HELPER INSTRUMENTS COMPANY

SM1000 OPERATOR INSTRUCTIONS

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Serial # 8194

SM1000 OPERATOR INSTRUCTIONS

CAUTION

Before connecting the SM1000 to a power source, be certain that it is set for the proper supply voltage. The rear panel of the SM1000 has a power cord receptacle that permits use on either 120 or 240 VAC, 50/60Hz supplies. A printed circuit card can be viewed through the plastic window of the receptacle. When this card is inserted for 120 or 240VAC operation, the label "120" or "240 is visible.

See Page 15 for information on changing voltage of operation. Do not drive more than 100 watts of power into the transceiver port. To avoid damaging the power pad in the transceiver port observe the following time limits for power into the transceiver port:

Power	On Time	Off time
100 Watts	30 Seconds	2 Minutes
50 watts	1 minute	2 Minutes
25 watts	2 minutes	2 Minutes
10 watts	Continuous.	

Do not exceed the time limits given above. There is no warning when the limits are exceeded.

If the LEVEL control is in the X1 (i.e.. the maximum clockwise condition) when a high power transmitter is delivering power into the TRANSCEIVER port, unnecessary strain is placed on the output stage of the GENerate system. Make a habit of never leaving this control in the X1 position.

CAUTION

Do NOT connect any transmitter to the "RF IN" port. SERIOUS DAMAGE CAN RESULT. This port is used to connect a receiving antenna for monitoring signals from nearby and distant transmitters.

Transmitters and transceivers should be connected to the TRANSCEIVER port, located at the lower left hand corner of the SM1000.

Power line interruptions of just the right duration can lock up the microprocessor. Under this condition, the frequency display looks normal, but none of the entry keys will function. To restore proper operation, turn the power switch off for a second and return it to the power on position.

CONTROLS AND THEIR FUNCTIONS

POWER SWITCH	OFF position	In this position, the instrument is inoperative, except for battery charging, and the crystal oven which continue as long as the power cord is connected to the AC power source, OR, a suitable battery is connected to the external battery port.
	AC position	Instrument operates from AC power if the AC power cord is connected. Instrument operates from external battery if ex- external battery is connected.
	BAT. position	Instrument operates from its Internal Battery. About 45 minutes of operation is available from a fully charged battery.
POWER LIGHT (red)		Lights when instrument is operated. Dims and finally goes out if battery voltage is too low.
BATTERY CHARGE SWITCH	Fast	Battery is charged at a rate that will provide full charge in 10-14 hours.
	Slow	Battery is charged at a low, maintenance, rate.
GEN-MEAS	GEN (generate)	Places instrument in GENerate mode, to generate signals.
	MEAS (measure)	Places instrument in MEASure mode to measure incoming signals.

Notice that there is a center position between the GENerate and the MEASure positions. This position is used in testing full duplex transceivers, and is explained later.

10W - 100 W — Determines the scale range of the power meter for measurement of transmitter power. Although the 100 watt scale has markings for power levels below 10 watts, the 10 watt scale position should be used for measurements under 10 watts.

This switch has no function in the MEASure mode.

SET 0

Used to calibrate the /\F measurement circuits so the /\F meter indications will be correct. Adjustment of the SET 0 control is done when the SINAD-/\F control is in the /\F position. Push the SET 0 knob all the way in, and rotate the knob to obtain a zero (center scale) reading on the /\F meter. Avoid moving this control unless you are setting it.

/\ F Control

In the GENerate mode, the /\F control is used to set the desired offset (if any) between the generated frequency and the frequency indicated on the numerical readout. The amount of this offset is shown on the middle meter when the SINAD-/\F switch is in the /\F position. This control has no function in the MEASure mode.

1000 HZ MOD

Sets the amount of 1,000 Hz modulation applied to the GENerate signal. This control has no function on the MEASure mode.

TONE MOD

Sets the amount of modulation by the Variable Tone generator.

GEN OUTPUT LEVEL

The combined setting of these two controls sets the level of the RF signal generated in GENerate mode. The GEN OUTPUT control allows setting of any level from 1 to 10 microvolts, and this level can be read on the left hand meter when the instrument is in the GENerate mode. The LEVEL control allows 10X steps of the meter reading. For example, if the meter reads 5 microvolts, and the LEVEL control is set to the X.1 scale, the actual GENerate level is .5 microvolts.

SET FLASH

Sets the modulation level at which the peak modulation LEDs flash. The Set Flash control can be adjusted so the Red LED flashes when any desired modulation level is reached. Once the flash level for the Red LED is set, the Yellow LED will flash at 90% of that level. This permits rapid go-no-go setting of trans-transmitter modulation.

VOL

Adjusts the volume to the loudspeaker in the instrument.

SQUELCH

Used to silence the loudspeaker in the absence of signals when in the MEASure condition. Squelch does not function in the AM mode.

