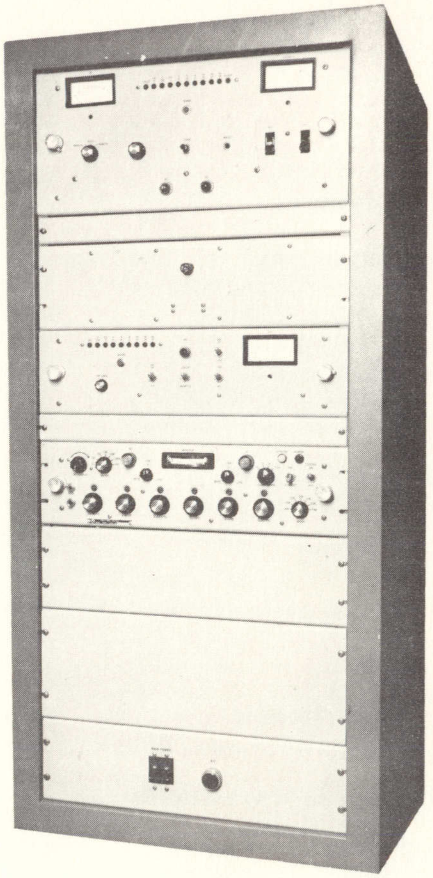
General Purpose H.F. Transmitter Model GPT-1K

TECHNICAL BULLETIN 202-2119



- ***1000 Watts PEP 2-26MHz***
- ***Synthesized or Multi-Channel***
- ***Full Protection Against Overload***
- ***Totally Automated with Manual Override***
- ***CW, AM, AME, USB, LSB, ISB, FSK, FAX***
- ***Rugged, Modular Construction***
- ***Compact and Light-weight***
- ***Reliable, Solid-State Power Supplies***

The GPT-1K series of general purpose HF transmitter operate continuously at 1,000 watts PEP throughout the frequency range 2-26MHz. The equipment is well-suited for point-to-point communications and is specially designed for transportable stations. All standard operating modes are provided in the GPT-1K including CW, AM equivalent, single sideband, independent sideband, and optionally frequency shift teletype or facsimile. Two basic models are available: the multi-channel GPT-1K/E which provides up to ten pre-set channels, and the synthesized GPT-1K/J which provides full-frequency coverage in 100Hz steps. The transmitter tuning is completely automatic with manual "over-ride" of all operating controls built in to each unit. Remote control of the transmitter is optional using a SCR or TCR control system. Many other accessories are available to build upon the basic capability of the transmitter.

The GPT-1K is manufactured as an integrated system of sub-modules. Each module is designed to perform a specific function in the transmitter and can be interchanged with other like units in the field. The exciter module provides the RF drive and requires no tuning or peaking once the operating frequency is selected by front panel control. This RF output in turn drives the intermediate and final amplifier stages to full output. The final amplifier delivers in excess of 1,000 watts to an unbalanced 50-ohm load and will operate into a 2-to-1 mismatch without damage. To operate properly, the transmitter requires only primary power, a suitable antenna system and an audio or keying input.

The GPT-1K circuits are solid-state except those handling high power in the final RF output stages. Maximum use is made of removeable assemblies that are securely fastened to the chasis yet easily removed for servicing. This type design simplifies troubleshooting and ensures that the equipment is continuously in service. The GPT-1K can be serviced completely from the front of the equipment. No access is required from the sides or rear. If space is limited, several transmitters can be installed next to each other without affecting performance or reducing capability.

TECHNICAL SPECIFICATIONS
GTP-1K

OPERATING PARAMETERS

FREQUENCY RANGE	2-30MHz multi-channel or synthesized in 100Hz increments.
FREQUENCY STABILITY	One part in 10^6 per day. Optional one part in 10^8 per day and higher.
MODES OF OPERATION	CW, AME, USB, or LSB. Optional MCW, AM, AFSK, FSK, FAX, 2ISB.
POWER OUTPUT	1000 watts PEP (SSB). 400 watts average (CW/FSK) key down and locked 2-26MHz. 26-30MHz at reduced power.
OUTPUT IMPEDANCE	50 ohms, unbalanced. Output network will match into a 2:1 load VSWR.
TUNING	Automatic with front-panel, manual over-ride of all operating controls.

AUDIO PARAMETERS

SIDEBAND RESPONSE	250-3040Hz CCIR ± 1.5db. Optional 250-6080Hz CCIR; equalized filters; others.
INPUTS	Audio: Two independent 600 ohm channels. -20 to + 5dbm. Mike: Front panel jack for low-level dynamic input. -55db into 47,000 ohms. FSK: Rear panel connector of 75 baud or higher. ± 42.5/85/170/425Hz shift; others. Input 20/60ma, 50 or 100 volts, dry contact, + /- to ground. FAX: Rear panel connector for up to 800Hz linear shift. Input + 1 to + 10vdc.
CONTROL	Front panel "fader" controls ease selection of line or mike inputs for USB or LSB.

RF PARAMETERS

SIDEBAND REJECTION	500Hz tone is minimum 50db below PEP in the unwanted sideband.
SPURIOUS SIGNALS	Minimum 50db below PEP.
DISTORTION	Minimum 30db below full PEP output..
HUM and NOISE	Minimum 50db below PEP at least 120Hz removed from carrier.
CARRIER SUPPRESSION	Selectable at -6/-20/-30/-55db (adjustable).
HARMONIC SUPPRESSION	Minimum 45db below PEP without accessory TFP output filter.

SPECIAL FEATURES

REMOTE CONTROL	Full remote control of frequency, mode, carrier, power output, antenna selection, antenna direction, and keying is available with SCR or TCR control systems.
METERING	Front panel meters and indicators provide continuous status display of transmitter operation to the module level.
SAFETY	Each transmitter module is fully high-voltage interlocked with fuse, overload, and audible alarm protection. Protective plates — labelled in red — are used throughout.
ALDC	Automatic load and drive control is included to improve linearity, limit distortion, and provide a relatively constant output during input peaks or load changes.
CONSTRUCTION	Completely solid-state, including power supply, up to the final RF output stages. US/Military Standard components are used whernever practicable.

ENVIRONMENTAL and INSTALLATION

COOLING	Filtered, forced air in semi-pressurized cabinet. Nominal 200cfm air flow.
OPERATING CONDITIONS	0° to 50°C. Up to 90% relative humidity at MSL.
STORAGE CONDITIONS	-30° to + 75°C. Up to 90% relative humidity at MSL.
PRIMARY POWER	115/230V/AC, 50/60Hz. Single-phase. Nominal 1200 watts.
HEAT DISSIPATION	Nominal 600 watts.
SIZE and WEIGHT	24.5" (62.2 cm) high x 23" (58.4 cm) wide x 26" (66.0 cm) deep. 356 pounds/162Kg. Size and weight varies slightly with accessories selected.
SHIPPING DATA	Commercial packing for U.S. shipment. Special packing available at additional cost. Two (2) containers. Largest 54" x 27" x 34". Weight/cube — 480 lbs./40 cu. ft.
LOOSE ITEMS	Technical manual (1) and mating RF/signal connectors.

ORDERING INFORMATION

MODELS	GPT-1K/E Multi-channel 1KW HF/SSB Transmitter. GPTR-1K/E Model GPT-1K/E with remote control interface circuits. GPT-1K/J Synthesized 1KW HF/SSB Transmitter. GPTR-1K/J Model GPT-1K/J with remote control interface circuits.

ACCESSORY PRODUCTS are described in sections 4-9 of the General Catalog and include RF/antenna, terminal, data, connector and power equipment. **TECHNICAL SERVICES** in design, engineering, training, and related areas are described in section 10. **OPTIONS** are listed after each TMC product in part A of the Price List.

