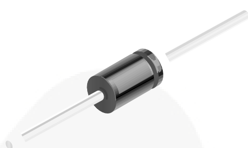
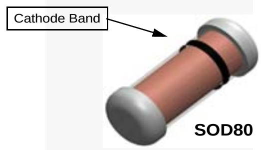
June 2015

1N/FDLL 914/A/B / 916/A/B / 4148 / 4448
Small Signal Diode



DO-35
Cathode is denoted with a black band



LL-34
THE PLACEMENT OF THE EXPANSION GAP HAS NO RELATIONSHIP TO THE LOCATION OF THE CATHODE TERMINAL

SOD-80 COLOR BAND MARKING

DEVICE	1ST BAND
FDLL914	BLACK
FDLL914A	BLACK
FDLL914B	BLACK
FDLL4148	BLACK
FDLL4448	BLACK

-1st band denotes cathode terminal and has wider width

Ordering Information

Part Number	Marking	Package	Packing Method
1N914	914	DO-204AH (DO-35)	Bulk
1N914_T50A	914	DO-204AH (DO-35)	Ammo
1N914TR	914	DO-204AH (DO-35)	Tape and Reel
1N914ATR	914A	DO-204AH (DO-35)	Tape and Reel
1N914B	914B	DO-204AH (DO-35)	Bulk
1N914BTR	914B	DO-204AH (DO-35)	Tape and Reel
1N916	916	DO-204AH (DO-35)	Bulk
1N916A	916A	DO-204AH (DO-35)	Bulk
1N916B	916B	DO-204AH (DO-35)	Bulk
1N4148	4148	DO-204AH (DO-35)	Bulk
1N4148TA	4148	DO-204AH (DO-35)	Ammo
1N4148_T26A	4148	DO-204AH (DO-35)	Ammo
1N4148_T50A	4148	DO-204AH (DO-35)	Ammo
1N4148TR	4148	DO-204AH (DO-35)	Tape and Reel
1N4148_T50R	4148	DO-204AH (DO-35)	Tape and Reel
1N4448	4448	DO-204AH (DO-35)	Bulk
1N4448TR	4448	DO-204AH (DO-35)	Tape and Reel
FDLL914	Black	SOD-80	Tape and Reel
FDLL914A	Black	SOD-80	Tape and Reel
FDLL914B	Black	SOD-80	Tape and Reel
FDLL4148	Black	SOD-80	Tape and Reel
FDLL4148_D87Z	Black	SOD-80	Tape and Reel
FDLL4448	Black	SOD-80	Tape and Reel
FDLL4448_D87Z	Black	SOD-80	Tape and Reel

Absolute Maximum Ratings[1]

Stresses exceeding the absolute maximum ratings may damage the device. The device may not function or be operable above the recommended operating conditions and stressing the parts to these levels is not recommended. In addition, extended exposure to stresses above the recommended operating conditions may affect device reliability. The absolute maximum ratings are stress ratings only. Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter		Value	Unit
V_{RRM}	Maximum Repetitive Reverse Voltage		100	V
I_O	Average Rectified Forward Current		200	mA
I_F	DC Forward Current		300	mA
I_f	Recurrent Peak Forward Current		400	mA
I_{FSM}	Non-repetitive Peak Forward Surge Current	Pulse Width = 1.0 s	1.0	A
		Pulse Width = 1.0 µs	4.0	A
T_{STG}	Storage Temperature Range		-65 to +200	°C
T_J	Operating Junction Temperature Range		-55 to +175	°C

Note:
1. These ratings are limiting values above which the serviceability of the diode may be impaired.

Thermal Characteristics

Symbol	Parameter	Max.	Unit
		1N/FDLL 914/A/B / 916/A/B / 4148 / 4448	
P_D	Power Dissipation	500	mW
$R_{\theta JA}$	Thermal Resistance, Junction-to-Ambient	300	°C/W

Electrical Characteristics[2]

Values are at T_A = 25°C unless otherwise noted.

Symbol	Parameter		Conditions	Min.	Max.	Unit
V_R	Breakdown Voltage		I_R= 100 µA	100		V
			I_R= 5.0 µA	75		V
V_F	Forward Voltage	914B / 4448	I_F= 5.0 mA	0.62	0.72	V
		916B	I_F= 5.0 mA	0.63	0.73	V
		914 / 916 / 4148	I_F= 10 mA		1.0	V
		914A / 916A	I_F= 20 mA		1.0	V
		916B	I_F= 20 mA		1.0	V
		914B / 4448	I_F= 100 mA		1.0	V
I_R	Reverse Leakage		V_R= 20 V		0.025	µA
			V_R= 20 V, T_A= 150°C		50	µA
			V_R= 75 V		5.0	µA
C_T	Total Capacitance	916/916A/916B/4448	V_R = 0, f = 1.0 MHz		2.0	pF
		914/914A/914B/4148	V_R = 0, f = 1.0 MHz		4.0	pF
t_{rr}	Reverse Recovery Time		I_F = 10 mA, V_R = 6.0 V (600 mA) I_{rr} = 1.0 mA, R_L = 100 Ω		4.0	ns

Note:
2. Non-recurrent square wave P_W= 8.3 ms.

Typical Performance Characteristics

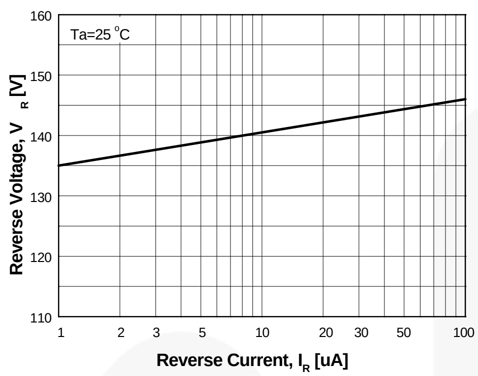
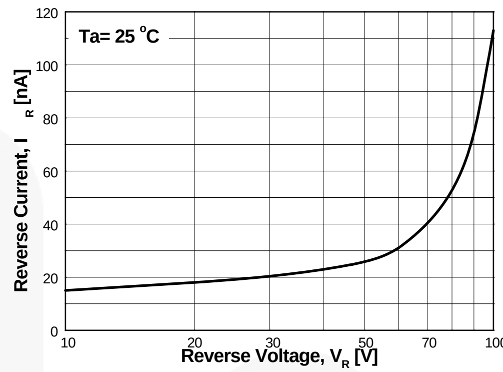


Figure 1. Reverse Voltage vs. Reverse Current
B_V - 1.0 to 100 µA



GENERAL RULE: The Reverse Current of a diode will approximately double for every ten (10) Degree C increase in Temperature

Figure 2. Reverse Current vs. Reverse Voltage
I_R - 10 to 100 V

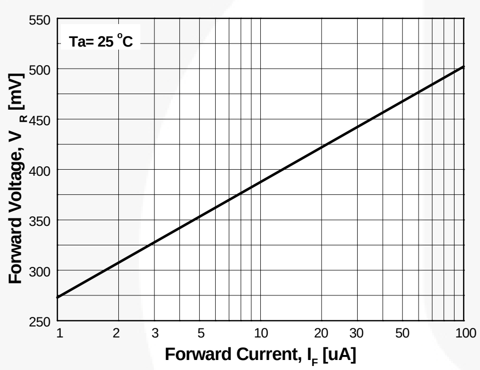


Figure 3. Forward Voltage vs. Forward Current
V_F - 1 to 100 µA

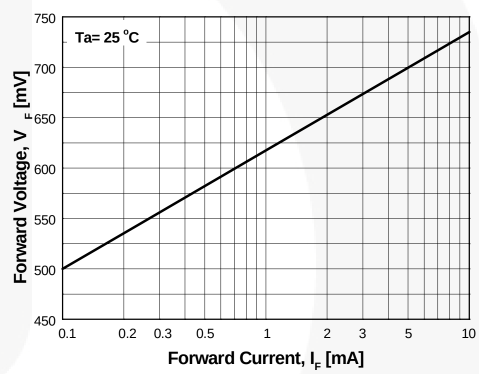


Figure 4. Forward Voltage vs. Forward Current
V_F - 0.1 to 10 mA

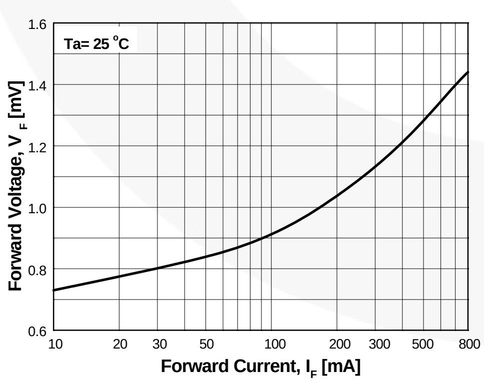


Figure 5. Forward Voltage vs. Forward Current
V_F - 10 to 800 mA

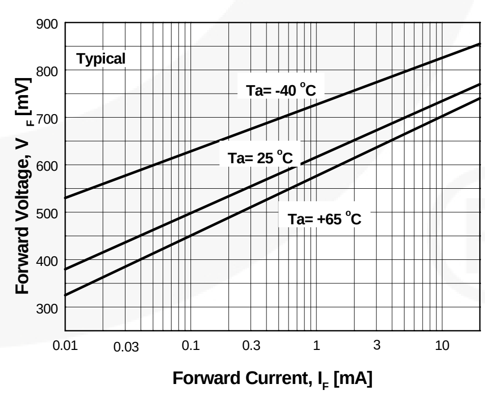


Figure 6. Forward Voltage vs. Ambient Temperature
V_F - 0.01 - 20 mA (- 40 to +65°C)

Typical Performance Characteristics (Continued)

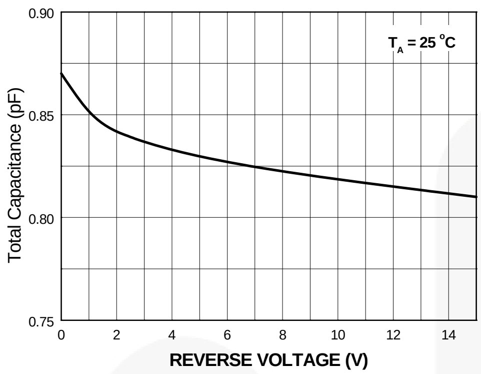


Figure 7. Total Capacitance

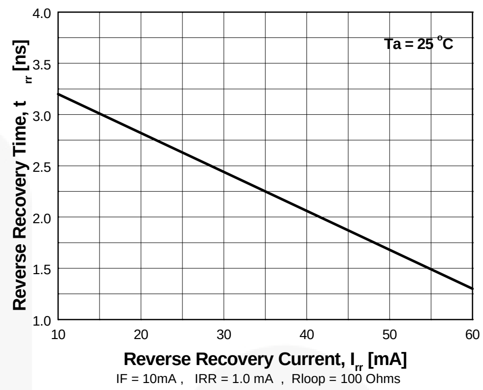


Figure 8. Reverse Recovery Time vs. Reverse Recovery Current

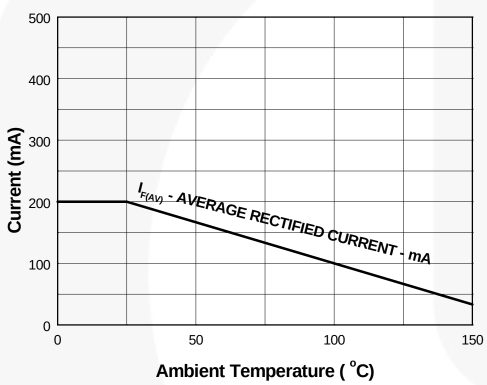


Figure 9. Average Rectified Current ($I_{F(AV)}$) vs. Ambient Temperature (T_A)

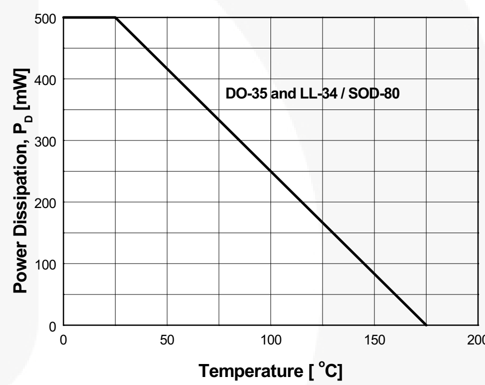
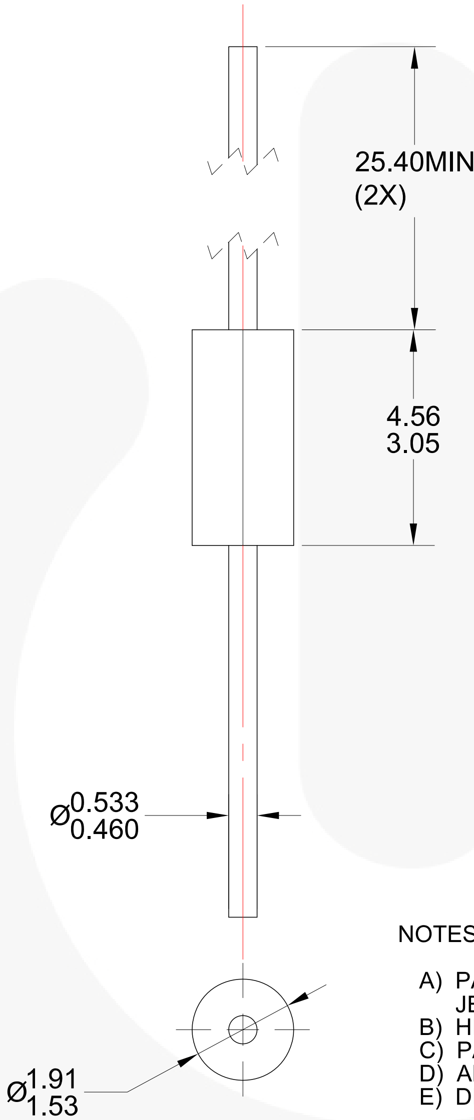


Figure 10. Power Derating Curve

Physical Dimensions

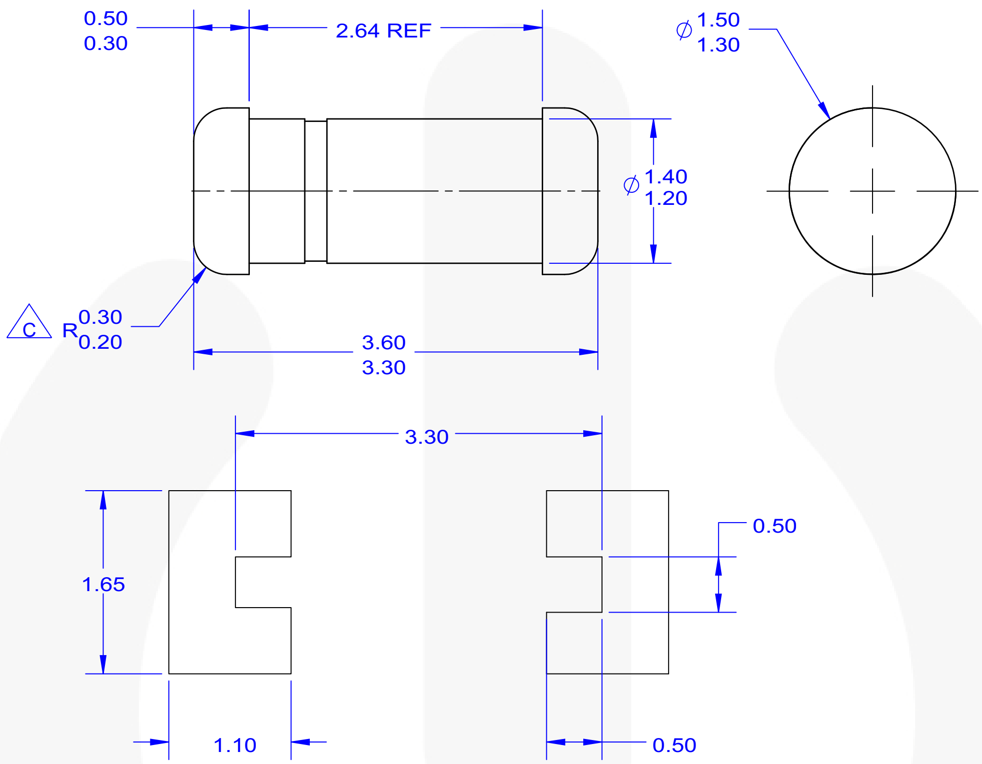


NOTES: UNLESS OTHERWISE SPECIFIED

A) PACKAGE STANDARD REFERENCE:
JEDEC DO-204, VARIATION AH.
B) HERMETICALLY SEALED GLASS PACKAGE.
C) PACKAGE WEIGHT IS 0.137 GRAM.
D) ALL DIMENSIONS ARE IN MILLIMETERS.
E) DRAWING FILE NAME:DO35AREV02

Figure 11. AXIAL LEADED, GLASS, JEDEC DO204, VARIATION AH, DO-204AH (DO-35)

Physical Dimensions (Continued)



LAND PATTERN RECOMMENDATION

NOTES: UNLESS OTHERWISE SPECIFIED

A) PACKAGE STANDARD REFERENCE:
JEDEC DO-213, VARIATION AC.

