rf/microwave instrumentation

Operating and Service Manual

PM2003 Power Meter

Model

10025222

Part Number

Serial Number

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rf/microwave instrumentation

Declaration of Conformity

Issue Date: December 2018
Model #/s: Model PM2003, PH2000 Series
Type of Equipment: Power Meters, Power Heads
Function: A DSP (digital signal processor) based dual-channel, 3 input, solid state RF power meter capable of measuring RF power levels from –70 dBm to +44 dBm (dependent on power head).

The equipment described above is declared to be in conformity with the following applicable national and international standards. The conformity is valid only when equipment is used in a manner consistent with the manufacturer's recommendations and the reference documents.

SAFETY:
DIRECTIVE 2014/35/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 26 February 2014 on the harmonisation of the laws of the Member States relating to the making available on the market of electrical equipment designed for use within certain voltage limits
CENELEC EN 61010-1 Issued 2010/10/01 Ed: 3 Safety Requirements for Electrical Equipment for Measurement Control and Laboratory Use – Part 1: General Requirements
UL 61010-1 Issued 2012/05/11 Ed: 3 Safety Requirements for Electrical Equipment for Measurement Control and Laboratory Use – Part 1: General Requirements
CAN/CSA C22.2 #61010-1 Issued 2012/05/11 Ed: 3 Safety Requirements for Electrical Equipment for Measurement Control and Laboratory Use – Part 1: General Requirements
HAZARDOUS SUBSTANCES (RoHS 3):
DIRECTIVE (EU) 2017/2105 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 15 November 2017 on the restriction of the use of certain hazardous substances in electrical and electronic equipment (recast)
RECYCLING (WEEE):
DIRECTIVE 2012/19/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 4 July 2012 on waste electrical and electronic equipment (WEEE) (recast)
SUBSTANCES OF VERY HIGH CONCERN (REACH):
REGULATION (EC) 1907/2006 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 18 December 2006 concerning the Registration, Evaluation, Authorization and Restriction of Substances of Very High Concern Chemicals (SVHC)

Supporting documentation is held by AR RF/Microwave Instrumentation's Quality department in Pennsylvania, United States.

Place of issue: AR RF/Microwave Instrumentation
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Authorized officer of the company:

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Manager Quality & Service

INSTRUCTIONS FOR SAFE OPERATION

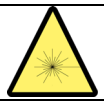
Observe the following safety guidelines to help ensure your own personal safety and to help protect your equipment and working environment from potential damage.

INTENDED USE

This equipment is intended for general laboratory use in generating, controlling, and measuring levels of electromagnetic Radio Frequency (RF) energy. Ensure that the device is operated in a location which will control the radiated energy and will not cause injury or violate regulatory levels of electromagnetic interference.

SAFETY SYMBOLS

These symbols may appear in your user manual or on equipment.

	This symbol is marked on the equipment when it is necessary for the user to refer to the manual for important safety information. The caution symbol denotes a potential hazard. Attention must be given to the statement to prevent damage, destruction, or harm.
	Dangerous voltages are present. Use extreme care.
	Indicates a terminal intended for connection to an external conductor for protection against electrical shock in case of a fault, or the terminal of a protective earth (ground) electrode.
	Indicates invisible laser radiation–do not view directly with optical instruments.
	Indicates frame or chassis ground connection terminal.
	Indicates alternating current.
	Indicates this product must not be disposed of with your other household waste.
	Indicates that the marked surface and adjacent surfaces can attain temperatures that may be hot to the touch.

EQUIPMENT SETUP PRECAUTIONS

Review the user manual and become familiar with all safety markings and instructions. Protection provided by the equipment may be impaired if used in a manner not specified by AR RF/Microwave Instrumentation (AR).

- Follow all lifting instructions specified in this document.
- Place the equipment on a hard, level surface.
- Do not use the equipment in a wet environment, for example, near a sink, or in a wet basement.
- Position your equipment so that the power switch is easily accessible.
- Leave 10.2 cm (4 in) minimum of clearance on all vented sides of the equipment to permit the airflow required for proper ventilation. Do not restrict airflow into the equipment by blocking any vents or air intakes. Restricting airflow can result in damage to the equipment, intermittent shut-downs or safety hazards.
- Keep equipment away from extremely hot or cold temperatures to ensure that it is used within the specified operating range.
- While installing accessories such as antennas, directional couplers and field probes, take care to avoid any exposure to hazardous RF levels.
- Ensure that nothing rests on your equipment's cables and that the cables are not located where they can be stepped on or tripped over.
- Move equipment with care; ensure that all casters and/or cables are firmly connected to the system. Avoid sudden stops and uneven surfaces.

BEFORE APPLYING POWER

Your AR equipment may have more than one power supply cable. Use only approved power cable(s). If you have not been provided with a power cable for the equipment or for any AC-powered option intended for the equipment, purchase a power cable that is approved for use in your country. The power cable must be rated for the equipment and for the voltage and current marked on the equipment's electrical ratings label.

Incorrectly installing or using an incompatible line voltage may increase the risk of fire or other hazards. To help prevent electric shock, plug the equipment and peripheral power cables into properly grounded electrical outlets. These cables are equipped with three-prong plugs to help ensure proper grounding. Do not use adapter plugs or remove the grounding prong from a cable.

Do not modify power cables or plugs. Consult a licensed electrician or AR trained service technician for equipment modifications. Always follow your local/national wiring rules.

Do not operate the equipment if there is physical damage, missing hardware, or missing panels.

SAFETY GROUND

This equipment is provided with a protective earth terminal. The mains power source to the equipment must supply an uninterrupted safety ground of sufficient size to attach wiring terminals, power cord, or supplied power cord set. ***DO NOT USE this equipment if this protection is impaired.***

INSTRUCTIONS FOR SAFE OPERATION

HAZARDOUS RF VOLTAGES

The RF voltages on the center pin of an RF output connector can be hazardous. The RF output connector should be connected to a load before AC power is applied to the equipment. Do not come into contact with the center pin of the RF output connector or accessories connected to it. Place the equipment in a non-operating condition before disconnecting or connecting the load to the RF output connector.

ACOUSTIC LIMITATIONS

If equipment noise exceeds 80dB, ear protection is required.

MAINTENANCE CAUTION

Adjustment, maintenance, or repair of the equipment must be performed only by qualified personnel. Hazardous energy may be present while protective covers are removed from the equipment even if disconnected from the power source. Contact may result in personal injury. Replacement fuses are required to be of specific type and current rating.

ENVIRONMENTAL CONDITIONS

Unless otherwise stated on the product specification sheet, this equipment is designed to be safe under the following environmental conditions:

- Indoor use
- Altitude up to 2000m
- Temperature of 5°C to 40°C
- Maximum relative humidity 80% for temperatures up to 31°C. Decreasing linearly to 50% at 40°C.
- Main supply voltage fluctuations not to exceed ± 10% of the nominal voltage or minimum and maximum autoranging values.
- Pollution degree 2: Normally non-conductive with occasional condensation. While the equipment will not cause hazardous condition over this environmental range, its performance may vary.

EQUIPMENT CONTAINING LASERS

AR Field Probes (FL/PL Series) and Field Analyzers (FA Series) are Class 1 laser products containing embedded Class 4 lasers. Under normal use, the laser radiation is completely contained within the fiber optic cables and poses no threat of exposure. Safety interlocks ensure that the laser is not activated unless the cables are properly connected. Always exercise caution when using or maintaining laser products. Do not view directly with optical instruments.

RF ANTENNAS

- This equipment (antenna or antenna assembly) may be heavy, requiring two persons to lift. Use caution when installing or removing unit. Follow all equipment setup and lifting instructions specified in this document.
- Ensure connectors are appropriate for intended operation. Connectors are specified in the user manual and product specification sheet.
- Do not exceed the maximum RF input level stated in the specifications. Refer to the user manual and product specification sheet to determine the applicable RF levels.
- Excessive RF input could damage the equipment or connectors, causing safety hazards.
- When in operation, the RF voltages on the antenna elements can be hazardous. Do not come into contact with the antenna or elements when the RF input connector is connected to a live RF source.
- To avoid injury to personnel and accidental damage to power amplifier or antenna, disable the RF output of power amplifier before connecting or disconnecting the input connection to the antenna.
- Perform periodic inspections of antenna and field probe systems to verify calibration due date, proper operation, and overall condition of equipment.

RACK MOUNTED TWT MODELS

Some TWT models are supplied without the removable enclosure offered for benchtop use. These rack-mountable models may be supplied with either carry handles or slides and front handles installed. Follow all lifting instructions specified in this document and installation instructions supplied in the TWT user manual.

LIFTING INSTRUCTIONS FOR AR EQUIPMENT

Because most products must be handled during distribution, assembly and use, the risk of serious injury due to unsafe product handling should be a fundamental consideration of every user. An authoritative guideline for eliminating unwarranted risk of injury caused by lifting is provided by the NIOSH Work Practices (Publication #94-110) available at:

https://www.cdc.gov/niosh/docs/94-110/pdfs/94-110.pdf.

In general, observe the following guidelines for lifting a weight of 50 lb or more:

- Use lifting eye (for floor standing) or side handles (table top) to lift unit only.
- Use equipment of adequate capacity to lift and support unit.
- If using forklift to move unit, be sure forks are long enough to extend beyond the side of the unit.
- For additional information, follow the link specified above.

HINWEISE FÜR DEN SICHEREN GEBRAUCH

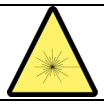
Bitte beachten Sie die folgenden Hinweise zum Schutz Ihrer persönlichen Sicherheit und um Ihre Ausrüstung und Ihren Arbeitsplatz vor möglichen Schäden zu bewahren.

VORGESEHENE VERWENDUNG

Dieses Gerät ist für den allgemeinen Einsatz im Labor bestimmt. Es dient der Erzeugung, Steuerung und Messung von elektromagnetischer Hochfrequenzenergie (RF). Stellen Sie sicher, dass das Gerät an einem Ort in Betrieb genommen wird, an dem die abgestrahlte Energie gesteuert werden kann, so dass niemand Schaden erfährt und elektromagnetische Störungen vermieden werden.

SICHERHEITSSYMBOLE

Einige dieser Symbole befinden sich sowohl in der Bedienungsanleitung als auch auf dem Gerät selbst.

	Dieses Symbol befindet sich auf dem Gerät und weist darauf hin, dass der Nutzer an dieser Stelle wichtige Sicherheitsinformationen in der Bedienungsanleitung studieren soll. Das Warnsymbol weist auf eine mögliche Gefahr hin. Zur Vermeidung von Personen- oder Sachschäden gilt es, die Hinweise zu beachten.
	Gefährliche elektrische Spannungen sind vorhanden. Höchste Vorsicht ist geboten.
	Weist darauf hin, dass an dieser Stelle eine Klemme für den Anschluss an einen Außenleiter anzubringen ist, zum Schutz vor einem Stromschlag oder im Fall einer auftretenden Störung, oder dass eine Klemme anzubringen ist, die als schützende Erdungselektrode fungiert.
	Zeigt unsichtbare Laserstrahlung an –nicht direkt hineinsehen.
	Weist auf eine Rahmen- oder Chassis-Anschlussklemme hin.
	Zeigt Wechselstrom an.
	Weist darauf hin, dass dieses Produkt nicht mit Ihrem restlichen Hausmüll entsorgt werden darf.
	Weist darauf hin, dass die markierte Oberfläche und benachbarte Flächen extrem heiße Temperaturen erreichen können und daher nicht angefasst werden sollten.

SICHERHEITSHINWEISE FÜR DEN AUFBAU DES GERÄTS

Lesen Sie die Bedienungsanleitung aufmerksam durch und machen Sie sich mit allen Sicherheitsmarkierungen und Anweisungen vertraut. Die Sicherheit kann beeinträchtigt sein, falls das Gerät in einer anderen Weise verwendet wird, als von der AR RF/Microwave Instrumentation (AR) vorgegeben ist.

- Zum Heben und Transport folgen Sie allen in dieser Anleitung angegebenen Anweisungen.
- Platzieren Sie das Gerät auf einer harten, ebenen Oberfläche.
- Verwenden Sie das Gerät nicht in feuchter Umgebung, zum Beispiel in der Nähe einer Spüle oder in einem feuchten Keller.
- Platzieren Sie Ihr Gerät so, dass der Netzschalter leicht zugänglich ist.
- Halten Sie einen Mindestabstand von 10,2 cm (4 in) auf allen belüfteten Seiten des Geräts ein, um eine ausreichende Luftzirkulation zu gewährleisten. Beeinträchtigen Sie den Luftstrom des Geräts nicht, indem Sie Lüftungsöffnungen oder den Lufteinlass blockieren. Wird der Luftstrom eingeschränkt, kann dies zu Schäden am Gerät, periodischen Abschaltungen und anderen Gefahren führen.
- Halten Sie das Gerät von extrem heißen oder kalten Temperaturen fern, um sicherzustellen, dass es nur in dem vorgeschriebenen Bedienungsbereich verwendet wird.
- Achten Sie beim Installieren von Zubehör wie Antennen, Richtungskupplungen und Feldsonden darauf, dass sie keinen gefährlichen HF-Werten ausgesetzt sind.
- Stellen Sie sicher, dass nichts auf den Kabeln Ihres Geräts steht. Bringen Sie die Kabel so an, dass niemand darauf treten oder darüber stolpern kann.
- Seien Sie vorsichtig, wenn Sie das Gerät bewegen. Achten Sie darauf, dass alle Rollen und/oder Kabel fest mit dem System verbunden sind. Vermeiden Sie plötzliche Stopps und Oberflächen, die nicht eben sind.

BEVOR SIE DAS GERÄT ANSCHLIESSEN

Ihre AR-Ausrüstung hat möglicherweise mehr als ein Stromversorgungskabel. Verwenden Sie nur zugelassene Stromkabel. Falls Sie kein Stromkabel oder AC-Netzkabel für dieses Gerät haben, kaufen Sie ein Stromkabel, das für den Einsatz in Ihrem Land zugelassen ist. Das Stromkabel muss für das Gerät, die Spannung und den Strom, die auf dem elektrischen Kennzeichnungsetikett des Geräts markiert sind, zugelassen sein.

Bei einer fehlerhaften Installation oder falls eine Netzspannung verwendet wird, die nicht mit dem Gerät kompatibel ist, erhöht sich die Brandgefahr. Auch andere Gefahren können auftreten. Um einen Stromschlag zu verhindern, schließen Sie das Gerät und die peripheren Stromkabel an ordnungsgemäß geerdete Steckdosen an. Die Kabel sind mit dreipoligen Steckern ausgestattet, um eine korrekte Erdung zu gewährleisten. Verwenden Sie keine Adapter. Entfernen sie niemals die Erdungsstange eines Kabels.

Modifizieren Sie niemals die Stromkabel oder Stecker. Konsultieren Sie einen lizenzierten Elektriker oder AR-ausgebildeten Servicetechniker, falls Veränderungen am Gerät durchgeführt werden müssen. Halten Sie sich stets an die nationalen/örtlichen Verdrahtungsregeln.

Schalten Sie das Gerät nicht ein, falls es äußerlich beschädigt ist oder Hardware-Teile oder Konsolen fehlen.

SYSTEMERDUNG

Dieses Gerät ist mit einer Schutzerdklemme ausgestattet. Die Netzstromquelle muss dem Gerät eine ununterbrochene Systemerdung von ausreichender Größe zur Verfügung stellen, damit Kabelklemmen, Netzkabel oder mitgeliefertes Netzkabel ordentlich befestigt werden können. *VERWENDEN SIE DIESES GERÄT NICHT, wenn dieser Schutz beeinträchtigt ist.*

HINWEISE FÜR DEN SICHEREN GEBRAUCH

GEFÄHRLICHE HF-SPANNUNGEN

Die HF-Spannungen am mittleren Pin eines HF-Ausgangsanschlusses können gefährlich sein. Der HF-Ausgangsanschluss sollte an eine Last angeschlossen werden, bevor das Gerät ans Stromnetz angeschlossen wird. Kommen Sie nicht mit dem Mittelstift des HF-Ausgangsanschlusses oder dem damit verbundenen Zubehör in Kontakt. Bevor Sie die Last vom HF-Ausgang trennen oder diese anschließen, stellen Sie das Gerät in einen nicht betriebsfähigen Zustand.

HÖRSCHUTZ

Sollten die Geräusche, die das Gerät verursacht, 80dB überschreiten, ist Gehörschutz erforderlich.

WARTUNGSHINWEISE

Einstellung, Wartung oder Reparaturen der Ausrüstung dürfen nur von qualifizierten Fachleuten durchgeführt werden. Gefährliche Spannungen können auftreten, wenn Schutzabdeckungen vom Gerät entfernt werden, auch wenn es nicht an die Stromquelle angeschlossen ist. Kontakt kann zu Verletzungen führen. Es können nur bestimmte Ersatzsicherungen mit speziellem Nennstrom verwendet werden.

UMGEBUNGSBEDINGUNGEN

Sofern auf dem Produktspezifikations-Blatt nichts anderes angegeben ist, ist dieses Gerät unter folgenden Bedingungen sicher einsetzbar:

- Gebrauch in Innenräumen
- Höhe bis zu 2000m
- Temperaturen von 5°C bis 40°C
- Maximale relative Luftfeuchtigkeit 80% bei Temperaturen bis 31°C. Lineare Abnahme auf 50% bei 40°C.
- Netzspannungsschwankungen sollen nicht mehr als ± 10% der Nennspannung oder der minimal und maximal eingestellten Werte betragen.
- Verschmutzungsgrad 2: Normalerweise nichtleitfähige Verschmutzung mit gelegentlicher Kondensation. Das Gerät wird bei Einsatz in diesem Bereich keine Gefahr verursachen, die Leistung kann dennoch variieren.

LASER-INFORMATION

AR - Feldsonden (FL/PL-Serie) und Feldanalysatoren (FA-Serie) sind Laserprodukte der Klasse 1 mit eingebetteten Klasse-4-Lasern. Bei normalem Gebrauch kann der Laserstrahlung nicht aus den Glasfaserkabel herausdringen. Sicherheitsverriegelungen sorgen dafür, dass der Laser nur aktiviert wird, wenn die Kabel richtig angeschlossen sind. Lassen Sie stets Vorsicht walten bei der Verwendung oder Wartung von Laserprodukten. Niemals direkt hineinsehen.

HF-ANTENNEN

- Die Ausrüstung (Antenne oder Antennenmontage) ist mitunter schwer. Die Montage erfordert daher oft zwei Personen. Folgen Sie allen in diesem Dokument angegebenen Anweisungen zur Anbringung.
- Stellen Sie sicher, dass alle Anschlüsse für den beabsichtigten Betrieb geeignet sind. Informationen zu den Anschlüssen erhalten Sie im Benutzerhandbuch und im Produktspezifikationsblatt.
- Überschreiten Sie nicht den in Spezifikationen angegebenen maximalen HF-Eingangspegel. Informationen zum geeigneten HF-Pegel erhalten Sie im Benutzerhandbuch und im Produktspezifikationsblatt.
- Ein übermäßiger HF-Eingang könnte das Gerät oder die Anschlüsse beschädigen, was zu Sicherheitsrisiken führt.
- Im Betrieb können die HF-Spannungen an den Antennenelementen gefährlich sein. Kommen Sie nicht mit der Antenne oder Antennenelementen in Kontakt, wenn der HF-Eingang an eine live-HF-Quelle angeschlossen ist.
- Um Verletzungen an Personen, am Leistungsverstärker oder der Antenne zu vermeiden, deaktivieren Sie den HF-Ausgang des Leistungsverstärkers, bevor sie die Eingangsverbindung an die Antenne anschließen oder trennen.
- Kontrollieren Sie die Antennen und die Feldsonde regelmäßig, um die nächstfällige Kalibrierung, den ordnungsgemäßen Betrieb und den Gesamtzustand der Ausrüstung zu überprüfen.

RACK MONTIERBARE TWT-MODELLE

Einige TWT-Modelle kommen ohne die abnehmbare Überdachung, die zur Verwendung als Tischgerät dient. Diese rack-montierbaren Modelle verfügen entweder über installierte Tragegriffe oder Rutschflächen. Befolgen Sie alle in diesem Dokument angegebenen Hebehinweise sowie die Installationsanweisungen in der TWT-Bedienungsanleitung.

HEBEANWEISUNGEN FÜR AR-GERÄTE

Die meisten Geräte müssen während des Versands, der Montage und des Gebrauchs transportiert werden. Jeder Nutzer sollte sich über das Risiko von schweren Verletzungen durch unsachgemäße Produkthandhabung bewusst sein. Leitlinien zur Beseitigung von vermeidbaren Verletzungsrisikos, die beim Heben entstehen können, werden in den NIOSH-Arbeitspraktiken (Veröffentlichung # 94-110) zur Verfügung gestellt:

https://www.cdc.gov/niosh/docs/94-110/pdfs/94-110.pdf.

Beachten folgende, allgemeine Richtlinien zum Heben eines Gewichts von 50 Pfund oder mehr:

- Verwenden Sie zum Heben der Einheit eine Hebeöse (für Platzierung auf dem Boden) oder Seitengriffe (für Platzierung auf einer Arbeitsplatte).
- Verwenden Sie Geräte mit ausreichender Kapazität zum Heben und Stützen.
- Falls Sie einen Gabelstapler verwenden, achten Sie darauf, dass die Gabeln lange genug sind und über die Seiten der Einheit hinausreichen.
- Für weitere Informationen folgen Sie dem oben angegebenen Link.

INSTRUCTIONS POUR UN FONCTIONNEMENT EN TOUTE SÉCURITÉ

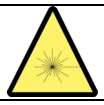
Respectez les consignes de sécurité suivantes pour veiller à votre propre sécurité et vous aider à protéger votre équipement et votre milieu de travail de dommages potentiels.

USAGE PRÉVU

Cet équipement est prévu pour un usage général en laboratoire afin de générer, contrôler et mesurer les niveaux d'énergie de radiofréquence (RF) électromagnétique. Assurez-vous que l'appareil est utilisé dans un endroit qui contrôlera l'énergie rayonnante et ne causera pas de blessure, ni ne violera les niveaux réglementaires d'interférence électromagnétique.

SYMBOLES DE SÉCURITÉ

Ces symboles peuvent apparaître dans votre manuel d'utilisation ou sur l'équipement.

	Ce symbole est apposé sur l'équipement lorsque l'utilisateur doit se référer au manuel pour des informations importantes concernant la sécurité. Le symbole de mise en garde indique un danger potentiel. Vous devez accorder une attention à la déclaration pour éviter tout dommage, destruction ou blessure.
	Présence de tensions dangereuses, soyez très prudent.
	Indique une borne de connexion d'un conducteur externe pour une protection contre l'électrocution en cas de défaillance ou la borne d'une électrode de mise à la terre de protection.
	Indique un rayonnement laser invisible – ne regardez pas directement avec des instruments optiques.
	Indique la borne de connexion de la mise à la terre du cadre ou du châssis.
	Indique un courant alternatif.
	Indique que ce produit ne doit pas être jeté avec vos autres déchets ménagers.
	Indique que la surface marquée et les surfaces adjacentes peuvent atteindre des températures qui risquent d'être chaudes au toucher.

PRÉCAUTIONS D'INSTALLATION DE L'ÉQUIPEMENT

Lisez le manuel d'utilisateur et familiarisez-vous avec tous les marquages et consignes de sécurité. La protection fournie par l'équipement peut être affaiblie s'il est utilisé d'une manière non indiquée par AR RF/instrumentation à hyperfréquence (AR).

- Respectez toutes les instructions de levage indiquées dans ce document.
- Placez l'équipement sur une surface dure et plane.
- N'utilisez pas l'équipement dans un environnement humide, par exemple près d'un lavabo, ou dans un sous-sol humide.
- Positionnez votre équipement de sorte que l'interrupteur d'alimentation soit facilement accessible.
- Laissez un espace minimal de 10,2 cm (4 in) de tous les côtés ventilés de l'équipement pour permettre le flux d'air nécessaire à une bonne ventilation. Ne limitez pas le flux d'air allant dans l'équipement en bloquant tout évent ou entrée d'air. La restriction du flux d'air peut endommager l'équipement, causer des coupures intermittentes ou des dangers pour la sécurité.
- Tenez l'équipement à l'écart de températures extrêmement chaudes ou froides pour veiller à ce qu'il soit utilisé dans la plage de fonctionnement indiquée.
- Lorsque vous installez des accessoires tels que des antennes, des coupleurs directionnels et des sondes de champ, prenez soin d'éviter toute exposition à des niveaux RF dangereux.
- Assurez-vous que rien n'est posé sur les câbles de votre équipement et que les câbles ne se trouvent pas à des endroits où l'on peut marcher dessus ou trébucher.
- Déplacez l'équipement avec soin ; veillez à ce que tous les câbles et/ou roulettes soient solidement raccordés au système. Évitez les arrêts brusques et les surfaces irrégulières.

