T-79-07-10

VA706

HIGH-SPEED, FAST-SETTLING PRECISION OPERATIONAL AMPLIFIER

FEATURES

- Fast Settling Time: ±0.1% in 200ns
- High Slew Rate: 42V/µs
- Wide Gain Bandwidth: 25MHz
- Ease of Use: Internally Compensated, Unity Gain Stable at C_L = 50pF
- Large Output Current: ±50mA
- Low Supply Voltage Operation: ±4V
- Wide Input Voltage Range: Within 1.5V of V+ and 0.5V of V-
- Short Circuit Protection

DESCRIPTION

The VA706 is a high-speed general purpose monolithic operational amplifier useful for signal frequencies extending into the video range. The same processing innovations which permit the high speed also allow very high output currents capable of driving large capacitive loads at high speeds.

The high open-loop voltage gain of 5000V/V and high slew rate of 40V/µs make the VA706 ideal for analog amplification and processing of high-speed signals.

The VA706 is internally compensated for stable operation when driving capacitive loads up to 500pF. The wide gain bandwidth of 25MHz and 40V/µs slew rate results in ±0.1% settling times of 200ns, which makes the amplifier ideal for fast data conversion systems.

The high output current capability of ±50mA allows the amplifier to drive terminated transmission lines of 50Ω with amplitudes of 5V peak to peak.

Along with the high speed and output drive capability, a 25nA offset current and trimmable offset voltage make the VA706 usable for signal conditioning applications where accuracy must be maintained.

ABSOLUTE MAXIMUM RATINGS

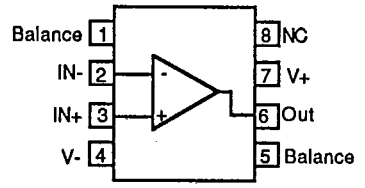
Supply Voltages ..... ±6V
Differential Input Voltage ..... ±9V
Common Mode Input Voltage ..... $|V_S|$ -0.5V
Power Dissipation (Note 1) 450mW
Output Short Circuit Current Duration (Note 2) ... Indefinite
Operating Temperature Range:
  Commercial (706 J, K) ..... 0° to 70°C
  Military (706 S) ..... -55° to +125°C
Storage Temperature Range ..... -65° to +150°C
Lead Temperature (Soldering to 60 Sec.) ..... 300°C

Note 1: Power derating above T_A = 70°C to be based on a maximum junction temperature of 150°C and the following thermal resistance factors:

PACKAGE	θ_{JC} (°C/W)	θ_{JA} (°C/W)
DIP	75	180
SOIC	115	180
TO-99	115	250

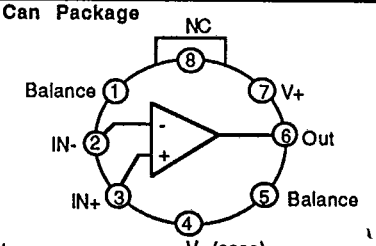
CONNECTION DIAGRAMS

Dual In-Line/SOIC Package



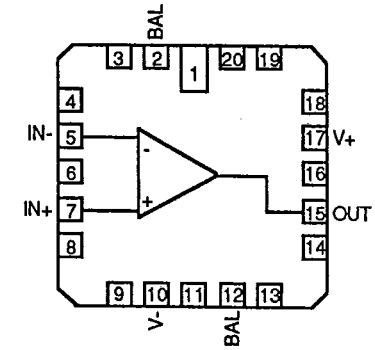
Top View

Metal Can Package



Top View V- (case)

LCC Package



Top View

Note 2: Continuous short circuit protection is allowed to the following case and ambient temperatures:

PACKAGE	T_C (°C)	T_A (°C)
DIP	110	70
SOIC	95	70
TO-99	95	30

PACKAGE TYPES AVAILABLE

- 8-Pin Plastic DIP
- 8-Pin CERDIP
- 8-Pin SOIC
- 8-Pin Metal Can, TO-99
- 20-Pin LCC

ELECTRICAL CHARACTERISTICS (V_S= ±5V, T_A= 25°C unless otherwise stated)

