

RFdesign

engineering principles and practices

1991 Directory Issue

**Your Guide to
RF Products
from Over
1250 Companies**

**Now Available—
Company Listings on Disk!
See Page 113**

**1991/1992 Directory
RF Products and Services**

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RF Design News



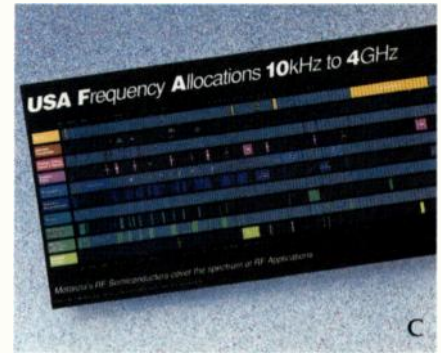
Satellite microwave power transistors at down-to-earth cost.

If you're designing satellite up links for land, sea or airborne transportation vehicles and want L-band large signal output and driver amplifier stages, look to Motorola's rugged new MRA1600/RF309X Series of 1600-1660 MHz microwave power transistors and associated linear devices. They feature gold metalization, diffused ballast resistors and internal impedance compensation—*plus* the lowest cost available.



New output transistor joins long pulse microwave power lineup.

Motorola's latest long pulse, L-band transistor is the output device of a 3-part lineup designed for common base amplifier applications such as JTIDS (military) and Mode S (commercial) transmitters. The MRF10120 is capable of providing over 9 dB gain operating from 36 volts and handling 10 micro-second pulses at 50% duty cycle for a period of 3.5 milli-seconds at a time. The frequency of operation extends from 960 to 1215 MHz.

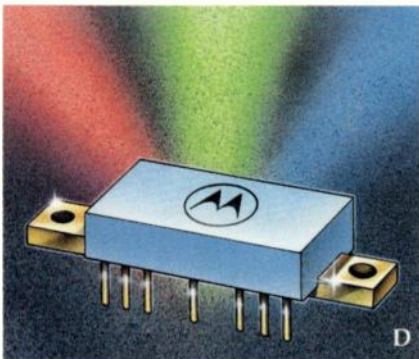


Revised USA Frequency Chart.

The popular USA Frequency Chart has been extensively revised, altered in shape and color-enhanced to make it more suitable and attractive for wall mounting. Obtain your copy by contacting the Linear Integrated Circuits Division of Motorola SPS.

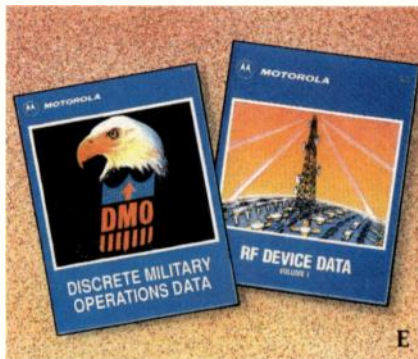
Get more information.

To get more information on any of the Motorola products shown, contact your local Motorola sales office, complete and return the coupon below to Motorola Semiconductor Products, Literature Distribution Center, P.O. Box 20912, Phoenix, AZ 85036. Or call toll-free any weekday, 8:00 a.m. to 4:30 p.m. (MST), 1-800-441-2447.



New high-speed, wideband, hybrid amplifier.

A new wideband hybrid amplifier designed specifically for use as the video channel final stage driver in high resolution color monitors is now available from Motorola. The CR3424 provides 2.7 nano-second typical rise and fall times with 40 volt peak-to-peak output circuit swings into a 10 pF load. Linearity error is less than 5%. Operation from an 80 volt supply provides the large DC offset range required for color monitors. To learn about the effects of video amplifiers on CRT picture quality and basic drive requirements and drive circuits for the CR3424, order application notes #AN1103.



New RF Data Book/Military Data Book.

Edition #4 of the Motorola Semiconductor RF Data Book is now available. Though similar in appearance to Edition #3, the new book has added 84 new data sheets and deleted 130 others. It also contains three additional items in the applications section.

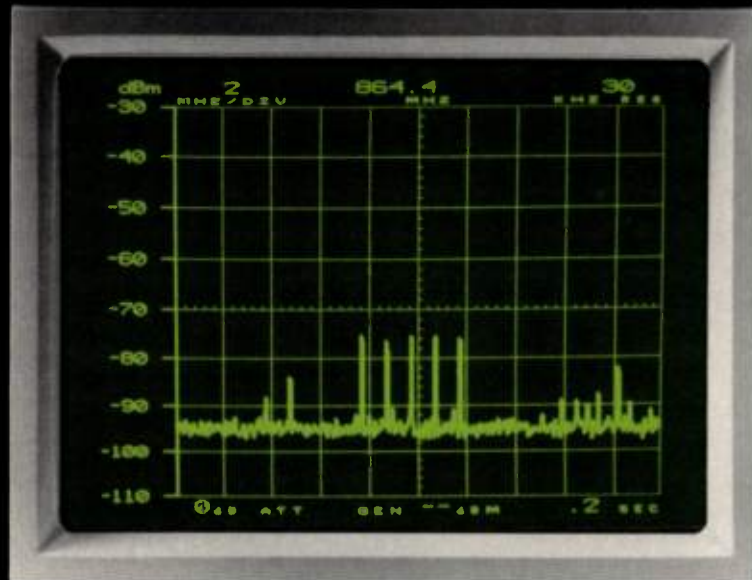
The Motorola Discrete Military Operation Data Book (Second Edition) defines Motorola's current line of semiconductors or components for military and other high-reliability applications.



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If you're not using a spectrum analyzer...



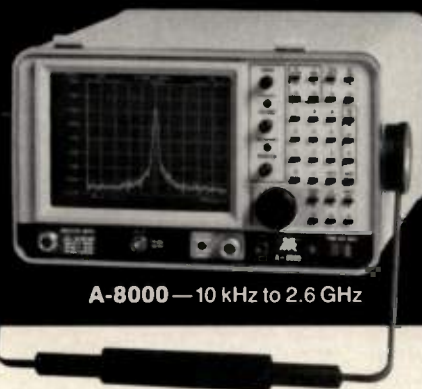
Spectrum analyzer display of cellular telephone transmissions.

maybe it's time to take a closer look.



A-7550 — 10 kHz to 1.0 GHz

ifr **Spectrum Analyzers**



A-8000 — 10 kHz to 2.6 GHz

You can't hear them or see them, but there are probably thousands of electromagnetic signals being transmitted through the air around you at this very moment.

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DSO699	SPST	5-1500	1.0	48	23.0	TO-8	TTL
DSO990	SPST	10-2000	1.5	62	25.0	14 Pin DIP	TTL
DSO850	SP2T	DC-2000	0.4	47	5.0	TO-5	0/-7
DSO813	SP2T	DC-2000	0.7	40	140.0	TO-5	TTL
DSO812	SP2T	10-1000	0.5	54	50.0	TO-8	TTL
DSO860	SP2T	10-1000	0.5	47	50.0	.380 sq	TTL
DSO602	SP2T	5-4000	1.3	65	26.0	14 Pin DIP	TTL
DSO842	SP2T	5-1500	1.0	75	50.0	14 Pin DIP	TTL
DSO864	SP4T	5-2000	1.3	49	28.0	16 Pin DIP	TTL
DSO874	SP4T	DC-2000	2.2	60	55.0	14 Pin DIP	TTL
DSO838	SP8T	5-1000	2.2	40	40.0	24 Pin DIP	TTL
DSO918	SP16T	DC-4000	3.8	30	150	58 Pin DIP	TTL

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6300 S. Syracuse Way, Suite 650
Englewood, CO 80111 • (303) 220-0600
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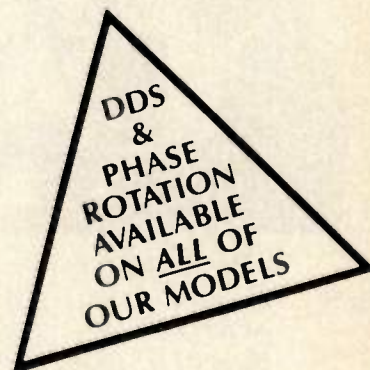
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Range: 0.1-40 MHz Resolution: 0.1Hz-100KHz (opt) Switching: 1-20μs	Output: +3 to +13dBm; 50ohm Spurious Outputs: -75dBc Phase Noise: -75dBc (0.5Hz-15KHz)	Freq. St'd: OCXO, TCXO, Ext. Interface: BCD par. or GPIB Price: \$5,125.00*	
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PTS 620			
Range: 1-620 MHz Resolution: 0.1Hz-100KHz (opt) Switching: 1-20μs	Output: +3 to +13dBm; 50ohm Spurious Outputs: -70dBc Phase Noise: -63dBc (0.5Hz-15KHz)	Freq. St'd: OCXO, TCXO, Ext. Interface: BCD par. or GPIB Price: \$8,675.00*	
PTS 1000			
Range: 0.1-1000 MHz Resolution: 0.1Hz-100KHz (opt) Switching: 5-10μs	Output: +3 to +13dBm; 50ohm Spurious Outputs: -70dBc (0.1-500 MHz), -65dBc (500-1000 MHz) Phase Noise: -60dBc (0.5Hz - 15KHz)	Freq. St'd: OCXO, TCXO, Ext. Interface: BCD par. or GPIB Price: \$11,275.00*	
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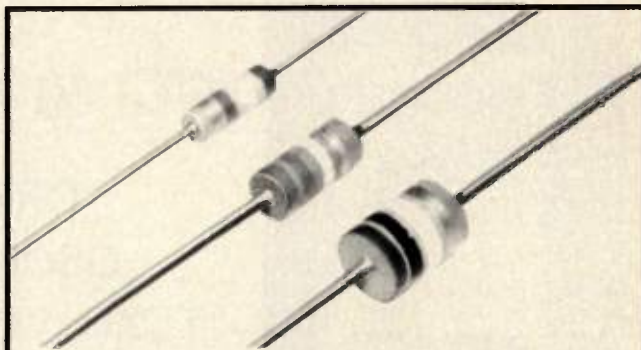
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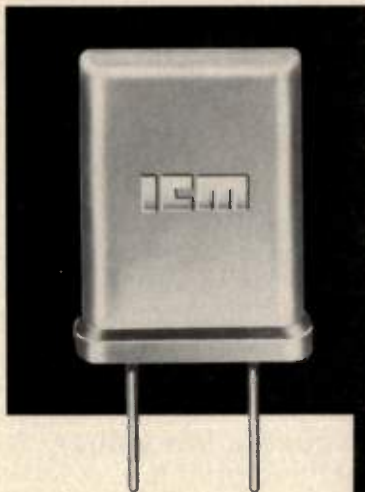
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DESCRIPTION	ORDER CODE
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The complete Cellular Demo Kit contains a chip set of 12 ICs, a tested demo board with all the hardware and firmware, documentation, schematics, RS-232 interface board, keyboard, handset and display. The chip set handles the processing of data, audio, the receiver, the switching of channels and the transmitter. The following is a list of the parts and the functions they perform:

- **UMA1000DT DPROC** - Handles data processing
- **UMA1014DT Synthesizer** - Handles the channel selection on both the receiver and transmitter (Two per system, TX and RX)
- **NE605DK FM IF System** - Handles the receiver portion of the system
- **NE5750D APROC** - Handles audio processing
- **NE5751D APROC** - Handles audio processing
- **PCB80C552 Microcontroller** - Controls the complete cellular board
- **27C512 EPROM** - Stores the "Test Harness" program along with the firmware for the phone functions.
- **FCB61C65 8K x 8 Static Ram** - Stores scratch pad information
- **NE5234D Quad Op-Amp** - Controls the TX power amp level
- **74HC573D Latch** - Memory address latch

Signetics

To obtain your Signetics Cellular Chip Set Demo Kit call 800-227-1817, Ext. 900 today for your local sales office or for more information on Signetics RF Communication products, see our BRC in the back of the directory.

Philips Semiconductors



PHILIPS

NE/SA606

High-performance low-power mixer FM IF system

DESCRIPTION

The NE/SA606 is a high performance monolithic low-power FM IF system incorporating a mixer/oscillator, two limiting intermediate frequency amplifiers, quadrature detector, logarithmic received signal strength indicator (RSSI), voltage regulator and audio and RSSI op amps. The NE/SA606 is available in 20-lead dual-in-line plastic, 20-lead SOL (surface-mounted miniature package) and 20-lead SSOP package.

The NE606 was designed for portable communication applications and will function down to 2.85V. The RF section is similar to the famous NE605. The audio and RSSI outputs have amplifiers with access to the feedback path. This enables the designer to level adjust the outputs or add filtering.

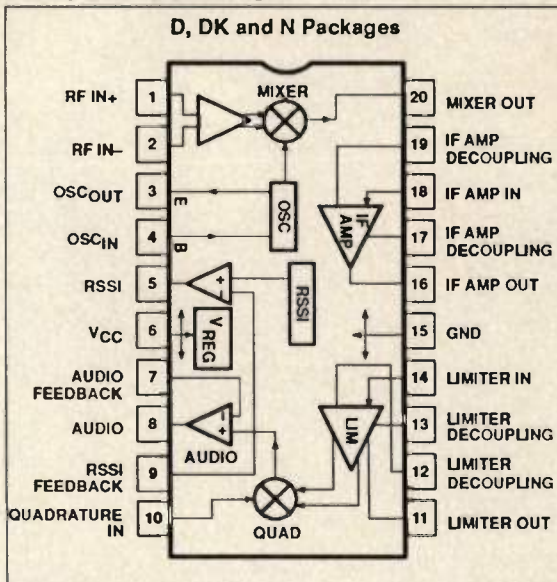
FEATURES

- Low power consumption: 3.5mA typical at 3V
- Mixer input to >100MHz
- Mixer conversion power gain of 13dB at 45MHz
- XTAL oscillator effective to 150MHz (L.C. oscillator or external oscillator can be used at higher frequencies)
- 102dB of IF Amp/Limiter gain
- 2MHz limiter small signal bandwidth
- Temperature compensated logarithmic Received Signal Strength Indicator (RSSI) with a 90dB dynamic range
- Low external component count; suitable for crystal/ceramic/LC filters
- Excellent sensitivity: 0.35 μ V into 50 Ω matching network for 12dB SINAD (Signal to Noise and Distortion ratio) for 1kHz tone with RF at 45MHz and IF at 455kHz
- SA606 meets cellular radio specifications
- Audio output internal op amp
- RSSI output internal op amp
- Internal op amps with rail-to-rail outputs

ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE
20-Pin Plastic DIP	0 to +70°C	NE606N
20-Pin Plastic SOL (Surface-mount)	0 to +70°C	NE606D
20-Pin Plastic SSOP (Surface-mount)	0 to +70°C	NE606DK
20-Pin Plastic DIP	-40 to +85°C	SA606N
20-Pin Plastic SOL (Surface-mount)	-40 to +85°C	SA606D
20-Pin Plastic SSOP (Surface-mount)	-40 to +85°C	SA606DK

PIN CONFIGURATION



APPLICATIONS

- Portable cellular radio FM IF
- RF level meter
- Spectrum analyzer
- Instrumentation
- FSK and ASK data receivers
- Log amps
- High performance communication receiver
- Single conversion VHF receivers

Signetics

Philips Semiconductors



PHILIPS

NE/SA630

Single pole double throw (SPDT) switch

DESCRIPTION

The NE630 is a wideband RF switch fabricated in BiCMOS technology and incorporating on-chip CMOS/TTL compatible drivers. Its primary function is to switch signals in the frequency range DC – 1GHz from one 50Ω channel to another. The switch is activated by a CMOS/TTL compatible signal applied to the enable channel 1 pin (ENCH1).

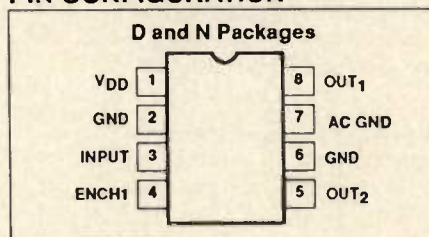
The extreme low current consumption makes the NE/SA630 ideal for portable applications. The excellent isolation and low loss makes this a suitable replacement for PIN diodes.

The NE/SA630 is available in an 8-pin dual in-line plastic package and an 8-pin SO (surface mounted miniature) package.

FEATURES

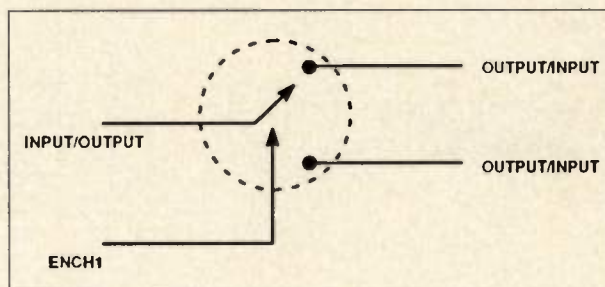
- Wideband (DC – 1GHz)
- Low through loss (1dB typical at 200MHz)
- Unused input is terminated internally in 50Ω
- Excellent overload capability (1dB gain compression point +17dBm at 300MHz)
- Low DC power (140μA from 5V supply)
- Fast switching (25ns typical)
- Good isolation (off channel isolation 60dB at 200MHz)
- Low distortion (IP₃ intercept +32dBm)
- Good 50Ω match (return loss 20dB at 400MHz)
- Full ESD protection
- Bidirectional operation

PIN CONFIGURATION



APPLICATIONS

- Digital transceiver front-end switch
- Antenna switch
- Filter selection
- Video switch
- FSK transmitter



ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE
8-Pin Plastic DIP	0 to 70°C	NE630N
8-Pin Plastic SO (Surface-mount)	0 to 70°C	NE630D
8-Pin Plastic DIP	-40 to +85°C	SA630N
8-Pin Plastic SO (Surface-mount)	-40 to +85°C	SA630D

Signetics

Philips Semiconductors



PHILIPS

NE/SA5200

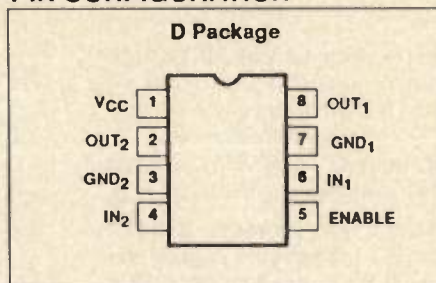
RF dual gain stage

DESCRIPTION

The NE5200 is a dual amplifier with DC to 1200MHz response. Low noise ($NF = 3.9\text{dB}$) makes this part ideal for RF front-ends, and a simple power-down mode saves current for battery operated equipment. Inputs and outputs are matched to 50Ω .

The enable pin allows the designer the ability to turn the amplifiers on or off, allowing the part to act as an amplifier as well as an attenuator. This is very useful for buffering the receiver front-end.