Technical Specifications Are Subject to Change Without Notice

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TMC [CANADA] LIMITED **TMC INTERNATIONAL**

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Technical Analysis

of

HIGH FREQUENCY 1KW TRANSMITTER SYSTEM

Series GPT-1K

General Description and Features

Physical Description

Functional Description

Operating Procedures
- Normal Conditions
- Emergency Conditions
- Maintenance Conditions

Maintainability
- Technical Manual
- Preventive Maintenance
- Troubleshooting and Repair (MTTR)

Reliability
- Equipment and Circuit Design
- Mean Time Between Failure (MTBF)

Technical Specifications

Test Equipment and Special Tools

Replacement Parts

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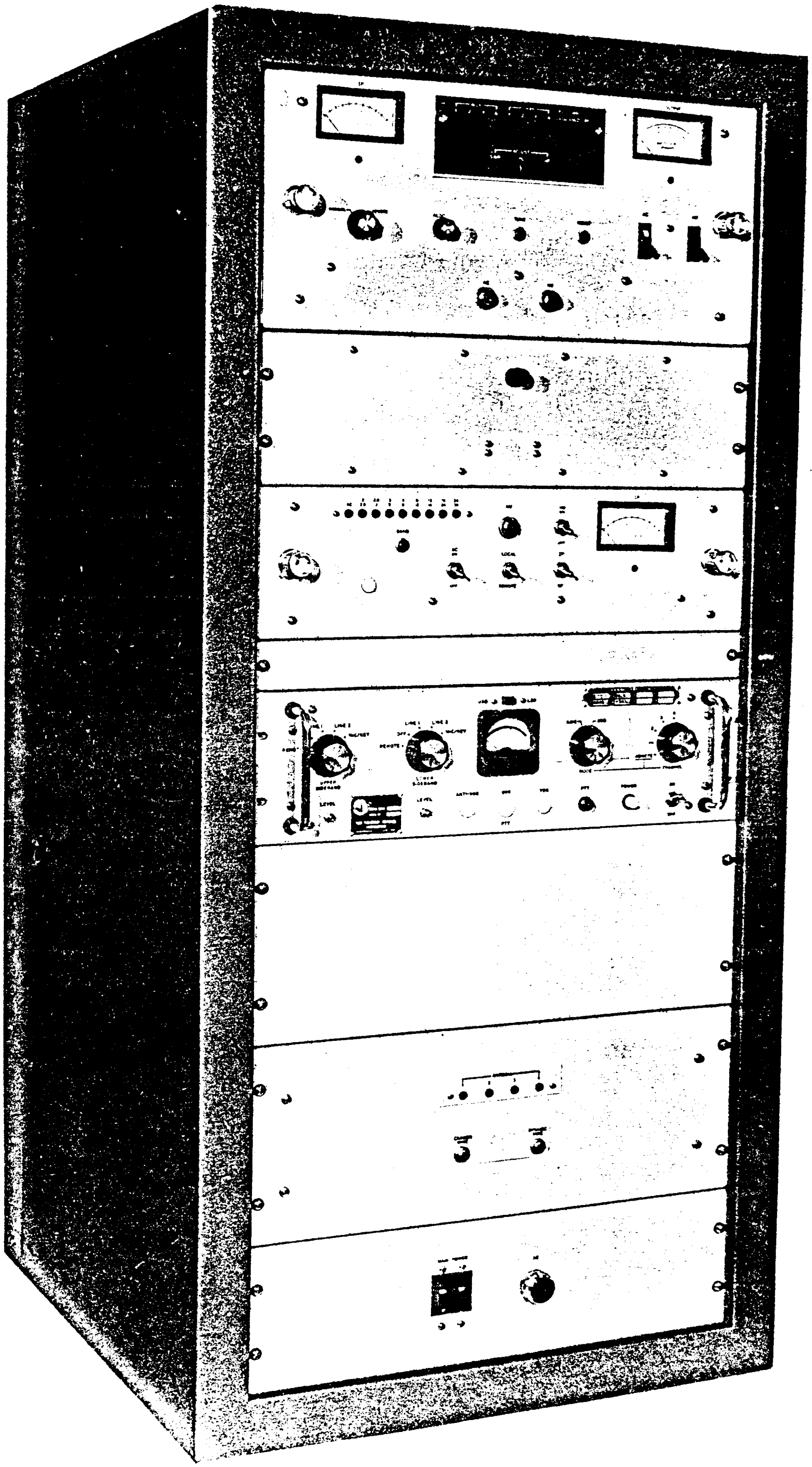


PHYSICAL DESCRIPTION

The basic transmitter system is housed in a single, completely enclosed metal cabinet capable of being operated as a single mechanical and electrical assembly. All components of the transmitter are housed in this cabinet with access ports cut into the base and top assemblies for routing of RF power, primary power and external connections. For remotely controlled transmitters, this cabinet also contains the control units and terminal equipment required for operation. The cabinet is designed for rigid mounting to a deck or properly constructed flooring.

In general, RF components are distributed throughout the upper portion of the cabinet while the heavier power supply components are located in the lower portion, bolted to the base module. The five transmitter sections are further described below.

The top module houses the power amplifier (PA) containing the two power amplifier tubes (8163) particularly designed for sideband operation. This tube is capable of dissipating in excess of 1,000 watts PEP power. The PA section houses the output circuit - a modified parallel-L designed to match an unbalanced antenna of 50 ohms with a VSWR of 3:1. The PA bandswitch and coil assembly located in this compartment is constructed with self-cleaning contacts designed to operate in excess of 10,000 times under rated loads without development of imperfections or of appreciable wear leading to erratic operation. The number of pressure contacts has been held to a minimum while still providing the necessary redundancy to assure reliable, trouble-free operation of the system. Automatic tuning and loading components are also located in the PA compartment along with the automatically switched harmonic output filter which decreases the harmonic content of the PA signal at rated loads.

The HFL-100 intermediate power amplifier (IPA) is located directly below the PA module. The IPA consists of two broad-band amplifier stages that provide approximately 50 watts drive to the PA section. The final PA and IPA tubes are air-cooled by a self-contained blower within the drawer.

The exciter unit is normally under the IPA DRAWER and provides drive for the succeeding amplifier stages. However, mircowave or telephone terminal units, remote control units, audio frequency shift keyers and other related accessories may also be mounted in this section. For monitoring and testing purposes a test, input jack, and exciter monitor jack are mounted on the exciter drawer.

The transmitter system is cooled by filtered, forced air which enters from the bottom front of the cabinet and is exhausted out the top. The transmitter is supplied with self-contained blowers of sufficient capacity to cool the equipment at the specified maximum ambient

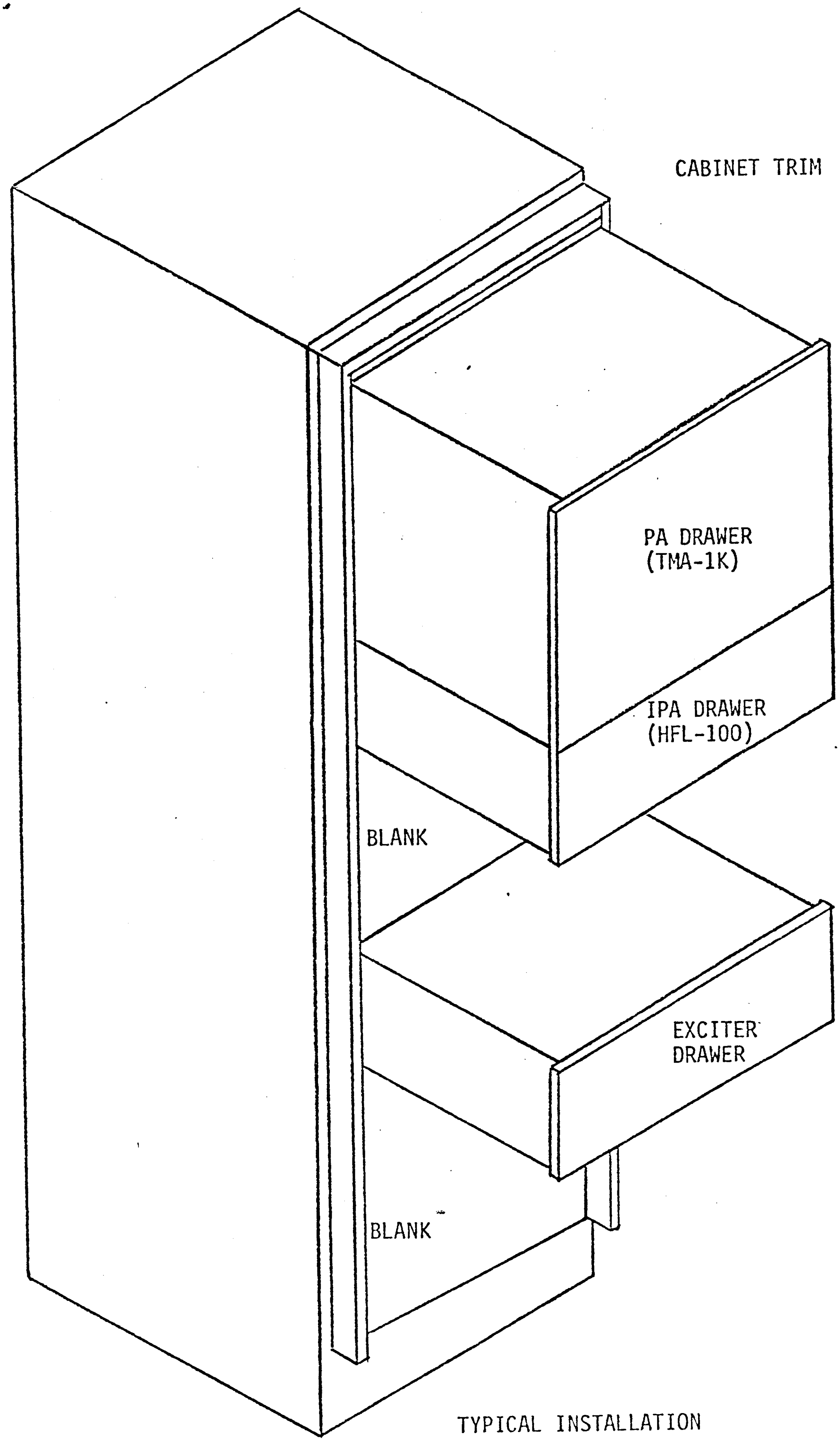
GENERAL DESCRIPTION AND FEATURES

The GPT-1K series of TMC transmitter systems provide the capability of long haul, point-to-point communications in the high frequency range of 2.0 to 29.9999MHz. The transmitters are an outgrowth of over 30 years experience in TMC developing, manufacturing, installing and maintaining high power HF systems. From the early SBT-1K/GPT-1K series (U.S. Military AN/FRT-70), the GPT-1K series has evolved with the technology of modern electronics until today it is unequalled in technical performance. The many active installations worldwide attest to the proven design of the GPT-1K series.

