January 1980

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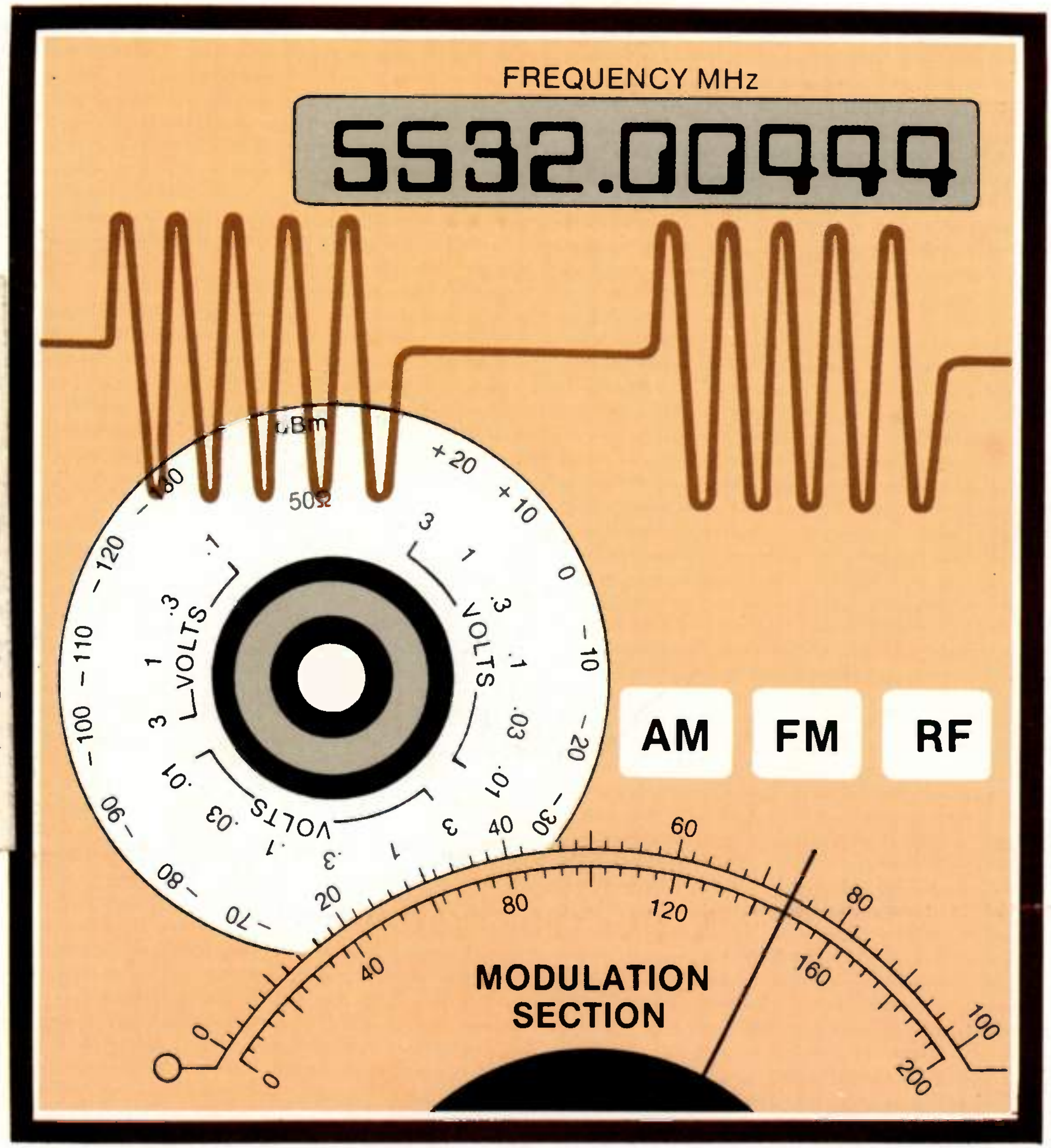
rf design



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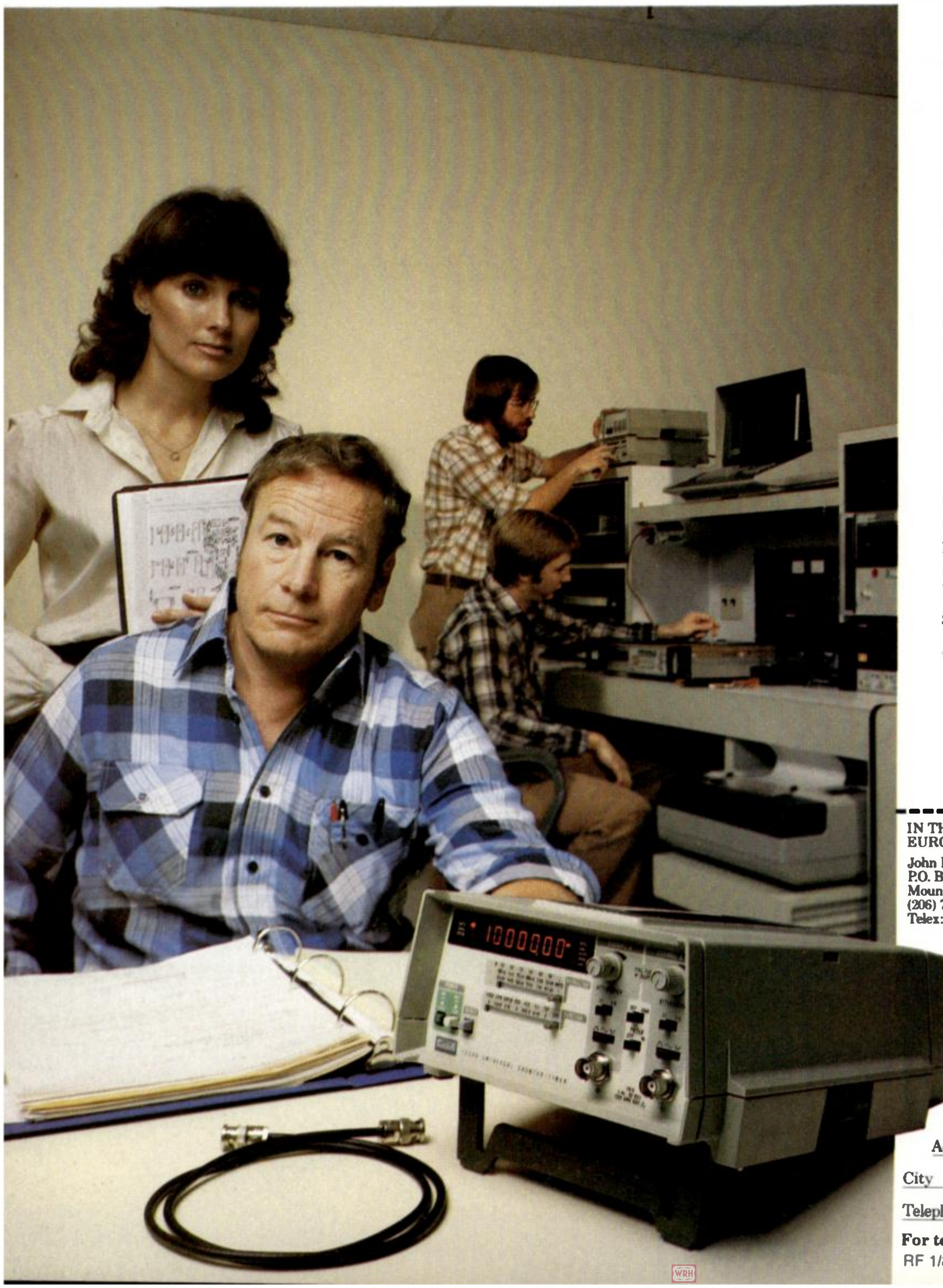

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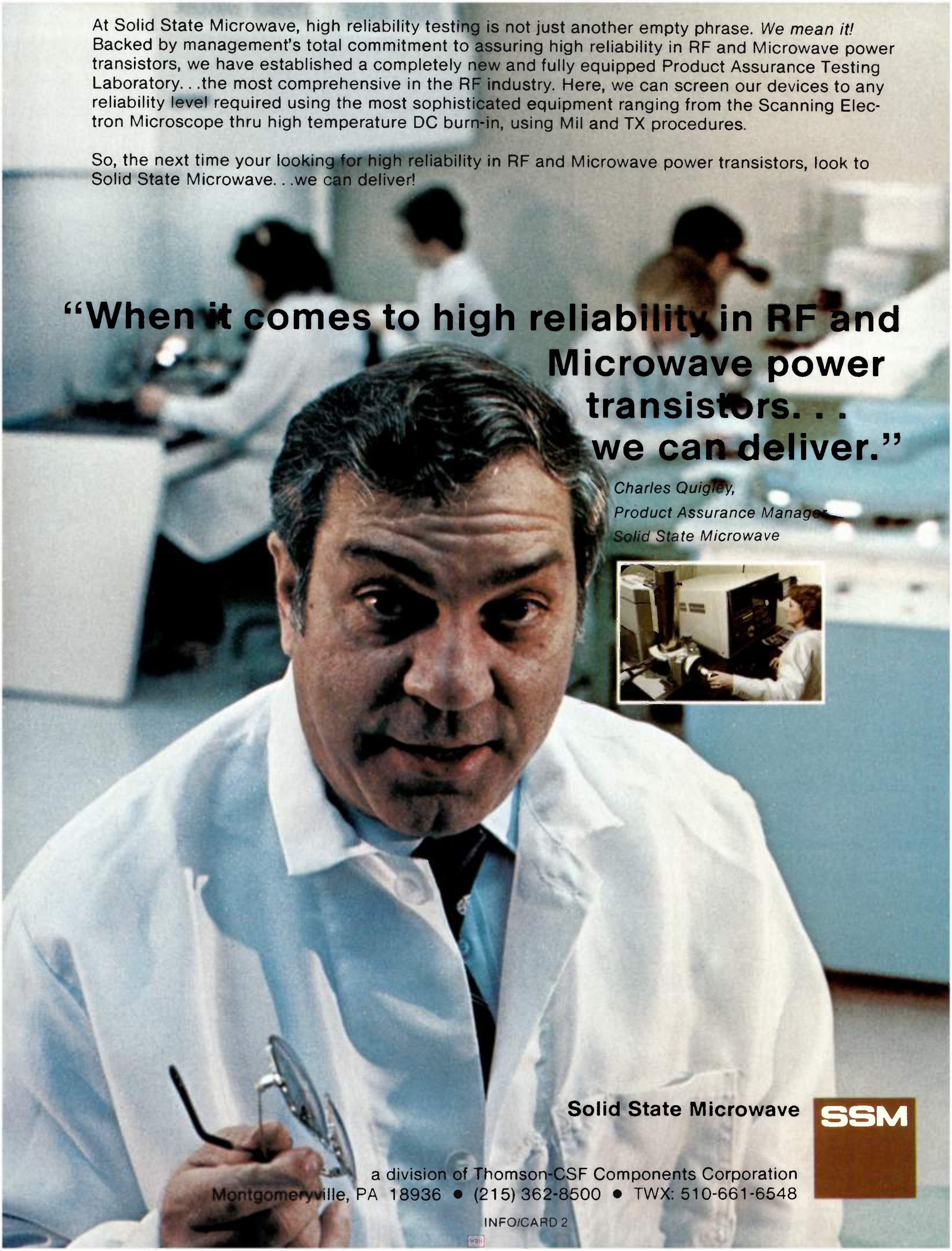

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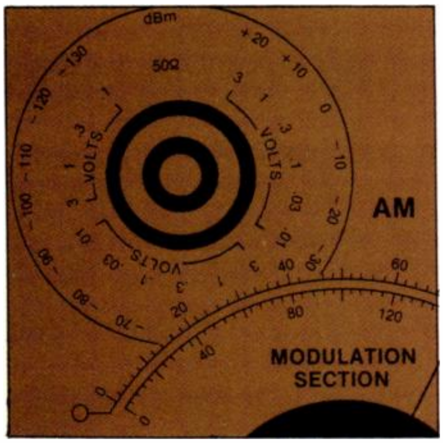

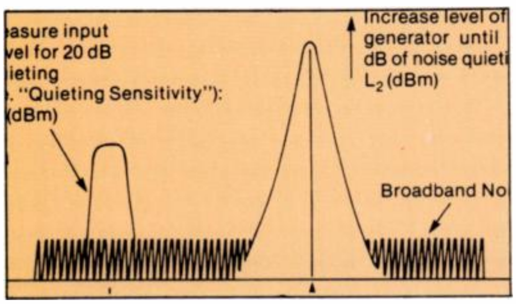

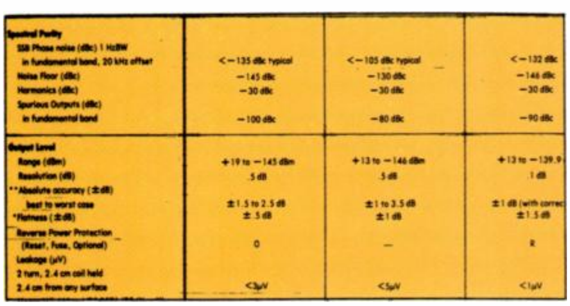

Spectral Purity			
SSB Phase noise (dBc) 1 HzBW in fundamental band, 20 kHz offset	<−135 dBc typical	<−105 dBc typical	<−132 dBc
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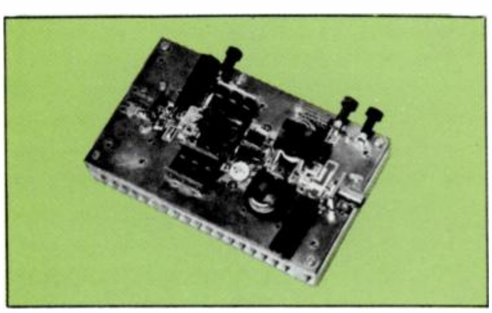
Harmonics (dBc)	−30 dBc	−30 dBc	−30 dBc
Spurious Outputs (dBc) in fundamental band	−100 dBc	−80 dBc	−90 dBc
Output Level			
Range (dBm)	+19 to −145 dBm	+13 to −146 dBm	+13 to −139.9
Resolution (dB)	.5 dB	.5 dB	.1 dB
**Absolute accuracy (±dB) best to worst case	±1.5 to 2.5 dB	±1 to 3.5 dB	±1 dB (with correc
*Flatness (±dB)	±.5 dB	±1 dB	±1.5 dB
Reverse Power Protection (Reset, Fuse, Optional)	O	—	R
Leakage (μV) 2 turn, 2.4 cm coil held 2.4 cm from any surface	<3μV	<5μV	<1μV



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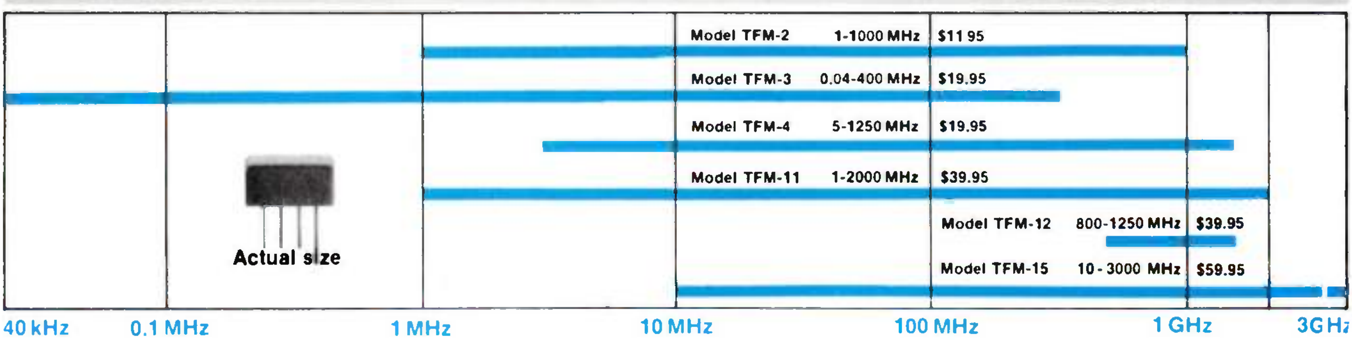

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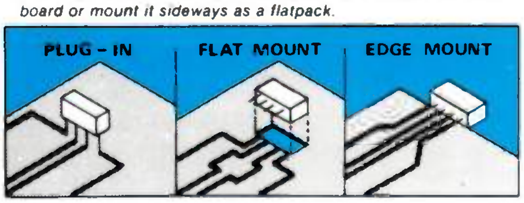

Model	Frequency, MHz			Conv. loss, dB				Isolation dB												Cost	
				One Octave From Band Edge		Total Range		Lower Band Edge To one Decade Higher				Mid Range				Upper Band Edge To Octave Lower					
								LO-RF		LO-IF		LO-RF		LO-IF		LO-RF		LO-IF			
Model No	LO	RF	IF	Typ	Max	Typ	Max	Typ	Min	Typ	Min	Typ	Min	Typ	Min	Typ	Min	Typ	Min	Quantity	Price
TFM-2	1-1000	1-1000	DC-1000	6.0	7.5	7.0	8.5	50	45	45	40	40	25	35	25	30	25	25	20	6-49	$11.95
TFM-3	.04-400	.04-400	DC-400	5.3	7.0	6.0	8.0	60	50	55	40	50	35	45	30	35	25	35	25	5-49	$19.95
TFM-4	5-1250	5-1250	DC-1250	6.0	7.5	7.5	8.5	50	45	45	40	40	30	35	25	30	25	25	20	5-49	$19.95
TFM-11	1-2000	1-2000	5-600	7.0	8.5	7.5	9.0	50	45	45	40	35	25	27	20	25	20	25	20	1-24	$39.95
TFM-12	800-1250	800-1250	50-90	—	—	6.0	7.5	35	25	30	20	35	25	30	20	35	25	30	20	1-24	$39.95
*TFM-15	10-3000	10-3000	10-800	6.3	7.5	6.5	9.0	30	20	30	20	30	20	30	20	30	20	30	20	1-9	$59.95

Signal 1 dB compression level +1 dBm. Impedance, all ports 50 ohms. Total input power 50 mW. Total input, current peak 40 mA. Operating and storage temperature −55°C to +100°C. Pin temperature 510°F (10 sec).
*LO power +10 dBm, 1 dB compression +5 dBm

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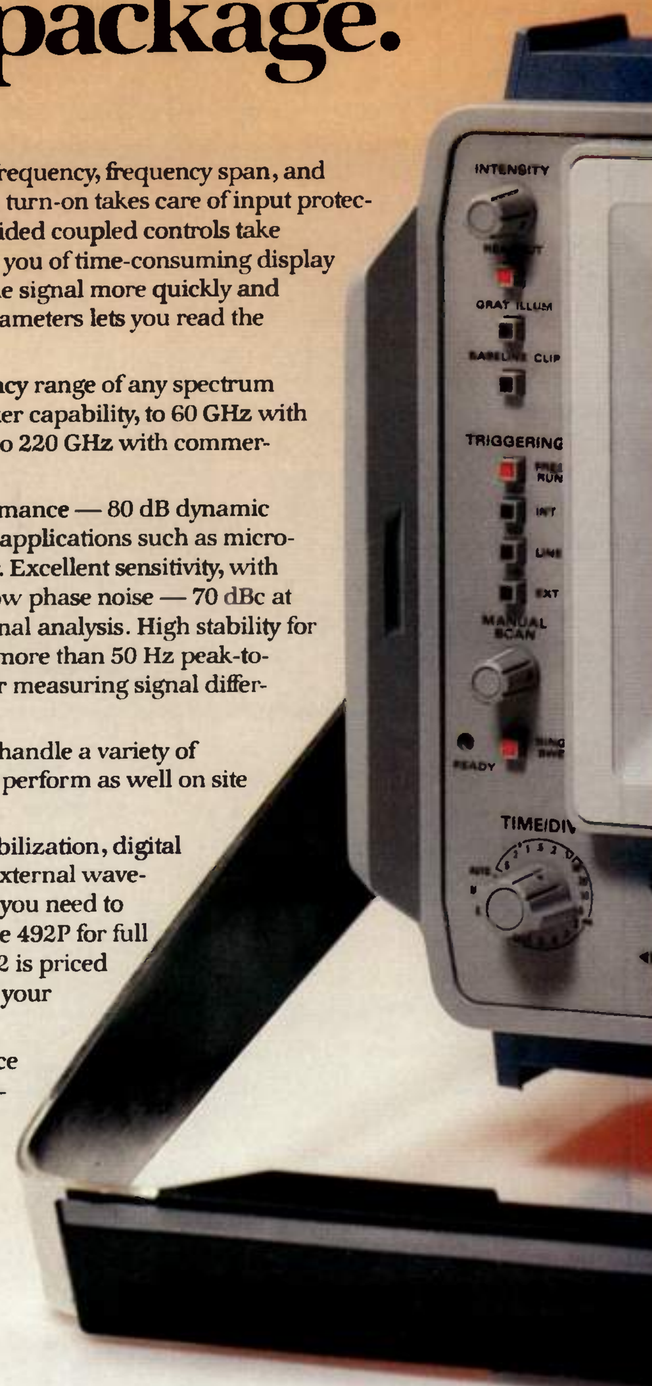