DISPLAY

Indicates the channel frequency and the channel storage number of the channel in use. If a tone frequency has been stored for the channel, the display will also display the tone frequency when in the GENerate condition. In the MEASure condition, the display will show the measured value of tone modulation on the received signal.

THE "TRANSCEIVER" AND "RF IN" PORTS

In normal testing of a transceiver, the transceiver coaxial antenna port is connected to the TRANSCEIVER port of the SM1000 with a suitable patch cable. Signals generated by the SM1000 are sent to the TRANSCEIVER port for testing of the receiver section of the transceiver under test. RF power generated by the transceiver under test enters the SM1000 at the TRANSCEIVER port, goes to the internal RF power measurement circuits, and the result is displayed on the left hand meter.

The signal for the frequency and modulation measurements circuits of the SM1000 are picked up by a small antenna connected to the "RF IN" port of the SM1000. For bench checking transceivers, a very small antenna, or no antenna at all, will suffice. For off-the-air checking of more distant transmitters, an appropriate antenna for the distance and frequency involved should be used.

NEVER connect the output of a transceiver or transmitter to the RF IN port of the SM1000. Serious damage may result.

CHANNEL FREQUENCY ENTRY

The SM1000 has the capability of remembering up to 50 radio channel frequencies, each with an associated tone frequency. Figure 1 shows the keyboard layout, and the functions of the various keys.

FIGURE 1

FREQUENCY ENTRY KEYBOARD

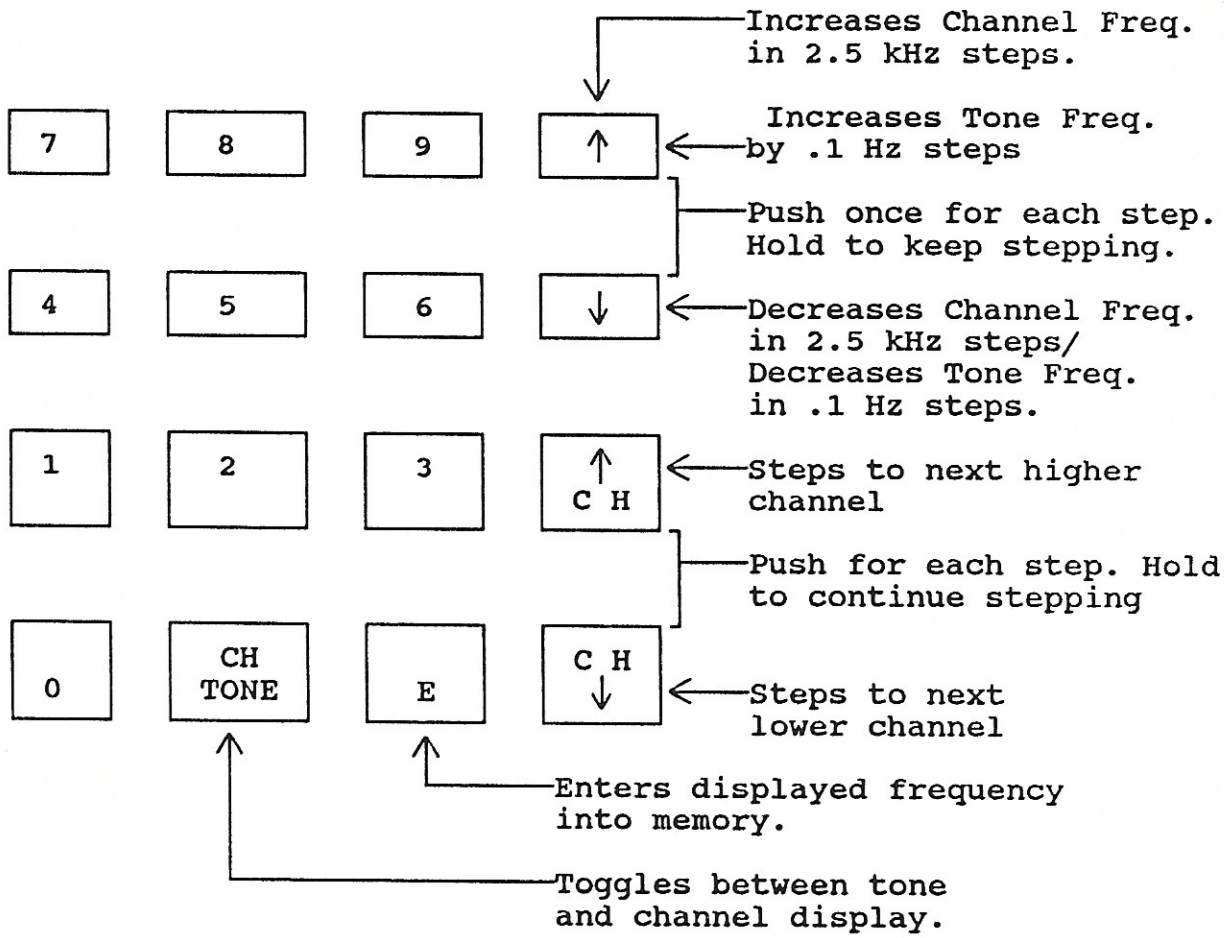
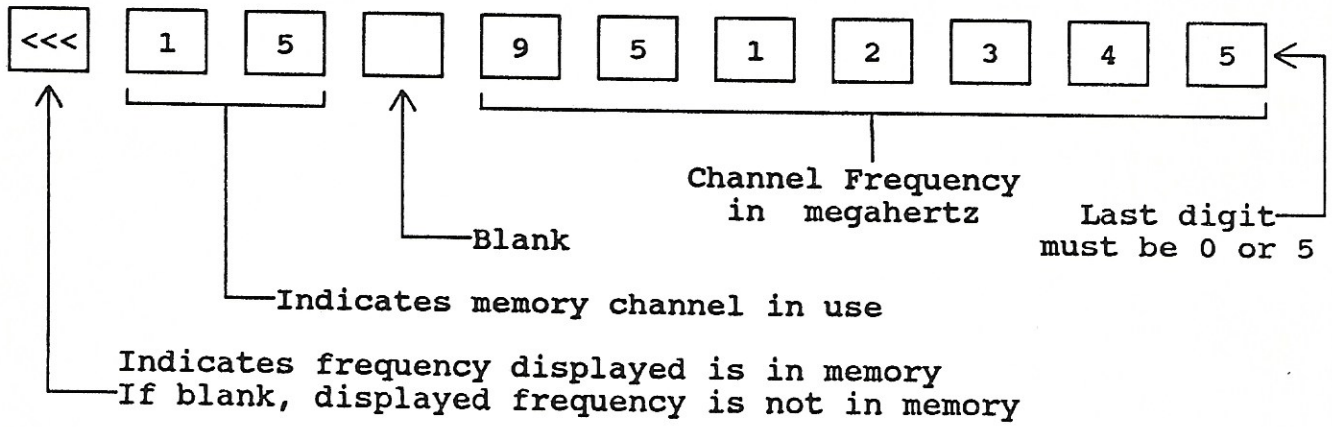


