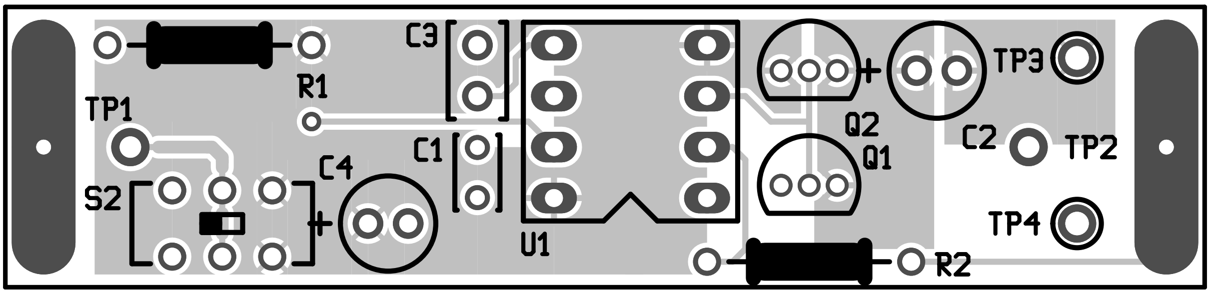


Open Source Remix of Drawdio

A Pencil that Lets You Draw Music

(* jcl *)

What is Drawdio?

Imagine you could draw musical instruments on normal paper with any pencil (cheap circuit thumb-tacked on) and then play them with your finger. The Drawdio circuit-craft lets you MacGuyver your everyday objects into musical instruments: paintbrushes, macaroni, trees, grandpa, even the kitchen sink...

Drawdio brings to life the everyday interconnections between people and environment, encouraging you to use your sense of touch, and letting you hear otherwise invisible electrical connections by creating, remixing, and playing.

How Can I Participate?

Built it on your own or build it from a kit then modify it, remix it, and invent with it.

Open Source EDA Tools

This remix of Drawdio was done using the open source gEDA/PCB tool. Information about my parts library and EDA automation tools is available here.

You can't create open hardware with closed EDA tools

This design is not proven, tested or done. All non-catastrophic infelicities are mistakes.
Catastrophic infelicities are just plain fun.

This document sure does look pretty. Thanks D.E.K.

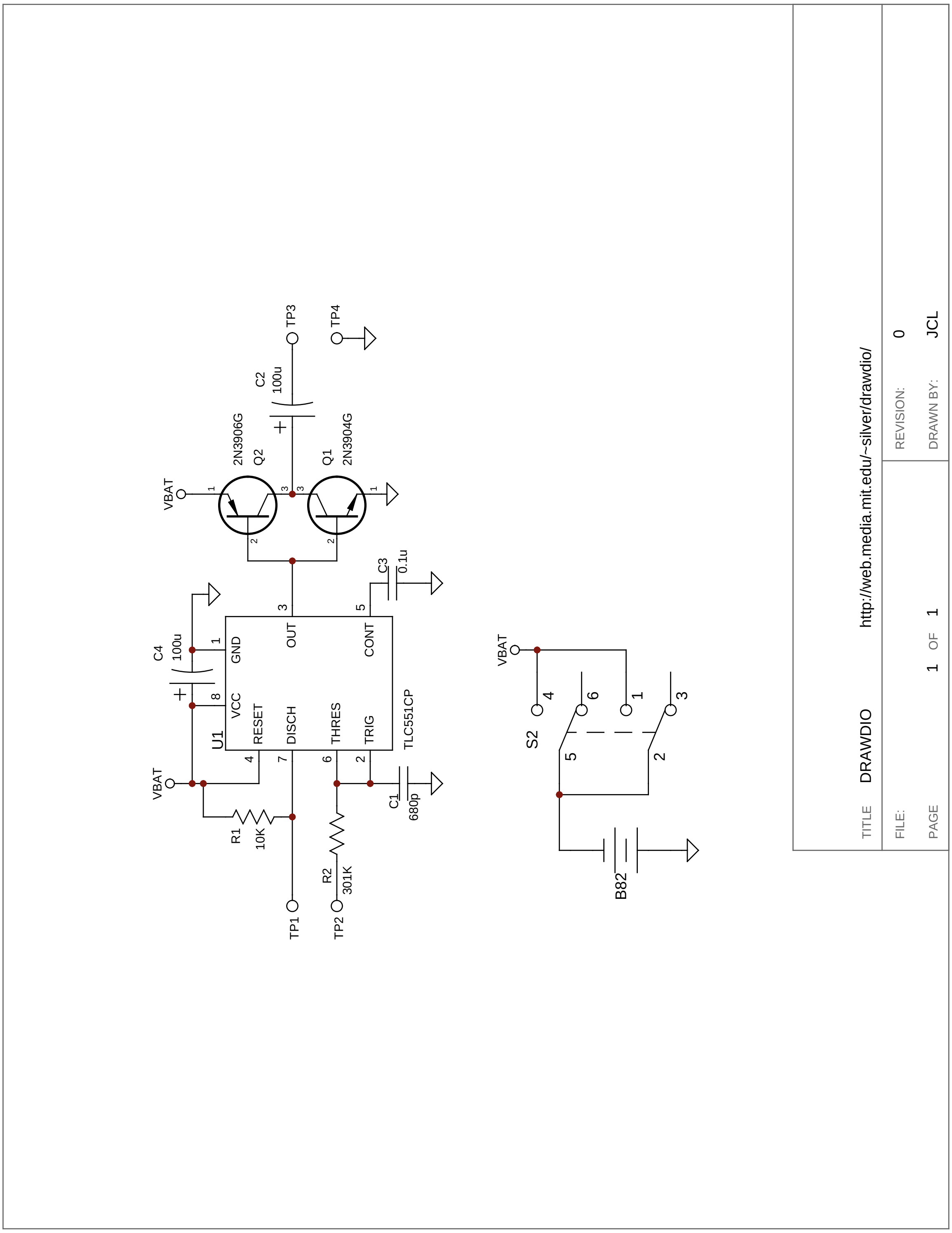


Figure 1: Drawdio Schematic

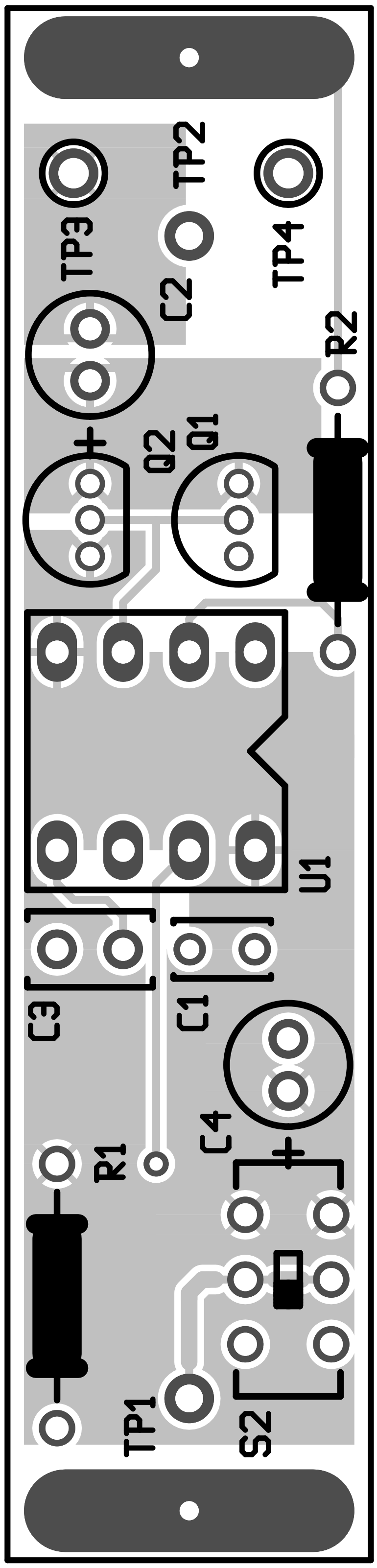


Figure 2: Drawdio PCB Layout

1 Bill of Materials

Table 1: Bill of Materials

Qty	Reference	Value	Footprint	Mfg PN	Notes
1	B82			Keystone 2466	
1	C1	680p		Vishay K681K15X7RF5TL2	
2	C2, C4	100u		Nichicon UVR1C101MDD	
1	C3	0.1u		Kemet C320C104K5R5TA	
1	Q1			On-Semi 2N3904G	
1	Q2			On-Semi 2N3906G	
1	R1	10K		Yageo MFR-25FBF-10K0	
1	R2	301K		Yageo MFR-25FBF-301K	
1	S2			CK JS202011CQN	
4	TP1, TP2, TP3, TP4			Vector K24A	
1	U1			TI TLC551CP	

Table 2: Component List

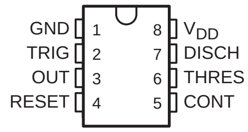
Reference	Value	Footprint	Mfg PN	Notes
B82			Keystone 2466	
C1	680p		Vishay K681K15X7RF5TL2	
C2	100u		Nichicon UVR1C101MDD	
C3	0.1u		Kemet C320C104K5R5TA	
C4	100u		Nichicon UVR1C101MDD	
Q1			On-Semi 2N3904G	
Q2			On-Semi 2N3906G	
R1	10K		Yageo MFR-25FBF-10K0	
R2	301K		Yageo MFR-25FBF-301K	
S2			CK JS202011CQN	
TP1			Vector K24A	
TP2			Vector K24A	
TP3			Vector K24A	
TP4			Vector K24A	
U1			TI TLC551CP	

Preliminary

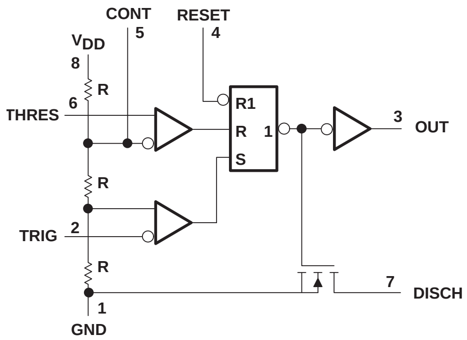
U1

- **Very Low Power Consumption**
  1 mW Typ at V_{DD} = 5 V
- **Capable of Operation in Astable Mode**
- **CMOS Output Capable of Swinging Rail to Rail**
- **High Output-Current Capability**
  Sink 100 mA Typ
  Source 10 mA Typ
- **Output Fully Compatible With CMOS, TTL, and MOS**
- **Low Supply Current Reduces Spikes During Output Transitions**
- **Single-Supply Operation From 1 V to 15 V**
- **Functionally Interchangeable With the NE555; Has Same Pinout**
- **ESD Protection Exceeds 2000 V Per MIL-STD-883C, Method 3015.2**

D, DB, P, OR PW PACKAGE
(TOP VIEW)



functional block diagram



RESET can override TRIG, which can override THRES.

description

The TLC551 is a monolithic timing circuit fabricated using the TI LinCMOS™ process. The timer is fully compatible with CMOS, TTL, and MOS logic and operates at frequencies up to 2 MHz. Compared to the NE555 timer, this device uses smaller timing capacitors because of its high input impedance. As a result, more accurate time delays and oscillations are possible. Power consumption is low across the full range of power supply voltage.

Like the NE555, the TLC551 has a trigger level equal to approximately one-third of the supply voltage and a threshold level equal to approximately two-thirds of the supply voltage. These levels can be altered by use of the control voltage terminal (CONT). When the trigger input (TRIG) falls below the trigger level, the flip-flop is set and the output goes high. If TRIG is above the trigger level and the threshold input (THRES) is above the threshold level, the flip-flop is reset and the output is low. The reset input (RESET) can override all other inputs and can be used to initiate a new timing cycle. If RESET is low, the flip-flop is reset and the output is low. Whenever the output is low, a low-impedance path is provided between DISCH and GND. All unused inputs should be tied to an appropriate logic level to prevent false triggering.

While the CMOS output is capable of sinking over 100 mA and sourcing over 10 mA, the TLC551 exhibits greatly reduced supply-current spikes during output transitions. This minimizes the need for the large decoupling capacitors required by the NE555.

The TLC551C is characterized for operation from 0°C to 70°C.

This device contains circuits to protect its inputs and outputs against damage due to high static voltages or electrostatic fields. These circuits have been qualified to protect this device against electrostatic discharges (ESD) of up to 2 kV according to MIL-STD-883C, Method 3015; however, it is advised that precautions be taken to avoid application of any voltage higher than maximum-rated voltages to these high-impedance circuits. During storage or handling, the device leads should be shorted together or the device should be placed in conductive foam. In a circuit, unused inputs should always be connected to an appropriated logic voltage level, preferably either supply voltage or ground. Specific guidelines for handling devices of this type are contained in the publication *Guidelines for Handling Electrostatic-Discharge-Sensitive (ESDS) Devices and Assemblies* available from Texas Instruments.

LinCMOS is a trademark of Texas Instruments Incorporated.

AVAILABLE OPTIONS

	PACKAGED DEVICES					CHIP FORM (Y)
T_A	V_{DD} RANGE	SMALL OUTLINE (D)	SSOP (DB)	PLASTIC DIP (P)	TSSOP (PW)	
0°C to 70°C	1 V to 16 V	TLC551CD	TLC551CDBLE	TLC551CP	TLC551CPWLE	TLC551Y

The D package is available taped and reeled. Add the suffix R (e.g., TLC551CDR). The DB and PW packages are only available left-end taped and reeled (indicated by the LE suffix on the device type; e.g., TLC551CDBLE). Chips are tested at 25°C.

FUNCTION TABLE

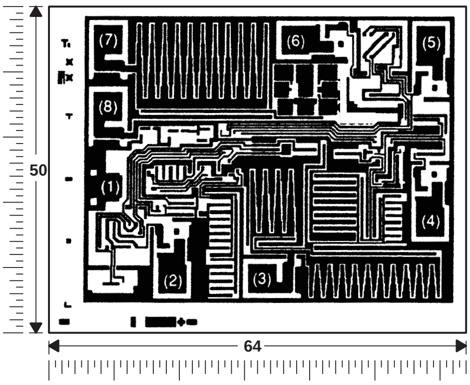
RESET VOLTAGE†	TRIGGER VOLTAGE†	THRESHOLD VOLTAGE†	OUTPUT	DISCHARGE SWITCH
<MIN	Irrelevant	Irrelevant	Low	On
>MAX	<MIN	Irrelevant	High	Off
>MAX	>MAX	>MAX	Low	On
>MAX	>MAX	<MIN	As previously established	

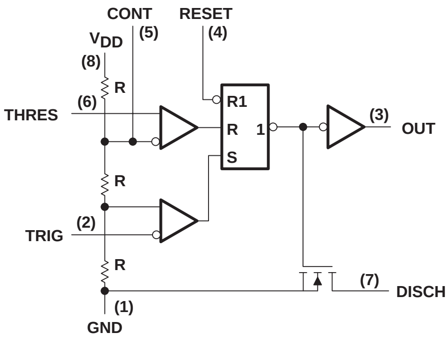
† For conditions shown as MIN or MAX, use the appropriate value specified under electrical characteristics.

TLC551Y chip information

This chip, when properly assembled, displays characteristics similar to the TLC551. Thermal compression or ultrasonic bonding may be used on the doped aluminum bonding pads. Chips may be mounted with conductive epoxy or a gold-silicon preform.

BONDING PAD ASSIGNMENTS





RESET can override TRIG, which can override THRES.

CHIP THICKNESS: 15 TYPICAL

BONDING PADS: 4 × 4 MINIMUM

$T_J$max = 150°C

TOLERANCES ARE ±10%.

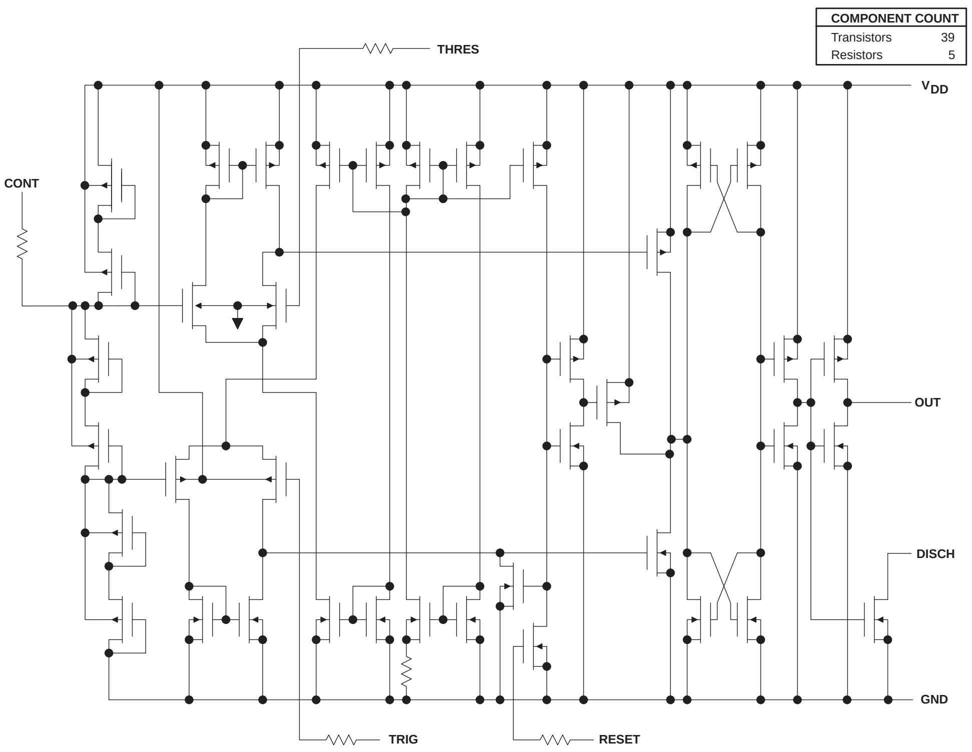
ALL DIMENSIONS ARE IN MILS.

PIN (1) IS INTERNALLY CONNECTED TO BACKSIDE OF CHIP.

Preliminary

U1

equivalent schematic



absolute maximum ratings over operating free-air temperature range (unless otherwise noted)†

Supply voltage, V_{DD} (see Note 1)	18 V
Input voltage range, V_I (any input)	–0.3 to V_{DD}
Sink current, discharge or output	150 mA
Source current, output, I_O	15 mA
Continuous total power dissipation	See Dissipation Rating Table
Operating free-air temperature range	0°C to 70°C
Storage temperature range	–65°C to 150°C
Lead temperature 1,6 mm (1/16 inch) from case for 10 seconds	260°C

† Stresses beyond those listed under “absolute maximum ratings” may cause permanent damage to the device. These are stress ratings only, and functional operation of the device at these or any other conditions beyond those indicated under “recommended operating conditions” is not implied. Exposure to absolute-maximum-rated conditions for extended periods may affect device reliability.

NOTE 1: All voltage values are with respect to network GND.

DISSIPATION RATING TABLE

PACKAGE	$T_A \le 25°C$ POWER RATING	DERATING FACTOR ABOVE $T_A = 25°C$	$T_A = 70°C$ POWER RATING
D	725 mW	5.8 mW/°C	464 mW
DB	525 mW	4.2 mW/°C	336 mW
P	1000 mW	8.0 mW/°C	640 mW
PW	525 mW	4.2 mW/°C	336 mW

recommended operating conditions

	MIN	MAX	UNIT
Supply voltage, V_{DD}	1	15	V
Operating free-air temperature range, T_A	0	70	°C

electrical characteristics at specified free-air temperature, V_{DD} = 1 V

PARAMETER		TEST CONDITIONS	T_A†	MIN	TYP	MAX	UNIT
V_{IT}	Threshold voltage		25°C	0.475	0.67	0.85	V
			Full range	0.45		0.875	
I_{IT}	Threshold current		25°C		10		pA
			70°C		75		
$V_{I(TRIG)}$	Trigger voltage		25°C	0.15	0.33	0.425	V
			Full range	0.1		0.45	
$I_{I(TRIG)}$	Trigger current		25°C		10		pA
			70°C		75		
$V_{I(RESET)}$	Reset voltage		25°C	0.4	0.7	1	V
			Full range	0.3		1	
$I_{I(RESET)}$	Reset current		25°C		10		pA
			70°C		75		
	Control voltage (open circuit) as a percentage of supply voltage		70°C		66.7%		
	Discharge switch on-stage voltage	I_{OL} = 100 µA	25°C		0.02	0.15	V
			Full range			0.2	
	Discharge switch off-stage voltage		25°C		0.1		nA
			70°C		0.5		
V_{OH}	High-level output voltage	I_{OH} = –10 µA	25°C	0.6	0.98		V
			Full range	0.6			
V_{OL}	Low-level output voltage	I_{OL} = 100 µA	25°C		0.03	0.2	V
			Full range			0.25	
I_{DD}	Supply current	See Note 2	25°C		15	100	µA
			Full range			150	

† Full range is 0°C to 70°C.