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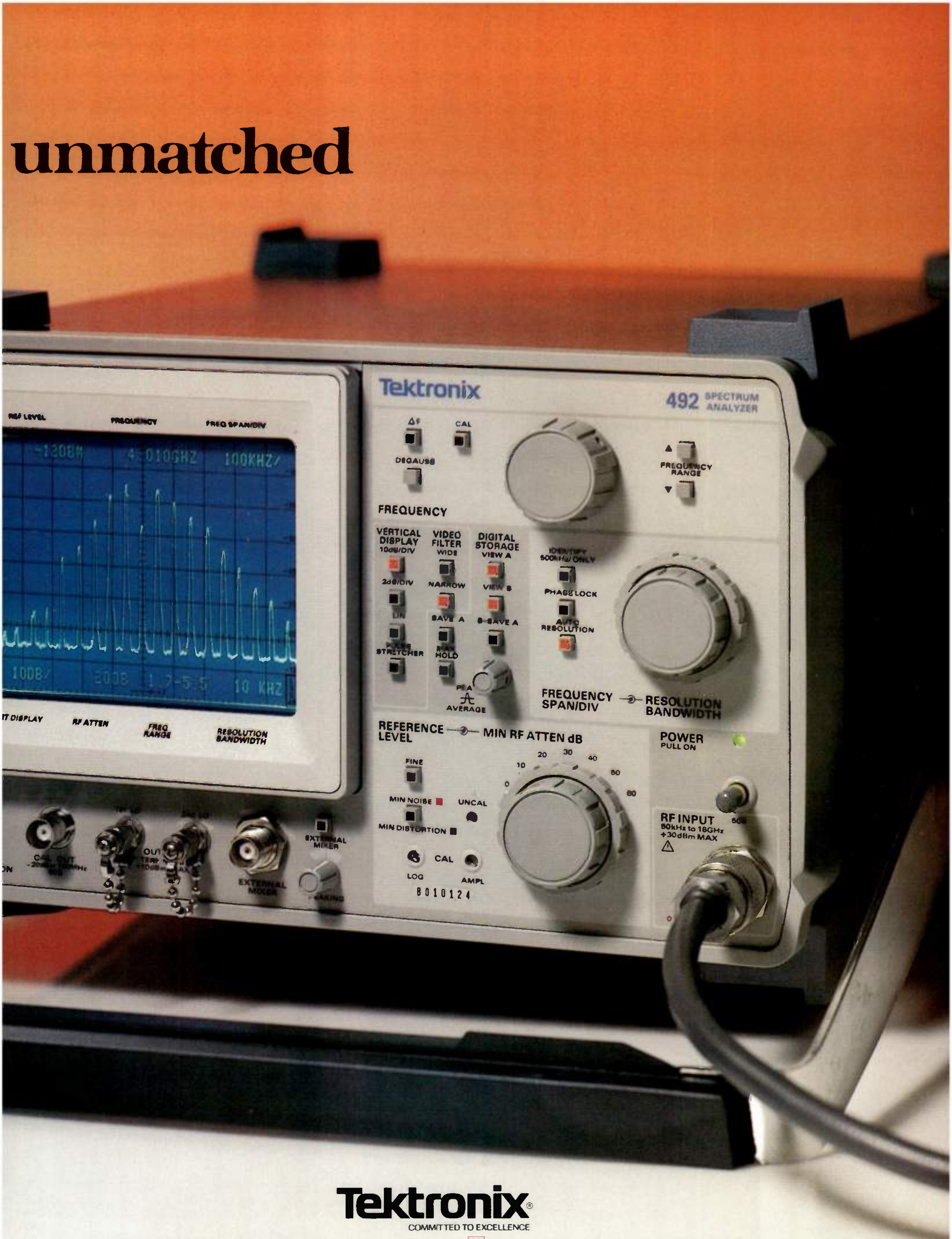

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Do not be fooled by the low prices, these brand new lab quality frequency counters have important advantages over instruments costing much more. The models 7010 and 8010 are not old counters repackaged but 100% new designs using the latest LSI state-of-the-art circuitry. With only 4 IC's, our new 7010 offers a host of features including 10 Hz to 600 MHz operation, 9 digit display, 3 gate times and more. This outperforms units using 10-15 IC's at several times the size and power consumption. The older designs using many more parts increase the possiblity of failure and complexity of troubleshooting. Look closely at our impressive specifications and note you can buy these lab quality counters for similar or less money than hobby quality units with TV xtal time bases and plastic cases!

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Quality metal cases with machine screws and heavy guage black anodized aluminum provide RF shielding, light weight and are rugged and attractive - not economical plastic.

For improved resolution there are 3 gate times on the 7010 and 8 gate times on the 8010 with rapid display update. For example, the 10 second gate time on either model will update the continuous display every 10.2 seconds. Some competitive counters offering a 10 second gate time may require 20 seconds between display updates.

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MODEL 7010 600 MHz

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- COMPACT SIZES—7010- 1-¾" Hx4-¼" Wx5-¼"D 8010- 3" Hx7-½" Wx6-½"D

MODEL	$ PRICE	RANGE 10Hz to	LED DIGITS	SENSITIVITY 50 OHM INPUT 25-250 MHz	250-450 MHz	450 MHz-1GHz	HI-Z INPUT 10Hz - 60 MHz	GATE TIMES	RESOLUTION 12 MHz	60 MHz	MAX FREQ	TCXO TIME BASE 20°-40° C	FREQ	EXT CLOCK INPUT	NI-CAD BATT PACK
7010 •7010.1	145.00 225.00	600 MHz	9	5-20 mV	10-30 mV	20-40 mV to 600 MHz	1-10 mV	[3] .1, 1, 10 SEC	.1Hz	1 Hz	10 Hz 600 MHz	1 PPM 0.1 PPM	10 MHz	YES OPTION $25	YES OPTION $15
8010 8010.1	325.00 405.00	1 GHz	9	1-10 mV	5-20 mV	10-25 mV	1-10 mV	[8] .01-20 SEC	.1 Hz	1 Hz	10 Hz 1 GHz	1 PPM 0.1 PPM	10 MHz	YES STD	YES OPTION $39

• Has precision 0.1 PPM TCXO time base

MODEL 7010

#7010	600 MHz Counter - 1 PPM TCXO	$145.00
#7010.1	600 MHz Counter - 0.1 PPM TCXO	$225.00

OPTIONS

#Ni-Cad-701	Ni-Cad Battery Pack & charging circuitry Installs inside unit	$ 15.00
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MODEL 8010

#8010	1 GHz Counter - 1 PPM TCXO	$325.00
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Pat Wiesner

Signal Generator Specifications — Part I

To an engineer or technician faced with the requirement for an RF signal generator, a proliferation of instruments is available. The challenge is to purchase the signal generator which has the specified capacity to fulfill all of the applications requirements. To aid the user in this task a review of the important signal generator specifications and how they affect various applications is presented here.

By Rob Oeflein
Marketing Engineer
Hewlett-Packard

To be classified as a signal generator an instrument must have three basic characteristics:

1. Calibrated and variable frequency over a broad range.
2. Calibrated and variable output level over a wide dynamic range.
3. One or more forms of calibrated modulation.

It is important to notice that not all frequency sources or synthesizers are signal generators. Sweepers, test oscillators, and traditional frequency synthesizers cannot be classified as signal generators because they usually lack a calibrated output or some form of calibrated modulation.

The wide variety of applications addressed by signal generators and some of the critical specifications associated with each are listed in Figure 1. The primary application in today's market, however, is that for which the signal generator was originally designed — receiver testing. Most signal generators can be easily classified, therefore, according to their capacity to perform in-channel (sensitivity, audio bandwidth, squelch threshold) or out-of-channel (adjacent channel selectivity, intermodulation distortion, spurious attenuation) receiver tests. Figure 2 lists some of the typical receiver tests and the standard signal generator characteristics which are required to perform them.

Types of Signal Generators

Most oscillators only cover a single octave, but many applications require greater than one octave of frequency coverage. Three techniques are commonly used to obtain wide frequency coverage in RF signal generators — reactance band-switching, high frequency tuned resonators with dividers or heterodyne circuits, and synthesis.

The reactance band-switched signal generator was the earliest design. Most of the older tube-type generators used switched inductors with variable capacitors and many updated solid-state signal generators still employ this technique.

The advent of broadband output power amplifiers and solid-state high frequency oscillators led to the development of signal generators that use a single high frequency tuned resonator. Dividers or a heterodyne technique can then be used to obtain the lower frequencies.

Division of the higher frequencies improves the

Major Uses of Signal Generators	Important Parameters
1) Receiver Testing and Calibration	Spurious Output Level Accuracy Phase Noise Modulation Distortion
2) R&D Design of Amplifiers, Antennas and Filters	Frequency Range Output Level Accuracy
3) Component Testing	Sweep Capability Frequency Accuracy Output Level Range
4) Local Oscillator Substitution	Frequency Stability Spectral Purity
5) EMI/RFI Susceptibility Testing or Calibration of Equipment	Leakage Output Level Accuracy Frequency Range
6) Communication System Maintenance	Modulation Flexibility Frequency Range Output Level Range
7) Metrology Lab Standard	Frequency Accuracy Output Level Accuracy Modulation Accuracy
8) Test Equipment Calibration	Frequency and Output Level Range and Accuracy

Figure 1. The major uses of signal generators and the signal generator parameters associated with each application.

Typical Receiver Tests	Signal Generator Characteristics Required
Usable Sensitivity	Low Leakage/Accurate, Low Level Signals
Image and IF Rejection — Tests Primarily RF Selectivity	Low Spurious/Output Levels >IV for Testing Large Rejection Ratios/Coverage of Both IF and RF Frequencies
Adjacent Channel Selectivity — Tests Primarily IF Selectivity	Low Noise at Typical Channel Spacings
Intermodulation — Tests RF Selectivity and Linearity	Good Isolation Between Two Generators
AM Rejection (on FM Receivers) — Tests Receivers' Immunity to AM Noise	Low Incidental FM/Simultaneous AM and FM Modulation
AGC Characteristics Audio Hum and Noise	Accurate, Wide Range Output Level Low Residual AM and FM
Audio Harmonic Distortion — Tests IF Amplitude and Phase Response Plus Discriminator Linearity	Low Modulation Distortion (Particularly Stringent for FM Broadcast, Typically <.1%)
IF and Discriminator Alignment	Wide Modulation Bandwidth/Sweep

Figure 2. Typical receiver tests and the critical signal generator characteristics associated with each test.

noise performance of these generators by a factor of about 6 dB for each divide by two. The tradeoff here is FM deviation capability which is halved with every division of two. Division also requires additional design to eliminate spurious, harmonics and noise caused by the dividers themselves.

Heterodyning, on the other hand, preserves the primary band FM deviations at the lower frequencies. Noise performance at the lower frequencies, however, is not improved from that of the primary band. To insure that the signal to noise performance is not degraded, a clean stable reference must be provided in the heterodyne design to act as local oscillator (LO) to down convert the primary oscillator's output.

Depending on the design, the output of either of these fundamental signal generators can be phase-locked to an external synchronizer or an internal reference to improve its long term stability.

Synthesizer techniques have recently been employed to yield the third type of signal generator. The synthesized signal generator is a source in which all of the output frequencies are derived from a fixed frequency reference oscillator. In this manner, the long and short term stability of this reference oscillator can be translated to the output.

Two techniques are employed to synthesize a signal. Indirect synthesis uses a combination of phase-lock loops and their associated voltage controlled oscillators (VCO's) to generate the RF spectrum. A direct synthesizer has one or more fixed frequency oscillators and all of the output frequencies are arithmetically generated by mixing, multiplying, or dividing with suitable filtering.

The advantages of a synthesized signal generator over a fundamental signal generator are better resolution (settability), higher long and short-term stability, and programming capability. The disadvantages include the presence of spurious signals from the synthesis process and the lack of a continuous tuning since synthesizers must increment frequency in discrete steps.

Signal Generator Specifications

The numerous specifications needed to quantify signal generator performance can be grouped in six basic categories. Figure 3 illustrates that these categories are frequency, spectral purity, output level, modulation, switching speed, and control. Each of these functions plays an important role in determining the overall capability of a signal generator to perform in a specific application.

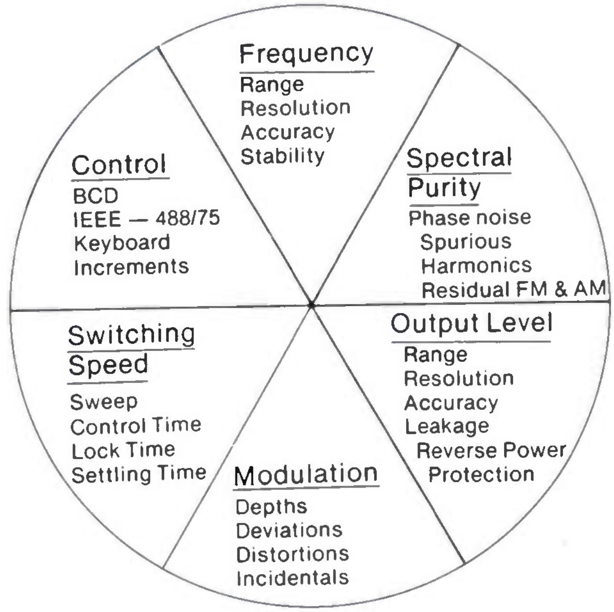


Figure 3. Six major categories for signal generator specifications.

Frequency

The choice of *frequency range* might at first seem fairly straightforward. In the maintenance of communication systems, however, it might be desirable for the generator to cover the IF, LO, and baseband frequencies as well as the RF. Image response testing, spurious checks and harmonic analysis all require RF capability greater than just the radio's receive frequency. In addition, the range of a fundamental generator's bands may restrict its usefulness if they are limited or divide certain commercial or military frequency groupings. In short, the versatility of a signal generator depends to a large extent on its frequency range.

Frequency resolution determines the minimum frequency change which can be made. The resolution may depend on the output frequency, providing less settability as the frequency increases. Synthesized RF generators available today may offer resolutions as broad as 1 kHz or as narrow as 0.1 Hz at an output frequency of 500 MHz. Fine resolutions are important for checking narrowband filters and testing radios which have 12.5 kHz or less channel spacings. In addition, if the source is to be multiplied up in frequency the resolution is reduced and finer resolution will allow better settability at the higher frequencies.

Repeatability of the frequency setting is determined primarily by the *frequency accuracy*. On mechanically tuned generators this is usually specified as a percent of the frequency set or as dial accuracy. Synthesized or phase-locked sources which digitally display the generator frequency usually derive their accuracy from the accuracy and aging rate of the reference oscillator. These generators will have their accuracy specified in parts per million (ppm) or as parts times ten to a minus power ($x10^{-y}$).

The frequency accuracy is particularly important in applications such as component testing or when the signal generator is used as a meteorology lab standard. It is important to notice that the resolution of a generator does not determine its accuracy. If a synthesizer has a resolution of 100 Hz but has a time

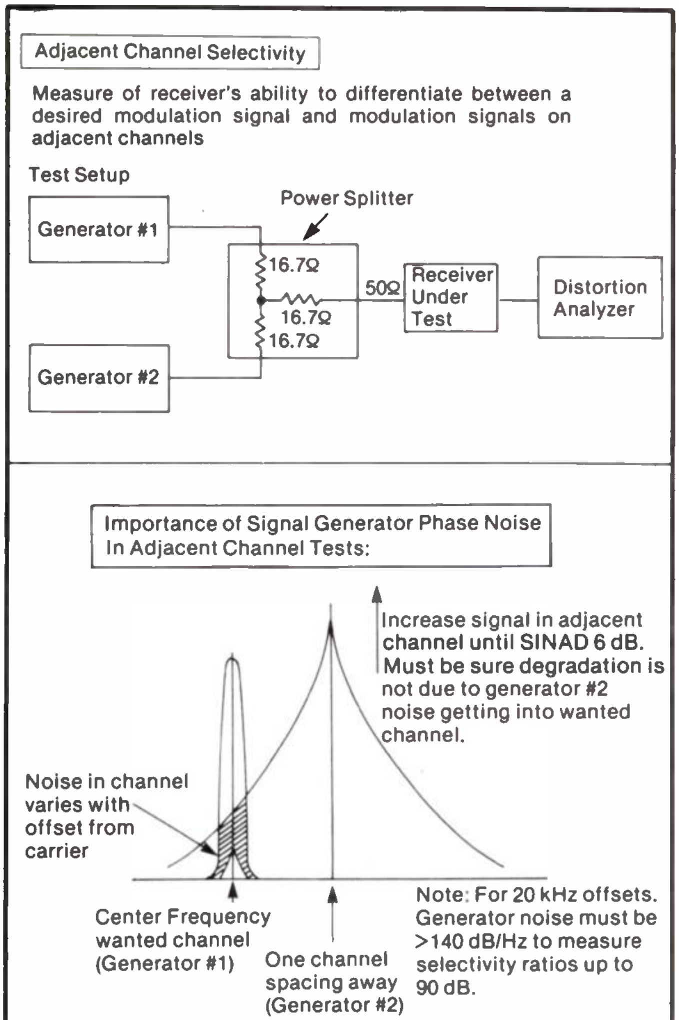


Figure 4. Effect of phase noise on adjacent channel selectivity tests.

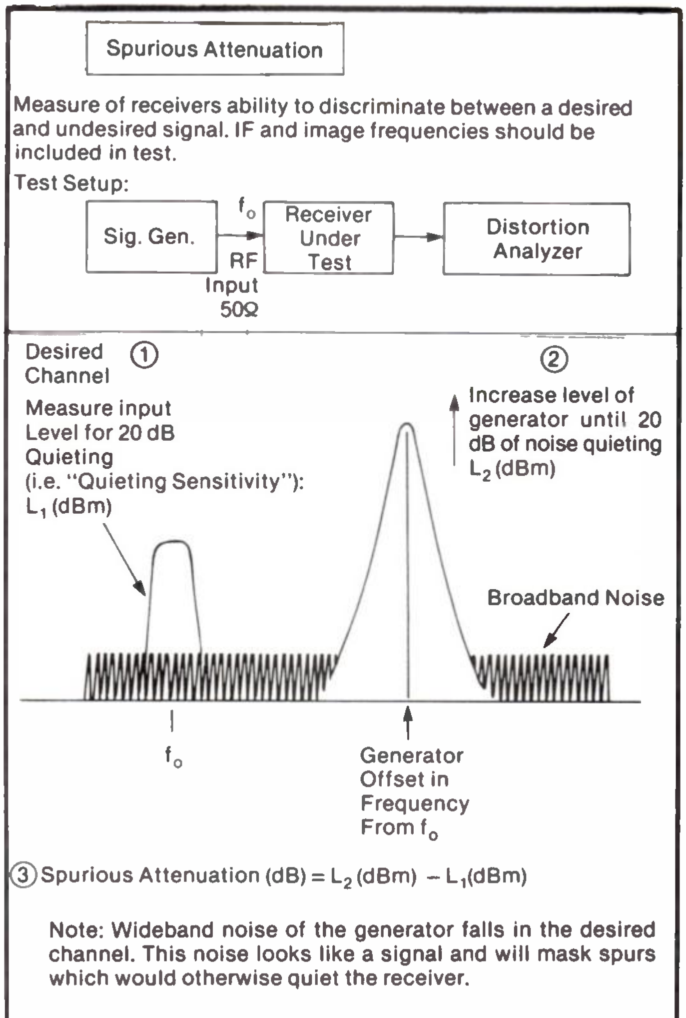


Figure 5. Effect of broadband noise on spurious attenuation tests.

base accuracy of 10ppm, the frequency accuracy at 500 MHz is ± 5 kHz.

Drift, or *long-term stability,* is usually defined over a period of time greater than one second. Specifications are usually given in ppm/hour or parts x 10^{-y}/day or year. An RF signal generator used to simulate a local oscillator in a deep space probe needs exceptional stability since the bandwidths of the receivers are typically very narrow.

For fundamental generators, which do not have frequency or phase-lock circuitry, temperature change is the primary cause of instability. Typical values may be 20 to 50ppm per ten minutes for an L-C oscillator, even after a two hour warm-up. This type of drift can become unacceptable for FM mobile radio testing, particularly with the new UHF 800-900 MHz radios that have 25 kHz channel spacings.

Phase-locked or synthesized sources rely on their internal reference oscillators for their long-term stability as well as frequency accuracy. Typical values may range from parts x 10^{-6}/day for a standard temperature controlled crystal to parts x 10^{-10}/day for an oven controlled oscillator. Oscillator drift improves as the temperature stabilizes during warm-up, so extrapolating specifications from per hour to per day or year will not usually yield accurate values for comparison. Other factors besides temperature, such as line voltage, output load variations and output level changes, may affect the generator's stability to a lesser degree.

Short-term stability of a signal generator is normally defined for averaging times less than one second, since it refers to changes in frequency which have negligible long-term effects. These instabilities result from noise modulating the carrier and are best characterized under the heading of spectral purity.

Spectral Purity

All oscillators exhibit noise which is made up of random nondeterministic signals. Thermal noise, shot noise, and 1/f or flicker noise contribute to time-dependent phase and amplitude fluctuations on the signal. These fluctuations manifest themselves as various amounts of amplitude and angular modulation on the carrier and may limit a signal generator's capability to perform in many applications.

Figures 4 and 5 illustrate how this noise can mask the true performance of a receiver during such critical tests as adjacent channel selectivity or spurious attenuation. If the signal is multiplied up in frequency, the maximum amplitude of the FM noise sidebands increases in direct relation to the multiplication ratio. This naturally limits the signal-to-noise performance at the higher frequencies.