PIN CONFIGURATION

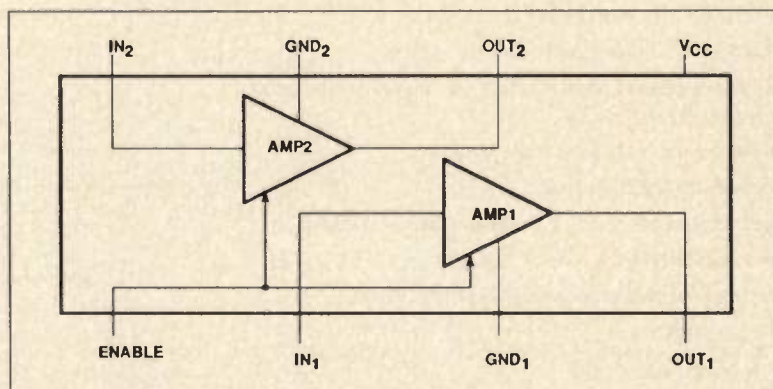


FEATURES

- Dual amplifiers
- DC - 1200MHz operation
- Low DC power (4mA @ $V_{CC} = 5\text{V}$ per amplifier)
- Power-Down Mode ($I_{CC} = 85\mu\text{A}$ typical)
- 3.9dB noise figure
- Unconditionally stable
- 2000V ESD protection
- Low cost
- Supply voltage 4-9V
- Gain $S_{21} = 7\text{dB}$ at $f = 1\text{GHz}$
- Input and output match $S_{11}, S_{22} < -10\text{dB}$

APPLICATIONS

- Cellular radios
- RF IF strips
- Portable equipment



ORDERING INFORMATION

DESCRIPTION	TEMPERATURE RANGE	ORDER CODE
8-Pin Plastic SO (Surface-mount)	0-70°C	NE5200D
8-Pin Plastic SO (Surface-mount)	-40-+85°C	SA5200D

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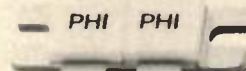
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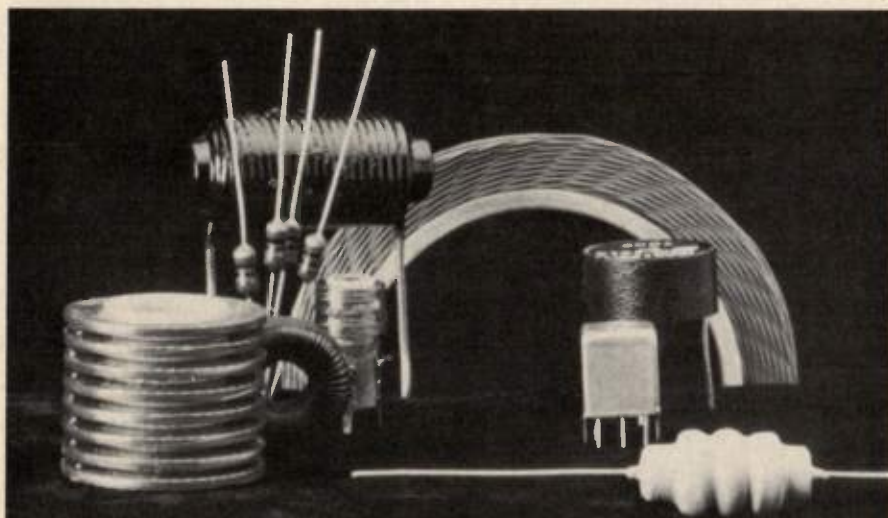
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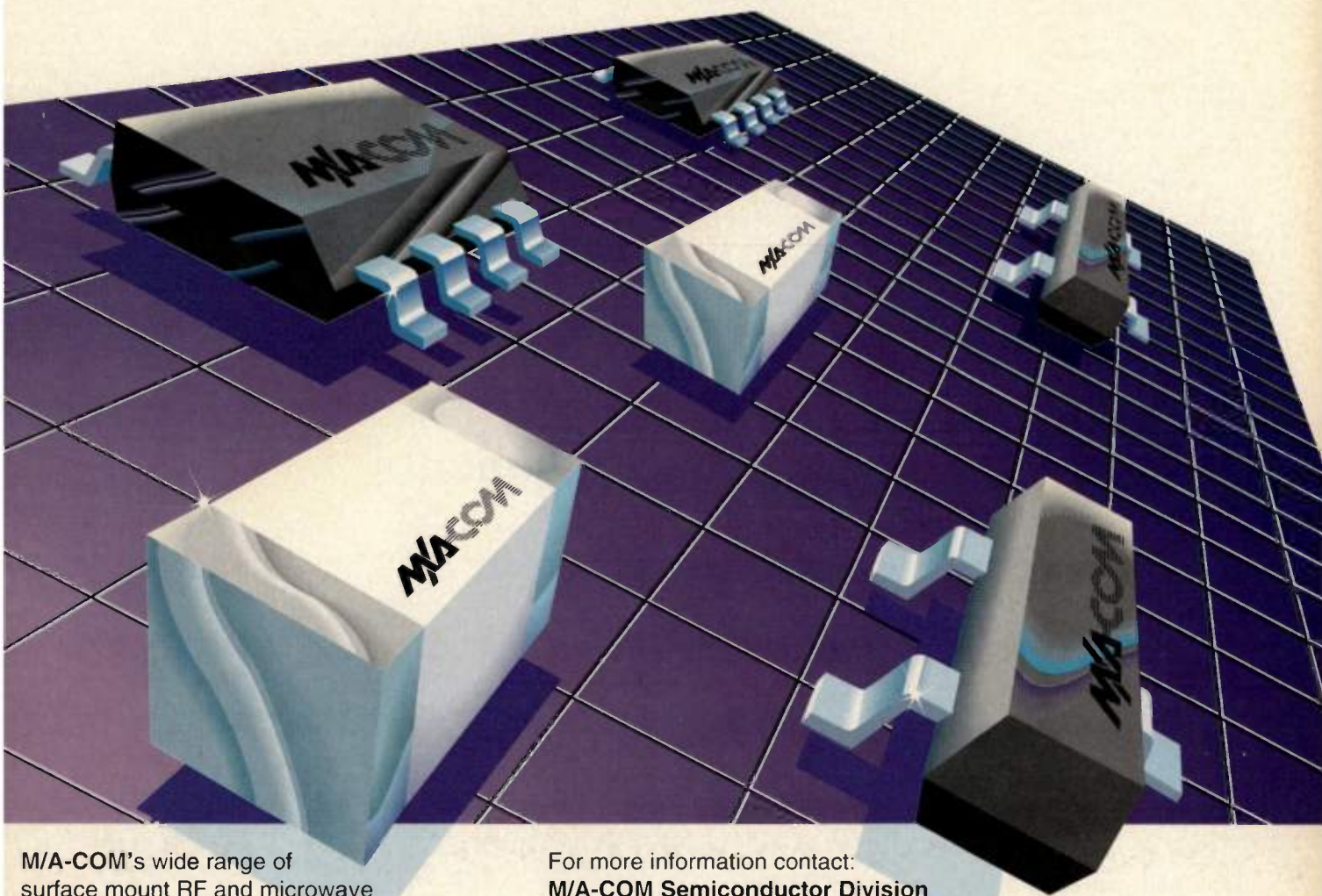
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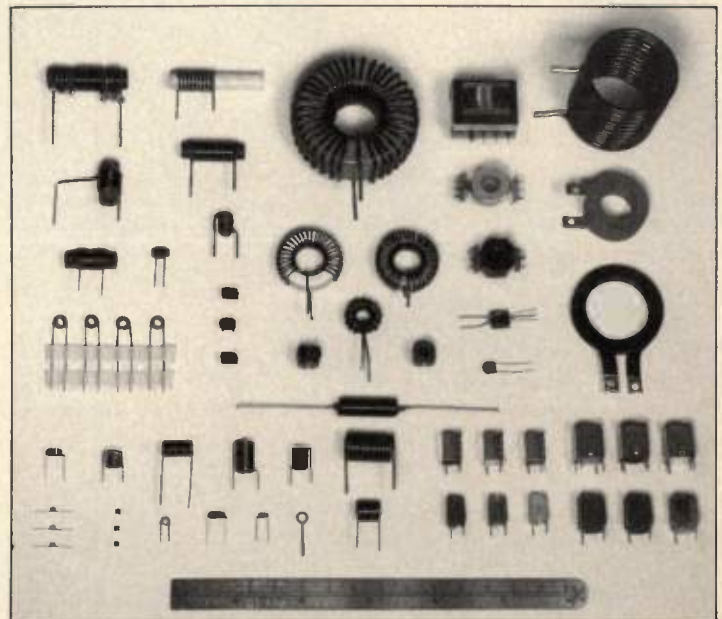
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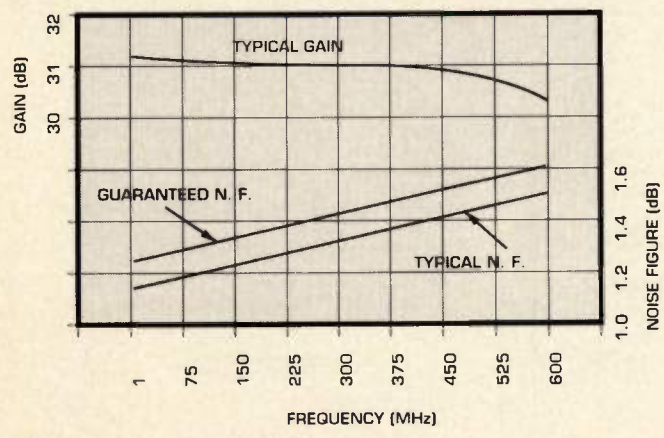
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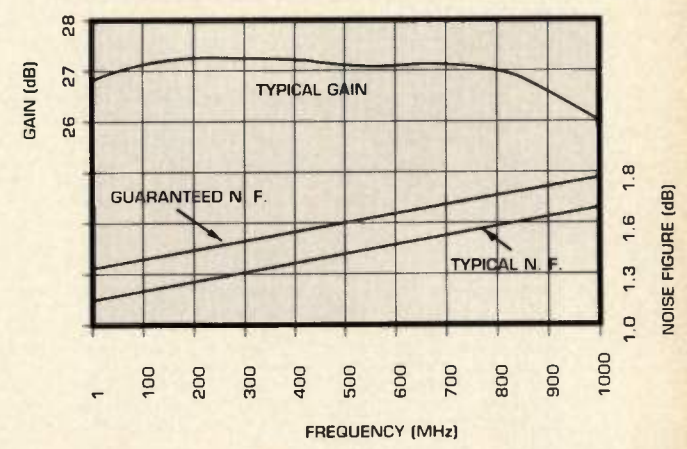
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				Low End	Mid Band	High End		Comp. Output (Min., dBm)		
AU-1054	1-500	30	0.5	1.25	1.4	1.5	2:1	+8		55
AU-2A-0150	1-500	30	0.5	1.25	1.4	1.5	2:1	+8		55
AU-3A-0150	1-500	45	0.5	1.25	1.4	1.5	2:1	+10		67
AU-1149	10-180	15	0.5	4.5	5.5	6.5	2:1*	+18		75
AU-1291	015-500	60	0.75	1.25	1.4	1.5	2:1	+8		90
AM-1300	01-1000	25	0.75	1.4	1.6	1.8	2:1	+6		50
AM-1052	1-1000	26	0.75	1.4	1.6	1.8	2:1	+6		50
AM-2A-000110	1-1000	27	0.75	1.4	1.6	1.8	2:1	+8		50
AM-1299	1-1000	38	0.75	1.4	1.6	1.8	2:1	+9		75
AM-3A-000110	1-1000	37	0.75	1.4	1.6	1.8	2:1	+9		75

* 75 ohm impedance level

AU-1054 and AU-2A-0150



AM-1052 and AM-2A-000110



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QBH-107	5-550	14.8	-1.0	2.8	25.0	8/12	\$85
QBH-110	5-500	15.0	9.0	3.5	25.0	22/32	\$90
QBH-119	5-500	15.0	11.0	3.3	25.0	24/33	\$95
QBH-120	5-500	14.5	1.0	2.3	26.0	13/17	\$95
QBH-122	10-500	17.0	19.0	4.6	22.0	24/32	\$110
QBH-126	5-500	15.0	15.0	4.2	24.0	28/34	\$95
QBH-155	5-300	15.0	21.0	6.4	28.0	36/48	\$65
QBH-183	5-1100	10.3	14.0	6.5	12.0	27/38	\$80
QBH-184	5-1000	14.8	10.0	5.0	17.0	24/33	\$85
QBH-815	5-1000	11.4	20.5	8.0	12.5	30/45	\$95
QBH-822	10-2000	20.0	10.0	6.0	24.0	23/34	\$162

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Sharpest Video Images: 0.01°/0.03% Diff Phase/Gain

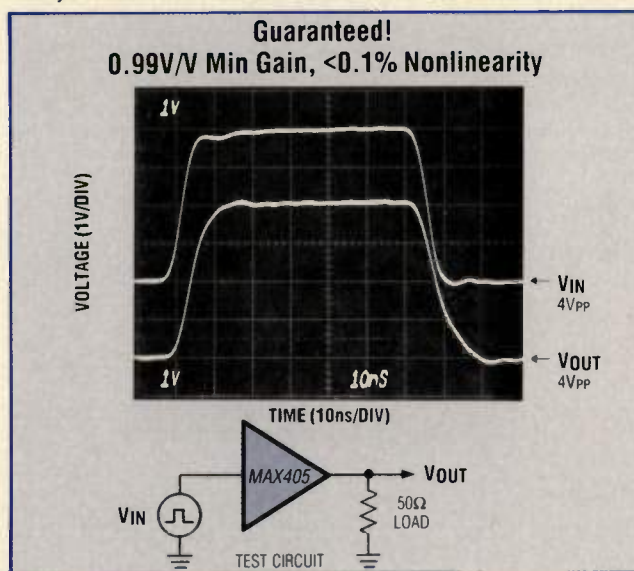
Maxim's new 180MHz MAX405 high-speed, precision buffer amplifier combines superior differential gain and phase with 650V/ μ s slew rate while operating from ± 5 V supplies. Gain is guaranteed to be greater than 0.99V/V over -40°C to $+85^{\circ}\text{C}$, with loads as low as 50 Ω . The MAX405 comes in compact 8-pin DIP or SOIC packages and, unlike existing buffers, access to the inverting input allows accurate gain adjustment from 0.99 to 1.1V/V.

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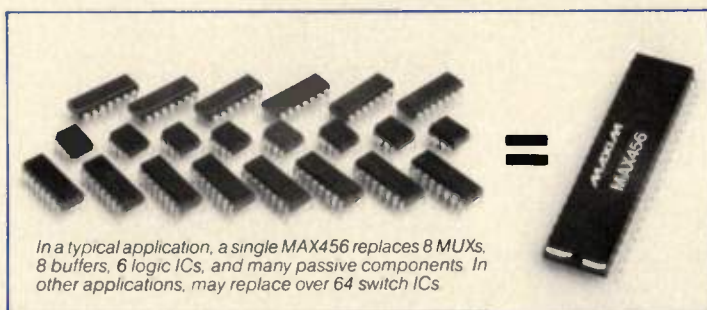
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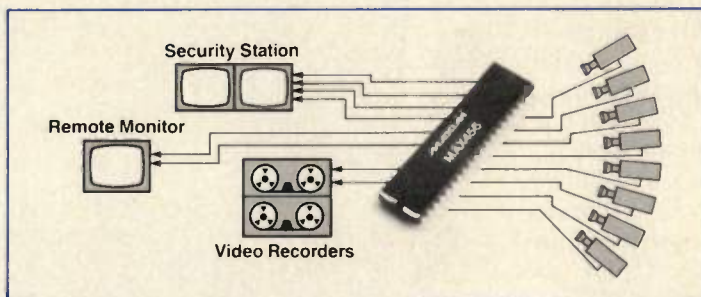


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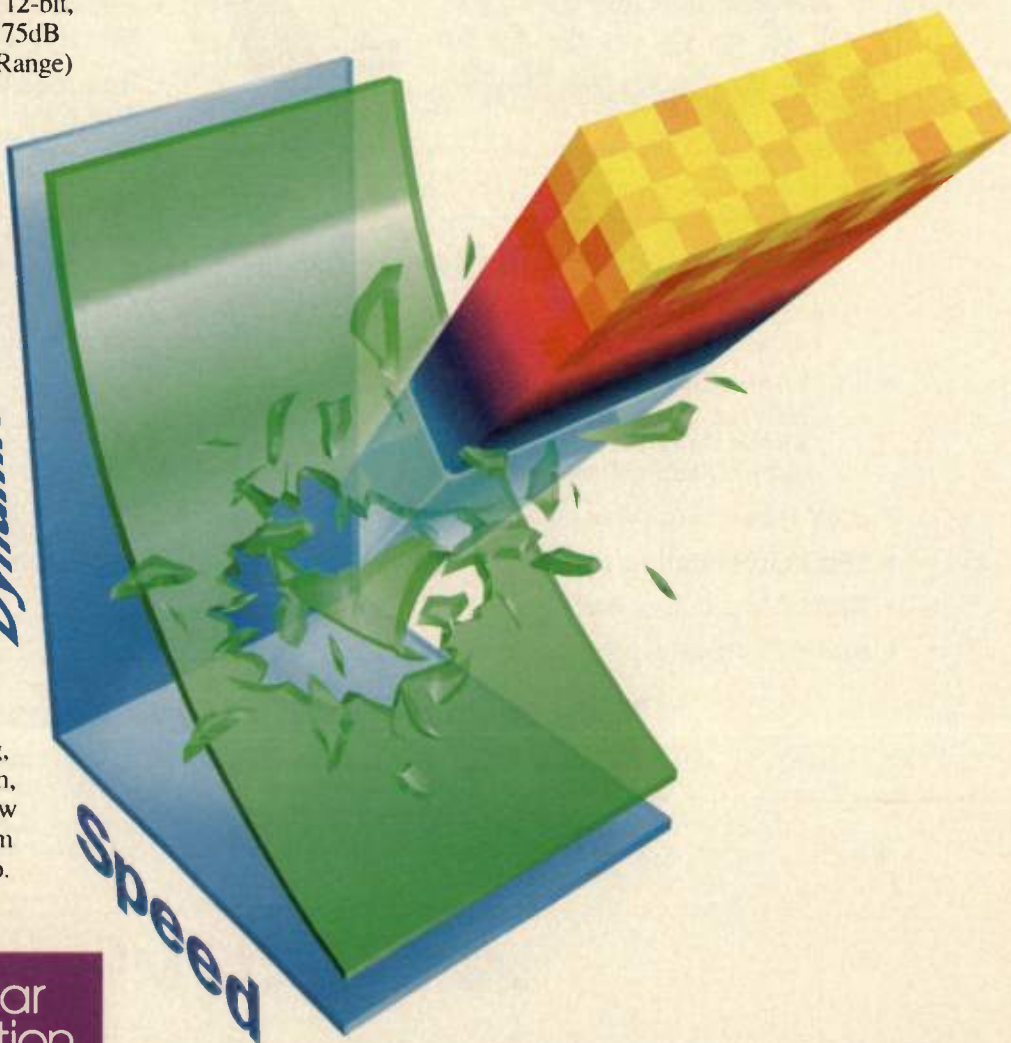
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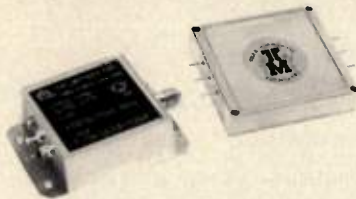
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Crystal Controlled Oscillators/Multipliers



FREQUENCY RANGE: 60 MHz to 18 GHz (fixed)
 Frequency set accuracy at room temperature: $\pm 0.001\%$
 Frequency stability: $\pm 0.003\%$
 Aging rate: $\pm 0.0005\%$ per year
 Power variation with temperature: ± 2 dB

Power supply: +15 VDC (other voltages optional)
 Load VSWR: 1.5:1 maximum
 Temperature Range: -55 to $+85^\circ\text{C}$ (to $+125^\circ\text{C}$ with degradation)
 Contact factory for other frequencies and/or power levels

10 MILLIWATTS MINIMUM OUTPUT. 100 MILLIWATTS AND 1 WATT VERSIONS AT MANY FREQUENCIES.

Frequency Multipliers



These drop-in multipliers demonstrate our capability in miniature frequency multipliers. They incorporate both lumped element filter techniques and new processes for miniaturizing combine filters.