NOTE 2: These values apply for the expected operating configurations in which THRES is connected directly to DISCH or to TRIG.

electrical characteristics at specified free-air temperature, V_{DD} = 2 V

PARAMETER		TEST CONDITIONS	T_A†	MIN	TYP	MAX	UNIT
V_{IT}	Threshold voltage		25°C	0.95	1.33	1.65	V
			Full range	0.85		1.75	
I_{IT}	Threshold current		25°C		10		pA
			70°C		75		
$V_{I(TRIG)}$	Trigger voltage		25°C	0.4	0.67	0.95	V
			Full range	0.3		1.05	
$I_{I(TRIG)}$	Trigger current		25°C		10		pA
			70°C		75		
$V_{I(RESET)}$	Reset voltage		25°C	0.4	1.1	1.5	V
			Full range	0.3		1.8	
$I_{I(RESET)}$	Reset current		25°C		10		pA
			70°C		75		
	Control voltage (open circuit) as a percentage of supply voltage		70°C		66.7%		
	Discharge switch on-stage voltage	I_{OL} = 1 mA	25°C		0.03	0.2	V
			Full range			0.25	
	Discharge switch off-stage voltage		25°C		0.1		nA
			70°C		0.5		
V_{OH}	High-level output voltage	I_{OH} = –300 µA	25°C	1.5	1.9		V
			Full range	1.5			
V_{OL}	Low-level output voltage	I_{OL} = 1 mA	25°C		0.07	0.3	V
			Full range			0.35	
I_{DD}	Supply current	See Note 2	25°C		65	250	µA
			Full range			400	

† Full range is 0°C to 70°C.

NOTE 2: These values apply for the expected operating configurations in which THRES is connected directly to DISCH or to TRIG.

electrical characteristics at specified free-air temperature, V_{DD} = 5 V

PARAMETER		TEST CONDITIONS	T_A†	MIN	TYP	MAX	UNIT
V_{IT}	Threshold voltage		25°C	2.8	3.3	3.8	V
			Full range	2.7		3.9	
I_{IT}	Threshold current		25°C		10		pA
			70°C		75		
$V_{I(TRIG)}$	Trigger voltage		25°C	1.36	1.66	1.96	V
			Full range	1.26		2.06	
$I_{I(TRIG)}$	Trigger current		25°C		10		pA
			70°C		75		
$V_{I(RESET)}$	Reset voltage		25°C	0.4	1.1	1.5	V
			Full range	0.3		1.8	
$I_{I(RESET)}$	Reset current		25°C		10		pA
			70°C		75		
	Control voltage (open circuit) as a percentage of supply voltage		70°C		66.7%		
	Discharge switch on-stage voltage	I_{OL} = 10 mA	25°C		0.14	0.5	V
			Full range			0.6	
	Discharge switch off-stage voltage		25°C		0.1		nA
			70°C		0.5		
V_{OH}	High-level output voltage	I_{OH} = –1 mA	25°C	4.1	4.8		V
			Full range	4.1			
V_{OL}	Low-level output voltage	I_{OL} = 8 mA	25°C		0.21	0.4	V
			Full range			0.5	
		I_{OL} = 5 mA	25°C		0.13	0.3	
			Full range			0.4	
		I_{OL} = 3.2 mA	25°C		0.08	0.3	
			Full range			0.35	
I_{DD}	Supply current	See Note 2	25°C		170	350	µA
			Full range			500	

† Full range is 0°C to 70°C.

NOTE 2: These values apply for the expected operating configurations in which THRES is connected directly to DISCH or to TRIG.

U1

electrical characteristics at specified free-air temperature, V_{DD} = 15 V

PARAMETER		TEST CONDITIONS	T_A†	MIN	TYP	MAX	UNIT
V_{IT}	Threshold voltage		25°C	9.45		10.55	V
			Full range	9.35		10.65	
I_{IT}	Threshold current		25°C		10		pA
			70°C		75		
$V_{I(TRIG)}$	Trigger voltage		25°C	4.65	5	5.35	V
			Full range	4.55		5.45	
$I_{I(TRIG)}$	Trigger current		25°C		10		pA
			70°C		75		
$V_{I(RESET)}$	Reset voltage		25°C	0.4	1.1	1.5	V
			Full range	0.3		1.8	
$I_{I(RESET)}$	Reset current		25°C		10		pA
			70°C		75		
	Control voltage (open circuit) as a percentage of supply voltage		70°C		66.7%		
	Discharge switch on-stage voltage	I_{OL} = 100 mA	25°C		0.77	1.7	V
			Full range			1.8	
	Discharge switch off-stage voltage		25°C		0.1		nA
			70°C		0.5		
V_{OH}	High-level output voltage	I_{OH} = –10 mA	25°C	12.5	14.2		V
			Full range	12.5			
		I_{OH} = –5 mA	25°C	13.5	14.6		
			Full range	13.5			
		I_{OH} = –1 mA	25°C	14.2	14.9		
			Full range	14.2			
V_{OL}	Low-level output voltage	I_{OL} = 100 mA	25°C		1.28	3.2	V
			Full range			3.6	
		I_{OL} = 50 mA	25°C		0.63	1	
			Full range			1.3	
		I_{OL} = 10 mA	25°C		0.12	0.3	
			Full range			0.4	
I_{DD}	Supply current	See Note 2	25°C		360	600	µA
			Full range			800	

† Full range is 0°C to 70°C.
NOTE 2: These values apply for the expected operating configurations in which THRES is connected directly to DISCH or to TRIG.

operating characteristics, V_{DD} = 5 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS		MIN	TYP	MAX	UNIT
	Initial error of timing interval‡	V_{DD} = 5 V to 15 V, C_T = 0.1 µF,	$R_A = R_B$ = 1 kΩ to 100 kΩ, See Note 3		1%	3%	
	Supply voltage sensitivity of timing interval				0.1	0.5	%/V
t_r	Rise time, output pulse	R_L = 10 MΩ,	C_L = 10 pF		20	75	ns
t_f	Fall time, output pulse				15	60	
f_{max}	Maximum frequency in astable mode	R_A = 470 Ω, C_T = 200 pF	R_B = 200 Ω, See Note 3	1.2	1.8		MHz

‡ Timing interval error is defined as the difference between the measured value and the average value of a random sample from each process run.
NOTE 3: R_A, R_B, and C_T are as defined in Figure 3.

electrical characteristics at V_{DD} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
V_{IT}	Threshold voltage		2.8	3.3	3.8	V
I_{IT}	Threshold current			10		pA
$V_{I(TRIG)}$	Trigger voltage		1.36	1.66	1.96	V
$I_{I(TRIG)}$	Trigger current			10		pA
$V_{I(RESET)}$	Reset voltage		0.4	1.1	1.5	V
$I_{I(RESET)}$	Reset current			10		pA
	Control voltage (open circuit) as a percentage of supply voltage			66.7%		
	Discharge switch on-state voltage	I_{OL} = 10 mA		0.14	0.5	V
	Discharge switch off-state current			0.1		nA
V_{OH}	High-level output voltage	I_{OH} = – 1 mA	4.1	4.8		V
V_{OL}	Low-level output voltage	I_{OL} = 8 mA		0.21	0.4	V
		I_{OL} = 5 mA		0.13	0.3	
		I_{OL} = 3.2 mA		0.08	0.3	
I_{DD}	Supply current	See Note 2		170	350	µA

NOTE 2: These values apply for the expected operating configurations in which THRES is connected directly to DISCH or to TRIG.

TYPICAL CHARACTERISTICS

DISCHARGE SWITCH ON-STATE RESISTANCE
vs
FREE-AIR TEMPERATURE

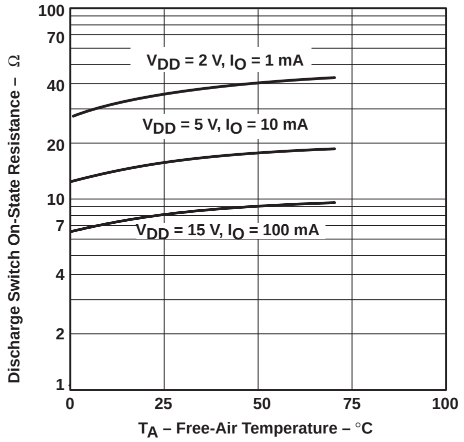
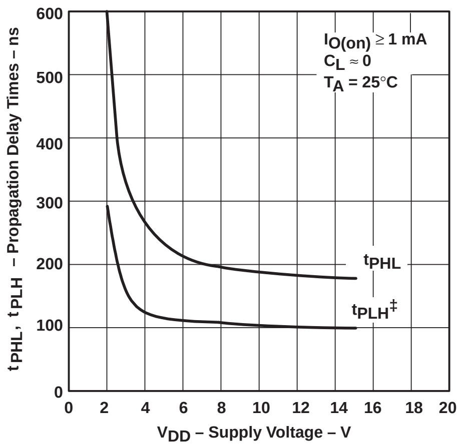


Figure 1

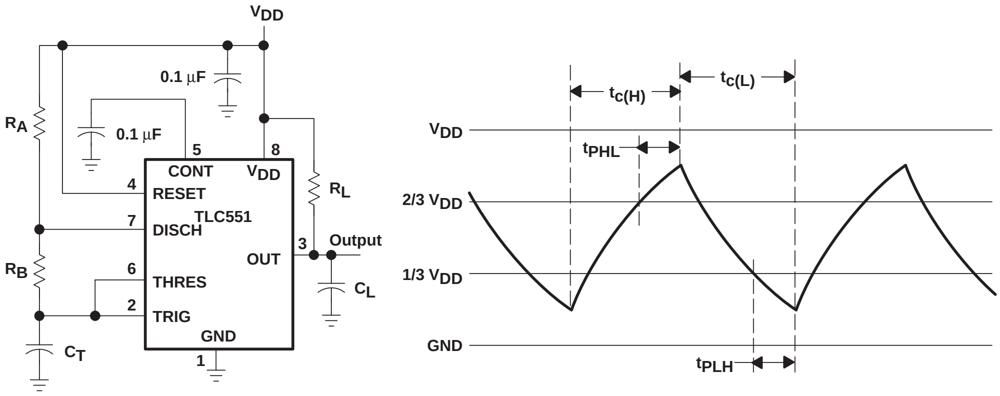
PROPAGATION DELAY TIMES (TO DISCHARGE OUTPUT FROM TRIGGER AND THRESHOLD SHORTED TOGETHER)
vs
SUPPLY VOLTAGE



‡ The effects of the load resistance on these values must be taken into account separately.

Figure 2

APPLICATION INFORMATION



CIRCUIT

TRIGGER AND THRESHOLD VOLTAGE WAVEFORM

Figure 3. Astable Operation

Connecting TRIG to THRES, as shown in Figure 3, causes the timer to run as a multivibrator. The capacitor C_T charges through R_A and R_B to the threshold voltage level (approximately 0.67 V_{DD}) and then discharges through R_B only to the value of the trigger voltage level (approximately 0.33 V_{DD}). The output is high during the charging cycle ($t_{c(H)}$) and low during the discharge cycle ($t_{c(L)}$). The duty cycle is controlled by the values of R_A, and R_B, and C_T, as shown in the equations below.

$$t_{c(H)} \approx C_T\,(R_A + R_B)\ \ln 2 \quad (\ln 2 = 0.693)$$

$$t_{c(L)} \approx C_T\,R_B\ \ln 2$$

$$\text{Period} = t_{c(H)} + t_{c(L)} \approx C_T\,(R_A + 2R_B)\ \ln 2$$

$$\text{Output driver duty cycle} = \frac{t_{c(L)}}{t_{c(H)} + t_{c(L)}} \approx 1 - \frac{R_B}{R_A + 2R_B}$$

$$\text{Output waveform duty cycle} = \frac{t_{c(H)}}{t_{c(H)} + t_{c(L)}} \approx \frac{R_B}{R_A + 2R_B}$$

The 0.1-µF capacitor at CONT in Figure 3 decreases the period by about 10%.

The formulas shown above do not allow for any propagation delay times from TRIG and THRES to DISCH. These delay times add directly to the period and create differences between calculated and actual values that increase with frequency. In addition, the internal on-state resistance r_{on} during discharge adds to R_B to provide another source of timing error in the calculation when R_B is very low or r_{on} is very high.

APPLICATION INFORMATION

The equations below provide better agreement with measured values.

$$t_{c(H)} = C_T\,(R_A + R_B)\,\ln\left[3 - \exp\left(\frac{-t_{PLH}}{C_T\,(R_B + r_{on})}\right)\right] + t_{PHL}$$

$$t_{c(L)} = C_T\,(R_B + r_{on})\,\ln\left[3 - \exp\left(\frac{-t_{PHL}}{C_T\,(R_A + R_B)}\right)\right] + t_{PLH}$$

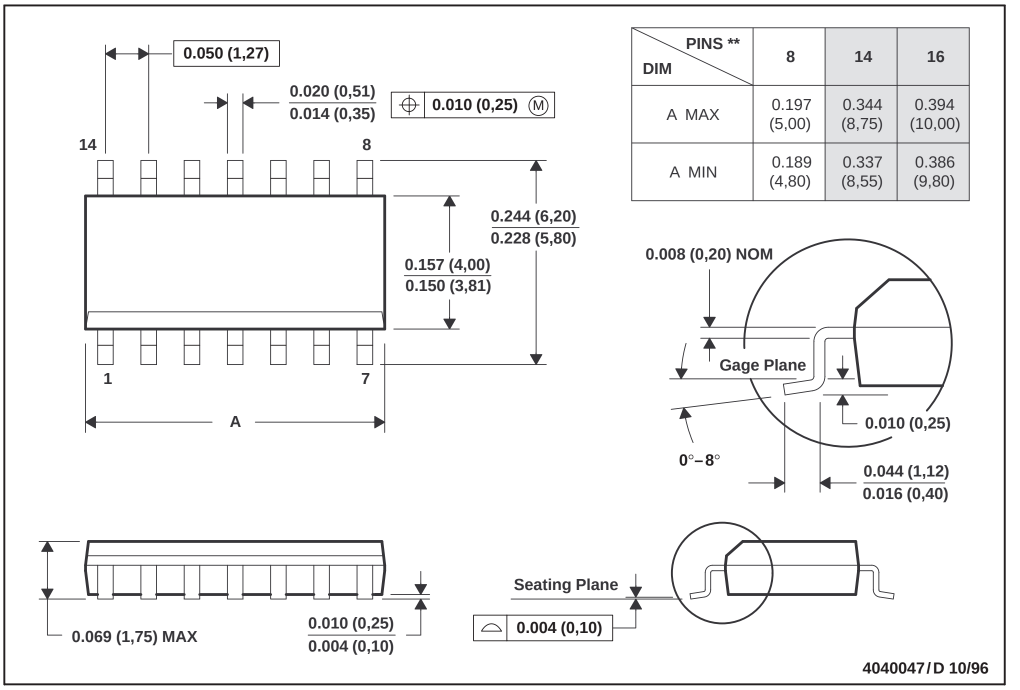
These equations and those given earlier are similar in that a time constant is multiplied by the logarithm of a number or function. The limit values of the logarithmic terms must be between ln 2 at low frequencies and ln 3 at extremely high frequencies. For a duty cycle close to 50%, an appropriate constant for the logarithmic terms can be substituted with good results. Duty cycles less than 50% $\frac{t_{c(H)}}{t_{c(H)} + t_{c(L)}}$ require that $\frac{t_{c(H)}}{t_{c(L)}} < 1$ and possibly $R_A \le r_{on}$. These conditions can be difficult to obtain.

In monostable applications, the trip point of the trigger input can be set by a voltage applied to CONT. An input voltage between 10% and 80% of the supply voltage from a resistor divider with at least 500-µA bias provides good results.

MECHANICAL INFORMATION

D (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PIN SHOWN



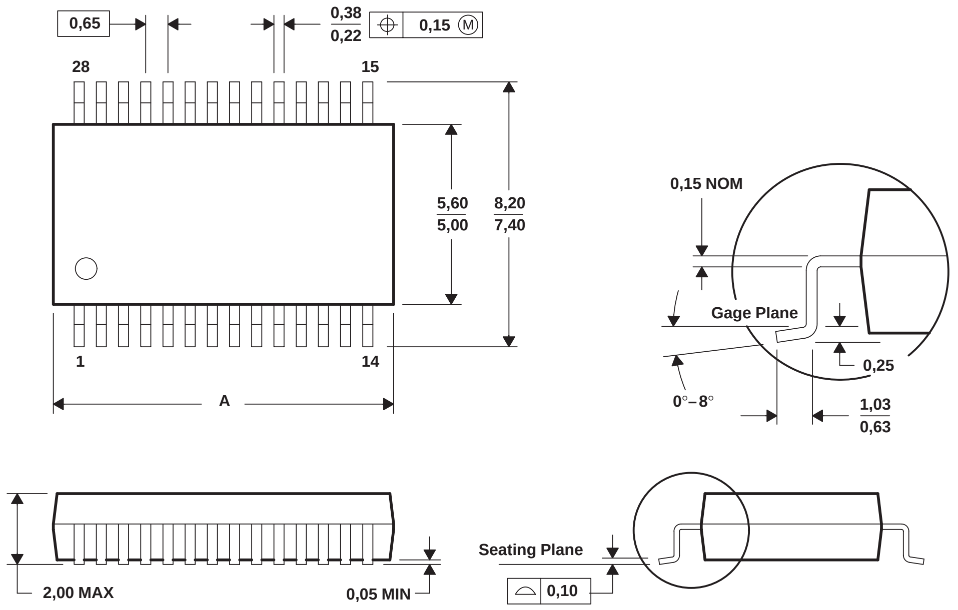
PINS ** / DIM	8	14	16
A MAX	0.197 (5,00)	0.344 (8,75)	0.394 (10,00)
A MIN	0.189 (4,80)	0.337 (8,55)	0.386 (9,80)

NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion, not to exceed 0.006 (0,15).
D. Falls within JEDEC MS-012

MECHANICAL INFORMATION

DB (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

28 PIN SHOWN



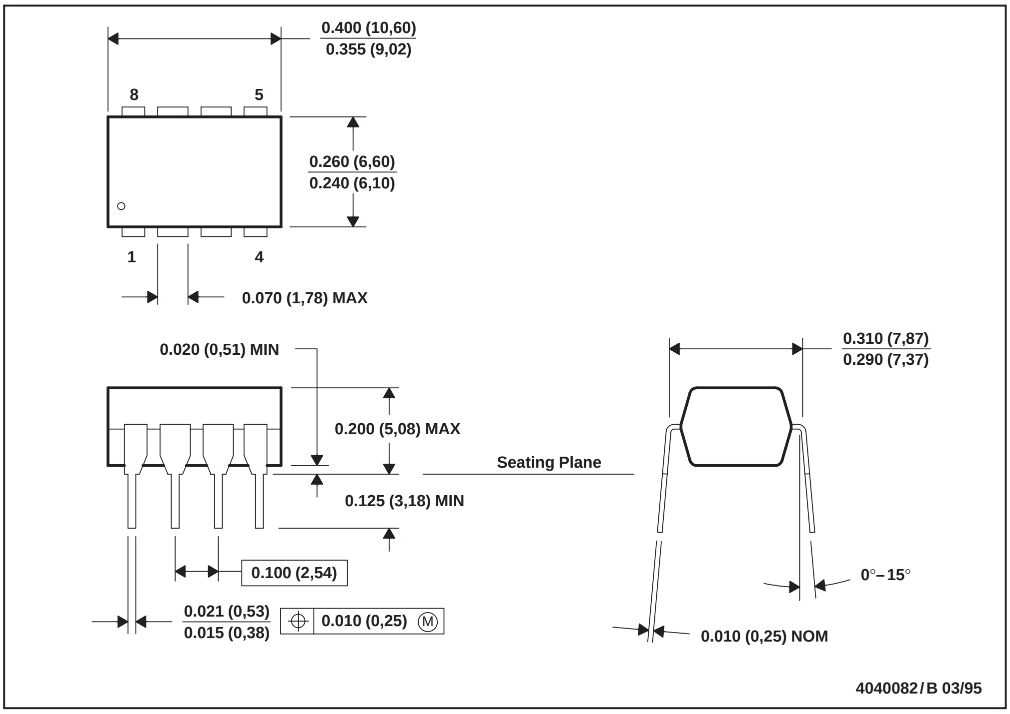
PINS ** / DIM	8	14	16	20	24	28	30	38
A MAX	3,30	6,50	6,50	7,50	8,50	10,50	10,50	12,90
A MIN	2,70	5,90	5,90	6,90	7,90	9,90	9,90	12,30

4040065 / C 10/95

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-150

MECHANICAL INFORMATION

P (R-PDIP-T8) **PLASTIC DUAL-IN-LINE PACKAGE**

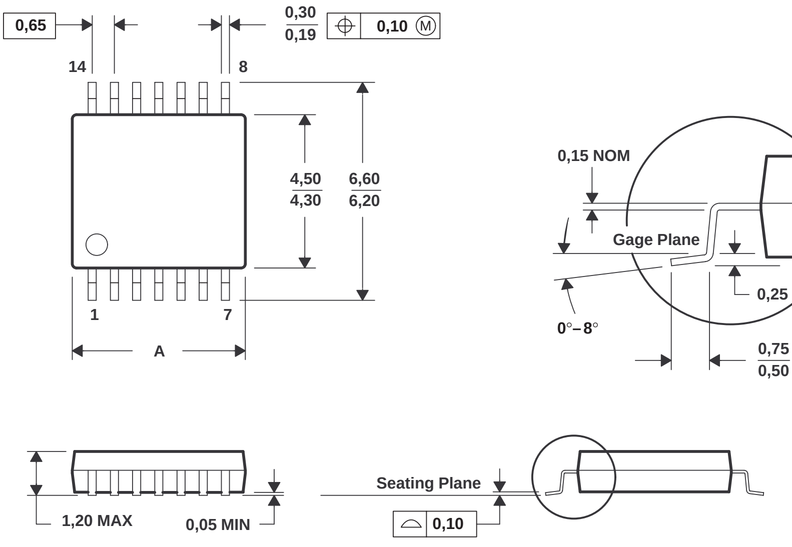


NOTES: A. All linear dimensions are in inches (millimeters).
B. This drawing is subject to change without notice.
C. Falls within JEDEC MS-001

MECHANICAL INFORMATION

PW (R-PDSO-G)** **PLASTIC SMALL-OUTLINE PACKAGE**

14 PIN SHOWN



PINS ** / DIM	8	14	16	20	24	28
A MAX	3,10	5,10	5,10	6,60	7,90	9,80
A MIN	2,90	4,90	4,90	6,40	7,70	9,60

4040064 / E 08/96

NOTES: A. All linear dimensions are in millimeters.
B. This drawing is subject to change without notice.
C. Body dimensions do not include mold flash or protrusion not to exceed 0,15.
D. Falls within JEDEC MO-153

Preliminary

U1

TEXAS INSTRUMENTS
www.ti.com

PACKAGE OPTION ADDENDUM

16-Dec-2006

PACKAGING INFORMATION

Orderable Device	Status (1)	Package Type	Package Drawing	Pins	Package Qty	Eco Plan (2)	Lead/Ball Finish	MSL Peak Temp (3)
TLC551CD	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC551CDG4	ACTIVE	SOIC	D	8	75	Green (RoHS & no Sb/Br)	CU NIPDAU	Level-1-260C-UNLIM
TLC551CP	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type
TLC551CPE4	ACTIVE	PDIP	P	8	50	Pb-Free (RoHS)	CU NIPDAU	N / A for Pkg Type

(1) The marketing status values are defined as follows:
ACTIVE: Product device recommended for new designs.
LIFEBUY: TI has announced that the device will be discontinued, and a lifetime-buy period is in effect.
NRND: Not recommended for new designs. Device is in production to support existing customers, but TI does not recommend using this part in a new design.
PREVIEW: Device has been announced but is not in production. Samples may or may not be available.
OBSOLETE: TI has discontinued the production of the device.

