB syntax error
Er 08	GPIB input buffer overflow (greater than 80 characters)
Er 09	Talk only error
Er 10	Under range
Er 11	Over range

GPIB program code detail: front panel key equivalent codes

'UNn' **Set units.** 'n' should be 0 or 1. 0 sets units to dBm, 1 to Watts. A typical command would be 'UN1'.

'DRm' **Enter dB offset.** Allows a dB offset to be entered into the power reading. Applies whether readings are being made in dBm or Watts. A typical command would be 'DR-10E'. This would increase the measured reading by 10 dB (to allow for a 10 dB attenuation, for example). Use 'DRA' to use current reading as offset. The range allowed is -100 to +100 dB.

'STn' **Store current settings.** n = 1 to 9, '-' or '.' Allows the current instrument settings to be stored to non-volatile memory for future use. Memories 1 to 9 are allowed. A typical command would be 'ST5' (stores current settings in memory 5). 'ST.' (or PU 2) or 'ST-' (or PU 1) may be sent to change the power-up condition. 'ST.' (or PU 2) will ensure that the power-up condition will be the same as at power-down. 'ST-' (or PU 1) sets the standard power-up conditions (see Table 3-5).

'RLn' **Recall stored settings.** n = 0 to 9. 'RL1' to 'RL9' recall settings stored using the 'ST' command. In addition 'RLO' restores the instrument settings before the last power down or reset. A typical command would be 'RL7' (recalls settings in memory 7).

'PUn' **Select Power up mode.** 'n' should be 1 or 2. PU1 selects Power-up mode 1 (Recall of standard settings). PU2 selects Power-up mode 2 (Recall power-down settings).

'SRn' **Set range.** n = Range 1 to 5, or A = Auto-range. Sending SR3 sets (holds) range 3. Range 5 is the least sensitive. Sending SRA or SR0 (SR - on early models) selects auto-ranging, that is the internal amplifiers will change range automatically, appropriate to the measured power level.

'PKn' **Set Max Hold mode.** 'n' should be 0 or 1. PK1 enables max hold. PK0 disables max hold. When enabled, only the maximum value of variable power level is measured and the 'average number' is set to 1.

'AVm' **Set average number.** m = Average number 1 to 254, or A = Auto-average. Sending AV50E sets the average number to 50 giving maximum resolution after 50 display updates. Increasing the average number increases the averaging. Sending AVA selects auto-averaging i.e. the 6960B automatically selects the default average factor for the range selected.
Use of this command is not allowed when 'Max Hold' is selected. Doing so will cause a syntax error.

Note that the average number is ignored if one of the 'fast trigger' modes has been selected. (see 'TRnn'"Trigger mode").

'LFm' **Enter linearity factor.** Enters RF power sensor linearity factor in the range 0.1 to 14.99. A typical command would be 'LF8.5E' (sets linearity factor to 8.5). 'LFA' will return value to default of 8.

'DCm' **Enter duty cycle.** Enters duty cycle of a pulse RF source, allowing display of peak power. The allowable range is 0.001% to 100%. A typical command would be 'DC0.15E'. Enters duty cycle of 0.15%. 'DCA' will return value to default of 100.

'CFm' **Enter sensor calibration factor.** Enters sensor cal. factor in the range 70% to 100% for the frequency in use. A typical command would be 'CF93.5E' (sets cal. factor to 93.5%). 'CFA' will return value to default of 100.

'PRn' **Power reference on/off.** Send 'PR0' to turn the power reference off or 'PR1' to turn it on.

'AC' **Auto calibration.** Performs instrument/sensor auto calibration. The sensor linearity factor and cal. factor should have been entered and an auto zero performed before performing auto calibration. The command syntax is 'AC'.

'AZ' **Auto zero.** Performs instrument/sensor auto zero. The command syntax is 'AZ'.

'RE' **Reset.** Resets instrument to power up state. The current settings are stored in memory 0. The command syntax is 'RE'. This should be the only command sent.

GPIB program detail: codes specific to GPIB operation

'TRnn' **Trigger mode.** Sets the trigger mode or starts a measurement after a hold condition. The modes available are as follows:-

TR00 **Normal operation.**
As local. Instrument takes 400 measurement samples and produces initial reading after 250 ms. Time to final resolution defined by average number (AVm). Free-running: measurement continues until countermanding instruction is received.