A useful measure of *short-term frequency stability* must allow the performance of the signal generator to be predictable in a wide variety of applications and serve as a basis to allow comparisons among signal generators. Single-sideband phase noise, residual FM, and fractional frequency deviation are all terms used to describe a generator's short-term stability. Either the time domain (using digital frequency counters) or the frequency domain (using spectrum analyzers) may be used to characterize this performance. The actual measurement procedures are well described in references 2 and 4.

Fractional frequency deviation can be measured in the time domain with a frequency counter. It is based on the statistical distribution of the output frequency which results from the random noise modulation. The statical measurement, more commonly known as the Allan variance after its developer, is expressed as the square of the standard deviation (σ) of the fractional frequency fluctuations over a measurement averaging time interval (τ). When the averaging time is varied a plot of σ (τ) versus τ may be generated.

It is evident that for a single point the averaging time must be the same for a comparison between any two sources to be valid. The plot of the fractional frequency deviation is helpful for many applications such as doppler radar or high stability crystal oscillator analysis. As the averaging time decreases, however, the measurement becomes difficult and a detailed characterization of the signal generator's performance is complicated. As measurement averaging times increase and the deviations become correspondingly smaller, the randomness of the fluctuations becomes obscured since the average must approach the nominal output frequency drift in the long run.

The most common and meaningful method of specifying short-term stability is a plot of the signal generator's *single-sideband (SSB) phase noise* in a 1 Hz bandwidth versus the offset from the carrier. This is illustrated in Figure 6. The SSB phase noise is expressed in dB relative to the carrier (dBc). A 1 Hz bandwidth is used since the noise in other bandwidths can then be easily calculated (a times 10 increase in bandwidth yields a 10 dB increase in the noise power).

This plot is a graphical representation of the phase noise distribution on one side of the carrier with the assumption that the distribution on the other side is identical. From this curve it is possible to calculate the other two principle methods of specifying short-term stability — fractional frequency deviation and residual FM. These calculations are described in detail in reference 3.

For SSB phase noise in a 1 Hz bandwidth to serve as a basis for comparison among signal generators, three parameters must be known: the phase noise, the offset, and the output frequency. All are important, and the specification becomes meaningless if one of them is missing. The need to specify the offset is clearly illustrated in Figure 6, while the need to indicate the generator's output frequency is apparent if one recalls that roughly a 6 dB improvement in noise performance is gained if the output frequency is divided by two.

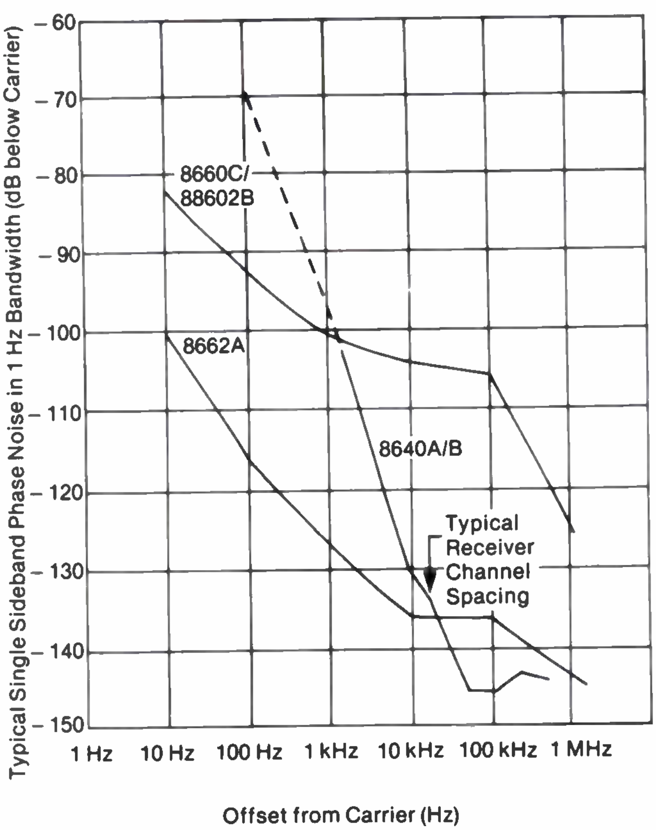


Figure 6. SSB phase noise plots of a cavity-tuned generator (8640A/B) and two synthesized generators. $F_c = 500$ MHz.

Noise floor refers to the signal generators broadband SSB phase and AM noise. It is desirable to have the noise floor as close to the thermal noise level (kTB) as possible for receiver tests such as image rejection or spurious response testing (see Figure 5). It is also preferable to reach the noise floor as close to the carrier as possible, since the SSB phase noise is a limiting factor in many applications.

Residual FM specifies undesired angular modulation. It is measured on a CW signal in a given bandwidth and includes the effects of both spurious and phase noise. It is essentially the integral of the phase noise curve (including spurious) whose limits represent the post-detection bandwidth of interest. The units are in RMS deviation and again the generator output frequency must be given since

residual FM varies with both bandwidth and frequency. Typical bandwidths used to measure residual FM are 300 Hz to 3 kHz and 20 Hz to 15 kHz. Without the bandwidth or the output frequency specified, residual FM is meaningless as a basis for comparison.

The residual FM specification gives the signal generator user an idea of the noise present on the signal which will limit his ability to measure the quieting of a receiver or the receiver's signal-to-noise ratio. It also acts as a figure of merit that indicates the signal generator's capability to be used as a local oscillator or a source that is to be multiplied. Because the actual distribution of the noise is not readily apparent, residual FM does not give a good indication of the generator's ability to make out-of-channel receiver measurements or to perform in narrowband applications which require the close-in phase noise to be very low.

Residual AM is similar to residual FM in that it results from noise modulating the carrier, but it is only concerned with that noise which causes undesired fluctuations in the signal amplitude. Residual AM does not affect short-term frequency stability, but it is an important aspect of the overall spectral purity. Besides limiting the signal generator's performance in AM systems, residual AM sidebands increase the total noise. The post-detection bandwidth is again critical to the specification, and the units are generally dBc for an average RMS value (this includes both sidebands).

Discrete spectral lines not harmonically related to the carrier are commonly referred to as *spurious outputs.* Spurious outputs are a direct result of mixing and dividing, so they are generally of more concern in synthesizers than fundamental generators. Spurs can appear symmetrically around the car-

References

1. *Today's Lesson — Learn About Low-Noise Design,* Deiter Scherer, "Microwaves," April 1979, pp. 116-122, May 1979, pp. 72-77.
2. *Frequency Stability Measurement Procedures,* Michael C. Fischer, Hewlett-Packard Co., presented at the 8th annual Precision Time and Time Interval meeting, December 1976.
3. *Frequency Domain Stability Measurement: A Tutorial Introduction,* N.B.S. Technical Note 679, March 1976.
4. *Understanding and Measuring Phase Noise in the Frequency Domain,* Hewlett-Packard Applications Note 207.
5. *Measuring Phase Spectral Density of Synthesized Sources Exhibiting f_0 and f_{-1} Noise Characteristics with the 5390A Frequency Stability Analyzer,* Hewlett-Packard Application Note 225.
6. *Output Level Accuracy,* Hewlett-Packard Application Note 170-1.
7. *Third Order Intermodulation Characteristics,* Hewlett-Packard Application Note 170-2.

rier, as in the case of power line related noise, or they can move rapidly relative to the carrier as the frequency is varied if they result from mixing in the synthesis process. Through judicious design these line related and assymmetrical spurs can be reduced in effect, but not eliminated.

Since spurs not only mask the performance of the system under test but also contribute to residual AM and FM, they can drastically effect many applications. Spurious attenuation, for example, is the ability of a receiver to discriminate between a desired signal and an undesired one, including IF and image responses. If the generator used to measure spurious attenuation has spurs larger than the specified performance of the radio, the test is meaningless. When the signal generator is used as a local oscillator, spurious signals will cause the desired output to vary in phase at the IF frequency, and they are a possible source of intermodulation products. Figure 7 illustrates how a 1 kHz spur of – 80 dBc will contribute – 86 dBc sidebands to residual AM and ØM at a 1 kHz rate.

The total *harmonic content* of the CW signal can be a key specification in some applications. If the harmonics are specified at – 20 dBc, one percent of the total output power resides in them. The harmonics will restrict the users ability to make linearity tests and broadband power measurements. Subharmonics which result from a doubling process are also undesirable signals on the output, but in most cases they can be externally filtered out. The harmonic content of the output may vary across the signal generator's frequency range and increase at high output levels.

(Editor's note: Next issue will carry the conclusion of Mr. Oeflein's article.) □

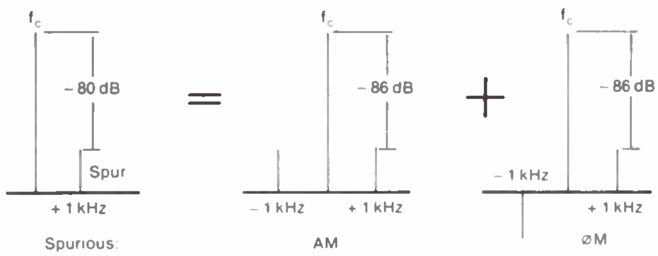
Figure 7. The effect of spurious outputs from a signal generator.

Spurious

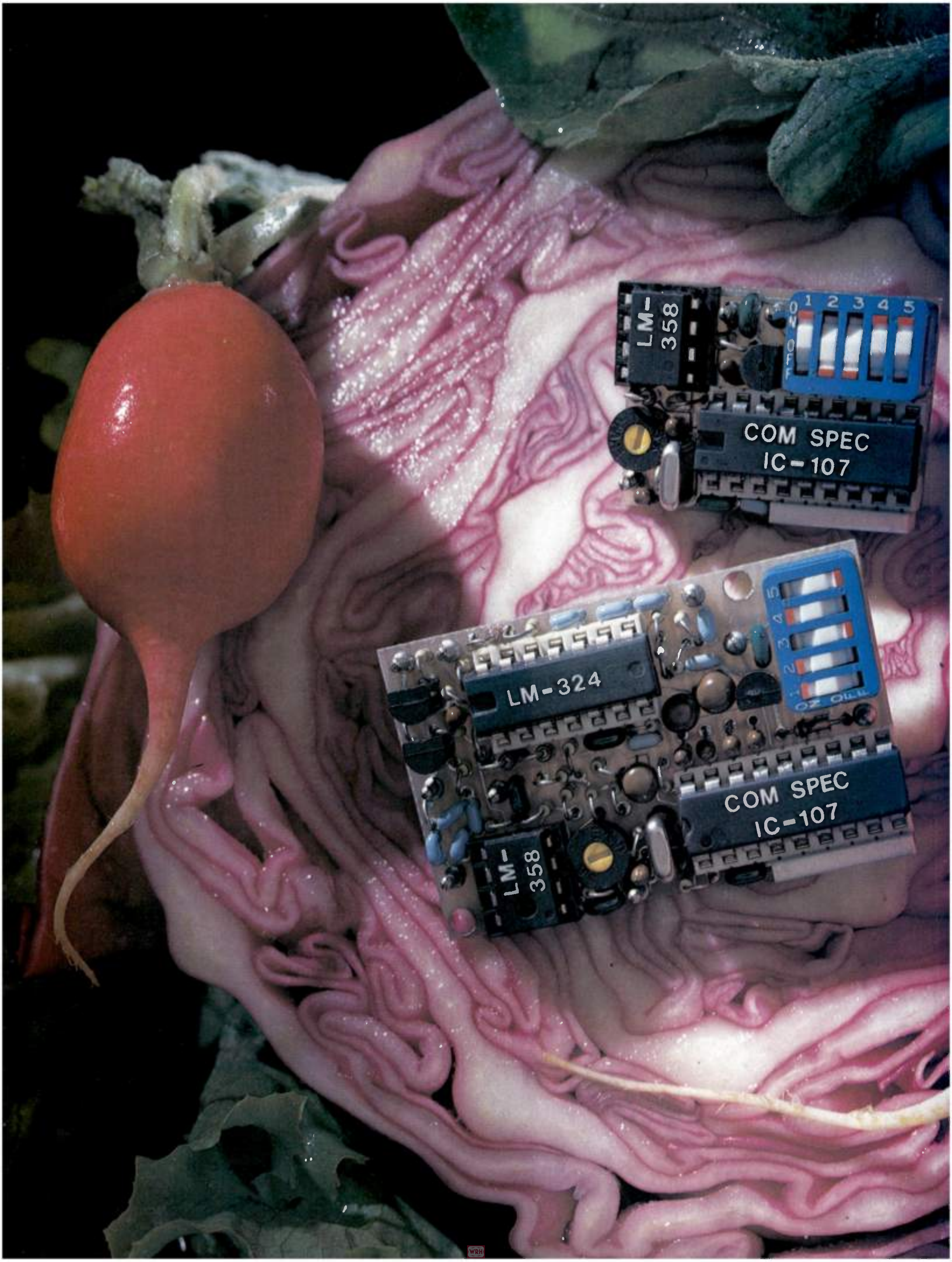
Problems Caused by Spurious:
1) When the Synthesizer Is Used Directly Into a Mixer or as an LO Spurious Result in Intermodulation Products at the Output of the Mixer.

2) In Receiver Testing Set-Ups, Spurious Can Feed Directly into the IF of the Receiver

3) Spurious Also Contribute to Residual AM and FM.



Residual AM and ØM Contribution of a Spurious Signal – 80 dB and 1 kHz from the Carrier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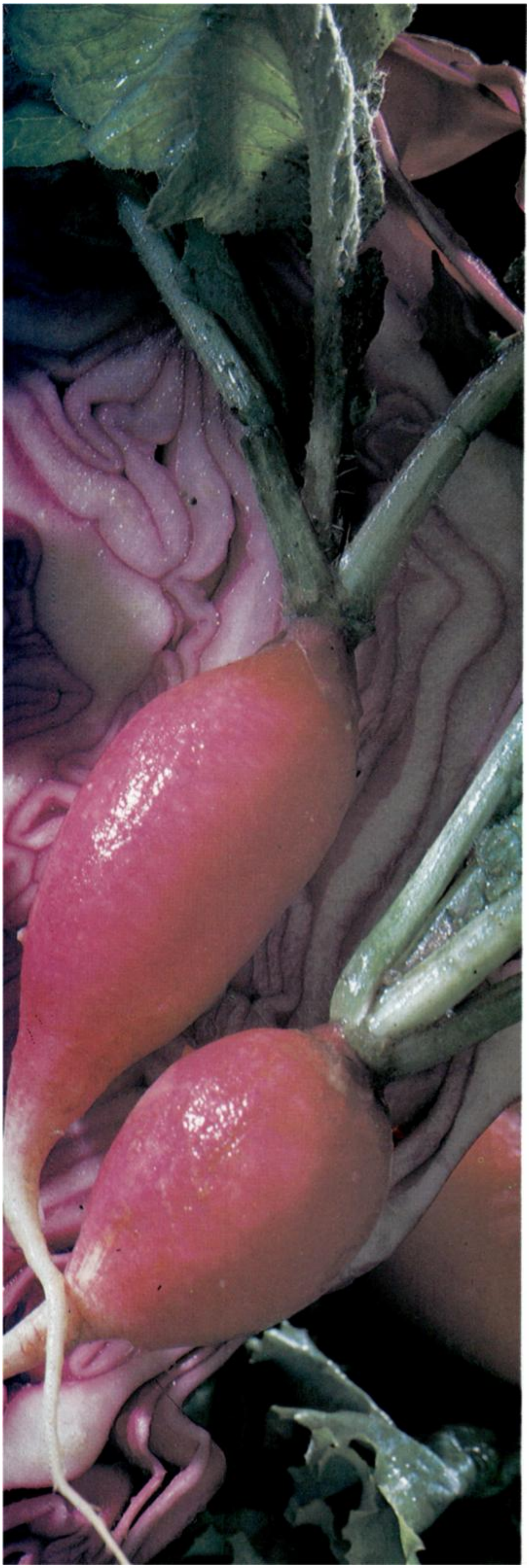

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- Meets all new RS-220-A specifications
- Available in all 32 EIA standard CTCSS tones

SS-32 Encoder

- Size: .9″ x 1.3″ x .40″
- Available with either Group A or Group B tones

Frequencies Available:

Group A			
67.0 XZ	91.5 ZZ	118.8 2B	156.7 5A
71.9 XA	94.8 ZA	123.0 3Z	162.2 5B
74.4 WA	97.4 ZB	127.3 3A	167.9 6Z
77.0 XB	100.0 1Z	131.8 3B	173.8 6A
79.7 SP	103.5 1A	136.5 4Z	179.9 6B
82.5 YZ	107.2 1B	141.3 4A	186.2 7Z
85.4 YA	110.9 2Z	146.2 4B	192.8 7A
88.5 YB	114.8 2A	151.4 5Z	203.5 M1

- Frequency accuracy, ± .1 Hz maximum − 40°C to + 85°C
- Frequencies to 250 Hz available on special order
- Continuous tone

Group B						
TEST-TONES:	TOUCH-TONES:		BURST-TONES:			
600	697	1209	1600	1850	2150	2400
1000	770	1336	1650	1900	2200	2450
1500	852	1477	1700	1950	2250	2500
2175	941	1633	1750	2000	2300	2550
2805			1800	2100	2350	

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*Over entire frequency range
**Includes temperature, flatness, attenuator accuracy, detector linearity, indicator accuracy, and measurement error.
Y=Yes N=No O=Optional

RF Signal Generator

	Automated Industrial Electronics Corp.				
	800A(1419)	801A(1420)	802A(1421)	803A(1429)	102C
Frequency					
Range	25 MHz to 960 MHz	25-470 MHz	25-470 MHz	25-516 MHz	450 kHz-520 MHz
Resolution	NA	NA	NA	NA	100 Hz, 1 kHz
Stability (parts x 10^{-4}/Day)	50	50	50	50	10PPM/10 Min.
at room temperature					
Spectral Purity					
SSB Phase noise (dBc) 1 HzBW in					
fundamental band, 20 kHz offset	40	40	40	40	125 dB
Noise Floor (dBc)	90	90	90	90	135 dB
Harmonics (dBc)	30	30	30	30	30 dB
Spurious Outputs (dBc)	70	70	70	70	80 dB
in fundamental band					
Output Level					
Range (dBm)	−8 to −130	−8 to −130	−8 to −130	−8 to −130	−130 to +13
Resolution (dB)	±.5	±.5	±.5	±.5	Var. 13 dB
**Absolute accuracy (±dB)					
best to worst case	±1.5	±1.5	±1.5	±1.5	1.1 dB/2 dB
*Flatness (±dB)	±1	±1	±1	±1	0.5
Reverse Power Protection	NA	NA	NA	NA	
(Reset, Fuse Optional)					
Leakage (μV)					
2 turn, 2.4 cm coil held	.1	.1	.1	.1	Unrestricted measurements on fractional-
2.4 cm from any surface					
Meets Mil 461 or VDE 0571/75 (Y or N)	N	N	N	N	
Modulation					
AM	FM only	FM only	FM only	FM only	0.30%, 0-100%
Depth (min to max%)					400 Hz, 1 kHz, 3 kHz, 10 kHz, 19 kHz
Rates INT					DC to 20 kHz
EXT AC/DC best case					1% to 30% AM,
Distortion (min to max%)					0.2
Incidental QM (radians)					
at 30% AM 1 kHz rate					
Modulation					
FM					
Deviation (max)	±32 kHz	±32 kHz	±32 kHz	±32 kHz	0-300 kHz, 32-175 MHz 0-300 kHz Int.
Rates INT					400 Hz, 1 kHz, 3 kHz, 10 kHz, 19 kHz
EXT AC/DC best case					DC-200 kHz
Distortion (min to max %)	1-3	1-3	1-3	1-3	
Incidental AM (%) at max deviation	3	3	3	3	0.2% at 100 kHz
QM (Y or N)	N	N	N	N	N
Pulse (Y or N)	N	N	N	N	N
Switching Speed					
Settling time (frequency to be within 100 Hz)	NA	NA	NA	NA	NA
Sweep (Y or N)	N	N	N	N	
Control					
BCD (Y, N, O)	N	N	N	N	N
IEEE-488 75 (Y,N,O)	N	N	N	N	N
General					
Dimensions H" x W" x D"	10 x 14 x 9	10 x 14 x 9	10 x 14 x 9	10 x 14 x 9	5.22 x 18.95 x 17.50
Weight lbs/KG	24 lbs	24 lbs	24 lbs	24 lbs	30 lbs
Type of Generator					
Fundamental or Synthesized	Fundamental	Fundamental	Fundamental	Fundamental	Fundamental
Price	$1295	$1295	$1295	$1295	$4,440