(2) Eco Plan - The planned eco-friendly classification: Pb-Free (RoHS), Pb-Free (RoHS Exempt), or Green (RoHS & no Sb/Br) - please check http://www.ti.com/productcontent for the latest availability information and additional product content details.
TBD: The Pb-Free/Green conversion plan has not been defined.
Pb-Free (RoHS): TI's terms "Lead-Free" or "Pb-Free" mean semiconductor products that are compatible with the current RoHS requirements for all 6 substances, including the requirement that lead not exceed 0.1% by weight in homogeneous materials. Where designed to be soldered at high temperatures, TI Pb-Free products are suitable for use in specified lead-free processes.
Pb-Free (RoHS Exempt): This component has a RoHS exemption for either 1) lead-based flip-chip solder bumps used between the die and package, or 2) lead-based die adhesive used between the die and leadframe. The component is otherwise considered Pb-Free (RoHS compatible) as defined above.
Green (RoHS & no Sb/Br): TI defines "Green" to mean Pb-Free (RoHS compatible), and free of Bromine (Br) and Antimony (Sb) based flame retardants (Br or Sb do not exceed 0.1% by weight in homogeneous material)

(3) MSL, Peak Temp. -- The Moisture Sensitivity Level rating according to the JEDEC industry standard classifications, and peak solder temperature.

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Interface	interface.ti.com	Digital Control	www.ti.com/digitalcontrol
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Power Mgmt	power.ti.com	Optical Networking	www.ti.com/opticalnetwork
Microcontrollers	microcontroller.ti.com	Security	www.ti.com/security
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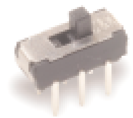
		Video & Imaging	www.ti.com/video
		Wireless	www.ti.com/wireless

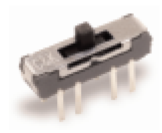
Mailing Address: Texas Instruments
Post Office Box 655303 Dallas, Texas 75265

JS Series
Sub-Miniature Slide Switches

Features/Benefits
- ***Positive detent***
- ***Low profile***
- ***IR reflow to 260º solder profile***
- ***Surface and thru hole mounting***
- ***SPDT, DPDT, DP3T models***
- ***RoHS compliant***

Typical Applications
- ***Telecommunication products***
- ***Computer peripherals***
- ***Thermostat select switch***
- ***Instrumentations***





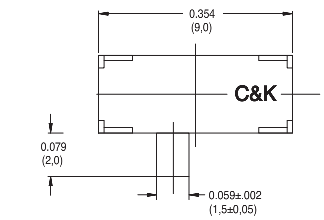
Specifications
CONTACT RATING: 6 VDC @ 0.3A
ELECTRICAL LIFE: 5,000 make-and-break cycles at full load.
CONTACT RESISTANCE: 70 mA max initial.
INSULATION RESISTANCE: 100 ohms @500 VDC
DIELECTRIC STRENGTH: 500 VAC min. @ sea level.
OPERATING TEMPERATURE: -10ºC to +60ºC
STORAGE TEMPERATURE: -30ºC to +85ºC

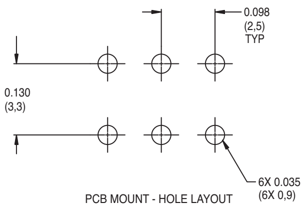
NOTE: Specifications and materials listed above are for switches with standard options. For information on specific and custom switches, consult Customer Service Center.

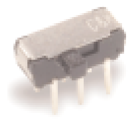
Materials
HOUSING: 4/6 nylon (UL94V-2), black.
ACTUATOR: 4/6 nylon (UL94V-2), black.
CONTACTS: Copper alloy, silver plated.
TERMINALS: Brass, silver plated

JS Series
Sub-Miniature Slide Switches

RIGHT ANGLE, PC THRU-HOLE

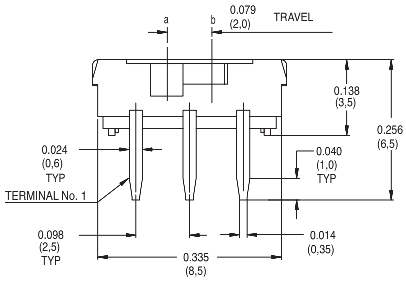


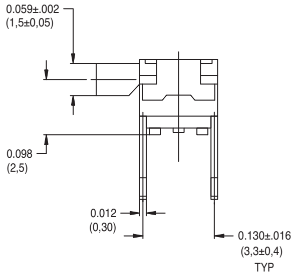


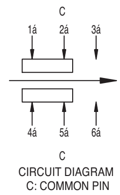


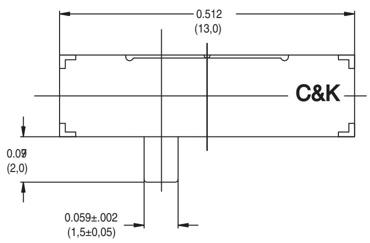
Part Number
JS202011AQN
DPDT

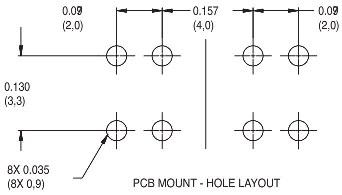
Shown in position 1a

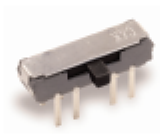






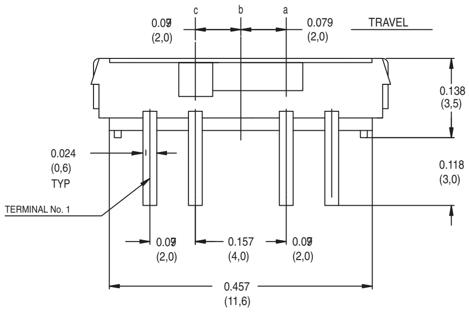


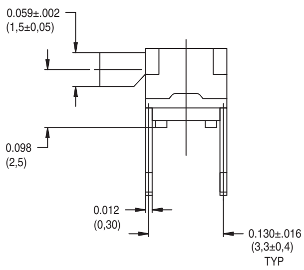


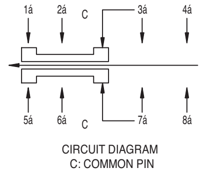


Part Number
JS203011AQN
DP3T

Shown in position 1a





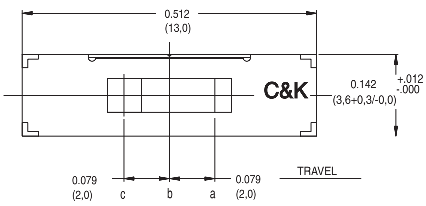


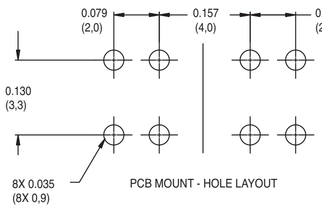
Third Angle Projection

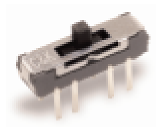
Dimensions are shown: Inch (mm)
Specifications and dimensions subject to change

JS Series
Sub-Miniature Slide Switches

PC THRU-HOLE

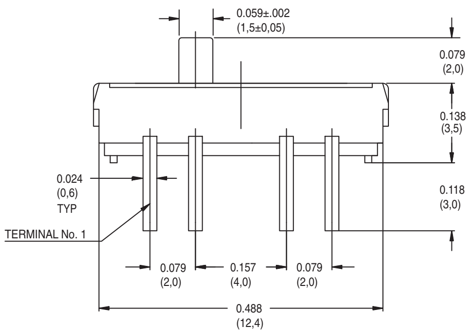


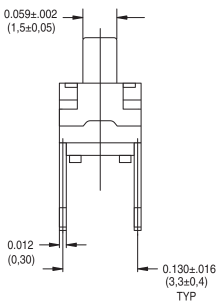


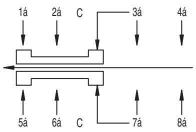


Part Number
JS203011CQN
DP3T

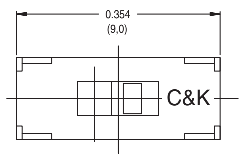
Shown in position 1a

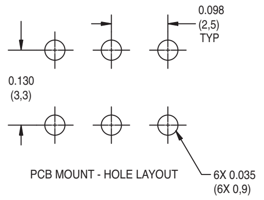


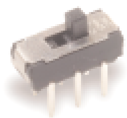




CIRCUIT DIAGRAM
C: COMMON PIN

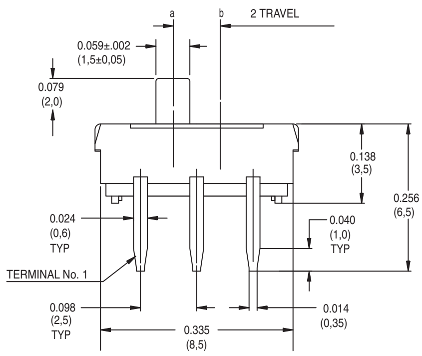


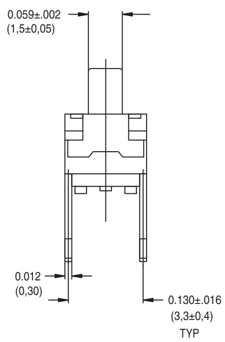


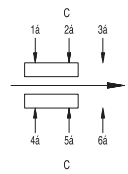


Part Number
JS202011CQN
DPDT

Shown in position 1a







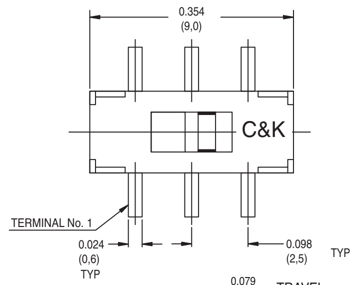
CIRCUIT DIAGRAM
C: COMMON PIN

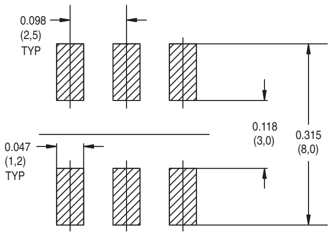
Third Angle Projection

Dimensions are shown: Inch (mm)
Specifications and dimensions subject to change

JS Series
Sub-Miniature Slide Switches

SURFACE MOUNT

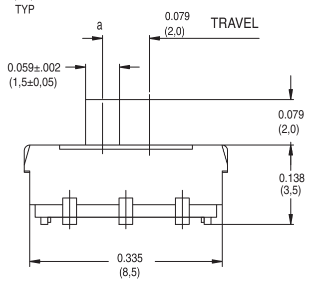


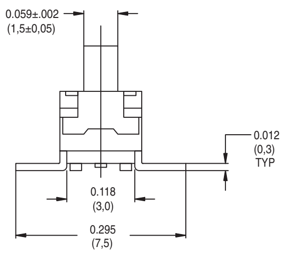


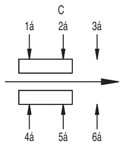
PCB MOUNT - TOLERANCE ±.002(0,05)

Part number
JS202011SCQN
DPDT

Shown in position 1a

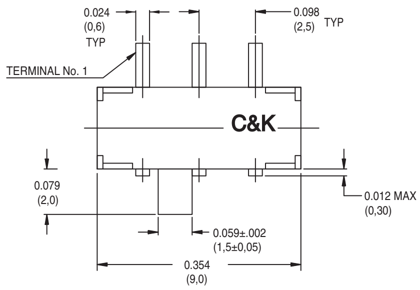


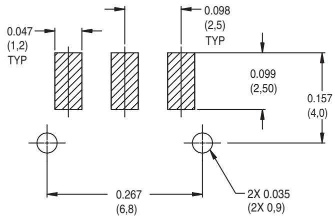




CIRCUIT DIAGRAM
C: COMMON PIN

RIGHT ANGLE SURFACE MOUNT

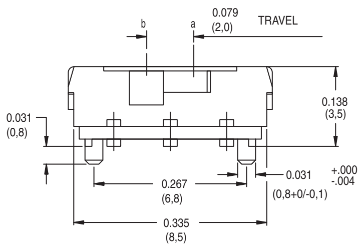


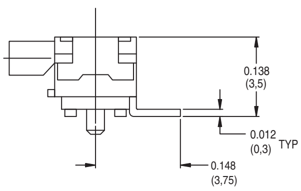


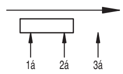
PCB MOUNT - HOLE LAYOUT

Part Number
JS102011SAQN
SPDT

Shown in position 1a







CIRCUIT DIAGRAM
C: COMMON PIN

Comes in Tape and Reel. See page J-22.
(JS102011SAQN only)

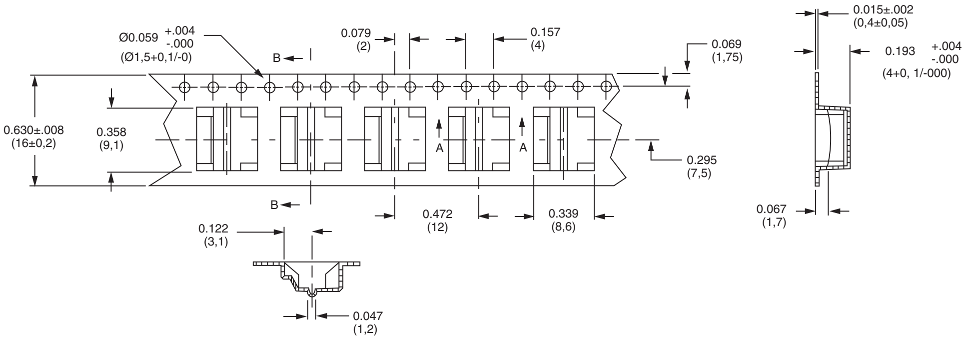
Third Angle Projection

Dimensions are shown: Inch (mm)
Specifications and dimensions subject to change

JS Series
Sub-Miniature Slide Switches

TAPE AND REEL FOR PART NUMBER JS10211SAQN

Quanity per reel 1000



Third Angle Projection

Dimensions are shown: Inch (mm)
Specifications and dimensions subject to change

KEMET

MULTILAYER CERAMIC CAPACITORS/AXIAL & RADIAL LEADED

Multilayer ceramic capacitors are available in a variety of physical sizes and configurations, including leaded devices and surface mounted chips. Leaded styles include molded and conformally coated parts with axial and radial leads. However, the basic capacitor element is similar for all styles. It is called a chip and consists of formulated dielectric materials which have been cast into thin layers, interspersed with metal electrodes alternately exposed on opposite edges of the laminated structure. The entire structure is fired at high temperature to produce a monolithic block which provides high capacitance values in a small physical volume. After firing, conductive terminations are applied to opposite ends of the chip to make contact with the exposed electrodes. Termination materials and methods vary depending on the intended use.

TEMPERATURE CHARACTERISTICS

Ceramic dielectric materials can be formulated with a wide range of characteristics. The EIA standard for ceramic dielectric capacitors (RS-198) divides ceramic dielectrics into the following classes:

Class I: Temperature compensating capacitors, suitable for resonant circuit application or other applications where high Q and stability of capacitance characteristics are required. Class I capacitors have predictable temperature coefficients and are not affected by voltage, frequency or time. They are made from materials which are not ferro-electric, yielding superior stability but low volumetric efficiency. Class I capacitors are the most stable type available, but have the lowest volumetric efficiency.

Class II: Stable capacitors, suitable for bypass or coupling applications or frequency discriminating circuits where Q and stability of capacitance characteristics are not of a major importance. Class II capacitors have temperature characteristics of ± 15% or less. They are made from materials which are ferro-electric, yielding higher volumetric efficiency but less stability. Class II capacitors are affected by temperature, voltage, frequency and time.

Class III: General purpose capacitors, suitable for by-pass coupling or other applications in which dielectric losses, high insulation resistance and stability of capacitance characteristics are of little or no importance. Class III capacitors are similar to Class II capacitors except for temperature characteristics, which are greater than ± 15%. Class III capacitors have the highest volumetric efficiency and poorest stability of any type.

KEMET leaded ceramic capacitors are offered in the three most popular temperature characteristics:

C0G: Class I, with a temperature coefficient of 0 ± 30 ppm per degree C over an operating temperature range of - 55°C to + 125°C (Also known as “NP0”).

X7R: Class II, with a maximum capacitance change of ± 15% over an operating temperature range of - 55°C to + 125°C.

Z5U: Class III, with a maximum capacitance change of + 22% - 56% over an operating temperature range of + 10°C to + 85°C.

Specified electrical limits for these three temperature characteristics are shown in Table 1.

SPECIFIED ELECTRICAL LIMITS

PARAMETER	TEMPERATURE CHARACTERISTICS		
	C0G	X7R	Z5U
Dissipation Factor: Measured at following conditions: C0G — 1 kHz and 1 vrms if capacitance > 1000 pF 1 MHz and 1 vrms if capacitance ≤ 1000 pF X7R — 1 kHz and 1 vrms* Z5U — 1 kHz and 0.5 vrms	0.15%	2.5%	4.0%
Dielectric Strength: 2.5 times rated DC voltage.	Pass Subsequent IR Test		
Insulation Resistance (IR): At rated DC voltage, whichever of the two is smaller	1,000 MΩ-µF or 100 GΩ	1,000 MΩ-µF or 100 GΩ	1,000 MΩ-µF or 10 GΩ
Temperature Characteristics: Range, °C Capacitance Change without DC voltage	-55 to 125 0 ± 30 ppm/°C	-55 to 125 ±15%	+10 to 85 +22%, -56%

* 1 MHz and 1 vrms if capacitance ≤ 100 pF on military product.

Table I

CERAMIC CONFORMALLY COATED/AXIAL & RADIAL
PERFORMANCE CHARACTERISTICS

KEMET

GENERAL SPECIFICATIONS

Working Voltage:

	Axial	Radial
C0G	50 & 100 volts	100 & 200 volts
X7R	50 & 100 volts	50, 100 & 200 volts
Z5U	50 & 100 volts	50 & 100 volts

Temperature Characteristics:

C0G 0 ± 30 PPM/°C from - 55°C to + 125°C(1)
X7R ± 15% from - 55°C to + 125°C
Z5U + 22%; - 56% from + 10°C to + 85°C

Capacitance Tolerance:

C0G ± 5%, ± 10%, ± 20%
X7R ± 10%, ± 20%
Z5U ± 20%, - 20 + 80%, - 0 + 100%

Construction:

Epoxy encapsulated - meets flame test requirements of UL Standard 94V-0.
High-temperature solder - meets EIA RS-198D, Method 302, Condition B (260°C for 10 sec.)

Lead Material:

Solder Coated Copper Clad Steel

Solderability:

EIA RS-198D, Method 302, Solder temperature - 230° ± 5°C. Dwell time in solder - 7 ± 1/2 seconds.

Terminal Strength:

EIA RS-198D, Method 303, Condition A (2.2 kg)

ELECTRICAL @ 25°C

Capacitance:

Within specified tolerance at 25°C and following test conditions.
C0G - Greater than 1000 pF with 1.0 vrms at 1 kHz.
- 1000 pF and less with 1.0 vrms at 1 MHz.
X7R - with 1.0 vrms at 1 kHz.
Z5U - with 0.5 vrms at 1 kHz.

