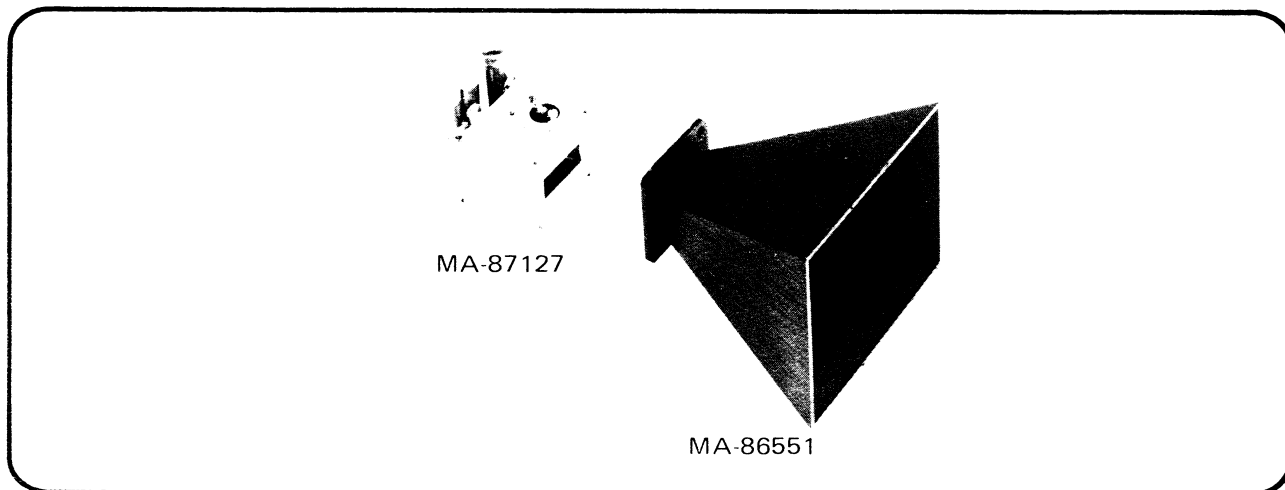


# MA-87127 SERIES

**VARACTOR TUNED GUNNPLEXER™ TRANSCEIVER**  
**“FRONT END” FOR AMATEUR APPLICATIONS**

**Bulletin 7624A**



## **FEATURES**

- LOW COST
- HIGH SENSITIVITY
- INTEGRATED ASSEMBLY (INCLUDES MIXER DIODE & CIRCULATOR)
- ELECTRONICALLY TUNABLE
- HIGH RELIABILITY
- LOW OPERATING VOLTAGE

## **DESCRIPTION**

The MA-87127 series of frequency modulated transceiver “front ends” using Gunn oscillators and Schottky mixer diodes has been specially designed to operate in the amateur 10.0 to 10.5 GHz Band.

The rear portion of the unit consists of a Gunn oscillator which directly converts DC to RF energy. The oscillator, unless otherwise specified, is delivered pre-set at 10.250 GHz (oscillators pre-set to other frequencies are available on request). Mechanical tuning is available to shift the center frequency  $\pm 100$  MHz. A tuning varactor is mounted close to the Gunn diode which will deviate the fundamental frequency typically 60 MHz when the proper tuning voltage is applied. FM, including both audio and video, can be applied to the tuning varactor input. In the front of the transceiver, a Schottky diode mixer is provided. The Gunn diode acts simultaneously as a transmitter and local oscillator with a portion of its energy (approximately 0.5 mW) being coupled to the mixer diode. The receiver noise figure is approximately 12 dB depending on auxiliary equipment used. A ferrite circulator has been integrated into the waveguide mount to isolate the transmitter and receiver functions.



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## APPLICATIONS

### TWO-WAY COMMUNICATIONS

It is anticipated that the primary application of the Gunnplexer "front end" will be for two-way communications (Figure 1). For this application, two units, as previously described, are used with their carrier frequencies off-set to provide a reasonable IF (i.e. 30, 40, 144 MHz or higher). At any given time, one unit is used as a transmitter, and the other a receiver down converter. It should be noted that the frequency stability of the unit is such that in most cases, some sort of AFC on the transceiver is desirable. The purpose is to provide a corrective tuning voltage to keep the IF at a constant frequency. The units lend themselves well to relaying remote receivers to repeater sites at VHF, etc. all of which place a premium on RELIABLE 24 hour communications. At the other end of the scale these units may also be used by the amateur microwave DX enthusiast chasing records at straight line of sight, refractive, and "ducting" paths. Here the user should use GOOD low noise IF preamps, as narrow band receivers as possible, and either high gain (25 dB) horns or big dishes. With 10 dB OMNI antennas the units also may be used as microwave beacons.

