



HARRIS

10E D 4302271 0012159 3

HA-2650/55**Dual High Performance
Operational Amplifier**

**Not Recommended
For New Designs
See HA-5102
or HA-5152**

Features

- SLEW RATE $5V/\mu s$
- BANDWIDTH 8MHz
- BIAS CURRENT 35nA
- AVG. OFFSET VOLTAGE DRIFT $8\mu V/^\circ C$
- POWER CONSUMPTION 75mW
- SUPPLY VOLTAGE RANGE $\pm 2V$ TO $\pm 20V$

Description

T-79-05-20

HA-2650/2655 contains two internally compensated operational amplifiers offering high slew rate and high frequency performance combined with exceptional DC characteristics. $5V/\mu s$ sec slew rate and 8MHz bandwidth make these amplifiers suitable for processing fast, wideband signals extending into the video frequency spectrum. Signal processing accuracy is enhanced by front-end performance that includes 1.5mV offset voltage, $8\mu V/^\circ C$ offset voltage drift and low offset and bias current (1nA and 35nA respectively). Offset voltage can be trimmed to zero on the devices offered in dual-in-line packages. Signal conditioning is further enhanced by $500M\Omega$ input impedance.

Applications

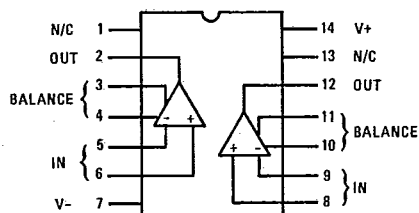
- VIDEO AMPLIFIERS
- HIGH IMPEDANCE, WIDEBAND BUFFERS
- INTEGRATORS
- AUDIO AMPLIFIERS
- ACTIVE FILTERS

Applications for HA-2650/2655 include video circuit designs such as high impedance buffers, integrators, tone generators and filters. These amplifiers are also ideal components for active filtering of audio and voice signals.

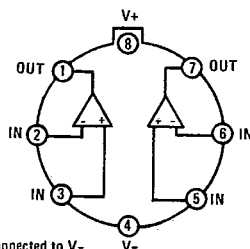
HA-2650/2655 are offered in 14 pin DIP and metal TO-99 packages and are also available in dice form. HA-2650 is specified from $-55^\circ C$ to $+125^\circ C$. HA-2655 operates from $0^\circ C$ to $+75^\circ C$.

Pinouts

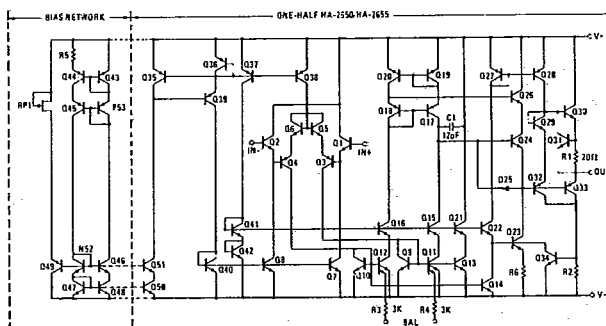
**HA1-2650/2655 (CERAMIC DIP)
TOP VIEW**



**HA2-2650/2655 (TO-99 METAL CAN)
TOP VIEW**



NOTE: Case Connected to V-

Schematic

Specifications HA-2650/2655

T-79-05-20

HARRIS SEMICONDUCTOR

Absolute Maximum Ratings (Note 1)

$T_A = +25^\circ\text{C}$, Unless Otherwise Specified
 Voltage Between V_+ and V_- Terminals 40V
 Differential Input Voltage $\pm 30\text{V}$
 Input Voltage (Note 1) $\pm 15\text{V}$
 Output Short Circuit Duration Indefinite
 Power Dissipation (Note 2)
 TO-99 300mW

Operating Temperature Ranges

HA-2650 $-55^\circ\text{C} \leq T_A \leq +125^\circ\text{C}$
 HA-2655 $0^\circ\text{C} \leq T_A \leq +75^\circ\text{C}$
 Storage Temperature Range: $-65^\circ\text{C} \leq T_A \leq +150^\circ\text{C}$