	#1	#2	#3
Output Frequency.....	480 MHz	960 MHz	11 GHz
Multiplication Factor.....	X4	X2	X11
Size (nominal).....	1.6 x 0.8 x 0.4 in. (41 x 20 x 10 mm)	1.6 x 0.8 x 0.4 in. (41 x 20 x 10 mm)	2.1 x 0.7 x 0.4 in. (53 x 18 x 10 mm)
Input Power (nom.).....	+10 dBm	+10 dBm	+10 dBm
Output Power (nom.).....	+5 dBm	+5 dBm	-7 dBm
Harmonics/Spurs (all three models)	-91 dBc..... -65 dBc.....	from 10 to 250 MHz above 250 MHz	

Flange Mount Micropuck® Isolators



MODEL NUMBER	FREQUENCY RANGE (GHz)	BANDWIDTH %	ISOLATION dB min.	INSERTION LOSS dB max.	VSWR max.	OPERATING TEMP °C	PEAK POWER WATTS	AVG. POWER WATTS	HEAT SINK TEMP °C	SIZE (INCHES NOMINAL) L W H
F9*6101	4.0 - 8.0	10	20	0.5	1.25	-54° to $+95^\circ$	50	7	95	62 x 375 x 21
F9*9001	8.0 - 12.0	10	20	0.4	1.25	-54° to $+95^\circ$	50	5	95	50 x 25 x 18
F9*2001	12.0 - 18.0	10	17	0.5	1.35	-54° to $+95^\circ$	50	5	95	50 x 25 x 18
F9A6141	3.7 - 4.3	FULLBAND	15	0.6	1.45	-30° to $+70^\circ$	50	7	70	62 x 375 x 21
F9A9101**	8.0 - 12.0	FULLBAND	16	0.7	1.45	-54° to $+95^\circ$	50	7	95	62 x 375 x 21
F9A2201**	12.0 - 18.0	FULLBAND	17	0.7	1.50	-55° to $+100^\circ$	50	5	95	50 x 25 x 18

SYNTHESIZERS



MULTI-CHANNEL INDIRECT FREQUENCY SYNTHESIZER

Frequency.....	5-17 GHz, triple output	Power.....	+2 dBm ± 2 dB
Step Size.....	2.5 MHz	Spurious.....	-70 dBc
Switching Speed.....	500 μsec , typical	Harmonics.....	-15 dBc
Frequency Accuracy.....	2 ppm	VSWR.....	2:1
Phase Noise:		Reference	
10 KHz.....	-75 dBc/Hz	1 MHz.....	-120 dBc/Hz
100 KHz.....	-90 dBc/Hz	10 MHz.....	-120 dBc/Hz
Size.....	7.7 x 6.8 x 4.7 inches	Output.....	100 MHz, +2 dBm, typical
		Power Dissipation.....	43W
		Weight.....	9 lbs, max.



NARROWBAND DIRECT SYNTHESIZER

Frequency.....	S-Band, 1 GHz BW	Power.....	+17 dBm typical
Step Size.....	1 MHz	Spurious.....	-45 dBc
Switching Speed.....	250 μsec , typical	Harmonics.....	-20 dBc
Frequency Accuracy.....	20 ppm	VSWR.....	1.5:1
Phase Noise:			
10 KHz.....	-110 dBc/Hz	1 MHz.....	-120 dBc/Hz
100 KHz.....	-110 dBc/Hz	10 MHz.....	-122 dBc/Hz
Size.....	6 x 8 x 3.5 inches	Power Dissipation.....	57W
		Weight.....	10 lbs, max.



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Specifications subject to change without notice.

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AM

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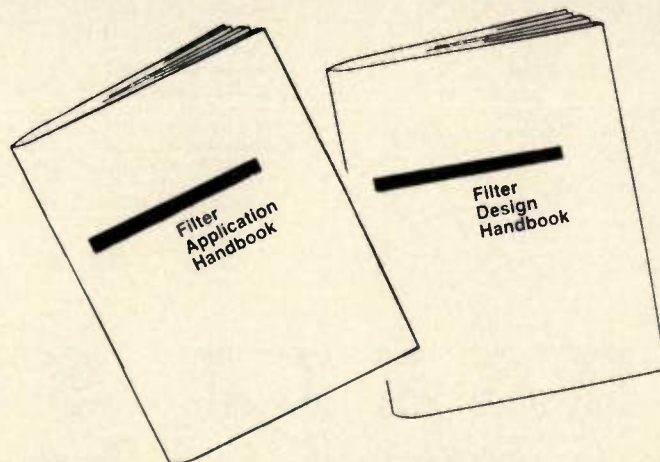
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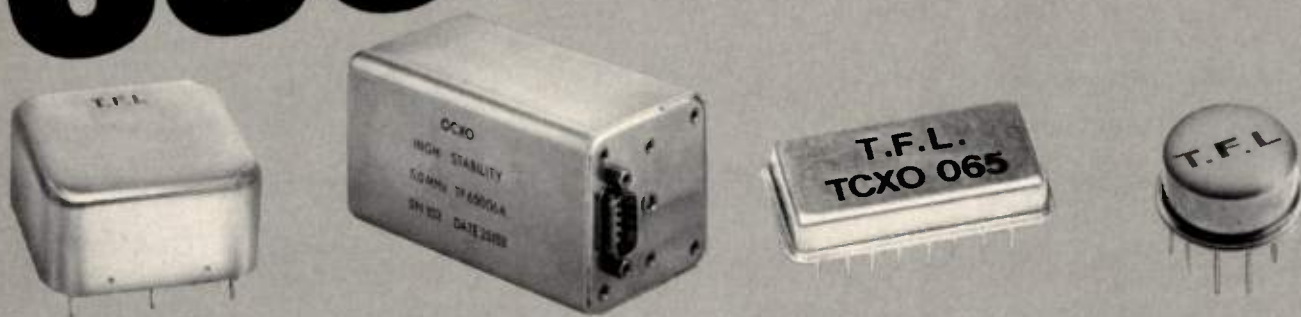
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 8×10^{-10} at 1 Sec

Long Term Stability:
 $< 1 \times 10^{-6}$ /year

Warm Up:
< 20 seconds to $\pm 1 \times 10^{-7}$

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5 V (TTL)

Input Power:
< 0.5 W During Warm-up
0.38 W Stabilized at Room-Temp.

Size: 1.26" $\times$ 1.26" $\times$ 0.7"

Output Waveform:
TTL (optionally Sine)

OCXO

*Oven Controlled
Crystal Oscillator*

Frequency Range:
to 50 MHz

Short Term Stabilities:
up to 5×10^{-12} (1 sec)

Warm-Up Time:
As low as 1 min

Temperature Stability:
 $\pm 5 \times 10^{-10}$
(0° to +50°C)

Low Aging Rate:
 $< 5 \times 10^{-11}$ /Day

Low Noise:
< –157 dBc@
10 kHz Offset

**Low Vibration
Sensitivity:**
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Temperature Range:
–55° to +120°C

TCXO

*Temperature Controlled
Crystal Oscillator*

Frequency Range:
0.02 Hz to 20 MHz

Frequency Stability:
 ± 0.8 PPM
(–40° to +85°C)

Aging: ± 1.0 PPM/yr
typ.

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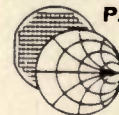
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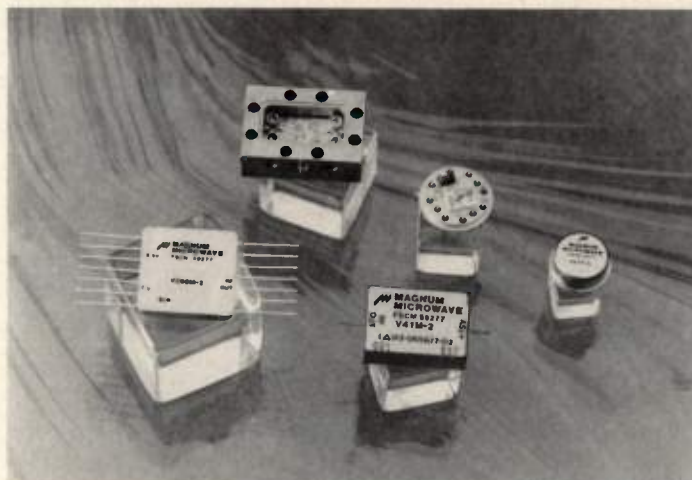
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30- 50	10	-123	1.5	.5	1.5	-55 to +100	23 (5)	0 to +15	HV16T-1
50- 85	10	-123	2.0	.7	2.0	-55 to +100	27 (5)	0 to +15	HV16T-2
50- 100	10	-115	.5	.5	1.5	-55 to +100	30	0 to +20	HV17T-1
120- 175	10	-125	2.5	3.0	3.0	-55 to +100	40 (5)	0 to +15	HV24T-1
100- 200	10	-110	1.0	1.0	3.0	-55 to +100	30	0 to +20	HV27T-1
200- 400	10	-110	1.0	1.5	5.0	-55 to +100	30	0 to +20	HV37T-1
225- 378	10	-120	3.0	3.0	5.0	-55 to +100	20	0 to +20	HV36T-1
400- 800	10	-105	6.0	3.0	10.0	-55 to +100	30	0 to +25	HV47T-1
600-1000	10	-110	10.0	2.0	45.0	-55 to +85	50	0 to +20	HV46T-1
950-1350	10	-107	6.0	2.0	30.0	-55 to +100	30	0 to +15	HV54T-1
900-1600	10	-100	18.0	6.0	45.0	-55 to +85	50	0 to +20	HV56T-1
1000-2000	10	-105	18.0	2.0	55.0	-55 to +85	60	0 to +20	HV67T-1
1500-2500	10	-97	35.0	7.0	45.0	-55 to +85	50	0 to +20	HV66T-1
2400-3700	10	-94	40.0	7.0	90.0	-55 to +85	50	0 to +20	HV85T-1
2000-4000	10	-100	5.0	10.0	100.0	-55 to +85	130	0 to +20	HV87T-1
3500-4500	10	-93	35.0	8.0	100.0	-55 to +85	50	0 to +20	HV83T-1
4000-5000	10	-92	40.0	10.0	110.0	-55 to +85	50	0 to +20	HV83T-2
4700-6000	7	-95	38.0	10.0	75.0	-55 to +85	50	0 to +20	HV93T-1
5500-7000	7	-87	60.0	10.0	140.0	-55 to +85	50	0 to +20	HV103T-1
6800-8000	7	-85	70.0	12.0	150.0	-55 to +85	50	0 to +20	HV103T-2
Abrupt* Varactor Tuned Voltage Controlled Oscillators									
400- 600	10	-110	4.0	3.0	14.0	-54 to +85	55	0 to +25	V34T-1
600-1000	10	-105	10.0	5.0	55.0	-54 to +85	60	0 to +60	V45T-1
900-1600	10	-108	18.0	6.0	78.0	-54 to +85	60	0 to +60	V56T-1
1500-2500	10	-97	35.0	10.0	50.0	-54 to +85	60	0 to +60	V66T-1
2700-3300	10	-95	35.0	6.0	90.0	-54 to +85	50	0 to +15	V72T-1
3000-3500	10	-100	25.0	6.0	65.0	-54 to +85	60	0 to +15	V82T-1
3600-4200	10	-93	35.0	8.0	75.0	-54 to +85	60	0 to +15	V82T-2
4000-4500	10	-92	35.0	8.0	85.0	-54 to +85	60	0 to +15	V82T-3
4500-5000	9	-100	30.0	10.0	85.0	-54 to +85	55	0 to +15	V92T-1
3900-4800	10	-92	40.0	8.0	85.0	-54 to +85	60	0 to +25	V93T-1

* Typical Electrical Specifications at +25°C.

Typical specifications subject to change without notice.

** Hyperabrupt varactor tuned VCOs offer lower modulation sensitivity variation and lower maximum tuning voltage than the abrupt varactor tuned VCOs for similar bandwidths.

NOTES:

- (1) Bias voltage +15 volts unless otherwise noted. Other bias voltages are available from +5 to +15 volts. For lower bias current options, consult factory.
- (2) Standard units in TO-8 package. Flatpack and connectorized packages available upon request.
- (3) Temperature Drift is specified over adjacent temperature range and represents typical drift at midband.
- (4) Screening and Qualification to the requirements of MIL-STD-883, Method 5008.4 are available upon request.
- (5) Bias voltage -6.5 V.

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Wide Band / Low Noise Amplifiers											
	W50ETC	10KHz—50MHz	24	±.5	5.3 Typ 6.0 Max	+23		2:1	+15	125	E-75/BNC
	W50ATC	10KHz—50MHz	50	±.5	1.3 Typ 1.5 Max	+5		2:1	+15	25	C-75/BNC
	W110F	5MHz—110MHz	55	±.5	1.1 Typ 1.2 Max	+15		2:1	+15	80	C/SMA
	W110H	5MHz—110MHz	30	±.5	1.2 Typ 1.4 Max	+5		2:1	+15	30	C/SMA
	W500K	1KHz—500MHz	30	±1	1.7 Typ 2.2 Max	+3		2:1	+15	25	C-75/BNC
	W500C	5MHz—500MHz	40	±.5	1.4 Typ 1.6 Max	+10		2:1	+15	50	C/SMA
	W500H	5MHz—500MHz	33	±.5	1.2 Typ 1.4 Max	+5		2:1	+15	25	C/SMA
	LF836C	821MHz—851MHz	44	±.5	1.2 Typ 1.5 Max	+19		2:1	+15	150	SPEC/SMA
	W1G2M	10KHz—1000MHz	30	±1	2.0 Typ 3.0 Max	+5		2:1	+15	35	C-75/SMA
	W1G2H	5MHz—1000MHz	30	±.5	1.3 Typ 1.5 Max	+5		2:1	+15	40	C/SMA
	W15GB3	50MHz—1500MHz	30	±.5	1.8 Typ 2.0 Max	+5		2:1	+15	50	C/SMA
	W2GH	500MHz—2000MHz	22	±1	4.0 Typ 4.5 Max	+5		2:1	+15	30	C/SMA
	WFR1-4GA-14	100MHz—4000MHz	28	±1	3.5 Typ 4.0 Max	+14		2:1	+15	175	A-75/SMA
Medium Power Amplifiers											
	P150D	35KHz—150MHz	27	±.5	5.0 Typ	+30	+40	2:1	+24	400	H/SMA
	P500A	2MHz—500MHz	37	±.5	4.5 Typ	+30	+40	2:1	+24	500	H/SMA
	P500L	5MHz—500MHz	17	±.7	10 Typ	+30	+40	2:1	+24	420	H/BNC
	P1GB	50MHz—1000MHz	30	±1	5.5 Typ	+30	+40	2:1	+20	800	A-S/SMA
	P2GF-1	1MHz—2000MHz	32	±1	10 Typ	+30	+40	3.5:1	+15	1000	FW1/SMA
	P2GF-2	10MHz—2000MHz	32	±1	7.5 Typ	+30	+40	2:1	+15	1000	FW1/SMA
	P42GA-29	.5GHz—4.2GHz	30	±1.5	6.5 Typ	+29	+39	2:1	+20	1200	FW1/SMA
High Power Linear Amplifiers											
	P300AM-33	3MHz—300MHz	33	±.5	10 Typ	+33/2W	+43	2:1	+24	1000	Y-B-S/BNC
	P1400M-37	400—1400MHz	20	±1	N/A	+37/5W	+47	2:1	+24	2500	Y-D/SMA
	PF19GA-40	1700—1900MHz	30	±1	N/A	+40/10W	+50	2:1	+24	5000	Y-D/SMA
	P1020-40	1000—2000MHz	27	±1	N/A	+40/10W	+50	2:1	+24	5000	X512/SMA