Specification Matrix

Boonton			John Fluke Company			
102D	**103C**	**103D**	**6010A**	**6011A**	**6039A**	**6160B**
450 kHz-520 MHz 10 kHz Selectable 0.05 PPM/Hr.	125 kHz-175 MHz 1 Hz to 16 MHz 10 PPM/10 Min.	125 kHz-175 MHz 10 Hz, 100 Hz, 1 kHz 0.05 PPM/Hr.	10 Hz-11 MHz 0.1 Hz/10 Hz 1 x 10^{-8}/day	10 Hz-11 MHz 0.1 Hz/10 Hz 1 x 10^{-8}/day	1 MHz-40 MHz 0.1 Hz/1 Hz 2 x 10^{-9}/day	1 MHz-160 MHz 0.1 Hz/1 Hz 2 x 10^{-9}/day
125 dB 135 dB 30 dB 80 dB	125 dB 135 dB 30 dB 60 dB	125 dB 135 dB 30 dB 60 dB	−106 No Spec −40 −60	−106 No Spec −40 −60	−116 −155 −25 −80	−122 −155 −25 −83
−130 to +13 Var. 13 dB 1.1 dB/2 dB 0.5 Int. Replaceable Fuse (Option .04) microvolt-sensitivity unshielded receivers in close proximity to the generator	−130 to +23 Var. 13 dB 1.1 dB/2 dB 0.5	−130 to +23 Var. 13 dB 1.1 dB/2 dB 0.5	+27 to −59 dBm 0.1 dB <7% range ±0.5 N — No Spec N	+27 to −59 dBm 4 digits 0.15% ±0.2 N — No Spec N	+13 to 3 dBm var. No Spec ±1 N — No Spec N	+13 to 3 dBm var. No Spec ±1 N — No Spec N
0-30%, 0-100% 400 Hz, 1 kHz, 3 kHz, 10 kHz, 19 kHz DC to 20 kHz 3% to 90% 0.2	0-30%, 0-100% 400 Hz, 1 kHz, 3 kHz, 10 kHz, 19 kHz DC to 20 kHz 1% to 30% 0.2	0-30%, 0-100% 400 Hz, 1 kHz, 3 kHz, 10 kHz, 19 kHz DC to 20 kHz 5% to 50% 0.2	0-90% N 10 kHz No Spec No Spec	0-90% N 10 kHz No Spec No Spec	No Mod No Mod No Mod No Mod No Mod	No Mod No Mod No Mod No Mod No Mod
0-300 kHz, 32-175 MHz 0-1 MHz Ext 400 Hz, 1 kHz, 3 kHz, 10 kHz, 19 kHz DC-200 kHz 0.2% at 100 kHz N N	0-300 kHz, 32-175 MHz 0-100 kHz 400 Hz, 1 kHz, 3 kHz, 10 kHz, 19 kHz DC-200 kHz 0.25% at 100 kHz N N	0-300 kHz, 32-175 MHz 0-32 MHz 400 Hz, 1 kHz, 3 kHz, 10 kHz, 19 kHz DC-200 kHz 0.25% at 100 kHz N N	20 kHz NA DC-10 kHz 3% N N	20 kHz NA DC-10 kHz 1% N N	No Mod No Mod No Mod No Mod No Mod No Mod	No Mod No Mod No Mod No Mod No Mod No Mod
NA	NA	NA	2 μSec N	2μSec N	800 μ Sec N	800 μ Sec N
N N	N N	N N	Y O	Y O	Y O	Y O
5.22 x 18.95 x 17.50 40 lbs Fundamental $5,315	5.22 x 18.95 x 17.50 30 lbs Fundamental $5,025	5.22 x 18.95 x 17.50 40 lbs Fundamental $5,590	5 1/4 x 8 1/2 x 19 25 lbs Synthesized $2995	5 1/4 x 8 1/2 x 19 25 lbs Synthesized $4595	7 x 19 x 20 42 lbs Synthesized $4395	7 x 19 x 20 45 lbs Synthesized $6395

Sweep Capability on 103C/D

f_o	Max Sweep Width	Marker (Intensity)
262 kHz	±30 kHz	No
465 kHz	±30 kHz	No
1.2 MHz	±100 kHz	No
10.7 MHz	± [illegible] MHz	Yes
98 MHz	±10 MHz	Yes

*Over entire frequency range
**Includes temperature, flatness, attenuator accuracy, detector linearity, indicator accuracy, and measurement error.
Y = Yes N = No O = Optional

RF Signal Generator Specification Matrix (Continued)

	Hewlett-Packard			
	8640B	**8660A/C**	**8662A**	**8654A/B**
Frequency		(Depends on plug-in)		
Range	.45 to 550 MHz (1100 MHz)	.01 to 1300 MHz (2600 MHz)	.01 to 1280 MHz	10 to 520 MHz
Resolution	.1 to 1000 Hz	1 Hz to 2 Hz	.1 to .2 Hz	5ppm
Stability (parts x 10^{-4}/Day) at room temperature	$<1.2 \times 10^{-6}$/day	$<3 \times 10^{-8}$/day	$<5 \times 10^{-10}$/day	$<57 \times 10^{-4}$/day
Spectral Purity				
SSB Phase noise (dBc) 1 HzBW in fundamental band, 20 kHz offset	<−135 dBc typical	<−105 dBc typical	<−132 dBc	<−110 dBc typical
Noise Floor (dBc)	−145 dBc	−130 dBc	−146 dBc	<−130 dBc typical
Harmonics (dBc)	−30 dBc	−30 dBc	−30 dBc	−20 dBc
Spurious Outputs (dBc) in fundamental band	−100 dBc	−80 dBc	−90 dBc	−100 dBc
Output Level				
Range (dBm)	+19 to −145 dBm	+13 to −146 dBm	+13 to −139.9 dBm	+10 to −130 dBm
Resolution (dB)	.5 dB	.5 dB	.1 dB	.5 dB
**Absolute accuracy (±dB) best to worst case	±1.5 to 2.5 dB	±1 to 3.5 dB	±1 dB (with correction)	±1.5 to 3 dB
*Flatness (±dB)	±.5 dB	±1 dB	±1.5 dB	±1 dB
Reverse Power Protection (Reset, Fuse, Optional)	O	—	R	O
Leakage (μV) 2 turn, 2.4 cm coil held 2.4 cm from any surface	<3μV	<5μV	<1μV	<.5μV
Meets Mil 461 or VDE 0571/75 (Y or N)	Y	Y	Y	Y
Modulation				
AM				
Depth (min to max %)	0 to 100%	0 to 90%	0 to 95%	0 to 90%
Rates INT	.4, 1 kHz	.4, 1 kHz	.4, 1 kHz	.4, 1 kHz
EXT AC/DC best case	20 Hz/DC to 60 kHz	DC to 60 kHz	DC to 10 kHz	DC to 20 kHz
Distortion (min to max %)	<1 to <3%	<1 to <5%	<2 to <5.75%	<3 to <5%
Incidental QM (radians) at 30% AM 1 kHz rate	<.3 radian	<.2 radian	<.11 radian	<.2 radian
Modulation				
FM				
Deviation (max)	2.56 MHz	1 MHz	200 kHz	100 kHz
Rates INT	.4, 1 kHz	.4, 1 kHz	.4, 1 kHz	.4, 1 kHz
EXT AC/DC best case	20 Hz/DC to 250 kHz	20 Hz/DC to 200 kHz	20 Hz/DC to 100 kHz	DC to 25 kHz
Distortion (min to max %)	<1 to <3%	<1 to <3%	<1.7%	<2 to <3%
Incidental AM (%) at max deviation	<1%	<.2%	<.11%	<1%
QM Y or N	N	Y	N	N
Pulse (Y or N)	Y	Y	N	N
Switching Speed				
Settling time (frequency to be within 100 Hz)	—	5μs	400μs	—
Sweep (Y or N)	N	Y	Y	N
Control				
BCD (Y,N,O)	N	Y	N	N
IEEE-488 75 (Y,N,O)	N	O	Y	N
General				
Dimensions H" x W" x D"	5 17/32" x 16 3/4" x 18 3/4"	6 15/16" x 16 3/4" x 23 5/8	7" x 16 3/4" x 20.75"	7" x 10.5" x 12"
Weight lbs/KG	45.8 lbs/20.8 kg	53 lbs/23.8 kg	65.5 lbs/30 kg	17.5 lb/8 kg
Type of Generator Functional or Synthesized	Functional	Synthesized	Synthesized	Functional
Price	$6950	$11,700 to $25,500	$24,700	$2400/$2900

*Over entire frequency range
**Includes temperature, flatness, attenuator accuracy, detector linearity, indicator accuracy, and measurement error.
Y = Yes N = No O = Optional

RF Signal Generator Specification Matrix (Continued)

	Krohn-Hite			
	2000	**2200**	**2400**	**SSG 520**
Frequency				
Range	3 MHz-30 MHz	3 MHz-30 MHz	3 MHz-30 MHz	10 MHz-520 MHz
Resolution	Infinite	Infinite	Infinite	100
Stability (parts x 10^{-4}/Day)	.05%	.05%	.05%	2ppm/yr
at room temperature				
Spectral Purity				
SSB Phase noise (dBc) 1 HzBW in fundamental				
band, 20 kHz offset				−115 dB
Noise Floor (dBc)				125
Harmonics (dBc)	<.5%	<.5%	<.5%	25
Spurious Outputs (dBc)				
in fundamental band				
Output Level				
Range (dBm)	20	20	20	0→−120
Resolution (dB)	Infinite	Infinite	Infinite	1 dB
**Absolute accuracy (±dB)	±0.2	±0.2	±0.2	±.2
best to worst case				
*Flatness (±dB)	±0.1	±0.1	±0.1	±1
Reverse Power Protection				O
(Reset, Fuse Optional)				
Leakage (μV)				None
2 turn, 2.4 cm coil held				
2.4 cm from any surface				<0.5
Meets Mil 461 or VDE 0571/75 (Y or N)	N			N
Modulation				
AM				
Depth (min to max %)			100%	90%
Rates INT			300 kHz	300 Hz and 1 kHz
EXT AC/DC best case			DC/2 MHz	20 Hz-50 kHz
Distortion (min to max %)			<1%	<1.5%
Incidental ØM (radians)				
at 30% AM 1 kHz rate				
Modulation				
FM				
Deviation (max)			20%	100 kHz
Rates INT				
EXT AC/DC best case			0.3 Hz-300 kHz	300 Hz & 1 kHz
Distortion (min to max %)			3 MHz-500 kHz	20 Hz-50 Hz
Incidental AM (%)			<.5%	<1.5%
at max deviation				
QM Y or N	N	N	N	N
Pulse (Y or N)	Y	Y	Y	N
Switching Speed				
Settling time (frequency to be within 100 Hz)	Dial Settling	Dial Settling	Dial Settling	200 μsec
Sweep (Y or N)	N	Y	Y	Y
Control		Trigger Gate Output		
BCD (Y,N,O)	N	N	N	Y
IEEE-488 75 (Y,N,O)	N	N	N	Y
General				
Dimensions H" x W" x D"	5 1/4" x 8 5/8" x 11 1/2"	5 1/4 x 16 5/8" x 11 1/2"	5 1/4" x 16 5/8" x 11 1/2"	5 3/8" x 17 5/16 x 17 5/16"
Weight lbs/KG	11/15	13/5.9	13/5.9	31.5/14.3
Type of Generator				
Fundamental or Synthesized	Functional	Functional	Functional	Synthesized
Price	$895	$1295	$1495	$5000

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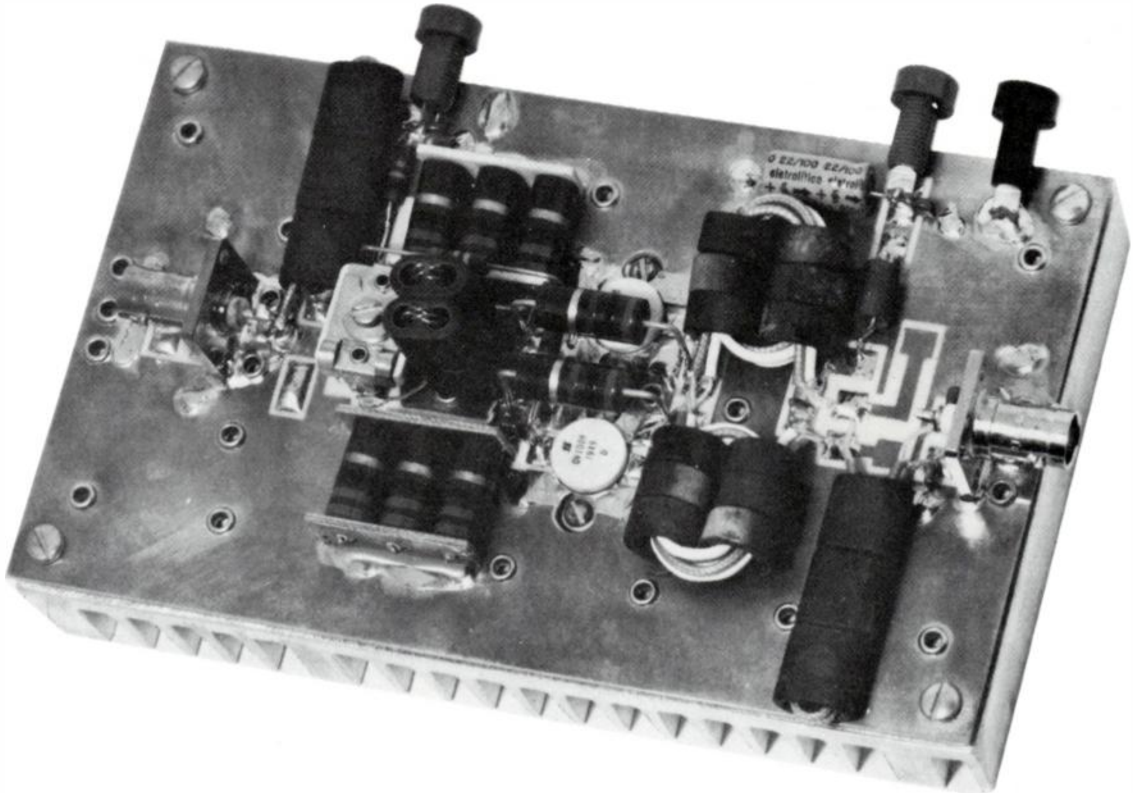
*Over entire frequency range
**Includes temperature, flatness, attenuator accuracy, detector linearity, indicator accuracy, and measurement error.
Y=Yes N=No O=Optional

RF Signal Generator

	Racal-Dana			Systron Donner
	9081	9082	9084	1702
Frequency				
Range	5-520 MHz	1.5-520 MHz	10 kHz-104 MHz	100 Hz-1000 MHz
Resolution	10 Hz	10 Hz	1 Hz	100 Hz
Stability (parts x 10^{-4}/Day) at room temperature	3×10^{-9}/day	3×10^{-9}/day	3×10^{9}/day	0.000007 .000003 optional
Spectral Purity				
SSB Phase noise (dBc) 1 HzBW in fundamental band, 20 kHz offset	−105 dB/Hz	−100 dB/Hz	−140 dB/Hz	95
Noise Floor (dBc)				125
Harmonics (dBc)	−35 dB	−35 dB	−40 dBc	25
Spurious Outputs (dBc) in fundamental band	−70 dB	−70 dB	−70 dB	50
Output Level				
Range (dBm)	−130 dBm to +9 dBm	−130 dBm to +9 dBm	−140 dBm to +19 dBm	140
Resolution (dB)				.1
**Absolute accuracy (±dB) best to worst case	0.8 dB+ 0.1 dB/10 dB	0.8 dB+ 0.1 dB/10 dB	0.5 dB+ 0.1 dB/10 dB	±2.5 ±4.5
*Flatness (±dB)	±0.7 dB	±0.7 dB	±0.5 dB	±.5 to ±2
Reverse Power Protection (Reset, Fuse Optional)	50W Opt. Solid State	50W Opt. Solid State	50W Opt. Solid State	Y Reset, Std
Leakage (μV) 2 turn, 2.4 cm coil held 2.4 cm from any surface	<1μV	<1μV	<0.5 μV	<.5μV
Meets Mil 461 or VDE 0571/75 (Y or N)	Y	Y	Y	N
Modulation AM				
Depth (min to max %)	0-100%	0-100%	0-100%	90%
Rates INT	400 Hz, 1 kHz, 5 kHz	same	400 Hz, 1 kHz, 3 kHz	1 kHz
EXT AC/DC best case	DC-100 kHz	DC-20 kHz	DC-20 kHz	DC-10 kHz
Distortion (min to max%)	3%	3%	1% to 3%	1.2%-5%
Incidental QM (radians) at 30% AM 1 kHz rate				<.002 rad.
Modulation FM				
Deviation (max)	0-100 kHz	0-100 kHz	0-300 kHz	20 kHz
Rates INT	400 Hz, 1 kHz, 5 kHz	same	400 Hz, 1 kHz, 3 kHz	1 kHz
EXT AC/DC best case			20 Hz-20 kHz	DC to 15 kHz
Distortion (min to max %)	3%	3%	3%	1% to 2.6%
Incidental AM (%) at max deviation	Less than 1%	Less than 1%	≤1%	1%
QM Y or N			N	N
Pulse (Y or N)			N	N
Switching Speed				
Settling time (frequency to be within 100 Hz)	10 ms	10 ms	1 msec	40ms to 350ms
Sweep (Y or N)	External	External	No	N
Control				
BCD (Y,N,O)	N	N	Y	N
IEEE-488 75 (Y,N,O)	N	N	O	Yes Optional
General				
Dimensions H" x W" x D"	133mm x 402mm x 499mm	133mm x 402mm x 498mm	133mm x 400mm x 495mm	5 1/4" x 16 3/4" x 18 3/4"
Weight lbs/KG	29 lbs. (13 kg)	29 lbs. (13 kg)	16 kg	52/23.6
Type of Generator Fundamental or Synthesized	Synthesized	Synthesized	Synthesized	Synthesized
Price				$4400

Specification Matrix (Continued)

Wavetek						
3000	**3001**	**3002**	**3003**	**3004**	**3005**	**3006**
1 MHz-520 MHz 1 kHz	1 MHz-520 MHz 1 kHz	1 kHz-520 MHz 1 kHz	1 MHz-520 MHz 1 kHz	1 kHz-520 MHz 1 kHz	1 MHz-520 MHz 100 Hz	1 kHz-520 MHz 100 Hz
10-520 MHz:>30 dBc 3-350 MHz:>55 dBc 3-520 MHz:>35 dBc	10-520 MHz >30 dBc 3-350 MHz:>55 dBc 3-520 MHz:>35 dBc	10-520 MHz:>30 dBc 3-350 MHz:>55 dBc 3-520 MHz:>35 dBc	10-520 MHz:>30 dBc 3-350 MHz:>55 dBc 3-520 MHz:>35 dBc	10-520 MHz:>30 dBc 3-350 MHz:>55 dBc 3-520 MHz:>35 dBc	10-520 MHz:>30 dBc 3-350 MHz:>55 dBc 3-520 MHz:>35 dBc	10-520 MHz:>30 dBc 3-350 MHz:>55 dBc 3-520 MHz:>35 dBc
+13 to −137 dBm 1 dB ±1.25 to ±2.75 ±1.0 to 130 dB Optional, Reversible 1µV	+13 to −137 dBm 1 dB ±1.25 to ±2.75 ±1.0 to 130 dB Optional, Reversible 1µV	+13 to −137 dBm 1 dB ±1.25 to ±2.75 ±1.0 to 130 dB Optional, Reversible 1µV	+13 to −137 dBm 1 dB ±1.25 to ±2.75 ±1.0 to 130 dB Optional, Reversible 1µV	+13 to −137 dBm 1 dB ±1.25 to ±2.75 ±1.0 to 130 dB Optional Reversible 1µV	+13 to −137 dBm 1 dB ±1.25 to ±2.75 ±1.0 to 130 dB Optional, Reversible 1µV	+13 to −137 dBm 1 dB ±1.25 to ±2.75 ±1.0 to 130 dB Optional, Reversible 1µV
30% to 90% 400 Hz + 1 kHz DC to 20 kHz <3% to <5%	30% to 90% 400 MHz + 1 kHz DC to 20 Hz <3% to <5%	30% to 90% 400 Hz + 1 Hz DC to 20 Hz <3% to <5%	30% to 90% 400 Hz to 1000 Hz DC to 20 kHz <3% to <5%	30% to 90% 400 Hz + 1000 Hz DC to 20 kHz <3% to <5%	30% to 90% 400 Hz + 1000 DC to 20 kHz <3% to <5%	30% to 90% 400 Hz + 1000 Hz DC to 20 kHz <3% to <5%
0 to 5 kHz and 0 to 500 kHz peak 400 Hz + 1 kHz DC to 25 kHz 4% @ 1 kHz	0 to 10 kHz and 0 to 100 kHz peak 400 Hz + 1 kHz 50 Hz to 25 kHz <2% to <4% @ 1 kHz	0 to 10 kHz and 0 to 100 kHz 400 Hz + 1 kHz 50 Hz to 25 kHz <2% to <4% @ 1 kHz	0 to 100 kHz 400 Hz + 1000 Hz 50 Hz to 20 kHz <2% to <4%	0 to 100 kHz 400 Hz + 1000 Hz 50 Hz to 20 kHz <2% to <4%	0 to 100 kHz 400 Hz + 1000 Hz 50 Hz to 20 kHz <2% to <4%	0 to 100 kHz 400 Hz + 1000 Hz 50 Hz to 20 kHz <2% to <4%
Y (Neg True Logic) 0	Y (Neg. True Logic) 0	Y (Neg. True Logic) 0	Y (Neg. True Logic) 0	Y (Neg. True Logic) 0	Y (Neg. True Logic) 0	Y (Neg. True Logic) 0
5 1/4 x 12 x 13 3/4 30 lb/13.6 kg Synthesized $2860	5 1/4 x 12 x 13 3/4 30 lb/13.6 kg Synthesized $3320	5 1/4 x 12 x 13 3/4 30 lb./13.6 kg Synthesized $3650	5 1/4 x 12 x 13 3/4 30 lb/13.6 kg Synthesized $3580	5 1/4 x 12 x 13 3/4 30 lb/13.6 kg Synthesized $3910	5 1/4 x 12 x 13 3/4 30 lb/13.6 kg Synthesized $3790	5 1/4 x 12 x 13 3/4 30 lb/13.6 kg Synthesized $4100



HF Power Amplifier Design Using

By Larry Leighton
Ed Oxner
Siliconix, Inc.