TR1n **Free run fast.** n = 0 to 6.
Allows the reading rate to be increased with respect to local operation by reducing the number of samples taken per reading. n = 6 corresponds to 400 samples and thus to fastest response in local operation: 250 ms. n = 0 corresponds to one sample and gives response in 25 ms. Reduction in response time is achieved at the expense of lower noise reduction and thus lower accuracy. For more information refer to Marconi Instruments application notes supplied with this manual, Measuretest no. 52 and 'Speed and Accuracy with Microprocessor Instrumentation'.

TR20 Trigger immediate then hold.
As TR00 but for single reading only.

TR3n Trigger immediate fast then hold.
As TR1n but for single reading only.

TR40 Free run with settling time.
As TR00, but data is made available to GPIB only when final resolution (as defined by AVm) has been achieved.

TR60 Trigger immediate with settling time then hold.
As TR40, but for single reading only.

Notes ...

(1) The average number (set by AVm) is ignored in the 'fast trigger' modes (TR1n and TR3n).

(2) In the 'hold' modes (TR20, TR3n and TR60), readings are repeated in the same mode by either repeating the specific command or by sending the Group Executive Trigger (GET) command.

(3) In the settling time trigger modes, the GPIB output buffer is not loaded with new data until the settling time is reached. Settling time is the time taken for the required number of display updates to be completed.
For TR00 and TR40; settling time = 5 x entered average factor.
For TR20 and TR60; settling time = 1 x entered average factor.

(4) TR5n is unused.

'RS' **Read settings.** Loads the GPIB output buffer with the complete instrument settings. Following this command, the next 'read' via the GPIB will contain all setting data in a fixed string 110 characters long. Each section of data contains a 2 digit prefix followed by the data and a comma as terminator all prefixed by the model number.

6960B,	Model number
UNn,	Current units
DRsnnnnEsnn,	Current dB offset
SRn,	Current range
AVsnnnnEsnn,	Current averaging factor
LFsnnnnEsnn,	Current linearity factor
DCsnnnnEsnn,	Current duty cycle
CFsnnnnEsnn,	Current calibration factor
PRn,	Current status of power ref.
TRnn,	Current trigger mode
SQn,	Current SRQ mode
RFn,	Relative flag (0=off 1=on)
AAn,	Auto average (0=off, 1=on)
HFn,	Hold flag (0=AUTO 1=RANGE HELD)
PKn,	Max Hold (0=off, 1=on)
PUn,	Current power up mode
ISn	Firmware issue number

The prefixes are the same as the GPIB commands used to define the settings, except for:

RFn **Relative flag.** n = 0 or 1. Indicates whether or not an offset has been entered via the DRm (dB REL) function.
RF0 = No offset. RF1 = Offset entered.

HFn **Hold range flag.** n = 0 or 1. Indicates whether the current range is 'held' or if auto-ranging is operating.
HF0 = Auto-ranging. HF1 = Current range held.

AAn **Auto average flag.** n = 0 or 1. Indicates that auto averaging is enabled/disabled.
AA0 = Auto averaging disabled. AA1 = Auto averaging enabled.

PKn Max hold flag. Indicates use of the max hold facility.
PK0 = Max hold off. PK1 = Max hold on.

A typical read setting result would be:-

6960B,UN0,DR-1000E-02,SR3,AV+2000E-02,LF+9100E-03,DC+1000E-01
,CF+9580E-02,PR1,TR60,SQ1,RF0,HF0,AA1,PU1,PK0,IS13

This would mean that the instrument settings are:-

UN0	Units set to dBm.
DR-1000E-02	Last dB relative entry -10 dB.
SR3	Range 3.
AV+2000E-02	Average set to 20.

LF+9100E-03	Linearity factor set to 9.1.
DC+1000-01	Duty cycle set to 100%.
CF+9580E-02	Sensor cal.factor set to 95.8%.
PR1	Power reference is on.
TR60	Trigger immediate with settling time then hold.
SQ1	SRQ mask is set for SRQ on end of measurement.
RF0	No dB offset entered.
HF0	Auto ranging.
AA1	Auto averaging on.
PU1	Power-up mode 1 selected.
PK0	Not in max hold.
IS1	Firmware issue 1 installed.

Note ...

No measurement data may be output until the whole of the settings string has been read.