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±		_____ dBm or _____ watts
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Gain Flatness Full Band	±	_____ dB
Input/Output Load Impedance		_____ ohms _____ ohms
Input VSWR/Output Load VSWR		_____
Load VSWR Protection		Yes No
Amplification Class		A AB B C D
Amplification Mode		CW Pulse
Pulse Width		_____ mS _____ microseconds
Duty Factor		% CW
Operating Temperature Range		C to C
Storage Temperature Range		C to C
D.C. Power Supply Voltage		_____ volts (range)
D.C. Power Supply Current		_____ amps
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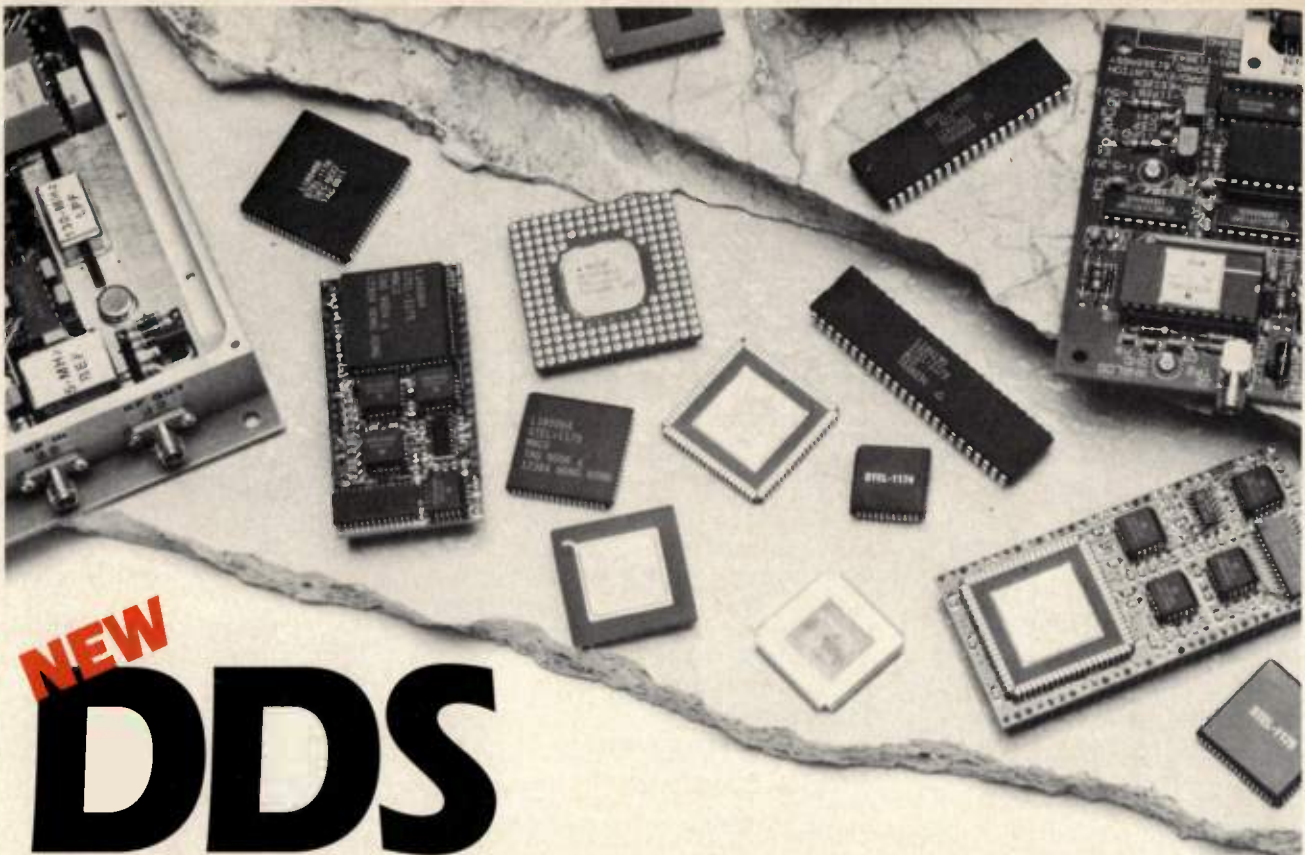
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STEL-1178	50 MHz, Dual NCO	NEW
STEL-1179	25 MHz, Serial Input PM NCO, \$5 in commercial quantities	NEW
STEL-2172	300 MHz, ECL, 32-bit	
STEL-2173	1 GHZ, GaAs, 32-bit, BPSK, QPSK	

BOARD-LEVEL DDS

STEL-1272	based on 1172B, 0-20 MHz	
STEL-1273	based on 1173, 0-20 MHz	
STEL-1275	based on 1175, 0-25 MHz	
STEL-1375A	miniature assembly based on 1175 MIL Spec version now available	NEW
STEL-1376	miniature assembly based on 1176	
STEL-1377	miniature assembly based on 1177 MIL Spec version now available	NEW
STEL-1378	miniature assembly based on 1178	NEW
STEL-1277	based on 1177, 0-25 MHz	
STEL-2272	based on 2172, 0-130 MHz	
STEL-2273	based on 2173, 0-400 MHz	
STEL-2373	based on 2173, 0-400 MHz - miniature hybrid	NEW

CHASSIS-LEVEL DDS

STEL-9272	300 MHz Synthesizer based on 2172	
STEL-9273	1 GHz Synthesizer based on 2173	
STEL-9275	Synthesizer with 1 GHz internal clock	NEW

RF and Microwave Telemetry Products



NCI SYSTEMS
A division of Noise Com, Inc.

NCI Systems: From Components to Complete Systems Under One Roof



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Crystal-controlled or synthesized indirect-modulated transmitters that handle Manchester/biphase-encoded data or analog audio.

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Small, rugged units that receive and demodulate FM or PM signals.

RF Modems 5

Fully integrated digital RF transceivers that consist of a receiver, transmitter, and modem.

Synthesizers 6

Low-phase-noise, fast-switching synthesizers in bands to 20 GHz.

Turnkey Systems 7

Complete commercial and military RF and microwave systems that combine analog, digital, and even mechanical technology.

Warranty and Ordering Information 8

NCI Systems has the capability to provide RF and microwave subsystems as well as complete turnkey RF-based telemetry systems. Telemetry has many benefits:

- Installations unreachable by cable can be monitored and controlled.
- The installation is invulnerable to cables being cut or knocked down by storms or accidents.
- There are no cable installation costs or fees for rental of dedicated telephone lines.

Our products are used in both commercial and military equipment throughout the world. NCI Systems products include transmitters, receivers, synthesizers, and RF modems operating at frequencies from 25 MHz to 20 GHz. Our turnkey solutions include all the components necessary to provide a complete telemetry system—along with the NCI Systems pledge of service and support.

And as a division of Noise Com, Inc., the leading supplier of noise sources, instruments, and subsystems, we have the talent and facilities to tackle even the most ambitious

projects, including military, space, and avionic systems. Our facilities include high-speed automated equipment for testing of vibration, shock, and temperature performance, as well as the latest automated network analyzers. NCI Systems capabilities are MIL-STD-454 for workmanship, MIL-STD-883 for screening, and MIL-STD-2000 for soldering.

We have gained our reputation not only for delivering high-performance equipment, but for delivering it right the first time—fast. It's a quality our customers have come to count on since 1985.

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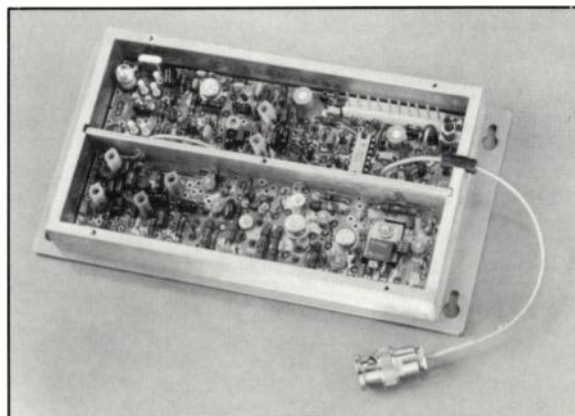
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NCX Series Transmitters

- Standard frequency coverage to 2 GHz
Custom frequency coverage to 20 GHz
- Output power to 10 W
- 12 VDC operation
- Low current (1 mA) standby mode
- Protection for over-temperature, over-drive, over-voltage, VSWR, and reverse-polarity
- Crystal or synthesizer control
- Frequency is mechanically adjustable to compensate for 5 to 10 years of aging
- Available in custom configurations
- Meets MIL-STD-810E for shock and vibration

NCI's NCX Series are rugged, compact crystal-controlled or synthesized transmitters. They transmit Manchester/ biphase-encoded data or analog audio signals using indirect frequency modulation. The transmitters are an excellent choice for applications such as remote monitoring and surveillance, status monitoring, and robotics control.

Like all NCI Systems products, the NCX Series can be tailored to the needs of specific applications. Various combinations of output power, operating voltage, frequency range and channels, emission type, enclosure, connectors, and other parameters can be custom configured to meet commercial and military requirements. Contact an NCI Systems engineer for further information.



Typical NCX Series Transmitter Specifications*

Modulation type	Indirect FM
Output frequency	between 25 and 2000 MHz
Number of channels	1 (2 optional)
Crystal models	1396
Synthesized models	
Step size	
Synthesized models	From 6.25 kHz
Frequency stability	$\pm 0.0005\%$ standard $\pm 0.00015\%$ optional
Spurious rejection	More than $43 + 10\log(P_o)$
Harmonic rejection	More than $43 + 10\log(P_o)$
Emission types	15f2-16f9
Frequency deviation	± 3 kHz
RF output power	2, 5, or 10 W standard
Duty cycle	Continuous
Output impedance	50 ohms
Load VSWR	No damage with infinite VSWR, any phase
Frequency response	300 to 3000 Hz
Analog input	Adjustable from $0.1 V_{pp}$ to $1 V_{pp}$
Digital input (optional)	0 to 8.5 VDC
Input impedance	10 kohm minimum
Power supply	10.5 to 15.5 VDC
Current (at 12 VDC)	
Standby	1 mA
2 W output	450 mA
5 W output	1 A
10 W output	2 A
Operating temperature	-30° to $+60^\circ\text{C}$
Connectors	
RF output	SMA female or BNC male (pigtail)
Power and input	Molex KK-156 Series (10 pin) Mating connector supplied

*Important FCC notice. See Page 8 of this catalog.

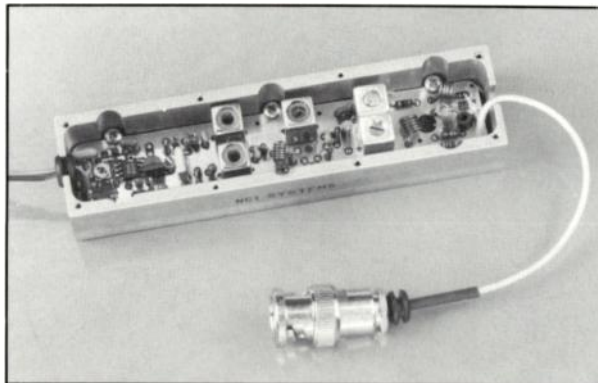
NCD Series Receivers

- Standard frequency coverage to 2 GHz
Custom frequency coverage to 20 GHz
- Lightweight
- 12 VDC operation
- High sensitivity
- Excellent image, spurious, and adjacent channel rejection
- Crystal or synthesizer control
- Frequency is mechanically adjustable to compensate for 5 to 10 years of aging
- Available in custom configurations
- Meets MIL-STD-810E for shock and vibration

The NCI Systems NCD Series receivers are small, rugged units that are excellent choices in alarm and security, status monitoring and control, robotics, energy management, and ocean surveying applications.

The NCD Series receives and demodulates an FM or PM signal. The demodulated signal baseband is at least 300 to 3000 Hz or an equivalent output to 1200 baud.

The NCD Series receivers produce a DC output voltage (RSSI) that is proportional to the field strength of the RF input. Sensitivity is excellent and short-and-long-term stability are maintained through crystal control. High levels of RF shielding are incorporated in the design to ensure immunity to interference from the surrounding electronic environment.



Typical NCD Series Receiver Specifications*

Modulation types	Indirect FM and PM
Input frequency	Between 25 and 2000 MHz
Number of channels	
Crystal models	1 (2 optional)
Synthesized models	1396
Step size	
Synthesized models	From 6.25 kHz
Frequency stability	± 0.0005% standard ± 0.00015% optional
Spurious and image rejection	More than 70 dBc**
Adjacent channel rejection	More than 80 dBc**
Input for 1 dB GCP	More than -40 dBm (in band)
Deviation from nominal output	± 3 kHz
Acceptable deviation	± 7 kHz minimum
Carrier detect output	CMOS or TTL
Sensitivity	
12 dB SINAD	0.25 μ V RMS**
20 dB quieting	0.35 μ V RMS**
Received signal strength indicator (RSSI)	1 to 4.5 VDC
Input impedance	50 ohms
Baseband bandwidth	300 to 3000 Hz
Analog output	0 to 1.5 V _{pp}
Data output	1 V _{pp}
Receiver time constant (squelch or data)	Less than 6 ms
Power supply	10.5 to 15.5 VDC
Current (at 12 VDC)	50 mA maximum
Operating temperature	-30° to +60°C
Connectors	
RF input	SMA female or BNC male (pigtail)
Power and output	Molex KK-156 Series (10 pin) Mating connector supplied

*Important FCC notice. See Page 8 of this catalog.

**Rejection and sensitivity data vary with the RF frequency.

Please consult an NCI Systems engineer for data specific to your requirements.

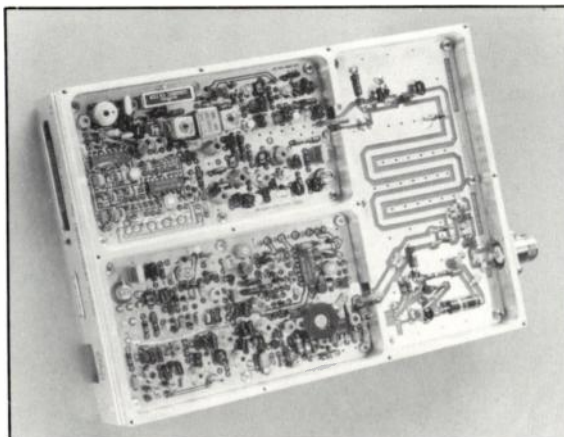
NCM Series RF Modems

- 25 MHz to 2 GHz frequency range
- RS-232C compatible
- Full modem functions
- Data transmission speeds to 1200 baud
- Simplex, half-duplex, or full duplex operation
- Output power from 250 mW to 10 W
- Bit error rate less than 1×10^{-6} at 12 dB SINAD

NCM Series digital RF modems are fully integrated digital RF transceivers that consist of a receiver, transmitter, and modem. They provide asynchronous communications at up to 1200 baud over considerable distances without wires. The NCM modems are designed for transparent asynchronous point-to-point telemetry and communications.

The NCM Series provides communications from point to point in a multiple-point system, or from remote monitoring points to a central site. Applications include alarm and security systems, status monitoring, robotics, process control, energy management, and ocean surveying. Any application that requires data transmission and reception that cannot accept cable is a good application for the NCM Series.

Various combinations of specifications and configurations can be delivered to meet the needs of individual systems. Contact an NCI Systems engineer for more information.



Typical NCM Series RF Modem Specifications*

Modulation type	Indirect FM
Frequency	Between 25 and 2000 MHz
Mark/space frequency	2200 Hz/1200 Hz
Frequency separation	5 MHz for full duplex
FM deviation	± 3 kHz
Frequency stability	$\pm 0.0005\%$ standard $\pm 0.00015\%$ optional
Spurious rejection	More than $43 + 10\log(P_o)$
Harmonic rejection	More than $43 + 10\log(P_o)$
Receiver adjacent channel rejection	More than 80 dBc**
Receiver image rejection	More than 70 dBc**
RF output power	250 mW to 10 W
RF sensitivity	$0.5 \mu V$ RMS at 12 dB SINAD**
RF impedance	50 ohms
Modes	Simplex, half duplex, or full duplex
Data interface	RS-232C serial
RTS-CTS delay	Less than 50 ms
Data transmission speeds	DC to 1200 baud
Bit-error rate	Less than 1×10^{-6} at 12 dB SINAD
Power supply	10.5 to 15.5 VDC
Current (at 12 VDC)	
Receive mode	150 mA
Transmit mode	
2 W output	600 mA
5 W output	1150 mA
10 W output	2150 mA
Operating temperature	-30° to $+60^\circ C$
Connectors	
RF	N female
Data (RS-232C)	25-pin subminiature D female
Power	#6 lug terminals

*Important FCC notice. See Page 8 of this catalog.

**Rejection and sensitivity data vary with the RF frequency. Please consult an NCI Systems engineer for data specific to your requirements.

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NCS Series Microwave Synthesizers

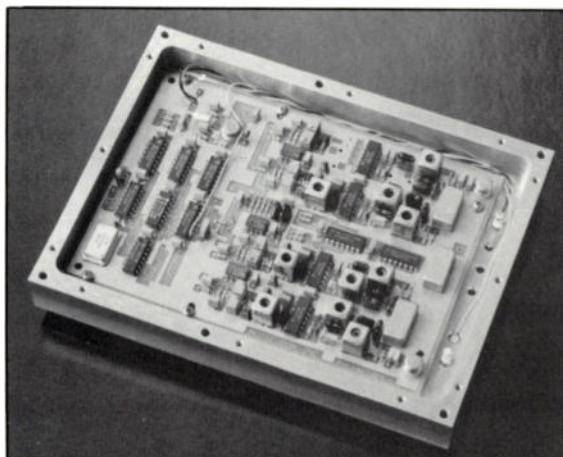
- Frequency coverage to 20 GHz
- FM modulation frequency to 50 MHz
- Fast switching
- Single-loop and multi-loop indirect synthesis types
- Step size from 62.5 kHz
- Parallel TTL or CMOS control
- Phase noise – 100 dBc/Hz at 1 kHz offset
- High spurious and harmonic rejection

NCI Systems's extremely flexible design capabilities can meet the needs of your unique synthesizer applications, including frequency-hopping radars, analog and digital communications, and jammers.

NCI Systems offers low phase noise, fast-switching synthesizers in bands from 10 MHz to 20 GHz. FM capabilities can be incorporated with modulation frequencies up to 50 MHz and wide deviation FM capabilities at low modulation frequencies.

The NCS Series synthesizers include single-loop and multi-loop indirect synthesis types. Each design is optimized for size, weight, power, and performance.

Whether your systems are used in commercial or military applications, we can design a DTO or synthesizer to your specifications. Contact an NCI Systems engineer for more information.



Typical NCS Series Microwave Synthesizer Specifications

Frequency range	To 20 GHz
Step size	From 62.5 kHz
Switching time	From 10 μ s*
Phase noise	– 100 dBc/Hz at 1 kHz offset – 110 dBc/Hz at 10 kHz offset – 130 dBc/Hz at 100 kHz offset
Stability	To ± 0.1 ppm
Output power	To 1 W
Load VSWR	No damage with infinite load, any VSWR
Spurious rejection	More than 60 dBc
Harmonic rejection	More than 20 dBc
FM modulation frequency	To 50 MHz
Control input	Parallel TTL or CMOS
Power supply	+ 15 VDC or + 5 VDC, + 15 VDC, and – 15 VDC
Operating temperature	– 55° to + 85°C
Connectors	
RF output	SMA female
Power and control	25-pin subminiature D
Quality	Full MIL-E-5400 or commercial grade

*The switching time depends on phase noise and step size. The switching time for the phase noise shown at 10 GHz is 1 ms.

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Turnkey Systems

NCI Systems designs, manufactures, and installs complete commercial and military RF and microwave systems that combine analog, digital, and even mechanical technology.