AVANT LA MISE SOUS TENSION

Votre équipement AR peut disposer de plus d'un câble d'alimentation électrique. Utilisez uniquement un ou des câbles d'alimentation approuves. Si un câble d'alimentation ne vous a pas été fourni avec l'équipement ou pour toute option alimentée en courant alternatif prévue pour l'équipement, achetez un câble d'alimentation qui est approuvé pour être utilisé dans votre pays. Le câble d'alimentation doit être prévu pour l'équipement et pour le courant et la tension indiqués sur l'étiquette de classement électrique de l'équipement.

Installer ou utiliser de façon incorrecte une tension de ligne incompatible peut augmenter le risque d'incendie ou d'autres dangers. Pour aider à éviter toute électrocution, branchez l'équipement et les câbles d'alimentation périphériques dans des prises électriques correctement mises à la terre. Ces câbles sont équipés de prises à trois broches pour veiller à une bonne mise à la terre. N'utilisez pas d'adapteur de prise, ni ne retirez la broche de mise à la terre d'un câble.

Ne modifiez pas les câbles ou les prises d'alimentation. Consultez un électricien agréé ou un technicien d'entretien AR qualifié pour les modifications d'équipement. Respectez toujours les règles locales/nationales de câblage.

N'utilisez pas l'équipement s'il est physiquement endommagé ou s'il manque des pièces ou des panneaux.

MISE À LA TERRE DE SÉCURITÉ

Cet équipement est fourni avec une borne de mise à la terre de protection. La source d'alimentation secteur à l'équipement doit fournir une mise à la terre de sécurité ininterrompue de taille suffisante pour attacher les bornes de câblage, le cordon d'alimentation ou l'ensemble de câbles d'alimentation fourni. ***N'UTILISEZ PAS cet équipement si cette protection est affaiblie.***

INSTRUCTIONS POUR UN FONCTIONNEMENT EN TOUTE SÉCURITÉ

TENSIONS RF DANGEREUSES

Les tensions RF sur la broche centrale d'un connecteur de sortie RF peuvent être dangereuses. Le connecteur de sortie RF doit être connecté à une charge avant que l'équipement ne reçoive l'alimentation en courant alternatif. N'entrez pas en contact avec la broche centrale du connecteur de sortie RF ou des accessoires raccordés à celle-ci. L'équipement doit être dans un état de non fonctionnement avant de déconnecter ou de connecter la charge au connecteur de sortie RF.

LIMITES ACOUSTIQUES

Si le bruit de l'équipement dépasse 80dB, une protection auditive est nécessaire.

AVERTISSEMENT CONCERNANT L'ENTRETIEN

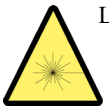
Le réglage, l'entretien ou la réparation de l'équipement doivent être effectués uniquement par un personnel qualifié. Une énergie dangereuse peut être présente lorsque les couvercles de protection sont retirés de l'équipement, même si celui-ci est déconnecté de la source d'alimentation. Un contact peut causer des blessures. Les fusibles de remplacement doivent être d'un type et courant nominal spécifiques.

CONDITIONS ENVIRONNEMENTALES

Sauf mention contraire sur la fiche signalétique du produit, cet équipement est conçu pour être sécuritaire dans les conditions environnementales suivantes :

- Utilisation à l'intérieur
- Altitude jusqu'à 2000 m
- Température de 5°C à 40°C
- Humidité relative maximale de 80 % pour les températures jusqu'à 31°C. Décroissance linéaire à 50 % à 40°C.
- Les fluctuations de tension d'alimentation principale ne doivent pas dépasser ± 10 % de la tension nominale ou des valeurs d'autoréglage minimales et maximales.
- Degré de pollution 2 : Normalement non conducteur avec une condensation occasionnelle. Bien que l'équipement ne cause pas de condition dangereuse dans cette gamme environnementale, sa performance peut varier.

ÉQUIPEMENT CONTENANT DES LASERS



Les sondes de champ AR (série FL/PL) et les analyseurs de champ (série FA) sont des produits laser de classe 1 contenant des lasers intégrés de classe 4. Lors d'une utilisation normale, le rayonnement laser est entièrement contenu dans les câbles à fibres optiques et ne pose aucun risque d'exposition. Des verrouillages de sécurité veillent à ce que le laser ne soit pas activé à moins que les câbles ne soient correctement raccordés. Soyez toujours prudent lorsque vous utilisez ou entretenez des produits laser. Ne regardez pas directement avec des instruments optiques.

ANTENNES RF

- Cet équipement (antenne ou ensemble antenne) peut être lourd nécessitant deux personnes pour le soulever. Soyez prudent lorsque vous installez ou retirez l'unité. Respectez toutes les instructions concernant l'installation et le levage de l'équipement indiquées dans ce document.
- Assurez-vous que les connecteurs sont appropriés pour l'utilisation prévue. Les connecteurs sont indiqués dans le manuel d'utilisation et la fiche signalétique du produit.
- Ne dépassez pas le niveau d'entrée RF maximal indiqué dans les spécifications. Référez-vous au manuel d'utilisation et à la fiche signalétique du produit pour déterminer les niveaux RF applicables.
- Une entrée RF excessive pourrait endommager l'équipement ou les connecteurs causant des dangers pour la sécurité.
- Lorsque l'équipement fonctionne, les tensions RF sur les éléments de l'antenne peuvent être dangereuses. N'entrez pas en contact avec l'antenne ou les éléments lorsque le connecteur d'entrée RF est connecté à une source RF active.
- Pour éviter que le personnel ne se blesse et que l'amplificateur de puissance ou l'antenne ne soit endommagé, désactivez la sortie RF de l'amplificateur de puissance avant de brancher ou débrancher la connexion d'entrée à l'antenne.
- Effectuez des inspections périodiques de l'antenne et des systèmes de sondes de champ pour vérifier la date d'échéance de la calibration, le bon fonctionnement et l'état global de l'équipement.

MODÈLES TWT MONTÉS SUR BÂTI

Certains modèles TWT sont fournis sans le boîtier amovible proposé pour l'utilisation sur un plan de travail. Ces modèles montés sur bâti peuvent être fournis avec des poignées de transport ou des coulisses et poignées frontales. Respectez toutes les instructions de levage indiquées dans ce document et les instructions d'installation fournies dans le manuel d'utilisation TWT.

INSTRUCTIONS DE LEVAGE POUR L'ÉQUIPEMENT AR

Comme la plupart des produits doivent être manipulés pendant la distribution, l'assemblage et l'utilisation, le risque de blessures graves en raison d'une manipulation dangereuse du produit doit être une considération fondamentale pour chaque utilisateur. Une directive faisant autorité pour éliminer le risque injustifié de blessures causées par le levage est fournie par les méthodes de travail de NIOSH (publication n° 94-110) disponibles sur :

https://www.cdc.gov/niosh/docs/94-110/pdfs/94-110.pdf.

De façon générale, respectez les directives suivantes pour lever un poids de 50 lb (22 kg) ou plus :

- Utilisez uniquement l'anneau de levage (si posé au sol) ou les poignées latérales (si sur la table) pour soulever l'unité.
- Utilisez un équipement de capacité adéquate pour soulever et supporter l'unité.
- Si vous utilisez un chariot élévateur pour déplacer l'unité, assurez-vous que les fourches sont assez longues pour s'étendre au-delà du côté de l'unité.
- Pour plus d'informations, suivez le lien indiqué ci-dessus.

INSTRUCTIES VOOR VEILIG GEBRUIK

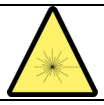
Neem de volgende veiligheidsrichtlijnen in acht om uw persoonlijke veiligheid te helpen waarborgen en uw apparaat en werkomgeving tegen mogelijke schade te beschermen.

BEOOGD GEBRUIK

Dit apparaat is bedoeld voor algemeen laboratoriumgebruik bij het genereren, regelen en meten van niveaus van elektromagnetische radiofrequentie(RF)-energie. Zorg ervoor dat het apparaat wordt gebruikt op een locatie die de uitgestraalde energie controleert, geen letsel veroorzaakt of de reglementaire niveaus van elektromagnetische interferentie schendt.

VEILIGHEIDSSYMBOLEN

Deze symbolen kunnen in uw gebruikershandleiding of op uw apparaat verschijnen.

	Dit symbool staat op het apparaat als de gebruiker de handleiding moet raadplegen voor belangrijke veiligheidsinformatie. Het waarschuwingssymbool geeft een mogelijk gevaar aan. Er moet aandacht worden besteed aan de verklaring om schade, vernietiging of letsel te voorkomen.
	Er zijn gevaarlijke elektrische spanningen aanwezig. Wees uiterst voorzichtig.
	Wijst op een terminal aan die bedoeld is voor aansluiting op een externe geleider voor bescherming tegen elektrische schokken in het geval van een storing, of de terminal van een veiligheidselektrode (aarding).
	Wijst op een onzichtbare laserstraling - bekijk niet rechtstreeks met optische instrumenten.
	Wijst op het frame of het chassis van de aardingsterminal.
	Wijst op wisselstroom.
	Geeft aan dat dit product niet bij het huishoudelijk afval mag worden weggegooid.
	Geeft aan dat het gemarkeerde oppervlak en de aangrenzende oppervlakken temperaturen kunnen bereiken, die warm aanvoelen.

VOORZORGSMAATREGELEN BIJ DE INSTALLATIE VAN HET APPARAAT

Raadpleeg de gebruikershandleiding en leer alle veiligheidsmarkeringen en -instructies kennen. De bescherming die door het apparaat wordt geboden, kan worden belemmerd bij gebruik op een manier die niet wordt vermeld door AR RF/Microwave Instrumentation (AR).

- Respecteer alle tilinstructies die in dit document vermeld zijn.
- Plaats het apparaat op een hard, waterpas oppervlak.
- Gebruik het apparaat niet in een natte omgeving, bijvoorbeeld in de buurt van een gootsteen of in een vochtige kelder.
- Plaats uw apparaat zodanig dat de aan/uit-schakelaar gemakkelijk bereikbaar is.
- Laat een vrije ruimte van 10,2 cm (4 inch) aan alle geventileerde zijden van het apparaat om de luchtstroom die nodig is voor goede ventilatie mogelijk te maken. Belemmer de luchtstroom in het apparaat niet door ventilatieopeningen of luchtinlaten te blokkeren. Het belemmeren van de luchtstroom kan leiden tot schade aan het apparaat, onregelmatige uitvallen of veiligheidsrisico's.
- Houd het apparaat uit de buurt van extreem hoge of lage temperaturen om ervoor te zorgen dat het apparaat binnen het gespecificeerde werkbereik wordt gebruikt.
- Bij de installatie van accessoires zoals antennes, directionele koppelingen en terreinsondes, moet u ervoor zorgen dat blootstelling aan gevaarlijke RF-niveaus wordt voorkomen.
- Zorg ervoor dat er niets op de kabels van uw apparaat rust en dat de kabels zich niet op een plaats bevinden, waar er op getrapt kan worden of waar er over gestruikeld kan worden.
- Verplaats de apparatuur voorzichtig; zorg ervoor dat alle zwenkwielen en/of kabels stevig op het systeem zijn aangesloten. Vermijd plotselinge stops en oneffen oppervlakken.

VOOR HET OPZETTEN VAN DE STROOM

Uw AR-apparatuur kan meer dan een netvoedingskabel bezitten. Gebruik alleen goedgekeurde netvoedingskabel(s). Koopt een netvoedingskabel die is goedgekeurd voor gebruik in uw land als u geen netvoedingskabel hebt ontvangen voor de apparatuur of voor een door wisselstroom aangedreven optie, die bedoeld is voor de apparatuur. De netvoedingskabel moet geschikt zijn voor het apparaat en voor de spanning en stroomsterkte die op het label met de elektrische classificatie van het apparaat staat vermeld.

Het verkeerd installeren of gebruiken van een incompatibele netspanning kan het risico op brand of andere gevaren verhogen. Sluit het apparaat en de perifere netvoedingskabels aan op geaarde stopcontacten om elektrische schokken te helpen voorkomen. Deze kabels zijn uitgerust met driepolige stekkers om voor een goede aarding te zorgen. Gebruik geen adapterstekkers of verwijder de aardingspen van een kabel niet.

Pas geen netvoedingskabels of stekkers aan. Raadpleeg een bevoegde elektricien of een door AR opgeleide servicemonteur voor aanpassingen van de apparatuur. Respecteer altijd uw lokale/nationale bedradingsreglementering.

Gebruik de apparatuur niet als er sprake is van fysieke schade, ontbrekende hardware of ontbrekende panelen.

AARDING

Deze apparatuur is voorzien van een beschermende aardingsterminal. De stroombron van de apparatuur moet een ononderbroken veiligheidsaarding van voldoende grootte leveren om de aansluitklemmen, de netvoedingskabel of de meegeleverde netvoedingskabelset aan te sluiten. ***GEBRUIK dit apparaat NIET als deze bescherming is beschadigd.***

INSTRUCTIES VOOR VEILIG GEBRUIK

GEVAARLIJKE RF-SPANNINGEN

De RF-spanning op de middelste pin van een RF-outputconnector kan gevaarlijk zijn. De RF-uitgangsconnector moet op een massa worden aangesloten voordat er wisselstroom op het apparaat wordt geplaatst. Raak de middelste pin van de RF-outputconnector of de accessoires die erop zijn aangesloten, niet aan. Plaats het apparaat in een niet-werkende staat voordat u de massa loskoppelt of verbindt met de RF-outputconnector.

AKOESTISCHE BEPERKINGEN

Als het geluid van het apparaat 80dB overschrijdt, is gehoorbescherming vereist.

ONDERHOUD WAARSCHUWING

Aanpassing, onderhoud of reparatie van de apparatuur mag alleen worden uitgevoerd door gekwalificeerd personeel. Er kan gevaarlijke energie aanwezig zijn terwijl beschermende afdekkingen van de apparatuur worden verwijderd, zelfs als deze van de stroombron is losgekoppeld. Contact kan tot persoonlijk letsel leiden. Wisselzekeringen moeten van het hetzelfde type en dezelfde stroomsterkte zijn.

OMGEVINGSVOORWAARDEN

Tenzij anders op het productspecificatieblad is vermeld, is dit apparaat ontworpen om veilig te zijn onder de volgende omgevingsomstandigheden:

- Binnengebruik
- Hoogte tot 2000 m
- Temperatuur van 5 °C to 40 °C
- Maximale relatieve vochtigheid 80% voor temperaturen tot 31 °C. Lineair afnemend tot 50% bij 40 °C.
- Schommelingen in de netspanning mogen niet groter zijn dan ± 10 % van de nominale spanning of minimum en maximum autobereikwaarden.
- Vervuilingsgraad 2: Normaal niet-geleidend met incidentele condensatie. Hoewel het apparaat geen gevaarlijke toestand veroorzaakt boven dit omgevingsbereik, kunnen de prestaties variëren.

APPARAAT DAT LASERS BEVAT

AR-terreinsondes (FL/PL-serie) en terreinanalysatoren (FA-serie) zijn laserproducten van klasse 1 met ingesloten klasse 4-lasers. Bij normaal gebruik is de laserstraling volledig vervat in de glasvezelkabels en vormt ze geen bedreiging voor blootstelling. Veiligheidsvergrendelingen zorgen ervoor dat de laser niet wordt geactiveerd, tenzij de kabels correct zijn aangesloten. Wees altijd voorzichtig bij het gebruik of het onderhoud van laserproducten. Bekijk niet rechtstreeks met optische instrumenten.

RF-ANTENNES

- Dit apparaat (antenne of antenne-set) kan zwaar zijn, waardoor er twee personen nodig zijn om het op te tillen. Wees voorzichtig bij het installeren of verwijderen van het apparaat. Respecteer alle instructies voor het instellen en optillen van de apparatuur, die in dit document worden vermeld.
- Zorg ervoor dat de connectoren geschikt zijn voor de beoogde werking. De connectoren worden gespecificeerd in de gebruikershandleiding en in het productspecificatieblad.
- Overschrijd het maximale RF-ingangsniveau niet, dat in de specificaties is vermeld. Raadpleeg de gebruikershandleiding en het productspecificatieblad om de toepasselijke RF-niveaus te bepalen.
- Een overmatige RF-input kan het apparaat of de connectoren beschadigen en veiligheidsrisico's veroorzaken.
- De RF-spanningen op de antenne-elementen kunnen gevaarlijk zijn tijdens het gebruik. Raak de antenne of elementen niet aan wanneer de RF-ingangsconnector is aangesloten op een actieve RF-bron.
- Om persoonlijk letsel en onopzettelijke schade aan de vermogensversterker of antenne te voorkomen, schakelt u de RF-output van de vermogensversterker uit voordat u de inputaansluiting op de antenne aansluit of loskoppelt.
- Voer periodieke inspecties uit van de antenne- en terreinsondesystemen om de vervaldatum van de kalibratie, de juiste werking en de algehele conditie van de apparatuur te controleren.

IN EEN REK GEMONTEERDE TWT-MODELLEN

Sommige TWT-modellen worden geleverd zonder de verwijderbare behuizing die wordt aangeboden voor gebruik als tafelmodel. Deze modellen die in een rek kunnen worden gemonteerd, kunnen worden geleverd met handgrepen of sledes en handgrepen die aan de voorkant zijn geïnstalleerd. Volg alle tilinstructies in dit document en de installatie-instructies in de gebruikershandleiding van de TWT.

TILINSTRUCTIES VOOR AR-APPARATUUR

Omdat de meeste producten tijdens de distributie, de assemblage en het gebruik moeten worden behandeld, moet het risico op ernstig letsel als gevolg van een onveilige behandeling van het product een fundamentele overweging voor elke gebruiker zijn. Een gezaghebbende richtlijn voor het elimineren van ongerechtvaardigd risico op letsel veroorzaakt door tillen, wordt aangeboden door de NIOSH-Work Practices (publicatie # 94-110) en is beschikbaar op:

https://www.cdc.gov/niosh/docs/94-110/pdfs/94-110.pdf.

Neem in het algemeen de volgende richtlijnen in acht voor het optillen van een gewicht van 25 kg of meer:

- Gebruik alleen het hijsoog (vloermodel) of de zijhandgrepen (tafelmodel) om de eenheid op te tillen.
- Gebruik apparatuur met voldoende capaciteit om de eenheid op te tillen en te ondersteunen.
- Als u een vorkheftruck gebruikt om de eenheid te verplaatsen, zorg er dan voor dat de vorken lang genoeg zijn om tot voorbij de zijkant van het eenheid uit te steken.
- Volg de link hierboven voor meer informatie.

TABLE OF CONTENTS

FIGURES

TABLES

1. GENERAL INFORMATION

1.1 INTRODUCTION.

This instruction manual provides general information, Installation and operating instructions, and application notes for the Model PM2003 RF power meter.

1.2 DESCRIPTION

The Model PM2003 series is a DSP (digital signal processor) based dual channel, 3 inputs, solid state RF power meter. They are capable of measuring RF power levels from –70 dBm to +44 dBm. The RF frequency range and power level range are head-dependent. AR Model PH2000 series of power heads provide measurement capabilities for frequencies from 10kHz to 40GHz.

Figure 1-1 Model PM2003 Series RF Power Meter

1.3 FEATURES

1.3.1 Power Heads

A wide range of diode and thermocouple power heads for both coaxial and waveguide applications are available for use with the model PM2003. Head data adapters are supplied with each power head, however, the power heads must be ordered separately.

- **Diode heads** measure the voltage across a precision resistor, using specially selected diodes. Detection is square law (true RMS) over approximately the lower two-thirds of the head's dynamic range, and peak detecting over the upper portion. Because the instrument is calibrated for sine waves over the entire range, measurements at the top one-third of the head's dynamic range are valid only for non-modulated signals. In the RMS region, linearity is excellent, and any signal type can be measured. The diode range has been extended into the peak detecting region with the use of real time shaping for the diode curve. When coupled with the high sensitivity of the diode, such shaping allows a dynamic range of 90 dB. Diode heads are rugged and have overload headroom of more than 5 dB for continuous signals. The dynamic range in the RMS region can be extended further through use of an external attenuator.

- **Thermal heads** measure the voltage developed across a dissimilar metal junction caused by thermal gradient generated by the RF power being measured. Because these heads are heat detecting, they

provide true RMS response over their entire range. Very high peak powers (15 to 30 watts) can be accommodated for very short duty cycles and still provide valid results. The dynamic range is 50 dB. Thermal heads are not as sensitive as diode heads.

- The **head data adapter** contains non-volatile memory for storage of the calibration data. In addition, calibration data for up to four heads can be stored in the instrument's non-volatile memory. The user can enter both the linearity and high frequency head calibration correction data, which are supplied with each head. For heads ordered with the Model PM2003, the calibration data is loaded into the head data adapter prior to shipment. When the frequency of the RF signal to be measured by these heads is entered; the instrument looks up the appropriate calibration factors, interpolates as necessary, and automatically applies the correction to the measured value. Calibration factors for heads ordered with the instrument are stored on the label and in the manual.

1.3.2 Simple Instrument Setup and Operation

In the operating mode, the functions: Frequency, Averaging Time, Reference Level, Zeroing/Calibration are selected with a single keystroke. Values for these parameters are displayed and can be adjusted by using the arrow and enter keys. Additional operating parameters can be modified through the menu driven structure accessible via the **<Menu>** and **<Sensor>** keys.

1.3.3 Alphanumeric Display

The alphanumeric LCD provides clear, unambiguous readouts of the instrument's setup and measurement values. Simultaneous display of both channels is available in duel channel mode. A bar graph provides a display of the channel's measured value for nulling and peaking applications.

1.3.4 Selectable Ranging.

Any of seven measurement ranges, or autoranging, can be selected during instrument setup. The selection will be held until the instrument is turned off. When measuring signals with levels that fall within a narrow range, selecting one specific instrument range may reduce measurement time. Autoranging is useful if the RF signal level is unknown, or if RF signals with widely varying levels are to be measured.

1.3.5 Selectable Filtering

Measurement speed and display stability can be optimized through the use of selectable filtering. Filter times can be adjusted up to 20 seconds maximum in 50 millisecond increments.

1.3.6 Zeroing.

Automatic zeroing (nulling of offsets for the head and input channel) is done independently on each range to eliminate zero carryovers.

1.3.7 Built-In Precision Calibrator

A built-in 50MHz calibrator provides an accurate, stable, and convenient power source for calibration of the instrument to specified tolerances. The calibrator may be toggled on or off from the Setup menu. The connector is mounted on the rear panel.

1.3.8 Chart Recorder Output

A 0 to 10 volt DC output, proportional to the measurement values, is available for application to a chart recorder.

1.3.9 Dimensions

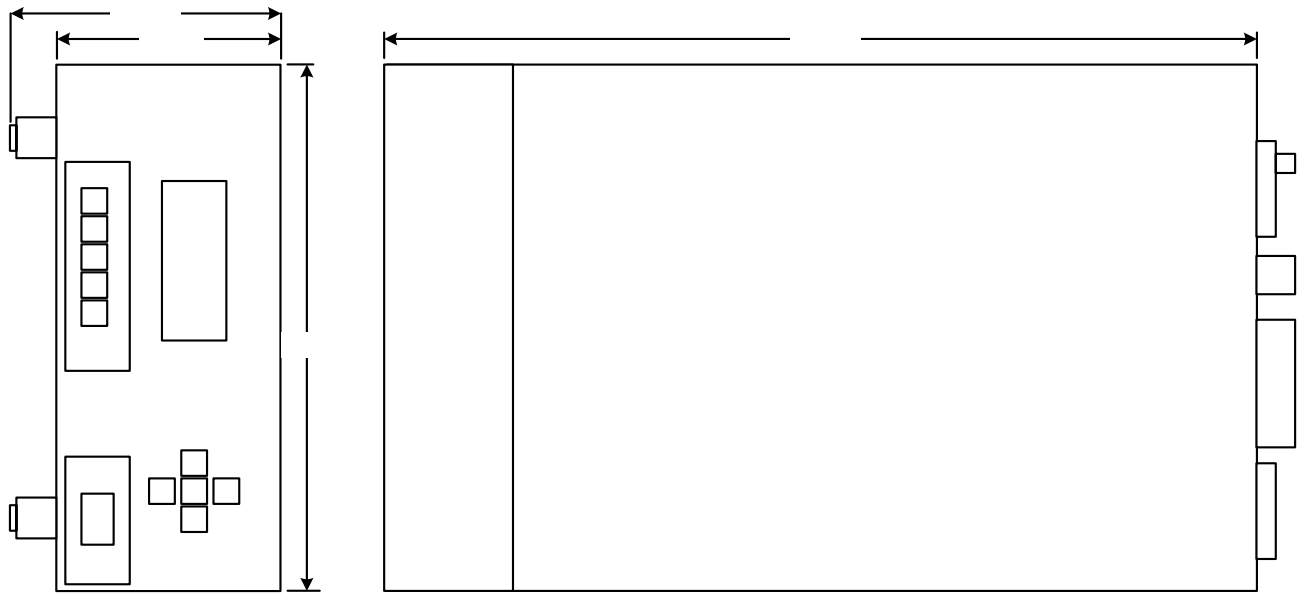


Figure 1-2. Outline Dimensions

See Figures 3-1 and 3-2 for a detailed drawing.