TMC has long used the "building block" approach in the design of its equipment. This approach enables any communications station to expand or alter its capability without replacing entire systems. As an example, the older SBT-1K/GPT-1K (AN/FRT-70) transmitters required an entire side-rack of equipment to produce the RF excitation for the 1KW linear amplifier. Today a single unit designed by TMC and occupying less than six inches of rack space does the same job better and is completely compatible with the older transmitters. This building block approach is used in the GPT-1K series and in addition to providing a variety of capabilities, results in commonality of parts, compatibility between equipments, and significant cost savings.

The GPT-1K series is actually an entire family of 1KW transmitter systems, each with a broad range of capabilities. The basic models provide either multi-channel or synthesized operation in the CW, AME, USB, LSB or two-channel ISB modes. Operating modes for AM, FSK, AFSK, FAX and four-channel ISB are also available depending on the type of service required. Automated tuning of the transmitter system is normally provided although completely manual tuning is available. Automated transmitter systems designed by TMC can be locally or remotely controlled. In either case, any operator can assume complete control of the system by manually overriding the transmitter functions at the front panel. This manual override feature is particularly important when operating under emergency or maintenance conditions.

All parts and assemblies in the GPT-1K series are accessible from the front of the transmitter to facilitate maintenance. No access is required from the sides or rear. Several units are mounted on track slides with interconnect cables of sufficient length to permit full operation of the equipment when the slides are extended to their maximum length. This feature is a result of TMC's experience with many "confining" installations where operating space was at a minimum. The transportable communications vans designed and installed by TMC for the U.S. Navy are examples of how valuable space can best be utilized. Such experience is one reason why the GPT-1K can provide 1,000 watts of RF power (PEP) reliably in less than four square feet of floor space.



TYPICAL INSTALLATION

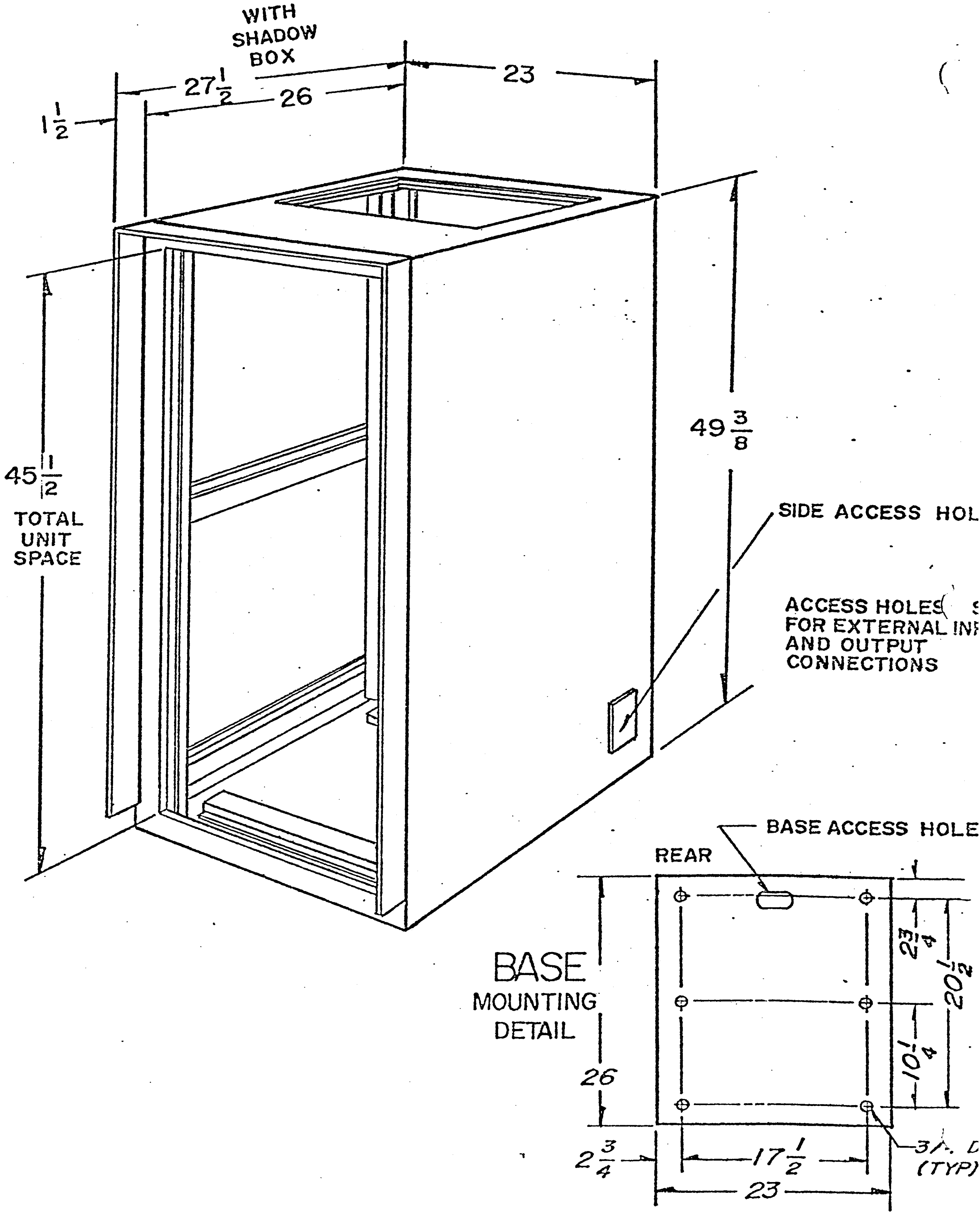
temperature which would tend to damage it or reduce its useful life. Alternate air ducting is available to meet specific installation requirements. Environmentally, the transmitter operates continuously in any ambient temperature between $0^{o}C$ and $50^{o}C$ at any value of humidity up to 90%. The system will not be materially affected under storage conditions of $-30^{o}C$ to $85^{o}C$ and humidity of up to 90%.

The entire transmitter system is (high voltage) interlocked for personnel safety and designed to prevent personnel from accidentally coming in contact with electrical potentials (MIL-E-16400 applies). The outside casing and main frame, i.e., all external parts exclusive of output terminals, are at ground potential when the system is properly installed and in operation. All control knobs are insulated and control shafts grounded. Primary power (line) input terminals are protected by an insulating cover and identified by warning labels attached to the equipment. Each compartment in the transmitter system is shielded both internally and externally.

The usual method of ducting internal and external cables is through access ports in the base assembly below the power supply. These external cables are then terminated on strips conveniently located to the cable openings and readily accessible to the technician. When not in use, access ports are covered with removeable plates. Provision has been made for alternate cable ducting depending on specific installation requirements. In general, cable ducting through the base compartment results in a neat and pleasing appearance from any viewing angle.

The transmitter system operates from a primary power source of 230 volts AC, 50 or 60Hz single phase. Power consumption does not exceed 1.5KW and the power factor is not less than .95.

The transmitter system without side cabinet but including a 2-inch (5cm) mounting base has the outside dimensions 49 inches (125cm) high x 23 inches (58cm) wide x 26 inches (66cm) deep and weighs less than 400 pounds (182 kg) installed depending on the accessory equipment supplied.


WITH SHADOW BOX
27 1/2
26
23
1 1/2
45 1/2
TOTAL UNIT SPACE
49 3/8
SIDE ACCESS HOL
ACCESS HOLES
FOR EXTERNAL IN
AND OUTPUT
CONNECTIONS
BASE ACCESS HOLE
REAR
BASE
MOUNTING
DETAIL
26
2 3/4
20 1/2
10 1/4
2 3/4
17 1/2
23
(TYP)

CRATED WEIGHTS, DIMENSIONS, AND CONTENTS

Crate	Contents	Gr. Wt.	Cu. Ft.	Dimensions
1	Cabinet & Loose Items	255 lb.	26.4	53-3/8"x26-3/8"x33"
2	TMA-1K Linear Amplifier HFL-100 HF Linear Amplifier SME-5 Exciter (or MMX)	225 lb.	13.4	31-7/8"x23-5/8"x30-3/4"
	TOTAL.....	480 lb.	39.8	

Exciter, SME-5

The SME-5 exciter is used with the Model GPT-1KE/GPT-1KC transmitters and provides the required RF drive in all operating modes.