'RC' **Read calibration data.** This command tells the 6960B to output an 83 character string in a similar format to 'RS'. In this case the data from the auto-zero and auto-cal is output. The prefixes used are as follows:-

AZ Auto zero point
AC Auto calibration point
OA Range 1 offset
OB Range 2 offset
OC Range 3 offset
OD Range 4 offset
OE Range 5 offset

'SQn' **Set SRQ mode.** n = 0 to 7. Defines if/when SRQs (service requests) will be raised. The basic commands are:

SQ0 Disables all SRQs.
SQ1 Enables SRQ at end of measurement.
SQ2 Enables SRQ on error.
SQ4 Enables SRQ at end of GPIB operation.

The basic SQ numbers are binary weighted and may be applied in any combination, thus:

SQ3 Enables SRQ at end of measurement and on error.
SQ5 Enables SRQ at end of measurement and at end of GPIB operation.
SQ6 Enables SRQ on error and at end of GPIB operation.
SQ7 Enables SRQ at end of measurement, on error and at end of GPIB operation.

Notes ...

(i) SQ4 is useful to indicate the end of a lengthy operation (e.g. AUTOZERO).

(ii) SRQ mode should be disabled before going to local.

Measurement data string

When in REMOTE and addressed to talk, or in TALK ONLY mode, the 6960B outputs a string in the format: AAAsnnnnEsnnCRLF^EOI

where A is an alphabetic character
n is a numeric digit
s is a sign (plus or minus)
E is an exponent indicator
CR is Carriage Return
LF^EOI is Line Feed with EOI (End or Identify).

Characters 1 to 3 contain status information:

1st character
- V = valid data
- S = waiting for settling time (trigger modes TR40 and TR60 only)
- U = under range
- D = over range
- K = waiting for valid reading after GPIB or keyboard operation

2nd character
- A = instrument on range 1
- B = instrument on range 2
- C = instrument on range 3
- D = instrument on range 4
- E = instrument on range 5

3rd character
- D = units are dBm
- R = units are dB relative
- W = units are watts
- O = units are watts with offset

The rest of the string is the data in exponential format. For example VDW+3020E-3 CRLF^EOI indicates a valid measurement of 3.02 milliwatts on range 4.

Notes ...

(1) In TALK ONLY mode data is output only at the end of free run settling time. EOI is not assserted.

(2) The 6960B must be sent to REMOTE or receive GROUP EXECUTIVE TRIGGER (GET) before any data is output. After receipt of data, send to REMOTE or GET again to receive more data.

Talk only mode

In the talk only mode, data is output in the normal format but only at the end of a settling time. The trigger mode is set to Free run with settling time (see 'TR40' GPIB command). EOI is not sent in this mode.

Note ...

When in the 'Talk only' mode, the 6960B should not be connected to a controlled system. 'Talk only' mode is provided to allow measurement output to device(s) set to 'Listen Only' mode e.g. printer or data logger which do not require an application program.

Serial poll

In response to a Service Request (SRQ) the controller should perform a serial poll of each instrument capable of generating that SRQ. A single byte of data is returned from each instrument which indicates if it generated the SRQ and, if so, why. In the case of the 6960B the binary data would be as follows:

Bit 7 Always zero.
Bit 6 1 indicates SRQ active.
Bit 5 1 indicates error caused SRQ, 0 for normal operation.
Bit 4 Always zero
Bits
0–3 Error number if SRQ due to error, 0 if end of measurement or 1 for end of GPIB instruction. Refer to Table 3–7 for error codes.

CAUTION

When sending commands to the 6960B, ensure that no spaces are sent in the middle of commands. This can occur on some controllers when sending numeric variables over the GPIB.

Example program

The program listed below runs on an HP 200 series controller and uses the fast trigger mode to obtain readings in 25 ms.

PROGRAM	DESCRIPTION
10 ASSIGN @Powermeter TO 709	The I/O path formed by the controller's I/O port (code 7) and the 6960B's GPIB interface (address 09) is redesignated as 'powermeter'. This means that all input/output statements will refer to 'powermeter' and thus be more meaningful to the user.
20 OUTPUT @Powermeter;"SR3SR–TR10SQ1"	Output statement breaks down as: **SR3:** Sets range 3. As this is the middle range, it is the optimum starting point to allow quickest acquisition of any input power level. **SR–:** Enables autoranging. Allows the instrument to auto–range from range 3 to the range appropriate to the input power level. **TR10:** Sets free–running fast triggering with fastest response. **SQ1:** Enables interrupt at end of measurement.
30 Start: ON INTR 7 GOTO Service	Directs controller to service routine on interrupt.