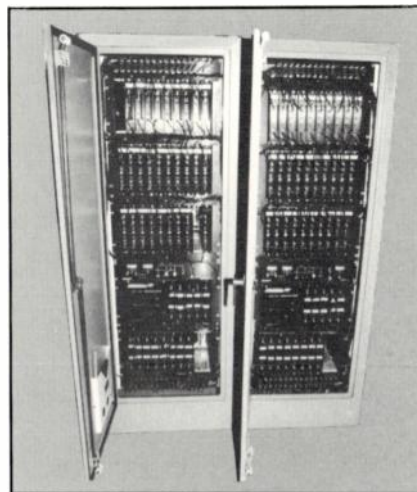
Typical projects include:

Port Authority of New York and New Jersey: Designed, manufactured, and installed the radiating cable communications systems in the Lincoln and Holland tunnels linking New Jersey with New York.

US Marines: Designed, manufactured, and integrated the digital telemetry links, video transmitter, direction finding, navigation, and electronics systems for the Unmanned Avionic Vehicles (UAV) program.

Immigration and Naturalization Service: Designed and manufactured the Remote Intrusion Monitoring System (RIMS), including thousands of infrared, magnetic, and acoustic sensors connected to telemetry transmitters and receivers along the US/Mexico border.

Massachusetts General Hospital: Designed and manufactured the telemetry system that transmits signals from heart and fetal function sensors worn by patients to a central site. The system allows patients from departments such as the maternity ward to move around freely.



Every turnkey project undertaken by NCI Systems is fully supervised by a project manager to ensure it is carried out in compliance with customer requirements. And of course it is backed by our unparalleled technical service and support. Contact an NCI Systems engineer to discuss your systems requirement—regardless of its complexity.

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NCI Systems

Notes and Warranty Information

Important FCC Notice

Products described in this catalog are at present available for use by the government of the United States or any agency thereof or for export. The following paragraph is applicable to all other uses:

"These devices have not been approved by the Federal Communication Commission. The devices are not, and may not be, offered for sale or lease, or sold or leased until the approval of the FCC has been obtained."

Contact NCI Systems for the current status of FCC approvals.

Rights and Advises

Noise Com, Inc., and its NCI Systems Division, reserve the right to make changes without notice in the devices or the device specifications identified in this publication. Customers are advised to obtain the latest version of the device specifications before placing an order to verify that the information relied upon is current.

Specifications contained in this publication supersede all data for these products published by Noise Com, Inc., prior to June 1991.

Warranty and Assistance

All NCI Systems products shown in the catalog are warranted against defects in materials and workmanship for a period of one year from the date of shipment. Noise Com will, at its option, repair or replace products that prove to be defective during the warranty period, provided they are returned to Noise Com and provided the preventive maintenance procedures in the supplied manuals are followed.

Repairs necessitated by misuse of the product are not covered by this warranty.

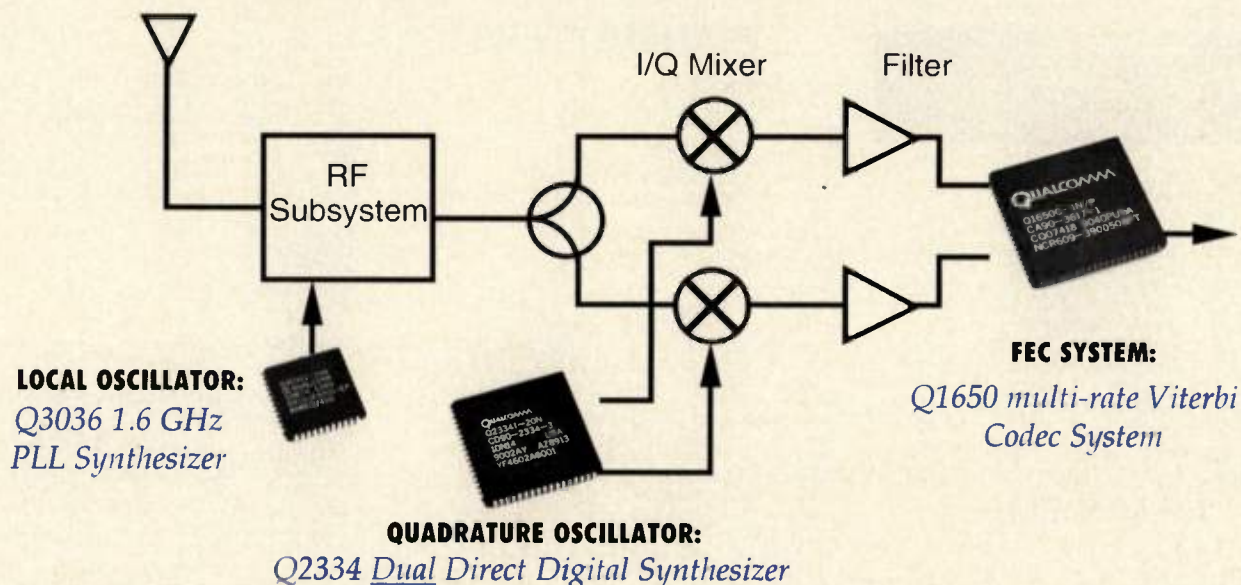
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FREQUENCY SYNTHESIS

examples...

The ADS-6, a 3rd generation GaAs DDS, is based upon a new 14-bit 1 GHz GaAs DAC, operated conservatively, plus proprietary Sciteq logic and a patent-pending memory system. By the end of 1991, it will be offered as a hybrid (with 883/1772 available). **Design goals.*

clock _____ ≤ 1 GHz*
bandwidth _____ ≤ 450 MHz*
steps _____ 32 bits
spurious _____ < -60 dBc*
phase control _____ 4 bits (22.5°)
update rate _____ ~ 40 MHz



The DDS-1 Waveformer™ is a complete CMOS DDS and modulator on an LCC, only 1" square. With frequency/phase control and auto-FSK, plus DIGITAL AM, it is an extremely flexible modulator. DDS-1 is an ideal way to reduce division ratios and improve phase noise of PLL designs. ± 5 V, ~ 1.5 W, max clock: 25 MHz.

bandwidth _____ DC-11 MHz
frequency resolution _____ 32 bits
control _____ parallel, TTL, binary
spurious _____ < -60 dBc
phase modulation _____ 16 bits
amplitude control _____ 11 bits



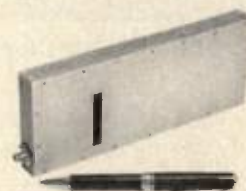
The VDS-1700 combines DDS with PLL, achieving multi-loop phase noise performance with single-loop simplicity/cost. Opt FM: 30 MHz deviation, 5 MHz rate, (consult factory). Useful in ATE, comm, radar, etc. Chassis and IEEE are options. Ext 10 MHz reference. BCD control.

bandwidth _____ < 1 octave < 2.4 GHz
step size _____ 25 kHz (10 kHz opt)
spurious _____ < -70 dBc
phase noise _____ < -95 dBc/Hz @ 10 kHz
package _____ 7.0 x 5.0 x 2.5 inches



The VDS-1306 uses Sciteq's patented DDS plus PLL technology to achieve a unique combination of small size, very good spectral purity, and fine steps. For satcom and radio IF applications, it uses very little power and has excellent reliability. Semi-custom versions can be packaged in a chassis or on VME cards. External reference.

bandwidth _____ 55-85 MHz
steps _____ 100 Hz (0.1 Hz opt)
spurs _____ -55 dBc
phase noise _____ -96 dBc @ 100 Hz
control _____ BCD, parallel
power _____ < 5 W
package _____ 7.5" x 3" x 0.75"



The VDS-100 uses a proprietary fractional- n plan to achieve remarkable spectral purity with high reliability and fine steps. It is a form/fit/function replacement for existing units, and should be considered as first choice in new applications. Control is BCD, 15-bit. All surface mount, hi-rel.

operating range _____ 50-150 MHz ($< 15\%$ BW)
step size _____ 1/384 MHz (or as required)
phase noise _____ < -120 dBc/Hz @ 1 kHz
spurious _____ < -95 dBc
power consumption _____ < 10 W
L and C band available



Several DDS products are available in VME format, with various bandwidths and step sizes. The electro-mechanical interface is standard VME, with control on user-defined pins rather than through VME protocol. RF I/O appear at SMA connectors.

VDS 3050 _____ 3U, DC-35 MHz, ~ 4 Hz
VDS 3001A _____ 6U, DC-32 MHz, 1/16 Hz
VDS 3000A _____ 6U, DC-15 MHz, ~ 1 mHz
VDS 3125 _____ 6U, DC-110 MHz, < 1 Hz
VDS 3A _____ 6U, DC-3 MHz, 1.0 mHz



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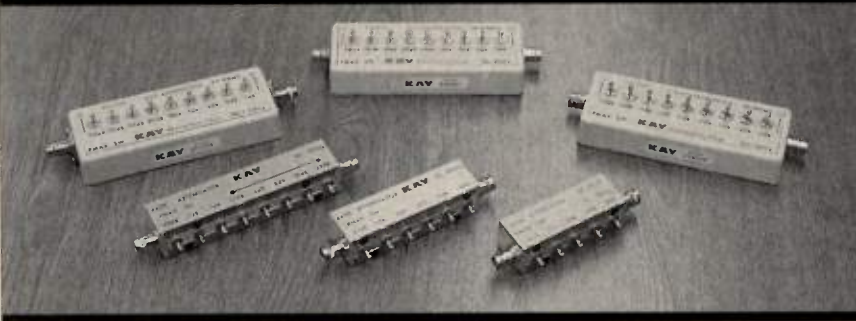
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839	50Ω	DC-2000MHz	0-101dB	1dB
1/839	50Ω	DC-1000MHz	0-22.1dB	.1dB
847	75Ω	DC-1000MHz	0-102.5dB	.5dB
849	75Ω	DC-1500MHz	0-101dB	1dB
1/849	75Ω	DC-500MHz	0-22.1dB	.1dB
860	50Ω	DC-1500MHz	0-132dB	1dB
865	600Ω	DC-1MHz	0-132dB	1dB
870	75Ω	DC-1000MHz	0-132dB	1dB
Programmable				
4440	50Ω	DC-1500MHz	0-130dB	10dB
4450	50Ω	DC-1500MHz	0-127dB	1dB
1/4450	50Ω	DC-1000MHz	0-16.5dB	.1dB
4460	50Ω	DC 1500MHz	0-31dB	1dB
4480	50Ω	DC-1500MHz	0-63dB	1dB

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0-1 dB in .1 dB Steps

50R-019
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0-10 dB in 1 dB Steps

50R-029
DC-2 GHz
0-70 dB in 10 dB Steps

50R-043
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0-100 dB in 10 dB Steps

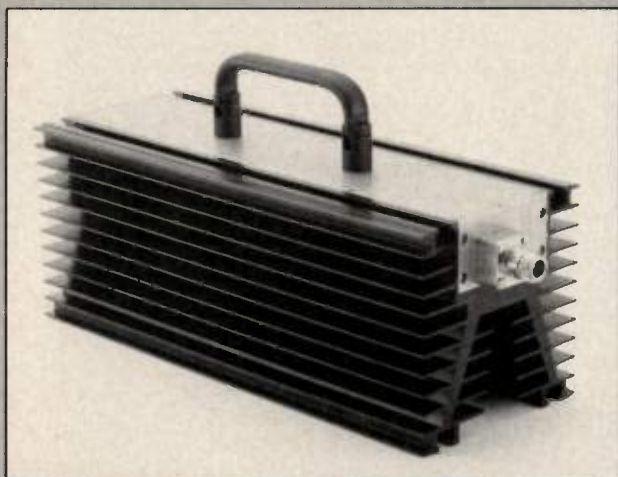
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Frequency Range
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1.1:1 3:1
1.2:1 5:1
1.5:1



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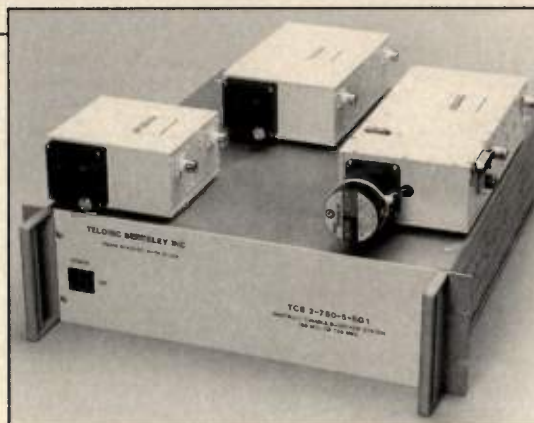
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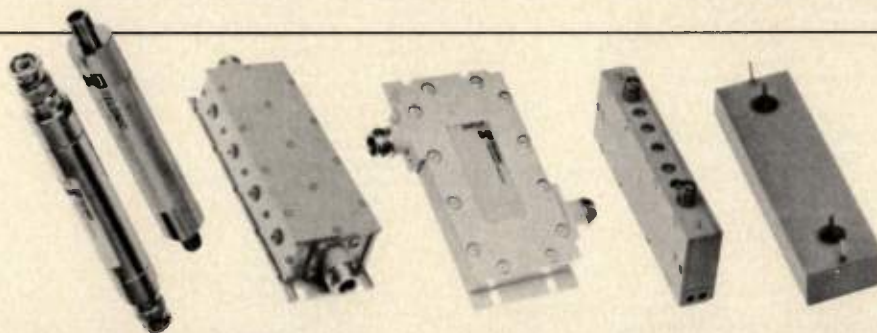
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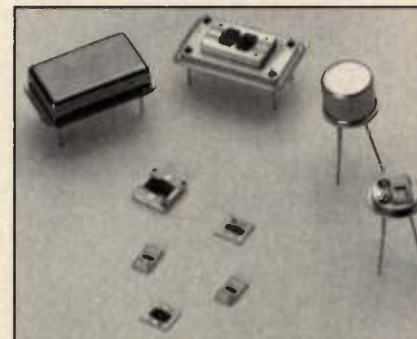
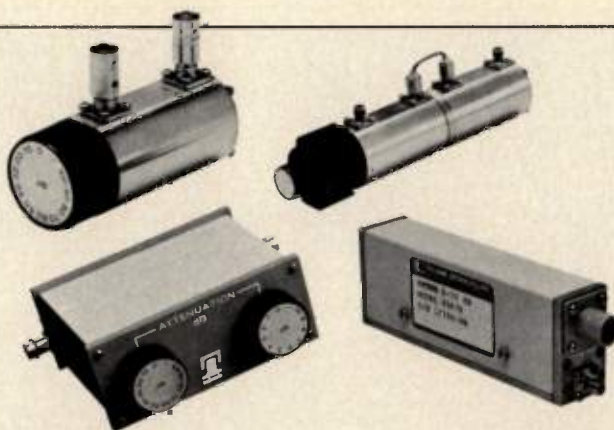
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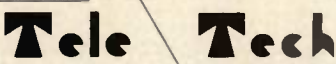
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2000 WATTS

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- **MODEL** C1460
- **COUPLING** 50 dB
- **DIRECTIVITY** 20 dB
- **VSWR** 1.15:1

100 WATTS

.05-1000 MHz

- **MODEL** C1634
- **COUPLING** 40 dB
- **DIRECTIVITY** 20 dB
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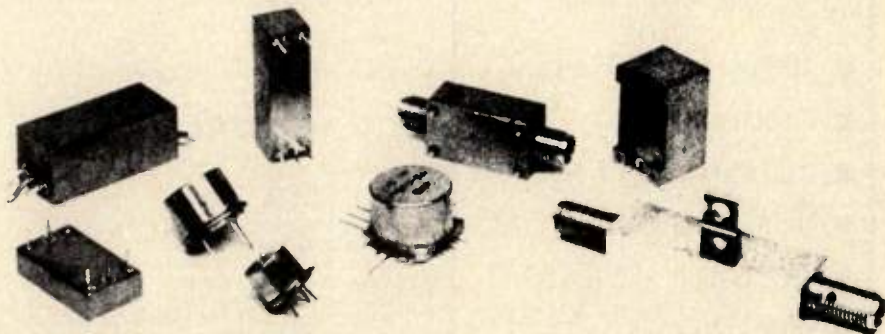
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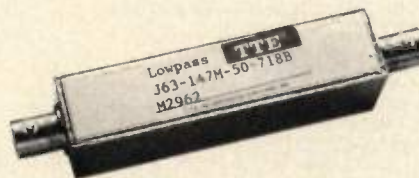
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- Designs Include : Bessel, Butterworth, Chebyshev and Elliptical Function
- Number of poles : 2 to 6
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- Package Styles : PCB, BNC or SMA
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- Designs Include : Bessel, Butterworth, Chebyshev and Elliptical Function
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- Frequency Range : 10Hz to 500MHz
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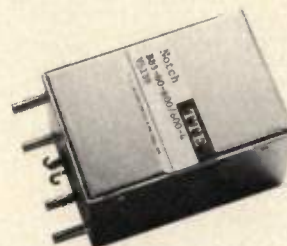
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- Designs Include : Bessel, Butterworth, Chebyshev and Elliptical Function
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- Frequency Range : 100Hz to 100MHz
- Package Styles : PCB, BNC or SMA
- Guaranteed Shipment : 10 Working Days ARO (QTY 1-10)

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- Guaranteed Shipment : 10 Working Days ARO (QTY 1-10)



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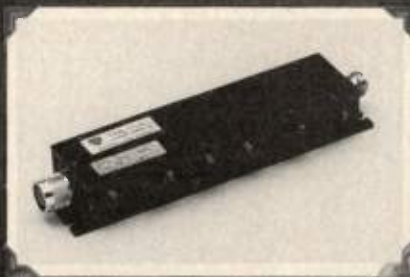
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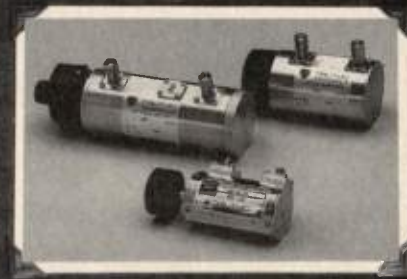
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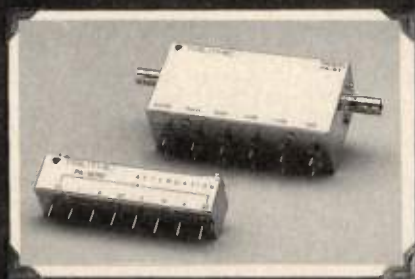
Coaxial attenuators



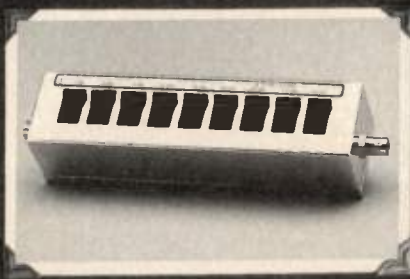
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Quality IF/RF/Microwave Filters

Miniature Combine Interdigital Bandpass Filters



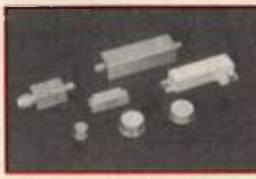
- 1-26.5 GHz center frequencies
- 1% to one octave bandwidths
- Miniaturization with high precision wire EDM fabrication
- High selectivity with low loss

Miniature Tunable (Voltage) Bandpass



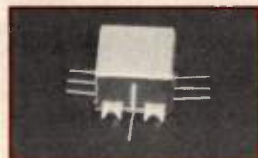
- 20 to 600 MHz
- 3 sections
- Sub-octave tuning
- 5%-20% bandwidths
- Fast slew rate

Miniature Lumped Constant



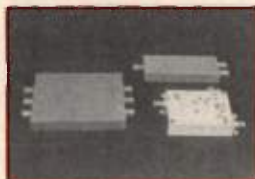
- DC to 18 GHz
- 2% to over 100%
- 2 to 12 sections
- Bandpass/Highpass/Lowpass
- Chebyshev, Pseudo-elliptic, Bessel, Gaussian, Gaussian to 12dB, Gaussian to 6dB designs

Impac Surface Mount Packages



- DC to 5000 MHz
- 0.5" - 2.0" lengths
- Low insertion loss, high selectivity
- High performance lumped element miniature filter technology
- Chebyshev, Pseudo-elliptic, Bessel, Gaussian, Gaussian to 12dB, and Gaussian to 6dB designs

Diplexers- Multiplexers

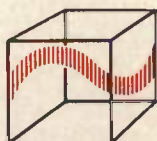


- DC to 26.5 GHz
- Contiguous/Non-contiguous
- Lumped Constant, Suspended Stripline, Coaxial

Microminiature Switched Filter Module



- 2, 3 or 4 channels
- Frequencies up to 3 GHz
- 60 dBC typical RF isolation
- 50 dBC typical control line isolation
- Lowpass, highpass, bandpass and band reject
- Less than 150 ns switching GaAs technology



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TELEWAVE INC.
TELONIC BERKELEY, INC.