The goal isn't simply to fit VMOS into an HF amplifier but to first derive a basic equation that will assist us in formulating a technique to simplify HF power amplifier design when using VMOS. Secondly, we will design a power amplifier using a real RF VMOS power transistor. This amplifier should offer both high fixed gain and a low input VSWR across the military communications band of 30 to 88 MHz.

Deriving the Formula

A good VMOS power FET has constant low-frequency g_m, high input impedance and unusually low feedback. Because of these unique features the well-known general expression for power gain can be further simplified to provide what amounts to a "cookbook" formula for power amplifier design.

The general expression for power gain for any linear amplifier is:

$$G_p = \frac{|y_{21}|^2 \, Re(Y_L)}{|Y_L + y_{22}|^2 \, Re\left(y_{11} - \dfrac{y_{12}\, y_{21}}{y_{22} + Y_L}\right)} \tag{1}$$

To begin our derivation we first set y_{12} equal to zero and the remaining imaginary admittance terms (b_{11}, b_{21}, b_{22}) also to zero. Later we'll justify this action.

It should be noted that within the general expression (Equation 1) is the formula defining the input admittance, Y_{in}, of the amplifier.

$$Y_{in} = y_{11} - \frac{y_{12}\, y_{21}}{y_{22} + Y_L} \tag{2}$$

Since we opted to equate y_{12} to zero, we immediately find that $Y_{in} = y_{11}$. One design objective is to provide a low input VSWR, or in other words a power match, so

$Y_{in} = Y_S$ (source admittance)

Interestingly, with the reverse transadmittance, y_{12}, set to zero, by definition the input admittance is unaffected by the load. Equation 1 can be rewritten

$$\frac{|y_{21}|^2 \, Re(Y_L)}{|Y_L + y_{22}|^2 \, Re(Y_S)} \tag{3}$$

Equation 3 can be further simplified by first substituting

$(y_{21})^2 = (g_m)^2$
$Re\, Y_L = 1/R_L$
$Re(y_{22}) = 1/R_{out}$
$Re\, Y_S = 1/R_S$

where

VMOS Power FETs

R_L is the load resistance;
R_S is the source resistance; and,
g_m is the forward transconductance of the VMOS power transistor.

which results in:

$$G_p = 10 \log \left[\frac{g_m^2 \; R_S}{R_L \left(\frac{1}{R_{out}} + \frac{1}{R_L} \right)^2} \right] \qquad (4)$$

Solving for R_S:

$$R_s = \frac{10^{\left(\frac{dB}{10}\right)} \left[R_L \left(\frac{1}{R_L} + \frac{1}{R_{out}} \right)^2 \right]}{g_m^2} \qquad (5)$$

where $R_{out} = 1/\mathrm{Re}(y_{22})$ (taken from Table 1 (see page 34) of small signal Y parameters)

Now fixing a resistor, R_S, across the gate-to-source terminals of the VMOS FET the gain and input impedance (hence source impedance) are set independent of the operating frequency within the HF bandwidth of the amplifier.

Why get excited about VMOS design?

What with the prospects that power VMOS FETs offer in high-frequency amplifier design, one might conclude that VMOS is the designer's choice. See what you think.

1. Stability
Within the HF region the shunt input impedance loading requirements are constant since the transconductance of the VMOS power FET exhibits little change with frequency. *Very little feedback is required to ensure total stability.*

Because little feedback is required *the overall efficiency is improved* and out-of-band stability is enhanced.

Because VMOS RF power FET admittance parameters are little affected over the operating drain current *small-signal Y parameters become increasingly useful in establishing basic stability criteria for high-power design.*

2. Input Admittance
A stable quiescent drain current (I_D) regardless of drive or operating temperature (T_A) offers a near-constant input impedance *governed mainly by the input impedance of the matching circuit and not by the reflective load impedance.*

3. Gain
Without benefit of feedback and with a fixed load the amplifier offers flat gain across the entire 30 to 90 MHz bandwidth. *Reverse gain exceeds −35 dB.*

4. Power Output
VMOS Power FETs, exhibiting a constant R_{DS}(on)
VMOS Power FETs, exhibiting a constant $R_{DS(on)}$ [$V_{DS(sat)} = R_{DS(on)} I_D$] regardless of frequency, will provide a leveled saturated output power. Most importantly: *they can withstand a 20:1 VSWR at any phase angle.*

5. Noise Figure
Because VMOS is a bulk semiconductor without the bipolar's base-emitter diode it appears they the measured small-signal noise figure represents *what can be expected when used in a power amplifier.*

In addition to these are the now well-known thermally-related benefits that VMOS offers: *no thermal runaway* and *no current hogging.*

Frequency Constraints

VMOS FETs possess a finite and frequency invarient input capacitance. There is an upper frequency at which this capacitance reactance will become appreciable with respect to R_S resulting in mismatch loss. Consequently, any designed increase in gain which also raises R_S (Equation 5) will adversely affect the input Q thus limiting the input frequency response.

Furthermore, as the frequency rises, y_{12} should not be equated to zero. From Equation 2 y_{12} affects Y_{in}, which, in turn, affects R_S which adversely affects mismatch loss. The limiting upper frequency is established by the maximum permissible input VSWR.

Into the Design

Our objective is to design a push-pull amplifier capable of at least 12 dB of power gain and outputting 100W, at a drain voltage of 28V across the 30 to 88 MHz band. Input VSWR not to exceed 1.5.

The first step is to define the load line using the classic formula

$$R_L = \frac{[V_{DD} - V_{DS(on)}]^2}{2P} \qquad (6)$$

The Siliconix RF VMOS Transistor, DV1008, is rated to output 80W minimum at a power gain of 10 dB at 175 MHz with total dissipation of 160W. $R_{DS(on)}$ is typically 0.5 ohm. We felt that this represented a comfortable margin and selected it for our design.

A push-pull design establishes that each VMOS should supply 50W minimum if we assume that the matching transformers are lossless. With a drain supply of +28V and the estimated peak drain current of approximately 3.6A, we can calculate $V_{DS(on)}$

$$V_{DS(on)} = R_{DS(on)} I_D = 0.5 \times 3.6 = 1.8V$$

Using Equation 6 the load line is calculated at 6 ohms.

The most convenient way to establish this load line is by using ferrite transmission-line transformers. However, were the load line to output port impedance not an integer ratio, the match would require a more complicated design effort. In this design the 6-ohm load line can be closely achieved with the relatively simple combination of a 1:1 unbalanced-to-balanced balun followed by a 4:1 balanced-to-balanced transformer. Together this combination provides a balanced 6.25-0-6.25 ohms across the drains of the push-pull FET's.

With the drain load design complete next establish the amplifier's gain and this is done with resistive input loading, R_S. Having gone through the exercise designing the output load we are very close to having the necessary information to calculate R_S. All that remains is to select a value for R_{out} [$Re(y_{22})$] which we take from Table I. To ensure our gain over the entire passband, it's wise to select worse-case $Re(y_{22})$ and that value is found at 90 MHz to be 0.026 mhos, or $R_{out} = 38$ ohms. Using Equation 5

$$R_S = \frac{10^{\left(\frac{12}{10}\right)}\left[6.25\left(\frac{1}{6.25} + \frac{1}{38}\right)^2\right]}{(0.7)^2} = 7 \text{ ohms}$$

Ideally we would need an input matching structure stepping down from 50 to 7 ohms which for this broadband amplifier would be both costly and unwieldy. Rather than complicate the design let us opt for a 'near match' by using the transmission-line transformer combination 1:1/4:1, 50 ohm unbalanced to 6.25-0-6.25 ohm balanced. By not meeting the value of R_S (6.25 ohms in lieu of the calculated R_S of 7 ohms) we will need to reaffirm what gain to expect from the amplifier. Using Equation 4

$$G_P = 10 \log\left[\frac{(0.7)^2\, 6.25}{6.25\left(\frac{1}{38} + \frac{1}{6.25}\right)^2}\right] = 11.5 \text{ dB}$$

Table I
Two-Port Y-Parameter Matrix in Millimohs Using DV1008, 28V, 1.6A

Freq.	Y11		Y21		Y12		Y22	
10.0	0.2	10.1	697.2	— 16.0	0.0	— 1.2	14.9	8.2
20.0	0.7	20.1	697.7	— 32.1	0.0	— 2.3	15.3	16.3
30.0	1.6	30.2	698.5	— 48.4	0.1	— 3.5	16.0	24.5
40.0	2.8	40.3	699.5	— 64.8	0.1	— 4.6	17.0	32.6
50.0	4.4	50.3	700.8	— 81.5	0.2	— 5.6	18.3	40.7
60.0	6.3	60.4	702.4	— 98.5	0.4	— 6.7	19.8	48.8
70.0	8.6	70.5	704.2	—116.0	0.5	— 7.7	21.7	56.7
80.0	11.4	80.5	706.2	—133.9	0.7	— 8.6	23.9	64.7
90.0	14.5	90.5	708.4	—152.3	0.9	— 9.5	26.4	72.5
100.0	18.1	100.4	710.6	—171.4	1.3	—10.2	29.3	80.2

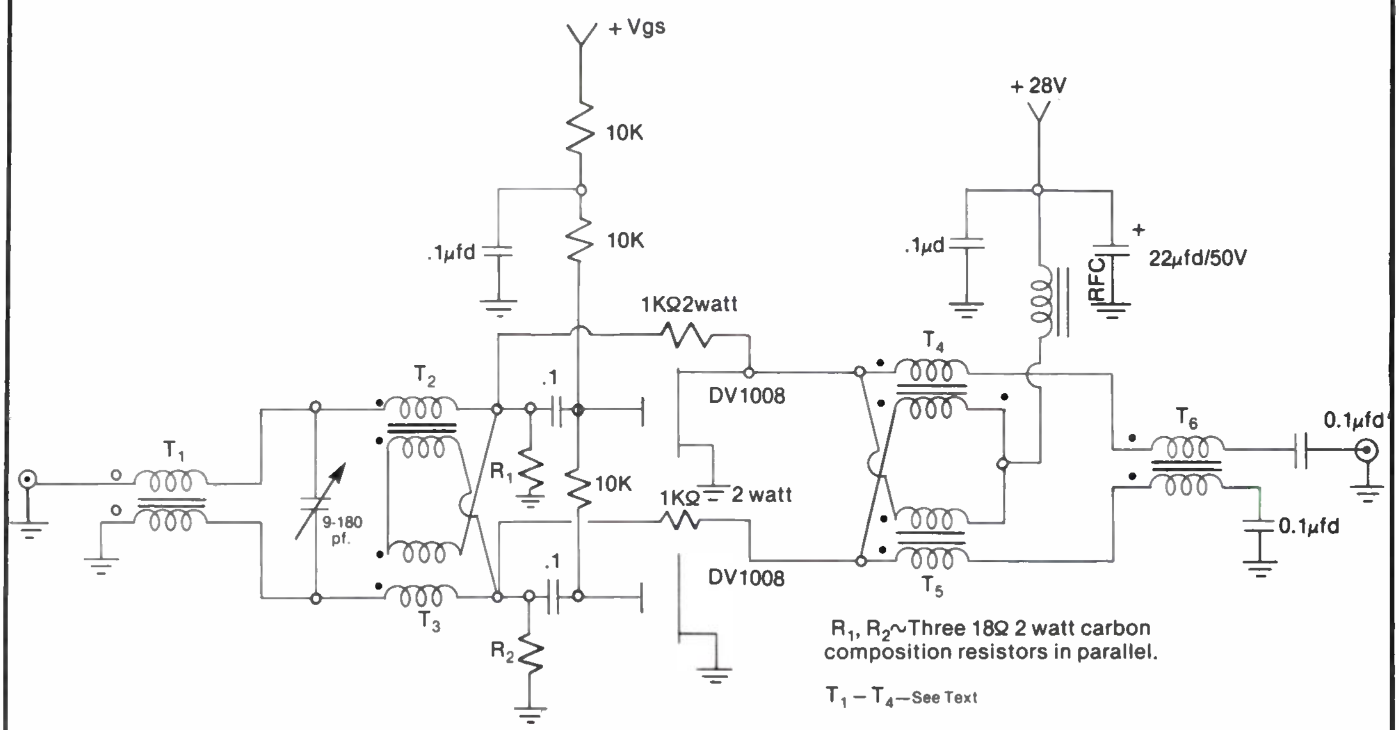


Figure 1. 100 Watt Broadband VMOS Power Amplifier Using Siliconix DV 1008 FET's.

RFC ~ Ferroxcube P/N VK200 09/3B

T1, T6 ~ Two turns of RG-196 A/µ 50Ω coax wound on three balun cores placed end on end cores are Stackpole P/N 57-0973

T2, T3 ~ Two turns #22 twisted pair, four turns per inch, wound on two balun core. Core is Stackpole P/N 57-1503

T4, T5 ~ Three turns of 25Ω coax wound on 6 torroid cores. Cores are configured similar to balun style core, three cores per side. Two 50Ω coax RG-196 A/µ were paralleled to simulate 25Ω coax. Cores are Indiana General P/N F627-8-Q2

The Matching Transformers

For both the input and output balanced-to-unbalanced 1:1 baluns, 2 turns of RG196A/µ coaxial were wound through 3 Stackpole balun cores, 57-0973, placed end-to-end. The drain load 4:1 transformer was wound with 3 turns of *parallel-connected* RG-196A/µ (for an equivalent 25 ohms) through a balun-style core made by using 6 Indiana General toroidal cores, F627-8-Q2, 3 cores per side. The input 4:1 transformer was wound with 2 turns of twisted (4 turns per inch) #22 AWG Beldsol 8051 through a pair of Stackpole baluns 57-1503, also placed end-to-end.

Building the Amplifier

The construction is uncomplicated. Two problems are worth mentioning. First, the shunting resistors, R_S, made of 3 parallel-wired 2W composition resistors (R1 & R2 in Figure 1) appear slightly inductive and fortuitously help compensate for the input capacitance of the VMOS transistors at the high end of the passband. Secondly, the input matching transformer requires a compensating trimmer capacitor, C1.

Conclusions

The performance of the finished amplifier (Figures 2 through 5) confirms the usefulness of Equation 5 in establishing both the desired gain and input VSWR. The latter is especially gratifying since VMOS power transistors offer a high input resistance across the HF band. The combined loss of the matching transformers amounts to 1 dB.

In operating the amplifier into a high output mismatch you will observe low level spurious oscillations which can be effectively removed by adding 1 k-ohm feedback resistors. These resistors will not affect gain, gain fullness or input VSWR.

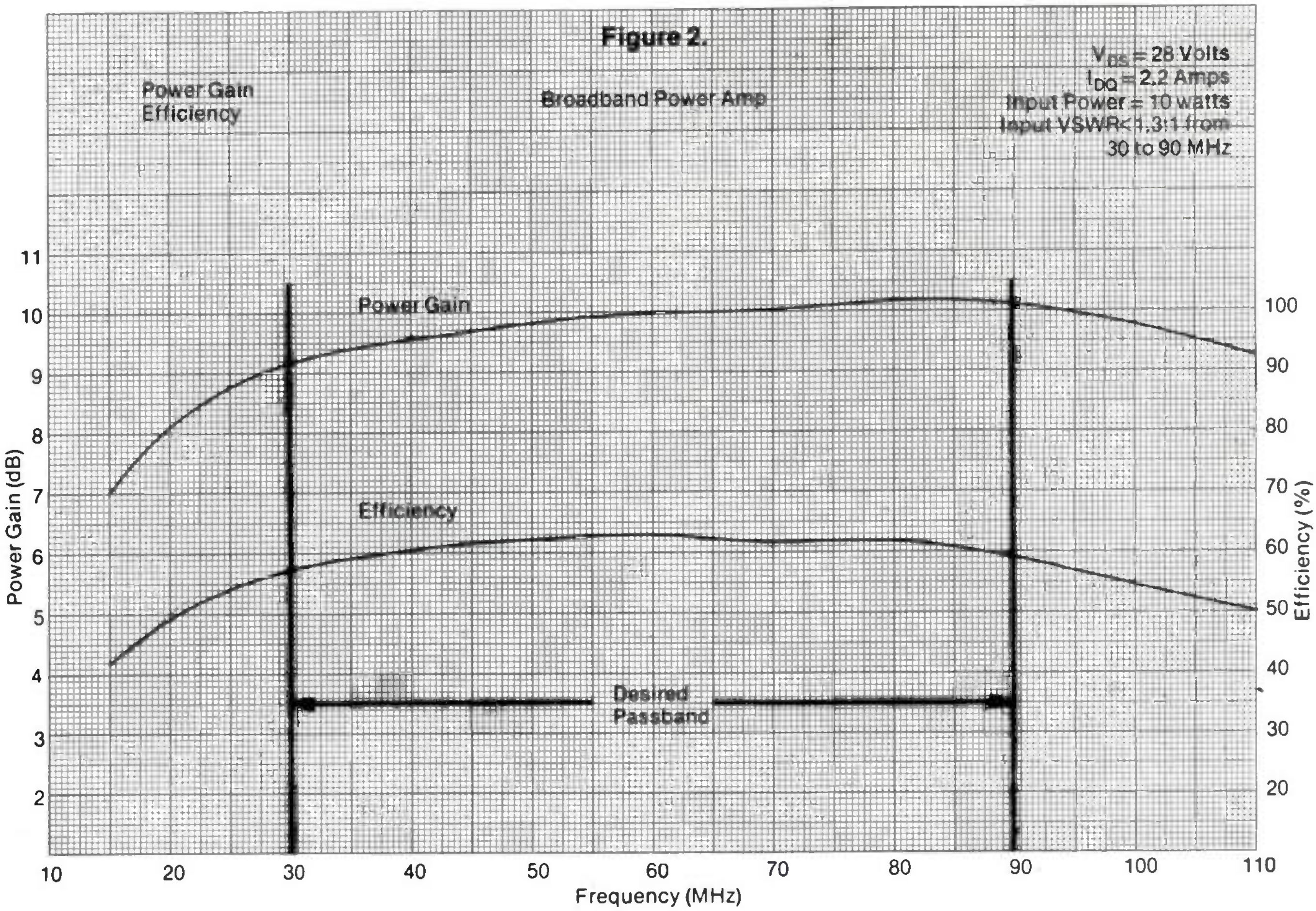


Figure 2.
Power Gain
Efficiency
Broadband Power Amp
V_{DS} = 28 Volts
I_{DQ} = 2.2 Amps
Input Power = 10 watts
Input VSWR<1.3:1 from
30 to 90 MHz
Power Gain
Efficiency
Desired
Passband
Power Gain (dB)
Efficiency (%)
Frequency (MHz)
11
10
9
8
7
6
5
4
3
2
100
90
80
70
60
50
40
30
20
10
20
30
40
50
60
70
80
90
100
110

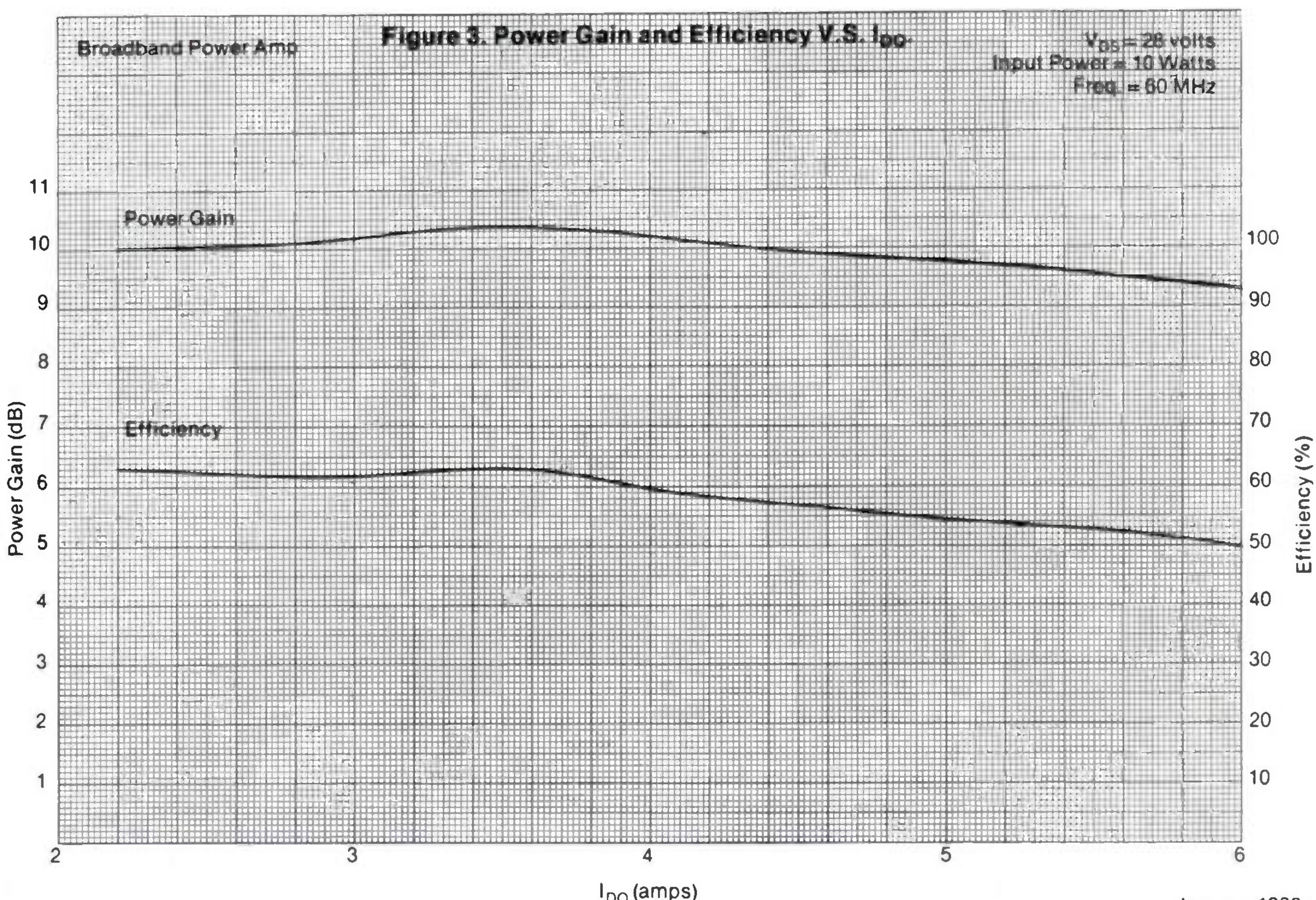


Figure 3. Power Gain and Efficiency V.S. I_{DQ}.
Broadband Power Amp
V_{DS} = 28 volts
Input Power = 10 Watts
Freq. = 60 MHz
Power Gain
Efficiency
Power Gain (dB)
Efficiency (%)
I_{DQ} (amps)
11
10
9
8
7
6
5
4
3
2
1
100
90
80
70
60
50
40
30
20
10
2
3
4
5
6