PROGRAM		DESCRIPTION
40	ENABLE INTR 7;2	Enables SRQ interrupt.
50	Idle: GOTO Idle	Controller waits here for interrupt.
60	Service: S=SPOLL (@ Powermeter)	Service routine causes serial poll of 6960B (on end-of-measurement interrupt).
70	ENTER @Powermeter; Reading$	Enters reading data-string.
80	DISP Reading$	Displays reading on controller's screen.
90	GOTO Start	Repeats measurement procedure.
100	END	

Clarification of Talk mode programming

Traditionally simple measuring instruments which measure one parameter (volts, power, etc.) are designed to output the current reading of that parameter when addressed to talk. No command has to be sent first. 6960B is in this category and would normally output a power reading when addressed to talk. However, 6960B outputs the END message with the last byte of the power reading. IEEE 728, with which 6960B was designed to conform, states (4.3.3.3):

> *A talker, having sent END, shall not output further data bytes automatically. The Talker must then receive a device dependent message or a specific interface message (for example, GET) prior to resuming output.*

This implies that a command would have to be sent to 6960B before each reading, but because power readings are the obvious default output this was felt to be unnecessary. In order to comply with IEEE 728, the 6960B talker state must be cycled from TADS (Talker Addressed State) to TIDS (Talker Idle State) and back again before a new reading will be output. This can be achieved in one of three ways:

(a) OTA (Other Talk Addrerss) or UNT (Untalk).
(b) MLA (My Listed Address).
(c) IFC (Interface Clear).

If this is not done, the 6960B will only output LF^END when addressed to talk.

In practical terms, this means that in HP BASIC the ENTER statement on its own will not work correctly. The usual solution is to execute the REMOTE statement prior to each ENTER. This has the effect of sending the 6960B listed address which satisfies option (b) above. A typical sequence would be:

```
REMOTE @Power_meter
ENTER @Power_meter;Reading
```

In TBASIC the problem does not arise because execution of the INPUT@ statement includes the UNT message at the end of the sequence which satisfied option (a) above.

Chapter 3-2

APPLICATIONS

Contents

INTRODUCTION

The techniques for RF power measurement are now well defined and must involve the sensing element responding directly or linearly to the amount of RF power applied to the sensing element. Once RF conversion to DC takes place, further amplification and signal processing can be made to establish the exact power applied to the sensor. In previous generations of power meters the signal processing has always been analogue, but now the 6960B brings to RF power measurement microprocessor enhancement of the signal processing circuitry. Information entered into the 6960B is in numerical format and displayed to a high resolution by a digital display.

Measurements that can be made with the 6960B fall into 4 main categories:-

Absolute power
Peak pulse power
Transmission loss/gain
Comparison or ratio measurements

Other applications of 6960B include:-

Levelling of sweep generators
Large dynamic range recording with correction factors included
RF blanking of sweep generators

PREPARATION FOR USE

Before making a measurement the RF sensor must be connected to the power meter by an RF power sensor cable. In order to calibrate the instrument and sensor as a system, the sensor must be connected to the Power Reference output.

Autozero and Autocal are then performed at 50 MHz giving 0 dBm (1 mW) displayed with a traceable uncertainty of ±0.7%.

ABSOLUTE POWER MEASUREMENTS

The 6960B may now be coupled to an RF Source whose output is to be measured. At this point correction factors may be entered into 6960B to give the best enhancement of accuracy possible.

From the RF power sensor obtain the Linearity Factor and the Cal Factor at the frequency of operation and measurement. Enter these numerically via the keypad to 0.01 resolution.

The measurement has now taken into account power voltage linearity, RF to DC conversion losses, frequency response (sensitivity) and VSWR effects.

PEAK PULSE POWER MEASUREMENTS

An RF power meter when measuring directly pulse power will only display the average power based on the duty cycle. In the past it has been necessary to calculate the peak pulse power from the average power, by using formulae.

The 6960B can now compute the peak pulse power from the average power by a numerical entry of the duty cycle, from 0.001 to 100%. For low rate PRFs a steadier display may be obtained by setting a higher average factor number.