B) ALL DIMENSIONS ARE IN MILLIMETERS.

C) CORNER RADIUS IS OPTIONAL.

D) LAND PATTERN RECOMMENDATION PER IPC DIOMELF3414N

E) DRAWING FILE NAME: SOD80A REV3

Figure 12. 2-TERMINAL, SOD-80, JEDEC DO-213AC, MINI-MELF

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Definition of Terms

Datasheet Identification	Product Status	Definition
Advance Information	Formative / In Design	Datasheet contains the design specifications for product development. Specifications may change in any manner without notice.
Preliminary	First Production	Datasheet contains preliminary data; supplementary data will be published at a later date. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve design.
No Identification Needed	Full Production	Datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice to improve the design.
Obsolete	Not In Production	Datasheet contains specifications on a product that is discontinued by Fairchild Semiconductor. The datasheet is for reference information only.

Rev. I74

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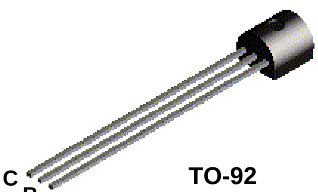
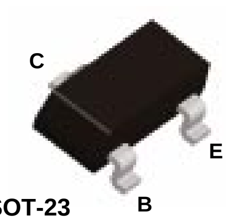
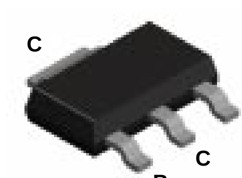
2N3904



MMBT3904



PZT3904



NPN General Purpose Amplifier

This device is designed as a general purpose amplifier and switch. The useful dynamic range extends to 100 mA as a switch and to 100 MHz as an amplifier. Sourced from Process 23.

Absolute Maximum Ratings*

TA = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	60	V
V_{EBO}	Emitter-Base Voltage	6.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.

Electrical Characteristics

TA = 25°C unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage	I_C = 1.0 mA, I_B = 0	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	I_C = 10 μA, I_E = 0	60		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	I_E = 10 μA, I_C = 0	6.0		V
I_{BL}	Base Cutoff Current	V_{CE} = 30 V, V_{EB} = 0		50	nA
I_{CEX}	Collector Cutoff Current	V_{CE} = 30 V, V_{EB} = 0		50	nA
ON CHARACTERISTICS*					
h_{FE}	DC Current Gain	I_C = 0.1 mA, V_{CE} = 1.0 V I_C = 1.0 mA, V_{CE} = 1.0 V I_C = 10 mA, V_{CE} = 1.0 V I_C = 50 mA, V_{CE} = 1.0 V I_C = 100 mA, V_{CE} = 1.0 V	40 70 100 60 30	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA I_C = 50 mA, I_B = 5.0 mA		0.2 0.3	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	I_C = 10 mA, I_B = 1.0 mA I_C = 50 mA, I_B = 5.0 mA	0.65	0.85 0.95	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	I_C = 10 mA, V_{CE} = 20 V, f = 100 MHz	300		MHz
C_{obo}	Output Capacitance	V_{CB} = 5.0 V, I_E = 0, f = 1.0 MHz		4.0	pF
C_{ibo}	Input Capacitance	V_{EB} = 0.5 V, I_C = 0, f = 1.0 MHz		8.0	pF
NF	Noise Figure (except MMPQ3904)	I_C = 100 μA, V_{CE} = 5.0 V, R_S =1.0kΩ, f=10 Hz to 15.7 kHz		5.0	dB
SWITCHING CHARACTERISTICS (except MMPQ3904)					
t_d	Delay Time	V_{CC} = 3.0 V, V_{BE} = 0.5 V,		35	ns
t_r	Rise Time	I_C = 10 mA, I_{B1} = 1.0 mA		35	ns
t_s	Storage Time	V_{CC} = 3.0 V, I_C = 10mA		200	ns
t_f	Fall Time	I_{B1} = I_{B2} = 1.0 mA		50	ns

*Pulse Test: Pulse Width ≤ 300 μs, Duty Cycle ≤ 2.0%

Spice Model

NPN (Is=6.734f Xti=3 Eg=1.11 Vaf=74.03 Bf=416.4 Ne=1.259 Ise=6.734 Ikf=66.78m Xtb=1.5 Br=.7371 Nc=2 Isc=0 Ikr=0 Rc=1 Cjc=3.638p Mjc=.3085 Vjc=.75 Fc=.5 Cje=4.493p Mje=.2593 Vje=.75 Tr=239.5n Tf=301.2p Itf=.4 Vtf=4 Xtf=2 Rb=10)

NPN General Purpose Amplifier
(continued)

Thermal Characteristics
TA = 25°C unless otherwise noted

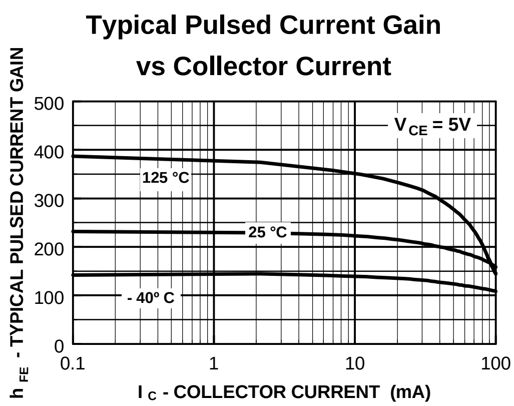
Symbol	Characteristic	Max		Units
		2N3904	*PZT3904	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	1,000 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3		°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	125	°C/W

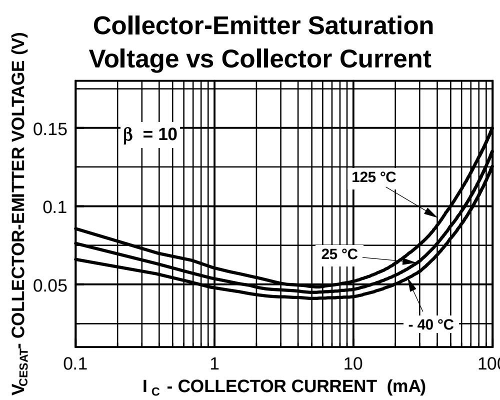
Symbol	Characteristic	Max		Units
		**MMBT3904	MMPQ3904	
P_D	Total Device Dissipation Derate above 25°C	350 2.8	1,000 8.0	mW mW/°C
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient Effective 4 Die Each Die	357	 125 240	°C/W °C/W °C/W

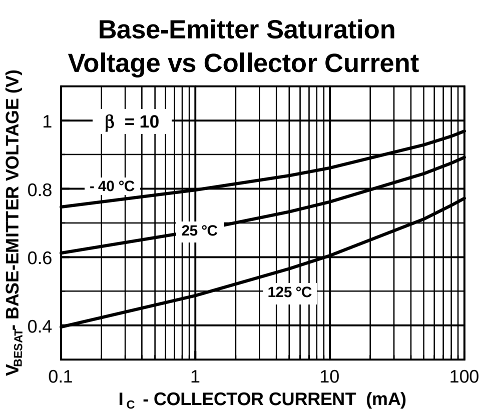
*Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

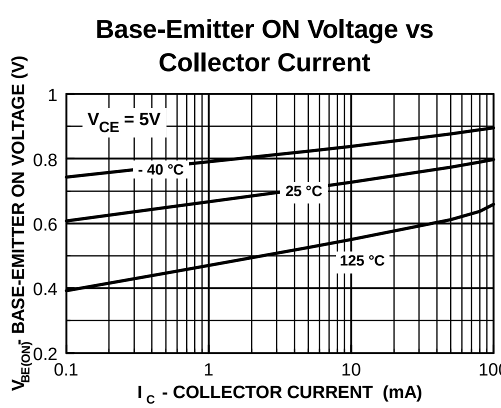
**Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

Typical Characteristics

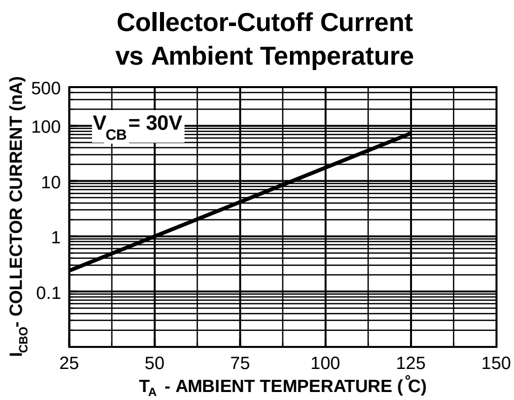


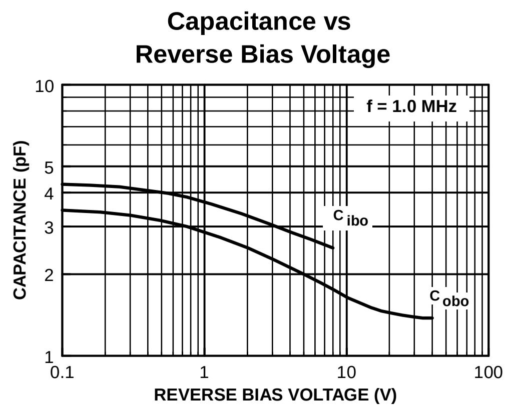


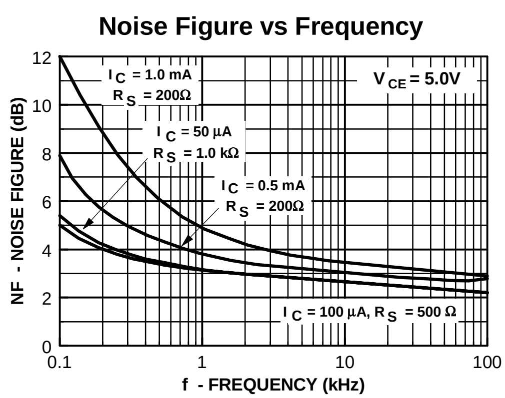


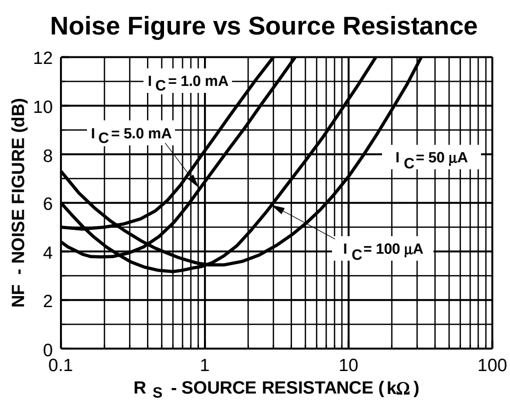


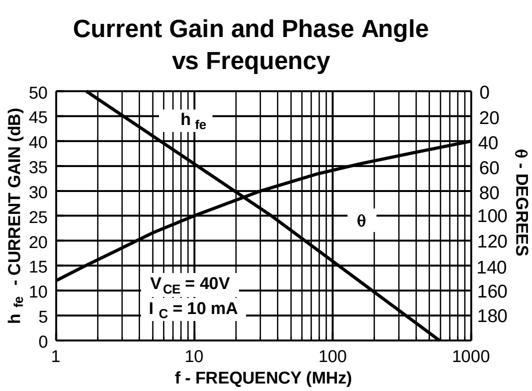
Typical Characteristics (continued)

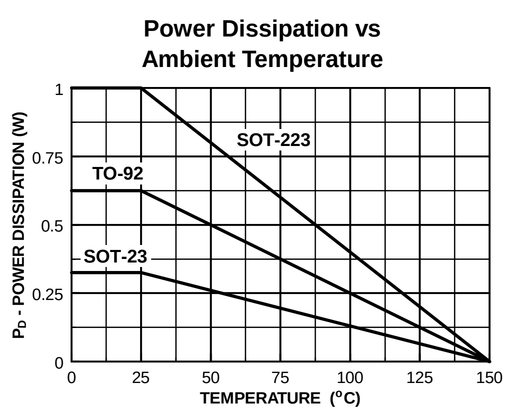






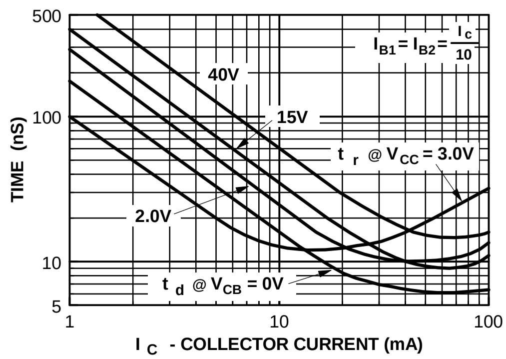




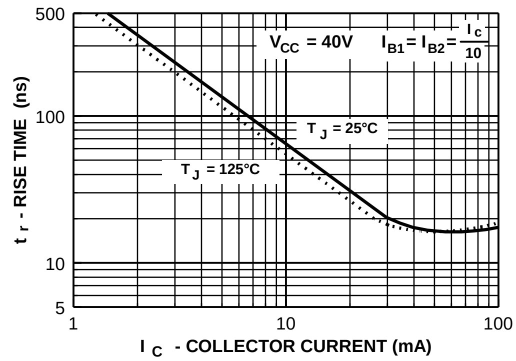


Typical Characteristics (continued)

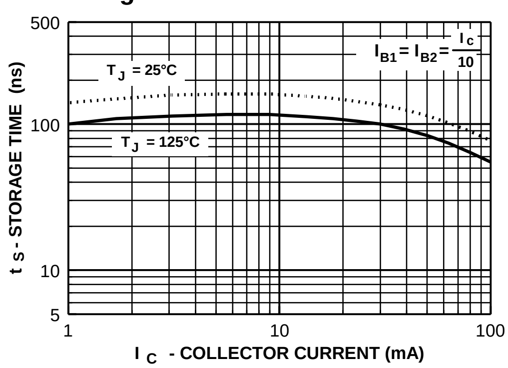
Turn-On Time vs Collector Current



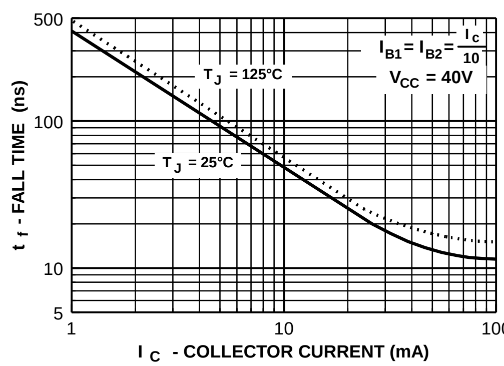
Rise Time vs Collector Current



Storage Time vs Collector Current



Fall Time vs Collector Current



Test Circuits

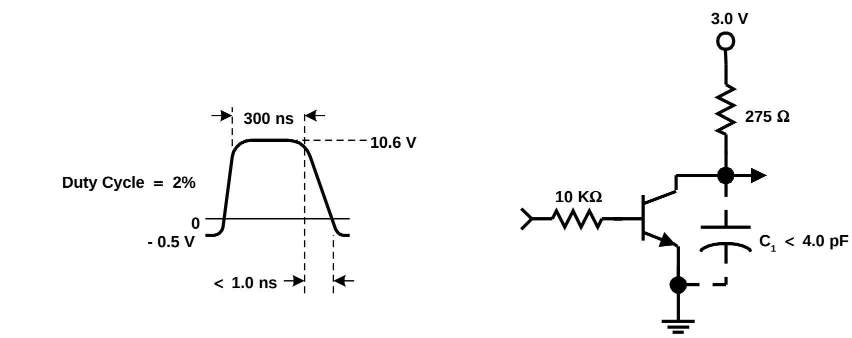


FIGURE 1: Delay and Rise Time Equivalent Test Circuit

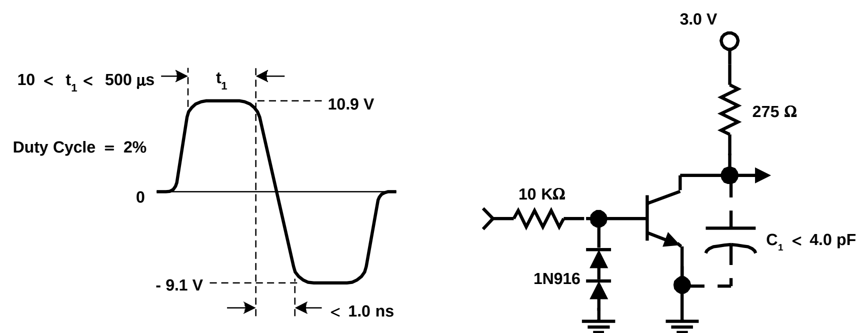


FIGURE 2: Storage and Fall Time Equivalent Test Circuit

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GTO™
HiSeC™
ISOPLANAR™
MICROWIRE™
POP™
PowerTrench™
QS™
Quiet Series™
SuperSOT™-3
SuperSOT™-6
SuperSOT™-8
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2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

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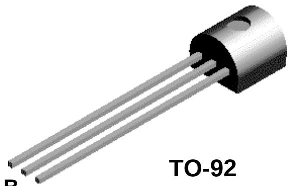
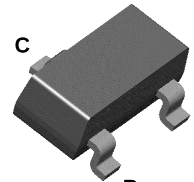
No Identification Needed	Full Production	This datasheet contains final specifications. Fairchild Semiconductor reserves the right to make changes at any time without notice in order to improve design.
Obsolete	Not In Production	This datasheet contains specifications on a product that has been discontinued by Fairchild semiconductor. The datasheet is printed for reference information only.