Electrical Specifications

 $V_+ = +15\text{V D.C.}, V_- = -15\text{V D.C.}$

PARAMETER	TEMP.	HA-2650 -55°C to +125°C			HA-2655 0°C to +75°C			UNITS
		MIN.	TYP.	MAX.	MIN.	TYP.	MAX.	
INPUT CHARACTERISTICS								
Offset Voltage	+25°C		1.5	3		2	5	mV
	Full			5			7	mV
Av. Offset Voltage Drift	Full		8			8		μV/°C
Bias Current	+25°C		35	100		50	200	nA
	Full			200			300	nA
Offset Current	+25°C		1	30		2	60	nA
	Full			60			100	nA
Common Mode Range	Full	±13			±13			V
Differential Input Resistance (Note 9)	+25°C	5	20		5	20		MΩ
Common Mode Input Resistance	+25°C		500			500		MΩ
Input Capacitance	+25°C		5			5		pF
TRANSFER CHARACTERISTICS								
Large Signal Voltage Gain (Note 3a)	+25°C	20K	40K		15K	40K		V/V
	Full	15K			10K			V/V
Common Mode Rejection Ratio (Note 4)	+25°C	80	100		74	100		dB
	Full	80			74			dB
OUTPUT CHARACTERISTICS								
Output Voltage Swing (Note 3c)	+25°C	±13	±14		±13	±14		V
	Full	±13			±13			V
Full Power Bandwidth (Notes 5 & 10)	+25°C	30	80		30	80		KHz
Output Current (Note 3a)	+25°C		±20			±18		mA
Output Resistance	+25°C		100			100		Ω
TRANSIENT RESPONSE (Note 6)								
Rise Time (Note 7)	+25°C		40	80		40	90	ns
Overshoot (Note 7)	+25°C		15	40		15	40	%
Slew Rate	+25°C	±2	±5		±2	±5		V/μs
POWER SUPPLY CHARACTERISTICS								
Supply Current	+25°C		2.5	4		3	5	mA
Power Supply Rejection Ratio (Note 8)	+25°C	80	100		74	100		dB
	Full	80			74			dB

- NOTES: 1. For supply voltages less than $\pm 15\text{V}$, the absolute maximum input voltage is equal to the supply voltage.
 2. Derate at $4.7\text{mW}/^\circ\text{C}$ at ambient temperatures above $+110^\circ\text{C}$.
 3. (a) $V_O = \pm 10\text{V}$ (b) $R_L = 2\text{K}$
 (c) $R_L = 10\text{K}$

4. $V_{CM} = \pm 5.0\text{V}$
 5. $A_V = 1, R_L = 2\text{K}, V_O = 20\text{V}_{pp}$
 6. See transient response/slew rate circuit.
 7. $V_{in} = 200\text{mV}$
 8. $\Delta V = \pm 5.0\text{V}$

