APPLICATION		REVISION			
NEXT ASSY	USED ON	LTR	DESCRIPTION	DATE	APPROVED

YIG HARMONIC MULTIPLIERS

&

COMB GENERATORS

APPLICATION NOTES

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES TOLERANCES ARE: FRACTIONS DECIMALS ANGLES ± .XX ± ± .XXX ±	CONTRACT NO.		OMNIYIG INC.
	APPROVALS	DATE	
	DRAWN		
MATERIAL	CHECKED		
FINISH			
DO NOT SCALE DRAWING			

SIZE	CODE IDENT NO.	DRAWING NO.
A	55682	2336

SCALE		SHEET 1 OF 4

DWG. NO. 2336

OMNIYIG INC

YIG HARMONIC MULTIPLIERS AND COMB GENERATORS

APPLICATION NOTES

YIG tuned multipliers and comb generators, manufactured at OMNIYIG, contain a Step Recovery Diode, which behaves as a non-linear capacitor. This property is utilized to generate a time domain impulse (fig. 1). The frequency response to this impulse is a series of harmonically related frequencies that follow a $(\sin^2 x)/x^2$ type envelope (solid line fig. 2). There is some design latitude in the placement or location of the zeroes of the function. For low harmonic numbers (less than 20-30) the output can be first lobe, the output conversion loss can be approximated by a $1/n^2$ distribution. For narrow band outputs within the first lobe, the output can be greater than that indicated by $1/n^2$, through careful location of the first zero. Also the first lobe can drop below $1/n^2$ as it approaches the first zero. For moderate and large harmonic numbers, the output will contain the second third lobes. The average power in the second lobe will be about 6 db below a $1/n^2$ distribution and the third lobe will be about 12 db below $1/n^2$.

For the case of YIG tuned multipliers, the output filter structure has losses that can become significant and will add to the above mentioned conversion losses. These filter losses will vary from as little as 2 db to as great as 12 db, depending on the lowest required output frequency. All YIG spheres have a low frequency cut-off point. This cut-off can be extended to lower frequencies by increasing the amount of Gallium doping in the YIG sphere, but only at the expense of lowering the unloaded Q of the sphere. The resultant increase in filter losses can become great enough that system design choices of operating with either the n+1 or n-1 harmonic numbers will show a distinct advantage for the n+1 case. Even though the n-1 case will result in a lower diode conversion loss, the n+1 case will allow usage of a higher Q sphere and resultant lower filter losses. This situation will occur when output are below 2 GHz and especially when below 1 GHz.

Due to the fact that the Step Recovery Diode has a very low input impedance and that the time domain geometry of the impulse is very critical, the input matching is very delicate and highly susceptable to interactions between the amplifier and multiplier sections. An exclusive matching technique, developed at OMNIYIG, allows operation of the multiplier at the $(\sin^2 x)/x^2$ zero locations with only a moderate power loss in what would normally be a zero power output condition (see fig. 2 dashed line). However, the most critical matching and amplifier-multiplier interactions occur in the vacinity of the $(\sin^2 x)/x^2$ zeroes. The simplest solution to this situation is to purchase the amplifier and multiplier from the same source so that the two units can be tuned as a matched set. Lengths of cable between the multiplier and amplifier should be kept under 6 inches. If the amplifier should be purchased from a separate source, there are a few important items to consider. In the case of broad band inputs such as 1-2 GHz or 2-4 GHz, the amplifier should have an output hybrid (fig. 3) that is well matched to 50 ohms. For the case of a single frequency input such as 100 or 200 MHz, the amplifier should be reactively

matched to 50 ohms and, in addition, should contain a 2 or 3 db pad to provide a resistive load (fig. 4). This 2 or 3 db pad can be either an external coaxial type or can be a Pi type resistor pad that can be built as an integral part of the amplifier output circuitry. In any case where the amplifier is purchased from a separate source it will be highly advantageous to provide a typical amplifier to the multiplier vendor for tuning purposes. Solid state amplifiers are the best for multiplier use as tube types have extremely bad output VSWR's and require prohibitively large amounts of padding between amplifier and multiplier.

When testing a multiplier, do not exceed 1 watt input power and preferably not greater than +29 dbm. In the case where large amounts of interaction between multiplier and amplifier are occuring, the result may be observed as low output power, especially in the vicinity of the $(\sin^2 x)/x^2$ zeroes. In this case, an increase of input power will not necessarily result in an increase of output power and may easily destroy the diode.