FAIRCHILD
SEMICONDUCTOR TM

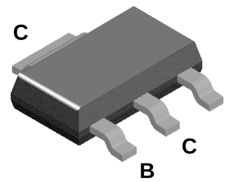
2N3906 MMBT3906 PZT3906



C B E TO-92



C E B
SOT-23
Mark: 2A



C E C B
SOT-223

PNP General Purpose Amplifier

This device is designed for general purpose amplifier and switching applications at collector currents of 10 µA to 100 mA.

Absolute Maximum Ratings*

T_A = 25°C unless otherwise noted

Symbol	Parameter	Value	Units
V_{CEO}	Collector-Emitter Voltage	40	V
V_{CBO}	Collector-Base Voltage	40	V
V_{EBO}	Emitter-Base Voltage	5.0	V
I_C	Collector Current - Continuous	200	mA
T_J, T_{stg}	Operating and Storage Junction Temperature Range	-55 to +150	°C

*These ratings are limiting values above which the serviceability of any semiconductor device may be impaired.

NOTES:
1) These ratings are based on a maximum junction temperature of 150 degrees C.
2) These are steady state limits. The factory should be consulted on applications involving pulsed or low duty cycle operations.
3) All voltages (V) and currents (A) are negative polarity for PNP transistors.

Thermal Characteristics

T_A = 25°C unless otherwise noted

Symbol	Characteristic	Max			Units
		2N3906	*MMBT3906	**PZT3906	
P_D	Total Device Dissipation Derate above 25°C	625 5.0	350 2.8	1,000 8.0	mW mW/°C
$R_{\theta JC}$	Thermal Resistance, Junction to Case	83.3			°C/W
$R_{\theta JA}$	Thermal Resistance, Junction to Ambient	200	357	125	°C/W

*Device mounted on FR-4 PCB 1.6" X 1.6" X 0.06."

**Device mounted on FR-4 PCB 36 mm X 18 mm X 1.5 mm; mounting pad for the collector lead min. 6 cm^2.

PNP General Purpose Amplifier
(continued)

Electrical Characteristics
$T_A = 25°C$ unless otherwise noted

Symbol	Parameter	Test Conditions	Min	Max	Units
OFF CHARACTERISTICS					
$V_{(BR)CEO}$	Collector-Emitter Breakdown Voltage*	$I_C = 1.0$ mA, $I_B = 0$	40		V
$V_{(BR)CBO}$	Collector-Base Breakdown Voltage	$I_C = 10$ µA, $I_E = 0$	40		V
$V_{(BR)EBO}$	Emitter-Base Breakdown Voltage	$I_E = 10$ µA, $I_C = 0$	5.0		V
I_{BL}	Base Cutoff Current	$V_{CE} = 30$ V, $V_{BE} = 3.0$ V		50	nA
I_{CEX}	Collector Cutoff Current	$V_{CE} = 30$ V, $V_{BE} = 3.0$ V		50	nA
ON CHARACTERISTICS					
h_{FE}	DC Current Gain *	$I_C = 0.1$ mA, $V_{CE} = 1.0$ V $I_C = 1.0$ mA, $V_{CE} = 1.0$ V $I_C = 10$ mA, $V_{CE} = 1.0$ V $I_C = 50$ mA, $V_{CE} = 1.0$ V $I_C = 100$ mA, $V_{CE} = 1.0$ V	60 80 100 60 30	 300 	
$V_{CE(sat)}$	Collector-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 50$ mA, $I_B = 5.0$ mA		0.25 0.4	V V
$V_{BE(sat)}$	Base-Emitter Saturation Voltage	$I_C = 10$ mA, $I_B = 1.0$ mA $I_C = 50$ mA, $I_B = 5.0$ mA	0.65	0.85 0.95	V V
SMALL SIGNAL CHARACTERISTICS					
f_T	Current Gain - Bandwidth Product	$I_C = 10$ mA, $V_{CE} = 20$ V, f = 100 MHz	250		MHz
C_{obo}	Output Capacitance	$V_{CB} = 5.0$ V, $I_E = 0$, f = 100 kHz		4.5	pF
C_{ibo}	Input Capacitance	$V_{EB} = 0.5$ V, $I_C = 0$, f = 100 kHz		10.0	pF
NF	Noise Figure	$I_C = 100$ µA, $V_{CE} = 5.0$ V, $R_S = 1.0$ kΩ, f = 10 Hz to 15.7 kHz		4.0	dB
SWITCHING CHARACTERISTICS					
t_d	Delay Time	$V_{CC} = 3.0$ V, $V_{BE} = 0.5$ V,		35	ns
t_r	Rise Time	$I_C = 10$ mA, $I_{B1} = 1.0$ mA		35	ns
t_s	Storage Time	$V_{CC} = 3.0$ V, $I_C = 10$mA		225	ns
t_f	Fall Time	$I_{B1} = I_{B2} = 1.0$ mA		75	ns

*Pulse Test: Pulse Width ≤ 300 µs, Duty Cycle ≤ 2.0%

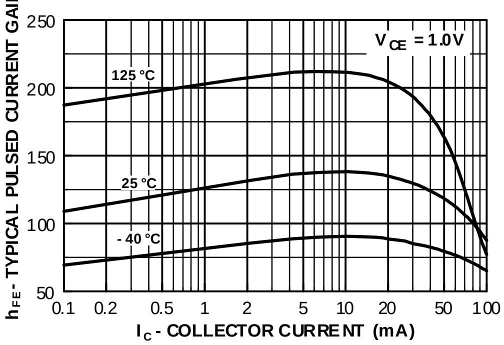
NOTE: All voltages (V) and currents (A) are negative polarity for PNP transistors.

Spice Model

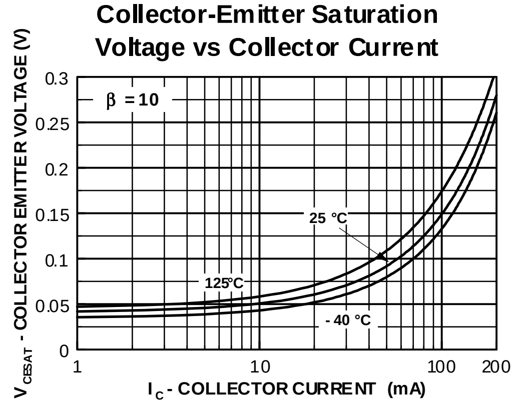
PNP (Is=1.41f Xti=3 Eg=1.11 Vaf=18.7 Bf=180.7 Ne=1.5 Ise=0 Ikf=80m Xtb=1.5 Br=4.977 Nc=2 Isc=0 Ikr=0 Rc=2.5 Cjc=9.728p Mjc=.5776 Vjc=.75 Fc=.5 Cje=8.063p Mje=.3677 Vje=.75 Tr=33.42n Tf=179.3p Itf=.4 Vtf=4 Xtf=6 Rb=10)

Typical Characteristics

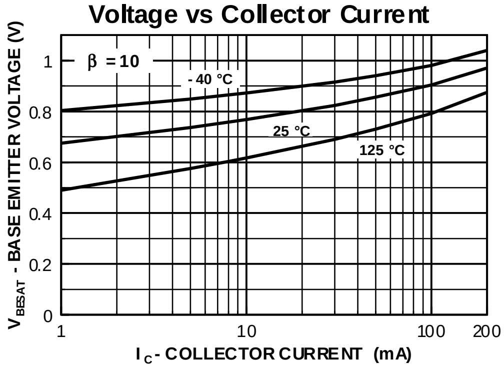
Typical Pulsed Current Gain vs Collector Current



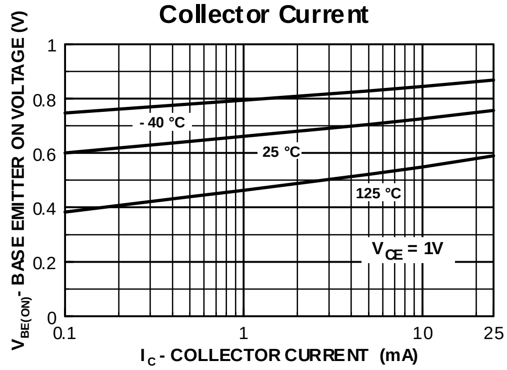
Collector-Emitter Saturation Voltage vs Collector Current



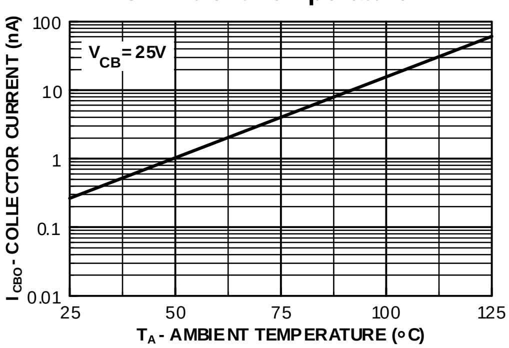
Base-Emitter Saturation Voltage vs Collector Current



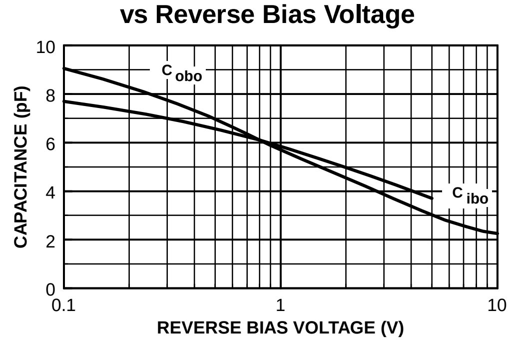
Base Emitter ON Voltage vs Collector Current



Collector-Cutoff Current vs Ambient Temperature

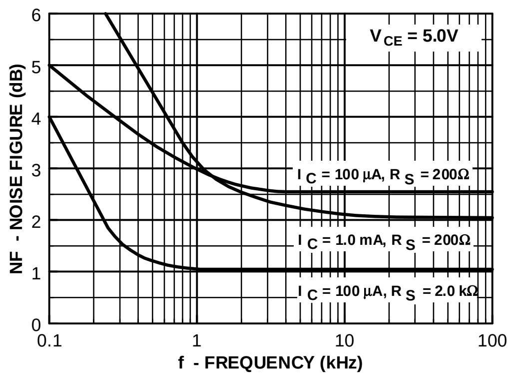


Common-Base Open Circuit Input and Output Capacitance vs Reverse Bias Voltage

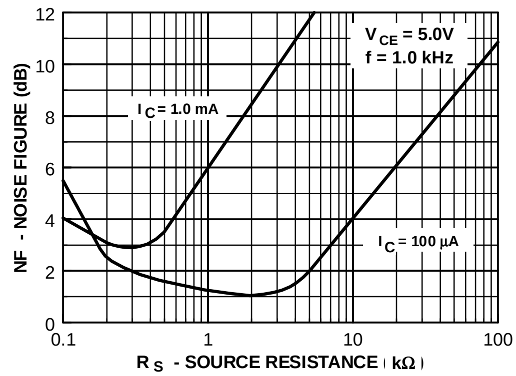


Typical Characteristics (continued)

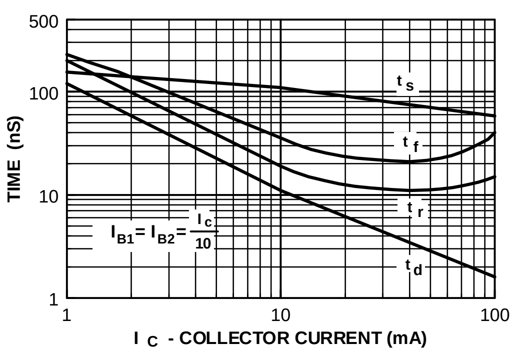
Noise Figure vs Frequency



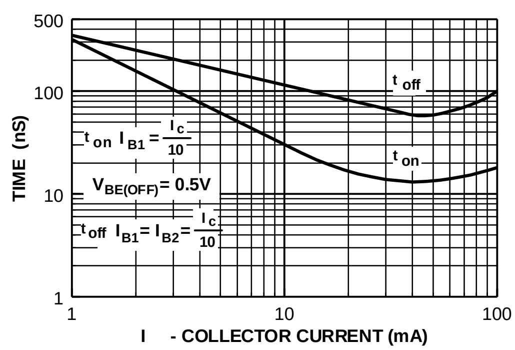
Noise Figure vs Source Resistance



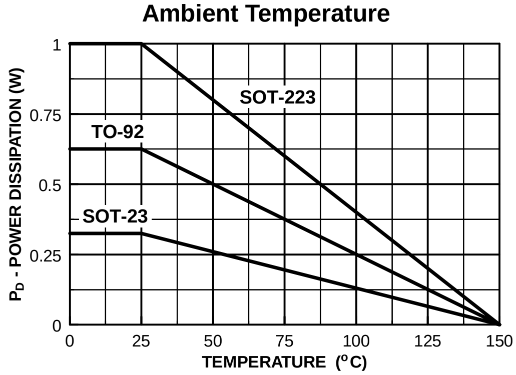
Switching Times vs Collector Current



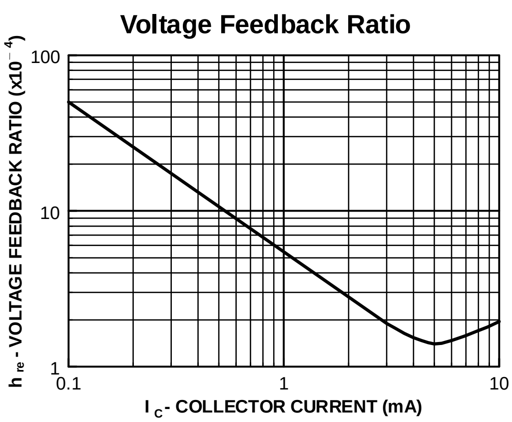
Turn On and Turn Off Times vs Collector Current

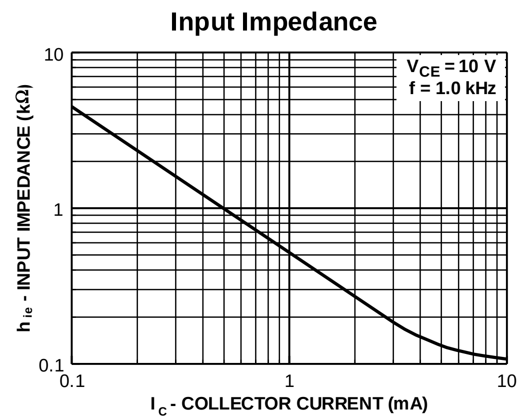


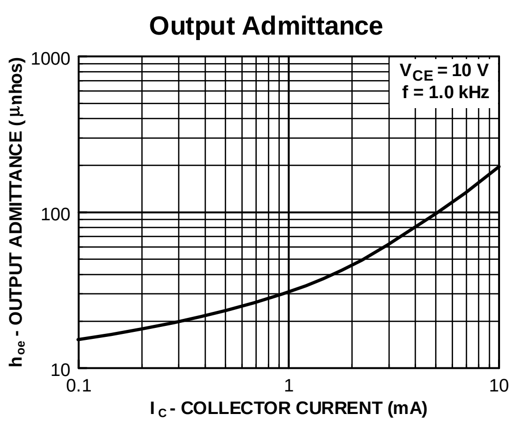
Power Dissipation vs Ambient Temperature