TRANSMISSION LOSS/GAIN

Any component having either attenuation or gain characteristics can be measured at a simple frequency or swept over a suitable frequency band. In the latter application the full response of the device under test can then be plotted from the recorder output.

COMPARISON OR RATIO MEASUREMENTS

In order to observe or plot changes relative between one power level and another, the 6960B makes the measurement in two forms using the dB REL facility:–

Referenced to 0 dB. In a typical application or amplifier bandwidth the maximum power is found and referenced to 0 dB using the 6960B. The frequency may then be altered in plus and minus direction until the 3 dB points are reached. The exact frequency at which this occurs can be read from the source or via a frequency counter.

Referenced to an offset value, +dB or –dB. In order to measure higher power than the sensor can safely handle, either an attenuator pad or coupler may be added ahead of the sensor. By entering the value of attenuation or coupling in –dB as a numerical offset into 6960B, the full RF power may be measured.

To measure the input power to a system with only the output being available and the gain known, by entering this value in dB the 6960B will display directly the input power to the system.

OTHER APPLICATIONS

Sweeper levelling – Use the LEVELLING OUTPUT for levelling of voltage tunable oscillators or sweep generators. (see Fig. 3–4).

Recording – Use the RECORDING OUTPUT to obtain the full 50 dB dynamic range of the power sensor, including all correction factors. (see Fig. 3–5).

RF blanking – Use this BLANKING OUTPUT to turn off the source RF while an AUTOZERO is performed. This enables the RF Sensor to remain connected in the system. (see Fig. 3–5).

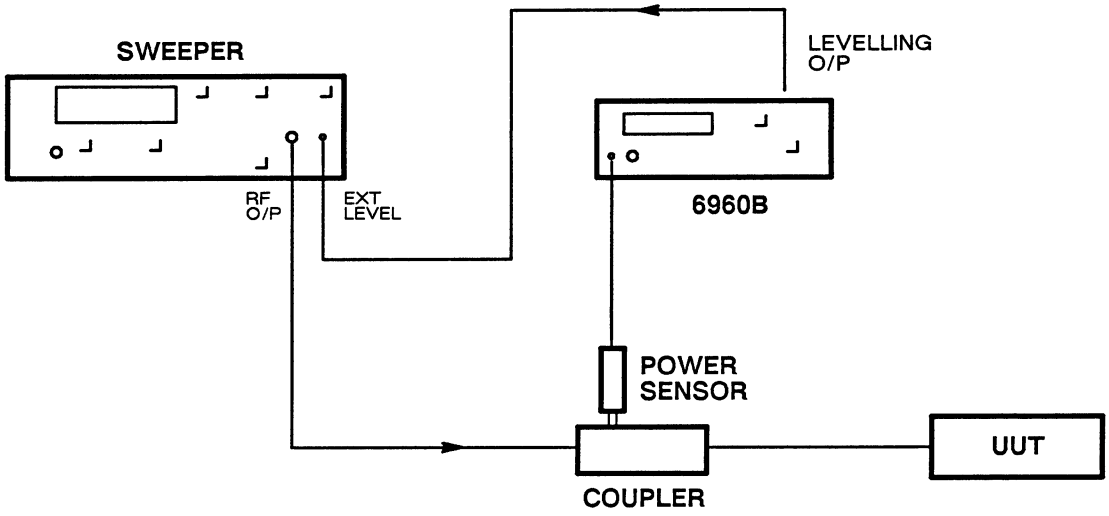


Fig. 3–4 Sweeper levelling using the 6960B

Notes...

(1) Set the 6960B RANGE as appropriate and hold. Levelling will not operate correctly if Auto Range is enabled.

(2) The power level displayed by the sweeper is not the level measured by the 6960B.