The output matching requirements are not so critical for the YIG tuned multiplier, as the filter section isolates the Step Recovery Diode from the output load. However, for the case of the comb generator the output load match can be significant. In this case, if the output VSWR's exceed 2:1, the reflected power returned to the diode can result in sub-harmonic and/or sideband frequency generations.

Ideal operation requirements are shown in fig. 3, fig. 4 and fig. 5. YIG tuned multipliers require the same considerations as all other YIG devices. Tuning coil connections must follow the manufacturer's polarity markings, and heaters must be turned on with approximately 30 seconds warm-up time.

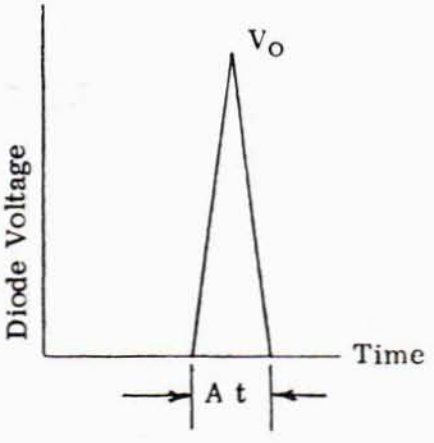


Fig. 1

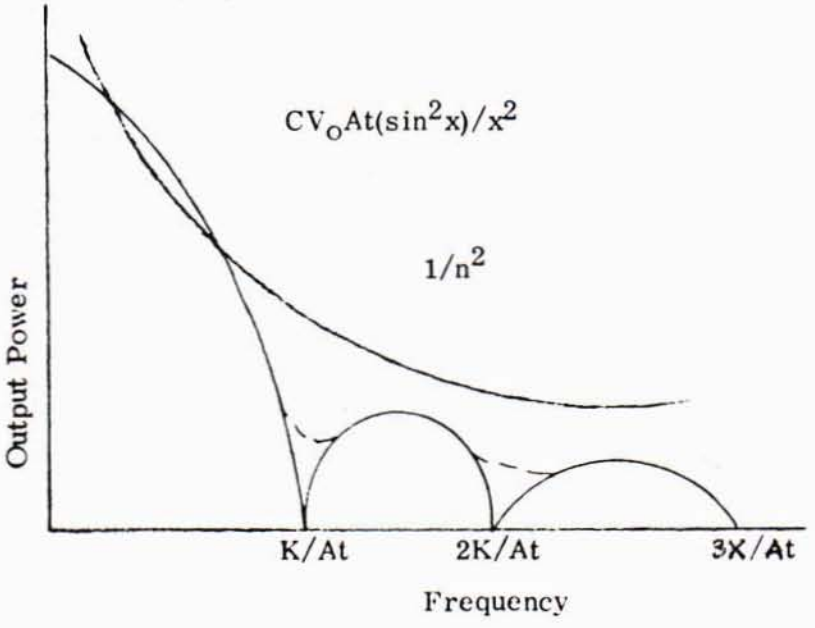


Fig. 2 Frequency response to impulse

DWG. NO. 2336

OMNIYIG INC

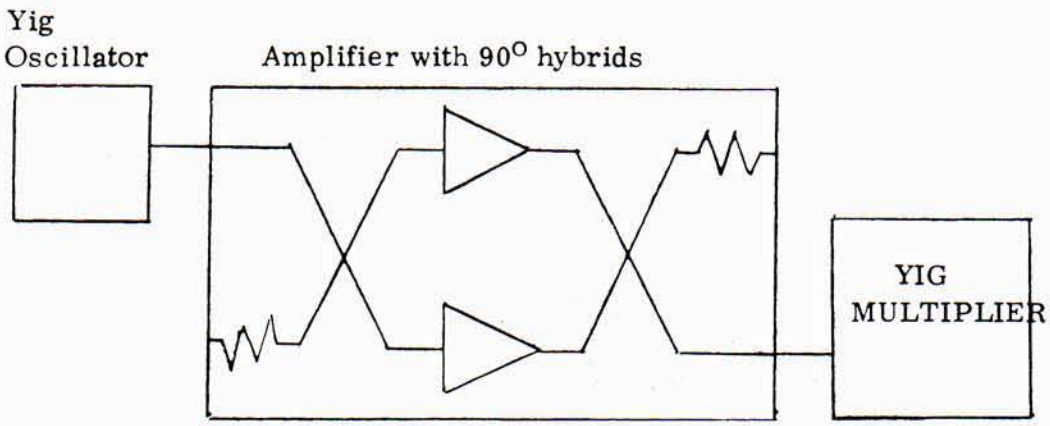


Fig. 3 Multiplier Operation with Broad Band input

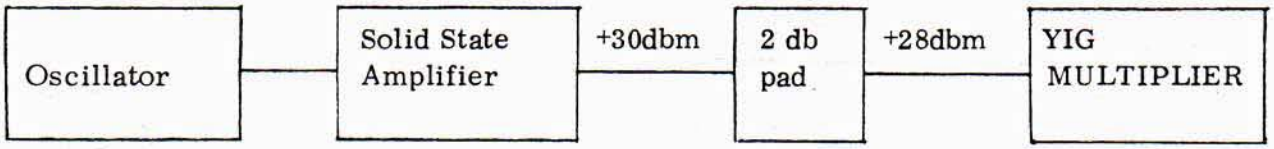


Fig. 4 Multiplier Operation with narrow band input

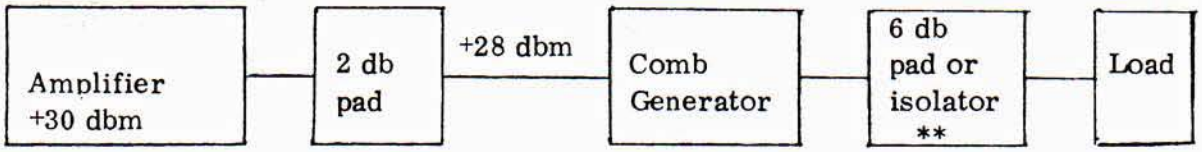


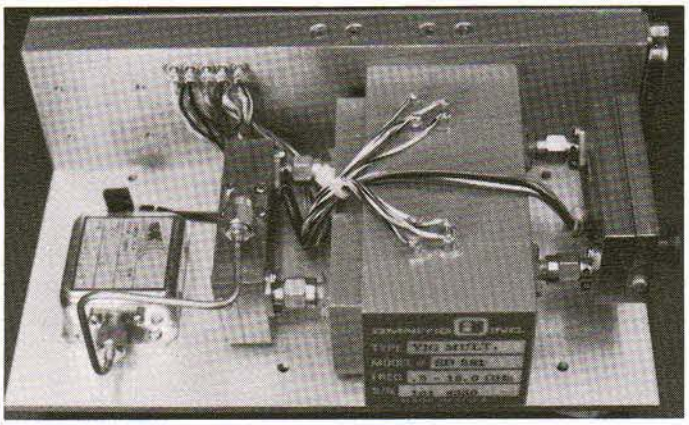
Fig. 5 Comb Generator Operation

Note: **Unnecessary if load has broad band VSWR less than 2:1

OMNIYIG INC.

YIG-TUNED HARMONIC GENERATOR SOURCE

0.5 – 18 GHz



DESCRIPTION