1.4 ACCESSORIES

A head data adapter, for each installed channel and an AC line cord are supplied with each instrument. One or more PH2000 SERIES power heads are required. The power heads are not supplied as part of the instrument, but must be ordered separately. A five-foot power head cable, 10017970, is supplied with each head ordered. Additional available accessories include the following:

- 10017971 Head/Probe Interconnecting Cable (10 ft)
- 10017972 Head/Probe Interconnecting Cable (20 ft)
- 10017973 Head/Probe Interconnecting Cable (50 ft)
- 10017974 Head/Probe Interconnecting Cable (100 ft)
- 10016003 AF/F Adapter, (for connecting cables end to end)

- Model FT3000 Bulkhead Connector F/F, (for connecting cables end to end)
- Model RM2000 A Rack Mounting Kit

1.5 SPECIFICATIONS

Performance specifications of the Model PM2003 are listed in Table 1-1. A complete AR data sheet appears at the end of this section.

Table 1-1. Performance Specifications

Parameter	Specification
Frequency Range	10 kHz to 40 GHz, head dependent
Power Range	-70 dBm to +44 dBm, head dependent
Power Heads	Accepts head data adapter and is compatible with all AR diode and thermal heads
Dynamic Range	Up to 90 dB with diode heads; up to 50 dB with thermal heads
Inputs	Rear panel head connector; rear panel IEEE-488 connector, rear panel RS-232 connector.
Outputs	Rear panel PWR REF connector, 50 MHz, 0 dBm; Rear panel recorder BNC Connector, 9.06 kilohm impedance, 0 to 10 volts into 1 megohm (may be operated into 1 kilohm for IV fs).
Display	Menu-driven 20 character x 4 line LCD
Display Units	MW, kW, W, mW, µW, nW, dBm, dBr, %
Display Resolution	0.001 (db, dBm, dBr) or 5 digits (nW, µW, mW and W)
Display Offset	-99.99 dB to +99.99 dB in 0.01 dB steps
Alarm	Individual high and low limit thresholds, -99.99 dB to +99.99 dB
Peak Power Mode	Programmable duty cycle from 0.01 to 100.00% in 0.01 steps
Ranging	Autoranging or manual (7 ranges)
Filtering	Filter times to 20.00 seconds in 0.05 second increments
Zeroing	Automatic function; calibrates, stores, and applies zero corrections to each range
High Frequency Cal Factors	+3 dB to –3 dB in 0.01 dB steps; cal factors for up to four power heads with up to 60 frequencies each may be stored in the instrument's non-volatile memory; cal factors also stored in head data adapter.
Reference Level	-99.99 dB to +99.99 dB in 0.01 dB steps for dBr measurements
Power Reference	
Frequency	50 MHz ±0.005%
Output Level	-60 to +20 dBm
Level Accuracy, 0° to 20° C, NIST traceable	0 dBm: ±0.055 dB (1.27%) +20 to -39 dBm: ±0.075 dB (1.74%) -40 to -60 dBm: ±0.105 dB (2.45%)
Source Impedance	50 +1 ohm
VSWR	< 1.05
Harmonic Output	<-50 dBc
Measurement Accuracy	Sum of following uncertainties (errors are + worst case): instrument uncertainty, noise/signal percentage, power reference uncertainty, head shaping, temperature drift, mismatch, and high frequency calibration factors
Instrument uncertainty	.002% at full scale
Noise/Signal Percentage	Refer to Power Head Specification
Power Reference	Refer to Power Head Specification
Uncertainty	
Head Shaping	Refer to Power Head Calibration Data
Temperature Drift	Refer to Power Head Specification
Power Requirements	90-260 VAC, 47-63 Hz, 24 VA maximum. No voltage switching required

Parameter	Specification
Ventilation Requirements	1 ½" clearance after installation, top, side, rear
Temperature	
Operating	0 to +55°C
Non-operating	-40 to +75°C
Altitude Operating	10,000 ft.
CE Mark:	Declares conformity to European Community (EC) Council Directives: 89/336/EEC//93/68/EEC, 73/23/EEC//93/68/ EEC & Standards: EN61326-1, EN55022, EN61000-4/-2,3,4,5,6,11,ENG1010-1
Humidity	95% non-condensing
Weight	5 lb (2.2 kg)
Dimensions	8.26 in. (21.0cm) wide 3.48 in. (8.9cm) high, 13.5 in. (34.3cm) deep

rf/microwave instrumentation

Model PM2003
Power Meter
10kHz–40GHz

The Model PM2003 is a three channel high performance power meter that features high speed measurement capability and wide dynamic range.

SPECIFICATIONS

FREQUENCY RANGE	10kHz-40GHz, power head dependent
POWER MEASUREMENT RANGE	-70dBm to +44dBm, power head dependent
NUMBER OF CHANNELS	Three (2 simultaneously viewable)
MEASUREMENT SPEED	1 channel: 200 readings/sec. 2 channels: 100 readings/sec.
POWER HEADS	Select from a large number of diode and thermocouple Power Heads. The linearity and frequency calibration factors for the heads are provided in an EEPROM contained in a Head Data Adapter shipped with the Power Head.
DYNAMIC RANGE	Up to 90dB with diode heads, 50dB with thermocouple heads. See Power Head Specifications.
INPUTS	Rear panel HEAD connectors and rear panel IEEE-488 connector standard.
OUTPUTS	Rear panel PWR/REF connector, 0dBm, 50MHz. Rear panel RECORDER BNC connector, 0 to 10V into 1MΩ. Output impedance is 9.09kΩ. May be operated into 1kΩ or 1V fs.
EMULATION	HP437, HP438 and Boonton 4230, SCPI
DISPLAYS	Menu-driven 20 character x 4 line LCD display. Simultaneous display of dual channels with bar graph proportional to data display.
DISPLAY UNITS	Absolute, watts and dBm. Relative, dBr
DISPLAY RESOLUTION	5 digits, nW, μW, mW and W; 4 digits dBm
MEASUREMENT ACCURACY	Total accuracy is the sum of the following uncertainties: (errors are ± worst case).
INSTRUMENTATION ACCURACY	0.23% of full scale. 0.46% of 1/10 full scale
POWER REFERENCE UNCERTAINTY	
Output Frequency:	50MHz ±0.005%.
Output Level:	-60 to +20 dBm
Resolution	0.1 dB steps
Accuracy, 0°-20°C, NIST Traceable	At 0 dBm ±0.055 dB (1.27%) +20 to -39 dBm ±0.075 dB (1.74%) -40 to -60 dBm ±0.105 dB (2.45%)
Source Impedance:	50 ± 1 ohm. SWR: <1.05
Harmonic Output	<-50dBc.
OTHER UNCERTAINTIES	For Head, Noise, High Frequency Calibration Uncertainty See Power Head Specifications
CALIBRATION FACTORS	+3dB to -3dB in 0.01dB steps. These calibration factors are stored in non-volatile memory. When a frequency other than that stored is used, the meter linearity interpolates between the calibration factor above and below the frequency entered to obtain a calibration factor.

SPECIFICATIONS, MODEL PH2003

RANGING	Automatic or Manual
FILTERING	Filter times in 0.05 second intervals to 20 seconds.
ZEROING	Automatic function to calculate, store and apply zero corrections to each range
DISPLAY OFFSET	-99.99 to 99.99 in 0.01dB steps (dBr)
POWER CONSUMPTION	90 to 260 VAC (±10%), 47-63Hz, 24 VA maximum
OPERATING TEMPERATURE	0° to +55°C
WEIGHT	4.9 lbs (2.2 kg)
DIMENSIONS	8.25 in (21.0 cm) wide, 3.5 in (8.9 cm) high, 13.5 in (34.3 cm) deep
INTERFACES	IEEE-488 and RS-232
ACCESSORIES REQUIRED	One or more of the available power heads and a 5 ft. power head cable (supplied with each head ordered) are both required. See PH2000 Specification Sheet.
ACCESSORIES AVAILABLE:	RM2000 19" Rack Mount Kit
EXPORT CLASSIFICATION	EAR99

2. INSTALLATION

2.1 INTRODUCTION

This section contains the installation instructions for the Model PM2003 RF Power Meter. It includes unpacking, mounting, power connections, cable connections and preliminary checkout procedures.

2.2 UNPACKING

The instrument is shipped complete and ready to use upon receipt. Unpack the instrument from its shipping container and inspect it for damage that may have occurred during shipment. Refer to Figure 2-1.

NOTE: Save the packing material and container for possible use in re-shipment of the instrument.

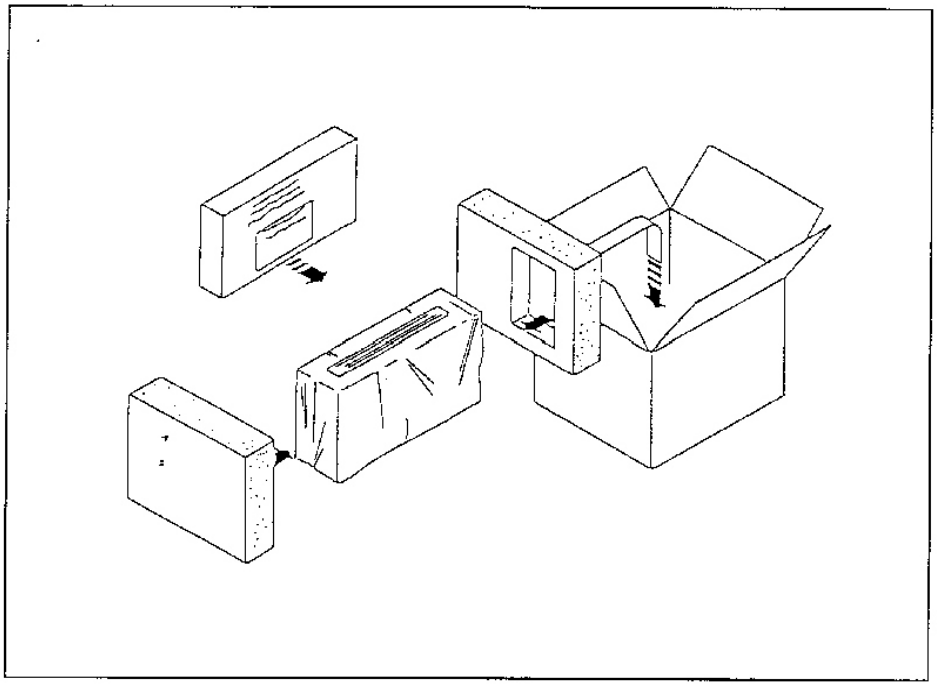


Figure 2-1. Packing and Unpacking Diagram

2.3 MOUNTING

For bench use, choose a clean, dry and uncluttered surface. For rack mounting, a Model RM2000 accessory kit is available which contains the necessary parts for mounting a single half-width Model PM2003 (or a compatible product) in a single 19-inch rack

2.4 POWER REQUIREMENTS

The Model PM2003 has a switching power supply that will operate from 90 to 260 VAC ± 10%, 47 to 63Hz, 24VA maximum.

2.5 CONNECTIONS.

An AC power cable is supplied with the instrument and a standard interconnecting cable, or cable/adapter combination is supplied with each RF head. Longer RF Head cables are available as accessories. All other cables required must be supplied by the user.

- **Head**
  The RF Head is to be used for measuring and is connected to the cable or Data Adapter-Cable combo supplied with the head. If the Data Adapter is a separate item, also connect the cable to the adapter. Make sure that the serial number on the Data Adapter matches the serial number of the RF head. Insert the 10-pin adapter plug into one of the two head inputs.
- **Recorder**
  A data recorder or other similar device can be connected to the Recorder BNC connector on the rear panel. The output is a DC voltage proportional to the channel 1 display value. The voltage range is 0 to 10 volts with an output impedance of approximately 9 kohms.
- **GPIB**
  The standard instrument is equipped with an IEEE-488 bus interface for remote operation. The connector is located on the rear panel.

2.6 PRELIMINARY CHECK

The following preliminary checks verify that the model PM2003 is operational. They should be performed before the instrument is placed in service. Proceed as follows:

1. Ensure that the voltage selector switch and fuses correspond to the AC power source voltage to be used.

2. Connect the AC power cable to the instrument and to the power source.

3. Connect one or two RF Heads to the instrument as described above.

4. Set the front panel OFF/ON power switch to the ON position.

5. Verify that the following is momentarily displayed:

   Amplifier Research
   PM2003 RF POWER METER
   REV. XXXXXX

6. Verify that the measurement display shows **CH 1** and **CH 2** for Model PM2003. Other data on this display will depend upon previous settings.

7. Press the **<MENU>** key and select **DIAGNOSTICS** with the down arrow key. Press **<ENTER>**. Verify the following submenu:

   DIAGNOSTICS:
   RTN
   SELFTEST<

SWITCHES
RECORDER

8. Press **<ENTER>** to execute the selftest. The items tested are:

   - Processor
   - SRAM Memory
   - EEPROM

   Each test will display the OK message if it passed. When the test is completed the menu will reappear.

9. Use the **<Down Arrow>** key to move the < cursor to **SWITCHES** and press **<ENTER>**. Press each front panel key, avoiding **<MENU>** until last. Each key press will result in an identifying message; **<MENU>** will exit the test and return to the **MENU**.

10. Use the **<Down Arrow>** key to select **RECORDER** and press **<ENTER>**. This test will sequentially send a DC voltage in 1-volt steps to the recorder output BNC connector on the rear panel. The test will continue until **<MENU>** is pressed. Use a DC voltmeter to verify correct operation.

11. Press **<MENU>** to return to the measurement display.

12. Press the **<Sensor>** key and verify that the RF Head serial number(s) appear under the channel heading(s). An active channel with no head installed will report a table number.

13. Press the **<AVG>**key and verify that the filter time and number of samples appear for each active channel.

14. Presses the **<REF Level>** key and verify that a reference level and mode is shown for each active channel.

15. With each installed head connected to the reference output, press the **<ZERO/CAL>** key and select **ZERO/CAL** function for the active channel. Verify the **ZERO/CAL** operation completes successfully. Repeat this operation for the other channel if installed.

16. For standard instruments equipped with the IEEE-488 interface, connect a GPIB controller to the Model PM2003. Verify that the instrument can be addressed to listen at its IEEE bus address, and set to **Remote**. The display must show the correct status on the bottom line of the display. For message passing, the line terminators for the controller and the Model PM2003 must be compatible for both Listen and Talk. Use **<MAIN><SETUP><IEEE>** to set address and terminators for the PM2003. Address the Model PM2003 to Listen/Remote and send the command **?ID** or ***IDN? EOL**. Then address the Model PM2003 to Talk (controller to listen) and verify that the correct identification string is returned.

3. OPERATION

3.1 INTRODUCTION

This section contains operation instructions for the Model PM2003. It is strongly recommended that the operator become familiar with all the material in this section and with the application notes in Section IV before attempting to operate the instrument; otherwise, the full capabilities of the instrument may not be realized.

3.2 OPERATING CONTROLS, INDICATORS, AND CONNECTORS.

See Figure 3-1 and 3-2 for the location of the operating controls and connectors. Refer to Table 3-1 for the function of each of these items.

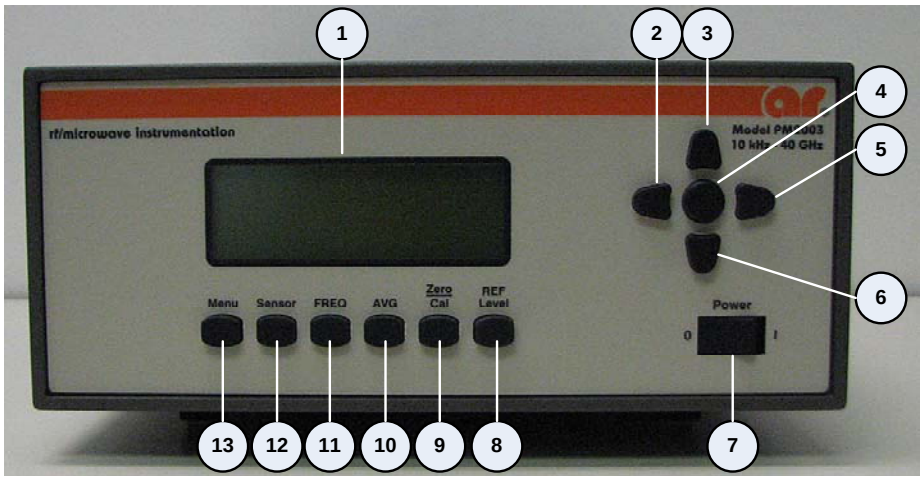


Figure 3-1. Front Panel Controls and Connectors

Table 3-1. Front Panel Operating Controls, Indicators and Connectors

Ref.	Nomenclature	Function
1	Display	LCD readout of the measurements and user interface for editing of the instrument's operating parameters.
2	Left Arrow Key	In entry mode, advances the cursor to the left.
3	Up Arrow Key	In entry mode, advances the cursor upwards. In parameter entry mode, scrolls forward through the parameter list. In numerical entry mode, advances the value to the next higher digit.
4	Enter Key	In entry mode, initiates the procedure to change a parameter. In parameter entry mode, terminates the current command and changes the parameters to the last displayed values.
5	Right Arrow Key	In entry mode, advances the cursor to the right.
6	Down Arrow Key	In entry mode, advances the cursor downwards. In parameter entry mode, scrolls backward through the parameter list. In numerical entry mode, advances the value to the next lower digit.
7	Power Switch	Turns the instrument off and on.
8	<REF Level> Key	Selects the reference level menu for relative measurements.
9	<Zero/Cal> Key	Selects the zeroing and 0 dBm reference level calibration functions.
10	<AVG> Key	Selects the filter averaging display for the measurement value.
11	<FREQ> key	Selects the operating frequency display.
12	<SENSOR> Key	Displays the serial numbers of the installed heads and allows for editing of the head parameters.
13	<Menu> Key	Displays and allows editing of the instrument's operating parameters. Returns instrument to local mode when operating in the bus remote mode. Escapes back to measurement screen from any menu.

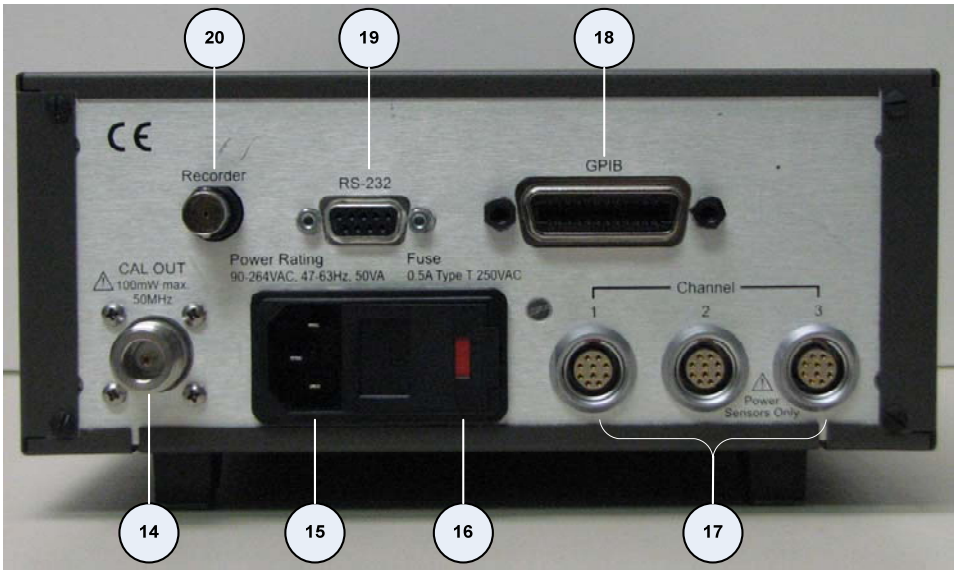


Figure 3-2. Model PM2003, Rear Panel Controls and Connectors

Table 3-2. Rear Panel Operating Controls, Indicators and Connectors

Ref.	Nomenclature	Function
14	0 dBm 50 MHz connector	Provides 50 MHz, 0dBm output for instrument calibration.
15	Power Receptacle	Provides means for connecting the AC power cord to the instrument.
16	Fuse	Protects the power circuits from overload.
17	Head connectors, Channels 1-3	Provides the means of connecting the power head to channels 1 through 3 of the instrument.
18	GPIB Connector	Provides means for connecting the instrument to the IEEE-488 bus for remote control.
19	RS-232 Connector	Provides means for connecting the instrument to the RS-232 bus for remote control.
20	Recorder Connector	Provides a DC voltage proportional to the measured values for use by an external recorder.

3.3 OPERATING THE INSTRUMENT

Energize the instrument by setting the POWER switch to the ON position. The instrument will perform a self-test routine and initialize the operating parameters to the power-up values.

3.4 MEASUREMENT DISPLAY

The measurement screen shown in Figure 3-3 can be configured to display one or two channels along with the corresponding bar graph. In alarm mode, the $\wedge$ and the $\vee$ symbols are displayed before the channel mode to indicate that the measured values are above or below the defined limits. An asterisk is displayed before the channel mode when the Manual range mode and the measured value is below the lower range limit indicating an uncalibrated measurement. The alarm indicators have precedence over the range limit display. In peak pulse, the $^{p}_{k}$ symbol is displayed after the measurement unit. The Δ symbol is displayed when the measurement is associated with an offset. When the instrument is configured for remote operations over the IEEE-488 bus, the last line, as shown in Figure 3-4, is always used for the bus indicators.

Figure 3-3. Measurement Display, Local Mode

DUAL CHANNEL

L	M	M	M	M	M		±	D	D	D	D	D	D	U	U	U		P_K	Δ
			(	B	A	R		G	R	A	P	H	)						
L	M	M	M	M	M		±	D	D	D	D	D	D	U	U	U		P_K	Δ
			(	B	A	R		G	R	A	P	H	)						

SINGLE CHANNEL

L	M	M	M	M	M		±	D	D	D	D	D	D	U	U	U		P_K	Δ
			(	B	A	R		G	R	A	P	H	)						

Key: O = 0 though 9 or a decimal point

L = ¸ , **°,** (alarm mode), *(range hold-low)
MMMMM = CH1, CH2, CH1+2, CH1/2
UUU = nW, μW, mW, kW, MW, dBm, dBr, %

Figure 3-4. Measurement Display, Remote Mode

L	M	M	M	M	M		±	D	D	D	D	D	D	U	U	U		P_K	Δ
			(	B	A	R		G	R	A	P	H	)						
L	M	M	M	M	M		±	D	D	D	D	D	D	U	U	U		P_K	Δ
	R	E	M		L	S	N			T	L	K			S	R	Q		

Key: REM = Remote mode enabled
LSN = Listen addressed
TLK = Talker addresses
SRQ = Service request activated

3.5 MENU STRUCTURE

The Model PM2003 can be configured for operation via the six switches on the front Panel; **<Menu>**, **<Sensor>**, **<FREQ>**, **<AVG>**, **<Zero/Cal>**, **<REF LEVEL>**. Pressing a key will bring the instrument to the next submenu. A flow chart of the instrument's command structure is shown in Figure 3-5. The **<Menu>** key also serves as an **ESCAPE** key to cancel the current operation from any point and return to the measurement screen.

To change a value, use the arrow keys to position the cursor to the desired parameter. Press the **<Enter>** key and then use the up/down arrow keys to scroll through the parameter list. When a number is to be entered, use the left/right arrow keys to position the cursor under the number that is to be changed, then use the up/down arrow keys to increment/decrement the number. Holding the up/down arrow key will initiate repeat mode to allow rapid movement through the selections. The **<Enter>** key must be pressed to accept the current selection.

Within a submenu, the ∧ and the ∨ indicators are displayed in the upper right portion of the display when the current screen has additional information that can be obtained by scrolling with the up/down arrow keys. Three conditions are possible:

- ∧ Use the up arrow key to scroll the screen upward for additional information.
- ∨ Use the down arrow key to scroll the screen downward for additional information.
- ∧∨ Use the up/down arrow keys to scroll the screen upward/downward for additional information.