Figure 2 shows the display. Note that the display has two modes: a Channel Frequency mode, in which the channel frequency is displayed, 5, and a Tone Frequency mode, which displays the tone frequency associated with the channel. The Memory Channel number (1 through 50) is shown on both of the display modes. You can tell which mode the display is in by looking for the presence or absence of three dashes - - - following the Memory Channel number. Presence of these dashes indicates the Tone Frequency Mode.

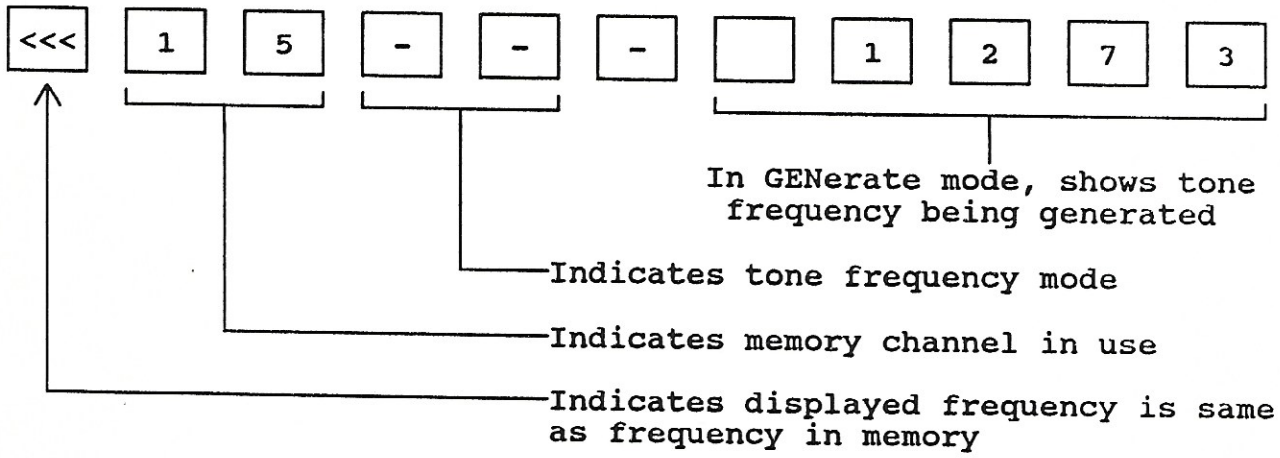
FIGURE 2

DISPLAY

CHANNEL FREQUENCY MODE



TONE FREQUENCY MODE



The last digit in the channel frequency readout is always a 0 or 5, and it is separated from the others by an additional decimal point. The two decimal points in the readout make it easy to express the frequency in terms of Megahertz or in terms of Kilohertz. If you use the first decimal point (the one to the left), the readout is in terms of Megahertz. If you use the second decimal point the readout is in terms of Kilohertz.