Omniyig SDXXX series Yig-tuned Harmonic Generator Sources provide RF Power Output in the frequency covering 0.5 – 18 GHz. These units have been designed to have internal integrated electronic Yig Filter tuning for selecting the output frequency required; at the same time provide rejection of all harmonics and spurious responses, in some cases, −60 dB rejection. The internal oscillator provided with the Harmonic Generator Source can be any one of the indicated designs, either a fixed or variable output frequency. The Harmonics of the input oscillator are generated by the integrated Comb Generator to the output frequency range determined by each individual unit. The integrated Yig Filter (either 2, 3, or 4-Stages) selects the required output frequency from the Comb Generator and is electronically tuned throughout the frequency range of the device. The Yig Filter can be eliminated and have an open-ended output from the Harmonic Multiplier with all the combs presented at the RF output at the same time.

The frequency coverage on all models is from 0.5 – 18 GHz in octave or multi-octave bands. One unit can cover the full frequency range of six (6) octaves from 0.5 – 18 GHz. These compact Harmonic Sources can be mounted either on a base plate (as illustrated) or can be put in an enclosed case. Yig analogic and digital drivers are available for input tuning. All the drivers are temperature compensated for frequency stability and RF power variation. All devices can be qualified to MIL-E-5400, Class II Specification.