Dissipation Factor:

At 25°C - same test conditions as capacitance.
C0G - 0.15% maximum
X7R - 2.5% maximum
Z5U - 4.0% maximum

Insulation Resistance:

EIA RS-198D, Method 104, Condition A
C0G - 100 gigohms or 1000 megohm x µF, whichever is less.
X7R -100 gigohms or 1000 megohm x µF, whichever is less.
Z5U -10 gigohms or 1000 megohm x µF, whichever is less.

Dielectric Withstanding Voltage:

EIA RS-198D, Method 103 (250% of rated voltage for 5 seconds, with current limited to 50mA)

ENVIRONMENTAL

Vibration:

EIA RS-198D, Method 304, Condition D (10-2000 Hz; 20g)

Shock:

EIA RS-198D, Method 305, Condition I (100g)

Life Test:

EIA RS-198D, Method 201, Condition D. Test Potential and Temperature.
C0G- 200% of rated voltage at + 125°C
X7R - 200% of rated voltage at + 125°C
Z5U - 200% of rated voltage at + 85°C

Post-Test Limits at + 25°C are:

Capacitance Change:
C0G - ± 3%, or 0.25 pF, whichever is greater.
X7R - ± 20% of initial value. (2)
Z5U - ± 30% of initial value. (2)

Dissipation Factor:
C0G - 0.25% maximum
X7R - 3.0% maximum
Z5U - 4.0% maximum

Insulation Resistance:
C0G - 10 gigohms or 100 megohm x µF, whichever is less.
X7R - 10 gigohms or 100 megohm x µF, whichever is less.
Z5U - 1 gigohm or 100 megohm x µF, whichever is less.

Moisture Resistance:

EIA RS-198D, Method 204, Condition A (10 cycles without applied voltage.

Post-Test Limits at + 25°C are:

Capacitance Change:
C0G - 3%, or 0.25 pF, whichever is greater.
X7R - ± 20% of initial value. (2)
Z5U - ± 30% of initial value. (2)

Dissipation Factor:
C0G - 0.25% maximum
X7R - 3.0% maximum
Z5U - 4.0% maximum

Insulation Resistance:
C0G - 10 gigohms or 100 megohm x µF, whichever is less.
X7R - 10 gigohms or 100 megohm x µF, whichever is less.
Z5U - 1 gigohm or 100 megohm x µF, whichever is less.

Thermal Shock:

EIA RS-198D, Method 202, Condition B (C0G & X7R: - 55°C to + 125°C; Z5U: - 55°C to + 85°C)

(1) +53 ppm -30 ppm/°C from + 25°C to - 55°C, ± 60 ppm below 10 pF.

(2) X7R & Z5U dielectrics exhibit aging characteristics; therefore, it is highly recommended that capacitors be deaged for 2 hours at 150°C and stabilized at room temperature for 48 hours before capacitance measurements are made.

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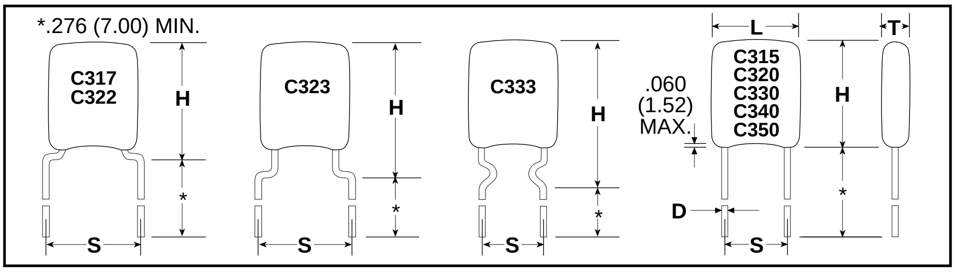
CERAMIC CONFORMALLY COATED/RADIAL
"GOLDEN MAX"

STANDARD LEAD CONFIGURATION — OUTLINE DRAWINGS



Drawings are not to scale. See table below for dimensions.
See page 9 for optional lead configurations.

DIMENSIONS — INCHES & MILLIMETERS

CASE SIZE	L MAX.	H MAX.	T MAX.	S(1) ±.030	D +.004 - .001
C315	.150 (3.81)	.210 (5.33)	.100 (2.54)	.100 (2.54)	.020 (.51)
C317	.150 (3.81)	.230 (5.84)	.100 (2.54)	.200 (5.08)	.020 (.51)
C320	.200 (5.08)	.260 (6.60)	.125 (3.18)	.100 (2.54)	.020 (.51)
C322	.200 (5.08)	.260 (6.60)	.125 (3.18)	.200 (5.08)	.020 (.51)
C323	.200 (5.08)	.320 (8.13)	.125 (3.18)	.200 (5.08)	.020 (.51)
C330	.300 (7.62)	.360 (9.14)	.150 (3.81)	.200 (5.08)	.020 (.51)
C333	.300 (7.62)	.390 (9.91)	.150 (3.81)	.200 (5.08)	.020 (.51)
C340	.400 (10.16)	.460 (11.68)	.150 (3.81)	.200 (5.08)	.020 (.51)
C350	.500 (12.70)	.560 (14.22)	.200 (5.08)	.400 (10.16)	.025 (.64)

NOTE: 1 inch = 25.4 mm.
NOTE: (1) Measured at seating plane.

ORDERING INFORMATION

C 320 C 102 M 1 R 5 C A*

CERAMIC — C

CASE SIZE — 320
(See Table Above)

SPECIFICATION — C
C — Standard

CAPACITANCE, CODE — 102
Expressed in Picofarads (pF)
First Two Digits — Significant Figures
Third Digit — Number of Zeros (Use 9 for 1.0 thru 9.9 pF. Example: 2.2pF — 229)

CAPACITANCE TOLERANCE — M
D — ±0.5 pF
F — ±1%
G — ±2%
J — ±5%
K — ±10%
M — ±20%
Z — -20, +80%

RATED VOLTAGE — 1
2 — 200
1 — 100
5 — 50

DIELECTRIC — R
EIA Designation
G — C0G (NP0) — Ultra-Stable
R — X7R — Stable
U — Z5U — General Purpose

INTERNAL CONSTRUCTION — 5
5 — Standard

LEAD MATERIAL — C
C — Standard

FAILURE RATE — A*
A — Not Applicable

***Part Number Example: C320C102M1R5CA (14 digits – no spaces)**

For packaging information, see pages 33 and 34.

CERAMIC CONFORMALLY COATED/RADIAL
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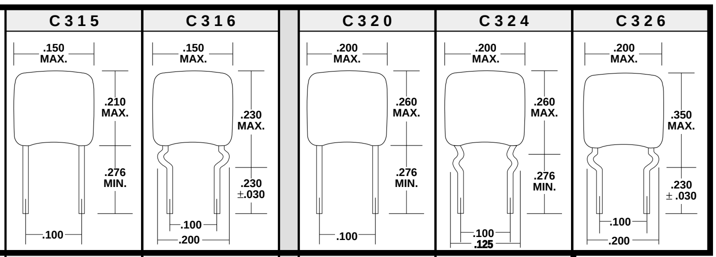
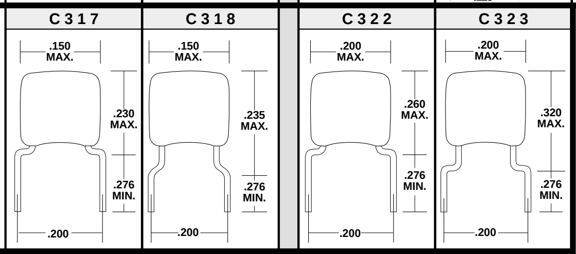
OPTIONAL CONFIGURATIONS BY LEAD SPACING

The preferred lead wire configurations are shown on page 8. However, additional configurations are available. All available options, including those on page 8, are shown below grouped by lead spacing.

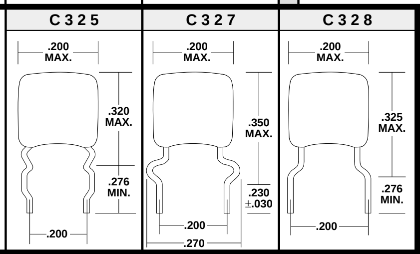
Lead Spacing .100" ± .030



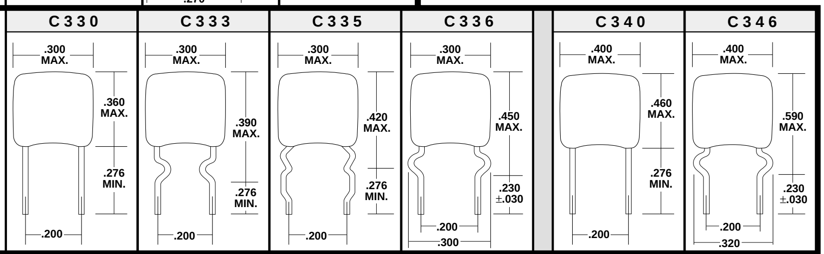
Lead Spacing .200" ± .030



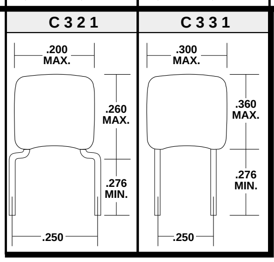
Lead Spacing .200" ± .030



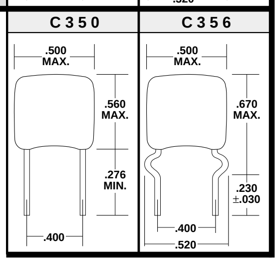
Lead Spacing .200" ± .030



Lead Spacing .250" ± .030



Lead Spacing .400" ± .030



Golden Max

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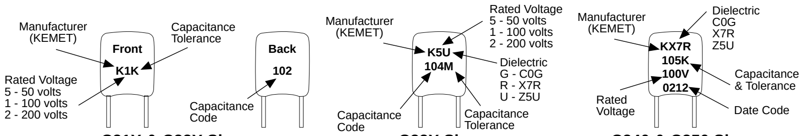
CERAMIC CONFORMALLY COATED/RADIAL
"GOLDEN MAX"

CAPACITOR MARKINGS



C31X & C32X Size   C33X Size   C340 & C350 Size

RATINGS & PART NUMBER REFERENCE: ULTRA-STABLE TEMPERATURE CHARACTERISTICS — C0G

CAPACITANCE	KEMET PART NUMBER
200 VOLT — C31X SIZE	
1.0 pF	C31(1)C109(3)2G5CA
1.5 pF	C31(1)C159(3)2G5CA
2.2 pF	C31(1)C229(3)2G5CA
2.7 pF	C31(1)C279(3)2G5CA
3.3 pF	C31(1)C339(3)2G5CA
3.9 pF	C31(1)C399(3)2G5CA
4.7 pF	C31(1)C479(3)2G5CA
5.6 pF	C31(1)C569(3)2G5CA
6.8 pF	C31(1)C689(3)2G5CA
8.2 pF	C31(1)C829(3)2G5CA
10 pF	C31(1)C100(3)2G5CA
12 pF	C31(1)C120(3)2G5CA
15 pF	C31(1)C150(3)2G5CA
18 pF	C31(1)C180(3)2G5CA
22 pF	C31(1)C220(3)2G5CA
27 pF	C31(1)C270(3)2G5CA
33 pF	C31(1)C330(3)2G5CA
39 pF	C31(1)C390(3)2G5CA
47 pF	C31(1)C470(3)2G5CA
56 pF	C31(1)C560(3)2G5CA
68 pF	C31(1)C680(3)2G5CA
82 pF	C31(1)C820(3)2G5CA
100 pF	C31(1)C101(3)2G5CA
120 pF	C31(1)C121(3)2G5CA
150 pF	C31(1)C151(3)2G5CA
180 pF	C31(1)C181(3)2G5CA
220 pF	C31(1)C221(3)2G5CA
270 pF	C31(1)C271(3)2G5CA
330 pF	C31(1)C331(3)2G5CA
390 pF	C31(1)C391(3)2G5CA
470 pF	C31(1)C471(3)2G5CA
200 VOLT — C32X SIZE	
1.0 pF	C32(2)C109(3)2G5CA
1.5 pF	C32(2)C159(3)2G5CA
2.2 pF	C32(2)C229(3)2G5CA
2.7 pF	C32(2)C279(3)2G5CA
3.3 pF	C32(2)C339(3)2G5CA
3.9 pF	C32(2)C399(3)2G5CA
4.7 pF	C32(2)C479(3)2G5CA
5.6 pF	C32(2)C569(3)2G5CA
6.8 pF	C32(2)C689(3)2G5CA
8.2 pF	C32(2)C829(3)2G5CA
10 pF	C32(2)C100(3)2G5CA
12 pF	C32(2)C120(3)2G5CA
15 pF	C32(2)C150(3)2G5CA
18 pF	C32(2)C180(3)2G5CA
22 pF	C32(2)C220(3)2G5CA
27 pF	C32(2)C270(3)2G5CA
33 pF	C32(2)C330(3)2G5CA
39 pF	C32(2)C390(3)2G5CA

CAPACITANCE	KEMET PART NUMBER
200 VOLT — C32X SIZE (Cont'd)	
47 pF	C32(2)C470(3)2G5CA
56 pF	C32(2)C560(3)2G5CA
68 pF	C32(2)C680(3)2G5CA
82 pF	C32(2)C820(3)2G5CA
100 pF	C32(2)C101(3)2G5CA
120 pF	C32(2)C121(3)2G5CA
150 pF	C32(2)C151(3)2G5CA
180 pF	C32(2)C181(3)2G5CA
220 pF	C32(2)C221(3)2G5CA
270 pF	C32(2)C271(3)2G5CA
330 pF	C32(2)C331(3)2G5CA
390 pF	C32(2)C391(3)2G5CA
470 pF	C32(2)C471(3)2G5CA
560 pF	C32(2)C561(3)2G5CA
680 pF	C32(2)C681(3)2G5CA
820 pF	C32(2)C821(3)2G5CA
1,000 pF	C32(2)C102(3)2G5CA
1,200 pF	C32(2)C122(3)2G5CA
1,500 pF	C32(2)C152(3)2G5CA
1,800 pF	C32(2)C182(3)2G5CA
2,200 pF	C32(2)C222(3)2G5CA
2,700 pF	C32(2)C272(3)2G5CA
3,300 pF	C32(2)C332(3)2G5CA
200 VOLT — C33X SIZE	
2,700 pF	C33(4)C272(3)2G5CA
3,300 pF	C33(4)C332(3)2G5CA
3,900 pF	C33(4)C392(3)2G5CA
4,700 pF	C33(4)C472(3)2G5CA
5,600 pF	C33(4)C562(3)2G5CA
6,800 pF	C33(4)C682(3)2G5CA
8,200 pF	C33(4)C822(3)2G5CA
.01 µF	C33(4)C103(3)2G5CA
.012 µF	C33(4)C123(3)2G5CA
.015 µF	C33(4)C153(3)2G5CA
.018 µF	C33(4)C183(3)2G5CA
200 VOLT — C340 SIZE	
.018 µF	C340C183(3)2G5CA
.022 µF	C340C223(3)2G5CA
.027 µF	C340C273(3)2G5CA
.033 µF	C340C333(3)2G5CA
.039 µF	C340C393(3)2G5CA
.047 µF	C340C473(3)2G5CA
200 VOLT — C350 SIZE	
.039 µF	C350C393(3)2G5CA
.047 µF	C350C473(3)2G5CA
.056 µF	C350C563(3)2G5CA
.068 µF	C350C683(3)2G5CA

CAPACITANCE	KEMET PART NUMBER
100 VOLT — C31X SIZE	
120 pF	C31(1)C121(3)1G5CA
150 pF	C31(1)C151(3)1G5CA
180 pF	C31(1)C181(3)1G5CA
220 pF	C31(1)C221(3)1G5CA
270 pF	C31(1)C271(3)1G5CA
330 pF	C31(1)C331(3)1G5CA
390 pF	C31(1)C391(3)1G5CA
470 pF	C31(1)C471(3)1G5CA
560 pF	C31(1)C561(3)1G5CA
680 pF	C31(1)C681(3)1G5CA
820 pF	C31(1)C821(3)1G5CA
1,000 pF	C31(1)C102(3)1G5CA
100 VOLT — C32X SIZE	
680 pF	C32(2)C681(3)1G5CA
820 pF	C32(2)C821(3)1G5CA
1,000 pF	C32(2)C102(3)1G5CA
1,200 pF	C32(2)C122(3)1G5CA
1,500 pF	C32(2)C152(3)1G5CA
1,800 pF	C32(2)C182(3)1G5CA
2,200 pF	C32(2)C222(3)1G5CA
2,700 pF	C32(2)C272(3)1G5CA
3,300 pF	C32(2)C332(3)1G5CA
3,900 pF	C32(2)C392(3)1G5CA
4,700 pF	C32(2)C472(3)1G5CA
5,600 pF	C32(2)C562(3)1G5CA
100 VOLT — C33X SIZE	
3,300 pF	C33(4)C332(3)1G5CA
3,900 pF	C33(4)C392(3)1G5CA
4,700 pF	C33(4)C472(3)1G5CA
5,600 pF	C33(4)C562(3)1G5CA
6,800 pF	C33(4)C682(3)1G5CA
8,200 pF	C33(4)C822(3)1G5CA
.01 µF	C33(4)C103(3)1G5CA
.012 µF	C33(4)C123(3)1G5CA
.015 µF	C33(4)C153(3)1G5CA
.018 µF	C33(4)C183(3)1G5CA
.022 µF	C33(4)C223(3)1G5CA
.027 µF	C33(4)C273(3)1G5CA
100 VOLT — C340 SIZE	
.027 µF	C340C273(3)1G5CA
.033 µF	C340C333(3)1G5CA
.039 µF	C340C393(3)1G5CA
.047 µF	C340C473(3)1G5CA
.056 µF	C340C563(3)1G5CA
.068 µF	C340C683(3)1G5CA
100 VOLT — C350 SIZE	
.039 µF	C350C393(3)1G5CA
.047 µF	C350C473(3)1G5CA
.056 µF	C350C563(3)1G5CA
.068 µF	C350C683(3)1G5CA
.082 µF	C350C823(3)1G5CA
.1 µF	C350C104(3)1G5CA
.12 µF	C350C124(3)1G5CA

NOTES: (1) Case Sizes C315/C317 are identical electrically, but differ in lead spacing. See table of dimensions. Insert the appropriate symbol, "5" or "7" in the part number.
(2) Case Sizes C320/C322/C323 are identical electrically. See table of dimensions. Insert the appropriate symbol, "0" or "2" or "3" in the part number.
(3) Insert proper symbol for capacitance tolerance as follows:
1.0 pF – 8.2 pF: D – ± 0.5pF
10 pF – 22 pF: J – ±5%, K – ±10%
27 pF – 47 pF: G – ±2%, J – ±5%, K – ±10%
56 pF and up: F – ±1%, G – ±2%, J – ±5%
(4) Case Sizes C330 and C333 are identical electrically. Insert the appropriate symbol "0" or "3" in the part number.