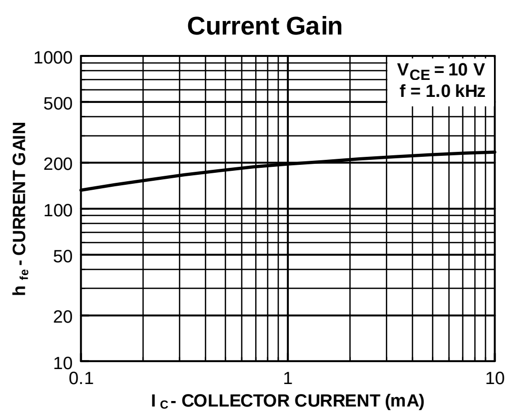


Typical Characteristics (continued)









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DOME™	ISOPLANAR™	Quiet Series™	
E^2CMOS™	MICROWIRE™	SILENT SWITCHER®	
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FACT™	OPTOPLANAR™	SuperSOT™-3	
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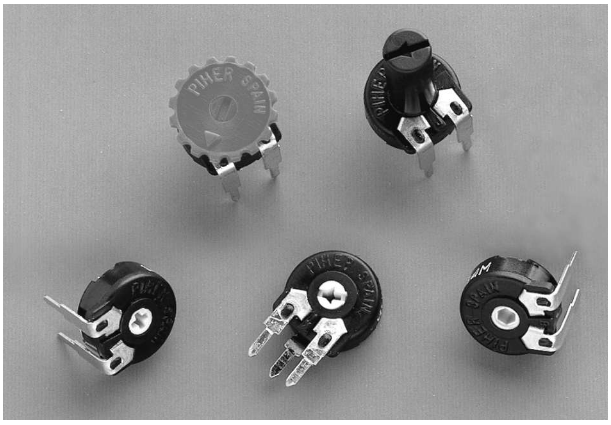
Rev. G

PIHER

PT-10 10 mm Carbon Potentiometer



FEATURES

- Carbon resistive element
- Dust proof enclosure
- Polyester substrate
- Also upon request:
  - Wiper positioned at 50% or fully clockwise.
  - Supplied in magazines for automatic insertion.
  - Long life model for low cost control potentiometer applications
  - Self extinguishable plastic UL 94V-0
  - Cut track option
  - Special tapers
  - Mechanical detents
  - Low & extra low torque versions

MECHANICAL SPECIFICATIONS

– Mechanical rotation angle:	235° ± 5°
– Electrical rotation angle:	220° ± 20°
– Torque:	0.4 to 2 Ncm. (0.6 to 2.7 in-oz)
– Stop torque:	> 5 Ncm. (>7 in-oz)

ELECTRICAL SPECIFICATIONS

- Range of values (*)
  $100\Omega \leq Rn \leq 5$ M (Decad. 1.0 - 2.0 - 2.2 - 2.5 - 4.7 - 5.0)
- Tolerance (*): $100\Omega \leq Rn \leq 1M\ \Omega$ ...... ± 20%
  $1M\Omega < Rn \leq 5M\ \Omega$ ...... ± 30%
- Max. Voltage: 200 VDC (lin) 100 VDC (no lin)
- Nominal Power 50°C (122°F) (see power rating curve)
  0.15 W (lin) 0.07 W (no lin)
- Taper (*) (Log. & Alog. only Rn > 1K) Lin ; Log; Alog.
- Residual resistance: $\leq 5.10^{-3}$ Rn (2 Ω min.)
- Equivalent Noise Resistance: $\leq 3\%$ Rn (3 Ω min.)
- Operating temperature**: -25°C + 70°C (-13°F +158°F)

(*) Others upon request

** Up to 85°C depending on application

HOW TO ORDER

STANDARD

PT 10 | L | H01 | 101 | A | 2020

OPTIONAL EXTRAS

Life | Cut track | Detent | Magazine | Shaft/Thum. | Flammability | Shaft/rotor colour | Wiper position | Torque

Series
PT-10

Rotors
G
L
M
K
X
W
Y
Z
(See note 1)

Code	Mounting Method
H01	H2.5
H05	H5
H02	H2.5P
H10	H5P
V05	V5
V10	V
V11	VP
V13	VJ

(See note 2)

Value
101 = 100Ω
504 = 500 K
505 = 5 M
(See note 3)

Taper
A = Lin.
B = Log.
C = Alog.

Tolerance
2020 = ± 20%
3030 = ± 30%
(See note 4)

Life
E= Long life
(See note 5)

Cut track
PCI = Initial
PCF = Final

Detent
See PT's with detents data sheet

Magazine
T
(See note 6)

Shaft/Thum.
01 = Fig. 1
02 = Fig. 2
17 = Fig. 17

Flammability
I = Non flammable
(See note 7)

Shaft/rotor colour
RO = Red
NE = Black
VE = Green
AM = Yellow
AZ = Blue
MA = Brown
GR = Grey
NA = Orange
CR = Cream
(See note 8)

Wiper position
PM = 50%
PF = Final

Torque
– = Standard
L= Low Torque
X = Extra Low Torque
(See note 9)

NOTES:

(1) "Z" adjustment only available on "H" versions
(2) Terminals styles: "P" & "J" are crimped terminals
(3) Value Example: Code: 10 1 100 Ω
  1 → Numb of zeros
  10 → First two digits of the value.
(4) Non standard tolerance, upon request. Example: +7% -5% Code: 07 05
  07 → positive tolerance
  05 → negative tolerance
(5) Life • Standard 500 cycles
  • Long life 10000 cycles
(6) Magazines: not available with the H10, V05 and V13 models, nor with adjustment types X, W, Y, Z.
(7) Non flammable: housing, rotor and shaft.
(8) Colour shaft/rotor: • Potentiometer without shaft: only rotor • Potentiometer with shaft: only shaft
  Cream colour only available in standard plastic.
(9) Low Torque: 0.25 to 1 Ncm (per pot.)
  Extra Low Torque: 0.1 to 0.4 Ncm (per pot.)
  No detent option available for low and extra low torque models

NOTE: The information contained here in may be changed without prior notice.

QS 9000 Certificate Nº 72037 ISO 14001 Certificate Nº 65663

MEGGITT

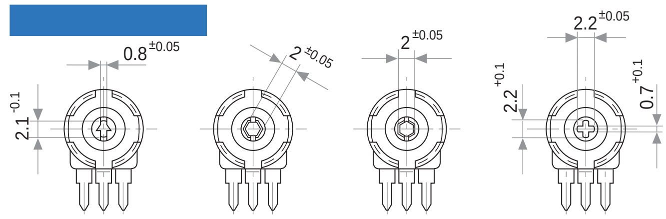
HOW TO ORDER CUSTOM DRAWING

PT-10 LH 01 + DRAWING NUMBER (Max. 16 characters)

This way of ordering should be used for options which are not included in the "How to order" standard and optional extras.

STANDARD OPTIONS

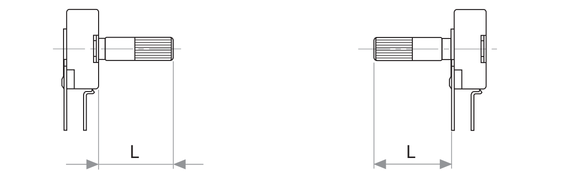
Mechanical Life	500 cycles
Cut track	No
Detents	None
Packing	Bulk
Non flammable	No
Rotor colour	White
Shaft colour	Natural
Wiper position	Initial
Torque	Standard



L = Screwdriver thru hole
M = Hexagonal thru hole
G = Hexagonal thru hole
K = Cross slot thru hole

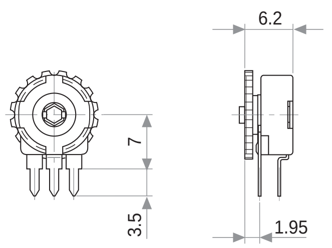
Wipers positioned at 50%

With shaft

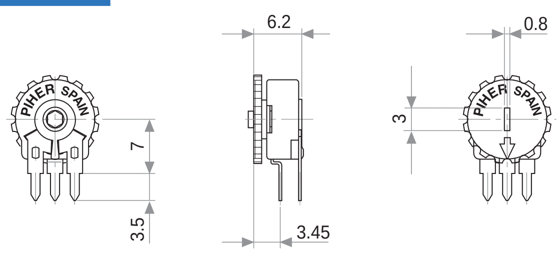


X = Adjustable from collector side
W = Adjustable from terminal side

With thumbwheel



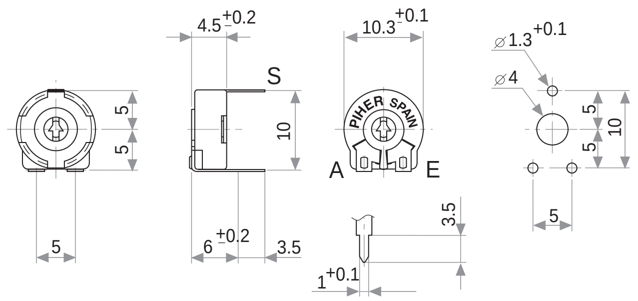
Y = Adjustable from terminal side



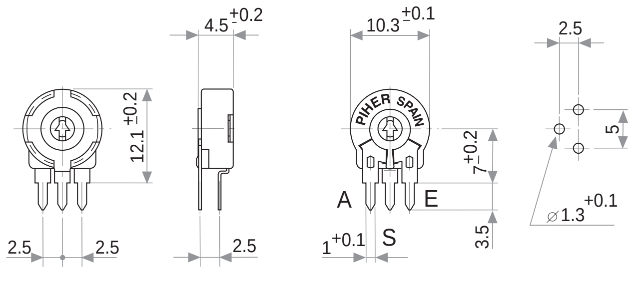
Z = Adjustable from collector side

v = horizontal mount – vertical adjust

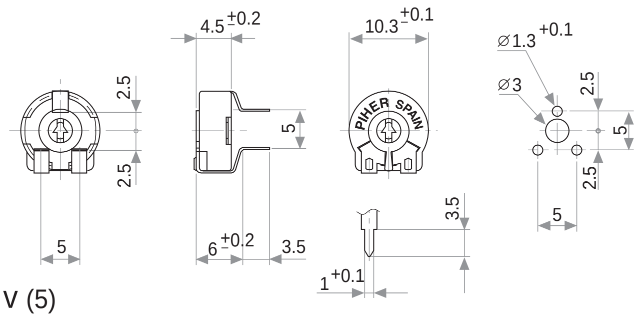
h = vertical mount – horizontal adjust



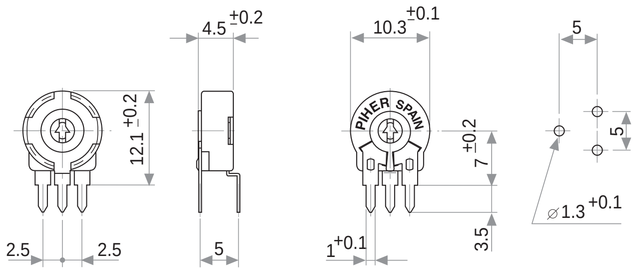
V (10) A = Initial S = Wiper E = Final



h (2.5) A = Initial S = Wiper E = Final



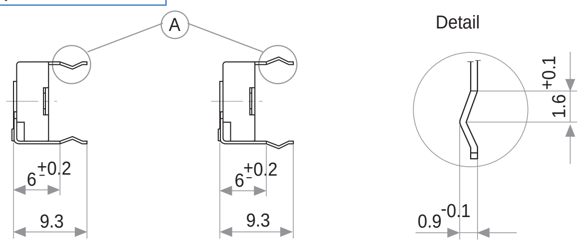
V (5)



h (5)

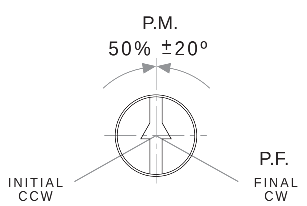
NOTE = Please note relative terminal positions when ordering non linear tapers.

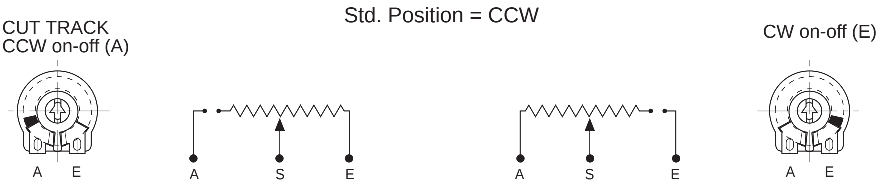
Crimped terminals



Mod. J Mod. P

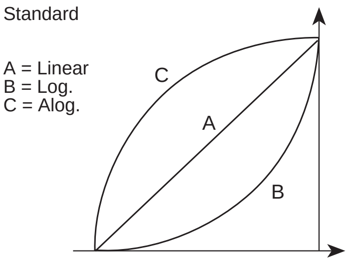
OPTIONS

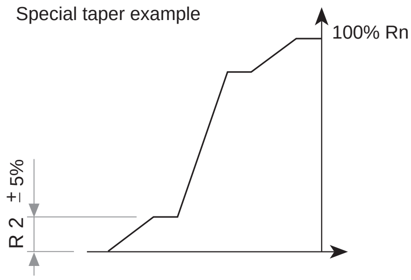




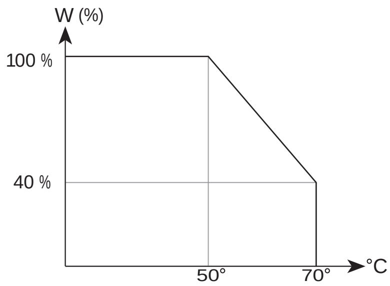
A = Initial E = Final S = Wiper

TAPERS





POWER RATING CURVE



NOTE = Please note relative terminal positions when ordering non linear tapers.

TESTS / TYPICAL VARIATIONS

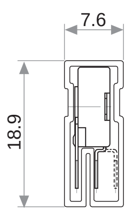
TESTS		TYPICAL VARIATIONS
ELECTRICAL LIFE	1.000 h. @ 50°C; 0.15 W	±5 %
MECHANICAL LIFE (CYCLES)	500 @ 10 CPM ...15 CPM	±3 % (Rn < 1 MΩ)
TEMPERATURE COEFFICIENT	–25°C; +70°C	±300 ppm (Rn <100 K)
THERMAL CYCLING	16 h. @ 85°C; 2h. @ –25°C	±2.5 %
DAMP HEAT	500 h. @ 40°C @ 95% HR	±5 %
VIBRATION (for each plane X,Y,Z)	2 h. @ 10 Hz. ... 55 Hz.	±2 %

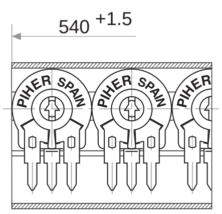
NOTE: Out of range values may not comply these results.

PACKAGING

BOXES

Model	Units
Without shaft	500 (40 x 85 x 185 mm.)
With thumbwheel	400 (40 x 85 x 185 mm.)
With shaft	200 (40 x 85 x 185 mm.)