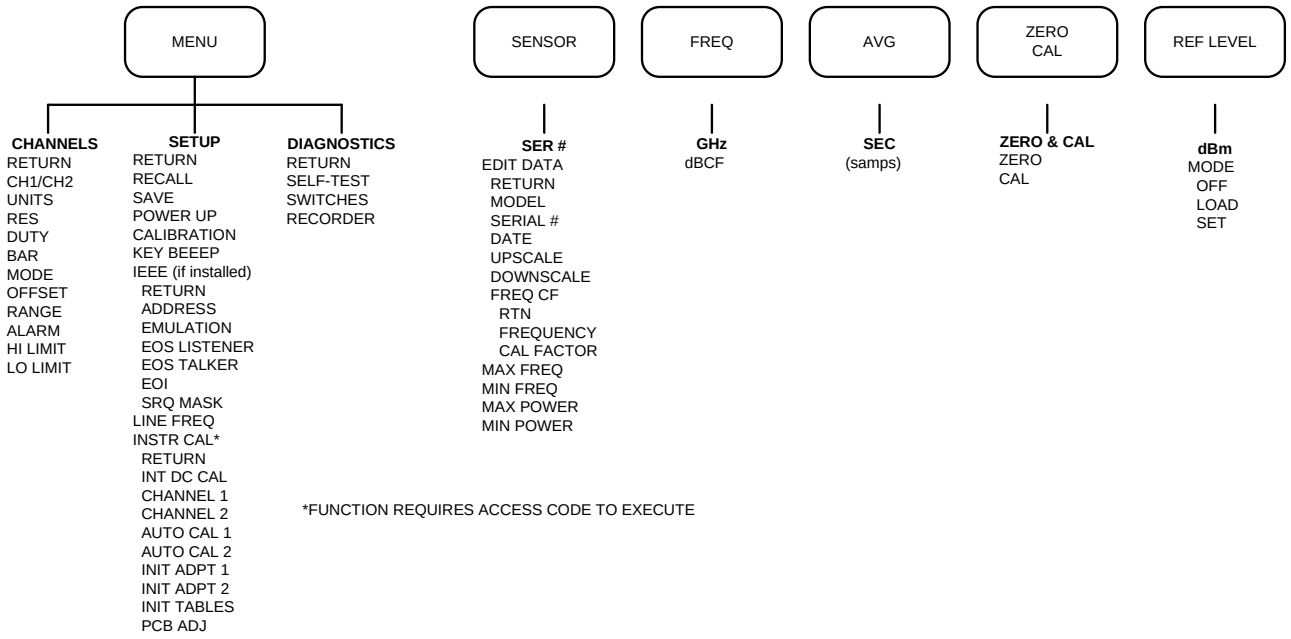


Figure 3-5. Model PM2003, Command Set

3.6 MENU Key

The instrument's Main Menu commands: **CHANNELS**, **SETUP**, and **DIANOSTIC** are accessed when the **<Menu>** key is pressed. The Main Menu display is shown in Figure 3-6.

Using the up/down arrow keys, the cursor can be positioned to select from the three submenus.

```
C H A N N E L S          <
S E T U P
D I A G N O S T I C S
```

Figure 3-6. Main Menu Display

3.6.1 CHANNELS Menu

An example of the display for the channel menu, when two channels are installed in the Model PM2003, is shown in Figure 3-7. Although the figure shows eleven lines, the instrument can only display four at a time. Therefore, it will be necessary to use the up/down arrow keys to sequence through the commands. When viewing the commands, the instrument will retain the first line as a header and use the next three lines to scroll through the remaining commands.

R	T	N					C	H	1				C	H	2			°		'
U	N	I	T	S		>	W	A	T	T	S		d	B	m					
R	E	S					X	X	X	X			X	.	X	X				
D	U	T	Y				1	0	0	.	0	0	1	0	0	.	0	0		
B	A	R					O	F	F				O	N						
M	O	D	E										C	H	2					
O	F	F	S	E	T		0	.	0	0			1	0	.	0	0			
R	A	N	G	E			A	U	T	O			4							
A	L	A	R	M			O	N					O	F	F					
H	I		L	M	T		1	0	.	0	0		0	.	0	0				
L	O		L	M	T		1	.	0	0				0	.	0	0			

Figure 3-7. Channels Menu Display

Table 3-3 gives a description of the commands available from the Channels menu. The associated parameters and factory default settings are also given.

Table 3-3. Channels Menu Functions

Command	Description	Parameters	Default
RTN	Return the instrument to the previous menu.	N/A	N/A
UNITS	Units used for measurement display	dBm, WATTS	dBm
RES	Display resolution	x.x, x.xx, x.xxx dBm or xxx, xxxx, xxxxx watts	X.XX
DUTY	Duty cycle for pulse power applications; a value less than 100.00 enables pulse power mode	0.01 to 100.00%	100.00
BAR	Enables the bar graph on the measurement display.	ON, OFF	ON
MODE	Sets the display mode for channel 2; only available when two channels are installed. The units for the sum and ratio modes track the units selected for Channel 2.	CH2, CH1+2, CH1/2, OFF	CH2
OFFSET	Sets the offset added to the measured value.	-99.99 to 99.99 dB	0.00
RANGE	Selects and holds the instrument's measurement range. If repetitive measurements are to be made over a narrow range of levels, selecting the appropriate instrument range may speed measurement.	Auto, 0, 1, 2, 3, 4, 5, 6	AUTO
ALARM	Enables alarm mode; the v or ^ symbol is displayed before the channel mode designator on the measurement display to indicate the upper or lower threshold limit is exceeded.	ON, OFF	OFF
HI LMT	Upper threshold limit for the alarm function.	-99.99 to 99.99 dBm	0.00
LO LMT	Lower threshold limit for the alarm function.	-99.99 to 99.99 dBm	0.00

3.6.2 SETUP Menu

An example of the display for the Setup menu, when the Model PM2003 configured with an IEEE interface, is shown in Figure 3-8. It will be necessary to use the up/down arrow keys to sequence through the commands since there are more than four lines of information to be displayed. When sequencing through the commands, the instrument will retain the first line as a header and use the next three lines to scroll through the command list.

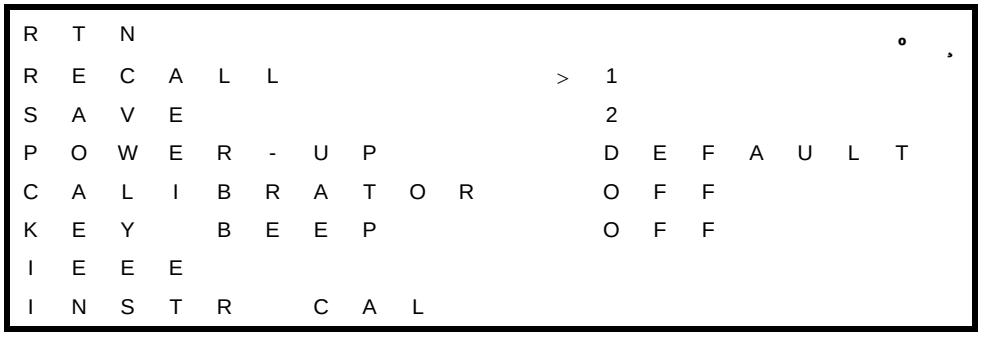


Figure 3-8. Setup Menu Display, IEEE Installed

Table 3-4 gives a description of the commands, parameters and settings of the Setup menu.

Table 3-4 Setup Menu Functions

Command	Description	Parameters	Default
RTN	Return the instrument to the previous menu.	N/A	N/A
RECALL	Recalls one of the ten user defined instrument configurations or the factory setup.	Default, 1-10	Default
SAVE	Saves the current instrument configuration to one of ten non-volatile memory locations.	1-10	1
POWER-UP	Instructs the instrument to power-up to the specified configuration.	Default, 1, 2, 3, 4	Default
CALIBRATION	Turns on/off the internal 50 MHz 0 dBm calibrator.	ON, OFF	ON
KEY BEEP	Turns ON/OFF the key beep.	ON/OFF	ON
IEEE	Brings the instrument to the IEEE menu. (if installed)	See table 3-5	N/A
LINEFREQ	Select line (mains) frequency.	50Hz, 60Hz	N/A
INSTRCAL	Refer to Service Manual.	N/A	N/A

3.6.2.1 Programming Interfaces

The appropriate setup menu will appear in the list.

3.7 IEEE MENU

The IEEE submenu is used to configure the Model PM2003 for communications over the GPIB. An example of the menu is shown in Figure 3-9 and description of the commands, parameters and factory defaults is given in Table 3-5.

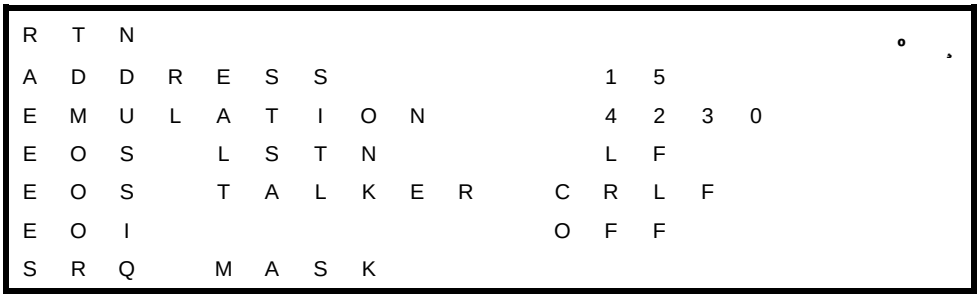


Figure 3-9. IEEE Menu Display

Table 3-5. IEEE Menu Functions

Command	Description	Parameters	Default
RTN	Return the instrument to the previous menu.	N/A	N/A
ADDRESS	GPIB address assigned to the instrument.	0 to 30	N/A
EMULATION	GPIB emulation mode	NONE, HP437B, HP438A	2002
EOSLSTN	End of string indicator for received message.	LF, CR, CRLF, NONE where: LF = Line Feed CR= Carriage Return CRLF= Carriage Return & Line Feed	LF
EOSTALKER	End of string of character sent with transmitted messages.	LF, CR, CRLF, NONE	CRLF

3.8 DIAGNOSTICS MENU.

The Model PM2003 can be directed to perform self-test from the diagnostics menu. The Diagnostics menu is shown in Figure 3-10 and a description of each command is given in Table 3-6.

Figure 3-10. Diagnostics Menu Display

Table 3-6. Diagnostics Menu Functions

Command	Description	Parameters	Default
RTN	Return the instrument to the previous menu.	N/A	N/A
SELF TEST	Instructs the instrument to perform internal diagnostics and the display test.	N/A	N/A
SWITCHES	Interactive test to verify proper operation of the front panel switches.	N/A	N/A
RECORDER	The recorder output DAC is exercised through its full range from 0 to 10 V.D.C. in IV steps until the <Menu> key is depressed.	N/A	N/A

3.9 SENSOR KEY

Pressing the **<Sensor>** key brings the instrument to the Head's menu and facilitates viewing and editing of the power head's parameters. An access code is required to enter the editing mode (refer to Figure 3-12). A sample display of the Head menu is shown in Figure 3-11.

The instrument is capable of using head calibration data from either the head data adapter or from one of four internal tables. The head calibration data contained within the head data adapter is only accessible to the installed channel. For example, Channel 1 can use the head calibration data from any of the internal tables or the head data adapter 1. Similarly, Channel 2 can use the head calibration data from any of the internal tables or the head data adapter2.

Referring to Figure 3-11, the cursor can be positioned to three fields. The two fields below the **CH 1** and **CH 2** indicate the serial number of the head whose calibration data is selected for channels 1 and 2 respectively. The instrument uses this data for the linearity and high frequency correction data and automatically applies the correction to the measured value.

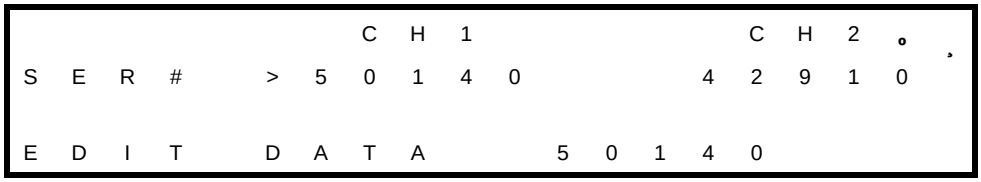


Figure 3-11. Head Display Menu

To change the current selection for channel 1, use the arrow keys to move to the SER# command line and position the cursor below the 'CH 1' field. Press the **<Enter>** key and use the up/down arrow keys to scroll through the parameter list. The parameter list typically consists of serial numbers for each power head. Scroll through the list until the desired serial number is displayed and press <Enter> to accept. Move the cursor below the 'CH 2' field and follow the same procedure used to change the table for channel 2.

The instrument detects the presence of the head data adapter and automatically down-loads the head calibration data. This occurs when the power to the unit is first applied or after plugging the head data adapter into the instrument. The power head and corresponding head data adapter have matching serial numbers for maintaining them as a matched pair.

The parameter list will show TBLn (where n= 1,2,3,4) when a serial number has not been entered for the corresponding internal table. For example, TBL3 will be displayed if the serial number has not been previously entered for internal Table 3. In addition, the parameter list will show ADPTn (where n=1,2) if a serial number has not been entered for the table contained within the head data adapter. For example, ADPT2 is displayed when the serial number has not been previously entered for head data adapter 2.

EDIT DATA ACCESS CODE

The access code to enter the Edit Data menu is as follows:
Press the front panel switches in the following order:
<FREQ><AVG><AVG><FREQ><Sensor><Enter>

Figure 3-12 Access Code

3.9.1 Edit Data Menu

An example of the Edit Data menu is shown in Figure 3-13. Table 3-7 contains a description of the commands and associated parameters.

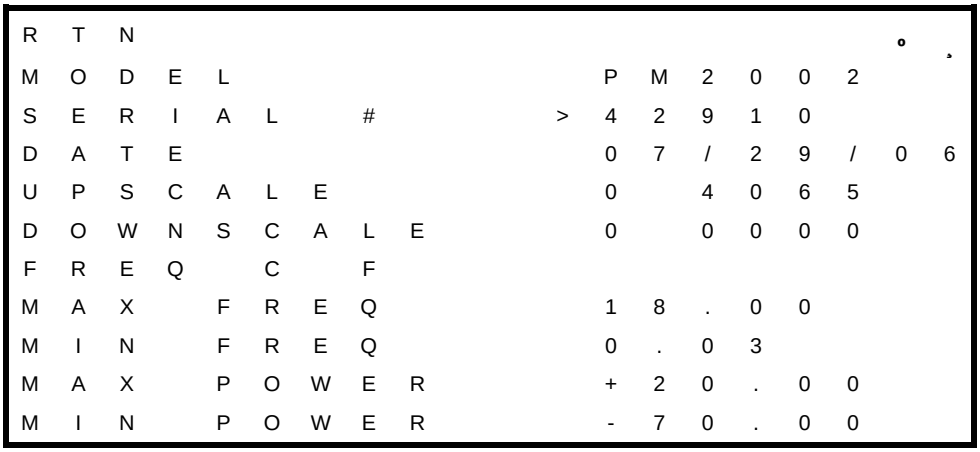


Figure 3-13. Edit Data Menu Display

Table 3-7. Edit Data Menu Functions

Command	Description	Parameters	Default
RTN	Return the instrument to the previous menu.	N/A	N/A
MODEL	Power Head model number.	0 to 99999	0
SER#	Power head serial number.	0 to 99999	0
DATE	Calibration date.	MM/DD/YY where: MM = 01 to 12 DD = 01 to 31 YY = 00 to 99	01/01/06
UPSCALE	Upscale linearity factors.	Range: Factor [0 to 6] : [0 to 9999]	5000
DOWNSCALE	Downscale linearity factors	Range: Factor [0 to 6] : [-999 to 999]	0
CAL FACTOR	Brings the instrument to the calibration factor menu.	N/A	N/A
MAX FREQ	Power head's maximum frequency.	0,40.00 GHz	18
MIN FREQ	Power head's minimum frequency.	0,40.00 GHz	0.03
MAX POWER	Power head's maximum power input.	[-99.99, 99.99] dBm	20
MIN POWER	Power head's minimum power input.	[-99.99, 99.99] dBm	-75

3.9.2 Linearity Factors

Seven upscale and downscale linearity factors are assigned to each power head. These values can be viewed or edited by moving the cursor to the UPSCALE or DOWNSCALE command and pressing the <**Enter**> key. The instrument will sequence through the linearity factors by pressing up/down arrow keys. If a value is to be edited, scroll to the desired linearity factor, use the right arrow key to move the cursor to the first digit in value field and then use the up/down arrow keys to increment/decrement the number. Set the remaining digits in the same manner. If another value needs to be changed, move the cursor back to the range field and use the up/down arrow keys to display the next value to be modified. Press the <**Enter**> key when all of the changes have been entered.

To edit the head calibration data, move the cursor to the EDIT DATA function and press **<Enter>**. Scroll through the power head serial numbers until the desired selection is displayed. Press **<Enter>** to proceed. Enter the access code to edit or depress the **<Menu>** key to escape. (See Figure 3-12.)

3.9.3 FREQUENCY Calibration Factors

Up to 60 head frequency calibration factors can be entered for each power head. Position the cursor to the FREQ C.F. command. Press the **<Enter>** key to advance to the Cal Factor menu. A sample of the display is shown in Figure 3-14, and an explanation of the commands is shown in Table 3-8.

R	T	N				F	R	E	Q	C	A	L			o	
0			>	0	0	0		0	3	+	0	0	-	0	0	
1				0	0	2		0	0	+	0	0	-	0	1	
2				0	0	3		0	0	+	0	0	-	0	4	

Figure 3-14. Cal Factor Menu Display

Table 3-8. Head Calibration Menu Functions

Command	Description	Parameters	Default
RTN	Return the instrument to the previous menu.	N/A	N/A
FREQ	Frequency	0.01 to 40.00 GHz	0.05
CAL	High frequency calibration factor	-3.00 to 3.00 dB	0.00

The up/down arrow keys are used to scroll through the calibration factor table. Use the arrow keys to move to the desired field and press the **<Enter>** key to change a value. The up/down arrow keys increment/decrement the value and the left/right arrow keys Select the digits. Press the **<Enter>** key when the desired value is displayed. Move the cursor to the RTN field or depress the **<Menu>** key to return to the Head menu.

The instrument scans the head calibration table for a value that matches the operating frequency. Linear interpolation is used if the operating frequency is between two of the table entries. To ensure proper operation, the calibration table must be entered in ascending order and terminated in the last table entry with a zero (o) value for both the FREQ and CAL FACTOR. In addition, new calibration values should be entered while adhering to the chronological order of the table. For example, to add the –0.01 dB calibration factor at 3.5 GHz to the example shown in Figure 3-15, the calibration factors for items four through six are re-entered.

Factor #	Frequency (GHz)	Cal Factor (dB)
0	1	0.00
1	2	0.08
2	3	-0.02
3	4	-0.15
4	5	-0.08
5	6	-0.08

Factor #	Frequency (GHz)	Cal Factor (dB)
0	1	0.00
1	2	0.08
2	3	-0.02
3	3.5	-0.01
4	4	-0.15
5	5	-0.08
6	6	-0.08

Figure 3-15. Calibration Data Example

3.9.4 SAVE

Exiting the EDIT DATA menu displays the confirmation menu as shown in Figure 3-16. Move the cursor to YES to save the edited parameters or NO to leave the data unchanged.

Figure 3-16. Save Display

3.10 FREQ Key

The frequency of the signal being measured must be entered in order to use the stored high frequency calibration factors. The instrument will then compute, display and apply the required correction factor to subsequent measurements.

The operating frequency is entered by pressing the **<FREQ>** key. The instrument will advance to the frequency menu as shown in Figure 3-17. The frequency for Channel 1 is entered by positioning the cursor to the value field under the CH1 heading and pressing the **<Enter>** key. A value between 0.01GHz and 40GHz can be entered. The power on default is 0.05GHz. Once the frequency is entered, the corresponding Cal Factor is displayed in dB beneath the frequency.

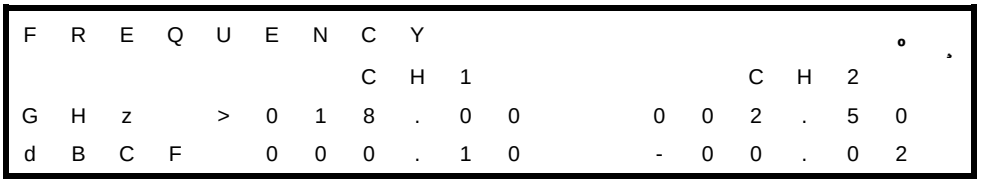


Figure 3-17. Frequency Display

3.11 AVG KEY.

The averaging time may be adjusted to optimize measurement speed and display stability. Averaging time, in seconds, can be adjusted in 0.05 increments to a maximum of 20.00 seconds. The length of the filter in number of samples is shown on the display.

To adjust the averaging time, press the **<AVG>** key and the instrument will display the screen as shown in Figure 3-18. Position the cursor under the desired channel heading and press the **<Enter>** key. Use the arrow keys to set the desired value and then press **<Enter>** to accept. Entering 00.00 selects the auto-filtering Mode. This menu can be accessed to show the filter setting in the auto mode.

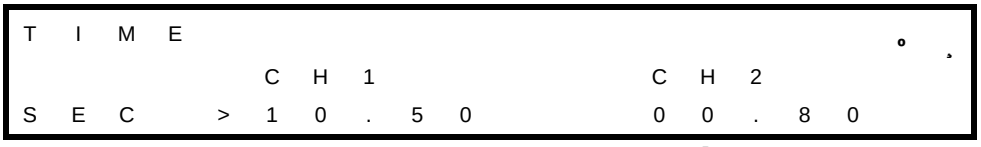


Figure 3-18. Averaging Time Display

3.12 ZERO/CAL Key.

Zeroing should be performed when the unit is first warmed-up, a head has been changed or the instrument has drifted a significant amount with respect to the signal level being measured. For large signals (measurements taken on range 4, 5, or 6), this may be done once every several hours. For small signals, (measurements taken on range 0, 1, 2, or 3), zeroing should be done before each measurement for optimum results. When zeroing is performed, the instrument calculates and stores zero corrections for each range, and supplies the corrections to subsequent measurements.

The built-in 50 MHz calibrator provides a convenient means for calibrating the instrument. Calibration can be performed any time to assure accuracy.

When measuring low level signals, it is important to zero the channel prior to measuring the signal. When the Active Channel is measuring levels below approximately –50 dBm, pressing the ZERO/CAL key will use the measured reading as the zero offset. This allows for fast zeroing of the channel so that the needed measurement can be performed faster.

The user may also perform a 0 dBm calibration by one key stroke of the ZERO/CAL button. Simply connect the sensor to a 0 dBm source and press the ZERO/CAL key. The instrument detects that a 0 dBm signal is present and sets a calibration factor accordingly to indicate 0.00 dBm.

The ZERO/CAL sub-menu can be displayed first by pressing the MENU key followed by the ZERO/CAL key. From there, the user chooses the function (zero, fixed cal, auto cal) and the channel on which to perform the calibration.

3.13 REF LEVEL Key

Press the **<REF Level>** key to enter a value or to use the current channel measurement for the reference level. The measurement units will automatically change to dBr for subsequent measurements.

Often relative measurements are required, especially when measuring system gains and losses. One key press of **REF/LEVEL** key makes this job easier and faster to perform. Simply connect the active channel's sensor to the input signal of the system under test. Press the **REF/LEVEL** key and the reference level is set. Next connect the sensor to the system output and read the gain or loss directly from the reference level measurement. Pressing the **REF/LEVEL** key while making a relative measurement will cancel this mode of operation.

The **REF/LEVEL** sub-menu can be displayed by first pressing the **MENU** key followed by the **REF/LEVEL** key. From there the user may LOAD or SET the reference level on either channel.

The instrument cal also load the current measured value as the reference level. To do this, depress the **<REF Level>** key to display the REFERENCE LEVEL sub-menu. Navigate the cursor using the arrow keys to the MODE selection of the desired channel. Depress the **<Enter>** key for the mode selection and using the **<Up>** or **<Down>** arrow keys, select LOAD. Depressing the **<Enter>** key will place the appropriate channel to dBr mode of operation using the measured value as the reference level. To turn off relative measurements, select OFF as the MODE.

Table 3-9. Reference Level Menu Functions

Command	Description	Parameters	Default
dBm	Reference level value in Preset mode	-99.99 to 99.99 dBm	0
MODE	Reference level mode. **LOAD** makes the current channel measurement as the reference level. The Set mode is used to select the entered reference level. The Off mode disables the reference level adjustment.	LOAD, SET, OFF	OFF

4. APPLICATION NOTES

4.1 INTRODUCTION

This section provides detailed background information on various aspects of operation of the PM2003. It is assumed that the reader is familiar with the basic operating procedures covered in Section III. This section covers the following topics:

- Head calibration
- Zeroing
- Filtering
- Noise
- Dynamic range
- Measurement time
- High frequency accuracy
- Chart recorder operation
- Waveform sensitivity
- Remote operation

4.2 HEAD CALIBRATION

4.2.1 General

Two types of calibration are associated with the Model PM2003 instrument calibration and head calibration. The instrument (less heads) must be calibrated using a stable and accurate DC source to ensure interchangeability of heads. Instrument calibration procedures are covered in the Model PM2003 Service Manual. Head calibration data is of two types: Linearity and High frequency calibration factors. Head calibration data for up to four heads can be stored in non-volatile EEPROM plus each head data adapter contains the data matched to the corresponding power heads.