The SME-5 is a solid state exciter that can provide up to 100mw of RF drive in the frequency range of 2.0 to 30MHz by selection of one of eight discrete channels. An internal oscillator provides a minimum stability to the selected frequency of one part in 10^6 per day. Modulation capabilities (operating modes) include CW, MCW, AME, USB, LSB, 2-channel ISB, AFSK and AFAX with the bandwidth of either sideband, 250-3040Hz (CCIR). Optional bandwidths are available.

An eight-position rotary switch mounted on the front panel provides for channel selection to one of eight pre-set frequencies in the 2.0 to 30MHz range. No tuning or peaking is required to obtain full output from the exciter. Outputs may also be adjusted independently depending on the operating frequencies of each channel.

The functional block diagram on the next page depicts the typical signal processing. The principles of operation of both LSB and USB are identical. For ease of explanation only LSB operation is described. When following the USB operation, LSB switch S1 is replaced by USB switch S2. Audio input from an external source is fed through input filter A17 to the primary of transformer A20T1. The output is taken at the potentiometer A20R6 and fed to the LSB input selector switch S1. S1 routes the selected input through LSB LEVEL adjust potentiometer R3 to the transformer A20T2. The output of the transformer A20T2 is fed to the IF board A9. This output is also fed to a metering circuit A7, through meter switch S9. The meter M1 is mounted on the front panel and enables the operator to set the correct audio level. The IF board is a modulator-oscillator. It combines the audio signal with the local oscillator frequency of 1750kHz. The modulated output of the IF board is fed to the mixer doubler A13. The mixer-doubler is controlled by channel switch S4. It doubles, under certain conditions, the input signal from the HF oscillator A12 and mixes it with the intermediate frequency supplied by the IF board A9. The HF oscillator is also controlled by channel switch S4. The output of the mixer-doubler A13 can be any one of the 8 channel frequencies selected by channel switch S4. The selected output of A13 is fed to the appropriate section of RF amplifier A14. The RF amplifier consists of eight boards, only one of which is operative at a time as determined by the channel switch. The output of the RF amplifier is fed to the wideband amplifier A15, which delivers the maximum RF output of 100mw PEP into a 50-ohm load, sufficient to drive any TMC transmitter.

The carbon microphone, the dynamic microphone input or the CW input, when selected are fed through an AF amplifier and oscillator board A20. The output of A20, a 1000Hz or compressed AF signal at a level of -20 dbm to +10 dbm is coupled to A9 as an audio input.

FSK inputs are first fed through input filter A18 to FSK board A1. The FSK inputs being in the form of teletype information is converted into an audio input in the board A1 and fed to the S1A-6 for onward transmission in the same manner as line audio input.

FUNCTIONAL DESCRIPTION

The GPT-1K series of transmitting systems are designed and constructed around the "building block" principle. As a result, this system could be described as containing two transmitters that are integrated into one by using a common exciter for control and drive. The transmitter system is a complete, self-contained functional unit which requires only the application of power, signal and antenna lines to meet all performance specifications. It is designed for reliability, simplicity and ease of operation consistent with operating requirements. As a result, the transmitter will operate continuously under full load with a 100% duty cycle within the environmental operating conditions specified.

The GPT-1K system consists of four functional groups: 1) exciter; 2) RF amplifier; 3) power distribution; and 4) control.

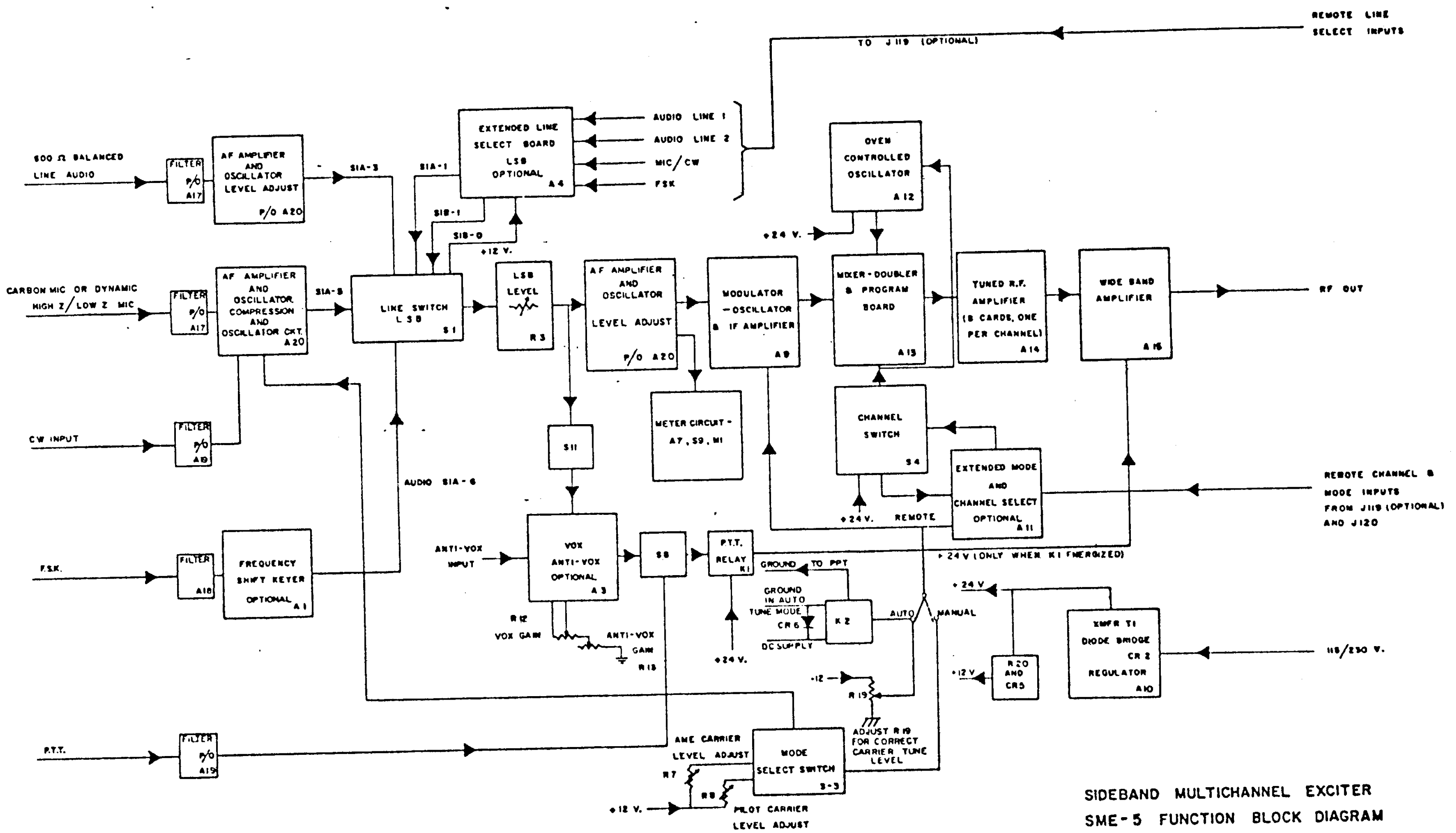
The operations described in the following paragraphs are applicable to both manually-tuned and automatically-tuned transmitters. The only essential difference is whether an operator controls each functional group or the operator gives command to an integral processor that takes control of the entire tuning sequence.

Basically, the exciter, which requires no tuning or peaking, provides a low-level RF signal to drive the first amplifier stage which in turn drives succeeding stages. The path of the RF signal is routed through the amplifier stages, output metering circuits and finally to a 50-ohm transmitting antenna or dummy load. Tuning capacitors are used to resonate the higher power amplifier stages.

One of two types of exciters is used to provide the required RF drive:

Model SME-5 for GPT-1KC Channelized Transmitter
and GPT-1KE Multi-Channel Transmitter
Model MMX-2 for GPT-1KJ Synthesized Transmitter

The following paragraphs describe each exciter and functional unit in detail.



SIDEBAND MULTICHANNEL EXCITER
SME-5 FUNCTION BLOCK DIAGRAM
(LSB OPERATION ONLY)

VOX/ANTI-VOX is operated by switching VOX USB/LSB switch on the rear panel to any position. A portion of audio is fed to VOX/ANTI-VOX board A3, where the predetermined level of audio operates relay K1 (S8 in VOX position). When energized, K1 applies +24 volts to wideband amplifier A15.

Extended line select boards A4 (LSB) and/or A5 (USB) (both optional) are provided for remote control of the unit. When S1/S2 is in REMOTE position, +12 volts is supplied to the relay in A4 (A5) which in turn routes the selected input for transmitting in the usual manner.

Extended mode and channel select ALL (optional) is provided for selection of channel and/or mode from remote location. This board operates when S4 is in REMOTE position.

The SME-5 is designed for track-slide mounting in a standard 19-inch rack. All operator controls are mounted on the front panel of the unit. The remaining controls, all connectors and terminal strips are located on the rear panel. Whenever possible, electronic components are mounted on printed circuit cards that plug into connectors on the main chassis.