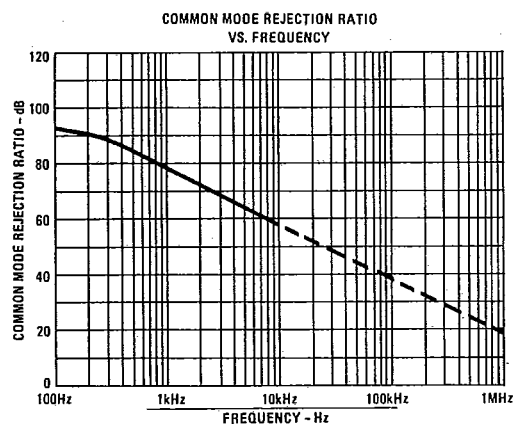
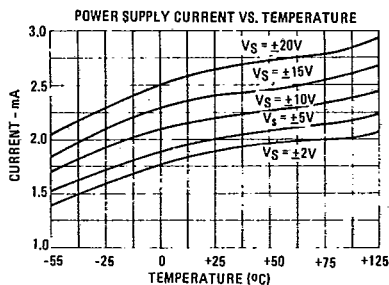
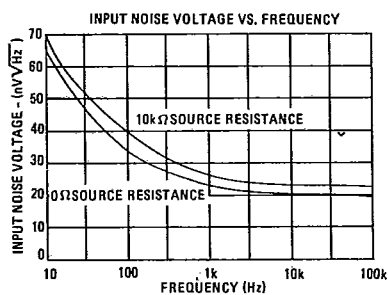
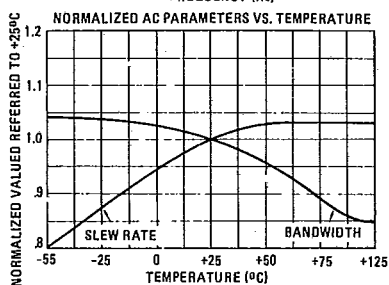
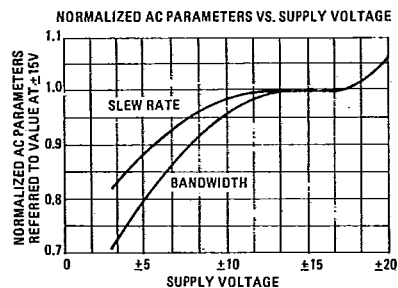
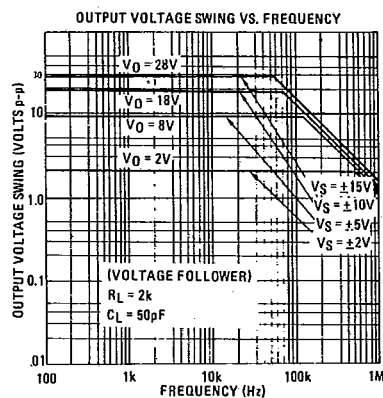
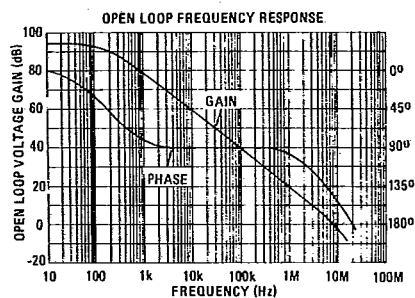
9. This parameter value based upon design calculations.
 10. Full power bandwidth guaranteed based upon slew rate measurement
 $\text{FPBW} = \text{S.R.}/2\pi V_{peak}$

HA-2650/55

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OP AMPS &
COMPARATORS

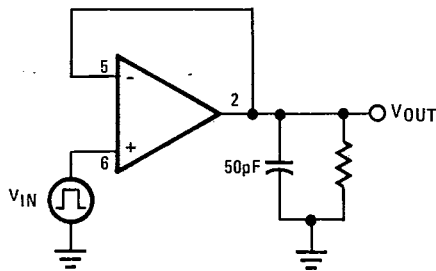
T-79-05-20

Typical Performance Curves $V_+ = +15V$, $V_- = -15V$, $T_A = +25^\circ C$, Unless Otherwise Specified.