4.2.2 14-Point Linearity Data

Linearity data, also referred to as AC reference frequency linearity data, is supplied with the head and can be manually entered into the non-volatile Tables or Adapters. For heads ordered with the instrument, linearity data is stored in the head data adapter before the instrument is shipped.

At the reference frequency (50 MHz), each head has two Gain factors for each range: upscale and downscale points. Refer to Figure 4-1. The upscale points are in the range of 4000-7000, which is a gain correction factor. Upscale points are calibrated at the factory at about 70% of full scale. The downscale number is an offset correction at about 25% of full scale. Thus, for a diode head (7 ranges), there are 14 points; for thermal heads there are eight points. Range 0 and 1 share the same data points.

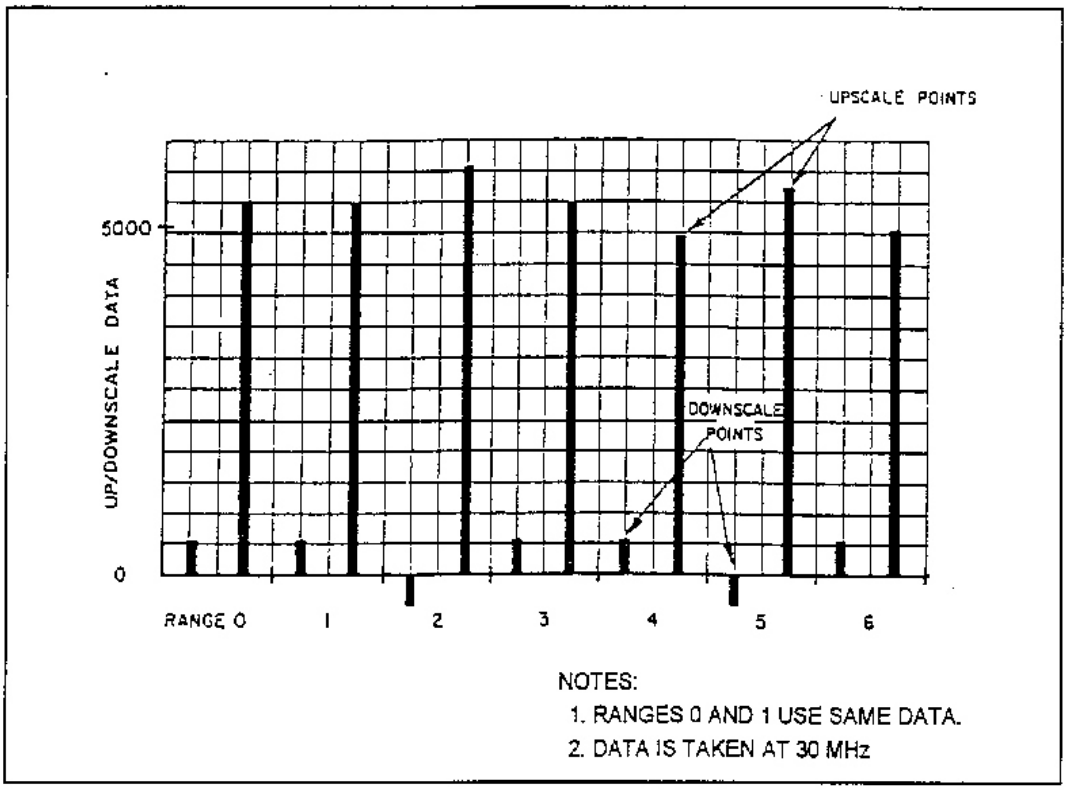


Figure 4-1. 14-Point Head Calibration

4.2.3 High Frequency Calibration Points

In addition to linearity data, there are high frequency calibration points. Calibration points covering the entire head frequency range are supplied with each head. Below 1 GHz, the head response is flat, and frequency calibration points need not be entered.

The Model PM2003 provides space for up to 60 points for each head table. Frequency calibration points need not be equal frequency increments; however, the entry of data must be done in ascending order of frequency. For both diode and thermal heads, a calibration factor of 0 dB is implied at 0.00 GHz so that the instrument may be operated below the first data point.

4.3 ZEROING

The automatic zeroing routine of the instrument takes measurements on the lowest five ranges and applies these as correction factors on subsequent measurements. Offsets in the head and input amplifiers are linearly corrected in the internal software. Offsets on the highest ranges are below 0.02% of the full scale, and do not need correction.

Input power to the head must be removed before the zeroing function is executed or an error message will be displayed. The instrument will perform zeroing, however, if the signal is less than full scale on range 0. This feature provides a great deal of offset capability for temperature effects without rezeroing the input amplifier hardware.

For full accuracy at low levels, power must be removed from the head several seconds before zeroing to allow the head to settle. This is especially true if a large signal had been applied to the head in the previous 20 seconds or so because of the dielectric absorption of the capacitors in diode heads, and because of thermal

retention in thermal heads. The error resulting from different input conditions can be determined from Figure 4-2 or 4-3, as applicable. The curves in these figures show the decay of measured power after a large signal has been applied. The typical error that can be expected by zeroing too quickly after application of a large signal is equal to the offset power at the time of zeroing.

The Model PM2003 initiates zeroing when the ZERO & CAL or ZERO commands are invoked. The user must delay zeroing according to system requirements when the heads are used over a wide dynamic range. For example, if it is determined from the application that five seconds are required from power off to zeroing operation, then the user must wait five seconds after removing power from head before executing the zero command.

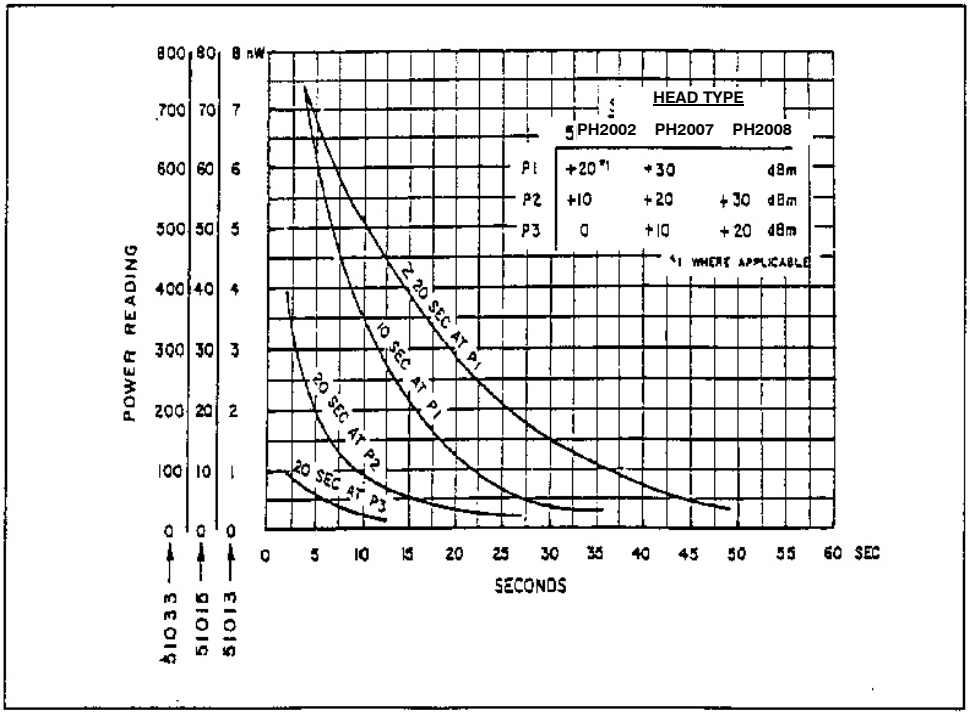


Figure 4-2. Diode Head Decay

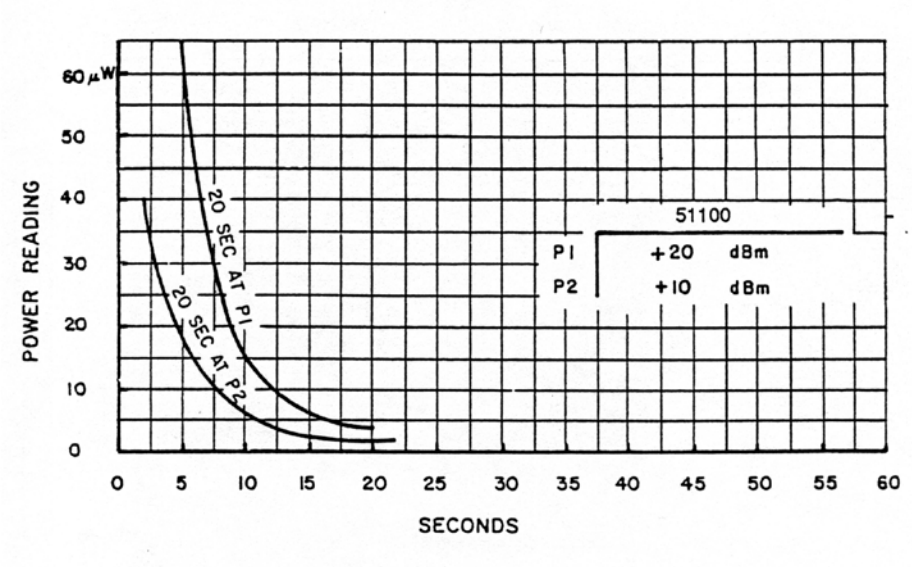


Figure 4-3. Thermal Head Decay

The zeroing time on each range has been optimized for speed and accuracy. Total zeroing time is approximately 30 seconds.

Zeroing should be done when the instrument is turned on, the head has been changed, or the instrument has drifted a significant amount with respect to the signal being measured. For large signals (range 4, 5, or 6), this may be once every several hours, if at all. For very small signals (range 0, 1, 2, or 3), for optimum results, zeroing should be done before each measurement.

4.4 DYNAMIC RANGE

The hold range mode is useful when it is known that the signal will vary over a certain limited range. (The hold range mode is active when a specific instrument range, other than autorange, has been selected.) The dynamic range of this mode is limited by the zero offset and the resolution, as shown in Figure 4-4. It can be seen from this figure that the useful dynamic range is 20 dB if the error is to be kept below 0.1 dB. An asterisk is displayed before the channel when the measured value is below the lower range limit indicating an uncalibrated measurement.

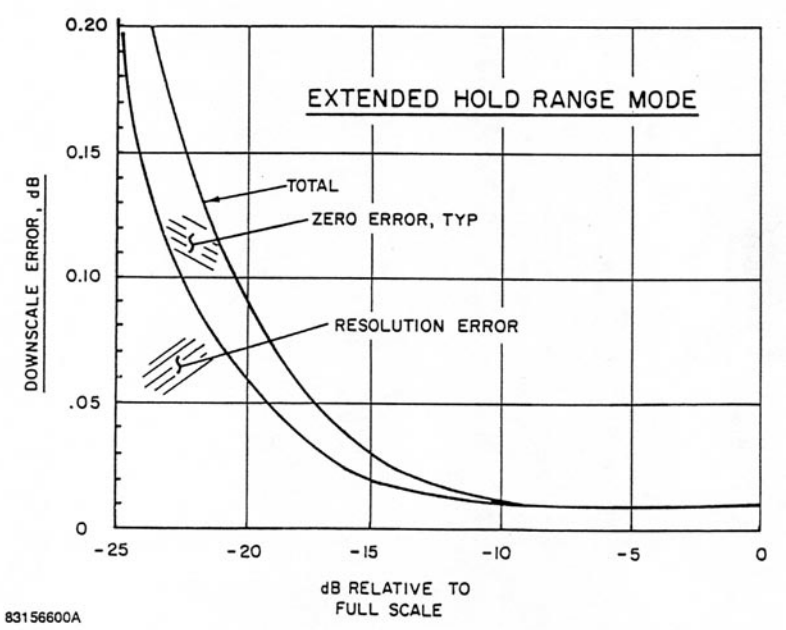


Figure 4-4. Extended Hold Range Mode

4.5 FILTERING.

The Model PM2003 employs digital filtering (average of measurements) to reduce the noise floor of the instrument and to stabilize measurements. The default values are optimized for speed and low noise under general conditions. Default values for normal and fast mode are as follows:

Range	Normal (sec.)	Fast (sec.)
0	2.8	2.8
1	0.8	0.8
2	0.8	0
3	0.8	0
4	0.8	0
5	0.8	0
6	0.8	0

The filtering technique used is digital pipeline filtering, also referred to as circular filtering or moving average filtering. The displayed measurement is simply an equally weighted average of the last X seconds worth of samples, where X is the filter length in seconds. For purposes of noise and settling time, the number of samples is not important, but the time is important. For example, if a three-second filter is used, the noise is the same whether 60 or 600 samples are taken in that interval, provided that the samples are taken above a certain rate. For this reason, filter selection in the Model PM2003 is done on the basis of seconds, rather than the number of samples.

The bottom end sensitivity of the instrument is limited by head noise. An RMS noise specification is valid since the head noise and the amplifier noise are band-limited and Gaussian. The noise level, specified in picowatts at a certain filter length, is sufficient to calculate the error due to noise at any signal level, for any filter, as shown in the discussion of noise that follows.

4.6 NOISE

4.6.1 Noise Reduction

The amount of noise reduction that can be realized has no theoretical limitations, except that drift enters into the picture at filter lengths over 20 seconds. The digital filter has a bandwidth and rolloff curve just as any filter does; the bandwidth can be reduced arbitrarily. The effective noise bandwidth is 0.469/t, where it is the filter length. For example, with a filter length of 4 seconds, the equivalent noise bandwidth is 0.12Hz.

Figure 4-5 is a nomograph showing the noise reduction that applies for various filter lengths, given the head noise with 2.8 seconds filtering. (This is the time for which diode head noise is specified.) Noise power is inversely proportional to the square root of the filter length. Normally, noise power varies directly with filter bandwidth; however, because power heads are square-law devices (detected voltage is proportional to power), the noise power is proportional to the square root of the bandwidth. This can be demonstrated with noise measurements. At very low filter lengths (less than 150 milliseconds), however, the noise does not increase without bound for all heads because the input amplifier noise is restricted with hardware filters. This additional filtering is not shown in the nomograph.

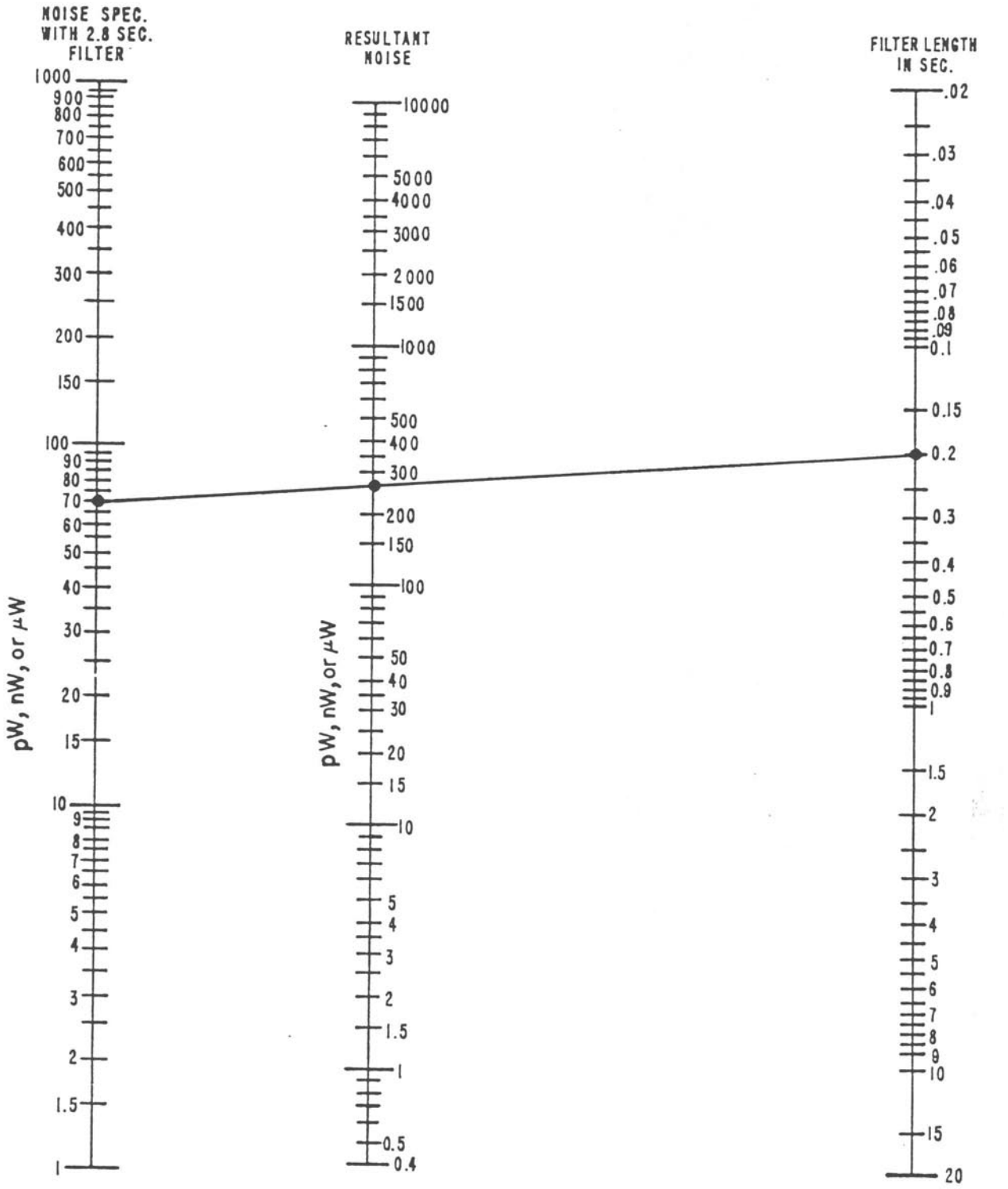


Figure 4-5. Noise Reduction

4.6.2 Error Computation

Since the noise is Gaussian, both before and after filtering, statistics show the level of confidence factor that can be associated with a given reading. (At medium and high power levels, the confidence factor is essentially unity.) Figure 4-6 shows a typical set of samples and a typical error band specification of 2 sigma. Under these conditions, 95.4% of the readings will fall within ±2 sigma.

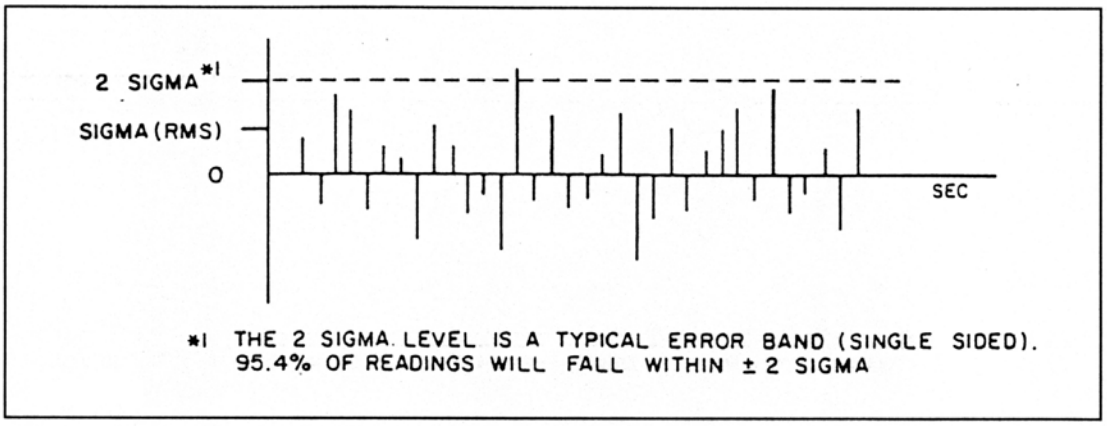


Figure 4-6. Typical Error Band Specifications

Figure 4-7 shows the confidence factor for other error bands. The error band is expressed in pW, regardless of the power level. (The percentage error band can also be calculated as shown below.) The RMS noise is taken from the head specifications and modified as necessary for filter lengths other than 2.8 seconds. Knowing any two of the three parameters (error band, RMS noise, and confidence factor), the third can be computed. For example, if the head RMS noise is 65 pW and the confidence factor is to be 95.4%, the error band is 130 pW, single sided (±130pW). If this were the case, at a measurement level of 1300 pW the percent error band would be 10%, corresponding to about ±0.44 dB.

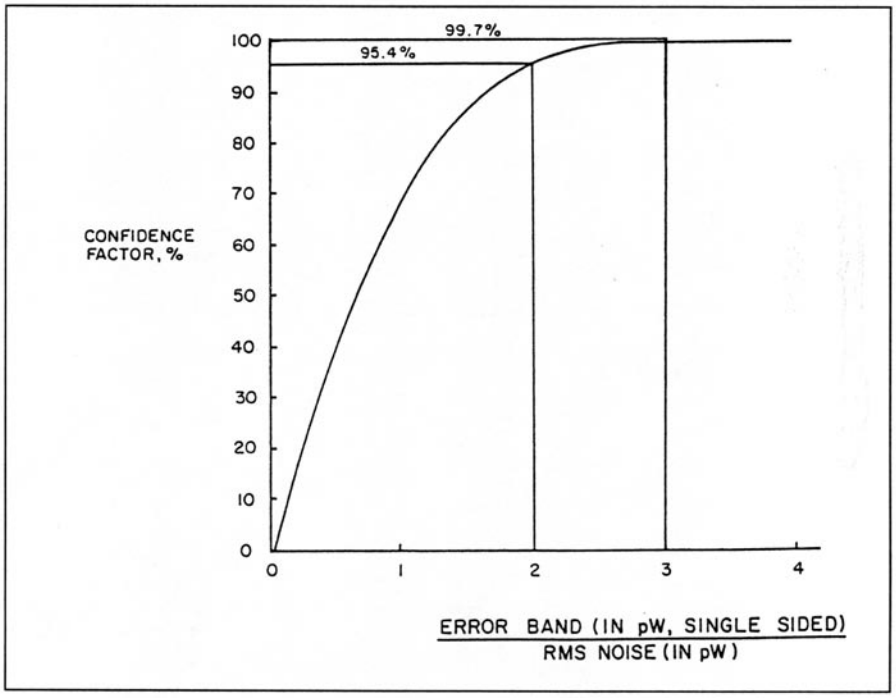


Figure 4-7. Probability of Falling within an Error Band

4.6.3 Noise Error Examples

Figure 4–8 and 4–9 show the computed error for the PM2004 diode head at different power levels, for 2.8 and 10 seconds filters. To attain these results, the heads must be at a stable temperature, and zeroing must be done immediately before the measurement is taken.