A separate power supply and FM modulator must be provided. It is suggested that the transceiver be used in conjunction with the MA-86551 (17 dB) horn antenna. Alternate antennas are available. The half power beamwidth in both planes is  $30^{\circ}$ .

### PRACTICAL RANGE CONSIDERATIONS

The actual useable range of the Microwave Associates' transceiver "front end" is a function of the transceiver characteristics such as output power, frequency stability and noise figure; ERP as affected by the antenna gains at both ends, and equally important, the characteristics of the associated IF receiver in particular its signal-to-noise ratio and bandwidth. In general, it is desirable to deviate the FM signal such that the available IF bandwidth is completely filled. The graph in Figure 3 indicates the MAXIMUM achievable range vs. IF bandwidth assuming a 17 dB horn at both ends. The range shown is at "threshold" with "threshold" defined as the beginning of reception of intelligible speech. The range indicated allows no fade margin. Severe fades will not only affect the "threshold" as defined above but could also cause the system AFC to "unlock." Conservative practice would indicate shorter ranges than indicated, depending on the environment, including rainfall, multipath affects, etc. Obviously, providing higher gain antennas will increase range but at the expense of increased costs both for the dishes and their stable mounts.

### MIXER/IF INTERFACE

In order to achieve optimum noise figure and prevent undesired pick up, the IF amplifier connection to the IF output on the mixer should be shielded and be kept as short as possible. The unit is supplied with a 1,000 ohm load resistor and protective diode to prevent damage to the receiver diode. The 1,000 ohm resistor provides a DC return for the mixer diode. In actual experience, a noise figure as low as 10 dB is achievable if some care is taken. In most cases the protective diode should be removed since it can degrade noise figure. Actual measured impedance at 30 MHz is approximately 200 ohms. The impedance can vary from transceiver to transceiver to transceiver; however, if the user makes some effort to match the diode/IF interface, he can generally improve receiver sensitivity. The noise figure of the IF preamp will obviously affect the performance of the receiver and for those who need maximum sensitivity, it is suggested that a separate IF preamplifier be constructed using an MA-42001 transistor. When operating with a standard 88-108 FM receiver, make sure that the antenna input is in the unbalanced, not the balanced condition.

### ACHIEVING OSCILLATOR FREQUENCY STABILITY

Keeping an oscillator with a maximum drift of  $-350$  KHz per degree centigrade centered in an IF bandwidth of, say, 200 KHz obviously requires some engineering ingenuity. The daily change in outside temperature can be as large as  $25^{\circ}\text{C}$  (8.75 MHz maximum) per day, but over periods of one hour,  $10^{\circ}\text{C}$  (3.5 MHz maximum) change would be unusual. In almost all cases, once the transceiver has reached equilibrium with its environment, the changes are relatively graceful. The electronic tuning range, 60 MHz, allows adequate capacity to accommodate for the above shifts even when modulated with video. The frequency drift over a short period of time can usually be corrected by adjusting the varactor bias manually. For reliable, long-term use such as receiver remotes for a UHF/VHF repeater, the user may wish to consider more sophisticated approaches. The first is to reduce the amount of the drift by placing the transceiver in a temperature-controlled environment such as produced by a crude oven using a thermostatic-controlled heater or light bulb. The advanced experimenter may even wish to use proportional control. The second approach involves electronic automatic frequency control of which many variations are possible ranging from the most sophisticated, using combinations of a digital AFC/phase lock shown in Figure 1, to the simple commercial FM receiver with AFC shown in Figure 2. In both cases, one VCO is allowed to "float", and the frequency of the second is adjusted electronically to the first in such a manner to provide a constant intermediate frequency to the IF receiver.