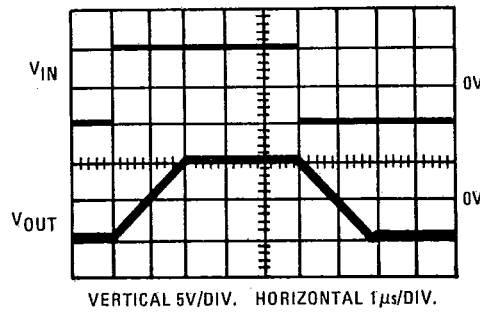
HARRIS SEMICOND SECTOR

Test Circuits

TRANSIENT RESPONSE/SLEW RATE CIRCUIT

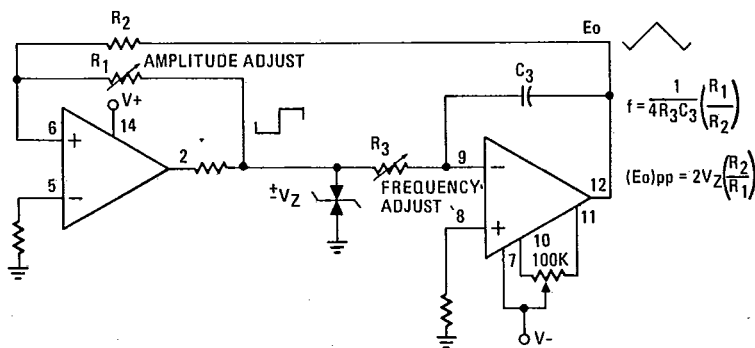


SLEWING WAVEFORM

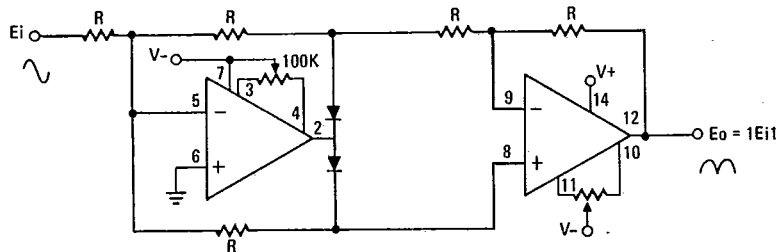


Typical Applications

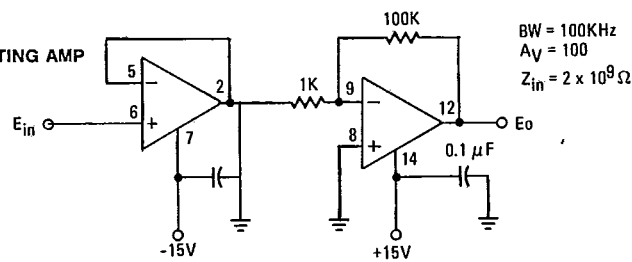
LOW COST HIGH FREQUENCY GENERATOR



ABSOLUTE - VALUE CIRCUIT



HIGH IMPEDANCE
HIGH GAIN
HIGH FREQUENCY INVERTING AMP



HA-2650/55

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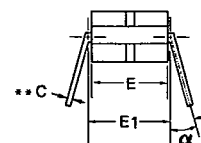
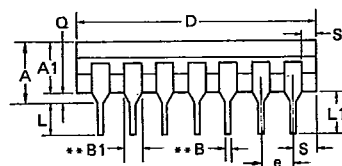
OP AMPS &
COMPARATORS

HARRIS SEMICONDUCTOR

Package Configuration

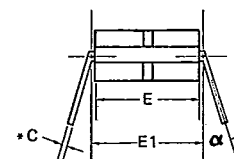
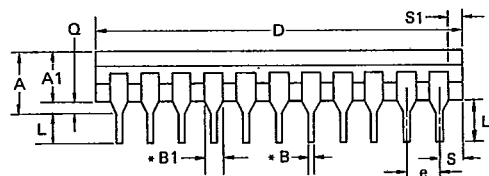
A**B****C****D****E****.300 CERAMIC DUAL-IN-LINE**

T-90-20



PKG. CODE	LEAD COUNT	DIM. A	DIM. A1	DIM. B	DIM. B1	DIM. C	DIM. D	DIM. E	DIM. E1	DIM. e	DIM. L	DIM. L1	DIM. S	DIM. S1	DIM. Q	DIM. α
A	8 SSI	—	.140 .200	.016 .023	.050 .065	.008 .015	.375 .395	.245 .265	.290 .310	.100 BSC	.125 .150	.150 —	— .055	.005 —	.015 .060	0° 15°
B1	14 MSI	—	.140 .170	.016 .023	.050 .065	.008 .015	.753 .785	.265 .285	.290 .310	.100 BSC	.125 .180	.150 —	— .098	.005 —	.015 .060	0° 15°
B2	14 LSI	—	.140 .170	.016 .023	.050 .065	.008 .015	.753 .785	.285 .305	.300 .320	.100 BSC	.125 .180	.150 —	— .098	.005 —	.015 .060	0° 15°
C1	16* MSI	—	.140 .170	.016 .023	.050* .065*	.008 .015	.753 .785	.265 .285	.290 .310	.100 BSC	.125 .180	.150 —	— .080	.005 —	.015 .060	0° 15°
C2	16* LSI	—	.140 .170	.016 .023	.050* .065*	.008 .015	.753 .785	.285 .305	.300 .320	.100 BSC	.125 .180	.150 —	— .080	.005 —	.015 .060	0° 15°
D	18 LSI	—	.140 .170	.016 .023	.050* .065*	.008 .015	.882 .915	.285 .305	.300 .320	.100 BSC	.125 .180	.150 —	— .098	.005 —	.015 .060	0° 15°
E	20 LSI	—	.140 .170	.016 .023	.050* .065*	.008 .015	.940 .970	.285 .305	.300 .320	.100 BSC	.125 .180	.150 —	— .080	.005 —	.015 .060	0° 15°