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RATINGS & PART NUMBER REFERENCE: STABLE TEMPERATURE CHARACTERISTICS — X7R

CAPACITANCE	KEMET PART NUMBER
200 VOLT — C31X SIZE	
100 pF	C31(1)C101(3)2R5CA
120 pF	C31(1)C121(3)2R5CA
150 pF	C31(1)C151(3)2R5CA
180 pF	C31(1)C181(3)2R5CA
220 pF	C31(1)C221(3)2R5CA
270 pF	C31(1)C271(3)2R5CA
330 pF	C31(1)C331(3)2R5CA
390 pF	C31(1)C391(3)2R5CA
470 pF	C31(1)C471(3)2R5CA
560 pF	C31(1)C561(3)2R5CA
680 pF	C31(1)C681(3)2R5CA
820 pF	C31(1)C821(3)2R5CA
1,000 pF	C31(1)C102(3)2R5CA
1,200 pF	C31(1)C122(3)2R5CA
1,500 pF	C31(1)C152(3)2R5CA
1,800 pF	C31(1)C182(3)2R5CA
2,200 pF	C31(1)C222(3)2R5CA
200 VOLT — C32X SIZE	
1,000 pF	C32(2)C102(3)2R5CA
1,200 pF	C32(2)C122(3)2R5CA
1,500 pF	C32(2)C152(3)2R5CA
1,800 pF	C32(2)C182(3)2R5CA
2,200 pF	C32(2)C222(3)2R5CA
2,700 pF	C32(2)C272(3)2R5CA
3,300 pF	C32(2)C332(3)2R5CA
3,900 pF	C32(2)C392(3)2R5CA
4,700 pF	C32(2)C472(3)2R5CA
5,600 pF	C32(2)C562(3)2R5CA
6,800 pF	C32(2)C682(3)2R5CA
8,200 pF	C32(2)C822(3)2R5CA
.01 µF	C32(2)C103(3)2R5CA
.012 µF	C32(2)C123(3)2R5CA
.015 µF	C32(2)C153(3)2R5CA
.018 µF	C32(2)C183(3)2R5CA
.022 µF	C32(2)C223(3)2R5CA
200 VOLT — C33X SIZE	
.015 µF	C33(4)C153(3)2R5CA
.018 µF	C33(4)C183(3)2R5CA
.022 µF	C33(4)C223(3)2R5CA
.027 µF	C33(4)C273(3)2R5CA
.033 µF	C33(4)C333(3)2R5CA
.039 µF	C33(4)C393(3)2R5CA
.047 µF	C33(4)C473(3)2R5CA
.056 µF	C33(4)C563(3)2R5CA
.068 µF	C33(4)C683(3)2R5CA
.082 µF	C33(4)C823(3)2R5CA
.1 µF	C33(4)C104(3)2R5CA
200 VOLT — C340 SIZE	
.1 µF	C340C104(3)2R5CA
.12 µF	C340C124(3)2R5CA
.15 µF	C340C154(3)2R5CA
.18 µF	C340C184(3)2R5CA
.22 µF	C340C224(3)2R5CA
.27 µF	C340C274(3)2R5CA
200 VOLT — C350 SIZE	
.22 µF	C350C224(3)2R5CA
.27 µF	C350C274(3)2R5CA
.33 µF	C350C334(3)2R5CA
.39 µF	C350C394(3)2R5CA
.47 µF	C350C474(3)2R5CA

CAPACITANCE	KEMET PART NUMBER
100 VOLT — C31X SIZE	
820 pF	C31(1)C821(3)1R5CA
1,000 pF	C31(1)C102(3)1R5CA
1,200 pF	C31(1)C122(3)1R5CA
1,500 pF	C31(1)C152(3)1R5CA
1,800 pF	C31(1)C182(3)1R5CA
2,200 pF	C31(1)C222(3)1R5CA
2,700 pF	C31(1)C272(3)1R5CA
3,300 pF	C31(1)C332(3)1R5CA
3,900 pF	C31(1)C392(3)1R5CA
4,700 pF	C31(1)C472(3)1R5CA
5,600 pF	C31(1)C562(3)1R5CA
6,800 pF	C31(1)C682(3)1R5CA
8,200 pF	C31(1)C822(3)1R5CA
.01 µF	C31(1)C103(3)1R5CA
100 VOLT — C32X SIZE	
4,700 pF	C32(2)C472(3)1R5CA
5,600 pF	C32(2)C562(3)1R5CA
6,800 pF	C32(2)C682(3)1R5CA
8,200 pF	C32(2)C822(3)1R5CA
.01 µF	C32(2)C103(3)1R5CA
.012 µF	C32(2)C123(3)1R5CA
.015 µF	C32(2)C153(3)1R5CA
.018 µF	C32(2)C183(3)1R5CA
.022 µF	C32(2)C223(3)1R5CA
.027 µF	C32(2)C273(3)1R5CA
.033 µF	C32(2)C333(3)1R5CA
.039 µF	C32(2)C393(3)1R5CA
.047 µF	C32(2)C473(3)1R5CA
.056 µF	C32(2)C563(3)1R5CA
.068 µF	C32(2)C683(3)1R5CA
.082 µF	C32(2)C823(3)1R5CA
.1 µF	C32(2)C104(3)1R5CA
100 VOLT — C33X SIZE	
.068 µF	C33(4)C683(3)1R5CA
.082 µF	C33(4)C823(3)1R5CA
.1 µF	C33(4)C104(3)1R5CA
.12 µF	C33(4)C124(3)1R5CA
.15 µF	C33(4)C154(3)1R5CA
.18 µF	C33(4)C184(3)1R5CA
.22 µF	C33(4)C224(3)1R5CA
.27 µF	C33(4)C274(3)1R5CA
.33 µF	C33(4)C334(3)1R5CA
.39 µF	C33(4)C394(3)1R5CA
.47 µF	C33(4)C474(3)1R5CA
100 VOLT — C340 SIZE	
.47 µF	C340C474(3)1R5CA
.56 µF	C340C564(3)1R5CA
.68 µF	C340C684(3)1R5CA
.82 µF	C340C824(3)1R5CA
1.0 µF	C340C105(3)1R5CA
100 VOLT — C350 SIZE	
.68 µF	C350C684(3)1R5CA
.82 µF	C350C824(3)1R5CA
1.0 µF	C350C105(3)1R5CA
1.2 µF	C350C125(3)1R5CA

CAPACITANCE	KEMET PART NUMBER
50 VOLT — C31X SIZE	
3,300 pF	C31(1)C332(3)5R5CA
3,900 pF	C31(1)C392(3)5R5CA
4,700 pF	C31(1)C472(3)5R5CA
5,600 pF	C31(1)C562(3)5R5CA
6,800 pF	C31(1)C682(3)5R5CA
8,200 pF	C31(1)C822(3)5R5CA
.01 µF	C31(1)C103(3)5R5CA
.012 µF	C31(1)C123(3)5R5CA
.015 µF	C31(1)C153(3)5R5CA
.018 µF	C31(1)C183(3)5R5CA
.022 µF	C31(1)C223(3)5R5CA
.027 µF	C31(1)C273(3)5R5CA
.033 µF	C31(1)C333(3)5R5CA
50 VOLT — C32X SIZE	
.012 µF	C32(2)C123(3)5R5CA
.015 µF	C32(2)C153(3)5R5CA
.018 µF	C32(2)C183(3)5R5CA
.022 µF	C32(2)C223(3)5R5CA
.027 µF	C32(2)C273(3)5R5CA
.033 µF	C32(2)C333(3)5R5CA
.039 µF	C32(2)C393(3)5R5CA
.047 µF	C32(2)C473(3)5R5CA
.056 µF	C32(2)C563(3)5R5CA
.068 µF	C32(2)C683(3)5R5CA
.082 µF	C32(2)C823(3)5R5CA
.1 µF	C32(2)C104(3)5R5CA
.12 µF	C32(2)C124(3)5R5CA
.15 µF	C32(2)C154(3)5R5CA
.18 µF	C32(2)C184(3)5R5CA
.22 µF	C32(2)C224(3)5R5CA
.27 µF	C32(2)C274(3)5R5CA
50 VOLT — C33X SIZE	
.15 µF	C33(4)C154(3)5R5CA
.18 µF	C33(4)C184(3)5R5CA
.22 µF	C33(4)C224(3)5R5CA
.27 µF	C33(4)C274(3)5R5CA
.33 µF	C33(4)C334(3)5R5CA
.39 µF	C33(4)C394(3)5R5CA
.47 µF	C33(4)C474(3)5R5CA
.56 µF	C33(4)C564(3)5R5CA
.68 µF	C33(4)C684(3)5R5CA
.82 µF	C33(4)C824(3)5R5CA
1.0 µF	C33(4)C105(3)5R5CA
50 VOLT — C340 SIZE	
1.2 µF	C340C125(3)5R5CA
1.5 µF	C340C155(3)5R5CA
1.8 µF	C340C185(3)5R5CA
2.2 µF	C340C225(3)5R5CA
50 VOLT — C350 SIZE	
2.2 µF	C350C225(3)5R5CA
2.7 µF	C350C275(3)5R5CA
3.3 µF	C350C335(3)5R5CA
3.9 µF	C350C395(3)5R5CA
4.7 µF	C350C475(3)5R5CA

NOTES: (1) Case Sizes C315/C317 are identical electrically, but differ in lead spacing. See table of dimensions. Insert the appropriate symbol, "5" or "7" in the part number.
(2) Case Sizes C320/C322/C323 are identical electrically. See table of dimensions. Insert the appropriate symbol, "0" or "2" or "3" in the part number.
(3) Insert proper symbol for capacitance tolerance as follows: K – ±10%, M – ±20%
(4) Case Sizes C330 and C333 are identical electrically. Insert the appropriate symbol "0" or "3" in the part number.

Preliminary

KEMET®

CERAMIC CONFORMALLY COATED/RADIAL
"GOLDEN MAX"

RATINGS & PART NUMBER REFERENCE
GENERAL PURPOSE TEMPERATURE CHARACTERISTIC — Z5U

CAPACITANCE	KEMET PART NUMBER
100 VOLT — C31X SIZE	
1,000 pF	C31(1)C102(3)1U5CA
1,200 pF	C31(1)C122(3)1U5CA
1,500 pF	C31(1)C152(3)1U5CA
1,800 pF	C31(1)C182(3)1U5CA
2,200 pF	C31(1)C222(3)1U5CA
2,700 pF	C31(1)C272(3)1U5CA
3,300 pF	C31(1)C332(3)1U5CA
3,900 pF	C31(1)C392(3)1U5CA
4,700 pF	C31(1)C472(3)1U5CA
5,600 pF	C31(1)C562(3)1U5CA
6,800 pF	C31(1)C682(3)1U5CA
8,200 pF	C31(1)C822(3)1U5CA
.01 µF	C31(1)C103(3)1U5CA
.012 µF	C31(1)C123(3)1U5CA
.015 µF	C31(1)C153(3)1U5CA
.018 µF	C31(1)C183(3)1U5CA
100 VOLT — C32X SIZE	
.01 µF	C32(2)C103(3)1U5CA
.012 µF	C32(2)C123(3)1U5CA
.015 µF	C32(2)C153(3)1U5CA
.018 µF	C32(2)C183(3)1U5CA
.022 µF	C32(2)C223(3)1U5CA
.027 µF	C32(2)C273(3)1U5CA
.033 µF	C32(2)C333(3)1U5CA
.039 µF	C32(2)C393(3)1U5CA
.047 µF	C32(2)C473(3)1U5CA
.056 µF	C32(2)C563(3)1U5CA
.068 µF	C32(2)C683(3)1U5CA
.082 µF	C32(2)C823(3)1U5CA
0.1 µF	C32(2)C104(3)1U5CA
.12 µF	C32(2)C124(3)1U5CA
.15 µF	C32(2)C154(3)1U5CA
100 VOLT — C33X SIZE	
0.1 µF	C33(4)C104(3)1U5CA
.12 µF	C33(4)C124(3)1U5CA
.15 µF	C33(4)C154(3)1U5CA
.18 µF	C33(4)C184(3)1U5CA
.22 µF	C33(4)C224(3)1U5CA
.27 µF	C33(4)C274(3)1U5CA
.33 µF	C33(4)C334(3)1U5CA
.39 µF	C33(4)C394(3)1U5CA
.47 µF	C33(4)C474(3)1U5CA
100 VOLT — C340 SIZE	
.47 µF	C340C474(3)1U5CA
.56 µF	C340C564(3)1U5CA
.68 µF	C340C684(3)1U5CA
.82 µF	C340C824(3)1U5CA
1.0 µF	C340C105(3)1U5CA
1.2 µF	C340C125(3)1U5CA
1.5 µF	C340C155(3)1U5CA
100 VOLT — C350 SIZE	
1.0 µF	C350C105(3)1U5CA
1.2 µF	C350C125(3)1U5CA
1.5 µF	C350C155(3)1U5CA
1.8 µF	C350C185(3)1U5CA
2.2 µF	C350C225(3)1U5CA

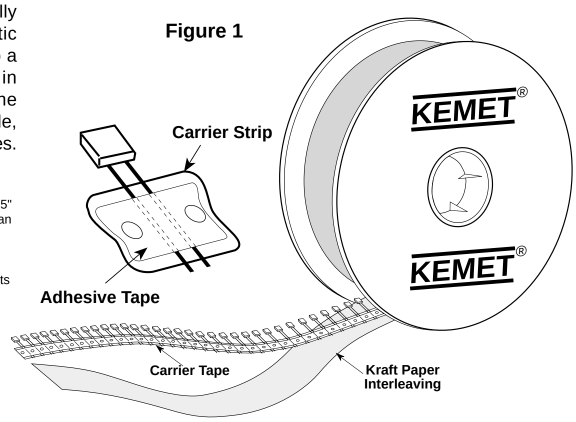
CAPACITANCE	KEMET PART NUMBER
50 VOLT — C31X SIZE	
4,700 pF	C31(1)C472(3)5U5CA
5,600 pF	C31(1)C562(3)5U5CA
6,800 pF	C31(1)C682(3)5U5CA
8,200 pF	C31(1)C822(3)5U5CA
.01 µF	C31(1)C103(3)5U5CA
.012 µF	C31(1)C123(3)5U5CA
.015 µF	C31(1)C153(3)5U5CA
.018 µF	C31(1)C183(3)5U5CA
.022 µF	C31(1)C223(3)5U5CA
.027 µF	C31(1)C273(3)5U5CA
.033 µF	C31(1)C333(3)5U5CA
.039 µF	C31(1)C393(3)5U5CA
.047 µF	C31(1)C473(3)5U5CA
.056 µF	C31(1)C563(3)5U5CA
.068 µF	C31(1)C683(3)5U5CA
.082 µF	C31(1)C823(3)5U5CA
0.1 µF	C31(1)C104(3)5U5CA
50 VOLT — C32X SIZE	
.027 µF	C32(2)C273(3)5U5CA
.033 µF	C32(2)C333(3)5U5CA
.039 µF	C32(2)C393(3)5U5CA
.047 µF	C32(2)C473(3)5U5CA
.056 µF	C32(2)C563(3)5U5CA
.068 µF	C32(2)C683(3)5U5CA
.082 µF	C32(2)C823(3)5U5CA
0.1 µF	C32(2)C104(3)5U5CA
.12 µF	C32(2)C124(3)5U5CA
.15 µF	C32(2)C154(3)5U5CA
.18 µF	C32(2)C184(3)5U5CA
.22 µF	C32(2)C224(3)5U5CA
.27 µF	C32(2)C274(3)5U5CA
.33 µF	C32(2)C334(3)5U5CA
.39 µF	C32(2)C394(3)5U5CA
.47 µF	C32(2)C474(3)5U5CA
.56 µF	C32(2)C564(3)5U5CA
50 VOLT — C33X SIZE	
.27 µF	C33(4)C274(3)5U5CA
.33 µF	C33(4)C334(3)5U5CA
.39 µF	C33(4)C394(3)5U5CA
.47 µF	C33(4)C474(3)5U5CA
.56 µF	C33(4)C564(3)5U5CA
.68 µF	C33(4)C684(3)5U5CA
.82 µF	C33(4)C824(3)5U5CA
1.0 µF	C33(4)C105(3)5U5CA
1.2 µF	C33(4)C125(3)5U5CA
1.5 µF	C33(4)C155(3)5U5CA
1.8 µF	C33(4)C185(3)5U5CA
2.2 µF	C33(4)C225(3)5U5CA
50 VOLT — C340 SIZE	
2.2 µF	C340C225(3)5U5CA
2.7 µF	C340C275(3)5U5CA
3.3 µF	C340C335(3)5U5CA
3.9 µF	C340C395(3)5U5CA
4.7 µF	C340C475(3)5U5CA
50 VOLT — C350 SIZE	
3.9 µF	C350C395(3)5U5CA
4.7 µF	C350C475(3)5U5CA
5.6 µF	C350C565(3)5U5CA
6.8 µF	C350C685(3)5U5CA

NOTES: (1) Case Sizes C315/C317 are identical electrically, but differ in lead spacing. See table of dimensions. Insert the appropriate symbol, "5" or "7" in the part number.
(2) Case Sizes C320/C322/C323 are identical electrically. See table of dimensions. Insert the appropriate symbol, "0" or "2" or "3" in the part number.
(3) Insert proper symbol for capacitance tolerance as follows:
M – ±20%
Z – +80%, -20%
(4) Case Sizes C330 and C333 are identical electrically. Insert the appropriate symbol "0" or "3" in the part number.

Ceramic Radial
Lead Tape and Reel Packaging

KEMET offers standard reeling of Molded and Conformally Coated Radial Leaded Ceramic Capacitors for automatic insertion per EIA specification RS-468. Parts are taped to a tagboard carrier strip, and wound on a reel as shown in Figure 1. Kraft paper interleaving is inserted between the layers of capacitors on the reel. Ammopack is also available, with the same lead tape configuration and package quantities.

Figure 1



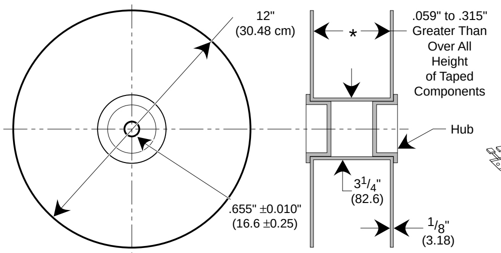


Figure 3: Standard Reel

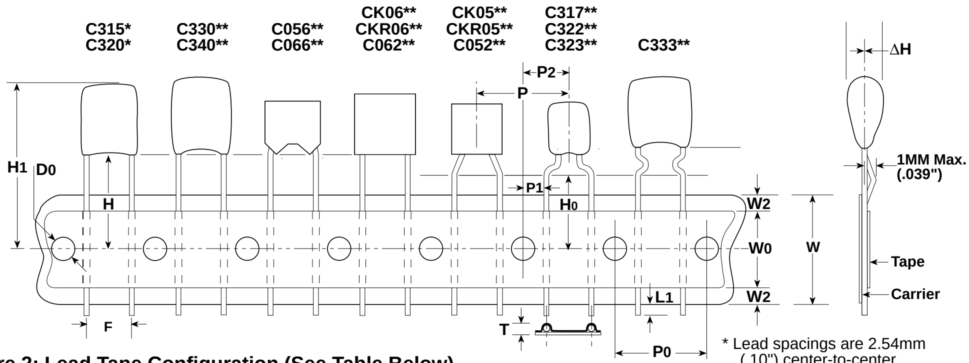


Figure 2: Lead Tape Configuration (See Table Below)

* Lead spacings are 2.54mm (.10") center-to-center.
** Lead spacings are 5.08mm (.20") center-to-center.

Ceramic Radial Tape and Reel Dimensions in Millimeters & (Inches)

Dimension	Symbol	Nominal mm (inch)	Tolerance mm (inch)	Dimension	Symbol	Nominal mm (inch)	Tolerance mm (inch)
Sprocket Hole Diameter	Do	4.0 (.157)	± 0.2 (.008)	Height to Seating Plane (formed leads) (2)	H0	C7301 16.0 (.630) C7303 18.0 (.709)	C7301 ±0.5 (.020) C7303 Minimum
Sprocket Hole Pitch	P0	12.7 (.500)	± 0.3 (.012)	Component Alignment	Δh	4.0 (.157)	±0.2 (.008)
Component Pitch	P	12.7 (.500)	± 0.3 (.012)	Lead Protrusion	L1	1.0 (.039)	Maximum
Lead Spacing (1)	F	5.08 (.20) 2.54 (.10)	+0.6 -0.2 (+.024 -.008)	Composite Tape Thickness	t	0.7 (.051)	±0.2 (.008)
Sprocket Hole Center to Lead Center (1)	P1	3.81 (.150) 5.08 (.200)	± 0.7 (.028)	Overall Tape and Lead Thickness	T	1.5 (.059)	Maximum
Sprocket Hole Center to Component Center	P2	6.35 (.250)	± 1.3 (.051)	Carrier Tape Width	W	18.0 (.709)	+1.0 - 0.5 (+.039 -.020)
Height to Seating Plane (straight leads) (2)	H	C7301 16.0 (.630) C7303 18.0 (.709)	C7301 ±0.5 (.020) C7303 Minimum	Hold-Down Tape Width	W0	5.0 (.197)	Minimum
Component Height Above Tape Center	H1	32.2 (1.27)	Maximum	Hold-Down Tape Location	W2	3.0 (.118)	Maximum

(1) Measured at the egress from the carrier tape, on the component side.
(2) Determined by a 4 digit suffix placed at the end of the part number, as follows:
7301 = Recommended for parts with formed leads. Example: C322C104K5R5CA7301
7303 = Recommended for parts with straight leads. Example: C320C104K5R5CA7303

CERAMIC PACKAGING

KEMET Number	Military Style	Military Specification	Standard (1) Bulk Quantity	Standard Reel Quantity	Reel Size
C114C-K-G	CK12, CC75	MIL-C-11015/	200/Box	5000	12"
C124C-K-G	CK13, CC76	MIL-PRF-20	200/Box	5000	12"
C192C-K-G	CK14, CC77		100/Box	3000	12"
C202C-K	CK15		25/Box	500	12"
C222C-K	CK16		10/Tray	300	12"
C052C-K-G	CK05, CC05		100/Bag	2000	12"
C062C-K-G	CK06, CC06		100/Bag	1500	12"
C114G	CCR75	MIL-PRF-20	200/Box	5000	12"
C124G	CCR76		200/Box	5000	12"
C192G	CCR77		100/Box	3000	12"
C202G	CC78-CCR78		25/Box	500	12"
C222G	CC79-CCR79		10/Tray	300	12"
C052/56G	CCR05		100/Bag	1700	12"
C062/66G	CCR06		100/Bag	1500	12"
C512G	CC07-CCR07		Footnote (2)	N/A	N/A
C522G	CC08-CCR08		Footnote (2)	N/A	N/A
C114T	CKR11	MIL-PRF-39014	200/Box	5000	12"
C124T	CKR12		200/Box	5000	12"
C192T	CKR14		100/Box	3000	12"
C202T	CKR15		25/Box	500	12"
C222T	CKR16		10/Tray	300	12"
C052/56T	CKR05		100/Bag	1700	12"
C062/66T	CKR06		100/Bag	1500	12"
C31X			500/Bag	2500	12"
C32X			500/Bag	2500	12"
C33X			250/Bag	1500	12"
C340			100/Bag	1000	12"
C350			50/Bag	N/A	N/A
C410			300/Box	5000	12"
C412			200/Box	5000	12"
C420			300/Box	5000	12"
C430			200/Box	2500	12"
C440			200/Box	2500	12"
C512	N/A	N/A	Footnote (2)	N/A	N/A
C522	N/A	N/A	Footnote (2)	N/A	N/A

NOTE: (1) Standard packaging refers to number of pieces per bag, box, tray or vial.
(2) Quantity varies. For further details, please consult the factory.