Channel frequency entry is quite simple, but rather difficult to describe. For that reason, we will go through the steps, using the following example:

> We want to set up memory channel # 18 for operation on 462.1375 MHz using a tone squelch frequency of 127.3 Hz.

TO BRING UP THE MEMORY CHANNEL:

PUSH [1] [8] [CH∧] or [1] [8] [CH∨].

You will then see the 18 toward the left of the display. If a frequency has already been entered in this channel, you will see it displayed. If not, you will see a series of 0s to the right of the display.

As an alternative, you can merely step to the channel by re-

repeatedly pushing [CH∧] or [CH∨]

TO ENTER THE CHANNEL FREQUENCY:

PUSH [4] [6] [2] [1] [3] [7] [5] [E]

Note that you do not have to enter the decimal points. Also, remember that the last digit must be either a 0 or a 5. If you make an error, simply push E and start over.

TO ENTER THE TONE FREQUENCY:

Put the instrument in the GENerate mode, using the GEN-MEAS switch.

PUSH CH\T once. There will be a short pause after which the channel frequency will leave the screen and three bars will appear to the right of the Memory Channel number. This indicates that the display is in the tone mode. If a tone frequency has been entered into this Memory Channel, it will be displayed.

PUSH [1] [2] [3] [7] [E]

The display should now be showing the numbers 123.7
NOTE: When the instrument is in the MEASure mode, the tone frequency that has been programmed for the GENerate mode will not be shown on the display. Instead, it will show the actual tone frequency of a received signal, as counted by the SM1000 tone counter. If you try to enter a tone while the monitor is in the MEASure mode, the instrument will not accept it.

OTHER FEATURES OF THE KEYBOARD AND DISPLAY

There are two ways to move to a desired Memory Channel: 1. Key in the number of the desired channel and push CH∨ or CH∧. (OR) 2. Repeatedly push CH∧ or CH∨ until you get to the channel you want.

You can move up and down around the entered Channel Frequency by pushing the /\ or the \/ key. Each push increases (or decreases) the channel frequency by 2.5 kHz. If you hold the key down, it will continuously step up or down at 2.5 kHz per step.

Similarly, you can move the tone frequency up and down from the frequency entered by going to the Tone Mode and pushing the /\ or the \/key. Each push of the key increases (or decreases) the channel frequency by one tenth of a Hertz. If you hold the key down, the tone frequency will continuously step up or down .1 Hz per step. Step to a memory channel which has a radio channel frequency entered in it. Notice the three hash marks in the upper left hand corner of the display. That indicates that the radio frequency shown on the display is the same as the one that was entered into the memory channel. Now increase the radio channel frequency by pushing the ^button once. Note that the three hash marks disappear, indicating that the frequency has been changed from the one entered into the Memory Channel. If you leave the memory channel and then return to it, the frequency will go back to the value that was duly entered into the memory. Thus, you can move up and down about the entered channel without disrupting the memory. The same feature operates with the tone mode display.

If you make an error and start to place a frequency into a memory channel, but do not want to disturb what has been entered into the channel, do NOT push the Enter button. Simply move up to the next memory channel by pushing CH /\ , then return to the wanted channel by pushing CH \/ .

TO GENERATE A TEST SIGNAL

1. Set the GEN-MEAS switch in the GENerate position.

2. Enter the desired radio channel and tone frequencies into the instrument keyboard as explained previously.

3. Set the /\F-SINAD switch to the /\F position.

4. While pushing inward on the SET 0 control knob, rotate the knob so that the top scale of the middle meter reads exactly zero. This centers the /\F metering circuitry and must be done accurately. Check this adjustment from time to time to see that the setting has not drifted.

5. Assuming that you wish to generate the exact frequency shown on the display, adjust the /\F control so that the top scale of M1 reads exactly zero.

If you want to generate a frequency slightly higher or lower than the one shown on the display, adjust /\F to the frequency difference between the wanted and displayed values. (example: Frequency shown on display 152.375.0, desired frequency 152.374.9. Set /\F control to show -100 Hz on the top scale of the middle meter)

6. Choose the type of modulation (AM, FM up to 6 kHz, FM up to 15 kHz) by means of the AM, 6kHz, 15kHz switch located under the right handmeter.

7. Set the modulation level: There are two controls for modulation level. The control labeled "1000 Hz MOD" sets the modulation from the 1,000 Hz precision internal tone source. The control labeled "TONE MOD" sets the modulation from the internal variable tone source. To observe the amount of modulation, put the "MOD-DENS" switch in the "MOD" position, and read the modulation level from the right hand meter.

When using the SM1000 with CTCSS systems, typical practice is to program the CTCSS tone into the tone segment of the Memory Channel. Then, set the "TONE MOD" control for about 800 Hz of deviation, and the "1000 Hz MOD" control to get a reading of about 3 KHz deviation.