PARAMETER	SYMBOL	CONDITIONS	VA706J			VA706K			VA706S			UNITS
			MIN	TYP	MAX	MIN	TYP	MAX	MIN	TYP	MAX	
Input Offset Voltage	V_{OS}			8	20		4	10		4	10	mV
T_{Min} to T_{Max}		0°≤T_A≤70°C		11	28		6	16				
		-55 ≤T_A ≤125°C								10	20	
Average Offset Voltage Drift	$\Delta V_{OS}/\Delta T$	0°≤T_A≤70°C		20			20					µV/°C
		-55 ≤T_A ≤125°C								15		
Input Bias Current	I_B			650	1100		650	1100		650	1100	nA
Input Offset Current	I_{OS}			35	120		35	120		35	120	nA
T_{Min} to T_{Max}		0°≤T_A≤70°C		70	200		70	200				
		-55 ≤T_A ≤125°C								70	300	
Input Common Mode Range	V_{CM}		+3 -4	+3.5 -4.5		+3 -4	+3.5 -4.5		+3 -4	+3.5 -4.5		V
Differential Input Resistance	R_{IND}	(Note 1)	3	10		3	10		3	10		MΩ
Common Mode Input Resistance	R_{INC}	(Note 1)	4	8		4	8		4	8		MΩ
Differential Input Capacitance	C_{IND}	(Note 1)		2						2		pF
Common Mode Input Capacitance	C_{INC}	(Note 1)		3			3			3		pF
Input Voltage Noise	e_N	BW = 10Hz to 100KHz		12			12			12		µVRMS
Open Loop Voltage Gain	A_V	V_{OUT} = ±3V R_L= 2kΩ	1	5		2	5		2	5		V/mV
Output Voltage Swing	V_{OUT}	R_L= 2kΩ	±3.5	+4 -4.2		±3.5	+4 -4.2		±3.5	+4 -4.2		V
		R_L = 51Ω	±2.0	±2.4		±2.5	±2.7		±2.5	±2.7		
Power Supply Current (Both Amplifiers)	I_S			7	10		7	10		7	10	mA
Common Mode Rejection Ratio	CMRR	V_{CM}=,±2V	60	70		60	70		60	70		dB
Power Supply Rejection Ratio	PSRR	ΔV_{PS} = ±0.5V	60	66		60	66		60	66		dB
Slew Rate	SR	10-90%of Leading Edge (Figure 1)	38	42		38	42		38	35		V/µs
Settling Time	t_S	To ±0.1%(±4mV) of Final Value (Fig. 1, Note 1)		200	250		200	250		200	250	ns
Gain Bandwidth Product	GBW			25			25			25		MHz
Small Signal Rise/Fall Time	t_r /t_f	e_O = ±50mV 10-90% (Figure 1)		7			7			7		ns
Full Power Bandwidth	BW_{FP}	R_L = 2kΩ C_L = 50pF V_{OUT} = 6Vp-p		2.2			2.2			2.2		MHz

Notes: 1. Not tested, guaranteed by design.

DIE INFORMATION

WAFER TEST LIMITS

V_S = ±5V, T_A = 25°C (unless otherwise stated)

PARAMETER	SYM	CONDITIONS	VA706XS LIMIT	UNITS
Input Offset Voltage	V_{OS}		20	mV Max.
Input Bias Current	I_B		1000	nA Max.
Input Offset Current	I_{OS}		50	nA Max.
Input Common Mode Range	V_{CM}		+3 -4	V Min.
Open Loop Voltage Gain	A_V	V_{OUT} = ±3V R_L = 2k	2	V/mV Min.
Output Voltage Swing	V_{OUT}	R_L = 2KΩ	±3.5	V Min.
		R_L = 51Ω	±2.0	
Power Supply Current	I_S		10	mA Max.
Common Mode Rejection Ratio	CMRR	V_{CM} = ±2V	60	dB Min.
Power Supply Rejection Ratio	PSRR	ΔV_{PS} = ±0.5V	60	dB Min.
Slew Rate	SR	10-90% of Leading Edge (Figure 1)	38	V/µs Min.

TYPICAL ELECTRICAL CHARACTERISTICS

V_S = ±5V, T_A = 25°C (unless otherwise stated)

PARAMETER	SYM	CONDITIONS	VA706XS TYPICAL	UNITS
Input Offset Voltage $T_{Min.}$ to $T_{Max.}$	V_{OS}		30	mV
Input Offset Current $T_{Min.}$ to $T_{Max.}$	I_{OS}		75	nA
Settling Time	t_S	To ±0.1% of Final Value (Figure 1)	200	ns
Gain Bandwidth Product	GBW		25	MHz
Small Signal Rise/Fall Time	t_r /t_f	E_O = ±100mV 10-90% (Fig. 1)	7	ns
Full Power Bandwidth	BW_{FP}	R_L = 2kΩ C_L = 50pf V_{OUT} = 6V p-p	2.2	MHz

DICE POLICY

Electrical Characteristics

Each die is electrically tested to the commercial or military grade DC parameters to guard band limits at 25°C to guarantee operation over the full temperature range.

Quality Assurance

All dice are 100% visually inspected to the requirement of MIL-STD-883C, Method 2010.2, Condition 3.

All dice are glass passivated with only the bonding pads exposed to provide scratch protection.

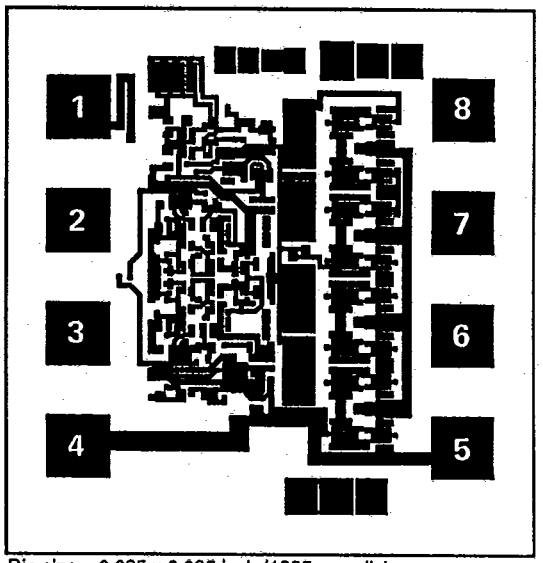
All dice are provided with gold backing.

Shipping Packages/Order Information

All dice are packaged in die crates with individual compartments which prevent damage to the die during shipping. The quantity per die crate is dependent on die size.