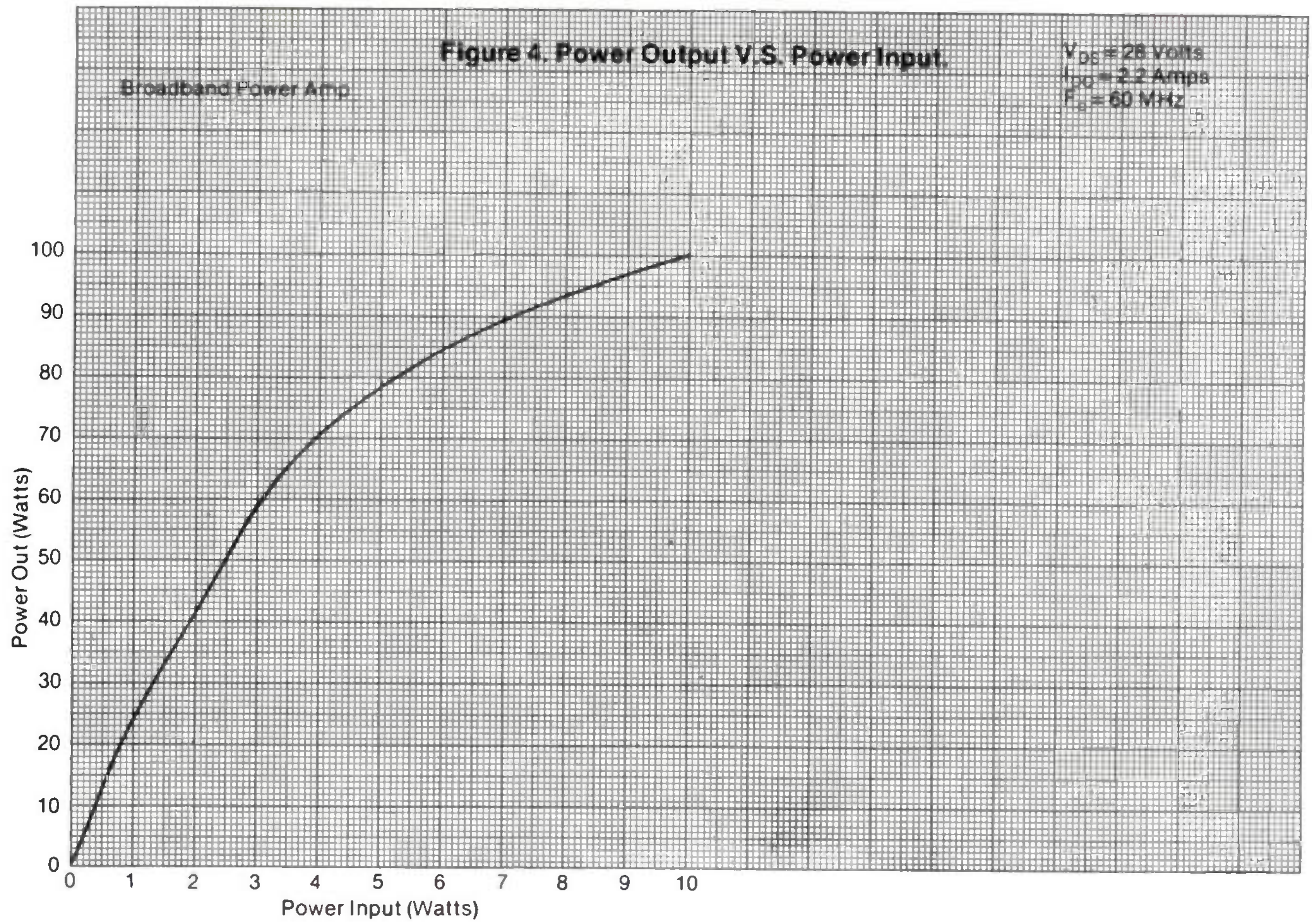


Figure 4. Power Output V.S. Power Input.

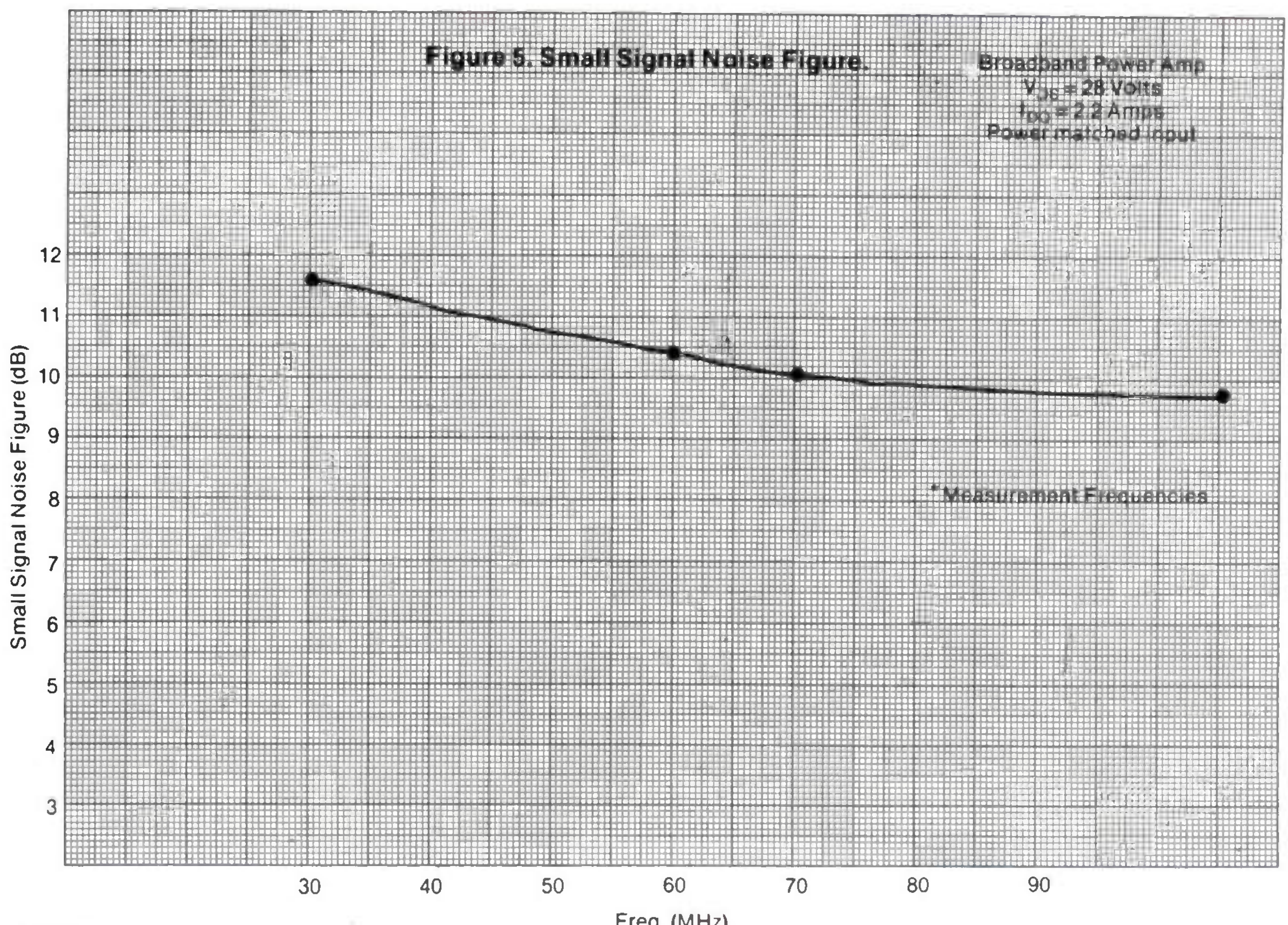


Figure 5. Small Signal Noise Figure.

Controller for Attenuators And Switches

This new Hewlett-Packard model 11713A attenuator/switch driver combines a relay actuator with a power supply in one package and interfaces with the HP-IB (IEEE-488). In microwave systems it can be used to actuate one or two step attenuators of the HP 8694/95/96 or 33320/21/22 series, plus one or two electromechanical switches such as the HP 8761B or 33311 series.

Two sets of four front panel pushbuttons can be used to manually control the attenuators; two additional pushbuttons control the switches. Because the ten front panel pushbuttons each control a transistor switch, they can also be used to control up to 10 external 24-volt relays.

Contact Hewlett-Packard Company, 1507 Page Mill Road, Palo Alto, California 94304. INFO/CARD #118.

Straight Thru 3MM/SMA Threaded Connectors

Self-adjusting sliding pins or tabs are now offered for some of its popular 3mm/SMA straight thru, threaded hermetic connector configurations by Tek-wave, Inc., a subsidiary of Frequency Electronics, Inc., New Hyde Park, New York. Three different body configurations are available in the company's 10-2045 Series.

The self-adjusting, temperature sensitive sliding tabs or pins are designed for maintaining reliable circuit contact during substrate expansion and contraction. This capability permits connectors to be used on circuit packages that are exposed to temperature extremes such as airborne and aerospace systems, undersea applications, and severe environments where temperature extremes are encountered including during processing.

The sliding pins and tabs are designed to move towards or away from the substrate as the substrate expands and contracts because of temperature variations during processing or operation. A range of movement over .002" would ordinarily break the circuit/connector pin or tab solder contact with resultant electrical failure.

Contact Tek-wave, Inc., a subsidiary of Frequency Electronics, Inc., 3 Delaware Drive, New Hyde Park, N.Y. 11040. INFO/CARD #133.

Test Encoder

The TE-64 test encoder is a very versatile piece of test equipment. Contained in one small package, this unit will provide a total of 64 audible and sub-audible tone frequencies for test purposes. Measuring 5.25" x 3.3" x 1.7". With the addition of a 9 volt transistor radio battery it may be made completely self-contained. Mounting brackets are included if permanent installation is required.

Frequencies available include all the 32 standard EIA sub-audible, 19 burst-tone frequencies beginning with 1600 Hz and increasing in 50 Hz increments to 2550 Hz, 8 touch-tone frequencies and 5 test frequencies including 600, 1000, 1500, 2175 and 2805 Hz.

This unit provides a low impedance, low distortion adjustable sinewave output at 5 volts peak-to-peak and may be operated from any external DC voltage from 6 to 30 volts.

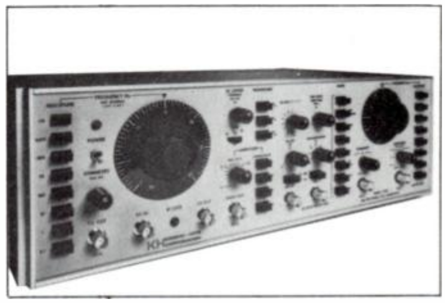
The output level is flat to within ±1.5 dB over the entire range selected and separate level adjustment controls and output connections are provided for each tone group. There is an "OFF" position for no tone output. No counter or other test equipment is required to set frequencies, a calibrated dial on the front panel allows selection of the desired frequency. The TE-64 is totally immune to RF and has built-in polarity protection. External connections are made to an internal terminal block. A full one year warranty is provided when returned to the factory for repair. Wired, tested and with complete instructions this unit sells for $79.95.

Contact Communications Specialists, 426 West Taft Avenue, Orange, Calif. 92667. INFO/CARD #132.

30 MHz AM/FM/Phase Lock Generator

The Krohn-Hite model 2400 consists of two complete generators in one package, providing features not available in a single unit.

Each generator may be used independently, or combined to provide 0-100 percent AM or suppressed carrier AM, 0-20 percent FM, Trigger (Pulse), Gate (Burst) and 100:1 sweep up or down or two, phase-locked outputs with 100:1 locking capture range and ±90° variable phase control. The main generator provides sine, square, triangle, ramps and pulses from .003 Hz-30 MHz and features 30V p-p output, pushbutton dB attenuator and vernier, fixed and/or variable DC offset, symmetry control and more. The auxiliary generator provides sine, square, triangle, ramps and pulses from 0.3 Hz-300 kHz, and features 20V p-p output and more.



The 2400 is priced at $1,495.00. Delivery is 60 days. Contact the Krohn-Hite Corporation, 255 Bodwell St., Avon Industrial Park, Avon, Mass. 02322. INFO/CARD #126.

RF Wattmeter

A new RF power wattmeter designed by Bird Electronic Corp. is first of a series. It is a portable multi-purpose digital directional RF wattmeter for power levels from 1/10 watt to 10,000 watts, and from 1/2 to 2300 MHz. CW or FM power in both forward or reflected directions is displayed in watts or dBm at the push of a button. VSWR is calculated continuously and indicated through a fifth button, as is dB return loss. Button seven and eight are for peak envelope power (as in SSB transmissions) in watts, and the ninth button calls up percent modulation. The final set of three buttons make tuning a transmitter, matching an antenna or tweaking RF

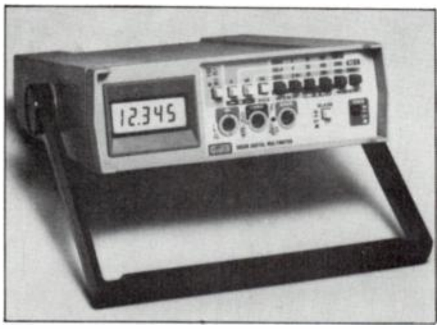
components a fast and simple task: A delta (Δ) function identifies either rise or fall in displayed values, while a minimum or maximum memory recals optimum conditions during adjustments. Other models in the 4380 series measure to 250kW or are panel mounted.

They are designed around existing Bird Plug-in Elements, which determine full-scale power and frequency range. Once a set of two Elements is chosen (for incident and reflected power), the large LED display places the decimal point correctly, making mental multipliers superfluous. Overranging of up to 120 percent in watts and 400 percent in dBm often obviates changing to a higher-power Element and retains "up-scale" accuracy.

Contact Bird Electronic Corporation, 30303 Aurora Road, Cleveland (Solon), Ohio 44139. INFO/CARD #131.

4 1/2-Digit DMM

The new 4 1/2-digit DMM from Fluke, the model 8050A, is a 4 1/2-digit bench DMM with true RMS, microprocessor controlled, large LCD



readout, and the inherent quality, accuracy, and reliability of all Fluke voltmeters.

In addition to the accuracy and resolution provided by other 4 1/2-digit DMM's, the 8050A has features previously found only in higher priced voltmeters, i.e., offset mode and dBm measurement mode.

In the offset mode the user may zero-out lead resistance for high resolution resistance measurements or establish a voltage to which all other voltages measured may be referenced. The offset mode is a standard feature of the 8050A, usable with all functions such as AC/DC volts and current, resistance, conductance, and dB and it's easy to use. Measure the desired reference and press the offset button.

In the dB measurement mode, the 8050A reads and absolute level (dB) of signals directly. In the past, a dedicated dB meter was required or complicated manual or calculator computation were required. With a range of −56 dBm to +48 dBm, and a choice of sixteen different reference impedances, this versatile function makes measurements on audio oscillators, stereo amplifiers, recording amplifiers and a host of audio equipment easy. The 8050A provides 38 ranges and 7 functions.

Contact John Fluke Mfg. Co., Inc., P.O. Box 43210, Mountlake Terrace, Wash. 98043. INFO/CARD #130.

Small Instrument And Clock LCDs

Liquid crystal displays feature 3 1/2 and 4 digits that are 0.25 inches (6.35 mm) high in a 0.94 inch x 0.54 inch (27.74 mm x 13.76 mm) package. Ideal for portable and pocket size instruments and clocks that require low power consumption and easy readability in high ambient light conditions, the displays are available through Beckman's nationwide distribution network.

The models 741-3 and 741-4 liquid crystal displays require between three and 20 volts RMS with less than eight microamperes of drive current. The models 741-3 includes 3 1/2 digits, a plus/minus symbol, decimal points, colon and arrow symbol (± 1.8:8.8). The model 741-4 includes four full digits, decimal points and colon (8.8:8.8). An optional Bezel and conductor assembly enables the displays to be attached directly to a circuit board.

Contact Display Systems Division, Beckman Instruments, Inc., 350 N. Hayden Rd., P.O. Box 3579 Scottsdale, Ariz. 85257. INFO/CARD #129.

Phaselock Up-To-Date

A 5-day course for engineers working with phaselock loops will be offered in 1980 at Washington DC (March 31-April 4), New York (June 16-20), Boston (October 6-10), and Los Angeles (December 8-12). Subject matter is designed to meet the needs of practicing engineers and covers foundations, applications, and implementation of PLLs, with emphasis on implementation. Many new topics not previously widely known are included. The lecturer is Dr. Floyd M. Gardner, consulting engineer and author of the book *Phaselock Techniques.* The new second edition, published 1979, is used as the course text. Further information and an enrollment form are available in a free brochure. Course/Fee is $495.

Contact Gardner Research Co., 1755 University Ave., Palo Alto, Calif. 94301. INFO/CARD #133.

Economy Microwave Amplifier

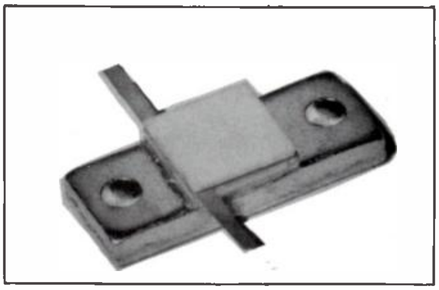
Cermods is a new series of low-cost epoxy encapsulated RF and microwave amplifier modules built to provide MIL-standard quality and reliability. Developed by the Optimax Division of Alpha Industries, Inc.,

Three different model numbers are presently offered. CM-151 covering the 5-150 MHz band, CM-501 covering 5-500 MHz and CM-1001 for the 5-1000 MHz range. Typical Gain of 12 to 15 dB with output power of +5 dBm can be obtained using a +15 volt power supply.

Contact Optimax Division of Alpha Industries Inc., P.O. Box 105 Advance Lane, Colmar, Pa. 18915. INFO/CARD #135.

Conduction Cooled Power Attenuators

KDI Pyrofilm has introduced a new family of flange-mounted attenuators for microstrip applications. The PPA 50 is the first of the series and will dissipate 50 watts at a heat sink temperature of 85°C. The rated input power is 100 watts for the 3.0 dB



unit, 75 watts for the 6.0 dB unit and 50 watts for the 10.0 dB or more unit.

These attenuators are designed to operate from DC to 1,000 MHz. The VSWR is 1.15 max from DC to 500 MHz and 1.20 max from 500 to 1,000 MHz. The attenuation accuracy is ±0.3 dB from DC-500 MHz and ±0.5 dB from 500-1,000 MHz.

Contact KDI Pyrofilm Corporation, 60 South Jefferson Road, Whippany, N.J. 07981. INFO/CARD #126.

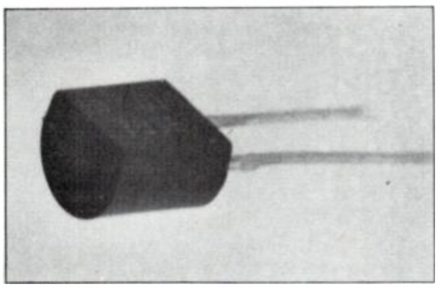
Hyprbrupt Tuning Diodes

At 20 volts reverse voltage bias, the 0.8 picofarad capacitance enables the new ZC898 tuning diode to extend its usefulness into the low microwave band. At 2 volts reverse, the capacitance is greater than 4.0 picofarads giving a better than 5:1 capacitance tuning range assuring octave frequency tuning with allowance for tuning out circuit strays. The Q of 300 at 3 volts increases rapidly with reverse voltage to provide low loss operation at the higher operating frequencies. The ZC898 is packaged in the DO-7 glass hermetically sealed case that makes it suitable for use in the most stringent industrial, airborne and military applications that call for VCXOs, TCXOs and frequency synthesizers.

Price $5.60/each in 100 piece quantity. Contact MSI Electronics, 34-32 57 St., Woodside, N.Y. 11377. INFO/CARD #125.