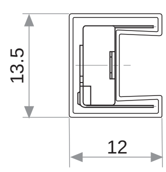


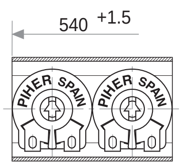
Magazines for PT-10 h 2.5; h 5

Also crimped term. h 2.5 P

AUTOMATIC INSERTION

Magazines	Units per magazine
PT-10H & PT-10V	50 Pieces





Magazines for PT-10 V

Also crimped term. VP

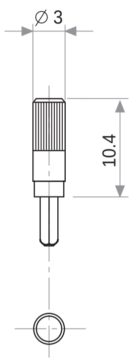


Fig. 1 / Ref. 5016

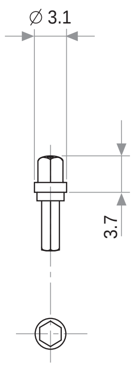


Fig. 2 / Ref. 5053

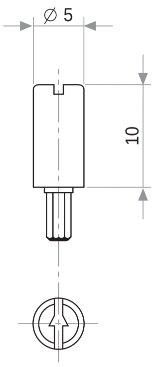


Fig. 3 / Ref. 5012

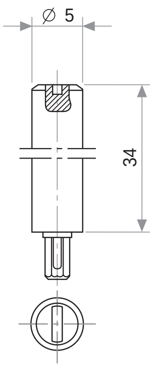


Fig. 4 / Ref. 6053

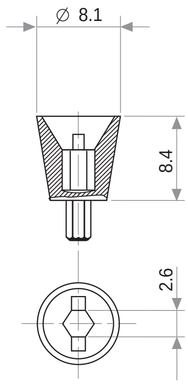


Fig. 6 / Ref. 5035

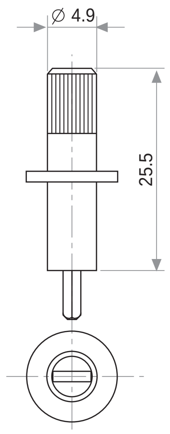


Fig. 7 / Ref. 5115

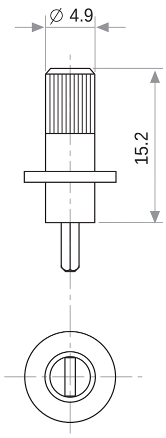


Fig. 8 / Ref. 5116

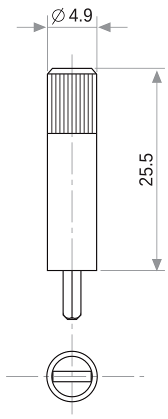


Fig. 9 / Ref. 5119

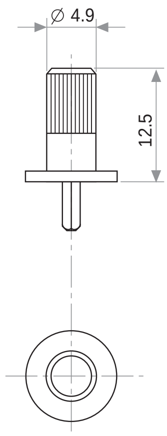


Fig. 10 / Ref. 5120

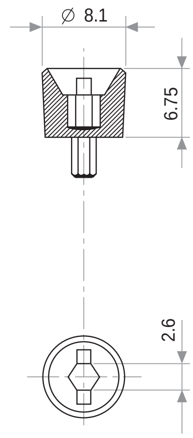


Fig. 11 / Ref. 5027

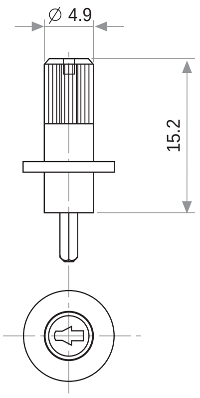


Fig. 12 / Ref. 6052

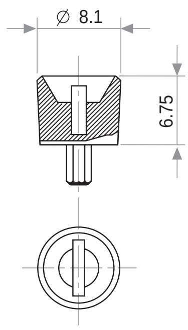


Fig. 13 / Ref. 5121

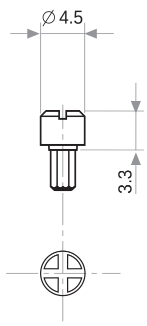


Fig. 14 / Ref. 5055

2- GANG Plastic Knob/ Plastic Shaft*

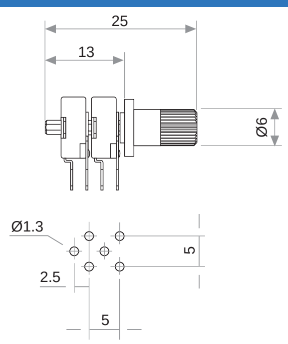


Fig. 18 / Ref. 6064

* Delivered unassembled
(For assembled contact your nearest PIHER supplier)

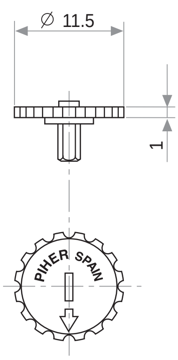


Fig. 5 / Ref. 5034

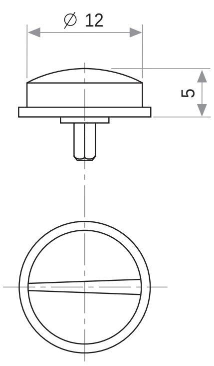


Fig. 15 / Ref. 6008

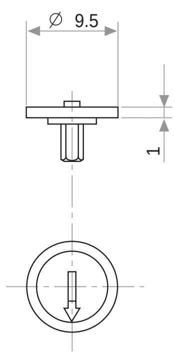


Fig. 16 / Ref. 5039

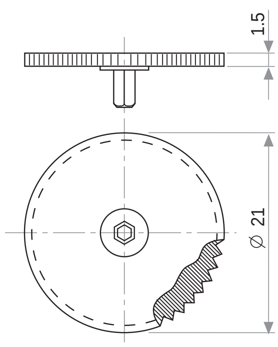


Fig. 17 / Ref. 5062

xx555 Precision Timers

1 Features

- Timing From Microseconds to Hours
- Astable or Monostable Operation
- Adjustable Duty Cycle
- TTL-Compatible Output Can Sink or Source Up to 200 mA
- On Products Compliant to MIL-PRF-38535, All Parameters Are Tested Unless Otherwise Noted. On All Other Products, Production Processing Does Not Necessarily Include Testing of All Parameters.

2 Applications

- Fingerprint Biometrics
- Iris Biometrics
- RFID Reader

3 Description

These devices are precision timing circuits capable of producing accurate time delays or oscillation. In the time-delay or mono-stable mode of operation, the timed interval is controlled by a single external resistor and capacitor network. In the a-stable mode of operation, the frequency and duty cycle can be controlled independently with two external resistors and a single external capacitor.

The threshold and trigger levels normally are two-thirds and one-third, respectively, of V_{CC}. These levels can be altered by use of the control-voltage terminal. When the trigger input falls below the trigger level, the flip-flop is set, and the output goes high. If the trigger input is above the trigger level and the threshold input is above the threshold level, the flip-flop is reset and the output is low. The reset (RESET) input can override all other inputs and can be used to initiate a new timing cycle. When RESET goes low, the flip-flop is reset, and the output goes low. When the output is low, a low-impedance path is provided between discharge (DISCH) and ground.

The output circuit is capable of sinking or sourcing current up to 200 mA. Operation is specified for supplies of 5 V to 15 V. With a 5-V supply, output levels are compatible with TTL inputs.

Device Information(1)

PART NUMBER	PACKAGE	BODY SIZE (NOM)
xx555	PDIP (8)	9.81 mm × 6.35 mm
	SOP (8)	6.20 mm × 5.30 mm
	TSSOP (8)	3.00 mm × 4.40 mm
	SOIC (8)	4.90 mm × 3.91 mm

(1) For all available packages, see the orderable addendum at the end of the datasheet.

4 Simplified Schematic

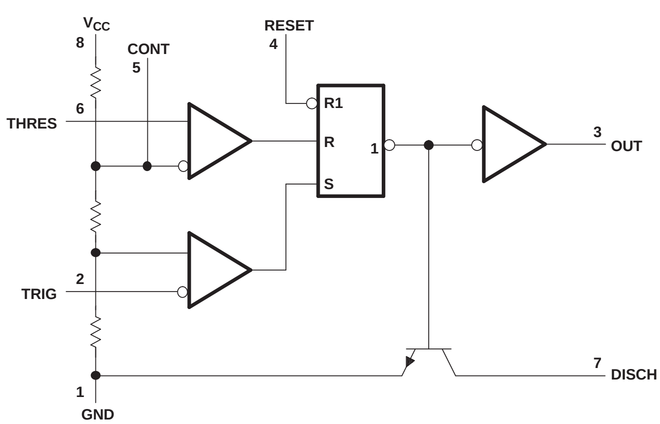


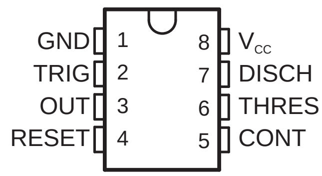
Table of Contents

5 Revision History

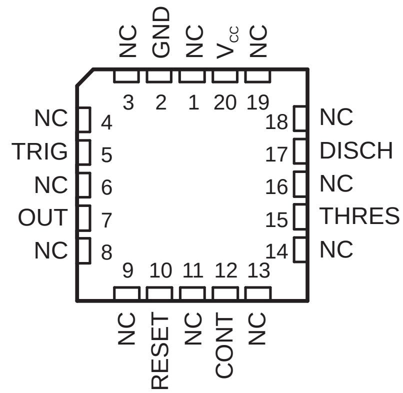
Changes from Revision H (June 2010) to Revision I	Page
• Updated document to new TI enhanced data sheet format.	1
• Deleted Ordering Information table.	1
• Added Military Disclaimer to Features list.	1
• Added Applications.	1
• Added Device Information table.	1
• Moved T_{stg} to Handling Ratings table.	4
• Added DISCH switch on-state voltage parameter.	5
• Added Device and Documentation Support section.	19
• Added ESD warning.	19
• Added Mechanical, Packaging, and Orderable Information section.	19

6 Pin Configuration and Functions

NA555...D OR P PACKAGE
NE555...D, P, PS, OR PW PACKAGE
SA555...D OR P PACKAGE
SE555...D, JG, OR P PACKAGE
(TOP VIEW)



SE555...FK PACKAGE
(TOP VIEW)



NC – No internal connection

Pin Functions

PIN			I/O	DESCRIPTION
NAME	D, P, PS, PW, JG	FK		
	NO.			
CONT	5	12	I/O	Controls comparator thresholds, Outputs 2/3 VCC, allows bypass capacitor connection
DISCH	7	17	O	Open collector output to discharge timing capacitor
GND	1	2	–	Ground
NC		1, 3, 4, 6, 8, 9, 11, 13, 14, 16, 18, 19	–	No internal connection
OUT	3	7	O	High current timer output signal
RESET	4	10	I	Active low reset input forces output and discharge low.
THRES	6	15	I	End of timing input. THRES > CONT sets output low and discharge low
TRIG	2	5	I	Start of timing input. TRIG < ½ CONT sets output high and discharge open
V_{CC}	8	20	–	Input supply voltage, 4.5 V to 16 V. (SE555 maximum is 18 V)

7 Specifications

7.1 Absolute Maximum Ratings(1)

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V_{CC}	Supply voltage(2)			18	V
V_I	Input voltage	CONT, RESET, THRES, TRIG		V_{CC}	V
I_O	Output current			±225	mA
θ_{JA}	Package thermal impedance(3)(4)	D package		97	°C/W
		P package		85	
		PS package		95	
		PW package		149	
θ_{JC}	Package thermal impedance(5)(6)	FK package		5.61	°C/W
		JG package		14.5	
T_J	Operating virtual junction temperature			150	°C
	Case temperature for 60 s	FK package		260	°C
	Lead temperature 1,6 mm (1/16 in) from case for 60 s	JG package		300	°C

(1) 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.
(2) All voltage values are with respect to GND.
(3) Maximum power dissipation is a function of T_J(max), θ_{JA}, and T_A. The maximum allowable power dissipation at any allowable ambient temperature is $P_D = (T_J(max) - T_A) / \theta_{JA.}$ Operating at the absolute maximum T_J of 150°C can affect reliability.
(4) The package thermal impedance is calculated in accordance with JESD 51-7.
(5) Maximum power dissipation is a function of T_J(max), θ_{JC}, and T_C. The maximum allowable power dissipation at any allowable case temperature is $P_D = (T_J(max) - T_C) / \theta_{JC}$. Operating at the absolute maximum T_J of 150°C can affect reliability.
(6) The package thermal impedance is calculated in accordance with MIL-STD-883.

7.2 Handling Ratings

PARAMETER	DEFINITION	MIN	MAX	UNIT
T_{stg}	Storage temperature range	–65	150	°C

7.3 Recommended Operating Conditions

over operating free-air temperature range (unless otherwise noted)

			MIN	MAX	UNIT
V_{CC}	Supply voltage	NA555, NE555, SA555	4.5	16	V
		SE555	4.5	18	
V_I	Input voltage	CONT, RESET, THRES, and TRIG		V_{CC}	V
I_O	Output current			±200	mA
T_A	Operating free-air temperature	NA555	–40	105	°C
		NE555	0	70	
		SA555	–40	85	
		SE555	–55	125	

7.4 Electrical Characteristics

V_{CC} = 5 V to 15 V, T_A = 25°C (unless otherwise noted)

PARAMETER	TEST CONDITIONS		SE555 MIN	SE555 TYP	SE555 MAX	NA555, NE555, SA555 MIN	NA555, NE555, SA555 TYP	NA555, NE555, SA555 MAX	UNIT
THRES voltage level	V_{CC} = 15 V		9.4	10	10.6	8.8	10	11.2	V
	V_{CC} = 5 V		2.7	3.3	4	2.4	3.3	4.2	
THRES current(1)				30	250		30	250	nA
TRIG voltage level	V_{CC} = 15 V		4.8	5	5.2	4.5	5	5.6	V
		T_A = –55°C to 125°C	3		6				
	V_{CC} = 5 V		1.45	1.67	1.9	1.1	1.67	2.2	
		T_A = –55°C to 125°C			1.9				
TRIG current	TRIG at 0 V			0.5	0.9		0.5	2	μA
RESET voltage level			0.3	0.7	1	0.3	0.7	1	V
	T_A = –55°C to 125°C				1.1				
RESET current	RESET at V_{CC}			0.1	0.4		0.1	0.4	mA
	RESET at 0 V			–0.4	–1		–0.4	–1.5	
DISCH switch off-state current				20	100		20	100	nA
DISCH switch on-state voltage	V_{CC} = 5 V, I_O = 8 mA						0.15	0.4	V
CONT voltage (open circuit)	V_{CC} = 15 V		9.6	10	10.4	9	10	11	V
		T_A = –55°C to 125°C	9.6		10.4				
	V_{CC} = 5 V		2.9	3.3	3.8	2.6	3.3	4	
		T_A = –55°C to 125°C	2.9		3.8				
Low-level output voltage	V_{CC} = 15 V, I_{OL} = 10 mA			0.1	0.15		0.1	0.25	V
		T_A = –55°C to 125°C			0.2				
	V_{CC} = 15 V, I_{OL} = 50 mA			0.4	0.5		0.4	0.75	
		T_A = –55°C to 125°C			1				
	V_{CC} = 15 V, I_{OL} = 100 mA			2	2.2		2	2.5	
		T_A = –55°C to 125°C			2.7				
	V_{CC} = 15 V, I_{OL} = 200 mA			2.5			2.5		
	V_{CC} = 5 V, I_{OL} = 3.5 mA	T_A = –55°C to 125°C			0.35				
	V_{CC} = 5 V, I_{OL} = 5 mA			0.1	0.2		0.1	0.35	
		T_A = –55°C to 125°C			0.8				
	V_{CC} = 5 V, I_{OL} = 8 mA			0.15	0.25		0.15	0.4	
High-level output voltage	V_{CC} = 15 V, I_{OH} = –100 mA		13	13.3		12.75	13.3		V
		T_A = –55°C to 125°C	12						
	V_{CC} = 15 V, I_{OH} = –200 mA			12.5			12.5		
	V_{CC} = 5 V, I_{OH} = –100 mA		3	3.3		2.75	3.3		
		T_A = –55°C to 125°C	2						
Supply current	Output low, No load	V_{CC} = 15 V		10	12		10	15	mA
		V_{CC} = 5 V		3	5		3	6	
	Output high, No load	V_{CC} = 15 V		9	10		9	13	
		V_{CC} = 5 V		2	4		2	5	

(1) This parameter influences the maximum value of the timing resistors R_A and R_B in the circuit of Figure 12. For example, when V_{CC} = 5 V, the maximum value is $R = R_A + R_B \approx 3.4$ MΩ, and for V_{CC} = 15 V, the maximum value is 10 MΩ.

7.5 Operating Characteristics

V_{CC} = 5 V to 15 V, T_A = 25°C (unless otherwise noted)

PARAMETER		TEST CONDITIONS[1]	SE555			NA555 NE555 SA555			UNIT
			MIN	TYP	MAX	MIN	TYP	MAX	
Initial error of timing interval[2]	Each timer, monostable[3]	T_A = 25°C		0.5	1.5[4]		1	3	%
	Each timer, astable[5]			1.5			2.25		
Temperature coefficient of timing interval	Each timer, monostable[3]	T_A = MIN to MAX		30	100[4]		50		ppm/°C
	Each timer, astable[5]			90			150		
Supply-voltage sensitivity of timing interval	Each timer, monostable[3]	T_A = 25°C		0.05	0.2[4]		0.1	0.5	%/V
	Each timer, astable[5]			0.15			0.3		
Output-pulse rise time		C_L = 15 pF, T_A = 25°C		100	200[4]		100	300	ns
Output-pulse fall time		C_L = 15 pF, T_A = 25°C		100	200[4]		100	300	ns

(1) For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
(2) Timing interval error is defined as the difference between the measured value and the average value of a random sample from each process run.
(3) Values specified are for a device in a monostable circuit similar to Figure 9, with the following component values: R_A = 2 kΩ to 100 kΩ, C = 0.1 µF.
(4) On products compliant to MIL-PRF-38535, this parameter is not production tested.
(5) Values specified are for a device in an astable circuit similar to Figure 12, with the following component values: R_A = 1 kΩ to 100 kΩ, C = 0.1 µF.

7.6 Typical Characteristics

Data for temperatures below –40°C and above 105°C are applicable for SE555 circuits only.