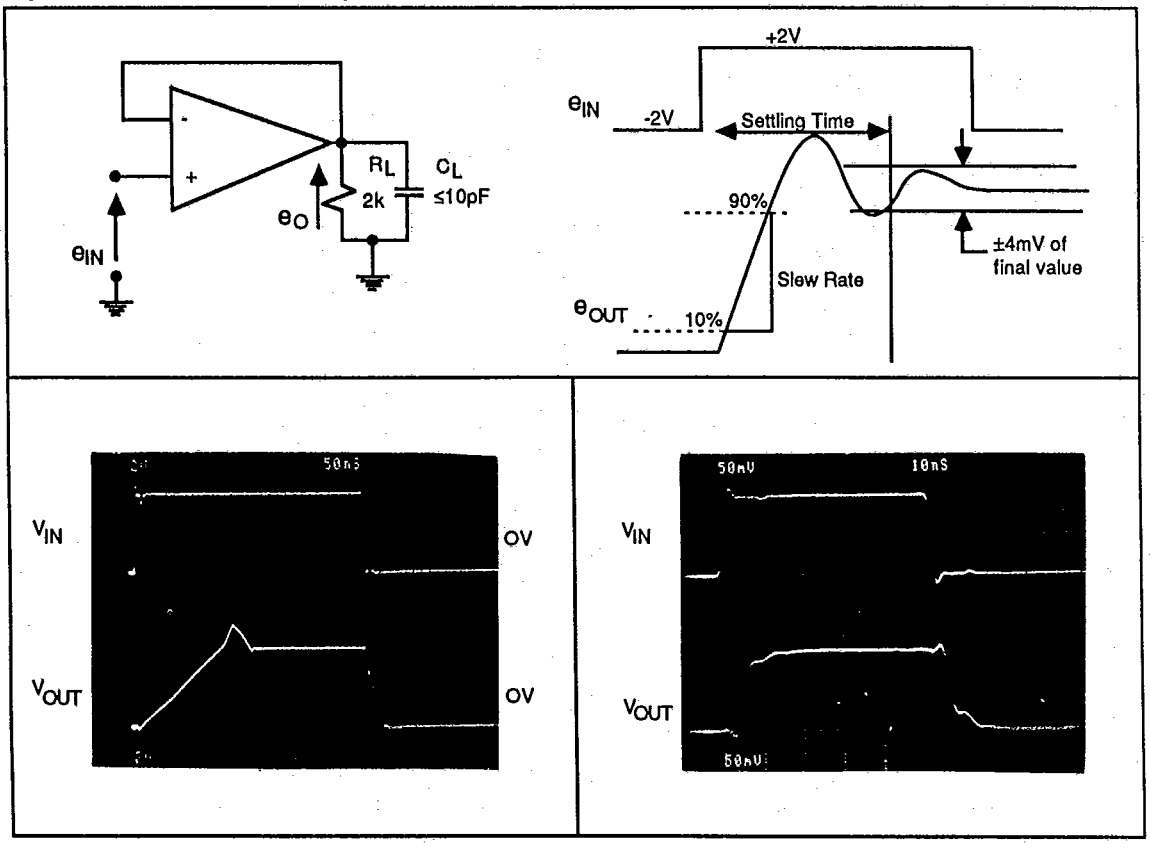
Minimum order for dice is 100, supplied only in multiples of 100.

DIE



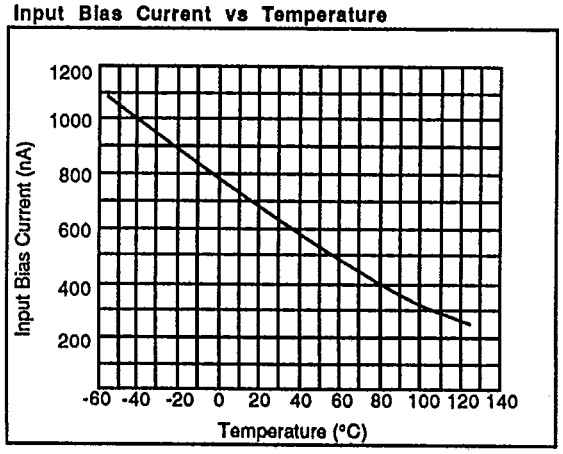
Die size = 0.035 x 0.035 inch (1225 sq. mils)
0.89 x 0.89 mm (0.79 sq. mm)
Shipped in die crates.

Figure 1: Slew Rate and Settling Time Test Circuit

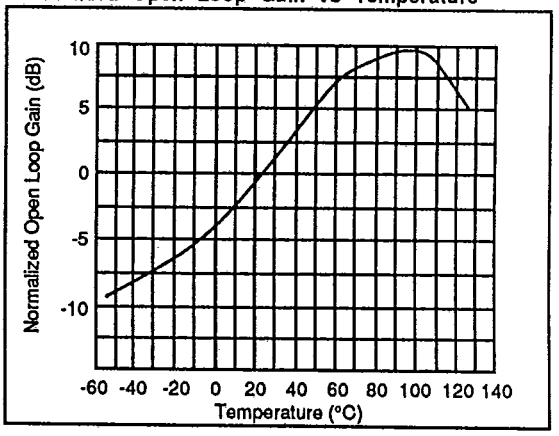


TYPICAL PERFORMANCE CHARACTERISTICS (V_S= ±5V, T_A= 25°C unless otherwise stated)