Preliminary

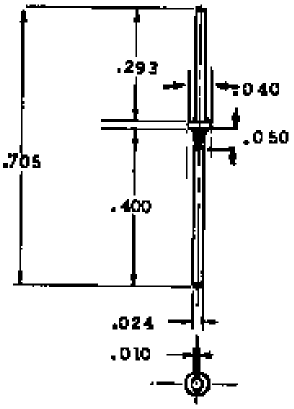
TP1, TP2, TP3, TP4

INBORD PINS — MINIATURE TERMINALS

INBORD PINS TO FIT .025 DIAMETER HOLES

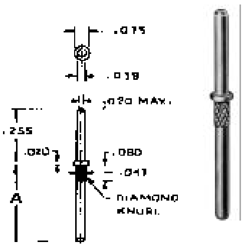
K36 SERIES

Cat. No.	Material & Finish
K36A	Phosphor Bronze Nickel plate,Gold Flash
K36C	Phosphor Bronze Bright tin plate
Pkg. Qty	1000



INBORD PIN APPLICATION

EYELET SOLDER
.040” dia. pins can be installed into .062” dia. holes if the T15.23 eyelet is used. Soldering provides permanency. Manual insertion of pins and retainer is accomplished with: .040” dia. pin, P133A.



K24 SERIES

Note: New knurled shank results in greater retention and requires more insertion force. Use on G10 glass epoxy boards only.

ORDERING INFORMATION

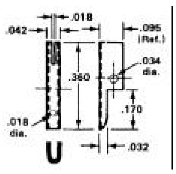
CAT NO.	A DIM.	PKG. QTY
K24A	.375	1000
K24C	.375	1000

TERMINALS TO FIT .042 DIA. HOLES

PUSH-IN MICRO-KLIP TERMINALS
to fit .042” diameter holes

The T42-1 terminal resembles the widely used T28 but is smaller to fit .042” instead of .062” dia. holes. It is useful for P pattern Micro-Vectorbord and is easily pushed into such holes using a P149 tool. It needs no staking for most applications, but if desired, the portion projecting through the board hole may be flared with pliers to further secure it. The main slot will hold 3 or 4: 0.025” diameter wires, 2: 0.032” wires or 5: 0.017” diameter wires. An 0.25” dia. wire can be pushed through the longitudinal hole with the terminal mounted in the board or through the holes perpendicular to the main slot. There is also a hole in the tab which accepts .018” transistor size wires and, if used, prevents terminal pull out.

Due to the thinness of the MICRO-KLIP (.042”) it is ideal for use in connecting integrated circuit leads which will lay in the slot or pass through the terminal vertically as preferred Material is copper alloy with bright tin plating.



ORDERING INFORMATION

CAT NO.	PKG. QTY	DESCRIPTION
T42-1	100	Terminals
T42-1	1000	Terminals
P149		Manual Installing Tool-Straight type
P149A		Manual Installing Tool-Wooden handle

11115 Vanowen St., North Hollywood, CA 91605 Phone (818) 985-8208
Toll-Free (800) 423-5659
Web site: http://www.vectorelect.com
VECTOR ELECTRONICS & TECHNOLOGY, INC.
A Fine Technology Group

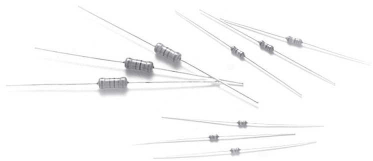
Preliminary

R1, R2

Metal Film Resistors

MFR Type

Normal & Miniature Style [MFR Series]



INTRODUCTION

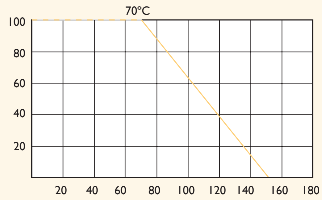
The MFR Series Metal Film Resistors are manufactured using vacuum sputtering system to deposit multiple layers of mixed metals alloy and passivative materials onto a carefully treated high grade ceramic substrate. After a helical groove has been cut in the resistive layer, tinned connecting leads of electrolytic copper are welded to the end-caps. The resistors are coated with layers of blue color lacquer.

FEATURES

Power Rating	1/6W, 1/4W, 1/2W, 1W, 2W, 3W
Resistance Tolerance	±0.5%, ±1%
T.C.R.	±15ppm/°C, ±25ppm/°C, ±50ppm/°C, ±100ppm/°C

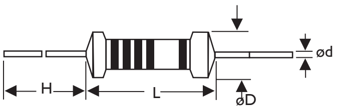
DERATING CURVE

For resistors operated in ambient temperatures above 70°C, power rating must be derated in accordance with the curve below.



DIMENSIONS

Unit : mm



STYLE		DIMENSION			
Normal	Miniature	L	øD	H	ød
MFR-12	MFR25S	3.4±0.3	1.9±0.2	28±2.0	0.45±0.05
MFR-25	MFR50S	6.3±0.5	2.4±0.2	28±2.0	0.55±0.05
MFR-50	MFR1WS	9.0±0.5	3.3±0.3	26±2.0	0.55±0.05
MFR100	MFR2WS	11.5±1.0	4.5±0.5	35±2.0	0.8±0.05
MFR200	MFR3WS	15.5±1.0	5.0±0.5	33±2.0	0.8±0.05

Note :

ELECTRICAL CHARACTERISTICS

STYLE	MFR-12	MFR25S	MFR-25	MFR50S	MFR-50	MFR1WS	MFR100	MFR2WS	MFR200	MFR3WS
Power Rating at 70°C	1/6W	1/4W		1/2W		1W		2W		3W
Maximum Working Voltage	200V		250V	300V	350V	400V	500V			
Maximum Overload Voltage	400V		500V	600V	700V	800V	1000V			
Dielectric Withstanding Voltage	300V	400V	500V			700V	1000V			
Resistance Range	1Ω ~ 10MΩ & 0Ω for E24 & E96 series value									
Operating Temp. Range	- 55°C to + 155°C									
Temperature Coefficient	±15ppm/°C, ±25ppm/°C, ±50ppm/°C, ±100ppm/°C									

* Below or over this resistance range on request.

ENVIRONMENTAL CHARACTERISTICS

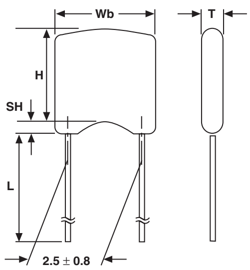
PERFORMANCE TEST	TEST METHOD		APPRAISE
Short Time Overload	JIS-C-5202 5.5	2.5 Times RCWV for 5 Seconds	±(0.25%+0.05Ω)
Dielectric Withstanding Voltage	JIS-C-5202 5.7	in V-Block for 60 Seconds	by Type
Temperature Coefficient	JIS-C-5202 5.2	-55°C to +155°C	by Type
Insulation Resistance	JIS-C-5202 5.6	in V-Block	>10000MΩ
Solderability	JIS-C-5202 6.5	260°C ±5°C for 5 ±0.5 Seconds	95% Min. Coverage
Resistance to Solvent	JIS-C-5202 6.9	IPA for 1 Min. with Ultrasonic	No deterioration of Coatings and Markings
Terminal Strength	JIS-C-5202 6.1	Direct load for 10 Sec. In the Direction of the Terminal Leads	≧2.5kg (24.5N)
Pulse Overload	JIS-C-5202 5.8	4 Times RCWV 10000 Cycles (1 Sec. On, 25 Sec. off)	±1.0%+0.05Ω
Load Life in Humidity	JIS-C-5202 7.9	40±2°C , 90~95% RH at RCWV for 1,000 Hrs. (1.5 Hrs. on , 0.5 Hrs. off)	±1.5%+0.05Ω
Load Life	JIS-C-5202 7.10	70°C at RCWV for 1,000 Hrs. (1.5 Hrs. on 0.5 Hrs. off)	±1.5%+0.05Ω
Temperature Cycling	JIS-C-5202 7.4	-55°C→Room Temp.→+155°C→Room Temp. for 5 Cycles	±0.75%+0.05Ω
Resistance to Soldering Heat	JIS-C-5202 6.4	350°C ±10°C for 3±0.5 Seconds	±0.25%+0.05Ω

* Rated Continuous Working Voltage (RCWV)= $\sqrt{\text{Power Rating} \times \text{Resistance Value}}$

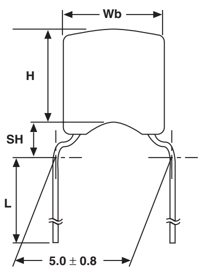
Dipped Radial Multilayer Ceramic Capacitors for 50 - 100 Vdc

RoHS COMPLIANT

DIMENSIONS

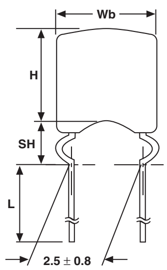


L2
Component outline for
Lead spacing 2.5 ± 0.8 mm
(straight leads)

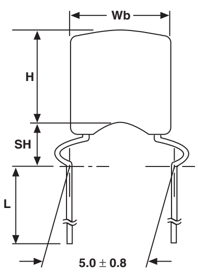


H5
Component outline for
Lead spacing 5.0 ± 0.8 mm
(flat bent leads)

L2 and H5 are preferred styles



K2
Component outline for
Lead spacing 2.5 ± 0.8 mm
(outside kink)



K5
Component outline for
Lead spacing 5.0 ± 0.8 mm
(outside kink)

CAPACITOR DIMENSIONS AND WEIGHT

SIZE	Wb_{MAX}	H_{MAX}	T_{MAX}	MAX. SEATING HEIGHT (SH)				WEIGHT (g)
				L2	H5	K2	K5	
15	4.0 (0.15)	4.0 (0.15)	2.5 (0.100)	1.58 (0.062)	2.54 (0.100)	3.50 (0.140)	3.50 (0.140)	≈ 0.15
20	5.0 (0.20)	5.0 (0.20)	3.2 (0.13)	1.58 (0.062)	2.54 (0.100)	3.50 (0.140)	3.50 (0.140)	≈ 0.16

Note

1. Bulk packed types have a standard lead length L = 25.4 mm (1.0 inch) minimum
2. Dimensions between parentheses are in inches
3. Thickness is defined as T

PLASTIC BATTERY HOLDERS

ECONOMICAL PLASTIC BATTERY HOLDERS

- Economical design, available with PC terminals or wire leads
- Batteries securely held in place to assure a positive connection and maintain a low contact resistance
- Contact springs self-adjust to variations in battery length
- Withstands shock and vibration
- Available with solder lugs or male/female snap fasteners
- For easy removal, available with ribbon

SPECIFICATIONS

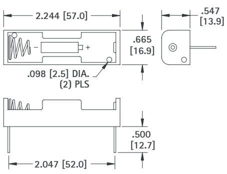
Holder: Polypropylene
Springs: Spring Steel, Nickel Plate
PC Pins: .031 (.79) thick Brass, Nickel Plate
Wires (Red & Black): #26 AWG, Tinned, .187 (4.8) end strip UL/CSA1007

MODIFICATIONS

We welcome the opportunity to quote on variations of standard items. Use our Engineering services for your custom-built holders. Holders for "C" and "D" cell are available on request.

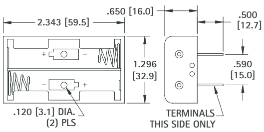
For "AA" • "AAA"

Holds One (1) "AA" Cell



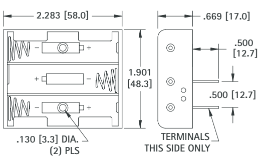
CAT. NO. 2460	PC Mount
CAT. NO. 2460RB	PC Mount w/ribbon
CAT. NO. 2461	Wire Leads - 6.0 (150)

Holds Two (2) "AA" Cells in Series



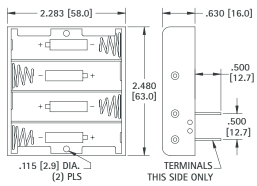
CAT. NO. 2462	PC Mount
CAT. NO. 2462RB	PC Mount w/ribbon
CAT. NO. 2463	Wire Leads - 6.0 (150)

Holds Three (3) "AA" Cells in Series



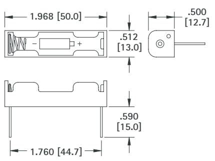
CAT. NO. 2464	PC Mount
CAT. NO. 2464RB	PC Mount w/ribbon
CAT. NO. 2465	Wire Leads - 6.0 (150)

Holds Four (4) "AA" Cells in Series



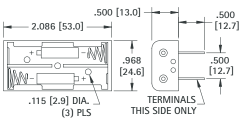
CAT. NO. 2477	PC Mount
CAT. NO. 2477RB	PC Mount w/ribbon
CAT. NO. 2478	Wire Leads - 6.0 (150)

Holds One (1) "AAA" Cell



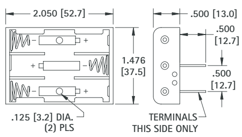
CAT. NO. 2466	PC Mount
CAT. NO. 2466RB	PC Mount w/ribbon
CAT. NO. 2467	Wire Leads - 6.0 (150)

Holds Two (2) "AAA" Cells in Series



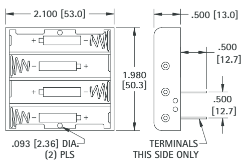
CAT. NO. 2468	PC Mount
CAT. NO. 2468RB	PC Mount w/ribbon
CAT. NO. 2469	Wire Leads - 6.0 (150)

Holds Three (3) "AAA" Cells in Series



CAT. NO. 2479	PC Mount
CAT. NO. 2479RB	PC Mount w/ribbon
CAT. NO. 2480	Wire Leads - 6.0 (150)

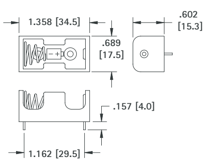
Holds Four (4) "AAA" Cells in Series



CAT. NO. 2481	PC Mount
CAT. NO. 2481RB	PC Mount w/ribbon
CAT. NO. 2482	Wire Leads - 6.0 (150)

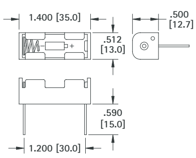
For "1/2 AA" • "N"

Holds One (1) "1/2 AA" Cell



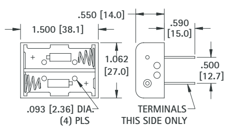
CAT. NO. 2485	PC Mount
CAT. NO. 2485RB	PC Mount w/ribbon
CAT. NO. 2486	Wire Leads - 6.0 (150)

Holds One (1) "N" Cell



CAT. NO. 2470	PC Mount
CAT. NO. 2470RB	PC Mount w/ribbon
CAT. NO. 2471	Wire Leads - 6.0 (150)

Holds Two (2) "N" Cells in Series



CAT. NO. 2472	PC Mount
CAT. NO. 2472RB	PC Mount w/ribbon
CAT. NO. 2473	Wire Leads - 6.0 (150)

Tel (718) 956-8900 • Fax (718) 956-9040
(800) 221-5510 • kec@keyelco.com
KEYSTONE
RoHS COMPLIANT ~ ISO 9001 CERTIFIED
www.keyelco.com
31-07 20th Road – Astoria, NY 11105-2017

2N3906

Preferred Device

General Purpose Transistors

PNP Silicon

Features

- Pb−Free Packages are Available*

MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector − Emitter Voltage	V_{CEO}	40	Vdc
Collector − Base Voltage	V_{CBO}	40	Vdc
Emitter − Base Voltage	V_{EBO}	5.0	Vdc
Collector Current − Continuous	I_C	200	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Power Dissipation @ T_A = 60°C	P_D	250	mW
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS (Note 1)

Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction−to−Case	$R_{\theta JC}$	83.3	°C/W

Stresses exceeding Maximum Ratings may damage the device. Maximum Ratings are stress ratings only. Functional operation above the Recommended Operating Conditions is not implied. Extended exposure to stresses above the Recommended Operating Conditions may affect device reliability.

1. Indicates Data in addition to JEDEC Requirements.

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

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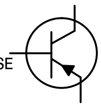
http://onsemi.com

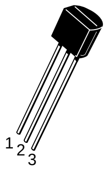
COLLECTOR
3

2
BASE

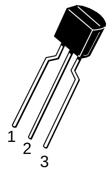


1
EMITTER

TO−92
CASE 29
STYLE 1

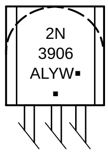


STRAIGHT LEAD
BULK PACK



BENT LEAD
TAPE & REEL
AMMO PACK

MARKING DIAGRAM



A = Assembly Location
L = Wafer Lot
Y = Year
W = Work Week
▪ = Pb−Free Package
(Note: Microdot may be in either location)

ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 3 of this data sheet.

Preferred devices are recommended choices for future use and best overall value.

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ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector−Emitter Breakdown Voltage (Note 2)	(I_C = 1.0 mAdc, I_B = 0)	$V_{(BR)CEO}$	40	–	Vdc
Collector−Base Breakdown Voltage	(I_C = 10 μAdc, I_E = 0)	$V_{(BR)CBO}$	40	–	Vdc
Emitter−Base Breakdown Voltage	(I_E = 10 μAdc, I_C = 0)	$V_{(BR)EBO}$	5.0	–	Vdc
Base Cutoff Current	(V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	I_{BL}	–	50	nAdc
Collector Cutoff Current	(V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)	I_{CEX}	–	50	nAdc
ON CHARACTERISTICS (Note 2)					
DC Current Gain	(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc) (I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc) (I_C = 10 mAdc, V_{CE} = 1.0 Vdc) (I_C = 50 mAdc, V_{CE} = 1.0 Vdc) (I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	h_{FE}	60 80 100 60 30	– – 300 – –	–
Collector−Emitter Saturation Voltage	(I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc	$V_{CE(sat)}$	– –	0.25 0.4	Vdc
Base−Emitter Saturation Voltage	(I_C = 10 mAdc, I_B = 1.0 mAdc) (I_C = 50 mAdc, I_B = 5.0 mAdc)	$V_{BE(sat)}$	0.65 –	0.85 0.95	Vdc
SMALL−SIGNAL CHARACTERISTICS					
Current−Gain − Bandwidth Product	(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	f_T	250	–	MHz
Output Capacitance	(V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)	C_{obo}	–	4.5	pF
Input Capacitance	(V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)	C_{ibo}	–	10	pF
Input Impedance	(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{ie}	2.0	12	kΩ
Voltage Feedback Ratio	(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{re}	0.1	10	X 10^{-4}
Small−Signal Current Gain	(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{fe}	100	400	–
Output Admittance	(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	h_{oe}	3.0	60	μmhos
Noise Figure	(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 kΩ, f = 1.0 kHz)	NF	–	4.0	dB
SWITCHING CHARACTERISTICS					
Delay Time	(V_{CC} = 3.0 Vdc, V_{BE} = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)	t_d	–	35	ns
Rise Time		t_r	–	35	ns
Storage Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	t_s	–	225	ns
Fall Time	(V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	t_f	–	75	ns

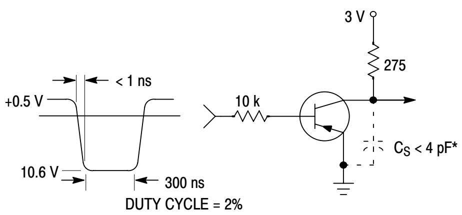
2. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2%.

2N3906

ORDERING INFORMATION

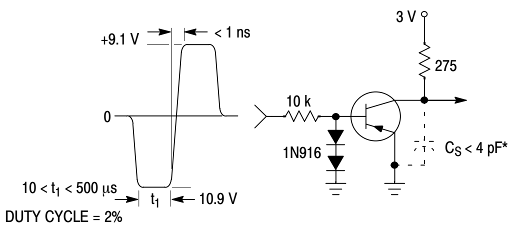
Device	Package	Shipping†
2N3906	TO−92	5000 Units / Bulk
2N3906G	TO−92 (Pb−Free)	5000 Units / Bulk
2N3906RL1	TO−92	5000 Units / Bulk
2N3906RL1G	TO−92 (Pb−Free)	5000 Units / Bulk
2N3906RLRA	TO−92	2000 / Tape & Reel
2N3906RLRAG	TO−92 (Pb−Free)	2000 / Tape & Reel
2N3906RLRM	TO−92	2000 / Ammo Pack
2N3906RLRMG	TO−92 (Pb−Free)	2000 / Ammo Pack
2N3906RLRP	TO−92	2000 / Tape & Reel
2N3906RLRPG	TO−92 (Pb−Free)	2000 / Tape & Reel

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.