* End leads are half leads where B remains the same and B1 is 0.035
 ** Solder dip finish add +0.003 inches 0.045

F**.400 CERAMIC DUAL-IN-LINE****G****H****.600 CERAMIC DUAL-IN-LINE**

PKG. CODE	LEAD COUNT	DIM. A	DIM. A1	DIM. B	DIM. B1	DIM. C	DIM. D	DIM. E	DIM. E1	DIM. e	DIM. L	DIM. L1	DIM. S	DIM. S1	DIM. Q	DIM. α
F .400	22 LSI	—	.150 .225	.016 .023	.050 .065	.008 .015	1.055 1.085	.375 .395	.395 .415	.100 BSC	.125 .180	.150 —	— .080	.005 —	.015 .060	0° 15°
G .600	24 LSI	—	.150 .225	.016 .023	.050 .065	.008 .015	1.24 1.27	.515 .535	.595 .615	.100 BSC	.125 .180	.150 —	— .098	.005 —	.015 .060	0° 15°
H .600	26 LSI	—	.160 .225	.016 .023	.050 .065	.008 .015	1.44 1.47	.515 .535	.595 .615	.100 BSC	.125 .180	.150 —	— .098	.005 —	.015 .060	0° 15°

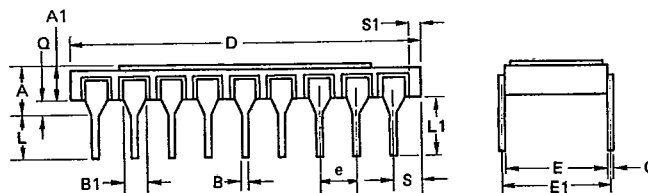
* Solder dip finish add +0.003 inches.

NOTE: Dimensions are $\frac{\text{Min}}{\text{Max}}$ Dimensions are in inches.

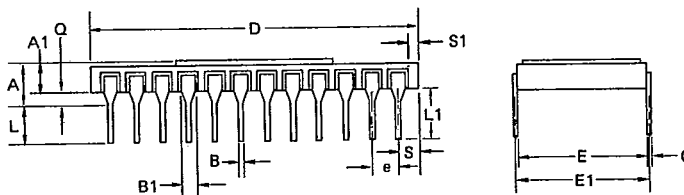
BSC means basic spacing between centerlines.

Package Configuration

T-90-20

I .300 SIDEBRAZE DUAL-IN-LINE

PKG. CODE	LEAD COUNT	DIM. A	DIM. A1	DIM. B	DIM. B1	DIM. C	DIM. D	DIM. E	DIM. E1	DIM. e	DIM. L	DIM. L1	DIM. S	DIM. S1	DIM. Q
I	18	— .200	.080 .110	.016 .023	.045 .060	.008 .015	.890 .910	.280 .300	.290 .310	.100 BSC	.125 .180	.150 —	— .098	.005 —	.025 .045

J K L .600 SIDEBRAZE DUAL-IN-LINE

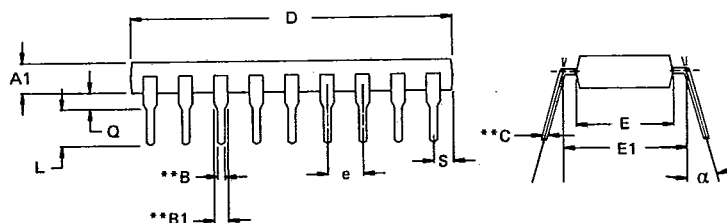
PKG. CODE	LEAD COUNT	DIM. A	DIM. A1	DIM. B	DIM. B1	DIM. C	DIM. D	DIM. E	DIM. E1	DIM. e	DIM. L	DIM. L1	DIM. S	DIM. S1	DIM. Q
J	24	— .225	.080 .110	.016 .023	.040 .054	.008 .015	1.185 1.215	.587 .603	.598 .612	.100 BSC	.125 .180	.150 —	— .080	.005 —	.040 .060
K	28	— .225	.080 .110	.016 .023	.040 .054	.008 .015	1.385 1.415	.587 .603	.598 .612	.100 BSC	.125 .180	.150 —	— .080	.005 —	.030 .060
L	40	— .225	.080 .110	.016 .023	.040 .054	.008 .015	1.980 2.020	.587 .603	.598 .612	.100 BSC	.125 .180	.150 —	— .080	.005 —	.040 .060