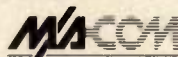
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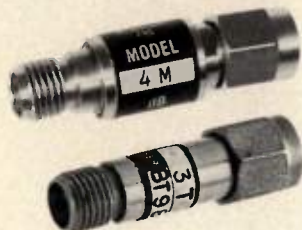
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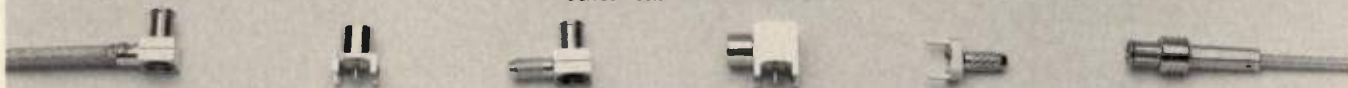
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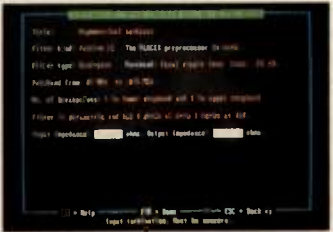
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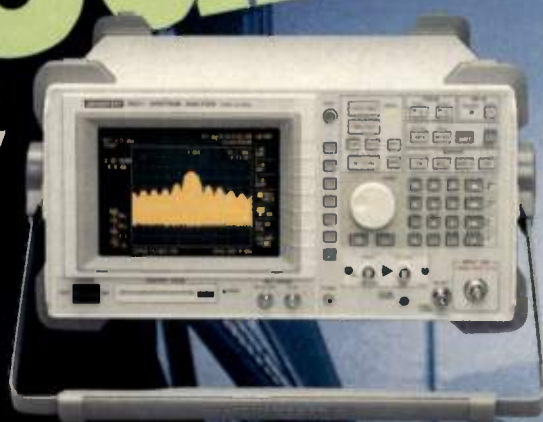
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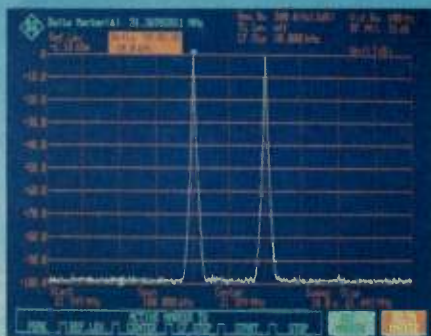
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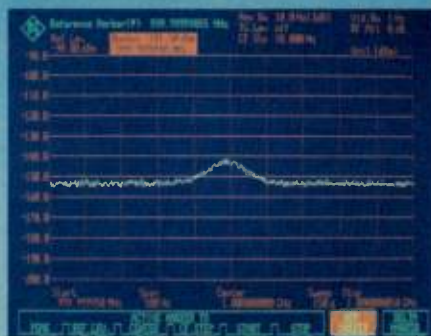
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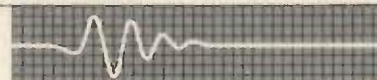
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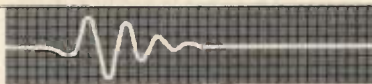
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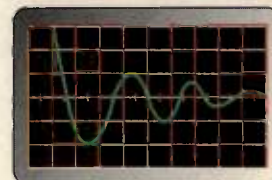
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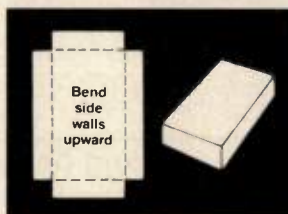
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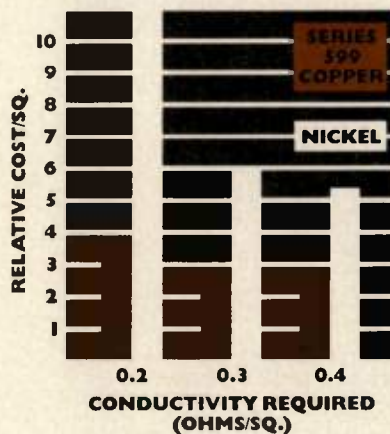
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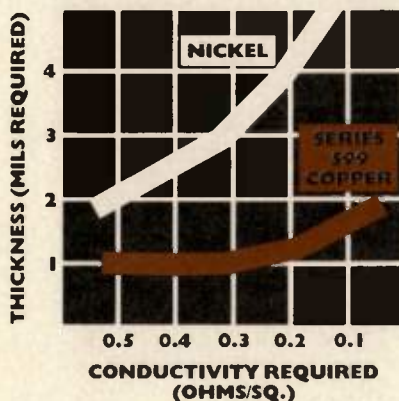
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A Tutorial on Crystal Specifications and Pullability

By C.W. Richards
Scientific Atlanta

A common component that often causes confusion is a quartz crystal which is used in both digital and analog designs. Much of the confusion is generated by the ambiguity in the nomenclature utilized to specify crystals. This is further aggravated when trying to specify crystals that will be required to be pulled in frequency via an external element. This essay is a tutorial on crystals with information that should alleviate some of this confusion.

First, general information will be presented on the circuit model of a crystal and the results of a software model of an 18.43 MHz crystal will be given as an example. This will be followed by a step by step guide which can be used to specify fixed-band-operation crystals or crystals that will be pulled in frequency. Typical values for each parameter specified will also be presented.

Schematically, a crystal can be modeled as shown in Figure 1. This model is comprised of a series combination resistor (R_1), inductor (L_1) and capacitor (C_1), these components are referred to as the motional elements. The motional elements L_1 and C_1 determine the series resonant frequency of the crystal while R_1 determines the quality factor (Q) of the resonator. The series resonance can be expressed as

$$\omega = \frac{1}{\sqrt{L_1 C_1}} \quad (1)$$

C_1 is typically very small, on the order of tenths of a picofarad and can be specified to a certain value if desired, which is often the case when the crystal will be pulled. L_1 is normally large, in the

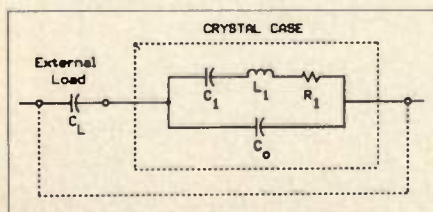


Figure 1. Crystal schematic.

milla-Henry range and is never directly specified. It is indirectly specified via the frequency of operation.

A shunt capacitance (C_0) appears across the series motional elements as shown in Figure 1. C_0 is a function of the crystal holder and is simply referred to as the parallel capacitance.

The last element, the load capacitance (C_L) is shown in Figure 1 and often takes the form of an intentional external varactor, used for frequency pulling or the stray capacitance of an oscillator circuit.

The following should act as a guide to alleviate some of the confusion of specifying crystals. The elements to be specified are listed in order of importance with the parameters required for all crystals listed first:

1. Crystal frequency: e.g. 100 kHz or lower to 100 MHz or higher.
2. Mode of operation; e.g. fundamental, third, fifth, etc.
3. Holder type; e.g., HC-18, HC-43, TO-5, etc.

Only the fundamental mode should be specified when the crystal is to be pulled.

4. Accuracy at reference temperature; e.g., 10 ppm at 25 degrees C.
5. Aging rate; e.g., ± 1 ppm/year, ± 3 ppm/year, etc.

These type holders are good down to approximately 8 MHz. At lower frequencies the crystal gets larger in order to maintain the desired pull range and these holders may not be large enough.

6. Temperature tolerance with temperature range; e.g., ± 10 ppm, 0 to 50 degrees C.
7. Or the stability tolerance for items 4 — 6 can be lumped together as a total tolerance; e.g. ± 50 ppm.

8. The circuit configuration — series or parallel.

The circuit condition is where the problem lies. The crystal industry refers to a parallel model crystal as any crystal that is ringing above its natural series resonance frequency through the influence of an external component, in most cases a load capacitor. Refer to Figures 2a, 2b, and 2c for a graphic illustration of this concept with a crystal specification for series resonance at 18.43 MHz. Figure 2a illustrates the circuit topology of an 18.43 MHz crystal that was modeled to generate the response shown in Figures 2b and 2c. Figure 2b is a linear plot of the input impedance (S_{11}) of an 18.43 MHz example crystal. Figure 2c is the same information (S_{11}) but plotted on a Smith chart.

The actual frequency that this "parallel" resonant crystal can operate at is above the series resonance but below the true parallel resonance of the crystal.

At series resonance, the reactances of the motional capacitance C_1 and motional L_1 are equal and opposite, and the net reactance of the series circuit is zero, as shown in the linear plot of input impedance S_{11} of Figure 2b. The parallel resonant frequency is higher than the series resonance and is at a point where the reactance of C_1 and L_1 become inductive. This is graphically illustrated in Figure 2c. This inductive impedance is in parallel with capacitance of the holder and when the net inductance reactance equals that of C_0 , the crystal vibrates at the parallel resonant frequency. This point is often referred to as the antiresonant frequency.

The method that we have used in the past of specifying a series resonance crystal with a frequency offset to compensate for the external tuning capacitance, is acceptable. According to many crystal vendors, some of their customers buy their crystals in this manner. However do not specify a load capacitance, because the crystal vendor will consider this to be a parallel resonance crystal and compensate the operating frequency accordingly.



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A good approximation for the offset when specifying series resonant crystals in the frequency range of 10 to 20 MHz would be 0.025 percent to the low side of the desired center frequency. Use this approximation with caution and just as a starting point. It is recommended that the crystals with external loads, which are intended to be pulled, be modeled to accurately determine the operating point and pull range.

Other parameters that should be specified if the crystal is to be pulled are as follows:

9. The motional capacitance C_1 ; e.g., ranging 0.01 pF to 0.03 pF.

10. The parallel capacitance C_0 ; e.g., ranging 3 pF to 5 pF.

The difference between the series resonant point (F_r) and parallel resonant point (F_a) is shown as:

$$F_a - F_r = 0.5F_r \left(\frac{C_1}{C_0} \right) \quad (2)$$

An approximation to define the pull range limits for a standard crystal is shown as:

$$\text{Pull Range} = \frac{0.5F_s C_1}{C_0 + C_L} \quad (3)$$

where C_L is the external load capacitor and F_s is the specified frequency for the standard crystal.

Another method of specifying a crystal for use in a circuit where it will be pulled is to specify the crystal as "parallel" resonant. When taking this approach the center load capacitance with the corresponding center frequency as well as the total pull range must be specified. The crystal vendor will determine the actual offset frequency as well as the motional capacitance C_1 and the parallel capacitance C_0 . When taking this approach, the designer loses some degree of freedom to do trade offs in order to optimize a circuit and thus this is often not a desirable approach.

11. Spurious mode suppression; i.e. -30 dBc.

Another method of defining this suppression for our type of applications would be by defining the series resistances at various overtones; i.e.. The series resistance at the third overtone to be greater than 5 times the series resistance at the fundamental. This is a rule that can be used when using hybrid IC oscillators in order to reduce the possibility of harmonic oscillation.

12. The drive level; i.e., 1 uW, 1 mW etc. (optional).

This last parameter is of concern only in very high stability applications. In most applications (< 1 ppm stability) where a stand alone crystal is being specified, this is a second order effect that is of little concern and thus, optional.

This guideline should help specify new crystals for future products and help clarify existing specifications for second source vendors. It should clarify some of the jargon of the crystal industry and reduce the selection of a crystal to a cook book approach. **RF**

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About the Author

C.W. Richards is a Section Leader in Hardware Data Systems Operations, Network Systems Group for Scientific Atlanta. He can be reached at 2108 Rosewood Drive, Melbourne Beach, FL 32951. Tel: (407) 725-4349.

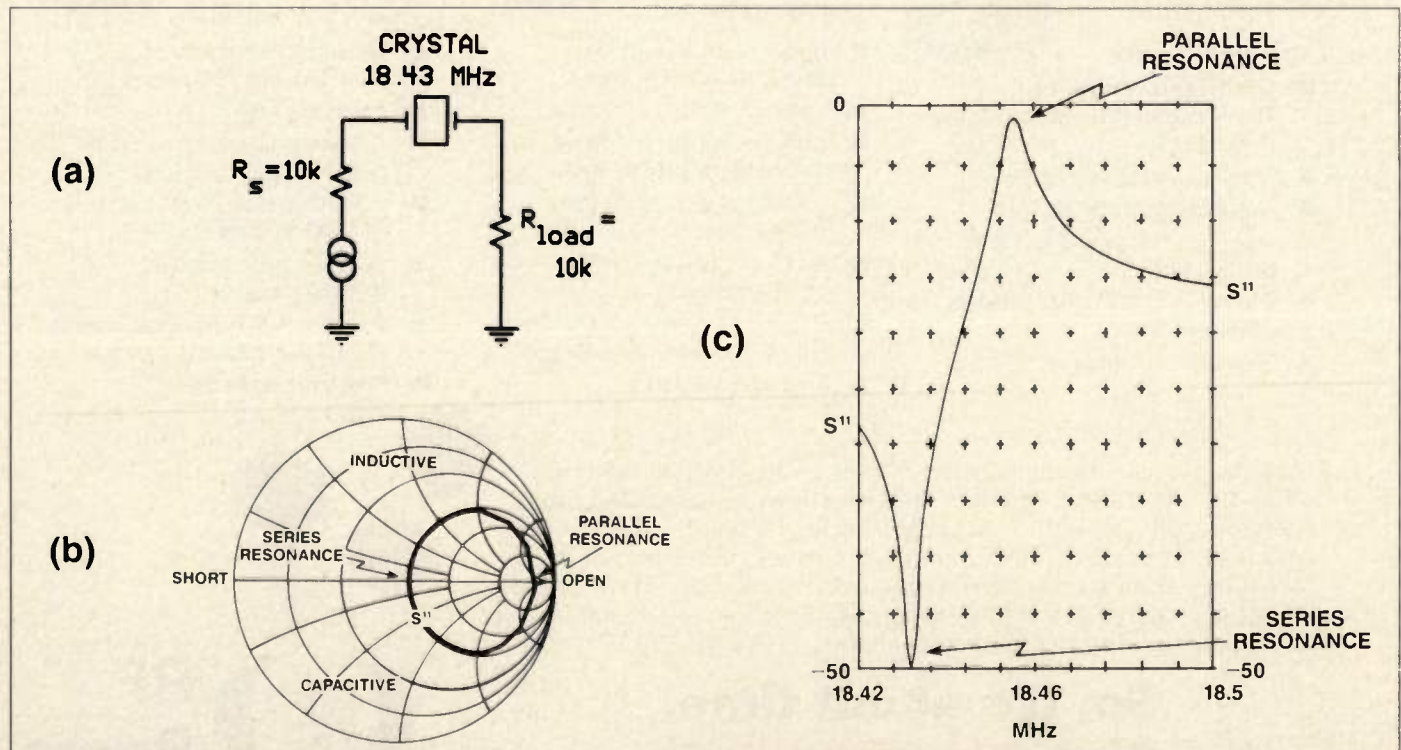


Figure 2. (a) circuit topology of an 18.43 MHz crystal, (b) input impedance of S_{11} plotted linearly, (c) input impedance of S_{11} plotted on a Smith chart.

The Effects of Package Capacitance on the Capacitance vs. Voltage Characteristic of a Tuning Varactor

By Richard A. Cory
M/A-COM Semiconductor Division
Burlington Semiconductor Operations

Engineers who design circuits that contain tuning varactors are often mystified by the way in which capacitance ratios of tuning varactors are specified. Frequently the varactor manufacturer's specifications do not correspond to the varactor package configuration that is used. This article describes a convenient way to convert such specifications into more meaningful information.

The capacitance ratio of a tuning varactor is simply the ratio of capacitance at one voltage to the capacitance at another voltage. The tuning ratio, which is the maximum frequency range over which a circuit that contains this varactor can be tuned, is the square root of this capacitance ratio. For example, in order to tune a resonant circuit over an octave bandwidth (a tuning ratio of 2), the capacitance ratio of the varactor must be 4, assuming there is no other capacitance present in the circuit.

The capacitance ratio of a packaged tuning varactor chip is reduced by the parasitic capacitance of the package in which it is mounted. The extent to which this total capacitance ratio is less than the junction capacitance ratio is determined by the relative magnitudes of the minimum chip junction capacitance and the package capacitance. The total capacitance ratio of a packaged chip follows the formula

$$\frac{C_t(V_{r1})}{C_t(V_{r2})} = \left[\frac{1}{1+r} \right] \left[\frac{C_j(V_{r1})}{C_j(V_{r2})} + r \right] \quad (1)$$

where

r is the package parasitic capacitance normalized to the minimum junction capacitance of interest of the chip

$$\text{i.e., } r = \frac{C_{pkg}}{\text{minimum } C_j} \quad (2)$$

$C_t(V)$ is the total varactor capacitance at

V volts, and $C_j(V)$ is the junction capacitance at V volts.