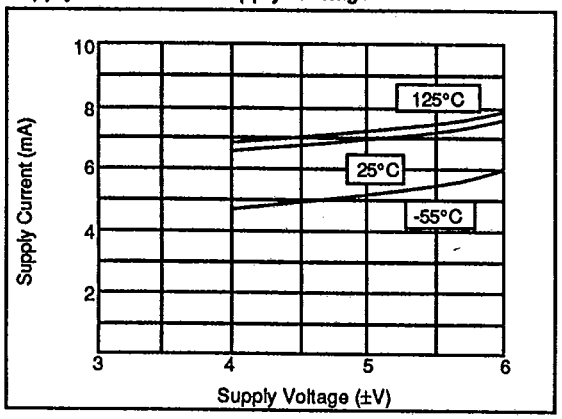
Input Bias Current vs Temperature



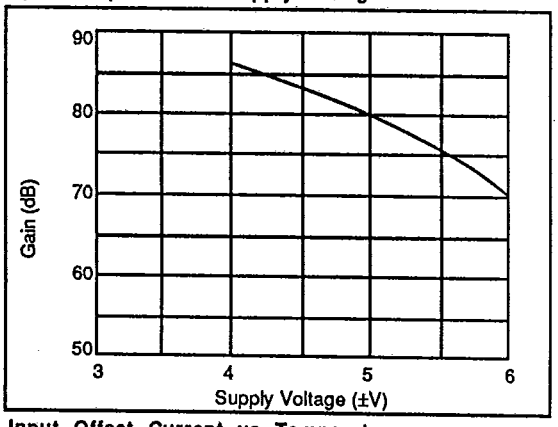
Normalized Open Loop Gain vs Temperature



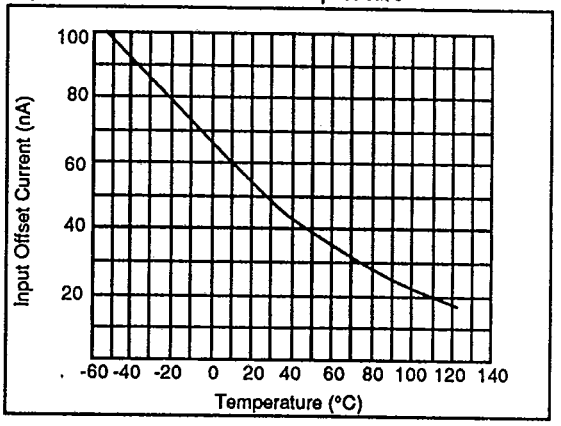
Supply Current vs Supply Voltage



Open Loop Gain vs Supply Voltage

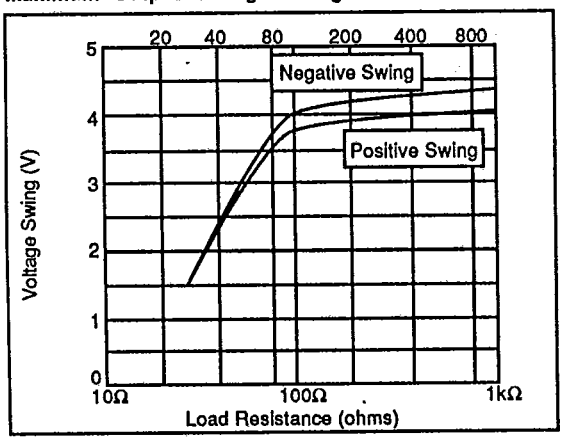


Input Offset Current vs Temperature

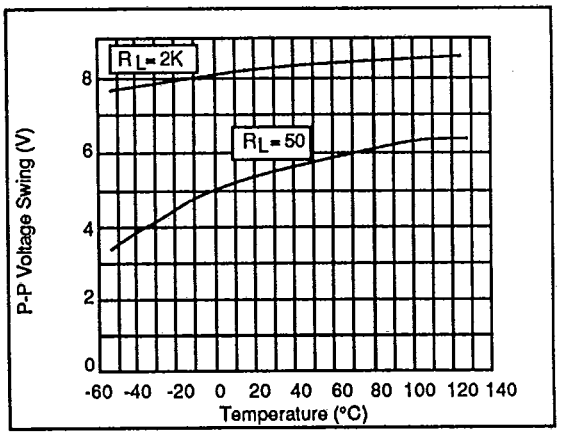


TYPICAL PERFORMANCE CHARACTERISTICS (V_S = ±5V, T_A = 25°C unless otherwise stated)

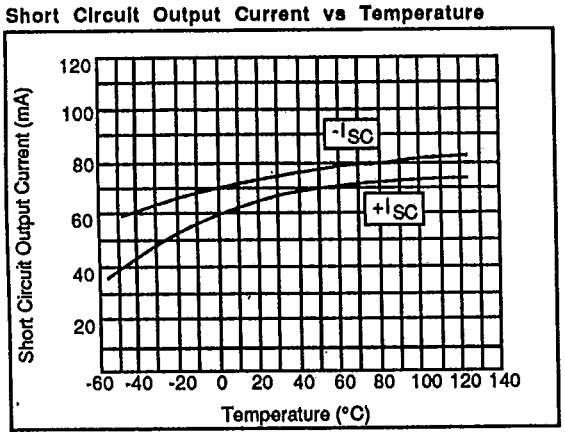
Maximum Output Voltage Swing vs Load Resistance