The exciter operates from a 115 or 230 volt, single phase, 50 or 60Hz primary power source. The power supply section consists of a transformer, rectifier and regulator which provides the +12 vdc and +24 vdc for operation. All power circuits are fused to protect components from damage due to excessive transients or surges.

Exciter, Model MMX-2

The MMX-2 exciter is used with the GPT-1KJ transmitter and provides the required RF drive in all operating modes.

The MMX-2 is a solid state exciter that can provide up to 250mw of RF drive in the frequency range of 2.0 to 29.9999MHz in 100Hz steps. An internal standard provides a minimum stability to the selected frequency of one part in 10^8 per day. An external standard, the CSS-2, can be used to stabilize the output frequency to one part in 10^9 per day (short term) and five parts in 10^9 per week (long term) as an option. The modulation capabilities (operating modes) include CW, AM, USB, LSB, 2-channel ISB, FSK and FAX with the bandwidth of either sideband, 250-3040Hz (CCIR). Optional bandwidths are available depending on requirements.

Six direct-reading, digital switches mounted on the front panel provide for carrier frequency selection in the 2.0 to 29.9999MHz range. The basic 1MHz signal from the internal or external standard is used to develop basic signal frequencies that synthesize the RF carrier output. The functional block diagram on the next page depicts this method of signal processing.

Referring to the block diagram, the spectrum generator board Z101 develops seven basic signal frequencies from the incoming precision 1MHz signal. The 1MHz input is amplified and sent to the mixer-divider circuits. The 1MHz input is also clipped, divided by a factor of 10 and applied to a 100kHz spectrum generator; this output, containing the 100kHz fundamental, plus harmonics, is applied to the comb filter circuits. The 1MHz input is squared to produce a 1MHz spectrum containing the required harmonics for generation of five additional output frequencies of 8, 12, 13, 14 and 40MHz. The 8MHz output is applied to the mixer-dividers; the 40MHz output is coupled to the frequency translator for determination of final output frequency range; and the 12, 13 and 14MHz outputs are sent to the step generator circuits for derivation of the frequency ranges.

The 100kHz spectrum output signal is applied to the two comb filter boards, Z102 and Z103. Circuits on these boards produce 12 precise output frequencies from 0.8 to 1.9MHz in 100kHz steps and apply them to the frequency switching network. These frequencies are generated by exciting corresponding crystal-filters at the appropriate harmonic of the 100kHz spectrum input.

The 8MHz basic signal is mixed with the selected mixing frequencies in mixer-divider boards Z104, Z105 and in mixer-final board Z106; the output signal from mixer-final Z106 establishes the four least significant digits of the output frequency and is applied to the translator board, Z112.

The step generator boards Z110, Z111 and Z113 contain mixer and multiplier circuits that derive the two most significant digit frequencies of the selected output frequency. Step generator board Z113 contains the 12MHz mixer circuits and the X2 multiplier circuits for the three frequency ranges. The three frequency ranges are combined in this board by a summing amplifier and coupled as the 104MHz to 132MHz to the translator Z112.

The carrier generator board Z109 receives a 1MHz standard input signal and divides this frequency by four to obtain a 250kHz basic subcarrier signal; this subcarrier is amplitude-modulated in AM mode of operation, is shifted in frequency by teletype mark and space modulation in FSK mode of operation, is applied to balanced modulators in the sideband generator board Z107 to derive upper and lower single-sideband signals and is applied to the frequency shift generator board Z108 for CW mode of operation and for carrier reinsertion when desired. The 250kHz is also multiplied by 11 on the carrier generator board to produce the 2.75MHz carrier which is applied to a mixer circuit in the frequency shift generator board. The 2.75MHz carrier is combined with the modulated 250kHz signal to produce an AM, a single-sideband (SSB) or independent sideband (ISB) output with a 3MHz center frequency.

The sideband generator board Z107 contains a microphone audio preamplifier and an audio impedance-matching transformer for translation of an external 600-ohm balanced or unbalanced audio line to a 500-ohm audio for application to the upper sideband (USB), lower sideband (LSB) and AM modulator circuits. Two balanced modulators produce the upper and/or lower sideband intelligence from the 250kHz signal subcarrier and the incoming USB and LSB audio signals; the 250kHz subcarrier is suppressed. The resulting USB and LSB signals are sent to the frequency shift generator board Z108.

The frequency shift generator board Z108 contains two circuit sections: the frequency shift generator section and the converter section. The frequency shift generator section provides either frequency shift keyer (FSK) or facsimile (FAX) modes of operation. The FSK mode applies the 250kHz subcarrier to the keyer modulator which also receives external teletype input via the FS Loop switch. The 250kHz subcarrier is modulated by the teletype current input producing a shift in frequency above and below the 250kHz center frequency representing marks and spaces. This shift is rectified and translated to a dc level which is then amplified and applied to the modulation input of the 3MHz voltage-controlled crystal oscillator (VXCO) which produces the required frequency shift above and below the 3MHz center frequency. The FAX mode connects an external FAX signal through a dc regulator circuit which produces a variable dc level at the input of the VXCO thereby producing the required frequency shift of the 3MHz center frequency output signal. The converter section of Z108 mixes the incoming 2.75MHz carrier signal with the selected modulation signal (250kHz AM, USB, LSB, ISB or CW from the carrier and sideband generator boards). The modulated 3MHz sum signal is amplified and sent as modulation to the translator board Z112.

The translator board Z112 contains an X3 multiplier circuit which produces a 120MHz frequency from the 40MHz basic signal and mixer circuits that mix the selected carrier frequency of the four least significant digits with the 3MHz modulator frequencies and mix the modulated sum frequency with the selected step generator frequency representing the two most significant digits of the selected carrier frequency. When the upper frequency range (20 - 29.9999MHz) is selected, a ground enable is applied to a filter in series with the rf signal from the RF OUTPUT control. Therefore, the rf signal is pre-filtered prior to being applied to rf output section Z115.

The rf output board Z115 amplifies the incoming rf carrier frequency and produces an automatic level dc voltage (ALDC) for feedback to the translator board Z112. The ALDC is used to control the rf output level. A metering circuit monitors the collector currents of the three amplifiers on rf output section Z115 and the rf output level of the selected frequency; these parameters are selected by a METER switch and displayed on the front panel MONITOR meter.

The MMX-2 is a direct reading device that displays all operating settings on the front panel. These include the functions of frequency, mode, carrier suppression, and RF output. All functions can be remotely controlled. No tuning or peaking is required when operating frequencies are selected. This exciter provides sufficient drive for any TMC transmitter system.

The MMX-2 is nomenclatured by the U.S. Military as MD-846/UR.

RF Amplifier

Two amplifiers are used to provide the 1KW PEP output: a Model HFL-100 intermediate and Model TMA-1K final. They are referred to as one unit in the following text.

The RF output from the exciter is nominally 100 milliwatts and is applied through an RF gain control to the grid of the first RF amplifier stage. This stage operates as a broadband class A amplifier providing an amplification of approximately five (5). The RF output at the plate of this stage is routed through a coupling network consisting of capacitors and a transformer to the input grid of the second amplifier stage.

The second amplifier also acts as a broadband class A amplifier providing additional amplification. Since both the first and second amplifiers are broadbanded, no resonate tuning to obtain output from the plate circuits is required. The output at the plate of the second amplifier is then coupled to the grid of the power amplifier (PA) stage.

The power amplifier operates as a class AB_1 amplifier providing 1,000 watts peak envelope power to a 50-ohm antenna or dummy load. The input power is coupled to the grid of the final tube. The PA output circuit consists of a bandswitch assembly, load capacitor assembly and tune capacitor assembly. The tune and load capacitors serve to match the output impedance of the 50-ohm antenna up to a maximum VSWR of 3:1. All tuning, bandswitching, and loading is accomplished in sequence and automatically. Tuning time is less than 15 seconds in the worse conditions. A harmonic filter Model TFP-1K is available as an option to further suppress second and higher order harmonics.

As the tuning sequences through the various stages, RF indicators located across the top level of the transmitter system monitor the performance of critical circuits. In particular the following levels are monitored:

- Plate Current Meter
  - First amplifier plate current
  - Second amplifier plate current
  - Power amplifier plate current
- PA Output Power Meter
  - Average PA output power in kilowatts

Power Distribution

The single-phase power supplies are self-contained in each section. Input terminals are provided at the rear of each compartment for application of power. Protective interlocks are used throughout the transmitter to prevent application of high voltage until specific requirements are met. Such safety precautions are designed into the system to prevent injury to personnel and damage to the transmitter. The interlock system is described in the Control section to this analysis.

AC power to the exciter is independent of the position of the main power breaker. This enables the primary frequency standard in the exciter to maintain its specified stability even when the power amplifier section is undergoing maintenance with no primary power applied.

The interlock system introduces a time delay when main power is first applied. This delay prevents the application of high voltage to the amplifier stages until the transmitter has warmed up. Such a delay increases tube life considerably and eliminates the effects of thermal shock to high power components.