Integrated Package Component Features

2-4 STAGE YIG FILTERS

- ☐ Low Insertion Loss, 2.5 dB in some models.
- ☐ Frequency vs. Temperature Stability as low as 5 MHz/60°C.
- ☐ Repeatable RF Performance from Unit to Unit.
- ☐ Package Sizes Typically 1.4 inch^3.
- ☐ Qualification to MIL-E-5400, Class II Specification available.

INPUT OSCILLATOR

- ☐ Crystal Stability in some models 50 ppm.
- ☐ Miniature Packaging.
- ☐ Super Temperature Stability.
- ☐ Excellent Tuning Linearity ±0.10% (for variable units).
- ☐ All other Spurious Signals 60 dB down.
- ☐ Qualification to MIL-E-5400, Class II Specification available.

HARMONIC GENERATOR

- ☐ Low Harmonic Conversion Loss
- ☐ Excellent Spectrum Purity.
- ☐ Repeatable Performance from Unit to Unit.
- ☐ Input Matched for Broadband Performance.
- ☐ Integrated Self Biasing.
- ☐ Small Packaging.

OUTPUT RF PERFORMANCE

- ☐ Excellent Signal Purity.
- ☐ All Harmonic and Spurious are −50 dB min.
- ☐ Miniature Packaging.
- ☐ Airborne Qualified.
- ☐ Qualification to MIL-E-5400, Class II Specification available.

OMNIYIG, INC. □ 3350 Scott Blvd., Bldg. #66 □ Santa Clara, California 95054-3125 □ (408) 988-0843 □ FAX (408) 727-1373

SPECIFICATIONS

MODEL	OUTPUT – (NOTE 1) FREQUENCY STEPS	OUTPUT – (NOTE 3) FREQUENCY RANGE, GHz	SPURIOUS OUTPUTS	OUTPUT POWER MINIMUM	HARMONIC REJECTION	YIG FILTER NO. STAGES
SD381	500 MHz	0.5-18 GHz	– 50 dB	– 18 dBm	50 dB	3
SD384	1000 MHz	2-18 GHz	– 50 dB	– 10 dBm	50 dB	2
SD385	500 MHz	2-18 GHz	– 50 dB	– 25 dBm	60 dB	3
SD386	200 MHz	2-18 GHz	– 50 dB	– 36 dBm	60 dB	3
SD387	1-1.5 GHz	2-18 GHz	– 40 dB	– 20 dBm	N/A	No Filter
SD388	100 MHz	2-12 GHz	– 50 dB	– 30 dBm	60 dB	3
SD389	200 MHz	2-18 GHz	– 40 dB	– 45 dBm	N/A	No Filter

ADDITIONAL SPECIFICATIONS – ALL MODELS WITH INTEGRATED YIG FILTERS

1. Typical Tuning Sensitivity (Note 2): 22 MHz/mA
2. Maximum Linearity Deviation: 0.15%
3. Maximum Tuning Hysteresis: 30 MHz
4. Typical Tuning Coil Resistance: 8 ohms
5. Typical Tuning Inductance: 110 MH
6. Maximum Weight: 40 ounces
7. Yig Filter Speed: 20 Milisec
8. Maximum Temperature Coefficient: ±200 KHz/°C
9. Heater Voltage: 20 – 30V
10. Heater Current:
    Maximum 4 second surge: 900 mA
    Maximum steady state at 0°C: 80 mA
11. Operating Temperature: 0° – 55°C

Mechanical Specifications

Output RF Connector	SMA female
DC Connector	Solder Pins
Dimensions:	
Model SD389	2.87 W × 4.00 L × 0.55 H, inches
Model SD387	3.25 W × 4.88 L × 0.55 H, inches
Models SD381, SD384, SD385, SD386, SD388	4.00 W × 7.00 L × 2.10 H, inches

Model No.	Outline Drawing	Weight (oz.)	Mounting
SD389		40	.125 Dia. through 4 places
SD387		40	.166 Dia. through 4 places
SD381, SD384, SD385	82394	45	6-32 THD through 6 places
SD386, SD388	82394	45	6-32 THD through 6 places

Power Supply Requirements

Driver Supply (if used)	±15 Volts at 500 mA – 900 mA
Oscillator Supply (includes 1 watt amplifier)	±15 Volts at 500 mA
Heater Supply	20-30 Volts unregulated 4 sec. 950 mA Steady State 60 mA

NOTES:

1. Other designs are available with different tuning frequency steps.
2. Units are available with analog and digital tuning or without drivers.
3. Other frequency ranges are available.