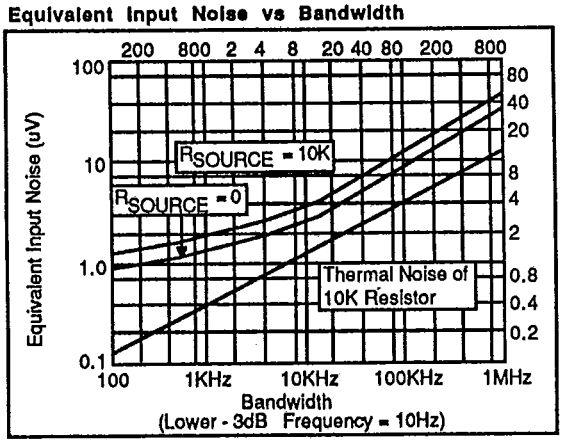
Maximum Output Voltage Swing vs Temperature



Short Circuit Output Current vs Temperature



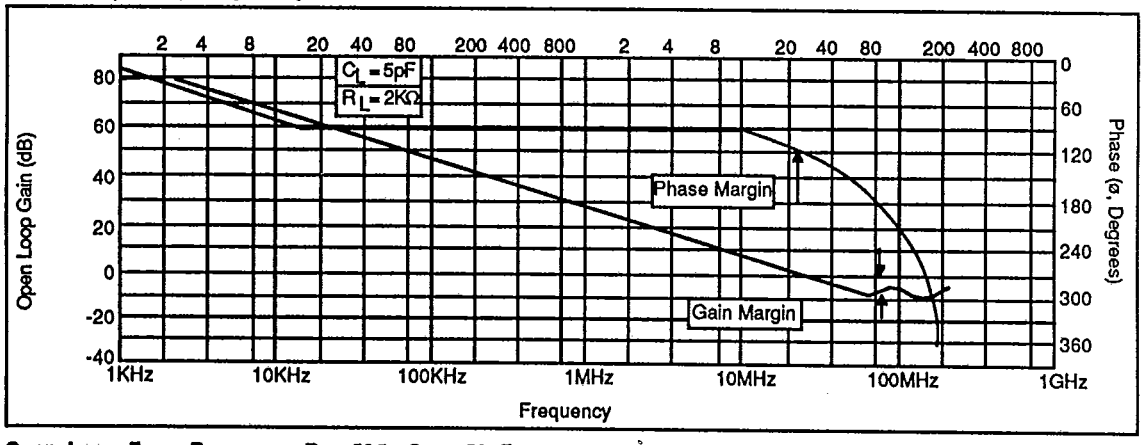
Equivalent Input Noise vs Bandwidth



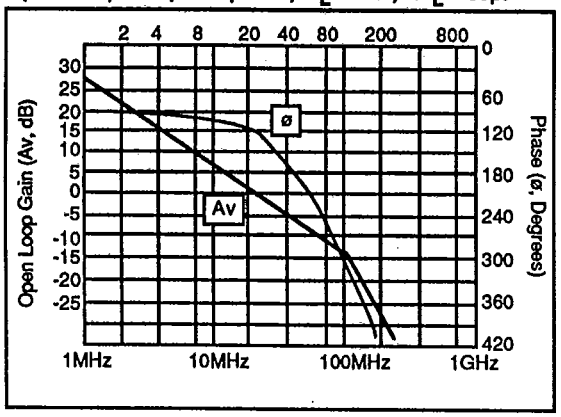
LSP FAMILY DATA SHEETS

TYPICAL PERFORMANCE CHARACTERISTICS (V_S= ±5V, T_A= 25°C unless otherwise stated)

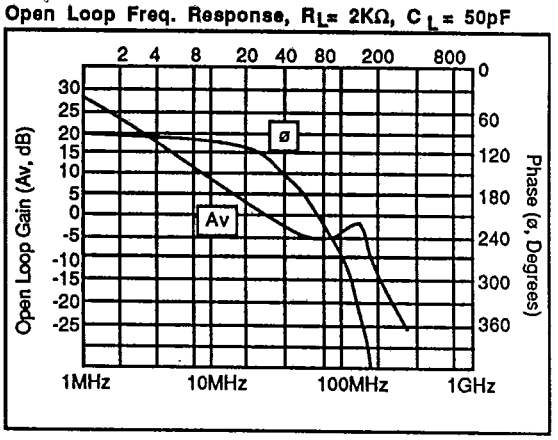
Open Loop Frequency Response



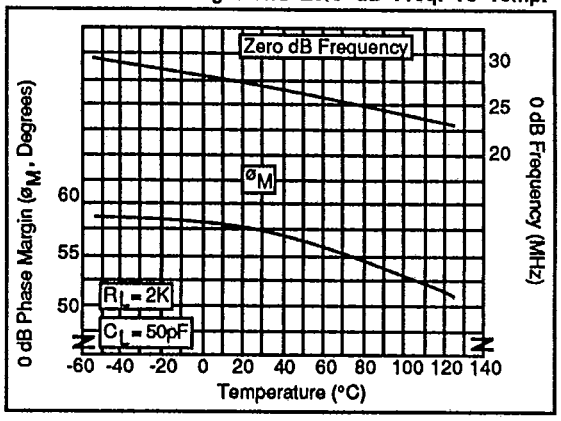
Open Loop Freq. Response, R_L= 50Ω, C_L= 50pF