Operating AC and DC voltages are derived from the high and low voltage supplies in the system. The plate and screen bias voltages in particular are full-wave bridge rectified and then fully filtered to remove residual ripple. Zener regulators provide constant voltages to the plate and screens of the amplifier stages. DC return for the supply voltages are through the screen circuit breaker for plate voltages; the screen overload circuit for screen voltages; and fuses for the bias and 24 VDC control voltages. During band changes, this control voltage is prevented from reaching the PTT switch by the bandswitch interlock system. The amplifier stages are thus kept at maximum bias, close to cutoff so that no RF power can be transferred through the switch contacts. This extends the useful life of the bandswitch and prevents inadvertent overload during band changes.

Control

Interlock and overload circuits provide protection for both operating personnel and equipment by preventing the application of any high voltage. Basically, the interlock/overload system is a series of switches located at strategic points throughout the transmitter system. Until all interlock switches are closed, no control voltage can be applied to the transmitter. Once all conditions are met, i.e., all interlocks mechanically closed and the time delay elapsed, the 24-volt control voltage is applied to the high voltage relay. If any interlocks open, such as might occur during excessive heat buildup or an inadvertent opening of a drawer or panel, the transmitter is automatically placed in an overload condition which prevents the application of high power. The high voltage switch must be depressed twice to restore high voltage once the fault is corrected.

The ALDC circuits (Automatic Load and Drive Control) provides negative feedback to the exciter to prevent excessive RF output. The ALDC threshold level can be adjusted by a potentiometer in the control drawer. The ALDC voltage is derived by sampling the RF output.

The PA bandswitch is also controlled by the application of 24 volts DC. By providing a ground to the bandswitch, AC voltages will be supplied to the PA bandswitch motor resulting in a stepping action of the bandswitch. While this indexing is taking place, the interlocks and relays prevent application of high voltage. The transmitter is thereby biased at or close to cut-off.

OPERATING PROCEDURES

Normal Conditions

Each TMC transmitter system consists of an exciter and a high power linear amplifier as a minimum. The method of tuning each system can be by manual adjustment or automated adjustment. At any time, the transmitter can be controlled locally - even with remotely controlled, automated systems - since all are equipped with a manual override feature. The next paragraphs outline the operations required for tuning the transmitter by manual/local control; automated/local control; or automated/remote control.

TMC transmitters are designed to operate continuously, 24 hours per day, and should be placed in a stand-by (high voltage OFF) condition when not in use. As a consequence of this, TMC transmitter systems do not normally have motor-driven main power breakers. To prevent damage to the transmitter system, all connections from the power mains to ground and to the antenna system should be inspected prior to the application of power. Once an operator verifies that all is in order and RF properly routed through patch panels to a load, the main power and screen breakers should be placed in the ON position and the aural alarm turned OFF. The transmitter requires a few minutes to warm up before high voltage can be applied. When the interlock indicates all operating conditions are met, the transmitter is in a STANDBY condition, ready for the application of high voltage and keying information. A visual inspection of the transmitter system can also be made by the operator to verify that indicator lamps operate properly and overload needles are set to proper values.

Manual tuning of the transmitter by local control is accomplished as follows:

1) Optional preliminary check for quiescent operation
   a) Set exciter output to minimum
   b) Index bandswitch to verify operation
   c) Press high voltage ON
   d) Check PA PLATE meter for 160ma approximate

2) Reduce RF gain control to minimum and select operating frequency, operating mode, and carrier suppression level on exciter. Increase exciter drive to 100 mv approximate

3) Select proper band by indexing bandswitch

4) Increase RF GAIN for indication on PA meter

5) Adjust PA TUNE control for a current peak on the PA PLATE current meter.

6) Rotate PA TUNE control for a resonant on the PA PLATE current meter.

Automated tuning of the GPT-1K series is accomplished with a servo system *controlled by a processor. Tuning time is nominally five seconds from the application of high voltage with a maximum limit of 15 seconds in the worse condition. The exciter operating frequency acts to pre-position the bandswitch as the front panel switches are either manually rotated or DC switched from a remote location (See Transmitter Remote Control Systems). Carrier suppression and operating mode are similarly selected but have no effect on the automated tuning of the transmitter. Once all exciter functions have been selected, the automated tuning sequence can begin.

Automated tuning, whether controlled locally or remotely, is initiated by the application of high voltage at the main control panel. This causes the PA servo amplifier to go into a "search" mode while adjusting the tune level control to the RF drive at which the transmitter will auto tune. The PA tuning capacitor begins turning as RF voltage is developed at the plate of the PA output tube. The first two class A amplifiers are broadbanded and require no tuning to develop the necessary RF level to drive the PA. When sufficient RF is developed at the PA plate, a plate trigger will cause the tuning sequence to begin. A DC correction voltage fine tunes the PA by comparing the phase relationship between the grid and plate circuits. As resonance is approached, the correction voltage drops to zero and the load capacitor, previously held at minimum, is adjusted for correct loading. At the point of correct loading, a relay is latched and the RF drive adjusted to 1KW average power. The transmitter now indicates a "READY" condition and the servo system is placed in a quiescent condition.

If a fault occurs in the tuning sequence, the sequence will halt for 30 seconds and then go into a "FAULT" condition, biasing the transmitter off. The sequence is reactivated by depressing the high voltage switch twice.

*The GPT-1KC is a channelized transmitter. No servo system is used since each channel is pre-set to a specific frequency of operation. Tuning is completed in under 0.5 seconds.

Emergency Conditions

The probability of line or copy failure in the transmitter system is extremely small as is failure of the servo tuning mechanism. However, should there be a failure, all functions of the transmitter can be controlled from the front panel, locally, by the on-site operator. The transmitter system as previously discussed, is designed to protect itself first by kicking down if the malfunction could cause electrical or mechanical damage. This protection occurs for such conditions as loss of a primary power phase, excessive heat buildup in the final amplifier, overload at the output, or accessing the transmitter when it is in operation. No damage can occur if the exciter output is lost. By manual override of all functions, the transmitter can be returned to full operation in a matter of minutes.

TMC transmitters also consist of interchangeable building blocks. One exciter works equally well in any transmitter system. This feature of commonality of units and compatibility between systems reduces the threat posed by failure of any one sub-system. By interchanging assemblies or complete sub-systems, an emergency condition can be handled with ease.

Maintenance Conditions

The GPT-1K transmitter system is designed so that maintenance can be performed in place without moving equipment. A qualified technician can isolate any malfunction and correct it while the transmitter is in an operating test condition. This can take place only if the transmitter system interlocks are overridden mechanically by the technician. Access to the transmitter is through the front panel. The functional drawers, including exciter, are on track slides which enable complete, unrestricted access to the transmitter when fully extended. Monitor jacks and input/output terminal strips are provided in convenient locations if it becomes necessary to check out the system with an external exciter or an external programmer. Routing of the transmitter RF output to a dummy load gives an added benefit in enabling full test of the transmitter system at fully rated output without radiating power. Troubleshooting is covered in the next section.

MAINTAINABILITY

Technical Manual

TMC technical manuals perform an important function in successfully maintaining GPT-1K transmitter systems. As a minimum, each manual consists of seven sections:

1) General Information
2) Installation
3) Operating Procedures
4) Principles of Operation
5) Maintenance and Troubleshooting
6) Replacement Parts
7) Drawings and Schematics

This breakdown simplifies the maintenance function by providing a ready reference for both operator and technician. Each manual is based on the actual equipment supplied and is updated by addenda sheets as changes in design occur. The manual can also be used as a training guide and as a reference for the ordering of spare parts.

Preventive Maintenance

A key factor in the successful operation of this transmitter system is the degree to which preventive maintenance is performed. Dust, dirt or other destructive elements can cause the equipment to fail if conditions are allowed to continue over an extended period of time.

At periodic intervals, the equipment should be pulled out on its slides for internal cleaning and inspection. The wiring and all components should be visually inspected for accumulations of dirt, dust, corrosion, grease and other harmful substances. Removal of these elements by dusting or treating with a solvent is essential to extending the useful life of the equipment.

Troubleshooting and Repair (MTTR)

An important feature of the TMC transmitter system is the number of front panel indicators visible to the operator. Virtually all critical circuits are monitored by meters or lamps. The use of these indicators simplifies the troubleshooting process by directing attention to a specific area. Corrective action can then be taken immediately with a minimum of down time.

The technical manual also assists in troubleshooting by devoting attention to fault indications, to probable causes, and to suggested remedies.

Extender cards are provided for all printed circuit boards so that test points can easily be accessed by the technician. In addition, adjustment controls for automated tuning, overload, output, bias and

ALDC are brought out to the front panel for ease of access by the technicians. All test points and adjustment controls are normally covered to protect both the operator and the equipment.

All low power circuits are mounted on removeable circuit cards mounted on slide-retainers. The higher power circuits up through the final amplifier section are composed of a series of interlocking assemblies that can easily be removed from the main frame. The final tube can be removed with ease from its socket. Test points are located in full view of the technician at specific locations throughout the system. These test points are clearly shown on technical manual schematics.