## APPLICATIONS (Continued)

In the first more sophisticated approach shown in Figure 1, the IF is divided by N and a stable crystal oscillator, by N' and the phases of the two outputs compared at a LOW frequency in a phase detector. The DC output of this detector is fed through an error amplifier to the varactor on the VCO. The audio input and loop centering controls are also shown. The shunting RC network allows the modulation frequencies to by-pass the error amplifier. In the event that the unit breaks "lock", some users may wish to design a "search" mode into the AFC loop. The second, using the traditional analogue approach, is shown in Figure 2 and utilizes a 88-108 MHz standard FM broadcast receiver of good quality as the IF. This receiver must be modified to disable the AFC control on the internal LO, and to transfer AFC control to the Gunn Oscillator. This AFC voltage, when combined with the manual tuning control and the audio modulation, is applied to the tuning varactor of the VCO. The second transceiver also uses an FM receiver for an IF. However, in this case, no modification is necessary since the second VCO is not AFC controlled but it must be tuned initially to the same frequency as the first FM receiver. This system allows the user to correct manually either with the manual tuning control of the varactor power supply or by the frequency control of the FM receiver. The user is always cautioned to place the VCO with the AFC control on the correct frequency side of the other VCO so that the frequency corrections converge rather than diverge. In actual practice, some on-the-air "tweaking" of the manual controls will be necessary to ensure that units center in the IF pass band and that the AFC "locks up."

It is suggested that the user contact the applications department of Motorola Semiconductor Products, Inc. in Phoenix, Arizona, and other similar companies for their latest data sheets and applications information on phase-locked loop components.

### RADAR

A single transceiver can be used as an FM Doppler radar. When the varactor diode is modulated, the reflected received signal provides an audio/video IF signal which has a frequency proportional to the velocity of the object moving toward or away from the transceiver, plus the round trip time frequency deviation. The round trip time frequency deviation contains the target range information. Intended applications include distance measurement, speed measurement, direction monitoring, and intrusion alarms. For further information on this application, write for the Microwave Associates' brochure entitled "Microwave Components for Motion Detection."

### OTHER FREQUENCIES

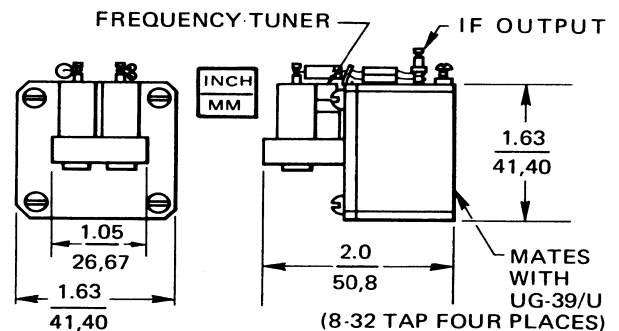
Gunn oscillators are available at other frequencies ranging from 4 GHz to 65 GHz. A transceiver similar to that described in this brochure will also be made available in the amateur 24 GHz band if sufficient interest is shown.

## MA-87127 - ELECTRICAL SPECIFICATIONS

RF Center Frequency	10.250 GHz <sup>1</sup>
Tuning	
Mechanical	±100 MHz
Electronic	60 MHz Min.
Linearity	1 to 40%
Frequency Stability	-350 kHz/°C Max.
RF Power vs. Temperature and tuning voltage	6 dB Max.
Frequency Pushing	15 MHz/V Max.
Input Requirements	
DC Gunn Voltage	+10.0 V Typ.
Maximum operating current	500 mA
Tuning Voltage	+1 to +20 Volts
Noise Figure <sup>2</sup>	< 12 dB
RF Output Power <sup>1</sup>	
Model	P out (mW)
MA-87127-1	15
MA-87127-2	25
MA-87127-3	40

NOTES: 1. Tuning voltage set at 4.0 volts.  
2. 1.5 dB IF NF at 30 MHz.