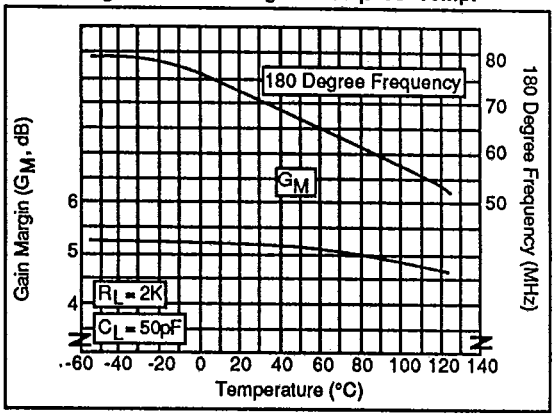
Open Loop Freq. Response, R_L= 2KΩ, C_L= 50pF



Zero dB Phase Margin and Zero dB Freq. vs Temp.



Gain Margin and 180 Degree Freq. vs Temp.



APPLICATION INFORMATION

AC Characteristics

The 28MHz 0dB crossover point of the VA706 is achieved without feed-forward compensation, a technique which can produce long tails in the recovery characteristic. The single pole rolloff follows the classic 20dB/decade slope to frequencies approaching 50MHz. The phase margin of 58°, even with a capacitive load of 50pF, gives stable and predictable performance down to unity gain follower configurations.

At frequencies beyond 50MHz, the 20dB/decade slope is disturbed by an output stage zero, the damping factor of which is dependent upon the load capacitor. This results in loss of gain margin (gain at loop phase = 360°) at frequencies of 70 to 100MHz which at a gain margin of 5dB (R_L = 2k, C_L = 50pF) results in a 10dB peak in the unity gain follower closed loop characteristic (Figure 2).

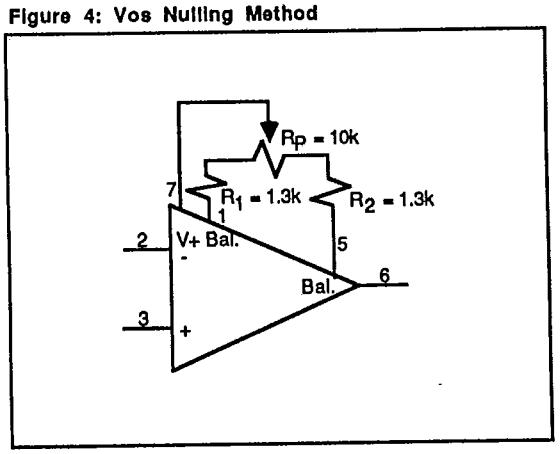
Figure 2 shows a blow up of the open loop characteristics in the 10MHz to 200MHz frequency range as well as the corresponding unity gain follower characteristics at similar load conditions. It is seen that the output stage zero results in bandwidth extension beyond the 28MHz, 0dB crossover point. In fact, with the proper choice of the R_L,C_L load, the unity gain follower can be "tweaked" to give flat small signal response to 100MHz.

Figure 3 shows corresponding time domain response for a small signal step. As expected there is a strong 80MHz ring for R_L = 2kΩ, C_L = 50pF which disappears at R_L = 50Ω, C_L = 5pF.

Offset Voltage Nulling

The configuration of Figure 4 will give a typical V_{OS} nulling range of ±15mV. If a smaller adjustment range is desired, resistor values R1 = R2 can be increased accordingly. For example, at R1 = 3.6kΩ, the adjustment range is ±5mV. Since pins 1 and 5 are not part of the signal path, AC characteristics are left undisturbed.

Figure 4: Vos Nulling Method



Layout Considerations

As with any high-speed wideband amplifier, certain layout considerations are necessary to ensure stable operation. All connections to the amplifier should be kept as short as possible, and the power supplies bypassed with 0.1µF capacitors to signal ground. It is suggested that a ground plane be considered as the best method for ensuring stability because it minimizes stray inductance and unwanted coupling in the ground signal paths.

To minimize capacitive effects, resistor values should be kept as small as possible, consistent with the application.