The Ratio of a Varactor's Junction Capacitances

The junction capacitance of a tuning varactor as a function of the bias voltage across the junction is

$$C_j(V_r) = \frac{C_j(V_{reference})}{\left[\frac{V_r + \phi}{V_{reference} + \phi} \right]^\gamma} \quad (3)$$

where

$C_j(V_r)$ is the junction capacitance at V_r , $C_j(V_{reference})$ is the junction capacitance at $V_{reference}$, ϕ is the contact potential of the semiconductor (0.7 V for Si, 1.2 V for GaAs), γ is the slope exponent of the capacitance-voltage relationship ($\gamma = 0.5$ for an ideal abrupt junction, $\gamma > 0.5$ for a hyperabrupt junction, $\gamma = 0.33$ for a linear graded junction, etc.).

In the discussion that follows, the value of γ is assumed to be constant and independent of the bias voltage applied to the diode. Junction capacitance versus bias voltage for a typical abrupt

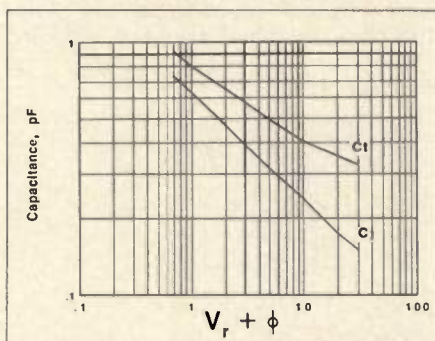


Figure 1. Total capacitance and junction capacitance vs. bias voltage (MA45225-30).

junction tuning varactor, MA45225, is shown in Figure 1.

The ratio of junction capacitance of a tuning varactor at V_{r1} to V_{r2} is then

$$CR_j = \frac{C_j(V_{r1})}{C_j(V_{r2})} = \frac{\left[\frac{C_j(V_{reference})}{\left[\frac{V_{r1} + \phi}{V_{reference} + \phi} \right]^\gamma} \right]}{\left[\frac{C_j(V_{reference})}{\left[\frac{V_{r2} + \phi}{V_{reference} + \phi} \right]^\gamma} \right]} \quad (4)$$

This expression can be simplified to

$$CR_j = \frac{C_j(V_{r1})}{C_j(V_{r2})} = \left[\frac{V_{r2} + \phi}{V_{r1} + \phi} \right]^\gamma \quad (5)$$

When $V_{r1} = 0$ V (as is frequently the case with catalog specifications) equation 5 further simplifies to

$$CR_j = \frac{C_j(0V)}{C_j(V_{r2})} = \left[1 + \frac{V_{r2}}{\phi} \right]^\gamma \quad (6)$$

Packaged Varactors

The total capacitance of the packaged varactor chip is the sum of the diode's junction and the package's capacitances, as they are in parallel, as shown in Figure 2.

$$C_t(V_r) = C_j(V_r) + C_{pkg} \quad (7)$$

The total capacitance ratio is

$$CR_t = \frac{C_t(V_{r1})}{C_t(V_{r2})} = \frac{C_j(V_{r1}) + C_{pkg}}{C_j(V_{r2}) + C_{pkg}} \quad (8)$$

Equation 8 cannot be algebraically rearranged to relate the junction capacitance ratio and the package capacitance to the total capacitance ratio. However,

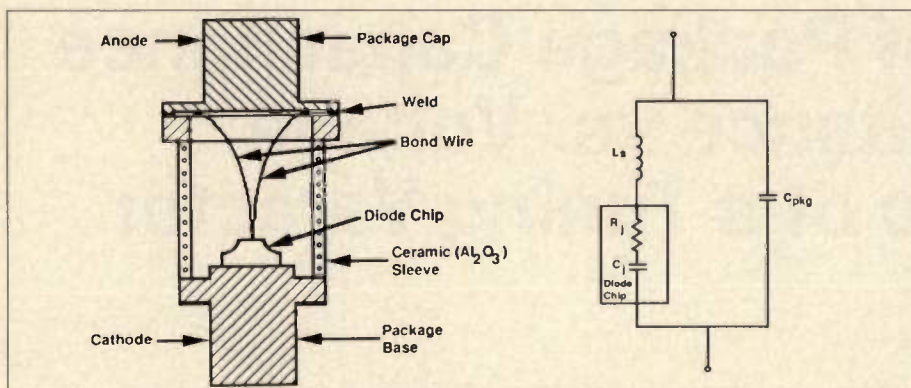


Figure 2. (a) Cross-sectional view of a packaged diode (case style 30), (b) Equivalent circuit of a packaged diode.

if the package capacitance is normalized to the minimum junction capacitance of the chip to be used, then this value may be substituted into equation 7 and used to resolve the relationship between the total and junction capacitance ratios:

$$r = \frac{C_{pkg}}{\text{minimum } C_j} = \frac{C_{pkg}}{C_j(V_{r2})} \quad (9)$$

$$CR_t = \frac{C_t(V_{r1})}{C_t(V_{r2})} = \frac{C_j(V_{r1}) + rC_j(V_{r2})}{C_j(V_{r2}) + rC_j(V_{r2})} \quad (10)$$

$$CR_t = \frac{C_t(V_{r1})}{C_t(V_{r2})} = \left[\frac{1}{1+r} \right] \left[\frac{C_j(V_{r1})}{C_j(V_{r2})} + r \right] \quad (11)$$

Simplifying gives

$$CR_t = \frac{C_t(V_{r1})}{C_t(V_{r2})} = \left[\frac{1}{1+r} \right] \left[\frac{C_j(V_{r1})}{C_j(V_{r2})} + r \right]$$

When $C_{pkg} \ll C_j(V_{r2})$ (i.e., $r \geq 0$), Equation 11 simplifies to

$$CR_t = \frac{C_t(V_{r1})}{C_t(V_{r2})} = \frac{C_j(V_{r1})}{C_j(V_{r2})} = CR_j, \quad [C_{pkg} \ll C_j(V_{r2})] \quad (12)$$

When $C_{pkg} \gg C_j(V_{r2})$ (i.e., $r \geq \text{infinity}$), Equation 11 simplifies to:

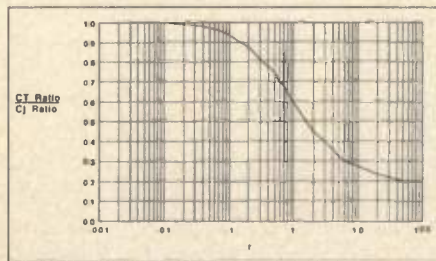


Figure 3. Total capacitance ratio normalized to junction capacitance ratio versus r.

$$CR_t = \frac{C_t(V_{r1})}{C_t(V_{r2})} = 1, [C_{pkg} \gg C_j(V_{r2})] \quad (13)$$

That is, the diode's total capacitance becomes independent of bias voltage as r becomes very large. Figure 3 shows the relationship between total and junction capacitance ratio as r is varied from very small to very large values.

Examples

Consider the MA45225 silicon abrupt junction tuning varactor. Its junction capacitance at $V_r = 4$ V is nominally 0.32 pF. γ for this series of devices (MA45XXX series) is typically 0.44. The values of its junction capacitance at $V_r = 0$ V and $V_r = 30$ V are found (using equation 3) to be 0.74 pF and 0.14 pF, respectively. Consequently, the junction capacitance ratio from 0 V to 30 V is

$$CR_j = \frac{C_j(0V)}{C_j(30V)} = \frac{0.74\text{pF}}{0.14\text{pF}} = 5.28 \quad (14)$$

Let us examine what happens to this varactor's total capacitance ratio when this chip is placed into two different

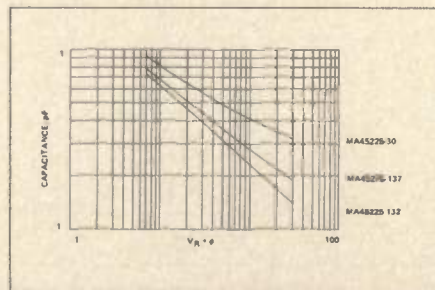


Figure 4. Capacitance versus voltage.

package styles. The package capacitance of case style ODS-30 is typically 0.18 pF. If the MA45225 chip is mounted inside this package, the effect of this package's capacitance on the varactor's total capacitance ratio can be found using equations 9 and 11, and is shown in Figures 4 and 5.

$$r = \frac{C_{pkg}}{C_j(30V)} = \frac{0.18\text{pF}}{0.14\text{pF}} = 1.286 \quad (15)$$

(MA45225-30)

and

$$CR_t = \frac{C_t(0V)}{C_t(30V)} = \left[\frac{1}{1+r} \right] \left[\frac{C_j(0V)}{C_j(30V)} + r \right] \quad (16)$$

$$CR_t = \frac{C_t(0V)}{C_t(30V)} = \left[\frac{1}{1+1.286} \right] [5.28 + 1.286] \quad (17)$$

$$CR_t = \frac{C_t(0V)}{C_t(30V)} = 2.87 \quad (18)$$

The parasitic capacitance of case style ODS-30 reduces the total capacitance ratio available to the circuit designer by almost 46 percent compared to the junction capacitance ratio of this chip.

If this same varactor chip is mounted in case style ODS-137, whose case capacitance is 0.05 pF, analysis, as discussed above, shows a much larger useful capacitance ratio, i.e. $r = 0.36$ (MA45225-137)

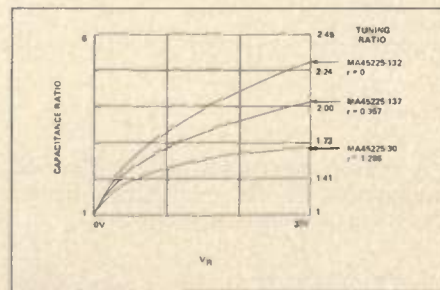


Figure 5. Capacitance ratio versus voltage.

$$CR_t = \frac{C_i(0V)}{C_i(30V)} = 4.15 \quad (19)$$

In this case, the total capacitance ratio is only 21 percent less than the junction capacitance ratio.

In a second example, if a varactor chip with much larger junction capacitance, MA45242 ($C_j(4V) = 14.82$ pF typical) is used in the same two case styles, the reduction of total capacitance ratio due to the package capacitance is much less pronounced. The MA45242's junction capacitance ratio is 5.28 ($\gamma = 0.44$), $C_j(0 V) = 34.26$ pF and $C_j(30 V) = 6.49$ pF. As above, the total capacitance ratios are $r = 0.028$ (MA45242-30)

$$CR_t = \frac{C_i(0V)}{C_i(30V)} = 5.16 \quad (20)$$

and

$$r = 0.0077 \quad (\text{MA45242-137})$$

$$CR_t = \frac{C_i(0V)}{C_i(30V)} = 5.24 \quad (21)$$

Clearly, the parasitic package capacitances of cases ODS-30 and ODS-137 do not significantly reduce the total capacitance ratio of the MA45242 chip.

The magnitude of the junction capacitance ratio of a tuning varactor chip has been shown to be reduced when a fixed capacitance, such as the parasitic capacitance of a diode package, is placed in parallel with the chip. The extent to which the junction ratio is reduced depends on the relative magnitudes of the junction and package capacitances. A method has been shown to calculate the magnitude of this reduction. **RF**

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About the Author

Richard Cory is an Applications Engineer with M/A-COM's Semiconductor Products Division. He may be reached at 43 South Avenue, M/S 111, Burlington, MA 01801. Tel: (617) 272-3000.

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Improved Mica RF Capacitors

By Laird Macomber
Cornell Dubilier Electronics

When a circuit designer is facing an analog design, it is only human to search for the ideal capacitor with none of those unwanted (and often unexpected) "gremlins" — e.g., resistance, inductance, and change in capacitance. Unfortunately, ideal capacitors simply don't exist. Real-world capacitors come with unwanted inductors and resistors, and the resistors appear to include trim pots that vary with temperature, frequency, and life. Worse, there is also a trimmer capacitor built into each real capacitor that changes the capacitance value. In addition, those unwanted resistors tend to get hot, thus limiting the ability of capacitors to handle fast pulses and high continuous currents. And last but not least, components usually have leads or terminals spaced to satisfy the regimentation of the 0.1 inch pc-board grid.

Figure 1 illustrates the unwanted "network" that is automatically included with every real-world capacitor. Gremlins stand ready to slip their adjusting screwdrivers into the trim pot slots and tweak them when it gets hot or cold or simply as time goes on.

This capacitor behavior is further complicated by the inability of the industry to make and stock odd-ball values that are frequently called for by the circuit requirements. Indeed, what to do when the SPICE model spits out 56.2 pF as your "must" capacitor value and then rubs it in with the requirement that its accuracy must be ± 0.5 pF and must

have a maximum series resistance of no more than 0.1 percent of the capacitor's reactance?

Or take an engineer designing a diplex filter for CATV and his spec says that 550 MHz was an okay bandwidth for the 80-channel system, but now the spec calls for 1 GHz for the next-generation, 150-channel system. Just where will the designer get capacitors that don't have an inductor in series that creates self-resonance well below 1 GHz and high impedance at 1 GHz?

Getting the Value You Need

It turns out that today there are mica capacitors around that are surprisingly close to that elusive "textbook" capacitor. Consider, for instance, the performance of the newly-introduced Type CD-4 mica capacitors by Cornell-Dubilier targeted at the applications requiring precision capacitors or high-frequency RF capacitors (Figure 2).

As was hinted above, the perversity of precision capacitance applications is that the CAD program that specifies the value does not know about manufacturer's catalog values and ratings. So, to enable the designer to find a 56.2 pF unit, rather than to force him to sort 47 pF units to come up with a high value or to sort 68 pF capacitors to find a low one, the CD-4 mica capacitor family offers 191 standard ratings (the values of the E48 preferred number series in 5 percent steps) from 1 to 1500 pF (and 56.2 pF is a standard rating). The ± 0.5 pF is also standard.

What about the series resistance no more than 0.1 percent of the capacitor reactance? Dissipation factor (DF) is the ratio of the Equivalent Series Resistance (ESR) to capacitive reactance, so that 0.1 percent of reactance means 0.1 percent maximum DF. The CD-4's DF is 0.07 percent maximum.

Keeping The Value You Picked

In addition to the closely-spaced values and tight tolerances, there are several parameters that help keep the selected capacitor value over time and through thick and thin of actual operating environments. These include:

1. High-frequency stability.
2. High-current stability.
3. Temperature stability.
4. Life-time stability.

High-frequency stability essentially means that a capacitor actually looks like a capacitor over the entire operating frequency range. Referring to Figure 3, impedance and phase angle versus frequency characteristics for several popular CD-4 capacitor ratings, note that impedance at resonance is consistently under 1 ohm. For a 1500 pF unit, it is about 0.15 ohm. A stock ceramic capacitor, under the same conditions, will exhibit impedance of around 0.5 ohm. For most applications, a designer can obtain a mica capacitor with average impedance values that will be 75 percent lower than those for ceramics.

In addition to this built-in stability, CD-4 units offer lead spacing of 0.1 inch (unlike older generation mica units with wider lead spacing) — which is a direct fit for today's standard pc-board grids. This reduces the series inductance and

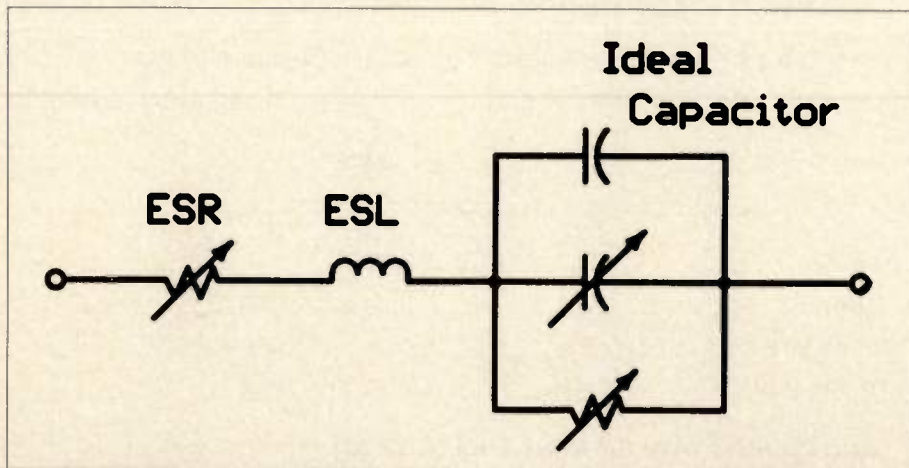


Figure 1. Capacitor "network."

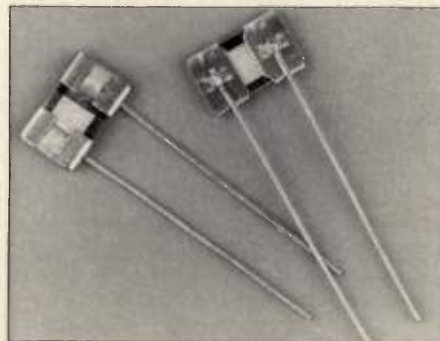


Figure 2. Mica RF capacitor.

Letter Designation	±Capacitance Tolerance
C	1 pf
D	0.5 pf
E	0.5%
F	1%
G	2%
J	5%

Table 1. Capacitance tolerance.

reveals the high-frequency performance of the mica dielectric. With a typical series inductance of 8 nH, all CD-4 capacitors have lower impedance at 1 GHz than at 1 MHz, as shown in Figure 3. And the higher self-resonant frequencies give the designer unchanging capacitance to even higher frequencies as shown in Figure 4.

High-current stability is a direct result of the low ESR and the use of metal clips holding together the internal sections of mica capacitors. To appreciate the role of ESR, consider what it takes to heat up a CD-4 capacitor. The power dissipated in a capacitor is given by the familiar I^2R product, where "I" is the capacitor current and "R" is the ESR. The temperature rise is governed by a fairly constant thermal resistance that is inversely proportional to the capacitor case surface area. i.e., ΔT , is proportional to $[(I^2R)/A]$, where "A" is the case area. Thus, these mica capacitors can

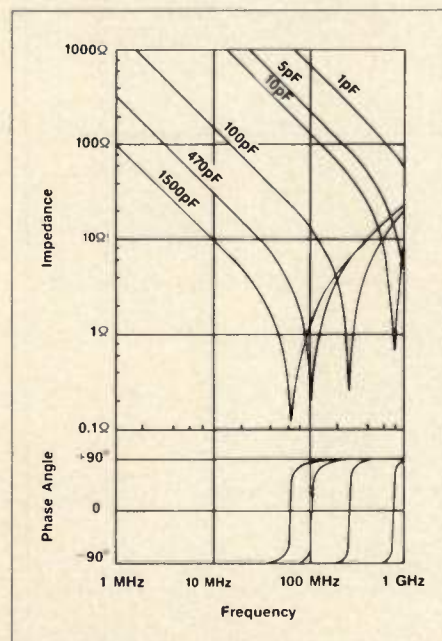


Figure 3. Impedance and phase angle versus frequency characteristics.