## OUTLINE DRAWING



Operating Temperature -30° to +70°C

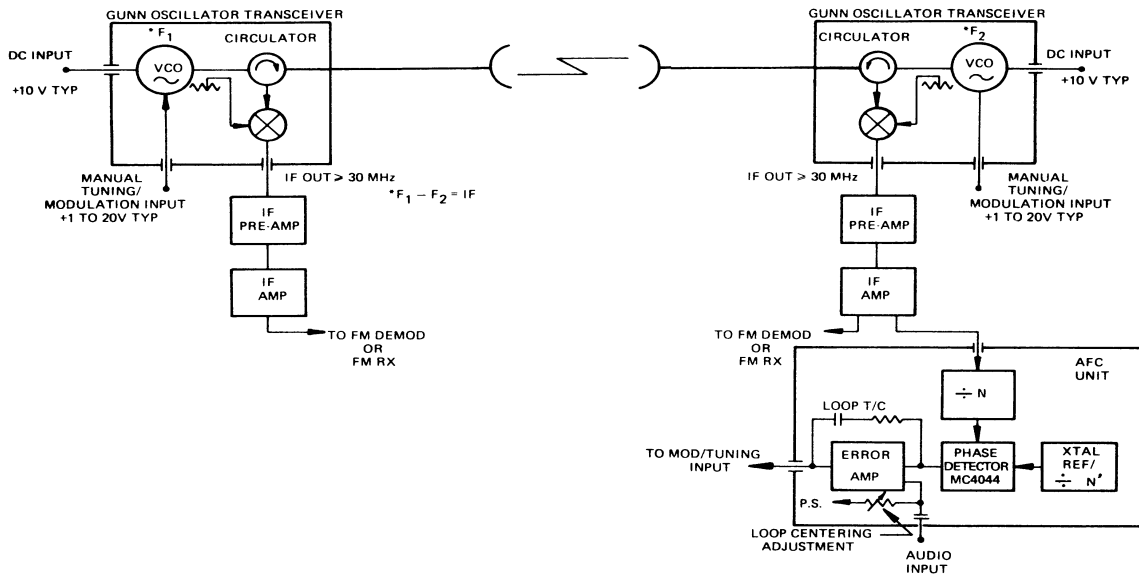


FIGURE 1 ONE POSSIBLE METHOD OF APPLYING AFC (DIGITAL)

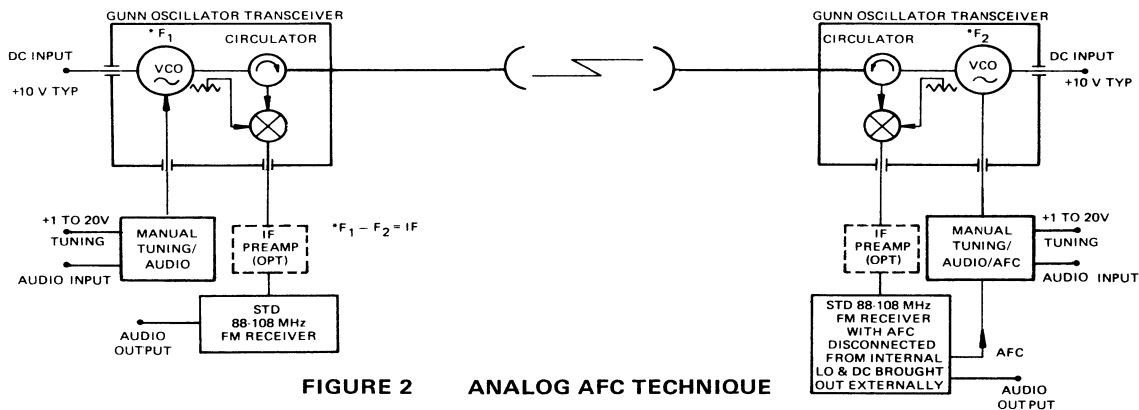
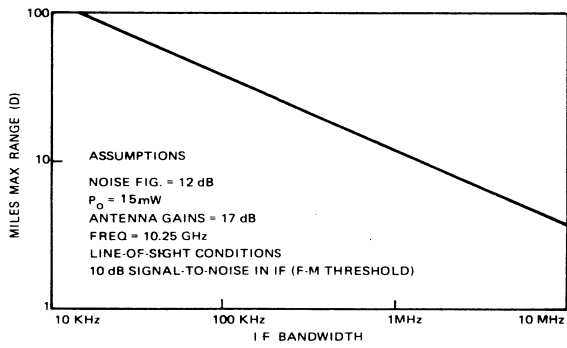


FIGURE 2 ANALOG AFC TECHNIQUE



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FIGURE 3

PRICE LISTINGS

Model	Description	Unit Price
MA-87108-1	Gunn Oscillator and Tuning Varactor	\$ 60
MA-87127-1	Complete Transceiver	\$ 85
MA-87127-2		\$135
MA-87127-3		\$170
MA-87140-1	Complete Transceiver and Antenna	\$108
MA-87140-2		\$158
MA-87140-3		\$193
MA-87141-1	2-Complete Transceivers and Antennas	\$180
MA-87141-2		\$285
MA-87141-3		\$370

Prices are F.O.B. Burlington, MA.  
Discounts available for quantity orders above 100 pieces.