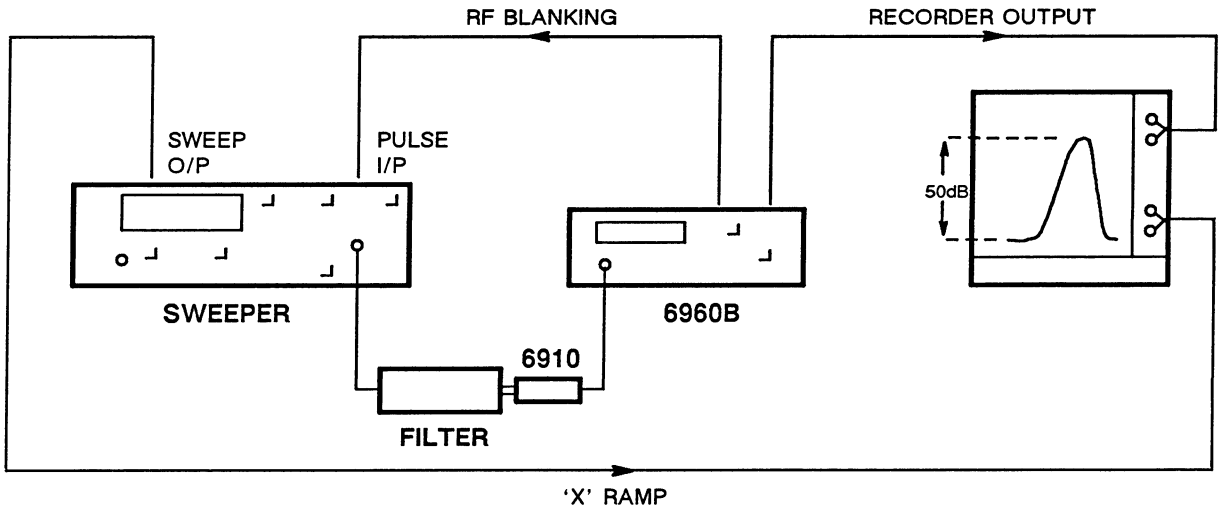


Fig. 3–5 A typical measurement set up using recording and RF blanking facilities of 6960B

Note ...

Refer to PERFORMANCE DATA section for 6960B Recorder and Blanking output characteristics.

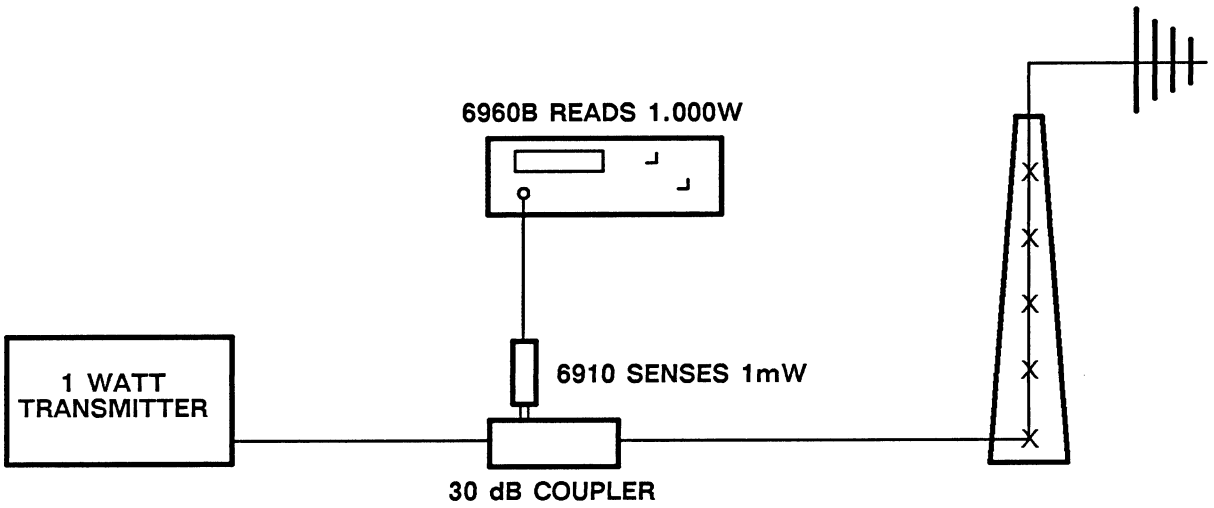


Fig. 3–6 A typical offset measurement being used for direct high power reading

POWER MEASUREMENT UNCERTAINTIES

RF power measurements are never free from uncertainties. These can be due to instrumentation error, mismatch uncertainty and sensor calibration uncertainty. High errors are possible unless these uncertainties are reduced to a minimum.

ERROR SOURCES – INSTRUMENTATION ERROR

The instrumentation error comes from component tolerances and calibration uncertainty of the power meter.