NOTE: Dimensions are $\frac{\text{Min.}}{\text{Max}}$. Dimensions are in inches.

BSC means basic spacing between centerlines.

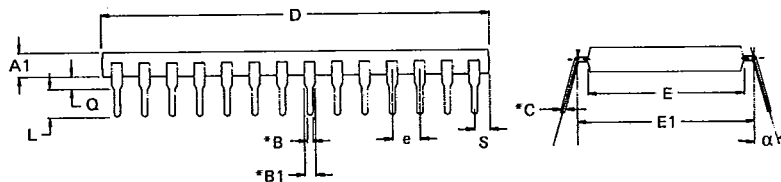
Package Configuration

T-90-20

M N O P Q .300 PLASTIC DUAL-IN-LINE

PKG. CODE	LEAD COUNT	DIM. A1	DIM. B	DIM. B1	DIM. C	DIM. D	DIM. E	DIM. E1	DIM. e	DIM. L	DIM. S	DIM. Q	DIM. α
M	8	.125 .140	.016 .023	.050 .070	.008 .015	.370 .390	.245 .265	.290 .310	.090 .110	.110 .150	.030 .050	.020 .040	0° 15°
N	14	.125 .140	.016 .023	.050 .070	.008 .015	.750 .770	.245 .265	.290 .310	.090 .110	.110 .150	.030 .050	.020 .040	0° 15°
O	16*	.125 .140	.016 .023	.050 .070	.008 .015	.750 .770	.245 .265	.290 .310	.090 .110	.110 .150	.025 .035	.020 .040	0° 15°
P	18	.125 .140	.016 .023	.050 .070	.008 .015	.900 .920	.245 .265	.290 .310	.090 .110	.110 .150	.040 .060	.020 .040	0° 15°
Q	20	.130 .145	.016 .023	.050 .070	.008 .015	1.030 1.050	.250 .270	.290 .310	.090 .110	.110 .150	.060 .080	.020 .040	0° 15°

* End leads are half leads where B remains the same and B1 is $\frac{0.035}{0.045}$
 ** Solder dip finish add 0.003 inches.

R S .600 PLASTIC DUAL-IN-LINE

PKG. CODE	LEAD COUNT	DIM. A1	DIM. B	DIM. B1	DIM. C	DIM. D	DIM. E	DIM. E1	DIM. e	DIM. L	DIM. S	DIM. Q	DIM. α
R	24	.145 .155	.016 .023	.050 .070	.008 .015	1.24 1.26	.540 .560	.590 .610	.090 .110	.110 .150	.045 .095	.020 .040	0° 15°
S	28	.145 .155	.016 .023	.050 .070	.008 .015	1.54 1.57	.540 .560	.590 .610	.090 .110	.110 .150	.110 .160	.020 .040	0° 15°

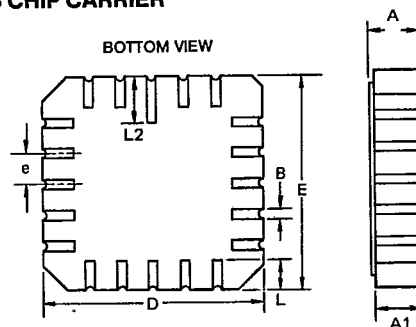
* Solder dip finish add 0.003 inches.

NOTE: Dimensions are $\frac{\text{Min}}{\text{Max}}$. Dimensions are in inches.

BSC means basic spacing between centerlines.