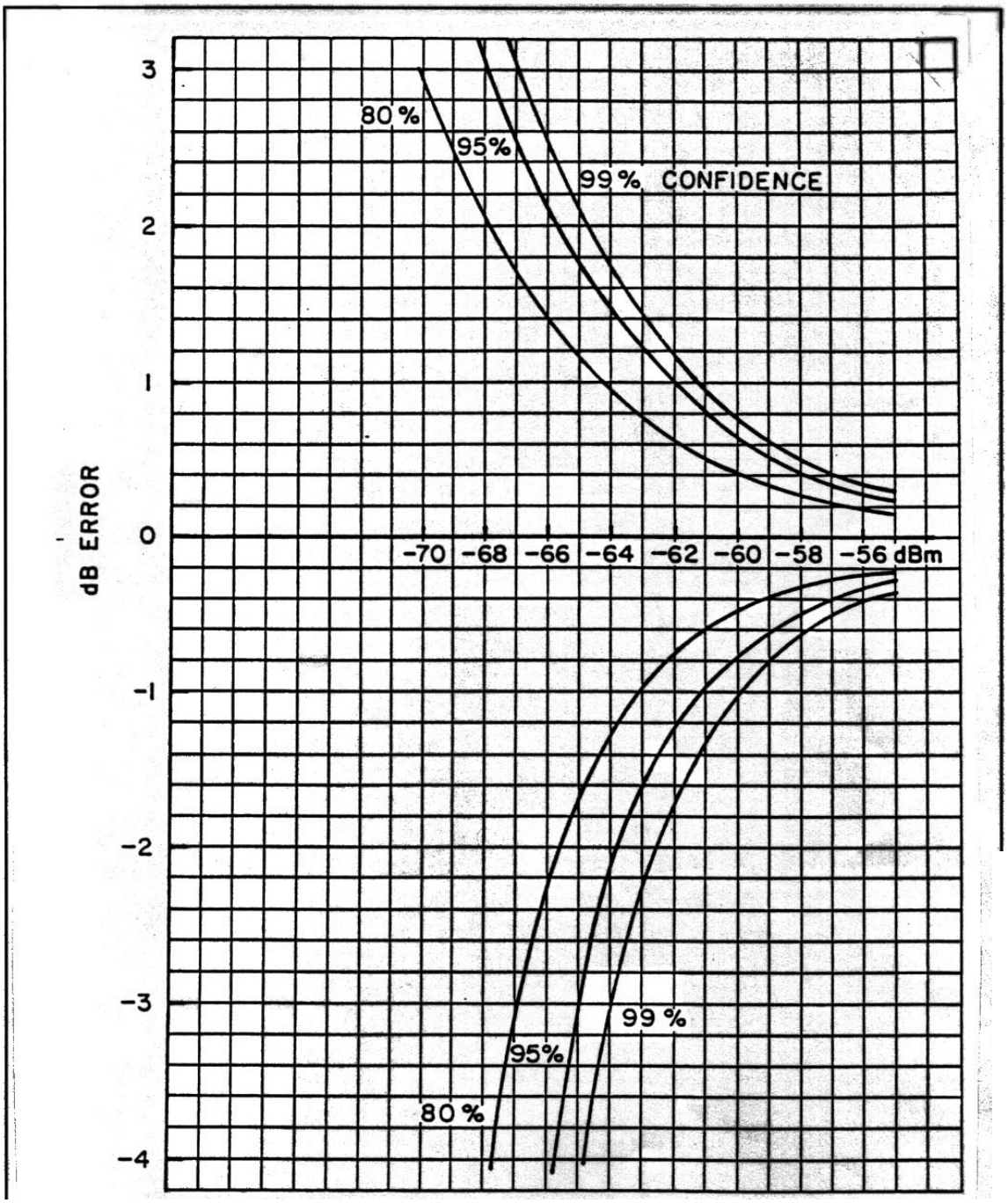


Figure 4-8. Confidence Curves, PH2004 Head with 2.8 Second Filter

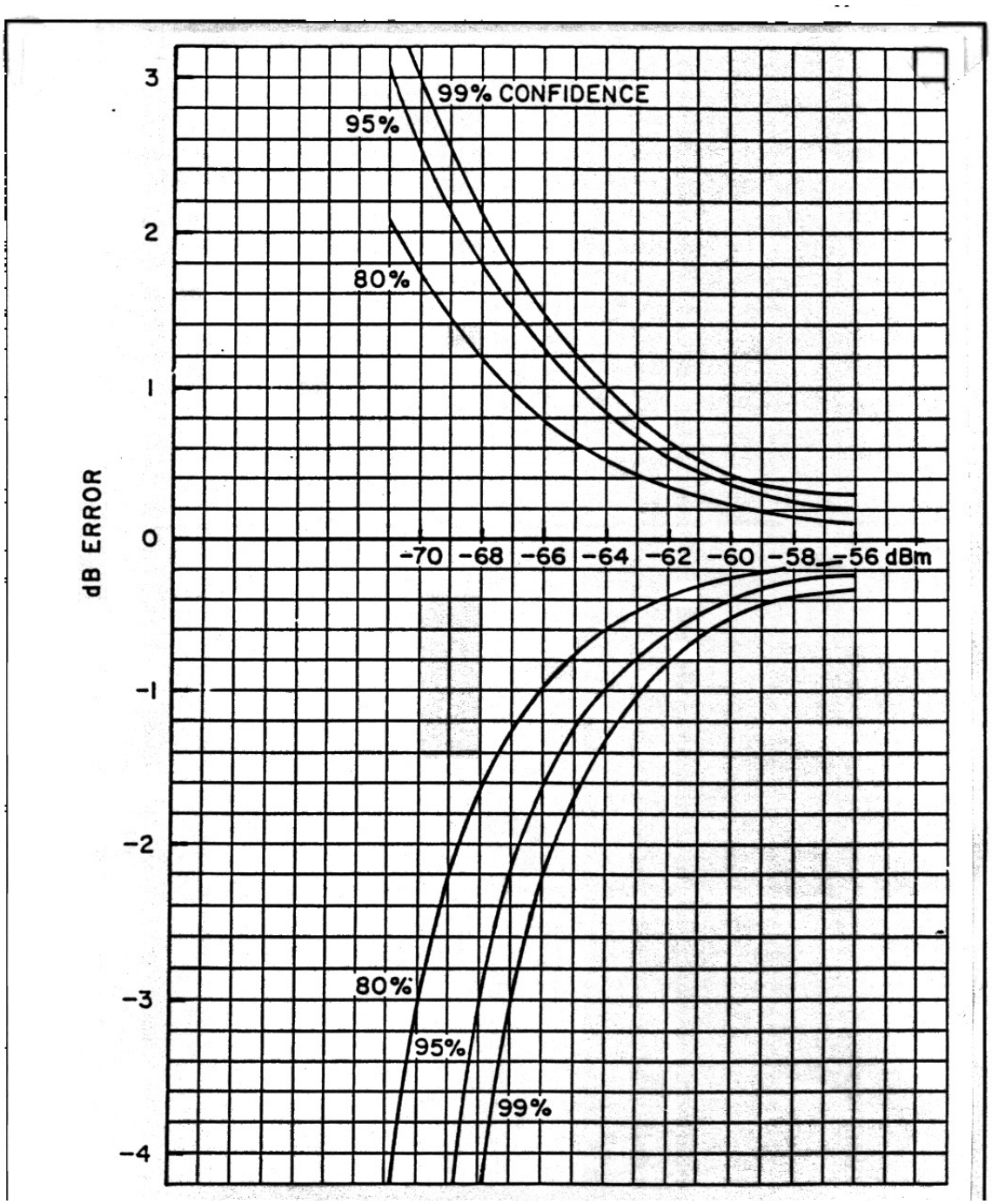


Figure 4-9. Confidence Curves, PH2004 Head with 10 Second Filter

4.6.4 Integration of Power

With long filtering, instrument readings may seem erroneous because the filter has not been cleared. For example, with a 20 second filter, if a 2 second RF pulse is applied, the instrument display will indicate a nonzero level for 18 seconds after the pulse has terminated. Additional pulses will be integrated along with the first until, by process of selective deletion, the pulses are removed one at a time from the filter. Actually measurement samples are deleted, not the pulses, giving rise to a ramping effect at the instrument display/output. This is shown in Figure 4-10. In all heads, the filter is a simple integrator.

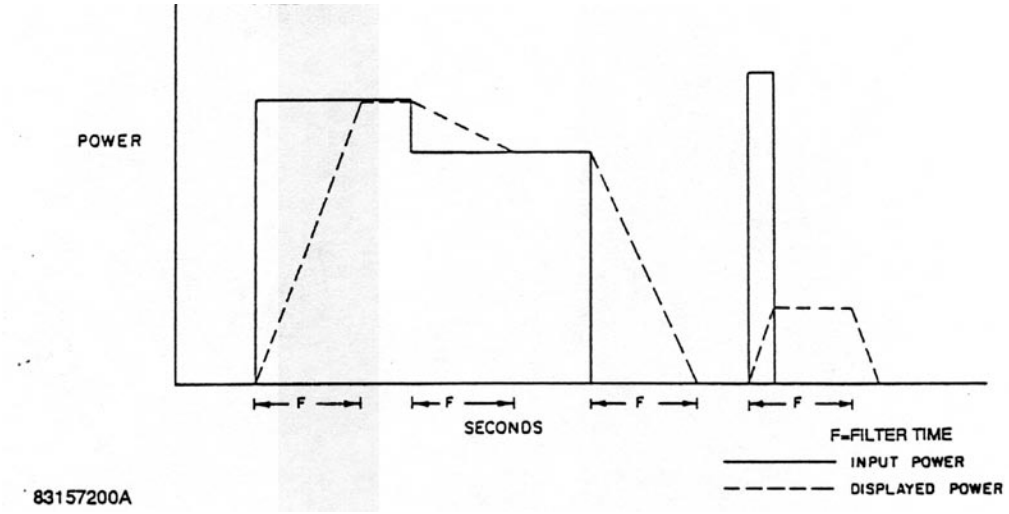


Figure 4-10. Integration of Power

4.6.5 Clearing of Filter

When long filter times are used, it may become troublesome at times to wait for the filter to clear. If the Auto filter function is selected, the filter is cleared after significant power changes, and filtering then resumes. Clearing can also be accomplished by changing the filter length to any different value and then resetting it using the interface bus; however, with bus operation, most of the trigger modes clear the filter at trigger time.

4.6.6 Partial Results

Measurement time is affected by the filter since valid readings to within a certain error band can be obtained only when the filter is full. If the filter has been cleared, data is available at reduced accuracy immediately after the first 50-millisecond sample period. The filter uses the number of samples as a divisor when computing the average, and the output/display does not ramp but homes in on the results instead as the samples accumulate.

4.7 MEASUREMENT TIME

4.7.1 Step Response

The measurement time from a power input step is the sum of the overhead time and the length of the digital filter, where the overhead time is defined as the time delay due to head response time and measurement software (processing). The overhead time is given in section 4.7.3 for certain conditions.

4.7.2 Continuous Response

Regardless of the overhead time or the digital filter length, the Model PM2003 will output readings at a maximum rate of about 200/second with the display operating. As the head and the digital filter settle, readings will ramp up or down at that rate.

4.7.3 Overhead Time

Overhead time is <350 milliseconds for diode heads and <450 milliseconds for thermal heads under the following conditions:

- Setting to 99% or 0.04 dB of final power
- Power step of 10 dB
- Range does not change
- Digital filter set to minimum

The power step may be upward or downward. Smaller power steps will decrease this time slightly; larger power steps in the downward direction will increase the time significantly. A 40dB downward step, for example, will take several seconds to settle to 0.04 dB.

4.7.4 Digital Filter

The digital filter is a moving average or pipeline filter which simply integrates the readings over the last X seconds, where X is the filter length. A step input to the filter will produce a linear ramp at the output, terminating when the filter is full.

4.7.5 Default Filter Lengths

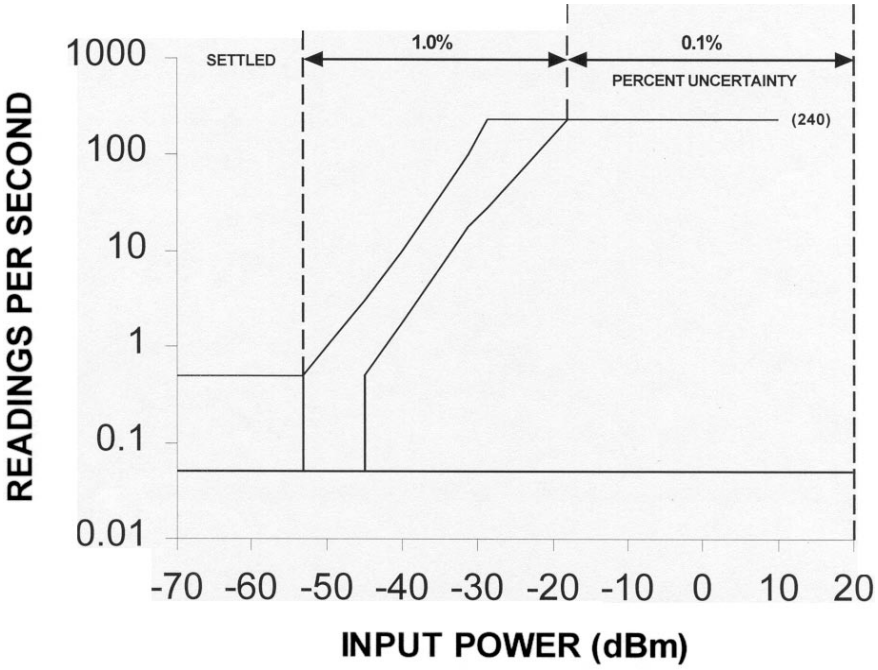
Although any filter length from 0 to 20 seconds may be chosen, default filter length are programmed into the instrument for optimum general conditions. (Refer to section 4.5). For diode heads, the range break-points are roughly in 10 dB steps, with the range 0 to 1 break-points at approximately –54 dBm.

4.7.6 Settled Measurement Time

In the free run settled mode, output data updates are held off until the measurements have settled.

4.7.7 Fast Mode Measurement Time

The Fast Mode can be invoked over the bus to put the instrument into its fastest sampling mode. Output data is taken after digital filtering and achieves sample rates that are dependent on the applied power level. Figure 4–11 shows this relationship.



Fast mode measurement uncertainty due to settling time and noise as a function of the measurement rate in readings per second using optimal filter settings at various power levels.

Figure 4-11. Fast Mode Sampling Rate

4.8 HIGH FREQUENCY ACCURACY

Power measurements, particularly at high frequencies, have a number of uncertainties which generally arise from imperfect SWRs. If all power sources and power meters had impedances that were resistive and equal to Z_o (the characteristic impedance of the measuring system), most problems would disappear. The incident, dissipated, and maximum available powers would all be equal, and the indicated power would differ only by the inefficiency of the power head in converting all dissipated power to indicated power. Tuning eliminates most of the SWR effects, but is cumbersome and is therefore seldom done. The use of attenuator pads can mask imperfect SWRs, as can the use of a directional coupler to level the source and reduce its reflection coefficient to a value equal to the directivity factor of the directional coupler. PH2007 and PH2008 power heads have precision, built-in attenuators which improve the SWR over that of other power heads.

When the complex coefficients of both an imperfect source and a power head are not known, but the maximum actual SWRs of both are known, the maximum positive and negative uncertainties of the measured power, Pm, can be determined from Figure 4-12. For example, if SWR of the source is known to be 1.2 and the SWR of the power head is 1.25, the uncertainty derived from Figure 4-12 is 2%.

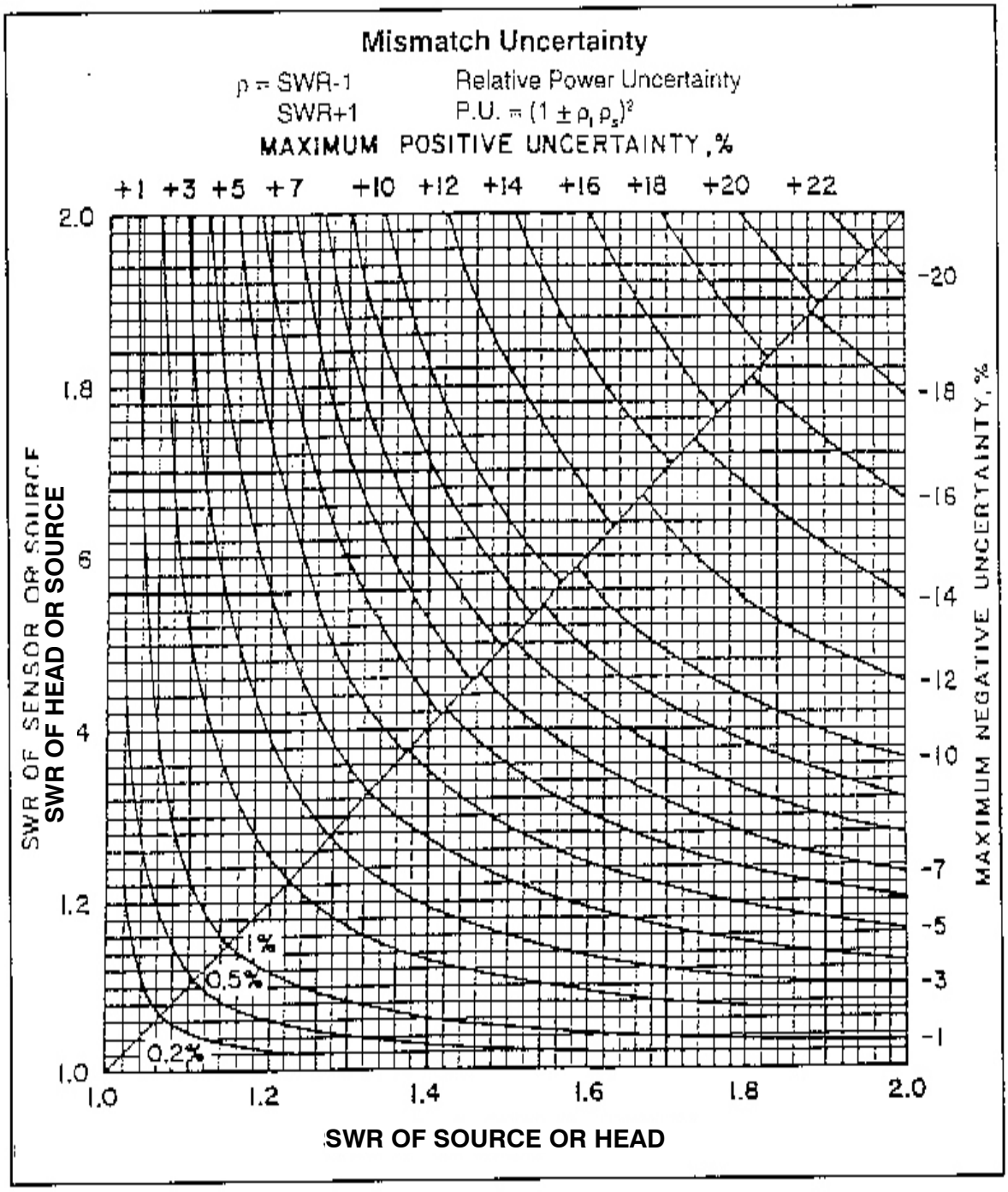


Figure 4-12. Mismatch Uncertainties Chart

4.9 WAVEFORM SENSITIVITY

Thermal heads are insensitive to the waveform because they average RF power over many tens of milliseconds. Modulated signals, non-sinusoidal waveforms, and even pulses can be detected without distortion of the measurement. Thermal heads are referred to as RMS responding.

Diode heads are also RMS responding below about –20 dBm (-10 dBm and 0 dBm for attenuated models PH2007 and PH2008). This response characteristic is obtained because the heads are dual diode types, and diodes respond in square-law fashion at low and medium levels. This is not an approximation, but rather an inherent effect. This effect results from the fact that the diodes do not turn on and off as switches, but behave

as a signal dependent resistors instead. Even with no signal input, the diodes have a finite conductance, and this conductance is modulated on a cycle by cycle basis to give a net DC offset proportional to the power.

The square-law response can be seen in Figure 4-13, where a 100% amplitude modulated signal is shown to have virtually no effect on the measured power at low levels. Of course, frequency modulated and phase modulated signals can be measured at any level, since the envelope of these modulated signals is flat. Frequency shift keyed (FSK) and quadrature modulated signals also have flat envelops and can be measured at any power level.

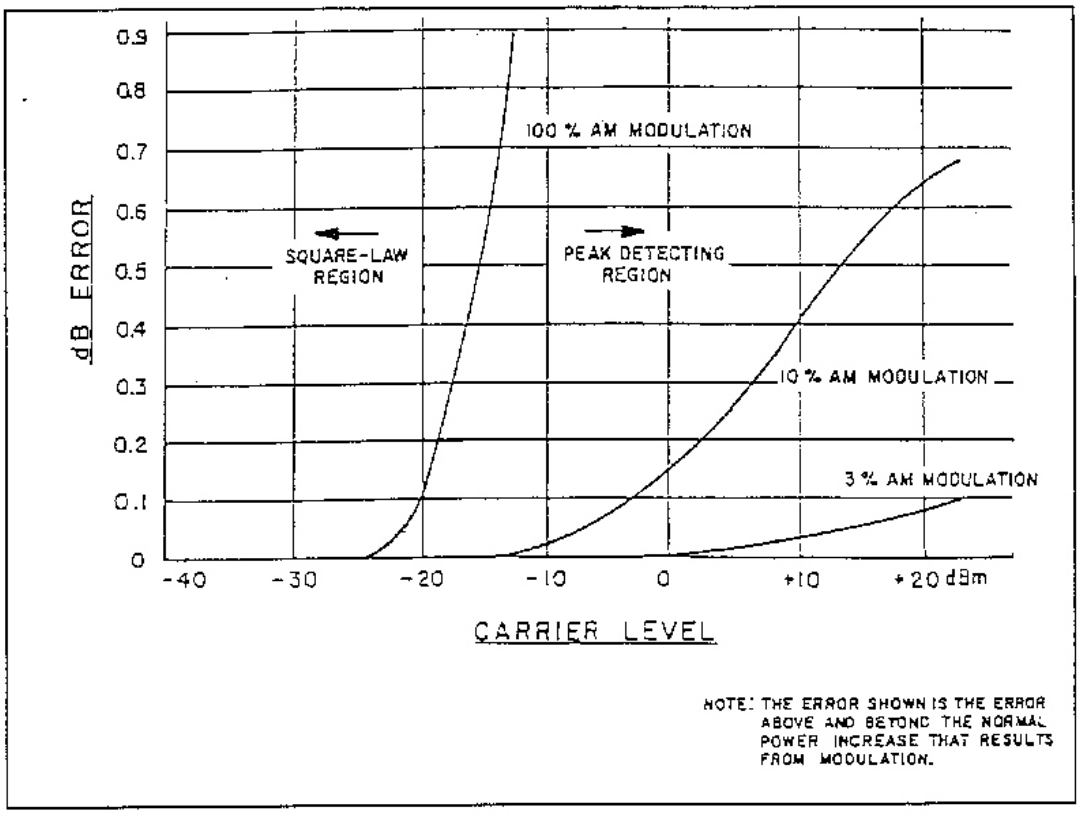


Figure 4-13. Error Due to AM Modulation (PH2004 Diode Head)

At higher power levels (above approximately –10 dBm for the PH2004 Head), the diodes operate as peak detectors. The Model PM2003 is software calibrated to calculate the RF power based on a shaping transfer function (RF to DC) for each head type. However, only measurements of RF signals with flat envelops (CW, FM, PM, FSK, quadrature, etc.) are valid in this region and in the transition region from –20 dBm to –10 dBm.

A special provision is made for the case of rectangular pulses where the duty cycle (on-time percentage) is known and the top level power of the pulse (pulse power) is to be measured. The duty cycle in percent is set into the DUTY entry in the CHANNELS menu. For example, if the signal consists of pulses with a duty cycle of 25%, set Duty to 25. This will add 6 dB to the displayed power and turn on the **PK** indicator following the units. Only the display is affected by the duty cycle calculation. The measurement process is subject to the same criteria discussed above. For thermal head no correction is needed for level. However, pulse periods on the order of tens of milliseconds may result in unstable readings because of inadequate averaging. If the filter time constant is too short, it can be increased by use of the AVG function and menu.

For diode heads, the RMS power region extends up to –30 dBm with a gradual change to peak voltage response. For accurate pulse power measurement, the power meter should read an average power of -30 dBm or less. This is the power indication when the duty cycle is set to 100%. Somewhat useful measurements can be made up to –20 dBm average power, but the uncertainty will typically be at least $\pm$ 1dB.

Extra care should be taken when using the pulse power feature to avoid overload damage to power heads. Pulses with small duty cycle have a very large peak to average power ratio. The average responding power meter has a small indicated power, but the peak signal at the head diode or thermal element may easily exceed the maximum ratings.

4.10 CHART RECORDER OPERATION

The chart recorder output is a DC voltage from 0 to 10 volts. In the Watts mode, the output voltage is equal to the digits displayed on the main display divided by 1100. In the dBm or dBr modes, the output voltage is directly proportional to the level of the RF signal being measured. 0 dBm is at 8.0 volts with a sensitivity of 1.0 volt/10 dB overrange of the head. The output impedance is 9.06 kilohms, which gives the user the option of loading it with 1 kilohm, thereby reducing the full scale output to 1 volt. The normal 12-bit resolution is still maintained with this method. With a 1 megohm load, the circuit is essentially open and the error is small. Absolute accuracy is $\pm$ 3%.

4.11 BARGRAPH OPERATION

The meter presents the power proportionally in the following manner.

4.11.1 Watts Mode

The meter follows the digital display as a percentage of the full scale. The bar graph consists of 100 segments resulting in a 1% resolution. A main data display of 1100.0 μW drives the meter to 100 percent of the full scale while a display of 561.0 μW drives the meter 51 percent of full scale. The meter reads full scale at 10 dB increments.

4.11.2 dBm Mode

The meter follows the digital display as a percentage of the full scale. The bar graph consists of 100 segments resulting in a resolution of 0.1 dB/segment. A main data display of 0.00 dBm (or any 10 dB increment) drives the bar graph to zero percent of full scale while 5.00 dBm and 9.99 dBm drives the meter to 45 percent and 90 percent of full scale respectively. A value of –7 dBm would drive the meter to 27 percent of full scale while a value of –2 dBm would drive the meter to 72 percent of full scale.