* Total shunt capacitance of test jig and connectors

Figure 1. Delay and Rise Time Equivalent Test Circuit



* Total shunt capacitance of test jig and connectors

Figure 2. Storage and Fall Time Equivalent Test Circuit

2N3906

TYPICAL TRANSIENT CHARACTERISTICS

— $T_J = 25°C$
– – $T_J = 125°C$

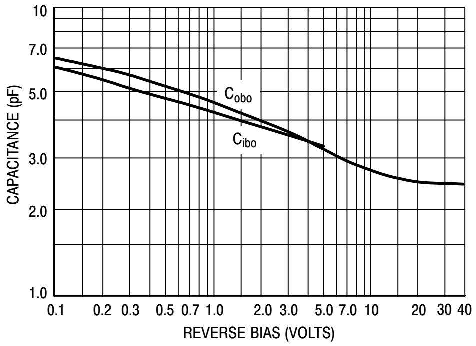


Figure 3. Capacitance

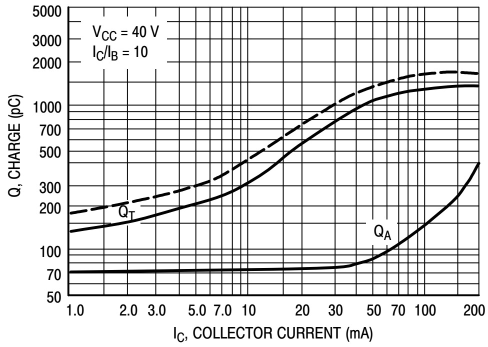


Figure 4. Charge Data

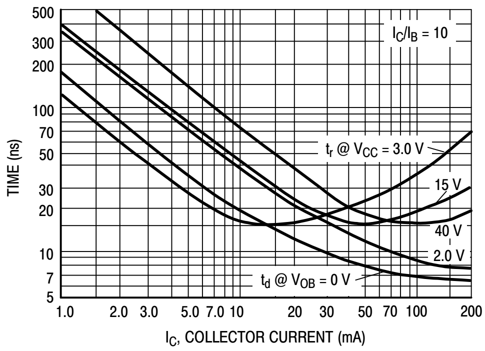


Figure 5. Turn−On Time

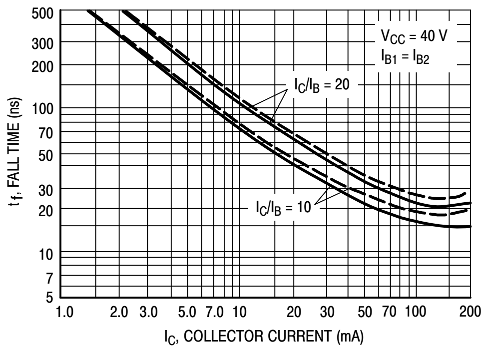


Figure 6. Fall Time

2N3906

TYPICAL AUDIO SMALL−SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

(V_{CE} = −5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)

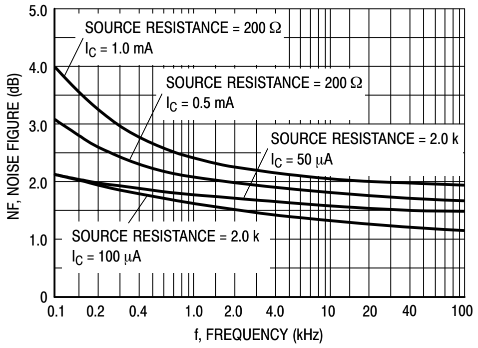


Figure 7.

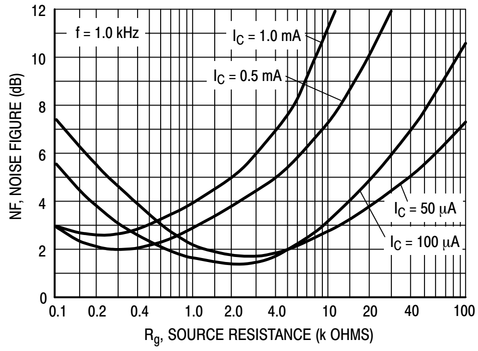


Figure 8.

h PARAMETERS

(V_{CE} = −10 Vdc, f = 1.0 kHz, T_A = 25°C)

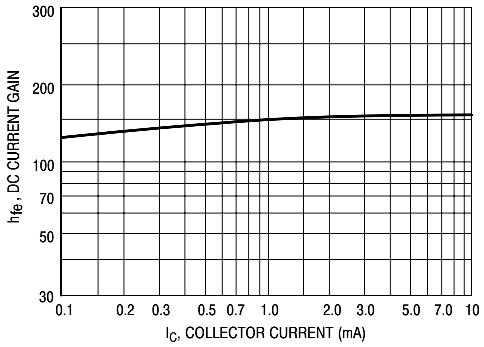


Figure 9. Current Gain

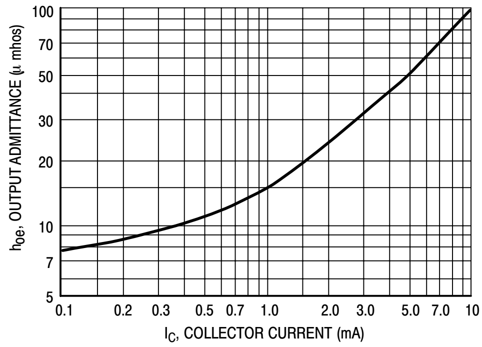


Figure 10. Output Admittance

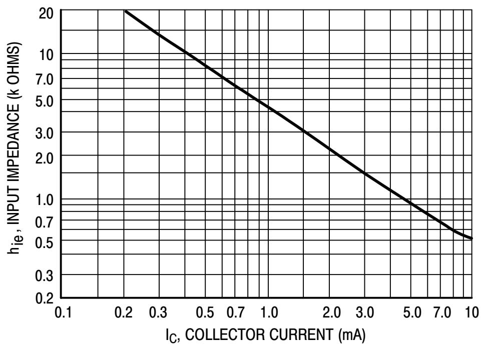


Figure 11. Input Impedance

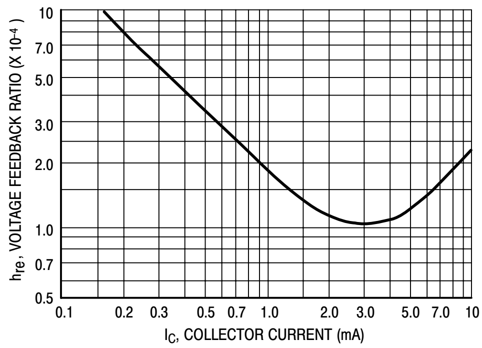


Figure 12. Voltage Feedback Ratio

2N3906

TYPICAL STATIC CHARACTERISTICS

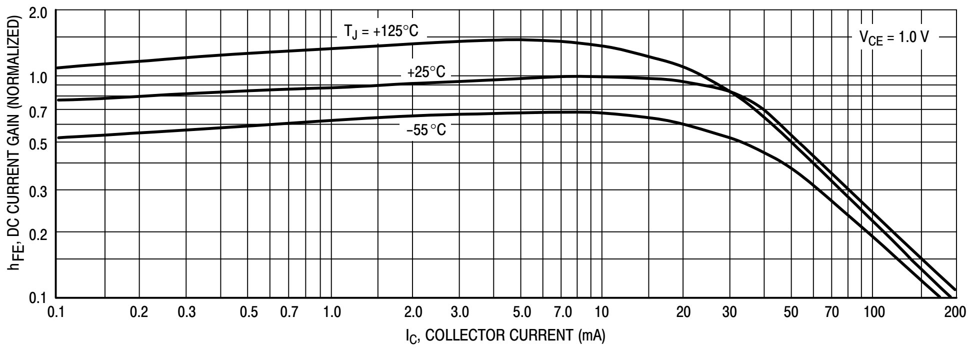


Figure 13. DC Current Gain

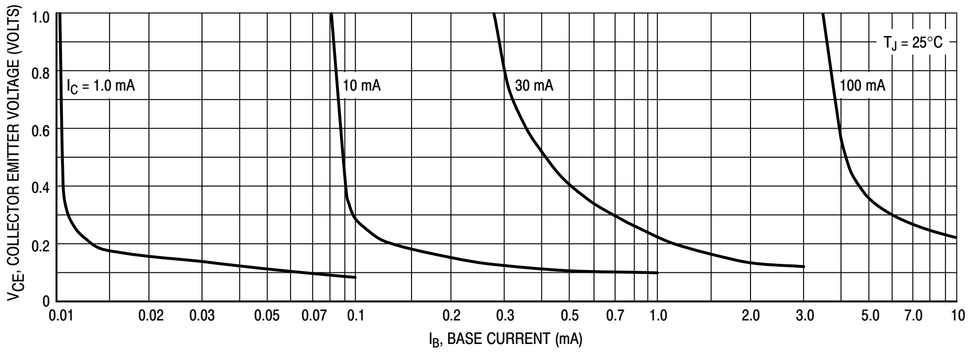


Figure 14. Collector Saturation Region

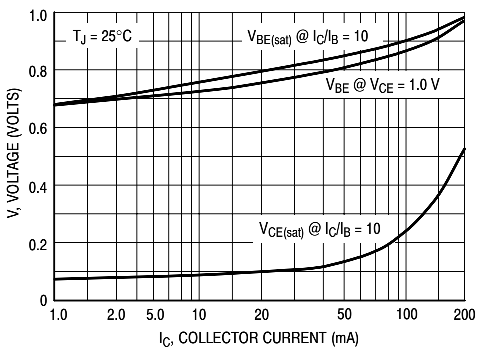


Figure 15. "ON" Voltages

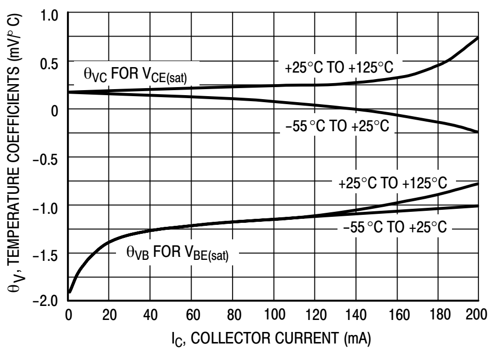


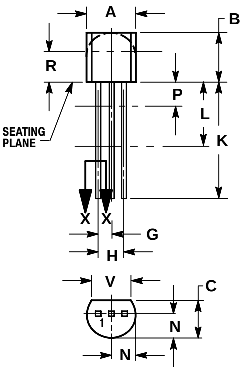
Figure 16. Temperature Coefficients

Q2

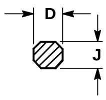
2N3906

PACKAGE DIMENSIONS

TO−92 (TO−226)
CASE 29−11
ISSUE AM



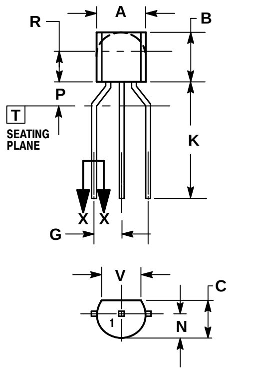
STRAIGHT LEAD
BULK PACK



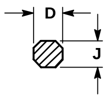
SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---



BENT LEAD
TAPE & REEL
AMMO PACK



SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ASME Y14.5M, 1994.
2. CONTROLLING DIMENSION: MILLIMETERS.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	MILLIMETERS	
DIM	MIN	MAX
A	4.45	5.20
B	4.32	5.33
C	3.18	4.19
D	0.40	0.54
G	2.40	2.80
J	0.39	0.50
K	12.70	---
N	2.04	2.66
P	1.50	4.00
R	2.93	---
V	3.43	---

STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

PUBLICATION ORDERING INFORMATION

LITERATURE FULFILLMENT:
Literature Distribution Center for ON Semiconductor
P.O. Box 5163, Denver, Colorado 80217 USA
Phone: 303−675−2175 or 800−344−3860 Toll Free USA/Canada
Fax: 303−675−2176 or 800−344−3867 Toll Free USA/Canada
Email: orderlit@onsemi.com

N. American Technical Support: 800−282−9855 Toll Free USA/Canada
Europe, Middle East and Africa Technical Support:
Phone: 421 33 790 2910
Japan Customer Focus Center
Phone: 81−3−5773−3850

ON Semiconductor Website: **www.onsemi.com**

Order Literature: http://www.onsemi.com/orderlit

For additional information, please contact your local Sales Representative

Preliminary

C2, C4

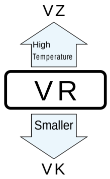
ALUMINUM ELECTROLYTIC CAPACITORS

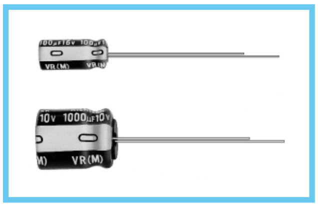
nichicon

VR Miniature Sized series

Anti-Solvent Feature (Through 100V only)

- One rank smaller case sizes than VX series.
- Adapted to the RoHS directive (2002/95/EC).





■Specifications

Item	Performance Characteristics
Category Temperature Range	–40 to +85˚C (6.3V to 400V), –25 to +85˚C (450V)
Rated Voltage Range	6.3 to 450V
Rated Capacitance Range	0.1 to 33000µF
Capacitance Tolerance	±20% at 120Hz, 20˚C
Leakage Current	(see table below)
tan δ	For capacitance of more than 1000µF, add 0.02 for every increase of 1000µF. Measurement frequency : 120Hz, Temperature : 20˚C
Stability at Low Temperature	Measurement frequency : 120Hz
Endurance	After 2000 hours' application of rated voltage at 85˚C,capacitors meet the characteristic requirements listed at right.
Shelf Life	After storing the capacitors under no load at 85˚C for 1000 hours, and after performing voltage treatment based on JIS C 5101-4 clause 4.1 at 20°C, they will meet the specified value for endurance characteristics listed above.
Marking	Printed with white color letter on black sleeve.

Leakage Current:

Rated voltage (V)	6.3 to 100V	160 to 450V
———	After 1 minute's application of rated voltage, leakage current is not more than 0.03CV or 4 (µA), whichever is greater. After 2 minutes' application of rated voltage, leakage current is not more than 0.01CV or 3 (µA), whichever is greater.	After 1 minute's application of rated voltage, CV ≦ 1000 : I = 0.1CV+40µA or less After 1 minute's application of rated voltage, CV > 1000 : I = 0.04CV+100 (µA) or less

tan δ:

Rated voltage (V)	6.3	10	16	25	35	50	63	100	160 to 315	350 to 450
tan δ (MAX.)	0.28	0.24	0.20	0.16	0.14	0.12	0.10	0.08	0.20	0.25

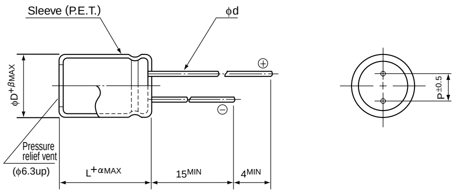
Stability at Low Temperature:

Rated voltage (V)		6.3	10	16	25	35	50	63	100	160 to 200	250 to 350	400	450
Impedance ratio	Z–25˚C / Z+20˚C	5	4	3	2	2	2	2	2	3	4	6	15
ZT / Z20 (MAX.)	Z–40˚C / Z+20˚C	12	10	8	5	4	3	3	3	4	8	10	—

Endurance:

Capacitance change	Within ±20% of initial value
tan δ	200% or less of initial specified value
Leakage current	Initial specified value or less

■Radial Lead Type



(mm)

φD	4	5	6.3	8	10	12.5	16	18	20	22	25
P	1.5	2.0	2.5	3.5	5.0	5.0	7.5	7.5	10.0	10.0	12.5
φd	0.45	0.5	0.5	0.6	0.6	0.6	0.8	0.8	1.0	1.0	1.0
β	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	1.0	1.0

α	(L<20) 1.5 (L≧20) 2.0

• Please refer to page 20 about the end seal configulation.

Type numbering system (Example : 10V 330µF)

1 2 3 4 5 6 7 8 9 10 11 12

U V R 1 A 3 3 1 M E D

- Configuration ※
- Capacitance tolerance (±20%)
- Rated Capacitance (330µF)
- Rated voltage (10V)
- Series name
- Type

※ Configuration

φ D	Pb-free leadwire Pb-free PET sleeve
4	DD6
5	DD
6.3	ED
8 · 10	PD
12.5 to 18	HD
20 to 25	RD

Please refer to page 20, 21, 22 about the formed or taped product spec.
Please refer to page 4 for the minimum order quantity.

● Dimension table in next page.

Preliminary

C2, C4

ALUMINUM ELECTROLYTIC CAPACITORS

nichicon

VR series

■Dimensions

Cap.(µF) \ V	Code	6.3 (0J)		10 (1A)		16 (1C)		25 (1E)		35 (1V)		50 (1H)		63 (1J)		100 (2A)	
0.1	0R1											• 5×11	1.3			5×11	2.1
0.22	R22											• 5×11	2.9			5×11	4.7
0.33	R33											• 5×11	4.3			5×11	7
0.47	R47											• 5×11	6.2			5×11	10
1	010											• 5×11	17			5×11	21
2.2	2R2											• 5×11	28			5×11	30
3.3	3R3											• 5×11	35			5×11	40
4.7	4R7							• 5×11	35	• 5×11	40	• 5×11	40			5×11	45
10	100					• 5×11	50	• 5×11	55	• 5×11	60	• 5×11	60	5×11	65	6.3×11	75
22	220	• 5×11	65	• 5×11	65	• 5×11	75	• 5×11	80	• 5×11	90	5×11	95	5×11	100	6.3×11	130
33	330	• 5×11	80	• 5×11	85	• 5×11	90	• 5×11	95	5×11	105	5×11	125	6.3×11	140	8×11.5	180
47	470	• 5×11	95	• 5×11	100	• 5×11	110	• 5×11	115	5×11	130	6.3×11	155	6.3×11	170	10×12.5	230
100	101	• 5×11	135	• 5×11	145	5×11	160	6.3×11	190	6.3×11	210	8×11.5	260	10×12.5	300	10×20	370
220	221	5×11	200	6.3×11	240	6.3×11	260	8×11.5	330	10×12.5	385	10×12.5	430	10×16	490	12.5×25	620
330	331	6.3×11	270	6.3×11	290	8×11.5	370	10×12.5	440	10×12.5	490	10×16	590	10×20	710	12.5×25	760
470	471	6.3×11	320	6.3×11	350	8×11.5	440	10×12.5	550	10×16	650	12.5×20	760	12.5×20	900	16×25	1000
1000	102	8×11.5	540	10×12.5	650	10×16	790	10×20	960	12.5×20	1150	12.5×25	1350	16×25	1300	18×40	1380
2200	222	10×20	1000	10×20	1100	12.5×20	1300	12.5×25	1550	16×25	1800	16×35.5	2100	18×35.5	2300	22×50 ▲25×40	2400 2400
3300	332	10×20	1190	12.5×20	1450	12.5×25	1700	16×25	1980	16×35.5	2280	18×35.5 ▲22×30	2500 2450	20×40 ▲25×30	2700 2600	25×50	2900
4700	472	12.5×20	1550	12.5×25	1800	16×25	2100	16×31.5	2450	18×35.5 ▲20×31	2700	20×40 ▲25×30	2900 2900	22×50 ▲25×40	3400 3200		
6800	682	12.5×25	1920	16×25	2250	16×35.5	2650	18×35.5 ▲20×31	2900 2700	20×40 ▲25×30	3000 2900	22×50 ▲25×40	3500 3300	25×50	3900		
10000	103	16×25	2350	16×35.5	2700	18×35.5 ▲20×31	2950 3000	20×40 ▲25×30	3000 2900	22×50 ▲25×40	3700 3600	25×50	4000				
15000	153	16×35.5	2850	18×35.5	3100	20×40 ▲25×30	3400 3300	22×50 ▲25×40	3800 3600	25×50	4300						
22000	223	18×40 ▲22×30	3350 3200	20×40 ▲25×30	3700 3300	22×50 ▲25×40	4200 4000	25×50	4500								
33000	333	22×50 ▲25×40	3900 3800	22×50 ▲25×40	4500 4800	25×50	4800									Case size φD×L (mm)	Rated ripple

Cap.(µF) \ V	Code	160 (2C)		200 (2D)		250 (2E)		315 (2F)		350 (2V)		400 (2G)		450 (2W)	
0.47	R47	6.3×11	15	6.3×11	15	6.3×11	15								
1	010	6.3×11	22	6.3×11	22	6.3×11	22	6.3×11	22	6.3×11	22	8×11.5	25	8×11.5	23
2.2	2R2	6.3×11	33	6.3×11	33	6.3×11	33	8×11.5	33	8×11.5	38	10×12.5	45	10×12.5	35
3.3	3R3	6.3×11	40	6.3×11	40	8×11.5	46	10×12.5	55	10×12.5	55	10×12.5	55	10×16	45
4.7	4R7	6.3×11	50	8×11.5	55	8×11.5	55	10×12.5	65	10×12.5	65	10×16	70	10×20	55
10	100	8×11.5	80	10×12.5	95	10×16	105	10×20	115	10×20	115	12.5×20	130	12.5×20	90
22	220	10×16	155	10×20	170	12.5×20	190	12.5×20	190	12.5×25	200	16×25	240	16×25	165
33	330	10×20	205	12.5×20	230	12.5×20	230	16×25	275	16×25	275	16×31.5	300	16×35.5	230
47	470	12.5×20	270	12.5×20	270	12.5×25	300	16×25	340	16×35.5	380	16×35.5	370	18×40 ▲22×30	300 290
100	101	12.5×25	430	16×31.5	530	16×31.5	520	18×35.5	560	18×40 ▲22×30	590 570	20×40 ▲25×30	550 530	22×40	350
220	221	16×35.5	800	18×35.5	810	20×40 ▲22×30	740 820	22×50 ▲25×30	850 770	22×50 ▲25×40	850 890	25×50	750		
330	331	18×40 ▲22×30	940 900	20×40 ▲25×30	1130 1090	22×50 ▲25×30	1170 970	25×50	1250						
470	471	22×40 ▲25×30	1410 1290	22×50 ▲25×40	1490 1550	25×50	1600							Case size φD×L (mm)	Rated ripple
1000	102	25×50	1900												

Size 4×11 is available for capacitors marked "•"
In this case, 6 will be put at 12th digit of type numbering system "▲"

Rated Ripple (mArms) at 85°C 120Hz

●Frequency coefficient of rated ripple current

V	Cap.(µF) \ Frequency	50Hz	120Hz	300Hz	1 kHz	10kHz or more
6.3 to 100	Less than 47	0.75	1.00	1.35	1.57	2.00
	100 to 470	0.80	1.00	1.23	1.34	1.50
	1000 to 33000	0.85	1.00	1.10	1.13	1.15
160 to 450	0.47 to 220	0.80	1.00	1.25	1.40	1.60
	330 to 1000	0.90	1.00	1.10	1.13	1.15

Preliminary

Q1

2N3903, 2N3904

2N3903 is a Preferred Device

General Purpose Transistors

NPN Silicon

ON Semiconductor®

http://onsemi.com

Features

- Pb−Free Package May be Available. The G−Suffix Denotes a Pb−Free Lead Finish

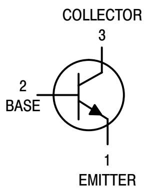
MAXIMUM RATINGS

Rating	Symbol	Value	Unit
Collector−Emitter Voltage	V_{CEO}	40	Vdc
Collector−Base Voltage	V_{CBO}	60	Vdc
Emitter−Base Voltage	V_{EBO}	6.0	Vdc
Collector Current − Continuous	I_C	200	mAdc
Total Device Dissipation @ T_A = 25°C Derate above 25°C	P_D	625 5.0	mW mW/°C
Total Device Dissipation @ T_C = 25°C Derate above 25°C	P_D	1.5 12	W mW/°C
Operating and Storage Junction Temperature Range	T_J, T_{stg}	−55 to +150	°C

THERMAL CHARACTERISTICS (Note 1)

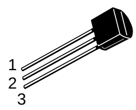
Characteristic	Symbol	Max	Unit
Thermal Resistance, Junction−to−Ambient	$R_{\theta JA}$	200	°C/W
Thermal Resistance, Junction−to−Case	$R_{\theta JC}$	83.3	°C/W

1. Indicates Data in addition to JEDEC Requirements.



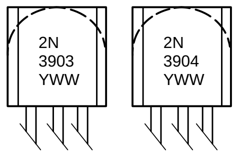
STYLE 1

*For additional information on our Pb−Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.