The Mean-Time-To-Repair (MTTR) is nominally fifteen (15) minutes for the entire transmitter system and is based on actual test times taken in the engineering laboratory under operating conditions. This MTTR figure will vary depending on the degree of the failure and the availability of spare parts. Interchangeable assemblies can be used to reduce MTTR further.

RELIABILITY

Equipment and Circuit Design

Designed into all TMC products is quality. From the time a circuit is first sketched on a drafting table, meticulous attention is given to minimizing the number and density of components while maximizing the functions performed. Whenever possible, solid-state components including large scale integrated (LSI) circuits are used. All of the modern TMC equipment is solid state except for the final tube circuits in the higher power linear amplifiers (1KW and above). This includes such sub-systems as the exciter, driver amplifiers, power supplies, and control circuits as well as such accessory equipment as frequency shift keyers and test generators. Maximizing the use of solid state components increases overall reliability by reducing the number of components needed to perform a given function and reducing the power requirement (stress) on the system. This improvement in reliability is reflected in a higher MTBF value (see below). Costs also decrease as the overall reliability improves since downtime, maintenance and the requirement for spare parts are all reduced. With each proven advance in modern technology, TMC modifies its designs to reduce cost and improve reliability while maintaining compatibility with older systems. Consequently, the reliability of TMC equipment, already well-known, improves with age as modern technologies are incorporated in designs. This attention to designing reliability into its transmitter systems is one reason why TMC equipment is selected more often to perform the most demanding jobs.

The reliability of electronic equipment is defined as the probability the equipment will perform properly for a desired length of time under the conditions (operational and environmental) for which it is designed. There are basic assumptions which underlie the construction of a mathematical model to be used to predict the reliability of equipment:

(1) Part failure rates are constant;
(2) Probability of part survival or part reliability follows a Poisson or exponential distribution;
(3) Parts within a particular equipment or the equipment within a particular system have a series relationship. That is, each part or each equipment must operate properly so that the function for which they are used can be performed.

Mathematically, the reliability of an item of equipment or a complete system is a function of the sum of the failure rates of the parts constituting the equipment or the equipment constituting the system. Normally, failure rates can be predicted for specific parts. However, for equipment in systems, failure rates are less precise since the time interval for which the equipment reliability is being determined is usually not well defined. Mean-Time-Between-Failure (MTBF) is used in this latter case and is equal to the reciprocal of the failure rate for the equipment.

The following steps were taken to calculate the reliability and the MTBF of the transmitter system:

(A) A list of all parts used in the design of the transmitter was compiled from material lists stored on magnetic disks on an IBM computer system.

(B) The failure rate of each part was determined using MIL-HDBK-217 Reliability Stress and Failure Rate Data for Electronic Equipment. In the case of equipment for which adequate test time was not available, a list of components with typically average failure rates was used. This list appears at the end of this Section.

(C) The predicted failure rate of each part was recorded on a magnetic disk. The summation of these failure rates yielded the failure rate for the entire equipment.

(D) The MTBF was then calculated by taking the reciprocal of the summation of the failure rates. Since the transmitter system has been operating well over 10,000 hours in the field, failure rates were calculated by computer and then modified to reflect actual performance.

The data for MTBF on the GPT-1K transmitter system was derived from actual installations in the following areas:

Ottawa, Canada	Government of Canada
Quito, Ecuador	Government of Ecuador/Navy
Baghdad, Iraq	Government of Canada/External Affairs
Santiago, Chile	Government of Chile
Sanai Peninsula	United Nations

Experienced over a period of 1,000 to 10,000 hours after acceptance, the transmitter average failure rates in terms of percent per 100,000 hours of operation is 0.28 including tubes. Without tubes, the failure rate reduced to 0.26. The calculated MTBF is 3571 hours with tubes and 3846 hours without tubes. Calculated from a computer analysis of the transmitter system using known stress values, the MTBF becomes:

3380 hours with tubes
3664 hours without tubes

TYPICAL AVERAGE FAILURE RATES*

Components	Estimated Failure Rates % per 100,000 Hours of Operation
Capacitors (general purpose)	0.01 - 0.6
Capacitors (electrolytic)	0.02 - 2.0
Crystal diodes	0.05
RF inductors	0.05
Integrated circuits	0.1
Meters	0.2
Motor/generators	0.04
Potentiometers	0.3
Relays	0.001 - 0.5
Resistors, fixed	0.01 - 0.3
Switches	0.01 - 0.1
Transformers	0.05 - 2.0
Transistors	0.2
Tubes (receiver types)	1.0 - 2.0
Tubes (high power, transmitting)	1.0 - 20.0
Soldered joints (dipped)	0.0001
Wrapped joints	less than 0.0001

*Based on actual performance from TMC field engineering and maintenance records

The difference in values can be attributed to the type of service the transmitter system is used in. The computer analysis assume 24-hour per day operation at fully rated loads under severe environmental conditions. In actual fact, transmitter systems are routinely shut down for periodic maintenance such as cleaning and minor adjustment. This procedure serves to extend the useful life of the system.

Two important factors further affect MTBF values: (1) the age of the equipment, and (2) the degree of preventive maintenance. TMC has found through experience that new equipment (less than one year operating) and old equipment (greater than seven years operating) have more failures than normal for a given period of time. The "burning in" of new parts and the normal wear of old parts are the primary factors which contribute to this condition. Once corrected, the system gives extremely reliable service particularly if the basic preventive maintenance procedures are conscientiously followed throughout the 20-year life of the equipment.

Frequency Display

The operating frequency of the transmitter is displayed on the exciter for local operation and on a panel-mounted unit for remote operation. Readback displays are installed in the programming console at the remote site for status indications.

Tuning

The GPT-1KE and GPT-1KJ automated transmitters use a true servo-tuning system that samples the RF from the exciter and tunes at low power until the resonance point is reached at the precise selected frequency. Bandswitch information is provided to the amplifier from the exciter's synthesizer. The tuning cycle is nominally five seconds and less than 15 seconds from initiation of the tune sequence. A front panel switch on the main control panel allows the operator to assume complete manual control (override) of the transmitter. Tuning sequence is initiated automatically by depressing the high voltage switch locally or remotely.

The GPT-1KC transmitters are pre-tuned to the operating frequencies of the channels selected. Switching is completed within 500 milli-seconds.

Remote Operation

Facilities for remote control of all transmitter functions are provided with each system. In addition, remote programmers can be set up locally to check out the remote control system. This technique is referred to as extended control. Revertive checking of all transmitter functions under remote control is initiated at the programmer by interrogating each transmitter system. Continuous, free-running check can be provided on request. All functions are controlled over a 75-baud channel. For Model GPT-1KE and GPT-1KC specify RCMT-1 Control System. For Model GPT-1KJ, specify RCST-1 Control Systems.

Spurious Signals

Spurious radiation is a minimum of 50db dwon from full PEP output.

Intermodulation Distortion

Signal to distortion is a minimum of 30db below full PEP output.

Residual Noise and Hum

Minimum 50db down from fully rated PEP output.

Carrier Insertion

Model GPT-1KJ enable front panel selection at 0db, -3db, -6db, -20db, -30db and -55db (full suppression). If the AME mode is

selected, the carrier is automatically suppressed -6db regardless of the position selected for carrier suppression.
Model GPT-1KE and GPT-1KC provide continuous adjustment to -55db.

Harmonic Suppression

Using the optional TFP-1K Harmonic Filter Unit, second and higher order harmonics are suppressed a minimum of 60db below fully rated PEP output. Second harmonics are suppressed 45db and higher harmonics 50db minimum without the TFP-1K.

Audio Input

1) Two independent 600-ohm channels balanced or unbalanced, -20dbm to +5dbm.
2) Built-in microphone preamplifier for low-level dynamic microphone.

Automatic Load and Drive Control (ALDC)

Accepts approximately -11 volts DC from linear amplifier to improve linearity, limit distortion and deliver a relatively constant output level during high modulation peaks or load changes.

Monitoring and Metering

Built-in multi-meters permit monitoring of exciter output, PA output and plate current for PA stages. VU meter on exciter providing indication of channel input levels. Indicating fuse holders are used for all low voltage supplies, blower, and tube filaments. Audible alarm is used in case of high voltage failure. Jacks on the front panel of the exciter can be used for audio test monitoring of each channel. Lamps for interlocks, fault, high voltage, ready and bandswitch position are positioned on the main control and PA sections.

Squelch and VOX

Voice operated relay (VOX) control on each channel reactivates channel when audio input exceeds -25dbm. (Optional with GPT-1KJ)

Cooling

Filtered forced air in a semi-pressurized cabinet is used for cooling. Internal fans are used to improve cooling within the cabinet. The air intake is across the bottom front of the cabinet with the exhaust ports at the top rear of the cabinet opposite the output coupler. Airflow requirements do not exceed 300 cfm at 60Hz operation.

as requested. Input is 60ma, 20ma, 50 volts, 100 volts either positive or negative with respect to ground.