4.11.3 dBr Mode

Selecting the dBr mode positions the bar graph to 50 percent of full scale when the digital display reads 0 dBr. The analog meter thereafter reads 100 percent of full scale at +5 dBr or more and zero percent of full scale at –5 dBr or less.

4.12 REMOTE GPIB & RS-232 OPERATION

4.12.1 Introduction

The Model PM2003 is equipped with IEEE-488 and RS-232 interfaces for remote operation. The IEEE-488 is a hardware standard, which describes the communication and handshaking across the 8-bit parallel bus between a bus controller and up to 15 instruments. The RS-232 does not require a null modem and can be connected directly to a PC comm. port. The RS-232. The RS-232 settings on the PM2003 can be found in the Setup menu.

The Model PM2003 IEE-488 capabilities are as follows:

CO	NOCONTROLLER	Capabilities
SHI	SOURCEHANDSHAKE	Complete capabilities
AHI	ACCEPTORHANDSHAKE	Complete capabilities
RLI	REMOTELOCAL	Complete capabilities
DCI	DEVICECLEAR	Complete capabilities
DTI	DEVICETRIGGER	Complete capabilities
RLI	REMOTELOCAL	Complete capabilities
DCI	DEVICECLEAR	Complete capabilities
DTI	DEVICETRIGGER	Complete capabilities
PPO	PARELLEPOLL	No capabilities
TEO	EXTENDEDTALKER	No capabilities
T6	BASICTALKER	Complete capability except for talker only
LEO	EXTENDEDLISTENER	No capability
L4	BASICLISTENER	Complete capability except for listener only
DMA		Not supported

4.12.2 Local Operation

This is the front panel operation of the instrument. The instrument initializes to the local mode on bus power on, and the remote mode becomes active only when the instrument is remote addressed by the bus controller. Once in the remote mode, the instrument can be returned to the local mode in any of three ways: by a GTL (go to local) command from the bus controller, by turning off power to the instrument, or by pressing the front panel <**Menu**> key. The third method can be disabled by a local lockout (LLO) command issued by the bus controller.

4.12.3 Remote Operation

In the remote mode. All front panel key closures are ignored except for the <**Menu**> key (which may also be disabled by a LLO command from the bus controller). When the instrument is in remote mode, the front panel REM annunciator is activated.

4.12.4 Bus Address

The IEEE-488 listen/talk address (MLTA) of the instrument can only be altered from the MENU-Setup-IEEE menu. Refer to section 3.5.3.1.

4.12.5 Terminating Characters

To inform the instrument that a message has been completed, the bus controller must end all messages with a terminating character or EOI control signal. The Model PM2003 can be programmed for several combinations of terminating characters as required by the controller employed. Selection of terminating characters is accomplished via the MENU-Setup-IEEE menu. There the instrument can be programmed for individual end of string characters in both listener and talker modes as well as independently enabling the end or initiate control signal.

4.12.6 Listen Operation

The instrument may be addressed as a listener without regard for remote or local mode. When the listener state is set by the bus controller, the instrument will receive bytes over the bus and place them in its input buffer. For listen operation, the input buffer is 150 characters long. Only one message can be entered into the input buffer at a time. A second message cannot be sent until the instrument has processed the previous message.

4.12.7 Talk Operation

When the instrument is requested to talk, the instrument response will depend on how it has been set up. The setup is either through talk modes or talk array commands. Talk modes are associated with making measurements; talk array commands are associated with the downloading of calibration data and instrument states. Refer to section 4.12.14 for setup of the talk mode.

Only one instrument at a time can be addressed to talk, but many instruments can be addressed to listen simultaneously. When the Model PM2003 is in the talk mode, the front panel TLK annunciator is illuminated. The format for each talk message is different and is explained in the paragraphs that follow.

4.12.8 IEEE-488 Command Support

The Model PM2003 supports the following standard IEEE-488 commands:

- Interface Clear Command. The interface clear (IFC) command forces all devices on the bus to clear their interfaces, and the bus to an initialized state, clearing the error condition. This command can only be issued by the bus controller in charge. The Model PM2003 responds by clearing the interface.

- Device Clear. For this instrument, the device clear (DCL) command operates the same way as the IFC command described above.

- Group Execute Trigger. The group execute trigger (GET) command allows the bus controller to issue a trigger to all instruments on the bus simultaneously. The Model PM2003 will save the current reading at the time of the GET command and return it at the time of the next talk message mode. This is in essence a bus latch. The instrument must be set to one of its trigger modes. See section 4.14.5.

- SRQ. The service request (SRQ) allows an instrument to inform the bus controller that some special event has occurred. The instrument then expects the bus controller to perform a serial poll to determine what event has occurred. Events that generate service request include instrument error, measurement error, measurement is ready, and zeroing or calibration is completed. When the instrument SRQ is active, the front panel SRQ annunciator is illuminated.

- Serial Poll. The serial poll (SP) command on the bus allows the bus controller to check the SRQ status byte of each instrument to determine which instrument is requesting service. The byte returned by the Model PM2003 is composed of multiple bits that represent different status and error conditions. These conditions are individually maskable, as shown in Table 4-7.

- Parallel Poll. The parallel poll (PP) command is not supported.

4.12.9 Number Formatting

Number formatting is shown for each of the commands in the paragraphs that follow, but general rules are as follows:

- Fixed or floating formats are accepted.
- The optional + or – may precede the mantissa and/or the exponent.
- An optional decimal point may appear at any position within the mantissa. A decimal point in the exponent is ignored.
- The optional **E** for exponent may be upper or lower case.
- All ASCII characters below and including ";" (3Bh) are considered command delimiters. The ASCII characters " " (20h), " , " (2 Ch), ";" (3Bh), and ":" (3Ah) are considered numeric delimiters.

4.12.10 String Format

String formatting is as follow:

- The programming sequence is in natural order, that is, a function mnemonic is sent first, followed by the argument value (parameter), if applicable.
- The data strings sent to the instrument are not case sensitive.
- This means lower case and upper case are the same.
- Spurious numbers occurring in the listen string are ignored.
- All block modes have formatted data arrays or ASCII strings. See Tables 4-3 and 4–4 for commands and section 4.13 to 4.13.8 for formats.

4.12.11 LISTEN PARAMETER COMMANDS

Listen parameter commands are listed in Table 4–1. These are commands, received by the instrument, that expect one numerical value to follow for setting a particular operating condition. Except as noted in the table, these commands correspond to specific front panel commands. Key commands correspond to single keystrokes; non-key commands are submodes or menu types of data entry.

Table 4-1. Listen Parameter Commands

Mnemonic	Function and Limits	Description	Parameter #
CH#	Channel select #1, 2, 3	Sets channel	12, N
DY#	Duty cycle #0.01 to 100.00 in 0.01 steps	Sets duty cycle percent (sets pulse power mode when not = 100%)	13, N
FL#	Filter time select #0 to 20.00 in 0.05 steps	Corresponds to AVG-Sec data entry (AUTO FILTER MODE when set to 0) (see FA command)	3, N
FD#	dB calibration factor #-3.00 to 3.00 in 0.01 steps	Change the frequency CAL FACTOR to #. Original CAL FACTOR is restored by entering the frequency	10, N
FR#	Frequency select #0-100.00	Corresponds to FREQ-GHz data entry	4, N
LH#	High limit select # -99.99 to 99.99 in 0.01 steps (or 0 to 99999 in Watts mode)	Corresponds to Menu –Channel-Hi Lmt data entry	14, N
LL#	Low limit select #-99.99 to 99.99 to 0.01 steps (or 0 to 99999 in Watts mode)	Corresponds to Menu-Channels-Lo Lmt data entry	15, N
LM#	Alarm select # 0 disables # 1 enables	Corresponds to Menu-Channels-Alarm command	17, N
OS#	Offset select #-99.99 to 99.99 in 0.01 steps	Corresponds to Menu-Channels-Offset data entry	16, N
RS#	Range select #0 to 6	Corresponds to Menu-Channels-Range selection	5, N (-1= RA)*
SM#	SRQ mask #0 – 255	Corresponds to Menu-Setup-IEEE-SRQ mask data entry	11, N
SR#	Set dBr reference #-99.99 to 99.99 in 0.01 steps	Corresponds to REF Level-dBm data entry with Mode = set	6, N
SS#	Head data source #1-6 where: #1-4 are internal tables #5 is the head data adapter for channel 1 #6 is the head data for adapter channel 2	Corresponds to Sensor-Ser# selection	1, N
TM#	Talk Mode #0 to 6	Sets talk mode for IEEE-488 bus operation	8, N

The numeric value (parameter) can be sent in the next listen string if the listen parameters command was the last value of the previous string. If, for any reason, a command is sent without a parameter following the command, the CL command can be used to clear the active command, or a new command can be used. The parameter number listed in Table 4–1 is the number returned when the talk parameter mode (talk mode 6) is exercised.

4.12.12 Listen Action Commands

Listen action commands are listed in Table 4–2. These commands initiate an action without any parameters being sent.

Table 4-2. Listen Action Commands

Mnemonic	Function	Description
CF	Calibrator off	Turns off 50 MHz calibrator
CL	Clear	Clears error number and error
CN	Calibrator on	Turns on 50 MHz calibrator
CP	Calibrate	Corresponds to Zero/ CAL-CAL selection
DB	dBm select	Corresponds to Menu-Channel-Units-dBm selection
DF	Display off	Turns off instrument display
DN	Display on	Turns on instrument display
DR	dBr select	Corresponds to REF-Level-Mode equal to SET using the previous reference level
FA	Auto filter	Sets instrument to auto filter
LR	Load reference	Loads the current measurement as the reference level. Corresponds to REF Level-Mode equal to LOAD
MF	Measure filtered	Sets filtered measurement Mode
MFD	Measure Fast Dual	Sets fast dual channels measurement mode
MFS	Measures Fast Single	Sets fast single channel (CH1 only) measurement mode
MN	Measure Normal (free run)	Sets normal free run measurement mode
MS	Measure Settled	Sets settled measurement mode
TF	Trigger Filtered	Selects filtered trigger mode
TFD	Trigger Fast Dual	Selects fast dual channels trigger mode
TFS	Trigger Fast Single	Selects fast single channel (CH1 only) trigger mode
TN	Trigger Normal	Selects normal trigger mode
TR	Bus trigger	Bus trigger command
TS	Trigger Settled	Selects settled trigger mode
ZR	Instrument zero	Corresponds to Zero/CAL-ZERO selection
?ID	Talk instrument ID	Calls up instrument identification
*IDN?	Talk instrument ID	Calls up instrument identification

4.12.13 Listen Array Commands

Listen array command listed in Table 4–3 transfer arrays of data (more than one parameter) to the instrument. Head data and DC calibration data are typical data. The data array is formatted as in sections 4.13. The actual amount of data depends on the specific command being used. Listen array commands are only operable over the bus, and have no application from the front panel.

Table 4-3. Listen Array Parameter Commands

Mnemonic	Function	Description
SI	Head ac calibration data in	Refer to section 4.13.2
FI	Head high frequency calibration data in	Refer to section 4.13.4

The talk array commands listed in Table 4–4 build a talk sting in the talk buffer for transmission. Not for general purpose measurement (the talk modes are used for that), the talk array commands are used for transmitting arrays of data (more than one parameter), such as head data and DC calibration data. The buffer contents are discarded at the time of the next instrument talk request. These commands automatically change the talk mode to talk mode 7, then reset the Model PM2003 to its previously selected talk mode. This is the only time that the instrument uses the talk buffer or talk array mode. Talk array commands are operable only over the bus.

Table 4-4. Talk Array Commands

Mnemonic	Function	Description
SO	Head calibration data out	Refer to paragraph 4.13.3
FO	Head high frequency calibration data out	Refer to paragraph 4.13.5

4.12.14 Talk Modes

When the Model PM2003 is requested to talk, it responds according to how it has been set up. The talk setup is either through talk array commands or talk modes. Talk modes are associated with making measurements; talk array commands are associated with downloading of calibration data and instrument states. The talk modes are described in the following paragraphs.

The Model PM2003 supports eight talk modes of operation, as listed in Table 4–5. Once the talk mode has been set, the bus controller need only tell the Model PM2003 to talk and it will respond according to the talk mode.

Table 4-5. Talk Modes

Talk Mode	Description
0	Talk measurement floating point
1	Talk measurement with units
2	Talk error
3	Talk both channels
4	Talk channel status
5	Talk instrument status
6	Talk parameter
7	Talk array
8	Not used

Talk modes 0 through 6 can be set directly by use of the talk mode (TM) command. For these modes, the instrument will remain in the selected mode until the talk mode is changed or until a talk array command is received. Talk mode 7 is a temporary talk mode that is automatically enabled in response to a talk array command. This mode cannot be set by the bus controller directly. This temporary talk mode is disabled when the talk array operation is complete.

The default condition for the talk mode is 0. The talk modes are described individually in sections 4.12.14 through 4.12.22.

4.12.15 Talk Mode 0 (Talk Measurement Floating Point)

The talk mode 0 format is as follows:

#1, #2

where:

#1 is the error flag (1= error, data invalid).

#2 is the measurement in floating point notation in the units selected (dBm, dBr, or milliwatts). In watts mode, the unit is fixed at mW.

Examples:

0,0.00E00 – No error, power is 0.00 dBm

1,0 – Under range error at –75.00 dBm

0,98.9E-6 – No error, power is 98.9 n W

4.12.16 Talk Mode 1 (Talk Measurement with Units)

The format for talk mode is as follows:

#1, $1

where:

#1 is the error flag (1 = error)

$1 is the measurement. The format is fixed point followed immediately by a three character string that indicates the unit of measurement.

Possible units are **dBm**, **dBr**, **nW**, **µW**, **mµ**, and **W**, **kW**,and **MW**. If needed, the string can be parsed externally into a number and a three character message.

Examples:

0,0.00dBm – No error at 0.00 dBm

1,0dBm – Under range error at –75.00 dBm

0,98.9uW – No error at 98.9 microwatts

4.12.17 Talk Mode 2 (Talk Error)

The talk mode 2 format is as follows:

#1, #2, #3

where:

#1 is the instrument error number. A 0 will always be reported in this position.

#2 is the measurement error, from 0 to 99. A 0 indicates no error. Refer to Table 4–6 for error messages.

#3 is the channel reporting errors. A 1 is reported for channel and a 2 is reported for channel 2.

Execution of this talk mode automatically clears the measurement error after it has been reported. If more than one error occurs, the instrument will indicate the first one that occurred.

Examples:

0,0,1 – No error is reported for channel 1

0,3,2 – Power level is underrange for channel 2

4.12.18 Talk Mode 3 (Talk Both Channels)

The talk mode 3 format is as follows:

#1, #2, #3, #4

where:

#1 is the error flag for channel 1 (1 – error, date invalid)

#2 is the measurement in floating point notation in the units selected (dBm, dBr, mW). In watts mode, the unit is fixed at mW.

#3 is the error flag for channel 2 (1 = error, data invalid)

#4 is the measurement in floating point notation in the units selected (dBm, dBr, mW). In watts mode, the unit is fixed at mW.

Examples:

0,0.00E00,0,1.00E00 – No error, power is 0.00 dBm on channel 1 and 1.00 dBm on channel 2.

1,0,0,1.00E00 - Channel 1 under range at –75 dBm and 1.00 dBm on channel 2.

0,90.1E – 6,0,1.00E1 – No error, power is 90.1 nW on channel 1 and 10.00 dBm on channel 2.

4.12.19 Talk Mode 4 (Talk with Channel Status)

The format for talk mode 4 is as follows:

#1, #2, #3, #4, #5, #6, #7

where:

#1 is always 1 in the PM2003

#2 is always 1 in the PM2003

#3 is the measurement units that the channel is set;

0 Power in watts, milliwatts, microwatts, or nanowatts
1 Power in dBm
2 Power in dBr

#4 indicates the trigger mode of operation;

0 Measure Normal (also known as free-run)
1 Measure Filtered
2 Measure Settled
3 Trigger Normal
4 Trigger Filtered
5 Trigger Settled

6 Reserved
7 Measure Fast Single
8 Measure Fast Dual
9 Reserved
10 Trigger Fast Single
11 Trigger Fast Dual

#5 is always 0 in the PM2003

#6 is always 0 in the PM2003

#7 is the software version number.

4.12.20 Talk Mode 5 (Talk Instrument Status)

The format for talk mode 5 is as follows:

#1, #2, #3, #4

where:

#1 is always 0 in the PM2003

#2 indicates calibrator status;

0 off
1 on

#3 is always 0 in the PM2003

#4 is always 0 in the PM2003

4.12.21 Talk Mode 6 (Talk Parameters)

The format for talk mode 6 is as follows:

#1, #2

where:

#1 is the active parameter number (0 – no parameter selected).

#2 is the active parameter value, for example “frequency”. The units are defaulted.

This command returns two numbers which describe the current “opened” or selected parameter in the instrument and its value. For example, the frequency to which the instrument is set can be read over the bus. To read a parameter, it must be “opened” first as described in section 4.12.21. A parameter in the Model PM2003 is defined as a front panel or bus command that allows or requires a numerical value to be entered into it. The parameters and parameter numbers are listed in Table 4 – 1. The data sent over the bus is the same as the data that would appear on the instrument’s displays when the parameter is selected.

To use this talk mode, the instrument is first placed in talk mode 6 and a parameter is then opened (made active) by sending the bus command. No numeric value should follow and the clear command should not be used. Then, while the parameter is active, a talk command is issued to the instrument and the data for that parameter is sent out on the bus. A parameter can be deactivated by simply entering a number or sending another command.

Examples:

0,0 - No parameter is active and the second value should be ignored

10, -3.00 - The dB cal factor is currently set to –3.00 dB

5, 1 - Range 1 is set

4, 1.23 - The frequency is set to 1.23 GHz

Table 4–6. Error Messages

ERROR MESSAGE CODE	DESCRIPTION
0	No errors
1	Number entry out of range for parameter set.
2	Unused
3	LO-indication on display. Is caused by a. Power level below amount allowed in dBm display during autorange b. Power level below amount allowed for range set in watts or dBm display.
4	HI-indication on display. Is caused by a. Power level above amount allowed in dBm display during autoranging b. Power level above amount allowed for range set in watts or dBm display.
5	Occurs when input channel attempts to autorange below the range 0. Caused by incorrect zeroing of channel or a head which is damaged or not connected.
6	Unable to zero instrument because power is applied to the head, the head is damaged, or the head is not connected.
7 thru 23	Unused
24	Frequency out of range of entry. This error applies to heads not calibrated at the frequency entered.
25 thru 29	Unused
30	The message string has exceeded 150 characters. All commands sent are ignored.
31	The command string sent has not been recognized by the instrument. If more than one command has been sent, the commands occurring before the unrecognized command have been executed, while subsequent commands will be ignored.
32 thru 38	Unused
39	Calibration attempted when power exceeds ± 3 dB of the 0 dBm reference, or when calibration is attempted at ± 3 dB from –10 dBm,+10 dBm or +20 dBm.

4.12.22 Talk Mode 7 (Talk Array)

Each of the different talk array commands has a different format. (Refer to the applicable section of section 4.14). This talk mode is not directly settable by the bus controller; it is set automatically by execution of one of the talk array commands. Talk mode 7 builds a data string in the talk buffer for a one-time transmission. It is used to send an array of numerical data or a string of character data, such as head and/or calibration data. Once executed, this mode is automatically cleared to its previously selected value or default conditions.

4.13 IEEE-488 BUS ONLY COMMANDS

The following paragraphs cover commands that are available only under remote control on the bus.

4.13.1 Talk Mode (T M) Command.

The talk mode command is used to change to a selected talk mode. The range of data for this command is from 0 to 6. Talk mode 7 can only be set indirectly by execution of a talk array command. The talk mode command is classified as a listen parameter command.

Example: TMI – Set talk mode 1 which is talk measurement with units.

4.13.2 SI Command

Used in conjunction with the SO command, this command is used to send a portion of the head calibration data to the Model PM2003 in form of an array of numeric data. In this way, head data can be transferred from one instrument to another, or stored on a disk.

The data is the head model, head S/N, and the 14-point linearity data (AC calibration data) for a selected head. This command complements the SO command over the bus, and the SO command would normally be the source of the data string for this command. The SI command is classified as a listen array command.

In addition to the 14-point linearity data, each head has a high frequency calibration data, which is loaded with the FI command. (See section 4.13.4.)

The format for the SI command is as follows:

SI head model, head serial number,
U0, U1, U2, U3, U4, U5, U6, D0, D1, D2, D3, D4, D5, D6

where:

Head model is a number in the form PHXXXX, where XXXX is a four digit number sent to the instrument. Heads must be resident in the instrument firmware.

Head serial numbers is from 0 to 99999, representing the last 5 digits of the head's full serial number.

U0 through U6 are the upscale gain factors (1000 to 9999, nominally 5000).

D0 through D6 are the downscale factors (-999 to +999).

Each numeric value must be separated by a valid delimiter.

Example:

SII3, 1234, 5012, 5003, 5032, 5013, 4995, 5005, 4891, -20, –21, 2, -3, -14, 15, 6

4.13.3 SO Command

Used in conjunction with the SI command, this command is used to send head 14-point linearity data out to the bus controller. (Refer to the SI command description for general use of these commands.) Head data also includes high frequency calibration data, but this data is handled with the FI command. See section 4.13.4.

When executed, the SO command instructs the instrument to build an array of numeric data in the talk buffer for transmission by next the talk request. The array consists of head model, head S/N, and numeric data representing the 14-point linearity data (AC calibration data) for a selected head. This command

complements the SI command over the bus, and the SI command would normally be the destination of the data string of this command. The SO command is classified as a talk array command.

The talk mode is set temporarily to talk mode 7 (talk array) when this command is executed. After execution, the talk mode is reset to the previous setting. A clear command will also reset the talk mode.

Formats are as follows:

To the instrument in a listen string: S0

From the instrument in the next talk string: head model, Head serial number,

U1, U2, U3, U4, U5, U6, D0, D1, D2, D3, D4, D5, D6,

where the format descriptions are the same as for the SI command. Each numeric value must be separated by a valid delimiter.

Example:

To the instrument in a listen string: SO

From the instrument in the next talk string:

PH2004, 1234, 5023,5001, 5012, 5010, 4997, 5005, 5003, 10, 13, -2, -23, 14, –15, 6

4.13.4 FI Command

Used in conjunction with the FO command, this command is used to send head high frequency calibration data to the Model PM2003 for a selected head in the form of an array. In this way, head data can be transferred from one instrument to another, or stored on a disk. In addition to the high frequency calibration data, there is 14-point calibration data for the head, but this is handled by the SI command.

The data is for a selected head. This command complements the FO command over the bus, and the FO command would normally be the source of the data string for this command. This command is classified as a listen array command. Data is loaded in blocks from 1 to 12 pairs.

The command format is as follows;

FI n, FRn, CRn, FRn+1, CFn+1,….FRN+11, CFn+11

where:

n is the table number pointer, from 0 to 59.

FRn is the first frequency of this group, from 0.00 to 100 GHz in 0.01GHz increments. It is head dependent.

CFn is the first dB cal factor for this group, from –3.00 to +3.00 dB in 0.01 dB increments.

Each numeric value must be separated by a valid delimiter.

The total number of frequency points is limited to 60 for head tables 1 through 6. The table number pointer is the beginning location for the frequency/db cal factor pairs. Frequency cal points must be in numerical order of frequency. Generally, the first point is at 0 GHz, with a cal factor of 0.

Example:

F10, 0.00, 0.00, 1.00, -0.05, 2.00, -0.07, 3.00, 0.10, 4.00, -0.06, 5.00, -0.05, 6.00, 0.00, 7.00, 0.13, 8.00, 0.42, 9.00, 0.34, 10.00, 0.00, 11.00, 0.15, F112,12,.12,13,-.13,14,1.14,15,.85

4.13.5 FO Command

Used in conjunction with the FI command, this command is used to send head high frequency calibration data out to the controller. Refer to the FI command description for the general use of these commands. Data points are loaded in blocks of 12.

When executed. This command instructs the instrument to build an array of numeric data in talk buffer for transmission by the next talk request. The array consists of numeric data representing the dB cal factor information for a selected head table. The FO command is classified as a talk array command.

The talk mode is temporarily set to talk mode 7 (talk array) when this command is executed. After the command has been executed, the talk mode is reset to the previous setting. A clear command will also reset the talk mode.

The format for the FO command is as follows:

To the instrument in the listen string: FO n

From the instrument in the next sting: FRn, CRn, FRn+1, CRN+1,….FRn+11, CFn+11

where:

n is the table number pointer, from 0 to 60.