TO−92
CASE 29
STYLE 1

MARKING DIAGRAMS



Y = Year
WW = Work Week

ORDERING INFORMATION

Device	Package	Shipping†
2N3903	TO−92	5000 Units/Box
2N3903RLRM	TO−92	2000/Ammo Pack
2N3904	TO−92	5000 Units/Box
2N3904RLRA	TO−92	2000/Tape & Reel
2N3904RLRE	TO−92	2000/Tape & Reel
2N3904RLRM	TO−92	2000/Ammo Pack
2N3904RLRMG	TO−92	2000/Ammo Pack
2N3904RLRP	TO−92	2000/Ammo Pack
2N3904RL1	TO−92	2000/Tape & Reel
2N3904ZL1	TO−92	2000/Ammo Pack

†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

Preferred devices are recommended choices for future use and best overall value.

Q1

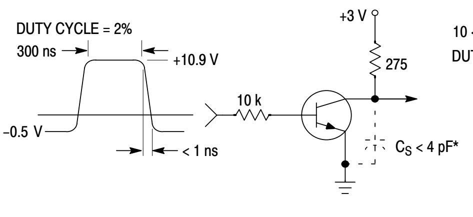
2N3903, 2N3904

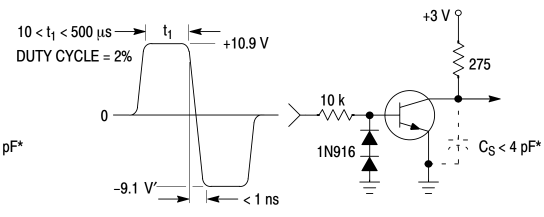
ELECTRICAL CHARACTERISTICS (T_A = 25°C unless otherwise noted)

Characteristic		Symbol	Min	Max	Unit
OFF CHARACTERISTICS					
Collector−Emitter Breakdown Voltage (Note 2) (I_C = 1.0 mAdc, I_B = 0)		$V_{(BR)CEO}$	40	−	Vdc
Collector−Base Breakdown Voltage (I_C = 10 μAdc, I_E = 0)		$V_{(BR)CBO}$	60	−	Vdc
Emitter−Base Breakdown Voltage (I_E = 10 μAdc, I_C = 0)		$V_{(BR)EBO}$	6.0	−	Vdc
Base Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)		I_{BL}	−	50	nAdc
Collector Cutoff Current (V_{CE} = 30 Vdc, V_{EB} = 3.0 Vdc)		I_{CEX}	−	50	nAdc
ON CHARACTERISTICS					
DC Current Gain (Note 2)		h_{FE}			−
(I_C = 0.1 mAdc, V_{CE} = 1.0 Vdc)	2N3903		20	−	
	2N3904		40	−	
(I_C = 1.0 mAdc, V_{CE} = 1.0 Vdc)	2N3903		35	−	
	2N3904		70	−	
(I_C = 10 mAdc, V_{CE} = 1.0 Vdc)	2N3903		50	150	
	2N3904		100	300	
(I_C = 50 mAdc, V_{CE} = 1.0 Vdc)	2N3903		30	−	
	2N3904		60	−	
(I_C = 100 mAdc, V_{CE} = 1.0 Vdc)	2N3903		15	−	
	2N3904		30	−	
Collector−Emitter Saturation Voltage (Note 2)		$V_{CE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			−	0.2	
(I_C = 50 mAdc, I_B = 5.0 mAdc			−	0.3	
Base−Emitter Saturation Voltage (Note 2)		$V_{BE(sat)}$			Vdc
(I_C = 10 mAdc, I_B = 1.0 mAdc)			0.65	0.85	
(I_C = 50 mAdc, I_B = 5.0 mAdc)			−	0.95	
SMALL−SIGNAL CHARACTERISTICS					
Current−Gain − Bandwidth Product		f_T			MHz
(I_C = 10 mAdc, V_{CE} = 20 Vdc, f = 100 MHz)	2N3903		250	−	
	2N3904		300	−	
Output Capacitance (V_{CB} = 5.0 Vdc, I_E = 0, f = 1.0 MHz)		C_{obo}	−	4.0	pF
Input Capacitance (V_{EB} = 0.5 Vdc, I_C = 0, f = 1.0 MHz)		C_{ibo}	−	8.0	pF
Input Impedance		h_{ie}			k Ω
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3903		1.0	8.0	
	2N3904		1.0	10	
Voltage Feedback Ratio		h_{re}			X 10^{-4}
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3903		0.1	5.0	
	2N3904		0.5	8.0	
Small−Signal Current Gain		h_{fe}			−
(I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)	2N3903		50	200	
	2N3904		100	400	
Output Admittance (I_C = 1.0 mAdc, V_{CE} = 10 Vdc, f = 1.0 kHz)		h_{oe}	1.0	40	μmhos
Noise Figure		NF			dB
(I_C = 100 μAdc, V_{CE} = 5.0 Vdc, R_S = 1.0 k Ω, f = 1.0 kHz)	2N3903		−	6.0	
	2N3904		−	5.0	
SWITCHING CHARACTERISTICS					
Delay Time — (V_{CC} = 3.0 Vdc, V_{BE} = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)		t_d	−	35	ns
Rise Time — (V_{CC} = 3.0 Vdc, V_{BE} = 0.5 Vdc, I_C = 10 mAdc, I_{B1} = 1.0 mAdc)		t_r	−	35	ns
Storage Time — (V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)	2N3903	t_s	−	175	ns
	2N3904		−	200	
Fall Time — (V_{CC} = 3.0 Vdc, I_C = 10 mAdc, I_{B1} = I_{B2} = 1.0 mAdc)		t_f	−	50	ns

2. Pulse Test: Pulse Width ≤ 300 μs; Duty Cycle ≤ 2%.

Q1





* Total shunt capacitance of test jig and connectors

Figure 1. Delay and Rise Time Equivalent Test Circuit

Figure 2. Storage and Fall Time Equivalent Test Circuit

2N3903, 2N3904

TYPICAL TRANSIENT CHARACTERISTICS

T_J = 25°C
T_J = 125°C

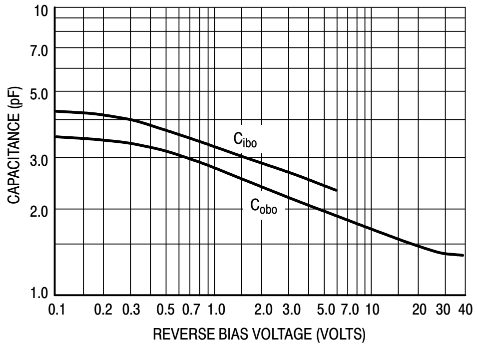


Figure 3. Capacitance

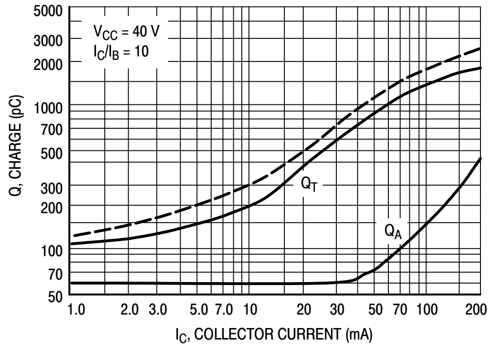


Figure 4. Charge Data

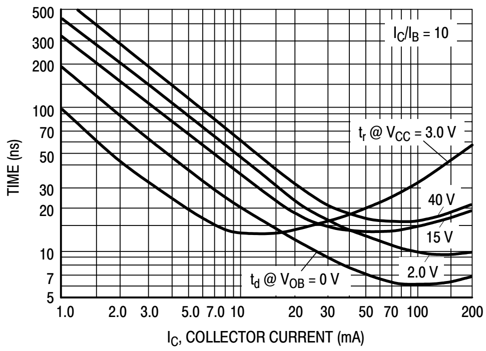


Figure 5. Turn−On Time

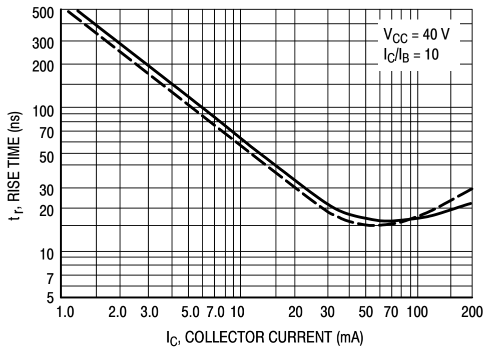


Figure 6. Rise Time

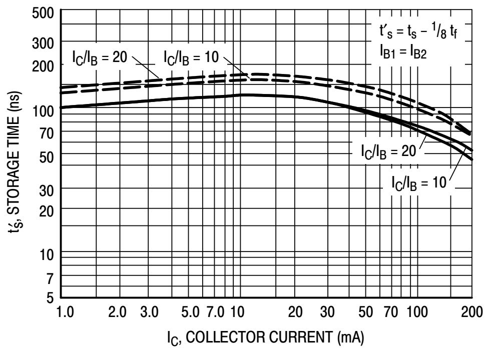


Figure 7. Storage Time

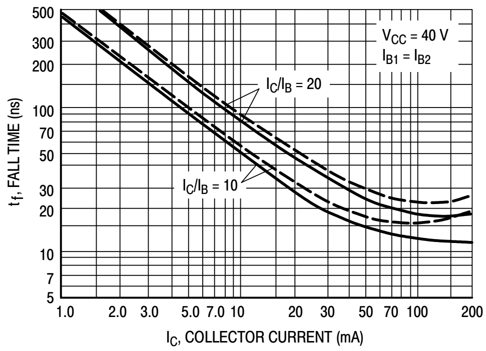


Figure 8. Fall Time

Q1

TYPICAL AUDIO SMALL−SIGNAL CHARACTERISTICS
NOISE FIGURE VARIATIONS

(V_{CE} = 5.0 Vdc, T_A = 25°C, Bandwidth = 1.0 Hz)

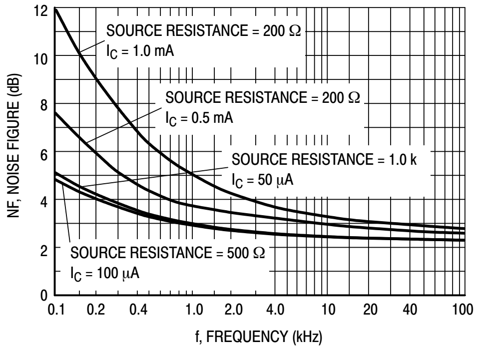


Figure 9.

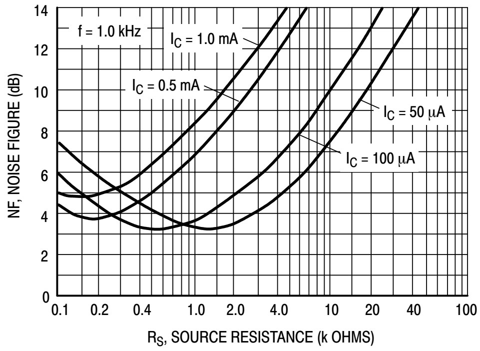


Figure 10.

h PARAMETERS

(V_{CE} = 10 Vdc, f = 1.0 kHz, T_A = 25°C)

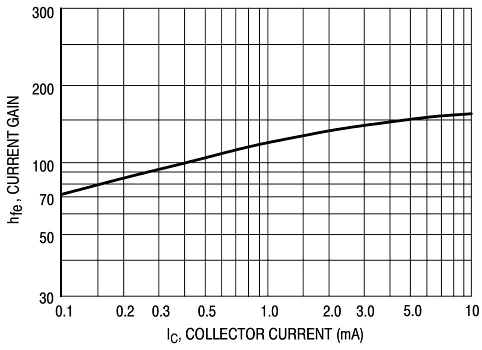


Figure 11. Current Gain

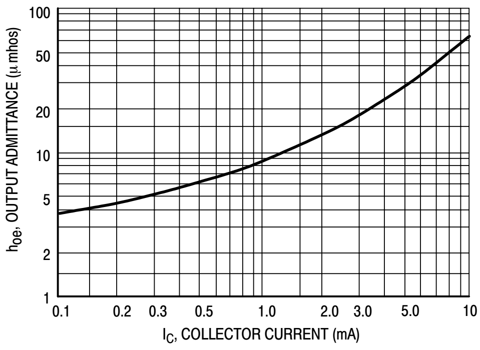


Figure 12. Output Admittance

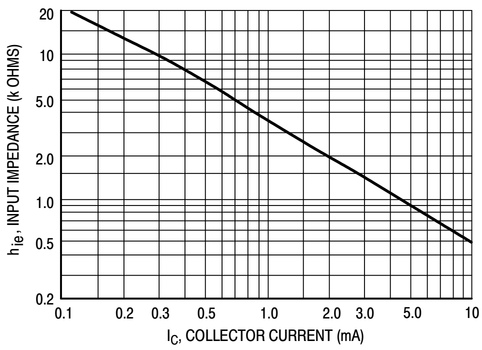


Figure 13. Input Impedance

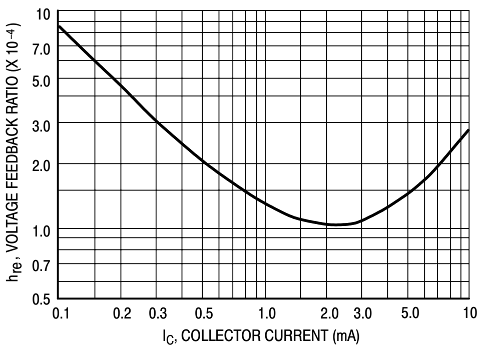


Figure 14. Voltage Feedback Ratio

Q1

TYPICAL STATIC CHARACTERISTICS

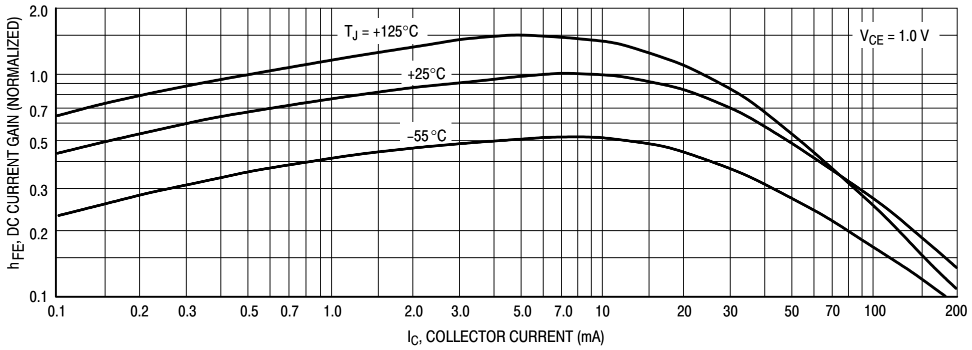


Figure 15. DC Current Gain

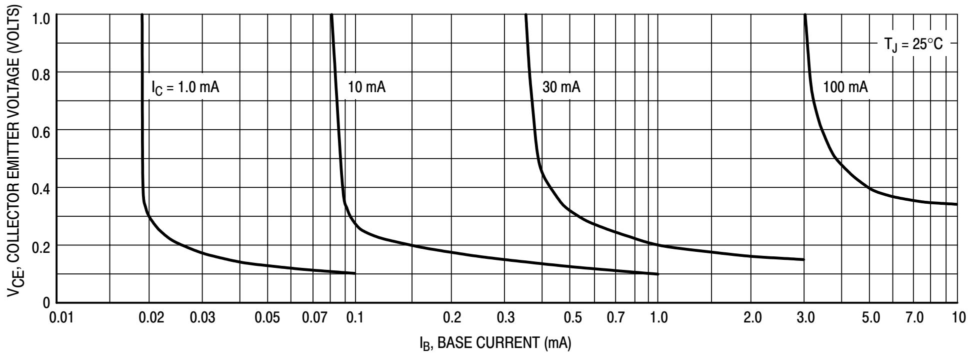


Figure 16. Collector Saturation Region

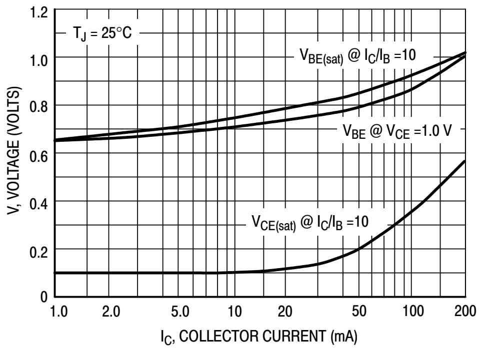


Figure 17. “ON” Voltages

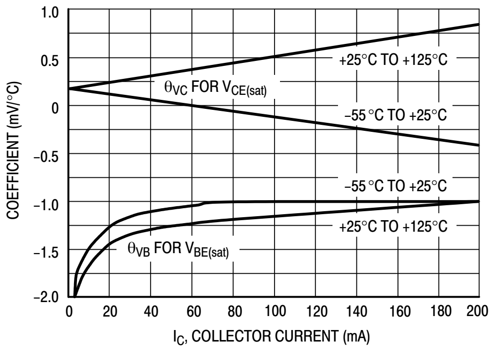
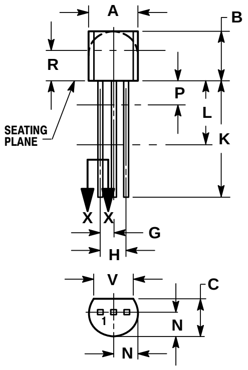


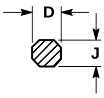
Figure 18. Temperature Coefficients

2N3903, 2N3904

PACKAGE DIMENSIONS

TO−92
TO−226AA
CASE 29−11
ISSUE AL





SECTION X−X

NOTES:
1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. CONTOUR OF PACKAGE BEYOND DIMENSION R IS UNCONTROLLED.
4. LEAD DIMENSION IS UNCONTROLLED IN P AND BEYOND DIMENSION K MINIMUM.

	INCHES		MILLIMETERS	
DIM	MIN	MAX	MIN	MAX
A	0.175	0.205	4.45	5.20
B	0.170	0.210	4.32	5.33
C	0.125	0.165	3.18	4.19
D	0.016	0.021	0.407	0.533
G	0.045	0.055	1.15	1.39
H	0.095	0.105	2.42	2.66
J	0.015	0.020	0.39	0.50
K	0.500	---	12.70	---
L	0.250	---	6.35	---
N	0.080	0.105	2.04	2.66
P	---	0.100	---	2.54
R	0.115	---	2.93	---
V	0.135	---	3.43	---

STYLE 1:
PIN 1. EMITTER
2. BASE
3. COLLECTOR

STYLE 14:
PIN 1. EMITTER
2. COLLECTOR
3. BASE

Preliminary

Q1

2N3903, 2N3904

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