**FAX	-	Facsimile with +1 to +10 VDC variation providing a linear shift of 800Hz.	F4
AFSK	-	Audio frequency shift keying (See FSK) NOTE: Model GPT-1KJ uses external tone keyer Model TIS-3D.	A7J
AFAX	-	Audio frequency shift facsimile (See FAX) NOTE: Model GPT-1KJ uses external audio tone keyer Model TIS-3D.	A7J

* Model GPT-1KE and GPT-1KC
** Model GPT-1KJ only.

Power Output

The transmitter system provides 1,000 watts peak envelope power and 500 watts average power output.

Output Impedance

The output terminal is located at the top rear of the PA drawer. The output is designed to match a 50-ohm load at a VSWR up to 3:1. The VSWR rating can be adjusted by front panel control before an overload condition is met. Normal setting is 2:1.

Frequency Stability and Control

Models GPT-1KE and GPT-1KC:

The exciter derives its primary frequency from an internal standard oscillator. Power is always supplied to the standard, even with the transmitter main breaker OFF, to assure a constant frequency is maintained at all times within close tolerances. Short term stability using the internal standard is one part in 10^6 per day; long term is less than five parts in 10^6 per week.

Model GPT-1KJ:

The synthesizer derives its primary frequency directly from an internal 1MHz standard oscillator. Power is always supplied to the standard, even with the transmitter main breaker OFF, to assure a constant frequency is maintained at all times within close tolerances. Short term stability using the internal standard is one part in 10^8 per day; long term is less than five parts in 10^8 per month. Using an optional standard, short term stability is one part in 10^9 per day; long term is less than ten parts in 10^9 per month. All output frequencies generated are phase-locked to the internal frequency standard.

TECHNICAL SPECIFICATIONS

The GPT-1K transmitter is an integrated system consisting of an exciter and amplifier. The electrical and mechanical specifications change only if accessory equipment is added to modify these characteristics. The following are system specifications for the GPT-1K.

Frequency Range

The operating frequency range of the transmitter is 2.0 to 30MHz. Frequency selection is as follows:

1) Model GPT-1KC:
Four pre-set channels are provided, selectable at the front panel of the exciter.

2) Model GPT-1KE:
Eight pre-set channels are provided, each selectable at the front panel by an indexed, rotary switch.

3) Model GPT-1KJ:
Full frequency coverage in 100Hz synthesized increments, selectable at the front panel by six indexed, rotary switches. Operating frequencies are derived directly from an internal standard and are displayed directly on the front panel.

Program push-buttons are used at remote sites for remotely controlled transmitters. All functions are DC switched in the exciter.

Operating Modes

The transmitter is capable of operating in the following modes, selectable at the front panel of the exciter or by program push-buttons at a remote site. DC switching techniques are used throughout.

CW	-	Key jack on the exciter front panel and terminals on the rear apron allow up to 300 WPM carrier keying, dry contact.	A1
*MCW	-	Modulated CW	A2H
**AM	-	Amplitude Modulation (DSB)	A3
AME	-	Compatible Amplitude Modulation	A3H
USB	-	Upper sideband 250-3040Hz, ±1.5db	A3A, A3J
LSB	-	Lower sideband 250-3040Hz, ±1.5db	A3A, A3J
ISB	-	Independent sideband (USB and LSB) Two-channel with SSB response as above	A3B
		NOTE: Additional SSB bandwidths and response characteristics, including equalized filters, are available on request.	
**FSK	-	Frequency shift keying at speeds up to 75 baud with a shift of ±425Hz or others	F1

Primary Power

The transmitter is designed for 230 volt ±10%, 50 or 60Hz, 1-phase primary power operation. Total power requirement is conservatively rated at 2.5KW for SSB operation and 1.5KW for CW, FSK or FAX operation. Power supplies are solid state throughout.

Size and Weight

The transmitter without optional accessories weighs less than 400 pounds (182 kg) installed and occupies an area less than 4 square feet. The floor loading is 100 pounds per square foot. The overall transmitter dimensions, including a 3" raised base are:

49" high* x 23" wide x 26" deep
125cm high x 58cm wide x 66cm deep

*Note: Includes rack space for adding accessory equipment.

Protection

The linear amplifier is completely interlocked and all hazardous voltages protected by cover plates. Access to the main frame cannot be made without tripping the high voltage breaker. Indicators on the front panel and signs on the cabinet warn the operator of the presence of high voltage. In addition, straps on the supply leads to the high voltage breaker can be disconnected to prevent use of the transmitter. Both load sense and power line sense circuits are incorporated in the design to prevent damage to the transmitter. These sense circuits are capable of detecting high VSWR, line failure, or intermittents. If the transmitter is in danger it will either remove high voltage from the system or trip the main power breaker. When the high voltage switch is activated, a red lamp indicates application of high voltage. The synthesizer is well-protected by fuses and utilizes cover plates for protection of operators and technicians.

Acoustic Noise

Using the TMC standard for measuring acoustic noise where residual noise is a factor, the level is nominally less than 60db down at 2 feet from the cabinet on any side. This assumes a completely "buttoned-up" transmitter with all external panels securely fastened and in place. Air intake and exhaust ducted to outside of transmitter room.

Environmental

Operates continuously in any ambient between $0^{o}C$ and $+50^{o}C$ at any value of humidity up to 90%. Will not be materially affected if stored between $-30^{o}C$ to $+85^{o}C$ at any value of humidity up to 90%.

TEST EQUIPMENT AND SPECIAL TOOLS

The GPT-1K series of transmitters normally do not require special tools or test equipment for operation. Installation and maintenance personnel on site may wish to supplement the station test equipment with the following equipment manufactured by TMC:

Model PTE-4	RF Spectrum Analyzer
Model TTG-2	Two-Tone Test Generator

These two units are used to troubleshoot and test any transmitter system, whether or not supplied by TMC. In addition, operating stations should be equipped with the following:

Series TER-2.5K	Antenna Terminator/Dummy Load

As its name implies, the TER-2.5K is used as the load for the transmitter system when operating under maintenance conditions. The terminator is capable of dissipating over 1,000 watts of RF power and is very useful when working into an antenna system is impractical.

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REPLACEMENT PARTS

TMC will support the equipment proposed with replacement parts as required for a period of 10 years after installation. If exact duplicates are not available, TMC will provide the equivalent part that will equal or better the characteristics of the original part. Replacement parts can be furnished on a component basis, sub-assembly basis, or a combination of both. The normal warranty of 12 months will apply to all replacement parts supplied by TMC (excludes tubes, fuses, semi-conductors, and other fragile materials).

The parts lists contained on the next pages represent those parts recommended by TMC as spares for the transmitter systems. The recommended parts cover two years operation of the equipment under normal conditions. Fire-up or interim spare parts are included in this list.

ITEM	QTY PER UNIT	TMC PART NUMBER	DESCRIPTION	TOTAL QTY	QTY REQUIRED
1	2	B1101-1820	LAMP,INCANDESCENT	2	6
2	2	B1105-1	LAMP,INCANDESCENT	2	6
3	1	B1110-10	LAMP,INCANDESCENT	1	3
4	6	B1110-7	LAMP,INCANDESCENT	6	18
5	13	B1114-2	LAMP,INCANDESCENT	13	39
6	2	BL106-2	FAN,AXIAL	2	2
7	1	BL134	FAN,CENTRIFUGAL	1	1
8	390	CC100-29	CAPACITOR,FIXED,CERAMIC	390	1
9	22	CE105-10-25	CAPACITOR,ELECTROLYTIC	22	1
10	14	DC139	SEMICONDUCTOR DEVICE,SET	14	1
11	8	DC140	RECTIFIER,SCOND DEVICE	8	1
12	1	FU100-4	FUSE,CARTRIDGE	1	2
13	3	FU102-0.200	FUSE,CARTRIDGE	3	6
14	7	FU102-0.500	FUSE,CARTRIDGE	7	14
15	2	FU102-0.750	FUSE,CARTRIDGE	2	4
16	5	FU102-1	FUSE,CARTRIDGE	5	10
17	2	FU102-1.5	FUSE,CARTRIDGE	2	4
18	1	FU102-2	FUSE,CARTRIDGE	1	2
19	1	FU102-2.5	FUSE,CARTRIDGE	1	2
20	1	NW134	MICROCIRCUIT,DIGITAL	1	1
21	1	NW135	MICROCIRCUIT,DIGITAL	1	1
22	2	NW136	MICROCIRCUIT,DIGITAL	2	3
23	1	NW137	MICROCIRCUIT,DIGITAL	1	1
24	3	NW156	MICROCIRCUIT,LINEAR	3	5
25	1	NW163	MICROCIRCUIT,DIGITAL	1	1
26	1	NW176	MICROCIRCUIT,DIGITAL	1	1
27	6	RL143-40	RELAY,ARMATURE	6	1
28	10	RL156-15	RELAY,ARMATURE	10	1
29	1	TS153-11	INDICATOR,LAMP,MINIATURE	1	3
30	12	1N541	DIODE,GERMANIUM	12	1
31	156	2N3646	TRANSISTOR,SILICON,NPN	156	5
32	1	4CX350A	ELECTRON TUBE	1	1
33	1	8233	ELECTRON TUBE	1	1
34	1	85767264	ELECTRON TUBE	1	1