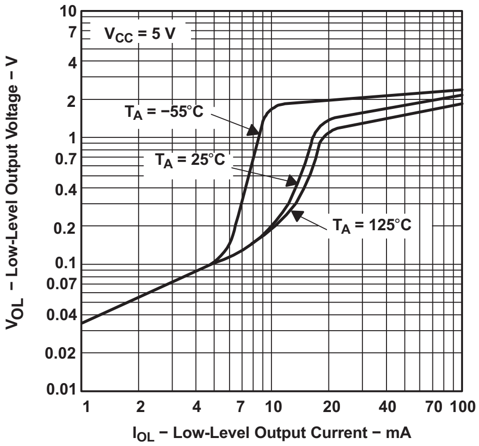


Figure 1. Low-Level Output Voltage vs Low-Level Output Current

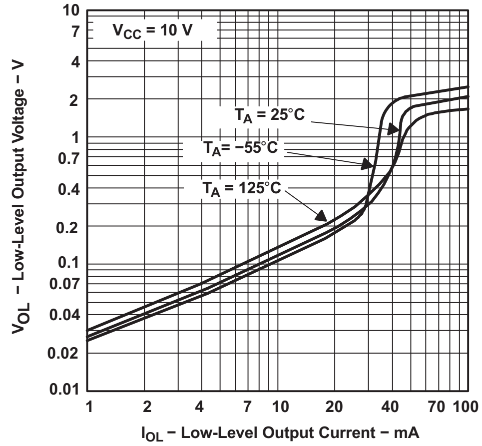


Figure 2. Low-Level Output Voltage vs Low-Level Output Current

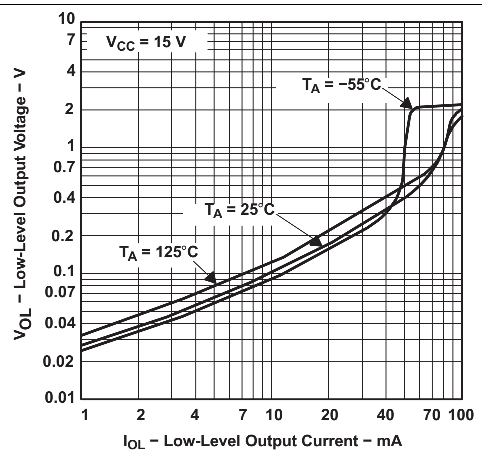


Figure 3. Low-Level Output Voltage vs Low-Level Output Current

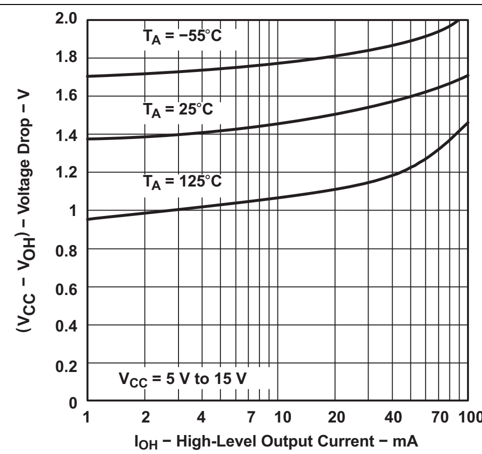


Figure 4. Drop Between Supply Voltage and Output vs High-Level Output Current

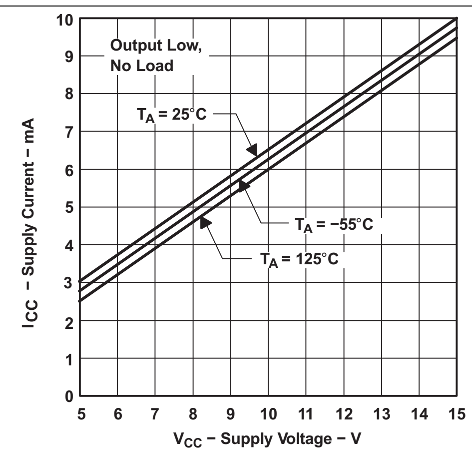


Figure 5. Supply Current vs Supply Voltage

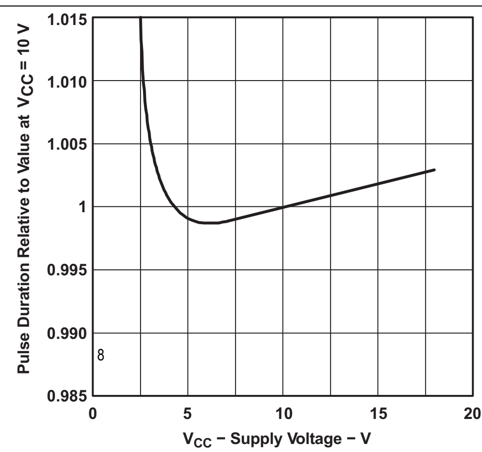


Figure 6. Normalized Output Pulse Duration (Monostable Operation) vs Supply Voltage

Typical Characteristics (continued)

Data for temperatures below –40°C and above 105°C are applicable for SE555 circuits only.

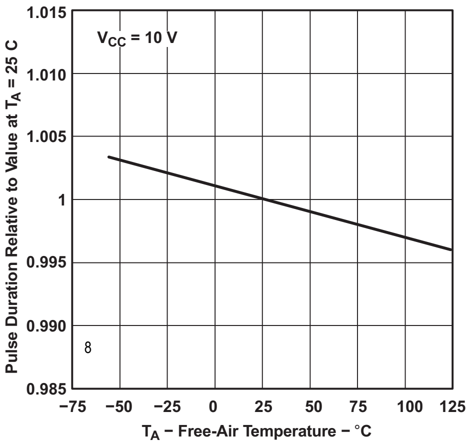


Figure 7. Normalized Output Pulse Duration (Monostable Operation) vs Free-Air Temperature

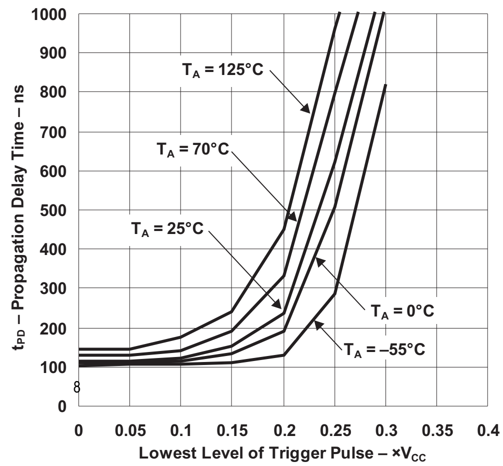


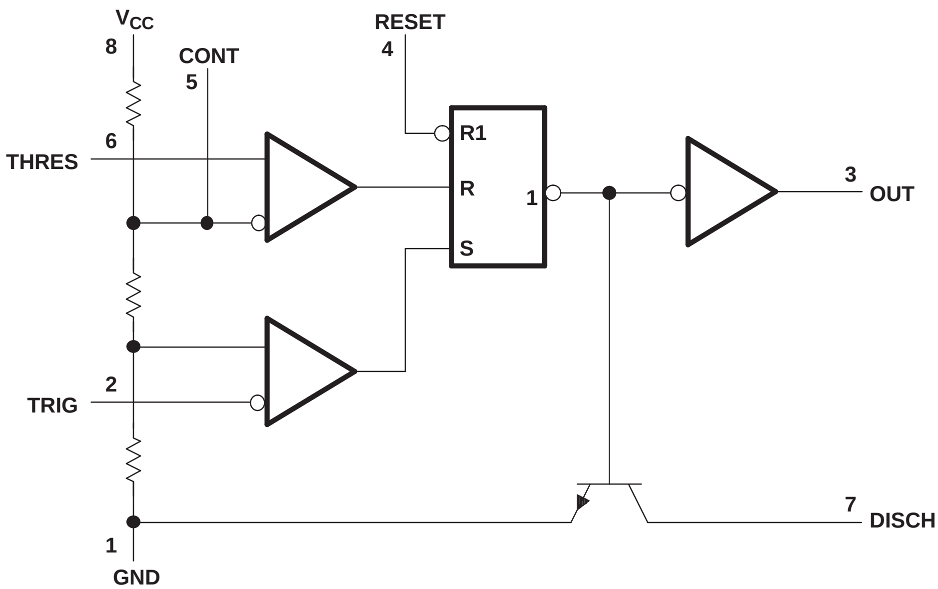
Figure 8. Propagation Delay Time vs Lowest Voltage Level of Trigger Pulse

8 Detailed Description

8.1 Overview

The xx555 timer is a popular and easy to use for general purpose timing applications from 10 µs to hours or from < 1mHz to 100 kHz. In the time-delay or mono-stable mode of operation, the timed interval is controlled by a single external resistor and capacitor network. In the a-stable mode of operation, the frequency and duty cycle can be controlled independently with two external resistors and a single external capacitor. Maximum output sink and discharge sink current is greater for higher VCC and less for lower VCC.

8.2 Functional Block Diagram



A. Pin numbers shown are for the D, JG, P, PS, and PW packages.

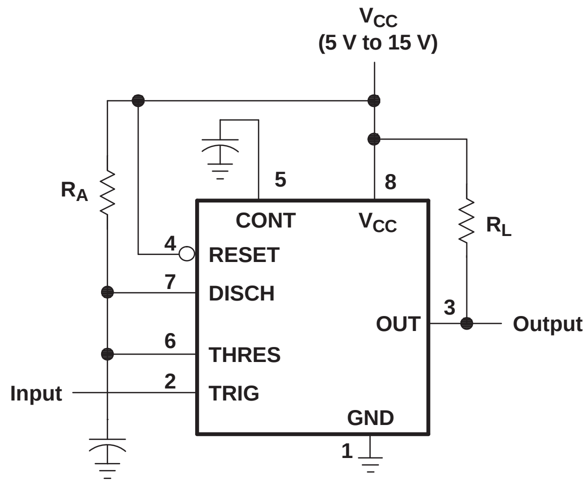
B. RESET can override TRIG, which can override THRES.

8.3 Feature Description

8.3.1 Mono-stable Operation

For mono-stable operation, any of these timers can be connected as shown in Figure 9. If the output is low, application of a negative-going pulse to the trigger (TRIG) sets the flip-flop ($\overline{Q}$ goes low), drives the output high, and turns off Q1. Capacitor C then is charged through R_A until the voltage across the capacitor reaches the threshold voltage of the threshold (THRES) input. If TRIG has returned to a high level, the output of the threshold comparator resets the flip-flop ($\overline{Q}$ goes high), drives the output low, and discharges C through Q1.

Feature Description (continued)



Pin numbers shown are for the D, JG, P, PS, and PW packages.

Figure 9. Circuit for Monostable Operation

Monostable operation is initiated when TRIG voltage falls below the trigger threshold. Once initiated, the sequence ends only if TRIG is high for at least 10 µs before the end of the timing interval. When the trigger is grounded, the comparator storage time can be as long as 10 µs, which limits the minimum monostable pulse width to 10 µs. Because of the threshold level and saturation voltage of Q1, the output pulse duration is approximately $t_w = 1.1R_AC$. Figure 11 is a plot of the time constant for various values of R_A and C. The threshold levels and charge rates both are directly proportional to the supply voltage, V_{CC}. The timing interval is, therefore, independent of the supply voltage, so long as the supply voltage is constant during the time interval.

Applying a negative-going trigger pulse simultaneously to RESET and TRIG during the timing interval discharges C and reinitiates the cycle, commencing on the positive edge of the reset pulse. The output is held low as long as the reset pulse is low. To prevent false triggering, when RESET is not used, it should be connected to V_{CC}.

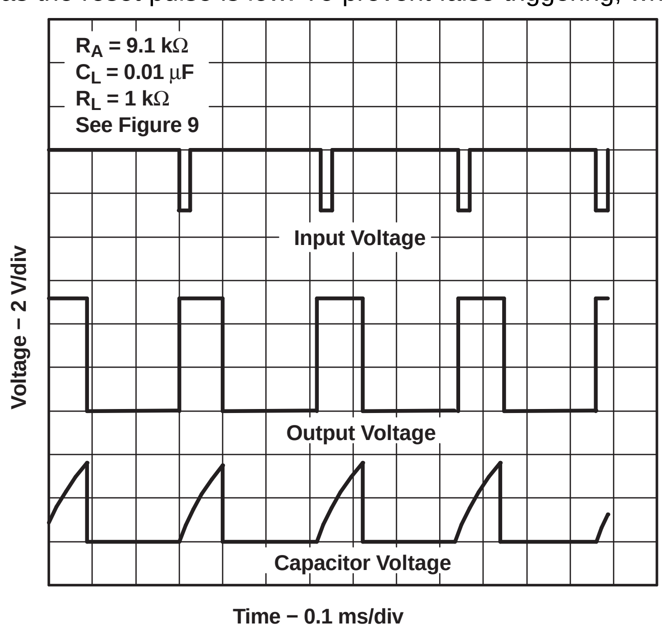


Figure 10. Typical Monostable Waveforms

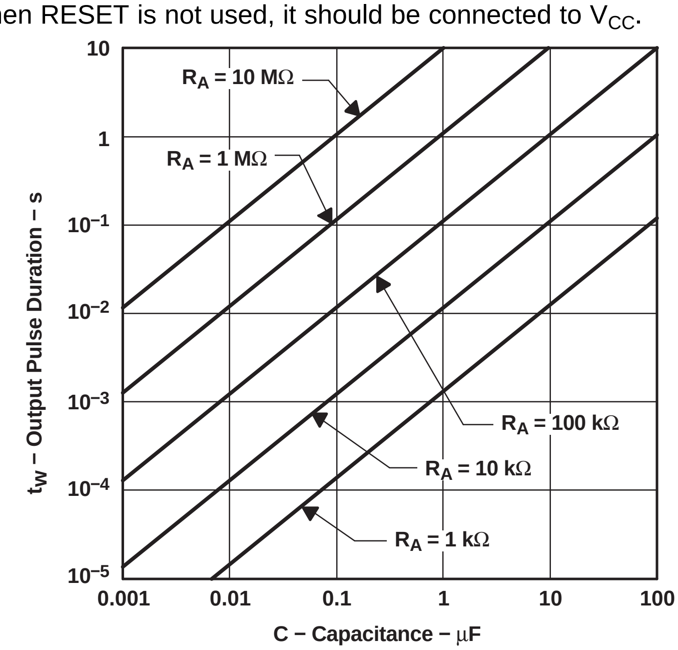


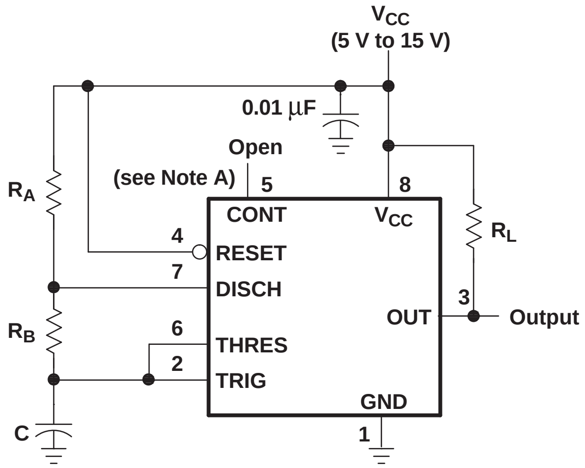
Figure 11. Output Pulse Duration vs Capacitance

Feature Description (continued)

8.3.2 A-stable Operation

As shown in Figure 12, adding a second resistor, R_B, to the circuit of Figure 9 and connecting the trigger input to the threshold input causes the timer to self-trigger and run as a multi-vibrator. The capacitor C charges through R_A and R_B and then discharges through R_B only. Therefore, the duty cycle is controlled by the values of R_A and R_B.

This astable connection results in capacitor C charging and discharging between the threshold-voltage level (≈ 0.67 × V_{CC}) and the trigger-voltage level (≈ 0.33 × V_{CC}). As in the mono-stable circuit, charge and discharge times (and, therefore, the frequency and duty cycle) are independent of the supply voltage.



Pin numbers shown are for the D, JG, P, PS, and PW packages.
NOTE A: Decoupling CONT voltage to ground with a capacitor can improve operation. This should be evaluated for individual applications.