Mismatches

Large uncertainties can arise from either sensor or source mismatches. The first effect of these mismatches is to cause a transmission loss, i.e. the sensor does not receive the maximum available power from the source. The second effect is multiple reflections occurring between the source and the sensor causing unpredictable transmission losses.

Power reference uncertainty

As the power reference is used to calibrate the power meter and the power sensor together, the accuracy of the reference oscillator becomes part of the overall measurement uncertainty.

Calculating measurement uncertainty

For a source and load having complex reflection coefficients of QS and QL respectively, the ratio of transmitted power to maximum available power is as follows:–

$$\frac{P_L}{P_O} = \frac{(1 - |\Gamma_S|^2)(1 - |\Gamma_L|^2)}{|1 - |\Gamma_S \Gamma_L|^2}$$

This has a maximum of:- $$\frac{(1 - |\Gamma_S|^2)(1 - |\Gamma_L|^2)}{(1 - |\Gamma_S||\Gamma_L|)^2}$$

and a minimum of:- $$\frac{(1 - |\Gamma_S|^2)(1 - |\Gamma_L|^2)}{(1 + |\Gamma_S||\Gamma_L|)^2}$$

Uncertainty is usually quoted as a percentage uncertainty.

From the previous formulae:-

Positive uncertainty = $100 \times ((1 + |\Gamma_S||\Gamma_L|)^2 - 1)$ %

Negative uncertainty = $100 \times ((1 - |\Gamma_S||\Gamma_L|)^2 - 1)$ %

The positive and negative uncertainties are essentially the same for low reflection coefficients, but as the reflection coefficients increase the positive uncertainty increases more rapidly than the negative uncertainty. If the source and load matches are quoted as VSWRs then they may be converted to reflection coefficients by the following simple formula:-

$$|\Gamma| = \frac{S - 1}{S + 1}$$ where S is the VSWR

If the reflection coefficients are small, typically less than 0.15, the positive and negative uncertainties can be taken to be equal and the uncertainty can be approximated by:-

Percentage uncertainty = $200 \times |\Gamma_S| \ |\Gamma_L|$

Typical uncertainty calculations

(1) Calculate the mismatch uncertainty for a source reflection coefficient of 0.33 and a sensor reflection coefficient of 0.05.

Positive uncertainty $= 100 \times ((1 + 0.33 \times 0.05)^2 - 1)$

$= 100 \times ((1 + 0.0165)^2 - 1)$

$= 100 + (1.0333 - 1)$

$= 3.33\%$

Negative uncertainty $= 100 \times ((1 - 0.33 \times 0.05)^2 - 1)$

$= 100 \times ((1 - 0.0165)^2 - 1)$

$= 100 \times (0.967272 - 1)$

$= -3.273\%$

(2) Calculate the uncertainties for a source VSWR of 1.3:1 and a sensor VSWR of 1.05:1.

The VSWRs must first be turned into reflection coefficients.

$$|\Gamma_S| = \frac{1.3 - 1}{1.3 + 1} = \frac{0.3}{2.3} = 0.130$$

$$|\Gamma_L| = \frac{1.05 - 1}{1.05 + 1} = \frac{0.05}{2.05} = 0.024$$

As both the source and sensor mismatches are low we can use the approximation formula.

Percentage uncertainty $= 200 \times 0.13 \times 0.024$

$= \pm 0.624\%$

Chapter 4–1

BRIEF TECHNICAL DESCRIPTION

Refer to the 6960B block diagram shown in Fig. 4–1. The RF sensor gives a low DC voltage when power is applied. This DC signal is converted to an AC signal by the signal chopper enabling high gain, low noise amplifiers to be used.

The chopped signal is fed to the first amplifier which is split into two parts, the first part being in the RF sensor package and the other in the power meter. The signal is then passed to the spike blanking circuit which removes spikes on the edges of the square wave signal produced by the signal chopper. The following buffer also corrects for sensor non–linearities. The signal is then fed to the 1st attenuator which, together with the 2nd attenuator controls the gain of the amplifier strip in 10 dB steps. The 2nd and 3rd amplifiers provide the rest of the required gain. The 4th amplifier, together with the gain D–A, provides fine adjustment of the AC gain.

The phase synchronous detector then synchronously demodulates the AC signal. Timing signals for the signal chopper, spike blanking and the detector are provided by the timing logic. The recovered DC signal passes to the peaking meter and, via a switch to the comparator.