If it is desired to modulate the signal with other sources, connect the source to the EXT MOD port on the front panel, and adjust the modulation level with the level control on the source generator.

AM modulation percentage is indicated by the lower scale of the right hand meter. This is a 0-10 scale. Multiply the scale reading by 10 to get percentage AM modulation. The AM-5Khz-15 Khz switch should be in the AM position and the MOD-DENSITY switch should be in the MOD position.

The waveshape of the generated AM envelope becomes distorted beyond 50% AM modulation. We sugtgest using the 30% modulation normally used in alignment and sensitivity measurement on AM receivers.

8. The "GEN OUTPUT" and "LEVEL" controls are used to obtain the wanted RF output amplitude. The "LEVEL" control is a stepped attenuator with 20 dB steps (i.e. 10 times voltage steps). The"GEN OUTPUT" control provides fine adjustment over a 10 times voltage range. When in the GENerate mode, the left hand meter reads a value in microvolts. Multiply this value by the multiplier shown on the "LEVEL" control to obtain the true output in microvolts.

In normal receiver testing, the "LEVEL" control will set to the X.1 step and adjustment of the "GEN OUTPUT" control will deliver RF output voltages from .1 to 1.0 microvolts, as shown on the left hand meter.

Note that one step of the "LEVEL" control is labeled with a "<" sign. This step allows signals below .1 microvolts to be obtained for certain high sensitivity receiver applications. Amplitude calibration for this step is only approximate.

9. The generated signal is available at the "TRANSCEIVER" port. Connect the transceiver or receiver to be tested there.

TO MEASURE A TRANSMITTER SIGNAL

1. If the transmitter is at a distance, connect a suitable pickup antenna to the RF IN port. For nearby transmitters the antenna supplied with the instrument will be satisfactory. DO NOT connect any transmitter output into the RF IN port. Serious damage could result.

2. Enter the desired channel into the instrument as shown earlier.

3. Set the"GEN-MEAS"switch to MEASure. This step is not necessary if the transmitter is connected to the "TRANSCEIVER" port. Any power level above about .1 watt going into the "TRANSCEIVER" port is sensed by the instrument and switches the circuits to the MEASure condition.

4. Set the /\F-SINAD switch to the /\F position.

5. While pushing inward on the SET 0 control knob, rotate the knob so that the top scale of the middle meter reads exactly zero, and carefully release the knob. Check this adjustment from time to time to see that the setting has not drifted.

NOTE: The adjustment of the SET 0 control is always done while /\F-SINAD switch is in the /\F position.

6. Select the appropriate modulation system using the AM-6kHz-15kHz.

7. If a transmitter has been connected to the TRANSCEIVER port, select the appropriate power setting of the 10W-100W switch (located under the left hand meter).

8. The SM1000 is now set to measure all three of the important parameters of the transmitter being checked:

Power of the transmitter (if connected to the TRANSCEIVER port) will be shown on the left hand meter. Note: For best accuracy of the power reading, the LEVEL control should NOT be in the X1000 position.

Frequency error from center channel (the channel shown on the channel frequency readout) will be shown on the middle meter. Modulation will be shown on the right hand meter.

If CTCSS is being used, the CTCSS tone frequency count will be shown on the TONE mode of the display. Read the following section on the Tone Generation and Measurement system.

TONE GENERATION AND MEASUREMENT SYSTEM:

The tone generation and measurement system of the SM1000 includes two tone generators. The 1,000 Hz generator is a precision frequency generator, derived from the instrument's basic frequency standard, and thus having the same accuracy. The variable frequency oscillator provides synthesized tones at .1 Hz increments up to 999.9 Hz and with 1 Hz increments up to 6000 Hz. Frequency of the variable frequency generator is determined when the operator programs a tone frequency into the TONE frequency mode of the keyboard-display section. (see Fig. 2). This tone generator functions only when the instrument is in the GENerate mode.

When the instrument is in the MEASure mode, an internal circuit counts the frequency of any audio modulation on the received signal. The major use of this function is to count CTCSS tones to be sure they are within tolerance. The SM1000 incorporates a 250 Hz low pass filter to facilitate the accurate counting of CTCSS tones. However, this filter must not be in the circuit when measuring tones at frequencies above 250 Hz.

How does the instrument "know" whether the low pass filter is to be used? When the tone frequency for the GENerate mode is entered into the TONE mode of the Memory Channel, the instrument determines whether the entered tone is below 250 Hz, and if so, switches in the low pass filter whenever the memory channel is chosen. In the event that you are programming for a channel where there is no need to generate a tone, but have reason to measure one, be sure to program the tone into the GENerate mode anyway, so the low pass filter will be properly selected.

If you are attempting to measure a CTCSS tone, it is imperative that you have entered a low frequency tone (any tone less than 250 HZ) into the TONE mode of the memory channel. This entry must be made while the SM1000 is switched to the GENerate mode. Then change to the MEAsure mode to count the tone. If you fail to make this entry, the low pass filter will not be activated, and noise will cause the tone count to be unsteady and unreliable.