Figure 12. Circuit for Astable Operation

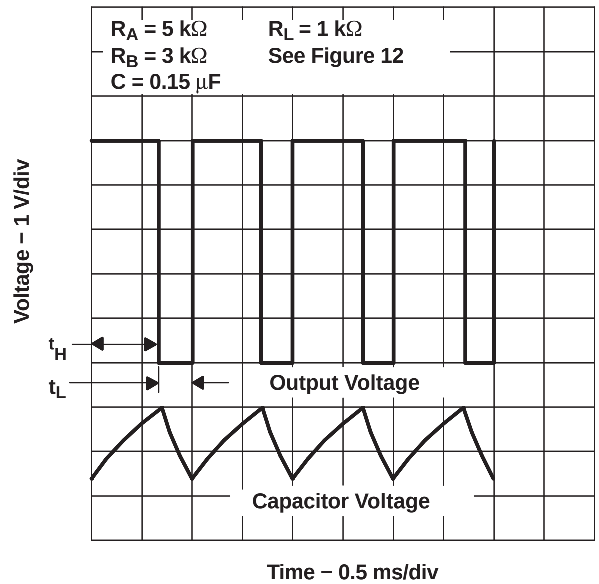


Figure 13. Typical Astable Waveforms

Figure 12 shows typical waveforms generated during astable operation. The output high-level duration t_H and low-level duration t_L can be calculated as follows:

$$t_H = 0.693\left(R_A + R_B\right)C \tag{1}$$

$$t_L = 0.693\left(R_B\right)C \tag{2}$$

Other useful relationships are shown below:

$$\text{period} = t_H + t_L = 0.693\left(R_A + 2R_B\right)C \tag{3}$$

$$\text{frequency} \approx \frac{1.44}{\left(R_A + 2R_B\right)C} \tag{4}$$

$$\text{Output driver duty cycle} = \frac{t_L}{t_H + t_L} = \frac{R_B}{R_A + 2R_B} \tag{5}$$

$$\text{Output waveform duty cycle} = \frac{t_H}{t_H + t_L} = 1 - \frac{R_B}{R_A + 2R_B} \tag{6}$$

$$\text{Low-to-high ratio} = \frac{t_L}{t_H} = \frac{R_B}{R_A + R_B} \tag{7}$$

Feature Description (continued)

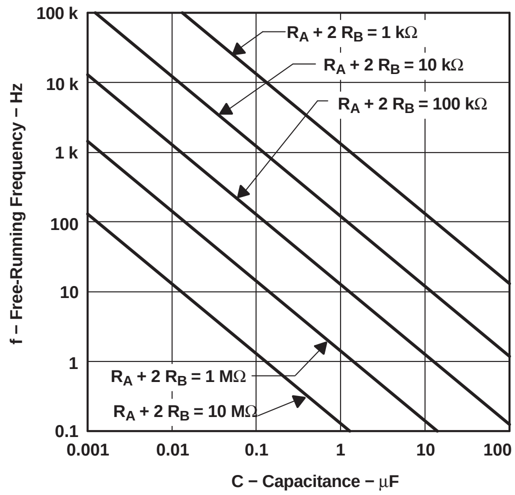


Figure 14. Free-Running Frequency

8.3.3 Frequency Divider

By adjusting the length of the timing cycle, the basic circuit of Figure 9 can be made to operate as a frequency divider. Figure 15 shows a divide-by-three circuit that makes use of the fact that re-triggering cannot occur during the timing cycle.

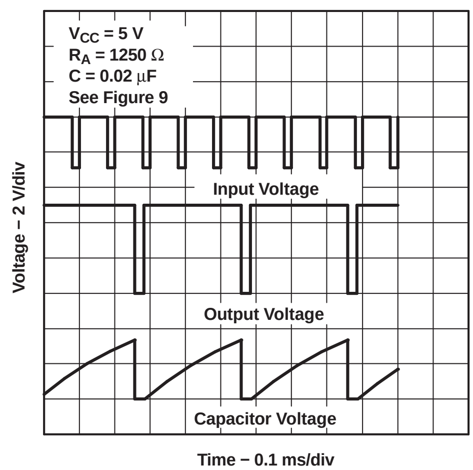


Figure 15. Divide-by-Three Circuit Waveforms

8.4 Device Functional Modes

Table 1. Function Table

RESET	TRIGGER VOLTAGE(1)	THRESHOLD VOLTAGE(1)	OUTPUT	DISCHARGE SWITCH
Low	Irrelevant	Irrelevant	Low	On
High	<1/3 V_{CC}	Irrelevant	High	Off
High	>1/3 V_{CC}	>2/3 V_{CC}	Low	On
High	>1/3 V_{CC}	<2/3 V_{CC}	As previously established	

(1) Voltage levels shown are nominal.

9 Applications and Implementation

NOTE

Information in the following applications sections is not part of the TI component specification, and TI does not warrant its accuracy or completeness. TI's customers are responsible for determining suitability of components for their purposes. Customers should validate and test their design implementation to confirm system functionality.

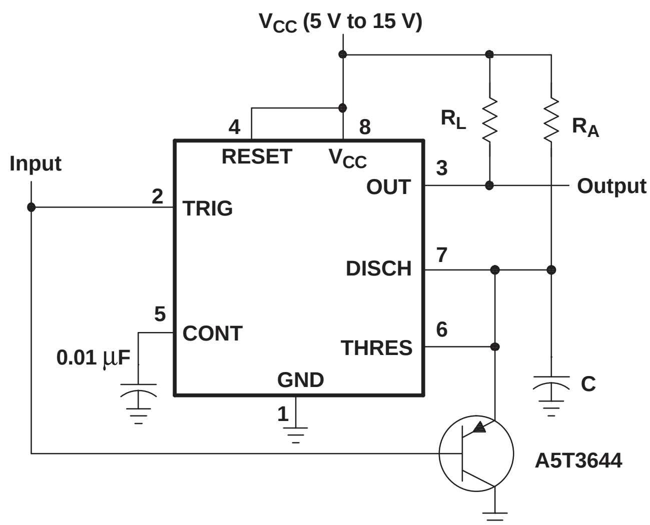
9.1 Application Information

The xx555 timer devices use resistor and capacitor charging delay to provide a programmable time delay or operating frequency. This section presents a simplified discussion of the design process.

9.2 Typical Applications

9.2.1 Missing-Pulse Detector

The circuit shown in Figure 16 can be used to detect a missing pulse or abnormally long spacing between consecutive pulses in a train of pulses. The timing interval of the monostable circuit is re-triggered continuously by the input pulse train as long as the pulse spacing is less than the timing interval. A longer pulse spacing, missing pulse, or terminated pulse train permits the timing interval to be completed, thereby generating an output pulse as shown in Figure 17.



Pin numbers shown are shown for the D, JG, P, PS, and PW packages.

Figure 16. Circuit for Missing-Pulse Detector

9.2.1.1 Design Requirements

Input fault (missing pulses) must be input high. Input stuck low will not be detected because timing capacitor "C" will remain discharged.

9.2.1.2 Detailed Design Procedure

Choose R_A and C so that $R_A \times C$ > [maximum normal input high time]. R_L improves V_{OH}, but it is not required for TTL compatibility.

Typical Applications (continued)

9.2.1.3 Application Curves

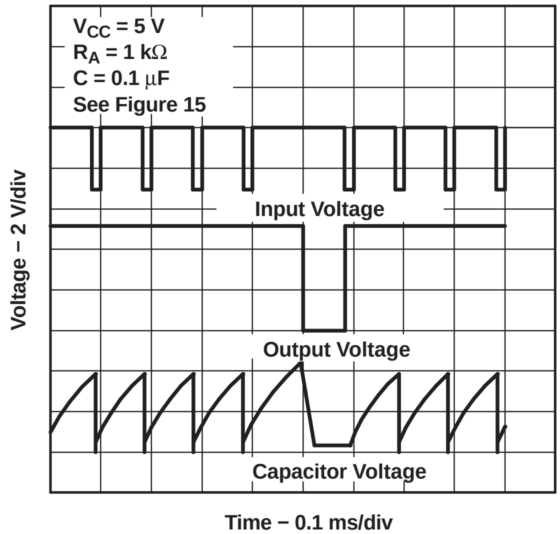
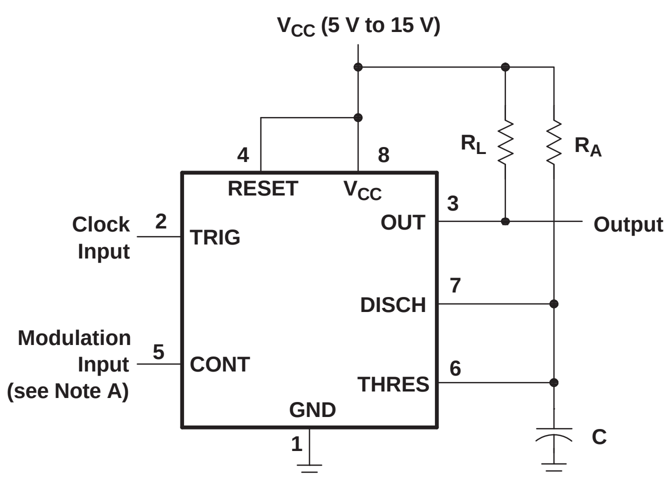


Figure 17. Completed Timing Waveforms for Missing-Pulse Detector

9.2.2 Pulse-Width Modulation

The operation of the timer can be modified by modulating the internal threshold and trigger voltages, which is accomplished by applying an external voltage (or current) to CONT. Figure 18 shows a circuit for pulse-width modulation. A continuous input pulse train triggers the monostable circuit, and a control signal modulates the threshold voltage. Figure 19 shows the resulting output pulse-width modulation. While a sine-wave modulation signal is shown, any wave shape could be used.



Pin numbers shown are for the D, JG, P, PS, and PW packages.

NOTE A: The modulating signal can be direct or capacitively coupled to CONT. For direct coupling, the effects of modulation source voltage and impedance on the bias of the timer should be considered.

Figure 18. Circuit for Pulse-Width Modulation

Typical Applications (continued)

9.2.2.1 Design Requirements

Clock input must have V_{OL} and V_{OH} levels that are less than and greater than 1/3 VCC. Modulation input can vary from ground to VCC. The application must be tolerant of a nonlinear transfer function; the relationship between modulation input and pulse width is not linear because the capacitor charge is based RC on an negative exponential curve.

9.2.2.2 Detailed Design Procedure

Choose R_A and C so that R_A × C = 1/4 [clock input period]. R_L improves V_{OH}, but it is not required for TTL compatibility.

9.2.2.3 Application Curves

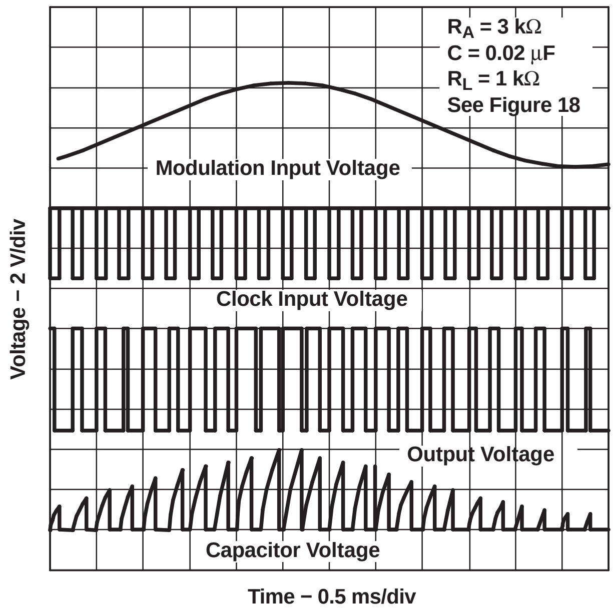
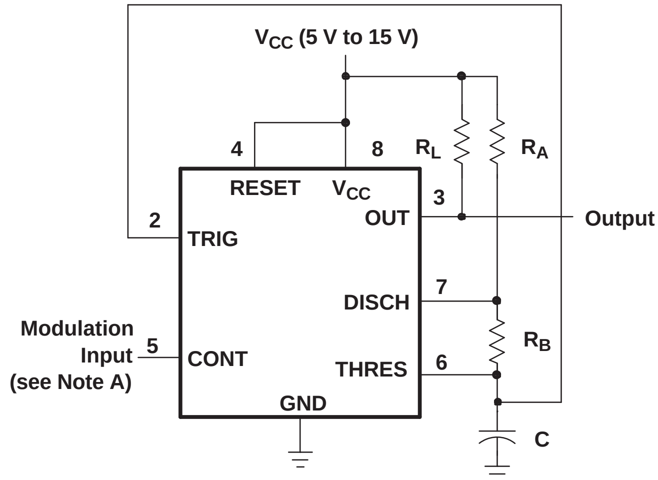


Figure 19. Pulse-Width-Modulation Waveforms

9.2.3 Pulse-Position Modulation

As shown in Figure 20, any of these timers can be used as a pulse-position modulator. This application modulates the threshold voltage and, thereby, the time delay, of a free-running oscillator. Figure 21 shows a triangular-wave modulation signal for such a circuit; however, any wave shape could be used.

Typical Applications (continued)



Pin numbers shown are for the D, JG, P, PS, and PW packages.

NOTE A: The modulating signal can be direct or capacitively coupled to CONT. For direct coupling, the effects of modulation source voltage and impedance on the bias of the timer should be considered.

Figure 20. Circuit for Pulse-Position Modulation

9.2.3.1 Design Requirements

Both DC and AC coupled modulation input will change the upper and lower voltage thresholds for the timing capacitor. Both frequency and duty cycle will vary with the modulation voltage.

9.2.3.2 Detailed Design Procedure

The nominal output frequency and duty cycle can be determined using formulas in A-stable Operation section. R_L improves V_{OH}, but it is not required for TTL compatibility.

Typical Applications (continued)

9.2.3.3 Application Curves

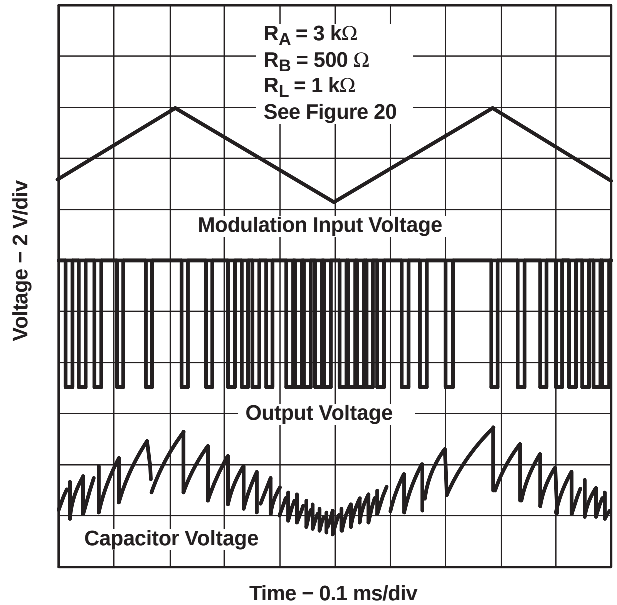
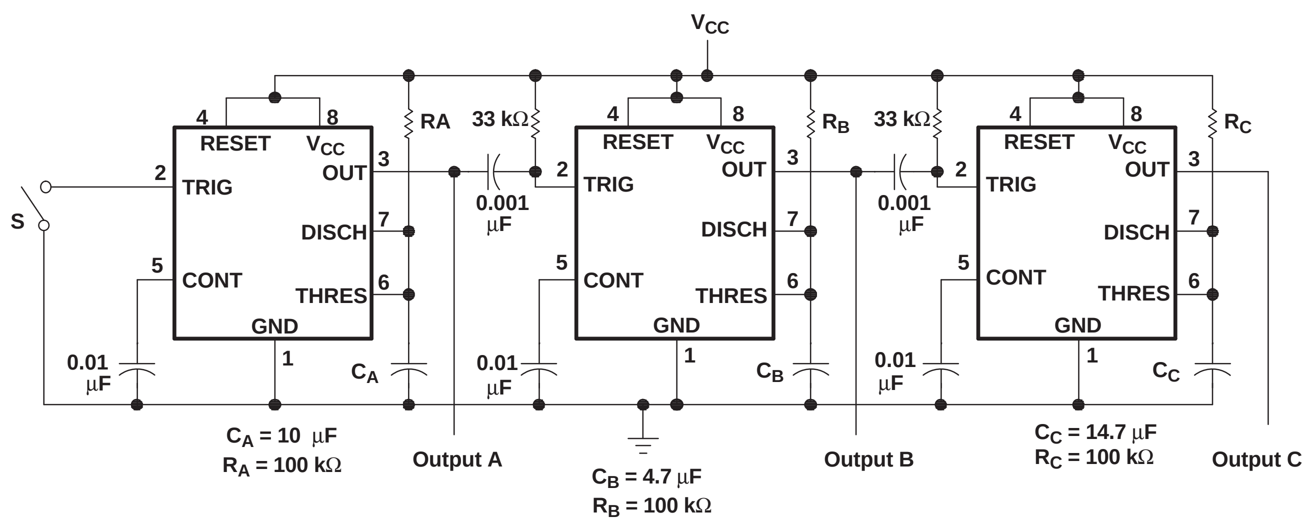


Figure 21. Pulse-Position-Modulation Waveforms

9.2.4 Sequential Timer

Many applications, such as computers, require signals for initializing conditions during start-up. Other applications, such as test equipment, require activation of test signals in sequence. These timing circuits can be connected to provide such sequential control. The timers can be used in various combinations of astable or monostable circuit connections, with or without modulation, for extremely flexible waveform control. Figure 22 shows a sequencer circuit with possible applications in many systems, and Figure 23 shows the output waveforms.



Pin numbers shown are for the D, JG, P, PS, and PW packages.
NOTE A: S closes momentarily at t = 0.