OMNIYIG INC.

OMNIYIG INC.

YIG TUNED HARMONIC MULTIPLIERS

The OMNIYIG YM100X YIG Tuned Harmonic Multipliers series have been designed to electronically tune in octave and multioctave bands and to provide harmonics of the input frequency with extreme purity. The harmonics can be selected by the continuously tunable YIG Filter which is integrated with the multiplier in one compact package.

Model YM1001 accepts an input signal from 1 to 2 GHz. The harmonics of that signal is selected by a tunable YIG Filter and offers a continuously swept output frequency from 2 to 13 GHz. Models YM1002, YM1003 and YM1004 are operated with a fixed input signal of 100 MHz, 250 MHz and 500 MHz respectively. Harmonics up to 12.4 GHz can be selected with their 3 stage filter to obtain signal with extreme purity.

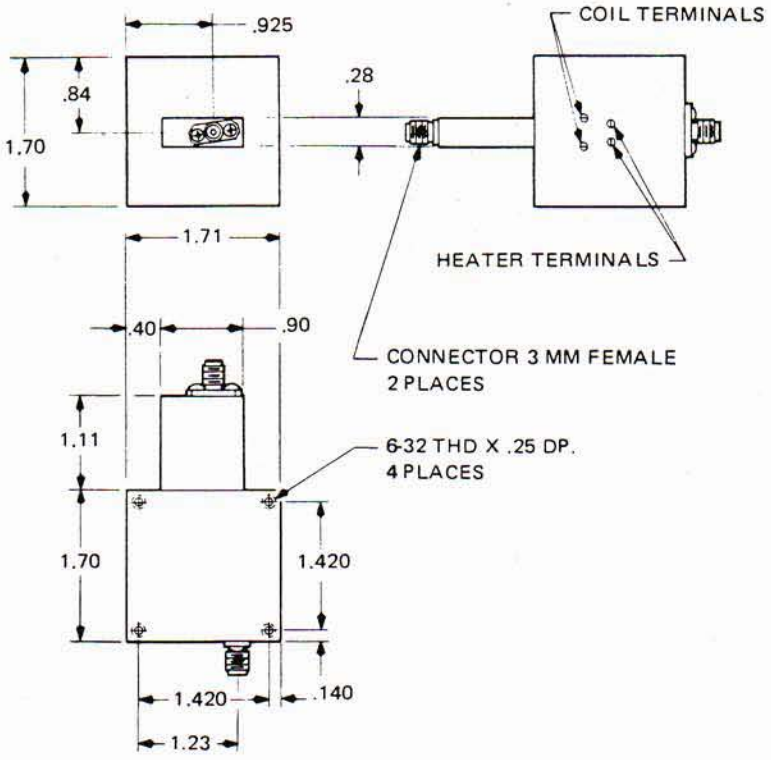
The integration of the multiplier and filter in one compact package gives an efficiency in the harmonic generation never obtained before.

The YM100X Series YIG Tuned Harmonic Multipliers have applications in octave and multioctave sweepers, frequency synthesizers, C-band oscillators, frequency counters, digital tuned ECM receivers.

Other special designs can be provided for octave bands with higher RF power outputs or other extended frequency ranges.

Features:

- **Compact Design**
- **High Efficiency**
- **Outstanding Reliability**

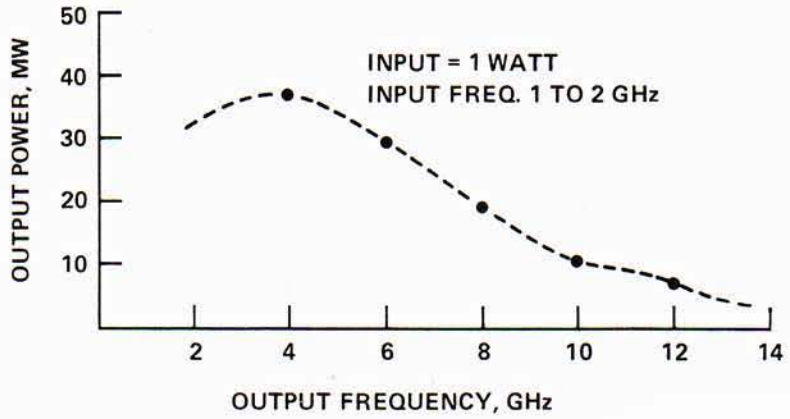


OMNIYIG, INC. ☐ 3350 Scott Blvd., Bldg. #66 ☐ Santa Clara, California 95054-3125 ☐ (408) 988-0843 ☐ FAX (408) 727-1373