When making measurements of CTCSS tones, a tone deviation of at least 500 Hz is required. The typical CTCSS setting of 750 Hz gives a very stable count. If the signal is heavily modulated by speech, especially from a low male voice, it will be necessary to wait for a break in the voice transmissions to get your reading.

PEAK DEVIATION FLASHERS

The peak deviation flashers are a major feature of the SM1000. They enable rapid setting of modulation levels. They avoid searching for peaks on a 'scope and catch peaks that are too fast for a meter to display properly.

Use the meter primarily for the measurement of steady signals such as tones and data. The peak flashing LEDs register voice peaks that are too short in duration for the meter to follow, and they should be used for setting modulation levels on speech signals.

The flashers must be set to the appropriate level for the type of system involved. In typical FM, 5 kHz deviation, systems, the flashers should be set so the red LED flashes a 5 kHz. The Yellow LED will then flash at 90% of that value, or 4.5 kHz.

To set the flasher level: Set the SM1000 to the GENerate mode. put the MOD-DENS switch in the MOD position. Put the AM-6kHz-15kHz switch in the appropriate position. Adjust the 1000Hz MOD control until the right hand meter shows the desired maximum peak deviation for the system involved. Then adjust the SET FLASH control to the threshold where the red LED just begins to light. The Yellow LED will then operate at 90% of the peak value.

With the flashers thus set, you can quickly adjust the modulation adjustment on any transmitter so the Yellow LED flashes consistently and the Red LED does not flash. (The transmitter must have sufficient audio input to be operating its speech limiters properly or the setting will not be correct.)

The modulation of FM transmitters is not necessarily symmetrical. That is, positive modulation peaks may be greater or less than the negative going peaks. For proper system operation, neither of the peaks should exceed the system maximum. (5 kHz for most systems). The AUTOPEAK (tm) circuits in the SM1000 measures both the positive and negative peaks and presents the greater value on the meter and on the flashers.
For accurate modulation deviation measurements, you must have a signal strong enough to be noise free. Otherwise noise peaks will add to the peaks caused by modulation and give an improperly high reading.

When bench testing and making modulation measurements on AM transmitters, avoid overload of the AM monitor circuits by using only enough pick up antenna at the RF IN port to assure a noise-free signal. In most cases, no antenna will be needed.

MEASURING MODULATION DENSITY

For simplicity, we will describe the procedure for measuring Modulation Density on the typical systems which use 5 kHz maximum peak deviation:

First, be sure that the transmitter is being modulated normally, as indicated by frequent flashing of the Yellow LED (4.5 kHz) and no flashing of the Red LED (5 kHz). Then, switch the MOD-DENS switch to DENS, and observe the meter movement for a few seconds, noting the maximum reading that is repeatedly achieved.

In 5 kHz systems, Density readings in the vicinity of 6 to 8 indicate a proper degree of speech clipping in the transmitter. As calibrated from the factory, the same readings will apply for 12 kHz deviation systems and for AM systems.

Proper attention to Density readings can be of substantial help in getting optimum performance from radio systems.

TESTING FULL-DUPLEX TRANSCEIVERS.

The transmit functions of a full duplex transceiver can be tested as described previously for ordinary transceivers.

Similarly the receive function of full duplex transceivers can also be tested in the same way as ordinary transceivers, if the transmitter is inhibited from operating during the test of receiver functions.

If you wish to test a full duplex transceiver for receiver desensitization (caused by its transmitter), place the GENerate-MEASure switch in the center position. In this position, the instrument is locked in the GENerate mode, and the presence of transmitter power at the TRANSCEIVER port will not switch the instrument to the MEASure mode.

When testing full duplex transceivers, be mindful that the transceiver is delivering transmitter power into the SM1000 power pad, and observe the time versus power limitations given on page 1.

To avoid errors of generated signal from the SM1000 (caused by transmitter power reaching the SM1000 generation system), the step level control should be in the .1 or <.1 positions.

USING AN OSCILLOSCOPE:

If you want to observe modulation waveforms, you can connect an oscilloscope to the SCOPE connector on the front panel.

The oscilloscope presentation can be calibrated by use of the following procedure:

1. Arrange to GENerate any channel frequency.

2. Set the 1000 Hz modulation to 5 kHz.

3. The scope will show a 1,000 Hz sine wave. Using the scope controls, adjust the height of the sine wave for plus and minus 5 divisions. The scope is now calibrated for one kHz of division per kHz of deviation.

MEASURING SINAD

To Measure SINAD, plug a shielded test lead into the SINAD port of the SM1000, and connect the other end of the lead to the receiver loudspeaker, being sure to connect the shield side to the grounded side of the loudspeaker.