The microprocessor (μP) runs the program stored in read only memory. Data storage is achieved by using non volatile RAM (Random Access Memory). Outputs from the microprocessor drive the zero D–A, the 14 bit D–A, the gain D–A, the recorder D–A, the attenuator drives, the liquid crystal display, the GPIB interface and the power reference. Inputs to the microprocessor are taken from the comparator, the keyboard and the GPIB interface.

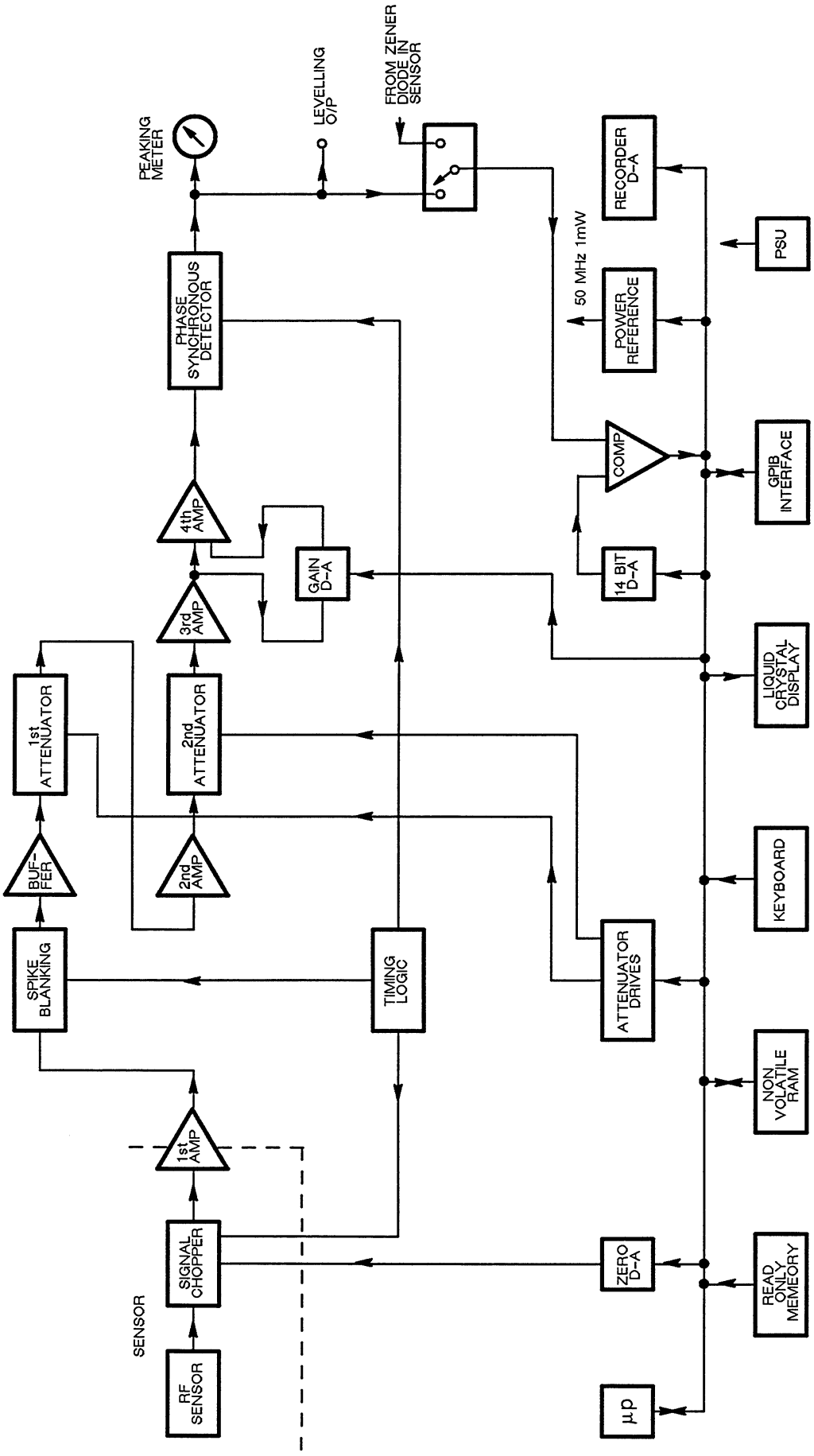


Fig. 4–1 Block diagram of 6960B

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