Low-Voltage Reference Device

Micro Power Systems has introduced the MPS5010 precision, low-voltage reference device. It is a temperature compensated, low-voltage reference device. Features include: low price (the MPS5010GN is 72 cents at the 100-piece level), low-temperature co-



efficient, guaranteed, long-term stability, and low noise. The MPS5010 is just one new device that is part of a complete family of Micro Power precision, low-voltage reference devices.

Specific specifications include: low breakdown voltage of 1.220V (typical), low bias current of 50μA, Tempco for models MPS5010JT and MPS5010GN is 100 ppm, and the Tempco for models MPS5010KT and MPS5010HN is 50 ppm.

Contact Micro Power Systems, Inc., 3100 Alfred Street, Santa Clara, California 95050. INFO/CARD #123.

Touch-Tone Decoder; Encoders

A subminiature touch-tone decoder, model TTD-1, has four digits, is field strappable with jumpers and decodes all 16 DTMF tone pairs. It has anti-falsing-error detection and measures 1 in. x 1 3/4 x 5/16. It fits most hand held and mobile radios and has a call light and horn relay driver.

The TT3 also employs a burst tone circuit, which prevents the tone from going out over 90 milliseconds regardless of how long the button is depressed. The ANI 1's sequence can be activated by pressing the * or by the radio's push-to-talk circuit. When using the * to activate the ANI, the * tone can go out ahead of the ANI or can be muted so that only the ANI is sent out.

Contact Midian Electronics, Inc., Tuscon, Ariz. 85710. INFO/CARD #124.

VMOS FET Family Has 2.5 on Resistance

A second new family of VMOS FETs from Intersil is rated at 2.5Ω ON resistance and is available in ultra-small TO-52 and TO-237 packages. The devices employ a distinctive flat-bottom V-groove from additional stability and have breakdown voltages of 40, 60, and 80 volts.

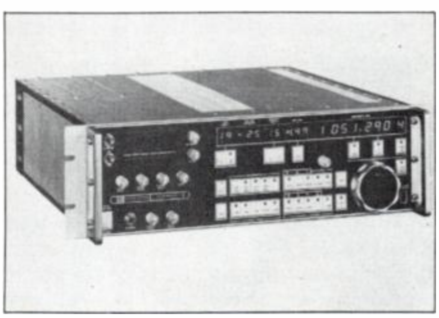
Twelve members of the IVN5000 family are proprietary N-channel enhancement mode power FETs, and four are designed ad direct replacements for the 2N6657 and 2N6658 parts (IVN6657 and IVN6658) and the 2N6660 and 2N6661 (IVN6660 and IVN6661) devices. All of the vertical-current path parts are fabricated with a silicon-gate for high reliability and improved threshold control.

Other design features include high-speed switching (t_{on} and t_{off} = 5 ns maximum) at 0.7 to 2.4 A continuous drain current and 2.0 and 3.0 A peak drain current. The devices have inherent current-sharing capability when paralleled, and directly interface to CMOS, TTL, or DTL logic. DC biasing is simple, and the IVN5000 family has extended safe operating areas.

Contact Intersil, 10710 N. Tantau Ave., Cupertino, Calif. 95014. Circle INFO/CARD #122.

Digitally Controlled

Watkins-Johnson Company has introduced the WJ-8617A general purpose digitally controlled VHF/UHF receiver. Representative of a new family of receivers, the WJ-8617A features



an entirely new receiver control concept based on the power and flexibility of microprocessor technology.

The integration of the decision and control power of the microprocessor with advanced receiver technology allows the receiver to accommodate multiple external interface options and appropriate acquisition, decision-making and hand-off functions within the receiver itself. The receiver can function under local or remote control and also handle a portion of the system control activity. Decentralized system control can reduce the complexity of the system control architecture which, in turn, may improve system response and provide considerable cost savings.

Contact Watkins-Johnson Company, 700 Quince Orchard Road, Gaithersburg, Md. 20760. INFO/CARD #121.

Rapid Switching Attenuators

Model 4440 rapid switching attenuator covers the DC to 1500 MHz frequency band and provides 0 to 130 dB attenuation with accuracies ranging from ± 0.5 to ± 2.5 dB. SWR goes from 1.2 to 1.4 insertion loss 1.5 to 2.0 dB range. RF power rating is 0.5W and switching speed is 6

ms per step. Switch life is 10M operations per step. Control voltage is + 12 V at 370 mW per step. BNC is standard, and SMA, TNC, N are available. Weight: 12 oz. Price from $185 (qty. of 100). Kay Elemetrics Corp., Pine Brook, N.J. Stephen Crump. INFO/CARD #120.

Capacitors Technology Solves Tantalum Shortage

A technological breakthrough by Panasonic in the manufacturing process of electrolytic (aluminum) capacitors resulted in the introduction of a new line of ultra-miniature aluminum electrolytics comparable in size to tantalum capacitors of the same capacity! Designated as "K Series," the new capacitors come in 17 capacitance values (0.1 through 100 μF), with DC rated working voltages between 6.3 and 63 VDC, maximum length of only 7 mm (0.28 of an inch), and diameters of 4, 5, and 6.3 mm (0.157, 0.177 and 0.248 of an inch, respectively).

With the K Series, a designer can now use an inexpensive, readily available capacitor of the same size as an identical tantalum unit. The fact is, there are numerous classes of electronic equipment that have been relying on tantalum capacitors only because of tight space requirements. At this time K Series capacitors are available with radial leads only.

Contact Panasonic, 1 Panasonic Way, Secaucus, N.Y. 07094. Circle INFO/CARD #119.

Thin-Film Resistor Products

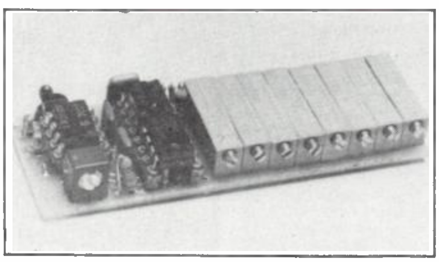
Hybrid Systems announces the availability of its new 120-page master catalog summarizing specifications and applications information for the company's complete data conversion and thin-film resistor product lines.

The catalog includes digital-to-analog converters (DACs), analog-to-digital converters (ADCs), thin-film resistor chips and packaged networks, as well as guidelines for specifying custom resistor networks.

Contact Hybrid Systems Corporation, Crosby Drive, Bedford, MA 01730. Tel (617) 275-1570. INFO/CARD #134.

Multi-Frequency Encoder

Selectone Corporation announces a versatile new multi-frequency encoder for both CTCSS and burst tone signalling applications. The miniature circuit board measures only 1"W x 2.85"L x .28"H and will accommodate up to eight (8) fully tunable tone frequencies. If fewer frequencies are required, the board may be sheared off to reduce the overall length.



Two standard configurations are available: the model ST-105 CTCSS encoder and the model ST-115 burst tone encoder. The ST-105 operates over the standard CTCSS frequency range of 67.0 to 250.3 Hz, while the ST-115 will generate burst tones within the range of 800 to 3000 Hz with field selectable burst durations of 300ms, 500ms, 1 sec., or continuous. Other frequency ranges are available on special order.

Contact Selectone Corporation, 26203 Production Ave., Suite 6, Hayward, Calif 94545. INFO/CARD #70.

Broad Band Three-Way Power Divider

The DS-323 is a new flatpack three-way power divider operating 25-1000 MHz. Unit features 30 dB typical isolation with low insertion loss and an input VSWR under 1.4:1. The unit provides in-phase outputs with an amplitude balance of .4 dB maximum and phase balance of 4° maximum over the -55 to +85°C. Unit designed for operation to 1 watt.

Contact Anzac Division, 80 Cambridge St., Burlington, Mass. 01803. INFO/CARD #128.

Switching Regulator Hybrids

Designers of CATV amplifiers and two-way radios requiring regulated supply voltages can now obtain hybrid power switching regulator circuits known as the PIC600 series from Unitrode Corporation. This series combines, in a 4-pin electrically isolated TO-66 package, a switching transistor, drive transistor, biasing resistors and commutating diode. The PIC600 series features controlled diode reverse recovery and transistor rise time. In addition to offering the designer considerable savings in design time, this hybrid device offers improvements in size, weight, efficiency, R.F.I. suppression and total cost when compared to use of equivalent discrete components.

Practical operating frequency ranges to greater than 100 kHz with typical efficiency of 85%. Voltage ratings offered are 60, 80 and 100V with either positive or negative output. Rated current outputs range from 5 to 15A.

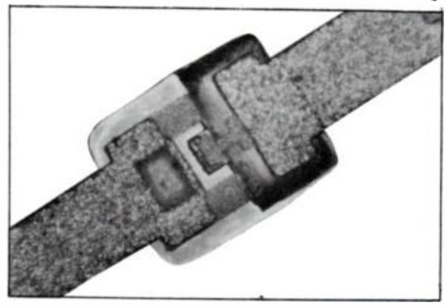
Contact Unitrode Corporation, 580 Pleasant Street, Watertown, MA 02172. INFO/CARD #91.

Low-Loss Beam Lead PIN Diodes

Two new beam lead PIN diodes designed specifically for low capacitance, low series resistance, and rugged construction have been introduced by Hewlett-Packard.

The HPND-4001 and the HPND-4050 are produced by a new HP mesa process which allows fabrication of beam lead PINs with a very low resistance-capacitance product. For example, the HPND-4001 has typical series resistance of 1.8Ω and typical capacitance of 0.07 pF; associated typical breakdown voltage is 80 V and typical reverse recovery time (switching time) is 3 ns. For the HPND-4050 typical specifications are: series resistance of 1.3 ; capacitance of 0.12 pF, breakdown voltage of 40 V; and reverse recovery time of 2 ns.

These new diodes are designed for use in stripline or microstrip circuits. Applications include switching, attenuating, phase shifting, and modulating



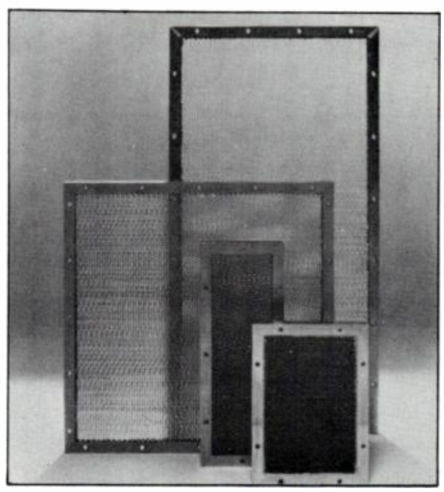
at microwave frequencies. The low capacitance and low series resistance at low current make these devices ideal for applications in the shunt configuration. And their rugged construction includes a deposited glass layer (glassivated) for scratch protection and leads that can withstand four grams minimum pull.

Contact Hewlett-Packard Company, 1507 Page Mill Road, Palo Alto, California 94304. INFO/CARD #90.

Shielded Vents

A new line of high performance shielded ventilation panels for high frequency environments and critical requirements such as Tempest specifications is being introduced by Chomerics, Inc. of Woburn, Massachusetts.

Chomerics' Cho-Cell™ vents are



shielded ventilation panels that provide better than 90 dB attenuation between 200 MHz and 10 GHz. Chomerics' Cho-Cell vents incorporate a combination of unique construction features, including especially well shielded corners, seams, and edges, to maximize shielding effectiveness. The vents are produced to customer specifications in sizes up to 24" x 24".

Contact Chomerics, Inc., 77 Dragon Court, Woburn, MA 01801. INFO/CARD #87.

Solid-State Digital Attenuator

Lorch Electronics Corp. announces a new solid-state digital attenuator, model DA-726W, with the following key features: frequency range, 20 to 400 MHz; attenuation range, 0 to 121 dB in 1 dB steps; insertion loss, 3.0 dB max.; RF power level, +16 dBm, 20 to 100 MHz, and +23 dBm, 100 to 400 MHz; attenuation accuracy, ±0.5 dB or ±4% of attenuation in dB, whichever is greater; attenuation characteristic, monotonic over entire range; switching time, 2.0 microseconds max.; size, 9.0" L x 2.3" W x 1.0" high.

The attenuator is ideal for a wide assortment of communications, radar and instrumentation applications. Wide attenuation range, high accuracy and low insertion loss are combined with broad frequency coverage.

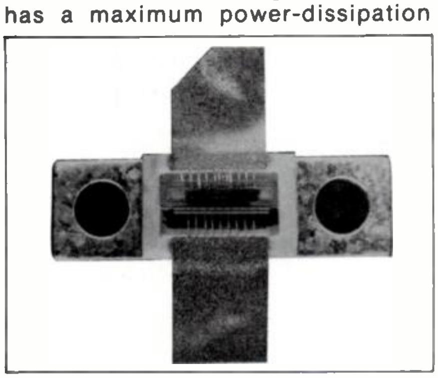
Contact Lorch Electronics Corp., 105 Cedar Lane, Englewood, New Jersey 07631. INFO/CARD #86.

Broad Band Linear Transistor

Communications Transistor Corporation, a wholly owned subsidiary of Varian Associates, announces the availability of a new broadband linear power transistor that provides six watts output over the 1.7 to 2.3 GHz frequency range. The new device, designated the 2.3L60, is a significant advancement over previously available devices. Until now, the highest power rating was 2.5 watts and this output was available only at a specific frequency, usually 2.0 GHz.

The 2.3L60 is designed for Class A operation over the entire band, and the device is gold metalized. The exceptional bandwidth has been achieved by unique input matching. With its power output and frequency range, the device is ideal for microwave relay, radio and data transmission network applications.

The 2.3L60 is characterized in a common-emitter configuration, and has a maximum power-dissipation rating of 35 watts at a 25°C case temperature. Maximum voltage and current specifications include a collectr-to-emitter voltage of 45 V, an emitter-to-base voltage of 3.5 V and a collector current of 2 A. In 100 to 499 quantities, the price of the 2.3L60 is $200 each, and small quantities are available off the shelf.



Contact Communications Transistor Corporation, 301 Industrial Way, San Carlos, CA 94070. INFO/CARD #85.

VMOS Power Transistors

Two new families of VMOS power transistors which employ a new type of V-groove structure for added stability, and which are rated at 0.5Ω maximum ON resistance are available from Intersil. Breakdown voltages range from 40 to 80 volts. The new IVN5200 and IVN5201 series of N-channel enhancement-mode power FETs include 15 individual devices. All of the VMOS parts are fabricated using a silicon gate process for high reliability, improved threshold control, and superior stability. A distinctive "flat-bottom" groove design eliminates the electrical and mechanical stresses associated with conventional V-groove structures.

Other design features include high-speed switching (t_{on} and t_{off} = 4.0 ns typical) at 4.0 to 5.0 A continuous drain current and 10.0 to 12.0 A peak drain current. The devices have inherent current-sharing capability when paralleled, and directly interface to CMOS, DTL or TTL logic. DC biasing is simple, and the VMOS FET families have extended safe operating areas.

Applications include switching power supplies, ultra high-speed pulse amplifiers, ultra high-speed high-current switches, and high-speed line drivers. Package availability is in TO-3 and TO-39 types. TO-66 and TO-220 packages will be added shortly. Price in 100-unit quantities ranges from $3.75 to $9.60, depending on specified packages and electrical specifications. Availability is from stock.

Contact Intersil Inc., 10710 North Tantau Ave., Cupertino, Ca. 95014. INFO/CARD #84.

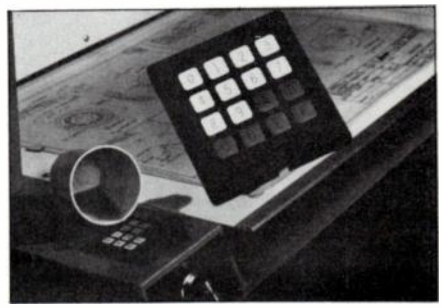
10 Ohm to 100 Megohm Chip Resistors

Thick film chip resistors in a broad range of standard ohmic values and sizes are available from TRX, Inc. TRX thick film chip resistors range in value from .1 ohm to 10K Megohm, with all standard RETMA values from 10 ohm to 100 Megohm available from stock in prototype to small production quantities. Standard tolerances are 5% and 10%; 2% can be provided on request. Sizes range from 20 mil x 30 mil (wrap around) and 20 mil x 40 mil (flip chip) up to 50 mil x 100 mil (wrap around and flip chip).

Contact TRX, Inc., 67 Mechanic Street, Attleboro, MA 02703. INFO/CARD #83.

Sealed Keyboards

Sealed keyboards in 3 x 4 and 4 x 4 button configurations are now available from Grayhill, Inc., La Grange, Illinois. The keyboard surface and the contact system is sealed by a graphic overlay which resists the vast majority of common contaminants. These keyboards can be used out-of-doors as well as in applications that require a washable front surface. Called the Grayhill series 88, these keyboards are flange mounted. A gasket seal that allows the keyboard to be sub-panel or topside mounted is available to provide complete sealing to the front panel.



The Grayhill series 88 is offered with matrix, 2 out of 7, 2 out of 8, or single pole/common bus circuitry. The contact system is rated for 3 million cycles per button. A snap dome contact system is utilized to provide positive audible and tactile feedback to the operator. The series 88 electrical characteristics have been designed to be compatible with logic circuitry.

For additional information request Bulletin 297 from Grayhill, INc., 561 Hillgrove Avenue, La Grange, Illinois 60525. INFO/CARD #82

Decorder for Mobile Radio Paging

Selectone Corporation announces the model ST-210 autopage decoder for mobile radio paging and selective calling applications. Compatible with all two tone sequential signalling formats the Selectone ST-210 autopage features full field tunability for easily adjusting both tone frequencies without reeds, resistors or frequency elements.

When the proper tone code is received, the ST-210 Autopage will: 1) momentarily sound an internal buzzer to alert the driver of the call; 2) light a red "call" indicator on the front panel;

and, 3) provide a latched relay closure to unmute the radio speaker. If the "horn" button is depressed, the unit will also provide a momentary relay closure to control a vehicle horn or other external function.

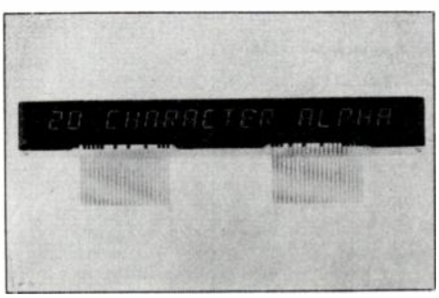
For more information, contact Selectone Corporation, 26203 Production Ave., Suite 6, Hayward, CA 94545. INFO/CARD #81.

Alphanumeric Displays

Two new 14-segment, alphanumeric, planar gas discharge displays are available from Beckman Instruments, Inc. The SP-450-018 screened image display features 20 half-inch characters. The HB-233-01 high brightness raised cathode display features three 0.28-inch characters, expandable by 3s on equal centerline spacing.

The SP-450-018 characters are visible up to 40 feet—70 footlamberts illumination—with 120° viewing angle. The HB-233-01 characters provide up to 500 footlamberts of neon-orange light for difficult viewing environments found in automotive, avionics and instrument applications. It has a wide 130° viewing angle.

The character set for both displays includes upper case letters, numbers,



many special characters and any symbol that can be made with fourteen segments.

Advanced package design minimizes display thickness for both products. Mounting depth for the SP-450-018 including tubulation is only 0.8 inches and is less than 0.5 inches for the HB-233-01.

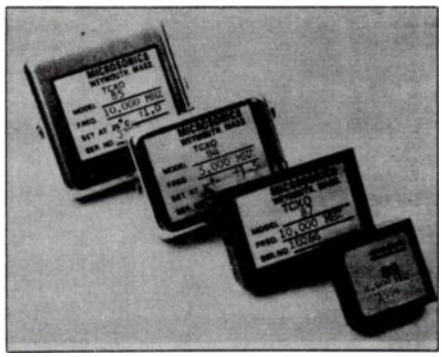
A keep alive cathode in HB-233-01 reduces reionization time to less than 30 microseconds, allows zero suppression, wide range dimming and improves low temperature operation.

Contact Beckman Instruments, Inc., Display Systems Division, P.O. Box 11866, Santa Ana, Calif. 92711. INFO/CARD #80.

Temperature Compensated Crystal Oscillators

A new line of temperature compensated crystal oscillators with an extensive range of temperature stability options is being introduced by Microsonics of Weymouth, Massachusetts.

Microsonics TCXO modules, series 80, are a line of temperature compensated crystal oscillators, including models 84 and 87 (10 MHz to 60 MHz), 85 (250 kHz to 60 MHz), and 89 (5 MHz to 20 MHz). Models 84, 85, and 87 are offered with ten temperature stability options ranging from .1 ppm (+20° to +30°C) to 15 ppm (-40° to +90°C).



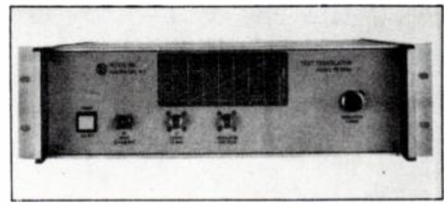
Model 89 provides a temperature stability of 2 ppm (0 to +55°C). Both commercial and MIL-SPEC grades are available.

Microsonics TCXO modules, series 80, provide TTL, complementary TTL, CMOS, sine wave, and ECL outputs for models 84, 85, and 87; model 89 is TTL exclusively. For models 84, 85, and 87, typical output signal to noise at 1 Hz bandwidth is -105 dB (100 Hz from F_0); -115 dB (1 kHz from F_0); and -125 dB (10 kHz from F_0). Models 84 and 85 are in metal packages; Models 87 and 89 in plastic. These units are enhanced, direct replacements for K1084A, K1085A, K1087A, and K1089A oscillators.