The 1,000 Hz internal tone source in the SM1000 generates the 1,000Hz modulation required for SINAD measurements. In typical SINAD measurement of 5 kHz systems, the 1000 hz modulation should be set for 3 kHz. peak deviation. Switch the MOD-SINAD switch to the SINAD position and the middle meter will display the SINAD value. The SM1000 incorporates a SINADDER (tm) circuit which computes SINAD as long as the input voltage from the receiver is between 20 millivolts and 10 volts RMS.

MONITORING DISTANT TRANSMITTERS

For testing transmitters on the bench and for checking base stations within their normal coverage area, the antenna supplied with the SM1000 will provide suitable signal pickup.

To measure distant transmitters, an elevated antenna suitable for the frequency band involved, may be desirable.

If intermodulation interference is bothersome when a high antenna is used, it can be substantially reduced by inserting a 6 or 10 dB, 50 ohm, pad between the antenna and the RF IN port. A high antenna results in a greater increase in signal on distant stations than it does on the nearby stations, which are usually the ones that create the intermodulation products. A 10 dB pad can result in a 30 dB reduction in intermodulation products, yet only gives a loss of 10 dB on the wanted signal. The squelch function does not operate in the AM mode.

USE OF A POWER PAD

The power attenuator in the SM1000 can dissipate 100 watts for no more than the times listed under the caution list on Page 1. If your work involves higher power transmitters, it is recommended that you purchase an external power pad, rated for continuous duty at the appropriate power level.

OPERATION FROM A VEHICULAR BATTERY SYSTEM

The SM1000 can be operated from 12.6 volt, negative ground, car or truck battery systems. The external battery input connector is located just above the A.C. power power receptacle, on the rear panel. A matching plug is shipped with the SM1000.

It is intended that the purchaser construct a battery power cable suitable to his particular application. Wiring requires the same precautions as the installation of a radio transceiver. An alternator whine filter may be required. If the battery voltage drops much below 12.6 volts, the power indicator light on the SM1000 will go out as a warning that proper operation cannot be relied upon.

The internal battery charging circuit is functioning when the external battery jack is connected to a 12.6 volt source. Thus, the internal battery can be charged while traveling between jobs, or even while the vehicle is parked. If the vehicle is parked for long periods, the operator should be aware of the constant drain on the vehicle battery. (.5 amperes on FAST charge condition)

CHECKING RECEIVER BANDPASS:

A manual /\F control is a feature that is being left out of many modern service monitors. It has been retained in the SM1000 because of its great value for checking receivers after an alignment procedure. The /\F control on the SM1000 permits you to manually move the GENerate frequency as much as 5 Khz above and below the frequency shown in the display. This enables the technician to see if the receiver bandpass is smooth and free of bumps or dips.

On wider band systems, the /\F control can be used in conjunction with the /\ and the \/ keys. to cover the full receiver bandwidth.

Although the /\F meter is calibrated for a full 5 kHz above and below the displayed frequency, to simplify sweeping the bandpass, it is best not to use the calibration at the ends of the scale for frequency measurement. Use the /\ or \/ keys to bring the meter closer to the center in order to use the most accurate portion of the scale (i.e.the center).

MINOR MAINTENANCE AND CALIBRATION ADJUSTMENTS

The following pages describe minor maintenance procedures and calibration adjustments that can be done in the field. The FM deviation calibration of the SM1000 is carried out in the factory by the very precise Bessel Function method. Users are cautioned against making any calibration adjustments unless they are sure that they are making them against suitably accurate standards.

CHANGING A.C. POWER SUPPLY VOLTAGE:

Locate the AC Power receptacle on the rear panel. If the power cord is not plugged into this receptacle, the plastic fuse shield can be slid to the left, exposing the AC power fuse and a small printed circuit card. Remove the printed circuit card, using a hook inserted into the hole in the card, and replace it so that either the "120" or the "240" shows.

Then, insert an appropriately rated fuse for the voltage in use. Proper fuse for 120 volts is 1/2 ampere. Proper fuse for 240 volts is 1/4 ampere.

FREQUENCY STANDARD CALIBRATION:

The channel frequency accuracy of the SM1000 is dependent upon a highly stable 10.4 MHz crystal oscillator. The crystal is enclosed in a temperature controlled "oven". This oven is operative at all times that the instrument is connected to external power (whether AC power source or external battery) regardless of the position of the BAT-AC-OFF switch, and when the instrument is being operated on its internal battery.

To retain the rated accuracy, the frequency of the 10.4 MHz oscillator should be checked and (if necessary) corrected at certain intervals. Since crystals exhibit their most rapid aging during the first few months of operation, checking should be done most frequently while the instrument is new. A suggested schedule is at the end of the first month of operation, the third month, the sixth month, and annually thereafter.

The preferred method of checking frequency is the use of a frequency counter having adequate accuracy and resolution for the job. It is best to do the comparison at the 500 MHz or 1,000 MHZ area. Be sure that you have set both the SET 0 and /\F knobs set precisely.The oscillator setting adjustment is accessible through a hole in the rear panel of the SM1000. It is covered with a small piece of metallic tape. After completing the adjustment, recover the hole with any available type of tape.