SPECIFICATIONS

OMNIYIG Models	YM1001	YM1002	YM1003	YM1004
Input Frequency	1-2.1 GHz	100 MHz	200 MHz	500 MHz
Output Frequency Range	2-13 GHz	1-12.4 GHz (Continuous Coverage)	1-12.4 GHz	1-12.4 GHz
Input RF Power	1 W	1 W	1 W	1 W
Harmonic Rejection	40 dB	60 dB	60 dB	60 dB
Output Power (at 12.4 GHz)	4 mW	-33 dBm	-28 dBm	-10 dBm
Tuning Sensitivity (typical)	18 MHz/mA	18 MHz/mA	18 MHz/mA	18 MHz/mA
Linearity	0.15%	0.15%	0.15%	0.15%
Tuning Hysteresis	30 MHz	30 MHz	30 MHz	30 MHz
Tuning Coil Resistance (typical)	80 ohms	80 ohms	80 ohms	80 ohms
Temperature Coefficient	200 kHz/°C	200 kHz/°C	200 kHz/°C	200 kHz/°C
Weight	16 oz.	16 oz.	16 oz.	16 oz.
Heater Voltage	18-32 V	18-32 V	18-32 V	18-32 V
Heater Current (typical)				
Surge for 4 seconds	500 mA	500 mA	500 mA	500 mA
Steady State at 0°C	80 mA	80 mA	80 mA	80 mA
Size (excluding connectors)	1.69 in. x 1.69 in. x 1.69 in., all models			
Connectors				
RF Input and Output	3 mm (5 mA) Female, all models			
DC	Solder Terminals, all models			

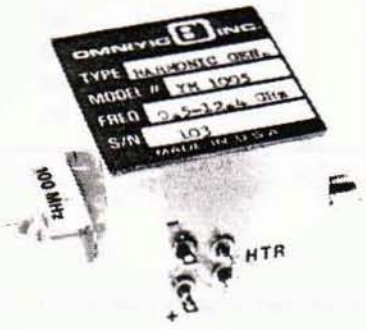
MODEL NO. YM1001
TYPICAL CONTINUOUSLY OUTPUT POWER
VERSUS 1 WATT INPUT POWER



OMNIYIG INC.

OMNIYIG INC.

YIG-TUNED HARMONIC MULTIPLIERS



APPLICATIONS

- Octave Sweepers
- Multioctave Sweepers
- Frequency Synthesizers
- Frequency Counters
- ECM Receivers

FEATURES

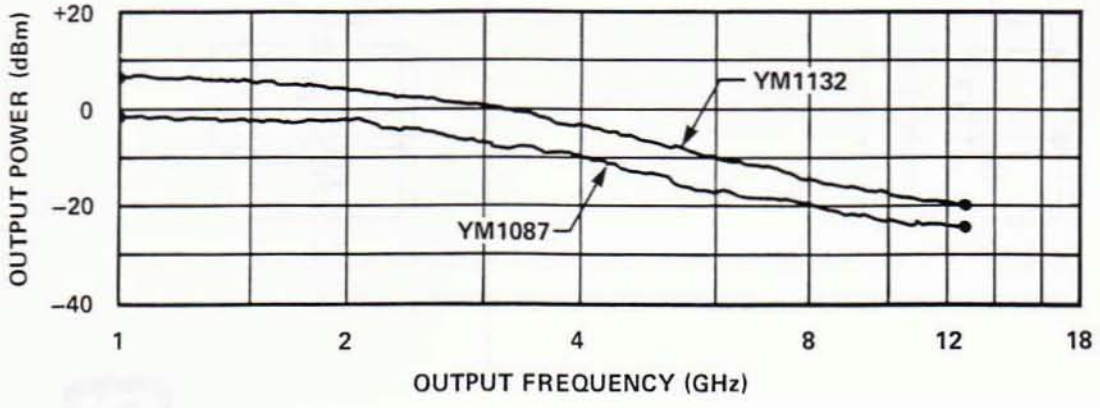
- Compact Design
- High Efficiency
- Outstanding Reliability
- Digital or Linear Tuning

The OMNIYIG YIG-Tuned Harmonic Multiplier Series YM100X designs have been improved and extended to cover continuous output. They can tune electronically in octave and multioctave frequency ranges with extreme purity output signal. These YIG-Tuned Multipliers can be used as continuous output local oscillators with input frequency synthesized from user's equipment.