SIMPLIFIED SCHEMATIC

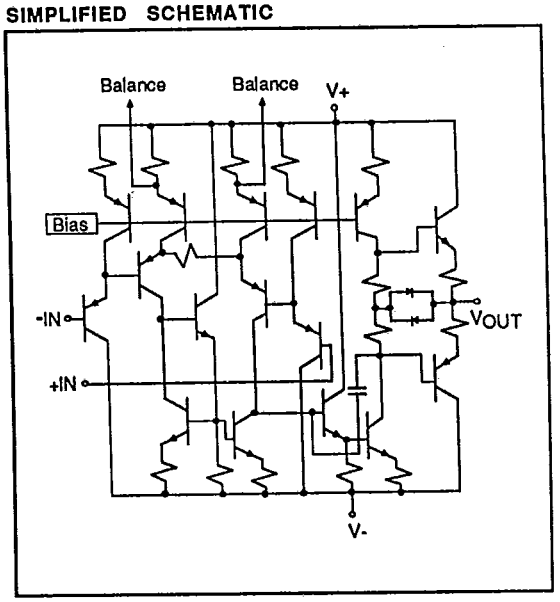


Figure 2: Unity Gain Follower Frequency Characteristics

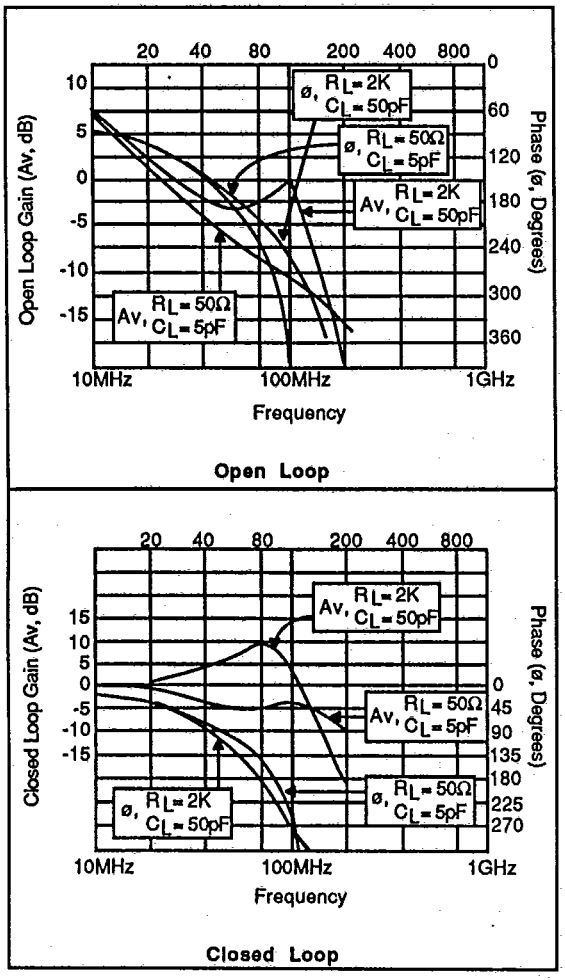
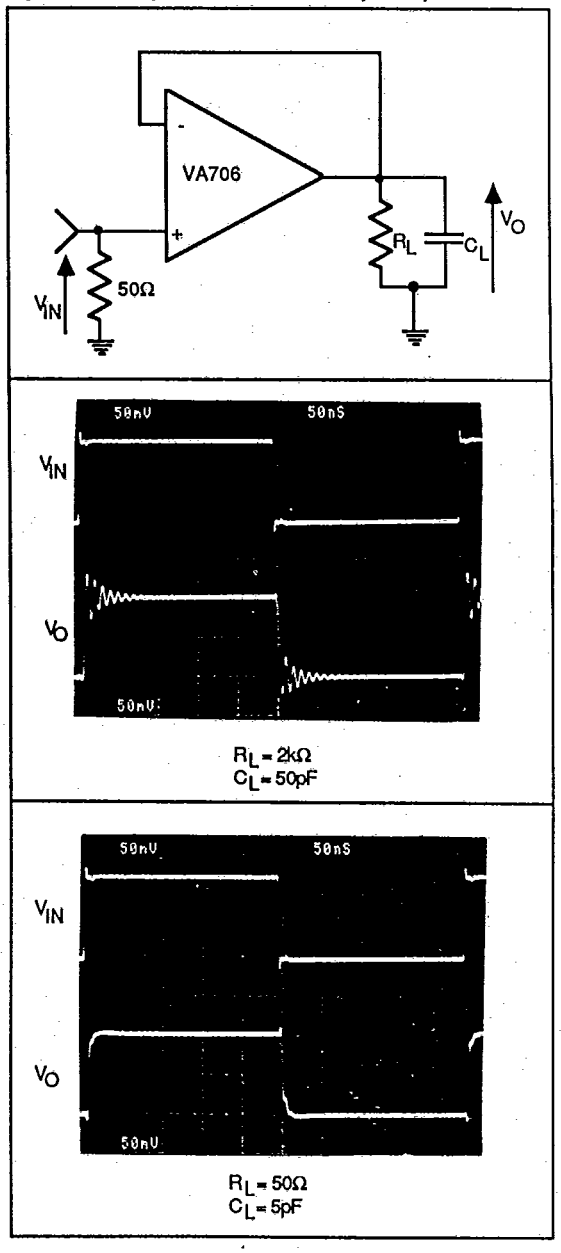


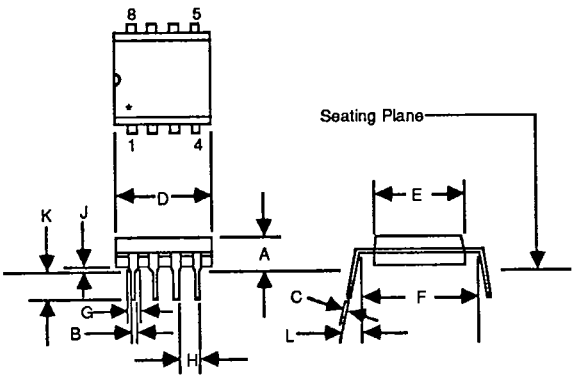
Figure 3: Unity Gain Follower Step Response