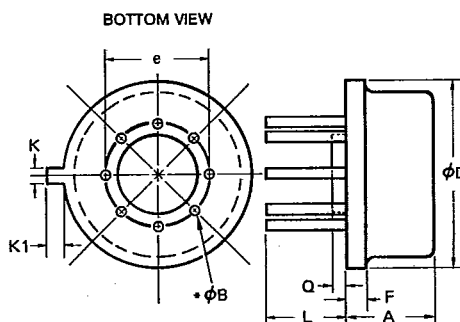
Package Configuration

T-90-20

T .350 CERAMIC LEADLESS CHIP CARRIER***U** .450 CERAMIC LEADLESS CHIP CARRIER***V** .650 CERAMIC LEADLESS CHIP CARRIER*

PKG. CODE	LEAD COUNT	DIM. A	DIM. A1	DIM. B	DIM. D	DIM. E	DIM. e	DIM. L	DIM. L2
T	20 .350 SQ	.073 .089	.063 .077	.022 .028	.342 .358	.342 .358	.050 BSC	.045 .055	.075 .095
U	28 .450 SQ	.074 .088	.064 .076	.022 .028	.442 .458	.442 .458	.050 BSC	.045 .055	.075 .095
V	44 .650 SQ	.073 .089	.063 .077	.022 .028	.643 .662	.643 .662	.050 BSC	.045 .055	.075 .095

* Solder dip finish for military parts conform to MIL-M-38510, Type A.

W TO-99 METAL CAN**X** TO-100 METAL CAN

PKG. CODE	LEAD COUNT	DIM. A	DIM. phi B	DIM. phi D	DIM. e	DIM. F	DIM. K	DIM. K1	DIM. L	DIM. Q
W	8 TO-99	.165 .185	.016 .018	.345 .365	.190 .210	.020 .040	.028 .034	.028 .040	.505 .550	.015 .040
X	10 TO-100	.165 .185	.016 .018	.345 .365	.220 .240	.020 .040	.028 .034	.028 .040	.505 .550	.015 .040

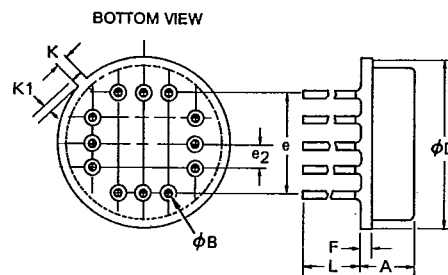
* Solder dip finish add +0.003 inches.

NOTE: Dimensions are $\frac{\text{Min}}{\text{Max}}$. Dimensions are in inches.

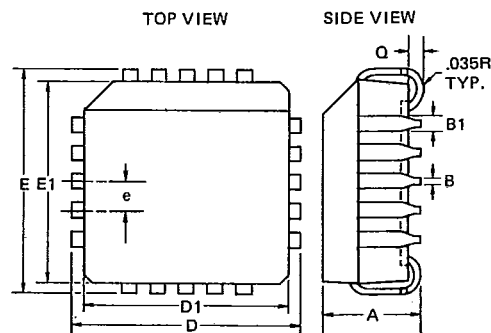
BSC means basic spacing between centerlines.

Package Configuration

T-90-20

Y TO-8 METAL CAN

PKG. CODE	LEAD COUNT	DIM. A	DIM. phi B	DIM. phi D	DIM. e	DIM. e2	DIM. F	DIM. K	DIM. K1	DIM. L
Y	12 TO-8	.130 .150	.016 .021	.585 .615	.400 BSC	.100 BSC	.020 .040	.027 .034	.027 .045	.500 .550

AA AB AC PLASTIC LEADED CHIP CARRIER

PKG. CODE	LEAD COUNT	DIM. A	DIM. B	DIM. B1	DIM. D/E	DIM. D1/E1	DIM. e	DIM. Q
AA	20	.165 .180	.013 .021	.026 .032	.385 .395	.350 .356	.050 BSC	.020 —
AB	28	.165 .180	.013 .021	.026 .032	.485 .495	.450 .456	.050 BSC	.020 —
AC	44	.165 .180	.013 .021	.026 .032	.685 .695	.650 .656	.050 BSC	.020 —

NOTE: Dimensions are $\frac{\text{Min}}{\text{Max}}$. Dimensions are in inches.

BSC means basic spacing between centerlines.