BATTERY REPLACEMENT:

The battery is located inside the bottom cover shield. To gain access to the battery, remove the top and bottom covers of the SM1000. Then, remove the right hand main bracket, which is held in place by two hex socket screws at the right hand end of the front panel and two hex head screws at the corresponding end of the rear panel.

MODULATION AND DENSITY METER ZERO ADJUSTMENT:

With the SM1000 turned off, adjust the mechanical zero of the left hand meter (the one used for MODulation and DENSITY readings) so the pointer is exactly at the zero position on the scales. Then turn the instrument on and place it in the GENerate condition with the AM-6KHz-15KHz switch in the 6 KHz position. Do not apply any modulation. Put the MOD-DENSITY switch in the MOD position, and adjust 2R033 so the pointer is exactly at the zero position.

MODULATION CALIBRATION ADJUSTMENT:

The FM modulation calibration of the SM1000 is carried out at the factory using the very precise Bessel Function method. Users are cautioned against making any modulation calibration adjustments unless they are sure that they are making them against suitably accurate standards. If you are suitably equipped to use the Bessel Function method, you are urged to use it to recalibrate your SM1000. All modulation calibration adjustments are accessible by removing the top cover of the instrument. Figure 3 shows the location of the various adjustments.

In the two FM modulation ranges, calibration of the modulation in the MEASure mode also properly calibrates the modulation in the GENerate mode, and vice versa. 2R010 sets the meter indication for the 6 KHz scale and 2R009 sets the indication for the 15 KHz scale. Best overall accuracy will occur if calibration is done at 75% of full scale on each range. This minimizes the effects of meter non-linearity.

The AM modulation scale must be calibrated separately for the GENerate and the MEASure mode. 2R139 calibrates the meter indication for the GENerate mode, and 2R93 calibrates the meter indication for the MEASure mode. Do NOT adjust R215.

OSCILLOSCOPE PORT CALIBRATION:

If you use a 'scope frequently with your SM1000, you may find it convenient to calibrate the output of the SCOPE port to some specific value, so you avoid the need to calibrate the scope input controls each time you use the scope. As shipped from the factory the SCOPE port delivers 50 millivolts per KHz of deviation on the 6 KHz scale and 20 millivolts per KHz of deviation on the 15KHz scale. If you wish to change this level, adjust R102.

SINADDER CIRCUIT ADJUSTMENT:

The procedure for checking, or resetting the SINADDER (tm) circuit is as follows:

1. Switch the SINAD-/\F switch to the SINAD position, and place a temporary short across the SINAD port. Adjust R109 so the left meter pointer of the middle meter is at the left hand end of the SINAD scale.

2. Put the SM1000 onto any radio channel frequency, and modu-modulate it with the internal 1,000 Hz tone. In addition, program a 2,000 Hz tone into the tone mode of the display. This will permit you to generate a 1,000 Hz test tone or a 2,000 Hz test tone for the procedure which follows. These test tones will appear at the SCOPE port. When you need the 1,000 Hz test tone, adjust the 1,000 MOD control to obtain 5 kHz of modulation deviation. When you need the 2,000Hz test tone, adjust the TONE MOD control to obtain 5 KHz of deviation.

3. Connect a coax jumper between the SCOPE and the SINAD ports. Using the 1,000 Hz test tone, adjust R74 and R75 to move the meter pointer as far to the left as possible. The controls interact; go back and forth between them. It should be possible to get the meter pointer into the black marked area at the left of the SINAD meter scale.

4. Now, using the 2,000 Hz tone, adjust the 2R178 so the meter pointer reads full scale on the SINAD scale.

POWER METER CALIBRATION:

Calibration of the RF power meter requires an RF power source capable of adjustment from .1 watts to 100 watts. Preferred frequency for the source is in the 100 MHz to 600 MHz range. Connect the power source to the TRANSCEIVER jack, using low SWR connectors and a connection cable with negligible losses.

Put the GENerate-MEAsure switch in the MEASure condition.

With the 10W-100W switch in the 100 W position, and set the power source of 10 watts output, and adjust R219 for a 10 watt reading on the meter. Then, set the power source to 100 watts and adjust R239 for a reading of 100 watts. Since these settings are interacting, it will then be necessary to go back to the 10 watt level and go through the procedure again.

With the 10W-100W scale in the 10 watt position, set the power source for .1 watts, and adjust R232 to obtain a .1 watt reading on the meter. Then, set the power source for 10 watts and adjust R235 to obtain a 10 watt reading. Then, set the power source for 1 watt and adjust R237 to obtain a 1 watt reading. Again, these settings are interactive, so it will be necessary to go back through the three settings until all three are correct.

Figure 3

Calibration A
Adjustment Locations