Contact Microsonics, 60 Winter Street, Weymouth, MA 02188. INFO/CARD #79.

Test Translator

Miteq TS 7050-3742 test translator converts any 40 MHz bandwidth in the 3.7-4.2 GHz frequency band to a 70 MHz IF frequency. A turns counting dial and frequency calibration chart allows precise setting of the mechan-

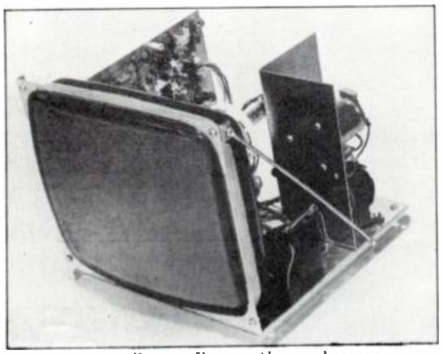


ically tuned local oscillator. Gain is 20 dB minimum, image rejection 20 dB typical and output power +5 dBm minimum.

Contact Miteq Corp., 100 Ricefield Lane, Hauppauge, N.Y. 11787. INFO/CARD #78.

CRT Modules

The Video Monitors, Inc. model M20L512H provides new capability in high resolution raster CRT modules. The 20" CRT tube can be mounted on the chassis in the "portrait" or the



"landscape" configuration shown.

The monitor provides a definition of 512 visible lines in 1/60 second for non-interlaced operation or 1024 visible lines in 1/30 second for interlaced operation. Scan frequency is approximately 30.5kHz. Separate synchronizing TTL inputs are provided. Video bit streams to 80 Mbits/second can be handled with the wide band width video amplifier.

Video Monitors, Inc. monochrome modules, normally supplied with white P4 or PC104 phosphors, can be supplied with any standard EIA registered phosphor required.

Contact Video Monitors Inc., 3833 N. White Ave., Eau Claire, Wis. 54701. INFO/CARD #76.

Temporary Spacer

The AWP-75 remov-a-pad temporary spacer is tough enough for automatic loading, and takes only seconds to disintegrate in water, chlorinated and slected fluorinated baths. The spacers are 100% polymeric and have no fillers, salt, sugar or soaps. Non-ionic, non-toxic and have an indefinite shelf-life as long as they are kept in dry storage.

AWP-75 remov-a-pads are built to come apart fast. There are 90 stock sizes available. The manufacturer advises that special sizes can also be made very economically. Samples are available on request from the manufacturer.

For more information contact Dynaloy, Inc., 7 Great Meadow Lane, Hanover, N.J. 07936. INFO/CARD #75.

Replacement for MI-B Mixer

Engelmann Microwave is offering a high level mixer model MHK-207 as a direct mechanical and electrical replacement for the model MI-B. All specifications for the model MHK-207 are guaranteed over the 0.1-500 MHz LO/RF and DC-500 MHz IF frequency ranges.

The maximum conversion loss is 7.5 dB, with LO/RF and LO/IF isolation of 25 and 20 dB respectively. The operating LO drive level is +17 dBm. Full MIL spec performance is guaranteed, including applicable requirements of MIL-STD-202E.

Contact Engelmann Microwave Company, Skyline Drive, Montville, New Jersey 07045. INFO/CARD #94.

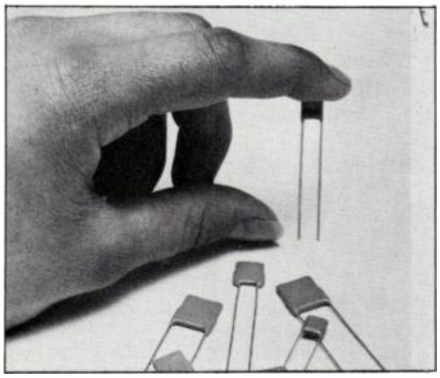
Capacitors

Emcon, a division of Illinois Tool Works Inc., is offering the Emcap line of radial lead, conformally coated ceramic capacitors that is ideal for replacing military specification parts in non-military applications. Tough epoxy coating provides moisture, shock and flame resistance. Both features give the advantages of a military part without the added expense.

Emcap capacitors are small sized, with maximum case height .500" (12.70mm); width .500" (12.70mm); and thickness .200" (5.08mm). Maximum lead thickness is .025" (.64mm) with maximum lead spacing of .400"

(10.16mm). Specially designed for volume efficiency and stability, Emcap capacitors are available in three formulations—general purpose (Z5U), stable (X7R) and ultra stable (NPO). Emcap capacitors offer wide capacitance and voltage ranges from 10pf to 4.7μf at 50 and 100 WVDC. Other capacitance and voltage values, as well as sizes and lead configurations are available on special order.

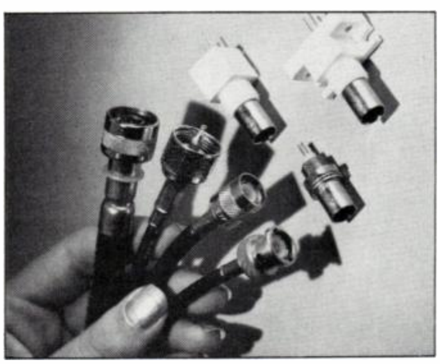
For complete details and literature, contact Emcon, ITW Electronic Com-



ponents Sales Division, 6615 West Irving Park Road, Chicago, Illinois 60634. INFO/CARD #110.

Coax Connectors

AMP Incorporated announced the expansion of their commercial RF connectors line with the introduction of four new low-cost coaxial connectors. The new BNC plug and receptacle, TNC plug, and N series plug



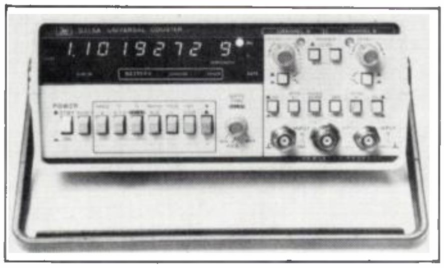
provide equivalent electrical performance to the fully intermateable MIL-C-39012 versions while costing up to 40% less.

Low cost hand-crimping tools, an economical coaxial cable stripper, and high-speed terminating machines are available for the rapid and economical application of these new connectors to a wide range of coaxial cables.

Further information contact AMP Incorporated of Harrisburg, PA. 17105. INFO/CARD #109.

Low-Cost Option Extends Frequency Range to 1 GHz

Hewlett-Packard's model 5315A universal counter extends its 100 MHz frequency measurement range to 1 GHz with a new option 003. This expanded measurement range opens up uses for the 5315A in new areas of design, production and maintenance of equipment for communications,



navigation and FM and TV broadcasting.

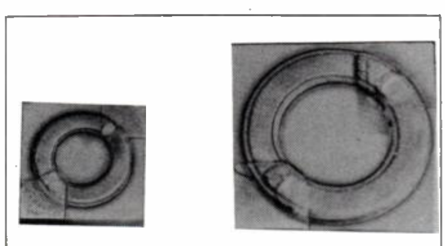
The 5315A also measures low frequency pilot tones to a high resolution in communications systems. Because it measures input waveform period and inverts the measurement to display frequency directly, the 5315A achieves a resolution of at least seven digits (0.0001%) in a measurement time of only one second, from 1 Hz up to 1 GHz.

The 5315A, without extra cost options has measurement functions of frequency, frequency ratio, period, period average, time interval, time interval with delay, time interval average and will totalize events. Its low cost, high capability and convenient operation are due to a new LSI integrated circuit chip (developed by Hewlett-Packard especially for electronic counters) and a microprocessor chip.

Contact Hewlett-Packard Company, 1507 Page Mill Road, Palo Alto, California 94304. INFO/CARD #101.

Supermicrominiature Nanohenry Chip Inductors

Series C, a new generation of 2 to 500 nanohenry chip inductors, are now available from Thinco. These gas-tight, ceramic-glass encapsulated thin film units combine an inductance

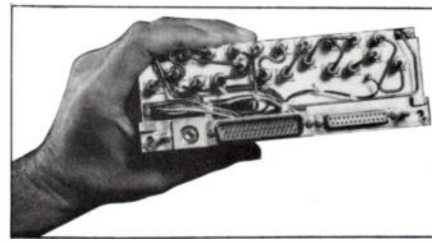


temperature coefficient of less than 20 PPM°C, F° to 6 GHz, and high power handling capability. Series C chips have been cycled from -196°C to +450°C with no change in value; subjected to standard shock and vibration testing with no deviation; and are radiation-qualified for space applications.

These new inductors, available singly or in matched sets with ± 2% tolerances, are ideal for applications up to and including "C" band. For information, contact Thinco, a division of Hull Corporation, Hatboro, PA 19040. INFO/CARD #116.

Frequency Measurement Receiver

Wide open, high-probability of intercept receiver increases signal processor efficiency by decreasing



complexity and reaction time. This receiver features ultra miniature size with 13 bit resolution, pulsed signal density to 3.3 x 106 per second, 100 ns measurement and modular construction with FET preamplifier and simultaneous signal detector. For more information Litton-AMECOM, 5115 Calvert Road, College Park, MD 20740. INFO/CARD #115.

Micromini Transistors and Diodes

A broad family of small-signal transistors, diodes, and FETs is now available from the Electronic Components Division of Panasonic Company in plastic microminiature packages. Previously available in TO-92 and DO-35 packages, the same "chips" are being packaged into microminiature packages that are considerably smaller than the conventional TO-92 and DO-35 cases.

The microminiature packages—tiny as a grain of wheat—are ideally suited for mounting by means of solder reflow method. All electrical characteristics of these "mini-mold" series are identical to their TO-92 and DO-35 counterparts, except the dissipation. Device reliability is ensured through the selection of chips that are already in volume production and thorough testing of the completed packages. The devices can be supplied in a specially designed cartridge to facilitate automatic insertion.

Among the 24 transistor types available in this mini-mold series, there are audio and high frequency amplifiers, general purpose amplifiers, audio output units.

Contact Panasonic, One Panasonic Way, Secaucus, NJ 07094. INFO/CARD #114.

Two LEDs in One Package

Proving that two lamps are better than one, Data Display Products' new bi-color panel lights provide two colors of super-bright LEDs in a single, panel-mounting enclosure. This reduces panel space requirements and provides a better human-factors presentation for two associated indications. In addition, the new panel lights offer a lower installed cost than two separate lamps.

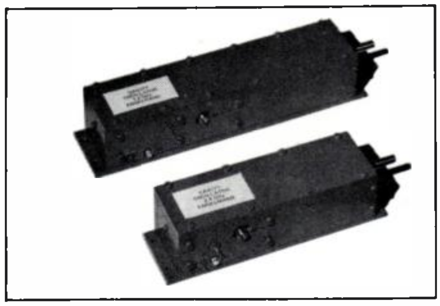
Any two of the three basic LED colors may be chosen: red, amber, or green. Since the two LED circuits are electrically isolated in the four-lead package, different resistor values may be chosen for different operating voltages. The 2.4-V LED requires an external resistor, however internal resistors are included in the other four (3.6 to 28 V) operating ranges.

Contact Data Display Products, 303 N. Oak St., Inglewood, Calif. 90302. INFO/CARD #74.

Full Octave Tunable Oscillators

Engelmann Microwave has designed a series of full octave tunable oscillators featuring ultra-fine mechanical tuning over the 1-4 frequency range. Resolution or settability to within 10 kHz is achievable with the exceptionally high quality tuning. The tuning mechanism provided allows resolution or settability to within 10 kHz.

The model CC-112 and CC-24 illustrated provide a minimum of 50 fundamental MW of CW power over the 1-4 GHz band and are supplied with AFC varactor tuning intended for external phase lock or voltage tuning for synthesizer applications. Due to the ex-



cellent spectral purity of output signal, both models are ideally suited for communications, receivers, test equipment and a wide variety of other critical applications. The maximum spurious content is specified at 80 dBc and the FM noise is 72 dB at 1 kHz and 100 dB at 10 kHz. Full-band tuning requires approximately 50 turns and the repeatability from unit to unit is held very tightly.

The models CC-12 and CC-24 include optional RFI shielding for applications that must strictly comply with demanding RFI requirements.

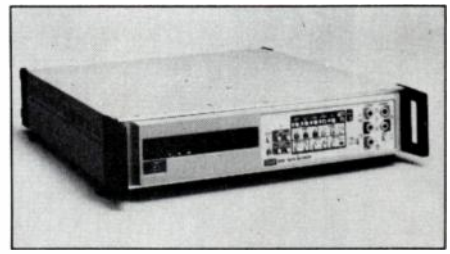
Contact Carl Schraufnagl, Engelmann Microwave Company, Skyline Drive, Montville, N.J. 07045. Circle INFO/CARD #73.

Systems and Human Interactive DMM

A new 5 1/2-digit systems/bench microprocessor based DMM which provides an extensive array of systems and operator interfaces to make the systems bench and product line user's life a lot easier. The model 8520 boasts complete systems capability of all functions, features, and ranges. The 8520A makes available the most extensive array of man/machine interfaces available in any bench/systems DMM. Diagnostics, program menu and operator prompting and man/machine responses make the 8520A truly a human interactive instrument.

The most unique features include "burst mode," and "very low frequency AC capability." The model 8520A includes a number of other new preprogrammed features such as math, limits, peak, and reading speeds up to 500 per second.

Designed with the user in mind, the 8520A is safe, easy to program, provides display prompting, and has as



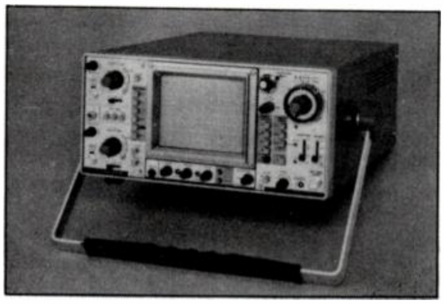
standard most wanted systems and bench user features.

Contact John Fluke Mfg. Co. Inc., P.O. Box 43210, Mountlake Terrace, Wash. 98043. INFO/CARD #72.

Low Cost 35 MHz Scope

A new 35 MHz, dual channel, portable scope with chop frequency of 500 kHz and an alternate sweep capability has been introduced by Kikusui International Corporation, a subsidiary of Kikusui Electronics Corporation.

An alternate sweep and calibrated delay are features of the 5630 not normally found on scopes of this class. The horizontal axis (sweep time) for channel A (main sweep) and channel B (delayed sweep) is 0.1 usec/div to 0.5 sec/div in 21 steps. A 10X magnification can accelerate the sweep time to 10nsec/div to 50msec/div. The vertical axis will accommodate signals from DC to 35 MHz (−3 dB). Normal sensitivity (deflection factor) is 5mV/div to 5V/div in 10 steps. A 5X magnification capability can increase this sensitivity to 1mV/div to 1V/div. Operational modes are channel 1, channel



2, alternate and chop, complemented with an Add mode and an X-Y mode.

There are four trigger modes for source A signals (internal, external, external ÷ 10 and line) plus two trigger modes for signal source B (internal and external). Trigger coupling includes AC, HF rejection, and DC. For video waveforms, a synchronization circuit linked to the time/div switch lets the user view signals associated with TV servicing.

In the X-Y mode, the model 5630 bandwidth is DC to 2 MHz (−3 dB) with a deflection factor of 5mV/div to 5V/div in 10 steps. Z-axis bandwidth is DC to 5 MHz with a sensitivity of ± 3V peak to peak.

Contact Kikusui International, 17121 South Central Avenue, Carson, Calif. 90746. INFO/CARD #71.

Dual A/N LEDS

IEE-Hercules models LR3784/85R .54" dual, alphanumeric, end-stackable LED displays with common cathode and right hand decimal point. This series has a gray face and white body; segments appear translucent when not lit.

These models consist of two .54" high, red 14-segment characters combined in a single, compact package, which can display alpha and numeric characters plus some symbols. The end-stackable feature allows designers variable display lengths in accordance with their needs. Composed of GaAsP emitting material, these solid state displays have a typical 600μcd/segment luminous intensity at 20mA/1.6V_F. The 18, horizontal double DIP pins on .100" (2.54mm) spacing are set up for multiplex drive for maximum pinout economy.

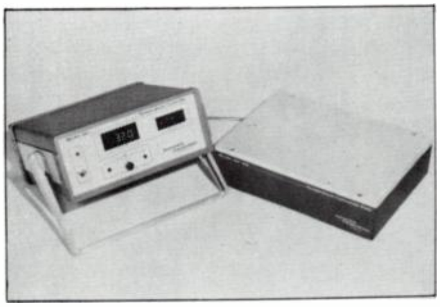
Request Data Sheet LR3784/85R

INFO/CARD 17

from IEE, 7740 Lemona Avenue, Van Nuys, CA 91405. INFO/CARD #127.

Temperature Controlled Test Plate

The model TCP-500 temperature controlled plate is for bench testing electronic assemblies that are specified to operate at base or mounting surface temperature rather than ambient



temperature such as RF, microwave and spaceborne equipment. It was designed for ATP testing, long-term burn-in, rapid temperature cycling and circuit development.

The 10" x 14" plate can be controlled from −55°C to +100°C in one degree increments with ±1°C trim adjust by a digital thumbwheel switch on the control panel. An LED readout indicates the plate temperature. The plate has integral heaters, a valve for either CO_2 or liquid nitrogen cooling, and plugs in to a standard 115v 50/60Hz outlet.

Contact Autronics Corp., 314 E. Live Oak, Arcadia, Calif. 91006. Please circle INFO/CARD #69.

Broadband Double-Balanced Biasable Mixer

The DBMB 1-18 and DBMB 2-18 double-balanced biasable mixer covers the RF range of 1.0 to 18.0 GHz and 2.0 to 18.0 GHz respectively. The IF range is 1 to 250 MHz for the DBMB 1-18 and 1 to 500 MHz for the DBMB 2-18. Conversion loss is 9 dB TYP. DC power and LO power is +12 VDC @ 6mA and 4 dBm max. LO and RF VSWR is 3:1 max. with LO to RF isolation of 20 dB TYP. Size is 1" x .6". Connectors are SMA female.

Contact Norsal Industries, Inc., 34 Grand Boulevard, Brentwood, N.Y. 11717. INFO/CARD #68. □

Advertiser Index

literature

H.H. Smith Component Catalog

A newly published, 104 page component/hardware catalog, featuring a completely updated format to expedite easy location of product categories by design engineers and purchasing agents, is now available from Herman H. Smith, Inc., a North American Philips Co., of Brooklyn, N.Y.

The edition details key product information and specifications along with technical illustrations and features of the more than 20,000 items the company produces.

Typical of some new products to be found in the latest Smith catalog are Terminal Blocks and Hardware, IC Test Clips, Binding Posts and "Mil-Spec" Jacks, Test Leads, Adapters, Transistor Sockets, Spacers and Standoffs.

Contact H.H. Smith, Inc., 812 Snediker Ave., Brooklyn, N.Y. 11207. Circle INFO/CARD #140.

Cornell-Dubilier Catalog

A new catalog, "1979, 1980 Cornell-Dubilier General Line/MRO Components Catalog," is now available.

The full-sized 60 page catalog also offers a comprehensive cross reference section. Product lines include: electrolytic capacitors aluminum, AC capacitors, film-metallized capacitors, MICA dielecric capacitors, disc ceramic capacitors, EMI filters, relays and decade-boxes.

Contact Cornell-Dubilier, 150 Avenue L, Newark, N.J. 07101. INFO/CARD #139.

FTS Free Newsletter

Free subscription to FTS' newsletter, "It's About Time," is available to engineers and scientists who work in the frequency control and precise time industry. To qualify for the free subscription call Marilyn Ellis at (617) 777-1255 or write on company letterhead to Frequency and Time Systems, Inc., 182 Conant St., Danvers, Mass. 01923. INFO/CARD #136.

CTC Transistor Reference Guides

Communications Transistor Corporation announces the availability of a series of "Quick Reference Guides" for the firm's transistor products. The one page guides are organized by applications to facilitate their use, and are available gratis to qualified individuals.

The guides available are military wideband balanced transistors, microwave transistors, military transistors, linear transistors, land mobile transistors, and TACAN/DME/IFF transistors.

The guides may be obtained from the Marketing Services Department, Communications Transistor Corporation, 301 Industrial Way, San Carlos, Calif. 94070. INFO/CARD #138.

Cherry Keyboard Application Data

This new 14 page brochure from Cherry Electrical Products Corporation contains an introduction to solid state capacitive keyboards and valuable application data. Specifications, detailed block diagrams and schematic charts give a concise description of these advanced design keyboards and show their versatility and reliability.

Special sections of step-by-step instructions and flow charts allow the user to customize Cherry keyboards and meet the needs of his particular application. Available options include data bus, handshake, serial data out.

Free copies can be obtained by writing Cherry Electrical Products Corporation, 3600 Sunset Avenue, Waukegan, Illinois 60085. INFO/CARD #137. □

Don't let the atmosphere fool you.

It won't cost you an arm and a leg for our high volume RF PIN diodes. That's an important consideration if you're into VHF/UHF switching and attentuation. And we can deliver them a lot faster than our competition.

Of course, we built our reputation on high-priced state of the art specials at microwave frequencies. But from this advanced technology and the reliability know-how developed for our military radar systems has evolved a line of low cost, high volume RF semiconductors.

To find out how you can use these cost conscious devices in your system, send for our data package of specifications, prices, and applications. For evaluation samples, contact the Semiconductor Sales Department, South Ave., Burlington, MA 01803 (617) 272-3000.

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