PACKAGE DIMENSIONS

8 PIN PLASTIC DIP

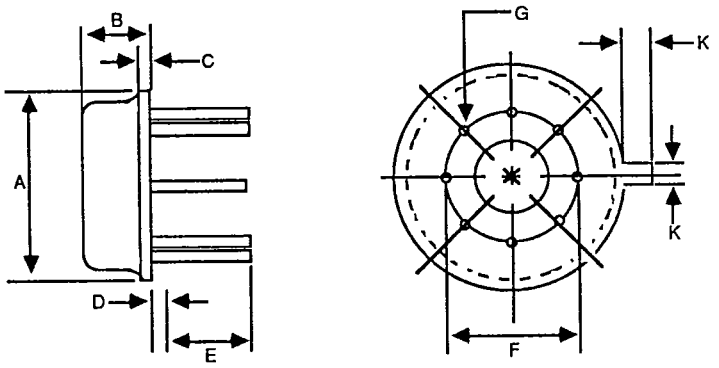
SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	0.148	0.152	3.76	3.86
B	0.016	0.020	0.41	0.51
C	0.008	0.012	0.20	0.30
D	0.370	0.390	9.40	9.91
E	0.245	0.265	6.22	6.73
F	0.290	0.310	7.37	7.87
G	0.050	0.070	1.27	1.78
H	0.090	0.110	2.29	2.79
J	0.128	0.132	3.25	3.35
K	0.020	0.040	0.51	1.02
L	0.030	0.050	0.76	1.27
	0°	15°	0°	15°



*Note: Index area; a notch or a lead one identification mark is located adjacent to lead one.

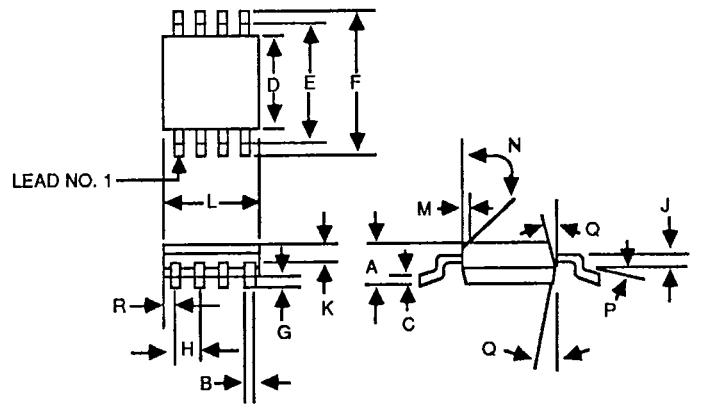
8 PIN METAL CAN

SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.345	.365	8.76	9.27
B	.165	.185	4.19	4.70
C	.020	.040	0.51	1.02
D	.010	.045	0.25	1.14
E	.500	.550	12.70	13.97
F	.200	BSC	5.08	BSC
G	.016	.021	0.41	0.53
J	.027	.045	0.69	1.14
K	.027	.034	0.69	0.86



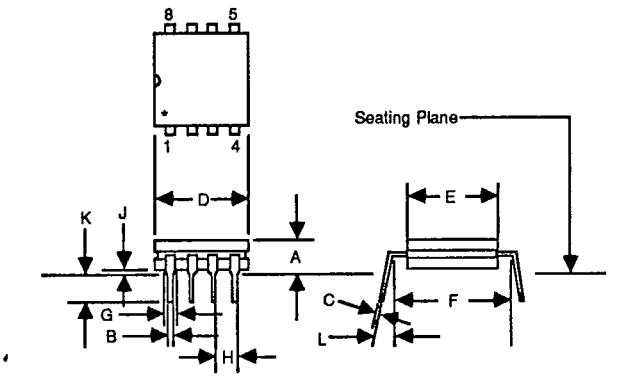
8-PIN SOIC, PLASTIC

SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	.053	.069	1.35	1.75
B	.014	.018	0.35	0.45
C	.007	.009	0.19	0.22
D	.150	.158	3.8	4.0
E	.181	.205	4.6	5.2
F	.228	.244	5.8	6.2
G	.004	.008	0.10	0.20
H	.50	BSC	1.27	BSC
J	.025	.030	0.64	0.77
K	.024	.031	0.61	0.78
L	.188	.197	4.8	5.0
M	.015	BSC	0.37	BSC
N	—	45°	—	45°
P	3°	6°	3°	6°
Q	—	7°	—	7°
R	.019	.022	0.49	0.56



VA706

8 PIN CERAMIC DIP				
SYMBOL	INCHES		MILLIMETERS	
	MIN.	MAX.	MIN.	MAX.
A	——	0.200	——	5.08
B	0.014	0.023	0.36	0.58
C	0.008	0.015	0.20	0.38
D	——	1.060	——	26.92
E	0.220	0.310	5.59	7.87
F	0.290	0.320	7.37	8.13
G	0.030	0.070	0.76	1.78
H	0.090	0.110	2.29	2.79
J	0.015	0.060	0.38	1.52
K	0.125	0.200	3.18	5.08
L	0°	15°	0°	15°



*Note: Index area; a notch or a lead one identification mark is located adjacent to lead one.

ORDERING INFORMATION:

V A 706 ___ J

Additional Processing
Family
Model
Package
Temperature Range/Performance

ADDITIONAL PROCESSING
Blank = No Burn-In B = Burn-In (168 Hours, T_j = 150°C or equivalent)

PACKAGE TYPE
D = Cerdip P = Plastic Dip T = Metal Can X = Die PO = SOIC

TEMPERATURE RANGE/PERFORMANCE
J thru K = Commercial (0° to 70°C)
T = Military (-55°C to +125°C)

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