FRn is the first frequency of this group, from 0.00 to100 GHz in 0.01 GHz increments. It is head dependent.

CRn is the first dB cal factor for this group, from –3.00 to +3.00 dB in 0.01 dB increments.

Each numeric value will be separated by a comma.

Refer to FI command for limitations on the pointer and starting frequencies, and for general use of this command.

Example:

Command sent to the instrument: **FO 0**

Numeric array built into the talk buffer:

0.00,0.00,1.00,-0.05,2.00,-0.07,3.00,-0.10,4.00,
-0.06,5.00,-0.05,6.00,0.00,7.00,0.13,8.00,0.42,
9.00,0.34,10.00,0.00,11.00,0.15

Command sent to the instrument: F0 3

Numeric array built into the talk buffer:

3,00, -0.10, 4.00, -0.06, 5.00, -0.05, 6.00, 0.00, 7.00,
0.13, 8.00, 0.42, 9.00, 0.34, 10.00, 0.00, 11.00, 0.15,
12.00, 0.32, 13.00, 0.25, 14.00, 0.43

4.13.6 DF Command

This command is classified as a listen action command. Its functions are to blank the front panel display for secure ATE applications and to speed up operations by reducing the number of tasks that have to be performed by the Model PM2003. When the display is turned off, the display hardware is still functional, but it is not updated for certain types of information.

4.13.7 DN Command

This command enables the front panel display, complementing the DF command. This command is classified as a listen action command.

4.13.8 SM (SRQ MASK) Command

This command is used to set the SRQ mask which selectively enables service requests generated by the Model PM2003. This command is classified as a listen parameter command. The range of numeric entry is from 0 to 255. The SRQ mask is logically ANDed with the SRQ sources to determine if an SRQ should be generated. The SRQ bit map is shown in Table 4–7. For more information on SRQ and the related serial poll, refer to section 4.12.8.

Example:

SM 0 – Disable all service requests

SM 2 – Enables SRQ only on measurement errors

SM 8 – Enables service request only when a zeroing operation is complete

Table 4–7. SRQ Masks—Native Mode

Bit	Description
0	Set bit indicates LO LIMIT alarm in Channel 1
1	Set bit indicates that a measurement error has occurred
2	Set bit indicates that either a Trigger Filter or Trigger Settled measurement is ready
3	Set bit indicates that a CAL/Zeroing command is complete
4	Set bit indicates HI LIMIT alarm in Channel 1
5	Set bit indicates LO LIMIT alarm in Channel 2
6	Set bit indicates that an SRQ is active; this is a summary bit used in serial poll, not a masked bit
7	Set bit indicates HI LIMIT alarm in Channel 2

4.14 MEASURED AND TRIGGERED OPERATION AND SETTLED READING

Five measurement modes and five triggered modes are available over the bus. They are:

- Measure Normal (also known as free-run)
- Measure Filtered
- Measure Settled
- Measure Fast Single Channel
- Measure Fast Dual Channels
- Trigger Normal
- Trigger Filtered
- Trigger Settled
- Trigger Fast Single Channel
- Trigger Fast Dual Channels

The instrument must be in remote bus operation to invoke these modes of operation. When in local operation, only measure normal is available. The five measurement modes are each self-triggering (free running) while the trigger modes require a bus trigger command. The operation of each mode is modified by filter selection and range selection. See sections 4.4 and 4.5 The modes are described below.

4.14.1 Measure Normal (MN)

This is the mode to which the instrument initializes at power up when the local command is issued in the bus operation or when returning from a calibration mode.

4.14.2 MEASURE Filtered (MF)

In this mode, the front panel display is self triggered and continuously updated. In response to a step change in power of approximately 0.02 dB or an internal range change, the front panel displays the "____. ____ "(dashes) message until the digital filter time constant has elapsed. This mode guarantees that the reading is filtered by holding off the display of partially filtered readings.

4.14.3 Measure Settled (MS)

In the MS mode, the front panel display is self-triggered and continuously updated. In response to a step change in power or an internal range change, the front panel displays the "____ " (dashes) message until the settled condition occurs. The minimum time for a settled reading is twice the selected filter time constant. The maximum time is unlimited, because the settled condition may never occur for noisy signals or constantly varying signals. This mode should not be used in a data acquisition system because the unsettled condition may holdoff the GPIB indefinitely.

4.14.4 Measure Fast Single (MFS)

The measure fast single channel mode of operation provides the instrument's fastest measurement response when addressed to talk over the IEEE bus. Measurements at a rate of 240 readings per second can be obtained (see Figure 4–11). This mode only applies to channel 1 and will disable channels 2 when executed. The fast hardware filter for channel 1 is employed.

4.14.5 Measure Fast Dual (MFD)

The measure fast dual channel mode of operation provides the instrument's fastest measurement response for both channels when addressed to talk over the IEEE bus. Measurements at a rate of 120 readings per second for each channel can be obtained. In this mode, the fast hardware filters for channel 1 and channel 2 are employed.

4.14.6 Trigger Normal (TN)

In this mode, the front panel displays the –TRIG- message until the PM2003 is triggered by a bus command. The instrument continuously measures power as in the measure normal mode but does not display the reading. When triggered, the instrument captures the most recent measurement and displays the reading until another trigger command changes the display. This mode provides a quick response to trigger and the capability to hold a reading until required. However, the user is required to assure stability of the reading at the time of trigger.

4.14.7 Trigger Filtered (TF)

When entering this mode, the front panel displays the **–TRIG-** message. When a bus trigger command is received, the instrument begins the measure filtered mode. The PM2003 displays the **-TRIG-** message until the digital time constant has elapsed. The instrument displays and holds the filtered reading until another bus trigger command is received. In this mode, the digital filter guarantees a filtered reading upon trigger and the capability to hold a reading until required.

4.14.8 Trigger Settled (TS)

When this mode is entered, the front panel displays the **-TRIG-** message. The measure settled mode begins when a bus trigger command (**GET**) is received. The **TRIG** message will continue to be displayed until the settled condition occurs. The minimum time for a settled reading is twice the selected filter time constant. The maximum time is unlimited, because the settled conditions may never occur for noisy signals or constantly varying signals. In a data acquisition system this mode should be used only in connection with a bus service request (**SRQ**) to signal the controller when the measurement is complete. This allows the user's program to limit the time allowed for settling and take appropriate action if it is not achieved. Otherwise, an unsettled condition may holdoff the (**GPIB**) indefinitely.

4.14.9 Trigger Fast Single (TFS)

When the TFS command is executed, the front panel displays the **-TRIG-** message. Once a bus trigger command is received, the instrument begins the fast single channel measurement mode of operation. The **-**

TRIG- message is displayed until the completion of the measurement. Triggered response times of 5 ms may be obtained (see Figure 4–11). This mode only applies to channel 1 and will disable channel 2 when executed. The fast hardware filter for channel 1 is employed.

4.14.10 Trigger Fast Dual (TFD)

When the TFD command is executed, the front panel displays the **-TRIG-** message. Once a bus trigger command is received, the instrument begins the fast single channel measurement mode of operation. The **-TRIG-** message is displayed until the completion of the measurement. Triggered response times of 10 ms may be obtained. In this mode, the fast hardware filters for channel 1 and channel 2 are employed.

4.15 IEEE PROGRAMMING EXAMPLES

The following programming examples demonstrate bus operation of the PM2003. The examples are written in a general format of BASIC and are not an example of any specific implementation of the language. The examples assume that the PM2003 is the only instrument connected to the bus so that all commands address the PM2003.

In the examples, **INPUT** refers to the case where the instrument is addressed as the talker; **OUTPUT** indicates that the controller is the talker.

4.15.1 Example 1

Zero the instrument and take a reading with channel 1 from a signal generator.

Setup conditions:

Select channel 1 head data adapter

Frequency of 5 Gigahertz

Reading in milliwatts and also dBm

Filter of 3 seconds

Generator output is –17 dBm

OUTPUT **CH1**: Select channel 1

OUTPUT **SS5**: use head data adapter

OUTPUT **FR5**: set frequency to 5 GHz

OUTPUT **FL3**: set filter to 3 seconds

OUTPUT **TM0**: set TALK MODE to "0"

disconnect head from generator

WAIT 1000: wait one second

OUTPUT **ZR**: zero instrument

WAIT 30000: wait for zero to complete

Reconnect head to generator

WAIT 3000:	the filter time constant
INPUT A, B:	get reading from PM2003
PRINT A:	print **0** which is the error code
PRINT B:	print**.01995** which is the power in milliwatts

Change talk mode and take another reading in dBm

OUTPUT **TMI**:	set TALK MODE to "I"
OUTPUT **DB**:	set PM2003 to dBm display
WAIT **3000**:	the filter time constant
INPUT **A$**:	gets a reading from the PM2003
PRINT **A$**:	print string variable **0, -17.00dBm**

4.15.2 Example 2

Take triggered readings with Channel 1 and 2 from signal generators.

Setup conditions:

Select head data adapters

Channel 1 power = 100 microwatts

Channel 2 power = 350 microwatts

Channel 1 frequency = 18 GHz

Channel 2 frequency = 5 GHz

Reading in milliwatts

Autofilter

Setup channel 1

OUTPUT **CHI**:	select channel 1
OUTPUT **SS5**:	use head data adapter
OUTPUT **FRI8**:	set frequency to 18 GHz
OUTPUT **PW**:	set WATTS display
OUTPUT **FA**:	set filter to Autofilter

Setup channel 2

OUTPUT **CH2**:	select channel 2
OUTPUT **SS6**:	use head data adapter
OUTPUT **FR5**:	set frequency to 5 GHz
OUTPUT **PW**	: set Watts display
OUTPUT **FA:**	set filter to Autofilter

Setup trigger mode

OUTPUT **TM3**:	set TALK MODE to 3
OUTPUT **TS**:	set Trigger Settled operation

Connect head to generator

TRIGGER:	send Group Execute Trigger
INPUT A,B,C,D:	get reading from Model PM2003
PRINT A,B:	print channel 1 **0,100.00E-3**
PRINT C,D:	print channel 2 **0,350.00E-3**

4.16 ERROR MESSAGES

The error messages returned over the bus are described in Table 4–6. They are in numerical order as would be sent out over the IEEE-488 bus.

4.17 HP 437B AND 438A BUS EMULATION.

The Model PM2003 native mode is a superset of the mnemonics. Additional commands have been added to support dual channel operation, head data adapters and high speed sampling modes. The Model PM2003 is equipped to emulate the HP 437B and 438A bus mnemonics. These modes are available for users wanting to use the Model PM2003 in existing systems that cannot re-write their application programs. Refer to section 3.6.2.1 for configuring the Model PM2003 for these modes of operation. The IEEE-488 capabilities in the HP emulation mode are the same as the native mode as described in sections 4.12-4.12.8.

4.17.1 Turn-on Default Conditions

Several emulation parameters are reset at turn-on. The parameters and their default conditions are listed below.

- Bus emulation mode = 2002 (factory default)
- GPIB Local Mode
- Unaddressed
- Service Request Mask cleared
- Status Byte cleared
- Free Run Trigger Mode
- GT2 (Trigger with Delay) response to Trigger message
- Event Status Enable Mask = 0

4.17.2 Sending the Data Message.

Data Output Format. The output data is usually formatted as a real constant in exponential form. That is; first the sign, then a 5 digit number with the decimal point appropriately located followed by the letter E (signifying that an exponent follows). The letter E is followed by a signed power-of-ten multiplier. The

string is terminated by the EOS character set via the Menu-Setup-IEEE-EOS talker/listener commands (refer to section 3.7).

Exceptions to this format are the data output for the following functions:

- Identification
- Read Service Request Mask Value
- Read Event Status Register Mask Value
- Read Event Status Register Value

Identification. This function is used to identify the Power Meter's model number and the firmware version. After receiving the *IDN? or ID (437B) or the ?ID (438A) mnemonic and when addressed to talk, the Power Meter sends the following string:

Amplifier Research, PM2003, X.XX.

where PM2003 is the instrument model number and X.XX. is the firmware version number.

4.17.3 Sending the Require Service Message

The Power Meter sends the Require Service message by setting the Service Request (SRQ) bus control line true. The front panel SRQ annunciator is enabled when the Status Byte has been set. The Require Service message is cleared when a serial poll is executed by the controller or when a **CS** (clear status byte) or ***CLS** (clear all status bytes) mnemonic is received via a Data message.

There are five conditions that can be enabled to cause the Require Service message to be sent. These conditions, which are enabled by the Service Request Mask, are as follows:

- **Data Ready**: When the Power Meter has a data point requested by a trigger command.
- **Cal/Zero Completed**: When the Power Meter has completed a calibration or a zeroing cycle.
- **Entry Error**: When a number is entered via GPIB that is out of the allowable range for the selected parameter.
- **Measurement Error**: When the power applied to the head is incorrect for the current instrument configuration.
- **Event Status Register**: When a specified condition in the Event Status Register occurs and the corresponding bit in the Event Status Enable Register is enabled (via *ESE), this bit will be set true.

4.17.4 Service Request Mask

This mask determines which bits can set the Status Byte's **SRQ** bit true (see Table 4–8). When this bit becomes true, the **SRQ** line is also true. To set the mask, use the ***SRE** or **@1** mnemonic followed by an argument between the values of 0 and 255. The argument is determined by summing the weights of each bit to be checked.

Sending the Service Request Mask Value. The program mnemonics ***SRE** and **RV** will cause the Power Meter to respond when addressed to talk, with the present value of the Service Request Mask. This value is

the summed weights of the bits that are set true. The bit pattern can be interpreted with the information in Table 4-8.

Table 4–8. Status Byte and Service Request Mask (HP437B and 438A Only)

BIT	VALUE		DESCRIPTION
	(decimal)	(hexadecimal)	
0	1	1	Data Ready
1	2	2	Cal/Zero Complete
2	4	4	Entry Error
3	8	8	Measurement Error
4	16	10	Not Supported
5	32	20	Event Status Register
6	64	40	Require Service (RQS)
7	128	80	Not used; always zero

4.17.5 Event Status Register.

This register is a second status byte which extends the use of the Service Request Status Byte (see Table 4–9). The bits are set true when the specified event occurs provided the enable mask has been previously set. The mask is set by sending the ***ESE** mnemonic followed by an argument, the summed value of the bits of the desired condition to request service.

When a bit in the Event Status Register is set true, bit 5 of the Status Byte will also be sent if so enabled. The value of this register can be read via the ***ESR?** program code. After the instrument receives this command, the next time it is addressed to talk a number will be sent representing the weighted value of the bits set.

Table 4–9. Event Status Register (HP437B and HP438A Only)

BIT	VALUE	DESCRIPTION
0	1	Not used; always zero
1	2	Not used; always zero
2	4	Not used; always zero
3	8	Device Dependent Error
4	16	Execution Error
5	32	Command Error
6	64	Not used; always zero
7	128	Power On

- **Device Dependent Error**. This bit is set when a measurement error occurs.
- **Execution Error**. This bit is set when improper data has been received by the instrument. For example, sending a negative value for frequency is considered an execution error.
- **Command Error**. This bit is set when the instrument parses a GPIB mnemonic which is not recognized. For example, the program code **XX** would produce a command error.
- **Power On**. This bit is set in the instrument's initialization sequences when the power is toggled from OFF (0) to ON (1).

4.17.6 HP Emulation Codes

The Model PM2003 has the ability to emulate many of the HP 437B and HP 438A remote programming modes. Tables 4–10 and 4–11 summarize the HP mnemonic set. In cases where the Model PM2003 cannot execute the HP code, it is noted with the command **NOT SUPPORTED**. The Emulation Mode can be enabled either by the Menu-SETUP-IEEE-EMULATION command (437B or 438A option) or by sending the**HPS** or **HPD** program code via the bus. This mode is disabled by setting the Menu-SETUP-IEEE-EMULATION command to the **PM2003** option or sending the **BN** mnemonic over the bus. The PM2003 command set is listed in Table 4–12.

Table 4-10. HP 437B Emulation GPIB Commands

437B	DESCRIPTION	COMMAND
CL	0 dBm Calibration [1]	
*CLS	Clear the status register [3]	
CS	Clear the status byte	
CTO-CT9	Clear head data tables 0-9[1]	NOT SUPPORTED
DA	All display segments on	
DC0	Duty cycle on (‘DY’ ARG # 100)	NOT SUPPORTED
DC1	Duty cycle off (‘DY’ ARG – 100)	NOT SUPPORTED
DD, DF	Display disable	
DE	Display enable	
DN	Down arrow key	
DU	Display user message	
DY	Duty cycle value[1]	
EN	ENTER	
ERR?	Device error query	
*ESE	Set event status enable mask[3]	
*ESE?	Event status register query[3]	
*ESE?	Event status register (ESR) query[3]	
ETO – ET9	Edit head calibration factor table 0-9[1]	NOT SUPPORTED
EX	EXIT	
FA	Automatic filter selection	
FH	Filter hold	
FM	Manual filter selection[1]	
FR	Frequency entry[1]	
GT0	Ignore group execute trigger (GET) bus command	
GT1	Trigger immediate response to GET command	
GT2	Trigger with delay response to GET command	
GZ	Gigahertz	
HZ	Hertz	
ID	GPIB identification query	
*IDN?	GPIB identification query[2]	
KB	Calibration factor[1] in percent	
KZ	Kilohertz	
LG	Log display	
LH	High limit[1]	
LL	Low limits[1]	
LMO	Disable limits checking function	
LM1	Enable limits checking function	
LN	Linear display	NOT SUPPORTED

437B	DESCRIPTION	COMMAND
LP	Learn mode	
LT	Left arrow key	
MZ	Megahertz	
OC0	Reference oscillator off	
OC1	Reference oscillator on	
OD	Output display test	NOT SUPPORTED
OF0	Offset off[4]	NOT SUPPORTED
OF1	Offset on[4]	NOT SUPPORTED
OS	Offset value[1]	
PCT	Percent	
PR	Preset	
RA	Autorange	
RC	RECALL[1]	1-4
RE	Resolution[1]	1-3
RF0 – RF9	Enter head reference calibration factor[1] NOT SUPPORTED	
RH	Range hold	
RL0	Exit REL mode	
RL1	Enter REL mode using new REL value	
RL2	Enter REL mode using old REF value	
RM	Set range[1]	
*RST	Soft reset	
RT	Right arrow key	
RV	Read Service Request Mask value	
SE	Head number[1]	1-6 only
SM	Status message	NOT SUPPORTED
SN0 – SN9	Enter head serial number[2]	NOT SUPPORTED
SP – N0P	SPECIAL	NOT SUPPORTED
*SRE	Set the service request mask[3]	
*SRE?	Service request mask query[3]	
ST	STORE[1]	1-4
*STB?	Read the status byte	
TR0	Trigger hold	
TR1	Trigger immediate	
TR2	Trigger with delay	
TR3	Trigger-free run	
*TST?	Self-test query[3]	
UP	UP arrow key	
ZE	ZERO	
@1	Set the service request mask	
@2	Learn mode prefix	NOT SUPPORTED
%	Percent	

1 A numeric entry is required by these GPIB codes, followed by the code EN (ENTER).
2 This GPIB code uses the next 6 characters (0 – 9, A-Z, or an underscore) as input data.
3 The * must be included as part of the GPIB command string.
4 Offset value is always applied. Set the offset value to 0 dB for off condition. Any other value the offset is on.

Table 4-11. HP 438A Emulation GPIB Commands

438A CODE	DESCRIPTION	COMMENTS
AD	Measure A – B	
AE	Set A	
AP	Measure head A	
AR	Measure A/B	
BD	Measure B-A	
BE	Set B	
BP	Measure head B	
BR	Measure B/A	
CL	CAL ADJ1, 2	
CS	Clear status byte 1	
DA	Display all1	
DD	Display disable1	
DE	Display enable1	
DO	Measured offset entry	
EN	ENTER1	(precede with AE or BE)
FA	Set auto average filtering	(precede with AE or BE)
FH	Hold present average number	(precede with AE or BE)
FM	Set filter number1, 2	
GT0	Group execute trigger cancel1	
GT1	Group execute trigger single measurement1	
GT2	Group execute trigger full measurement with setting1	
GZ	Gigahertz1	
HZ	Hertz1	
?ID	Ask of ID1	
KB	Calibration factor1, 2	(dB or dBm)1
KZ	Kilohertz1	
LG	Set log units	
LH	High limit1, 2	
LL	Low limit1, 2	
LM0	Disable limit checking1	
LM1	Enable limit checking1	(watts or %)1
LN	Set linear units	NOT SUPPORTED
LP1	Set learn mode #1	NOT SUPPORTED
LP2	Set learn mode #2	
MZ	Megahertz1	
OC0	Turn off calibrator source1	
OC1	Turn on calibrator source1	
OS	Offset1,2	
PR	Preset instrument to a known state1	
RA	Resume autorange1	1-4 ONLY
RC	RECALL1, 2	
RH	Range hold1	
RL0	Relative mode off1	
RL1	Relative mode on1	
RL2	Relative mode with old REL value1	
RM	Set manual range1, 2	
RV	Ask for status request mask1	

438A CODE	DESCRIPTION	COMMENTS
SM	Ask for status message1	1-4
ST	STORE1,2	
TR0	Trigger hold mode1	
TR1	Trigger single measurement1	
TR2	Trigger full measurement with settling1	
TR3	Free range trigger mode1	(precede with AE or BE)1
ZE	Zero head	
@1	Prefix for service request mask1	

1. These commands are fully compatible with the HP437B Power Meter command codes.
2. Requires numeric entry followed by program code EN.

Table 4–12. PM2003 GPIB Commands

Code	Description	Comments
AM	Measure A – B	
AP	Measure A + B	
AR	Measure A/B	
BD	Measure B – A	
BR	Measure B/A	
BN	PM2003 Native mode	NO EMULATION
CH	Channel select	1-3
CF	Calibrator off	
CL	Clear	
CN	Calibrator on	
CP	Calibrate	
DB	dBm select	
DF	Display off	
DN	Display on	
DR	dBr select	
DU	Display user message	
DY	Duty cycle value	0.01-100.00 in 0.01 steps
FA	Auto filter	
FD	dB calibration factor	-3.00 to 3.00 in 0.01 steps
F1	Send high frequency calibration data to instrument	
FL	Filter time select	0 to 20.00 in 0.05 steps
F0	Get high frequency calibration data from instrument	
FR	Frequency select	
HPS	Enable HP 437B emulation mode	
HPD	Enable HP 438A emulation mode	
?ID	Talk instrument ID	
*IDN?	Talk instrument ID	
LH	High limit	99 to 99.99 in 0.01 steps
LL	Low limit	99 to 99.99 in 0.01 steps
LM0	Disable limits checking function	
LM1	Enable limits checking function	
LR	Load reference	
MF	Measure filtered	
MFD	Measure Fast Dual Channels	
MFS	Measure fast single channel	

MN	Measure normal, free run	
MS	Measure settled	
OS	Offset value	99 to 99.99 in 0.01 steps
PW	Watts select	
RA	Autorange	
RB	Recorder bottom	
RC	Recall instrument configuration	1-4
RE	Resolution	1-3
RN	Recorder normal	
RS	Range select	0-6
RT	Recorder top	
SI	Send linearity data to instrument	
SM	Service request (SRQ) mask	0-255
SO	Get linearity data from instrument	
SR	Set dBr reference	99 to 99.99 in 0.01 steps
SS	Head select	1-6
ST	Store instrument configuration	1-4
TF	Trigger filtered	

1 A numeric entry is required by these GPIB codes, followed by the code EN (ENTER).
2 This GPIB code uses the next 6 characters (0 – 9, A-Z, or an underscore) as input data.
3 The * must be included as part of the GPIB command string.

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Seller warrants (i) that seller has title to the goods sold and (ii) that Amplifiers (all parts excluding traveling wave and vacuum tubes), Antennas, field monitors, field probes, field analyzers, field analyzer processor units, system controllers, system interlock, power meters, leak detectors, RF conducted probes, RF conducted clamps, Multi-tone, EMI receiver systems, RF down converters, RF conducted immunity systems, conducted immunity accessories, radiated immunity test systems, safety meters, safety sensor heads, tripods, directional couplers, waveguide adapters, termination loads, load attenuators, impedance stabilization networks, and coaxial cables will be free from defects in material and workmanship for a period of three (3) years from date of shipment shown on AR RF/Microwave Instrumentation invoice.

All modules, used in the amplifiers for the 1-6 GHz, 4-18 GHz, 6-18 GHz, all HPM products, and other applications, are hermetically-sealed. This sealing process protects the internal hybrid circuitry from humidity that could compromise the long term reliability of the product. These modules are not field-repairable and should *never* be opened outside of AR's Microelectronics Lab. The modules in these product lines have a security label on two sides of the modules between the housing and lid/cover. If the security label is removed and or cut, the warranty of the module will be voided.

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