Letter Designation	Temp. Coefficient PPM/°C	Capacitance Drift
C	-200 to +200	±(0.5 percent +0.1 pF)
E	-20 to +100	±(0.1 percent +0.1 pF)
F	0 to +70	±(0.05 percent +0.1 pF)

Table 2. Stability.

handle continuous current given by the following expression:

$$I = 0.12 \sqrt{\frac{\Delta T A}{R}} \quad (1)$$

where:

- I — capacitor current in amperes ac,
- ΔT — temperature rise,
- A — capacitor case area, square in.,
- R — ESR in ohms.

If we were to plug-in numbers to the above expression for an off-the-shelf 1500-pF CD-4 capacitor, we would see that for a 15 degrees C temperature rise, it would be able to handle 2.7 amperes of continuous ac current. Also note that the lower the ESR, the less voltage drop across the capacitor, e.g., the better job of transient suppression the capacitor can do. And, as can be seen from Figure 5, ESR is another parameter that stays reasonably low over the frequency range all the way to 1 GHz.

While the low ESR ensures cool operation, the metal clips equip mica capacitors with an excellent capability for handling extremely severe transient currents. They effectively spread the current flowing into the capacitor and act as heatsinks that dissipate the heat

resulting from current transients. As a result, all CD-4s are rated to handle current pulses with rise and fall gradients of more than 20,000 V/ μ s. Thus, the same 1500 pF capacitor can comfortably swallow transients of 30 amperes peak.

Temperature stability of a mica capacitor, Figure 6, is due to the inherent stability of the mica dielectric. As is shown in Table 2, a 100 pF unit, "F" characteristic, the capacitance does not change more than 0.16 pF from the combined effects of -55 degrees C to 125 degrees C temperature swings and life. From Table 2, the temperature coefficient for a CD-4 capacitor is 0 to 70 ppm/degree C, i.e., a maximum of 0.0126 percent capacitance change per degree Fahrenheit. So, when the thermometer climbs from a comfortable 72 degrees F to a sweltering 90 degrees F, the 100-pF CD-4 has changed less than 0.07 pF.

Life-time stability of mica units derives from the undisputable fact that mica material, after all, is a rock. So it's no surprise that it is stable with time. For our 100 pF unit, the maximum capacitance change obtained in an accelerated life test at 125 degrees C is $\pm(0.05$

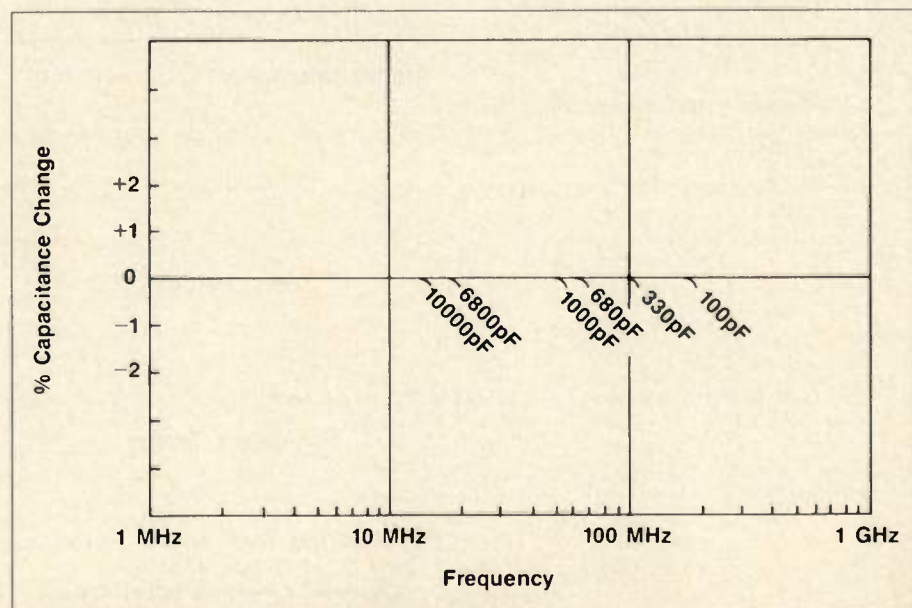


Figure 4. Percent capacitance change versus frequency.

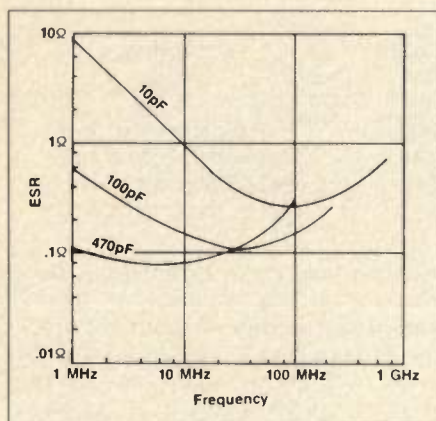


Figure 5. Equivalent series resistance parameters.

percent + 0.1 pF) — that's 0.15 pF. Actually, capacitance change is less than 0.05 pF, and the +0.1 pF is included in the limit to avoid accuracy quibbles with different capacitance meters.

Perhaps the best proof of mica capacitors' stability is the fact that they have been the backbone of radio transmitters since day one and there is no replacement market. The few transmit-

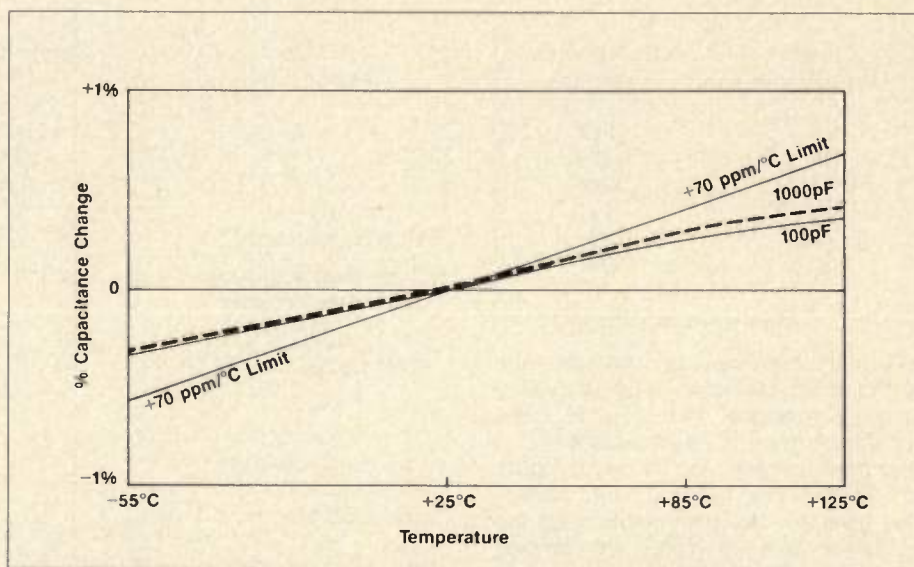


Figure 6. Percent capacitance change versus temperature.

ting mica capacitors that are replaced each year — many after 35 to 50 years of service — are typically due to lightning strikes and other circuit failures, a testimony to reliable circuit design, and the "rock solid" stability of mica capacitors. **RF**

About the Author

Laird L. Macomber is Manager, Business Development for Cornell Dubilier Electronics. He may be reached at Cornell Dubilier Electronics, Pickens, SC 29671.

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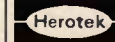
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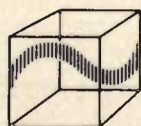
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Corvallis, OR 97333
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Steve Blum

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(805) 498-6794
Dave Biddle

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5134 Commerce Square Dr.
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(317) 887-1340 FAX: (317) 881-6790
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(301) 749-2424 FAX: (301) 749-5725
Jim Price

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(708) 884-8688 FAX: (708) 884-9327
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K S ELECTRONICS
16406 N. Cavecreek Road #5
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60 S. Jefferson Rd.
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(201) 887-8100 FAX: (201) 884-0445
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1090 Granada Lane, Ste. 201
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(913) 491-6825 FAX: (913) 491-6812
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Jean Hogan

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(818) 846-9210 FAX: (818) 567-0283
R. Baroda

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260 Fordham Rd.
Wilmington, MA 01887
(508) 658-0880 FAX: (508) 657-4803
Michael Hopkins

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Torrance, CA 90503
(213) 371-4662
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PO Box 10
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(805) 646-9645 FAX: (805) 646-9645
Sales

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(805) 684-4560 FAX: (805) 684-9679
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Henry Pessah

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255 Bodwell St.
Avon, MA
(508) 580-1660 FAX: (508) 583-8989
Dick Haddad, Joe Inglis

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126 Pennsylvania Ave.
Paterson, NJ 07509
(201) 345-8900 FAX: (201) 345-1172
Elaine Auerbach

KRYTAR
1292 Anwillwood Court
Sunnyvale, CA 94089
(408) 734-5999 FAX: (408) 734-3017
Corrine Williford

KVG NORTH AMERICA, INC.
2240 Woolbright Road, Suite 320
Boynton Beach, FL 33426-6325
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Werner Mueller

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Doug Hartje, VP Marketing/Sales

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Bill Heeter

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Karolina Garrett

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Steve Montgomery

ELECTROMAGNETICS, INC.
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Los Angeles, CA 90016
(213) 870-9383 FAX: (213) 870-0828
Janet Nichols

ELECTRONIC RESEARCH LABS
1423 Ferry Ave.
Camden, NJ 08104
(609) 541-4200 FAX: (609) 541-7852
Ray Van Orden

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Cedar Rapids, IA 52408
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Mike Howard

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Ben Sellitto

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(408) 988-1331 FAX: (408) 970-9950
Debbie LeBaker

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(415) 591-8411
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Newbury Park, CA 91320
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Plainview, NY 11803
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801 Scholz Dr., PO Box 427
Vandalia, OH 45377-0427
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P.O. Box 6001
Gaithersburg, MD 20884-6001
(301) 948-3434 FAX: (301) 948-3625
Curt Crews

LUCAS ZETA DIVISION, LUCAS AEROSPACE COMMUNICATIONS & ELECTRONICS
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San Jose, CA 95134
(408) 434-3600 FAX: (408) 433-0205
Barbara Dominguez

LUCAS ZETA, INC.
2811 Orchard Parkway
San Jose, CA 95134
(408) 434-3600 FAX: (408) 433-0205
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Floral Park, NY 11001
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(415) 962-8110
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10 Commerce Drive
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Eric Sonneman

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Tony Ramsden

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Campbell, CA 95008
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(408) 737-8181 FAX: (408) 733-7645
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(708) 867-9600 FAX: (708) 867-9130
Marketing Manager

MIC TECHNOLOGY CORPORATION HERMATIC PACKAGE DIVISION
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(508) 222-6925 FAX: (508) 222-2489
Arthur Rice, Capabilities/Marketing Specialist

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1910 N. Firman Dr.
Richardson, TX 75081
(214) 680-9810 FAX: (214) 437-5135
David Chapman, Director, Sales and Marketing

MIC TECHNOLOGY CORPORATION THIN FILM DIVISION
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(914) 735-4900 FAX: (914) 735-4931
Dan Mambert, Capabilities/Marketing Specialist

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Joseph Barbeito

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(603) 883-2900 FAX: (603) 882-8987
Peter Gale, Director of Marketing

MICRONETICS

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Norcross, GA 30091
(404) 441-9193 FAX: (404) 449-8236
Robert Garvey

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3200 Highland Ave., Ste. 3A
National City, CA 91950
(619) 474-6906 FAX: (619) 474-7003
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(415) 651-6700 FAX: (415) 651-2208
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Marketing Manager

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(619) 560-1301
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RFDC INC.

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LaFox, IL 60147
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(203) 774-9605 FAX: (203) 774-9630
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Sebastopol, CA 95472
(707) 829-0164 FAX: (707) 829-0164
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(415) 982-9111
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2922 S. Roosevelt St.
Tempe, AZ 85282-2042
(602) 968-5995 FAX: (602) 894-1731
Rick Zelichowski

SOUTHWEST RESEARCH INSTITUTE

6220 Culebra Rd.
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(512) 522-2721 FAX: (512) 522-3396
William McGinnis

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2100 Earlywood Dr.
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Eric Parker

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101 Despatch Dr.
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2185 W. 8th St.
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(814) 455-0966
Tom Venable

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(805) 964-7791 FAX: (805) 683-3481
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(516) 689-6582
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SPIRA MFG CORP.

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(818) 764-8222 FAX: (818) 764-9880
Bonnie Kunkel

SPRAGUE ELECTRIC CO.

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Mansfield, MA 02048
(508) 339-8900 FAX: (508) 339-5063
Francis E. DeBlois

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134 Fulton Ave.
Garden City Park, NY 11040
(516) 746-1385 FAX: (516) 746-1396
Bernice Feller

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(800) 800-XTAL FAX: (213) 769-0154
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STANFORD APPLIED ENGINEERING

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STANFORD RESEARCH

1290 D Reamwood Ave.
Sunnyvale, CA 94089
(408) 744-9040 FAX: (408) 744-9049
Dan Melick

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2421 Mission College Blvd.
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(408) 980-5684 FAX: (408) 727-1482
Chuck Frank

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636 Remington Rd.
Schaumburg, IL 60173
(312) 490-7150
Don Slonecker

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(714) 639-7810 FAX: (714) 997-1256
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636 Remington Rd.
Schaumburg, IL 60173
(708) 490-7150 FAX: (708) 490-9707
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185 New Boston St.
Woburn, MA 01801
(617) 935-8460 FAX: (617) 935-8848
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3344 Schierhorn Ct.
Franklin Park, IL 60131
(708) 671-4208 FAX: (708) 671-5270
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116 Shore Dr.
Hinsdale, IL 60521
(708) 323-9121 FAX: (708) 323-9398
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 Phone: 812-372-8869 **CALL TOLL FREE: 800-423-5190**
 FAX: 812-372-5909

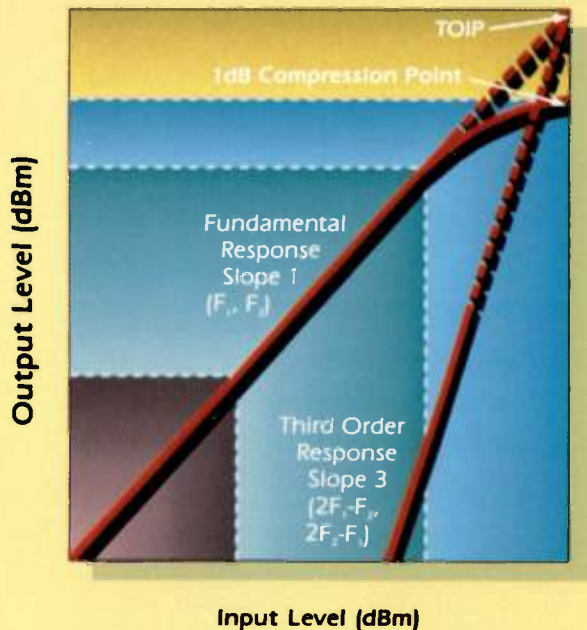
Alan

Manufacturers of...

Attenuators: Programmable • Rotary • Manual Switch • Fixed • Continuously Variable
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RF AMPLIFIER PERFORMANCE

The More You Know... The Higher We Score



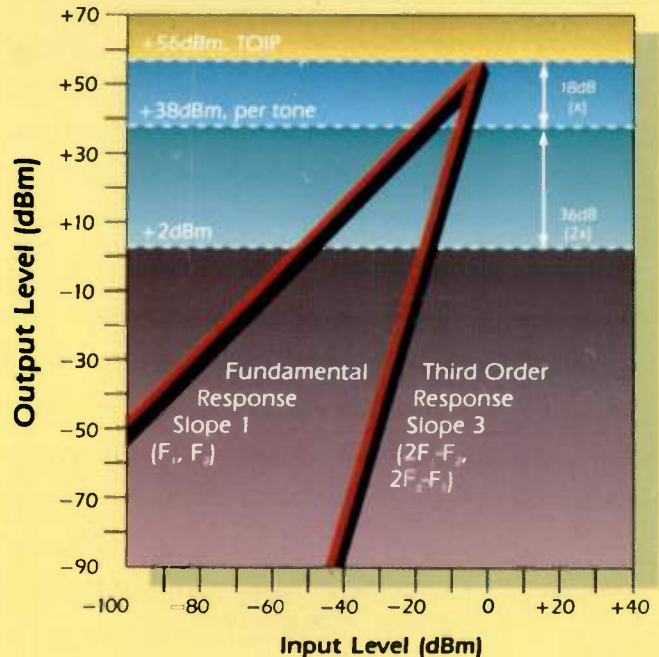
The determination of the Third Order Intercept Point (TOIP) is the best way to study an amplifier's linearity performance.

Linearity performance — the ability to accurately reproduce an input signal — is a major factor in the selection of any RF power amplifier. Usually, linearity is evaluated by measuring the amplifier's output level at 1dB compression. At ENI, we recognize that this method — a "snapshot" approach providing an indication of linearity at only **one** power level — has limited usefulness.

To evaluate linearity at **any** given power level, we measure two-tone intermodulation distortion, using the concept of the Third Order Intermodulation Intercept Point (TOIP) in the following formula:

$$\text{TOIP} = (\text{PEP Output Level} - 6\text{dB}) + 1/2 (3\text{IM})$$

We inject two signals with equal amplitude but slightly different frequencies into the amplifier. The third order intermodulation product (3IM) is the largest



Intercept plot for Model 525LA Amplifier (25W, 1-500MHz).

close-in distortion product present at the amplifier's output. The TOIP is the theoretical output signal level at which the undesired 3IM level is equal to one of the two desired output signal levels. The higher the TOIP, the more linear the amplifier.

Using the calculated TOIP of an amplifier, the relative linearity can be determined at any desired power level. To provide you with a complete picture of linearity performance, we include TOIP data with every ENI amplifier product specification.

Write or call us for our four-page Tech Note, "Evaluating Amplifier Linearity."

ENI manufactures a complete line of solid state RF power amplifiers for industrial, research, and medical applications. For more information, contact the nearest ENI office listed below:

ENITM

WORLD HEADQUARTERS, ENI, A Division of Astec America, Inc., 100 Highpower Road, Rochester, NY 14623 Tel: (716) 427-8300 Fax: (716) 427-7839
Santa Clara, CA Tel: (408) 727-0993 Fax: (408) 727-1352 Welwyn Garden City, UK Tel: (0707) 371558 Fax: (0707) 339286
Stuttgart, West Germany Tel: 7156-2 10 95 Fax: 7156-4 93 72 Tokyo, Japan Tel: 0425 229011 Fax: 0425 222636
Osaka, Japan Tel: (06) 367-0823 Fax: (06) 367-0827