YIG Multiplier Model YM1132 accepts an input signal continuous from 200 MHz to 400 MHz. The harmonics of that input signal are selected by the tunable integrated 3-stage YIG Filter in the YIG Multiplier, which offers continuous output frequency from 1.0 GHz to 18 GHz. The output signal, as a result of the 3-stage integrated filter, will exhibit all harmonics and spurious responses down by 60 dB. The user can synchronize the YIG Multiplier filter tuning with the input frequency to provide output tracking.

Models YM1131, YM1087, YM1133 and YM1134 are operated with the same principle; output ranges are different. Many special YIG Multiplier designs can be built to meet the frequency ranges or power outputs. OMNIYIG will be pleased to offer price quotations to your requirements.

TYPICAL PERFORMANCE CURVES



OMNIYIG INC. ☐ 3350 Scott Blvd., Bldg. #66 ☐ Santa Clara, California 95054-3125 ☐ (408) 988-0843 ☐ TWX 910/338/7356

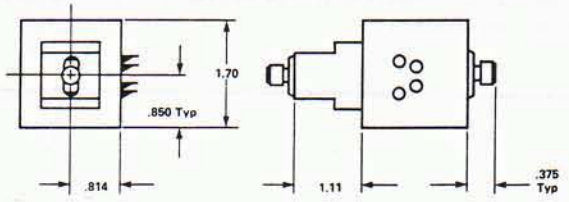
SPECIFICATIONS

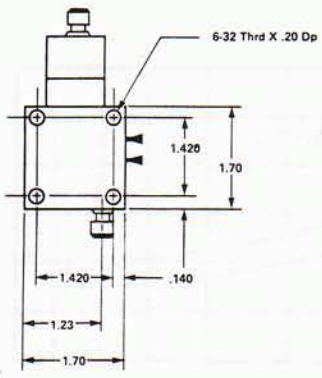
MODEL	CONTINUOUS INPUT FREQUENCY (GHz)	CONTINUOUS OUTPUT FREQUENCY (GHz)	INPUT RF POWER MAX.	OUTPUT RF POWER MIN.	HARMONIC REJECTION	OUTLINE
YM1131	0.1 - 0.2	0.5 - 12	1w	–33dBm	60	B
YM1087	0.1 - 0.2	1.0 - 12	1w	–30dBm	60	B
YM1132	0.2 - 0.4	1.0 - 18	1w	–25dBm	60	B
YM1133	0.2 - 0.4	0.5 - 12	1w	–20dBm	60	B
YM1134	1.0 - 2.0	2.0 - 8.0	1w	+10dBm	60	A

ADDITIONAL SPECIFICATIONS — ALL MODELS:

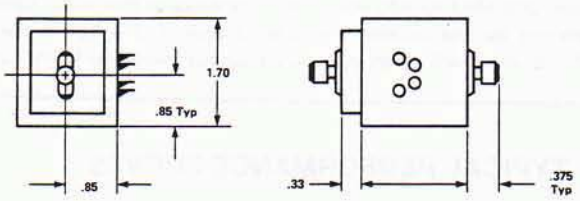
1. Typical Tuning Sensitivity: 22 MHz/mA
2. Maximum Linearity Deviation: 0.15%
3. Maximum Tuning Hysteresis: 30 MHz
4. Typical Tuning Coil Resistance: 8 ohms
5. Maximum Weight: 16 ounces
6. Maximum Temperature Coefficient: ±200 KHz/°C
7. Heater Voltage: 20 – 30V
8. Heater Current
   - Max. 4 second surge: 700 mA
   - Max. steady state at 0°C: 80 mA

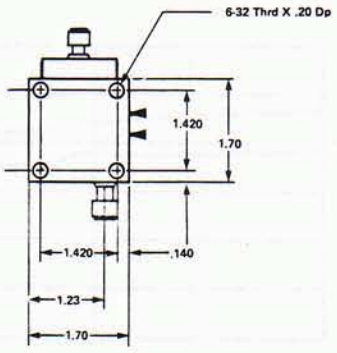
OUTLINE A





OUTLINE B





OMNIYIG INC.