Figure 22. Sequential Timer Circuit

Typical Applications (continued)

9.2.4.1 Design Requirements

The sequential timer application chains together multiple mono-stable timers. The joining components are the 33-kΩ resistors and 0.001-µF capacitors. The output high to low edge passes a 10-µs start pulse to the next monostable.

9.2.4.2 Detailed Design Procedure

The timing resistors and capacitors can be chosen using this formula. $t_w = 1.1 \times R \times C$.

9.2.4.3 Application Curves

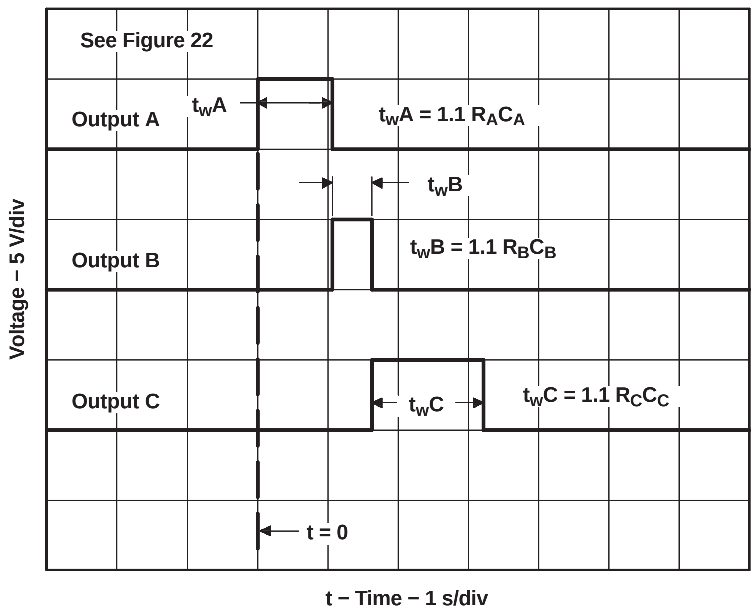


Figure 23. Sequential Timer Waveforms

10 Power Supply Recommendations

The devices are designed to operate from an input voltage supply range between 4.5 V and 16 V. (18 V for SE555). A bypass capacitor is highly recommended from VCC to ground pin; ceramic 0.1 µF capacitor is sufficient.

11 Device and Documentation Support

11.1 Related Links

The table below lists quick access links. Categories include technical documents, support and community resources, tools and software, and quick access to sample or buy.

Table 2. Related Links

PARTS	PRODUCT FOLDER	SAMPLE & BUY	TECHNICAL DOCUMENTS	TOOLS & SOFTWARE	SUPPORT & COMMUNITY
NA555	Click here	Click here	Click here	Click here	Click here
NE555	Click here	Click here	Click here	Click here	Click here
SA555	Click here	Click here	Click here	Click here	Click here
SE555	Click here	Click here	Click here	Click here	Click here

11.2 Trademarks

All trademarks are the property of their respective owners.

11.3 Electrostatic Discharge Caution

This integrated circuit can be damaged by ESD. Texas Instruments recommends that all integrated circuits be handled with appropriate precautions. Failure to observe proper handling and installation procedures can cause damage.

ESD damage can range from subtle performance degradation to complete device failure. Precision integrated circuits may be more susceptible to damage because very small parametric changes could cause the device not to meet its published specifications.

11.4 Glossary

SLYZ022 — *TI Glossary*.

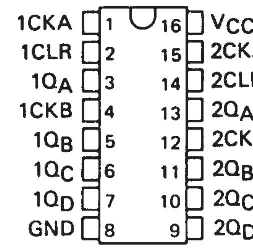
This glossary lists and explains terms, acronyms and definitions.

12 Mechanical, Packaging, and Orderable Information

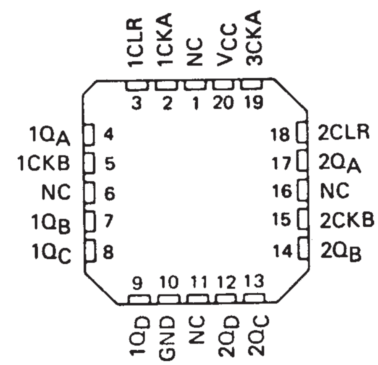
The following pages include mechanical packaging and orderable information. This information is the most current data available for the designated devices. This data is subject to change without notice and revision of this document. For browser based versions of this data sheet, refer to the left hand navigation.

- Dual Versions of the Popular '90A, 'LS90 and '93A, 'LS93
- '390, 'LS390 . . . Individual Clocks for A and B Flip-Flops Provide Dual ÷ 2 and ÷ 5 Counters
- '393, 'LS393 . . . Dual 4-Bit Binary Counter with Individual Clocks
- All Have Direct Clear for Each 4-Bit Counter
- Dual 4-Bit Versions Can Significantly Improve System Densities by Reducing Counter Package Count by 50%
- Typical Maximum Count Frequency . . . 35 MHz
- Buffered Outputs Reduce Possibility of Collector Commutation

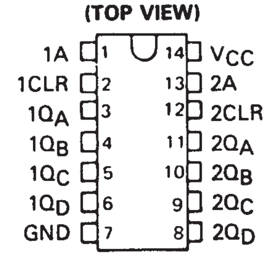
SN54390, SN54LS390 . . . J OR W PACKAGE
SN74390 . . . N PACKAGE
SN74LS390 . . . D OR N PACKAGE
(TOP VIEW)



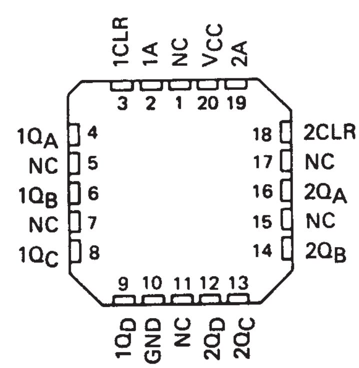
SN54LS390 . . . FK PACKAGE
(TOP VIEW)



SN54393, SN54LS393 . . . J OR W PACKAGE
SN74393 . . . N PACKAGE
SN74LS393 . . . D OR N PACKAGE
(TOP VIEW)



SN54LS393 . . . FK PACKAGE
(TOP VIEW)



NC - No internal connection

description

Each of these monolithic circuits contains eight master-slave flip-flops and additional gating to implement two individual four-bit counters in a single package. The '390 and 'LS390 incorporate dual divide-by-two and divide-by-five counters, which can be used to implement cycle lengths equal to any whole and/or cumulative multiples of 2 and/or 5 up to divide-by-100. When connected as a bi-quinary counter, the separate divide-by-two circuit can be used to provide symmetry (a square wave) at the final output stage. The '393 and 'LS393 each comprise two independent four-bit binary counters each having a clear and a clock input. N-bit binary counters can be implemented with each package providing the capability of divide-by-256. The '390, 'LS390, '393, and 'LS393 have parallel outputs from each counter stage so that any submultiple of the input count frequency is available for system-timing signals.

Series 54 and Series 54LS circuits are characterized for operation over the full military temperature range of −55°C to 125°C; Series 74 and Series 74LS circuits are characterized for operation from 0°C to 70°C.

FUNCTION TABLES

'390, 'LS390
BCD COUNT SEQUENCE
(EACH COUNTER)
(See Note A)

COUNT	OUTPUT			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H

'390, 'LS390
BI-QUINARY (5-2)
(EACH COUNTER)
(See Note B)

COUNT	OUTPUT			
	Q_A	Q_D	Q_C	Q_B
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	H	L	L	L
6	H	L	L	H
7	H	L	H	L
8	H	L	H	H
9	H	H	L	L

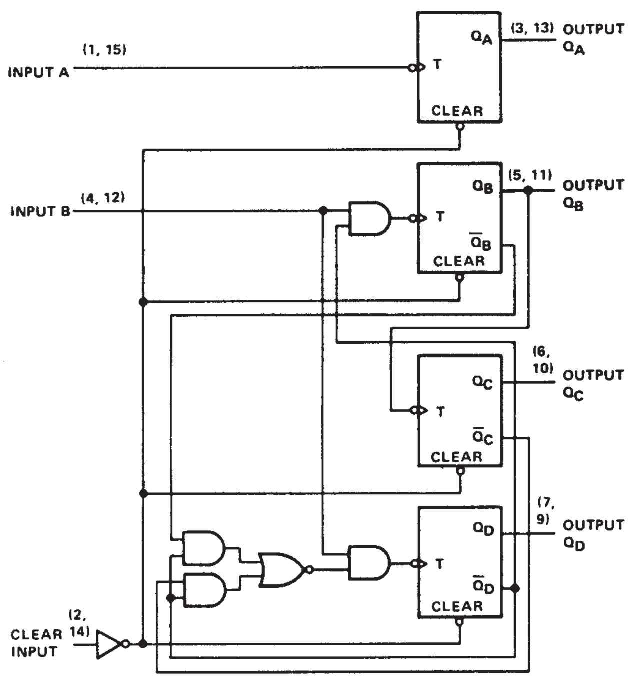
NOTES: A. Output Q_A is connected to input B for BCD count.
B. Output Q_D is connected to input A for bi-quinary count.
C. H = high level, L = low level.

'393, 'LS393
COUNT SEQUENCE
(EACH COUNTER)

COUNT	OUTPUT			
	Q_D	Q_C	Q_B	Q_A
0	L	L	L	L
1	L	L	L	H
2	L	L	H	L
3	L	L	H	H
4	L	H	L	L
5	L	H	L	H
6	L	H	H	L
7	L	H	H	H
8	H	L	L	L
9	H	L	L	H
10	H	L	H	L
11	H	L	H	H
12	H	H	L	L
13	H	H	L	H
14	H	H	H	L
15	H	H	H	H

logic diagrams (positive logic)

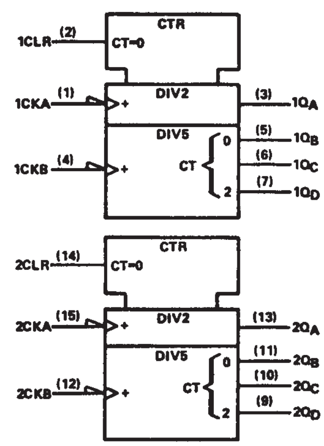
'390, 'LS390



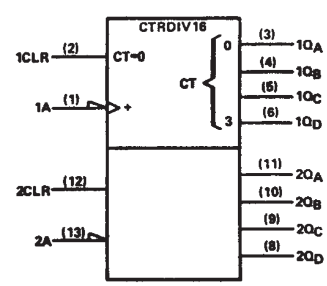
Pin numbers shown are for D, J, N, and W packages.

logic symbols†

'390, 'LS390



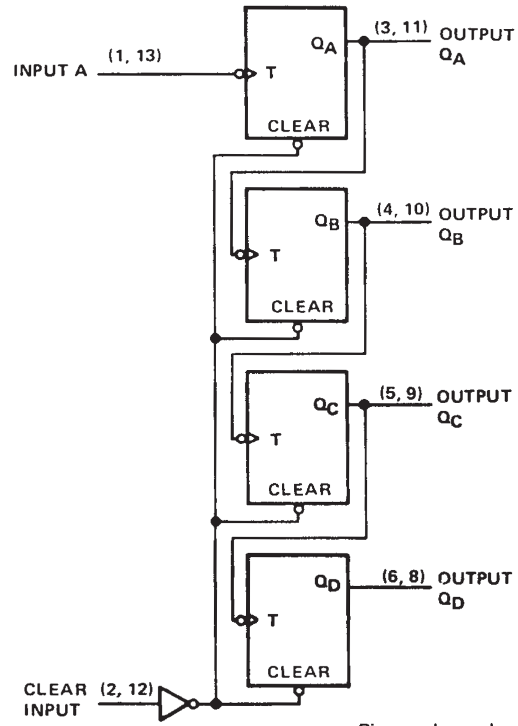
'393, 'LS393



†These symbols are in accordance with ANSI/IEEE Std. 91-1984 and IEC Publication 617-12.

logic diagrams (continued)

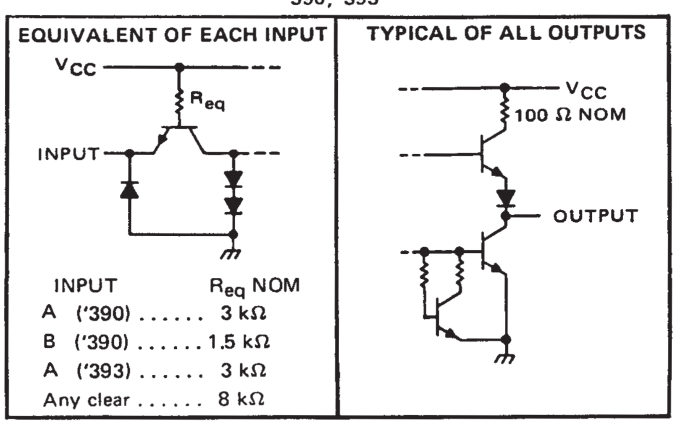
'393, 'LS393



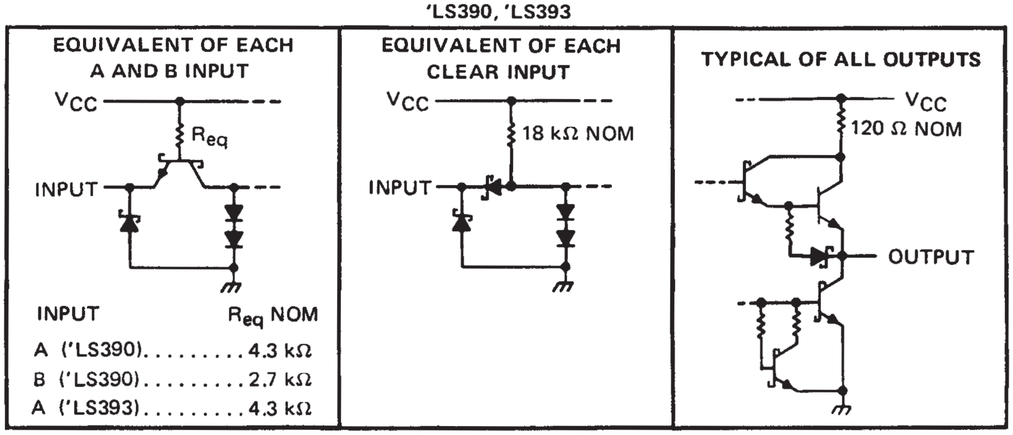
Pin numbers shown are for D, J, N and W packages.

schematics of inputs and outputs

'390, '393



'LS390, 'LS393



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

Supply voltage, V_{CC} (see Note 1) . . . . 7 V
Input voltage . . . . 5.5 V
Operating free-air temperature range: SN54390, SN54393 . . . . –55°C to 125°C
SN74390, SN74393 . . . . 0°C to 70°C
Storage temperature range . . . . –65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

		SN54390 SN54393 MIN	NOM	MAX	SN74390 SN74393 MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}				–800			–800	μA
Low-level output current, I_{OL}				16			16	mA
Count frequency, f_{count}	A input	0		25	0		25	MHz
	B input	0		20	0		20	
Pulse width, t_w	A input high or low	20			20			ns
	B input high or low	25			25			
	Clear high	20			20			
Clear inactive-state setup time, t_{su}		25↓			25↓			ns
Operating free-air temperature, T_A		–55		125	0		70	°C

↓ The arrow indicates that the falling edge of the clock pulse is used for reference.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER			TEST CONDITIONS†		'390 MIN	TYP‡	MAX	'393 MIN	TYP‡	MAX	UNIT
V_{IH}	High-level input voltage				2			2			V
V_{IL}	Low-level input voltage						0.8			0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN, I_I = –12 mA				–1.5			–1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = –800 μA		2.4	3.4		2.4	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = 16 mA¶			0.2	0.4		0.2	0.4	V
I_I	Input current at maximum input voltage		V_{CC} = MAX, V_I = 5.5 V				1			1	mA
I_{IH}	High-level input current	Clear	V_{CC} = MAX, V_I = 2.4 V				40			40	μA
		Input A					80			80	
		Input B					120				
I_{IL}	Low-level input current	Clear	V_{CC} = MAX, V_I = 0.4 V				–1			–1	mA
		Input A					–3.2			–3.2	
		Input B					–4.8				
I_{OS}	Short-circuit output current§		V_{CC} = MAX	SN54'	–20		–57	–20		–57	mA
				SN74'	–18		–57	–18		–57	
I_{CC}	Supply current		V_{CC} = MAX, See Note 2			42	69		38	64	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
§ Not more than one output should be shorted at a time.
¶ The Q_A outputs of the '390 are tested at I_{OL} = 16 mA plus the limit value for I_{IL} for the B input. This permits driving the B input while maintaining full fan-out capability.

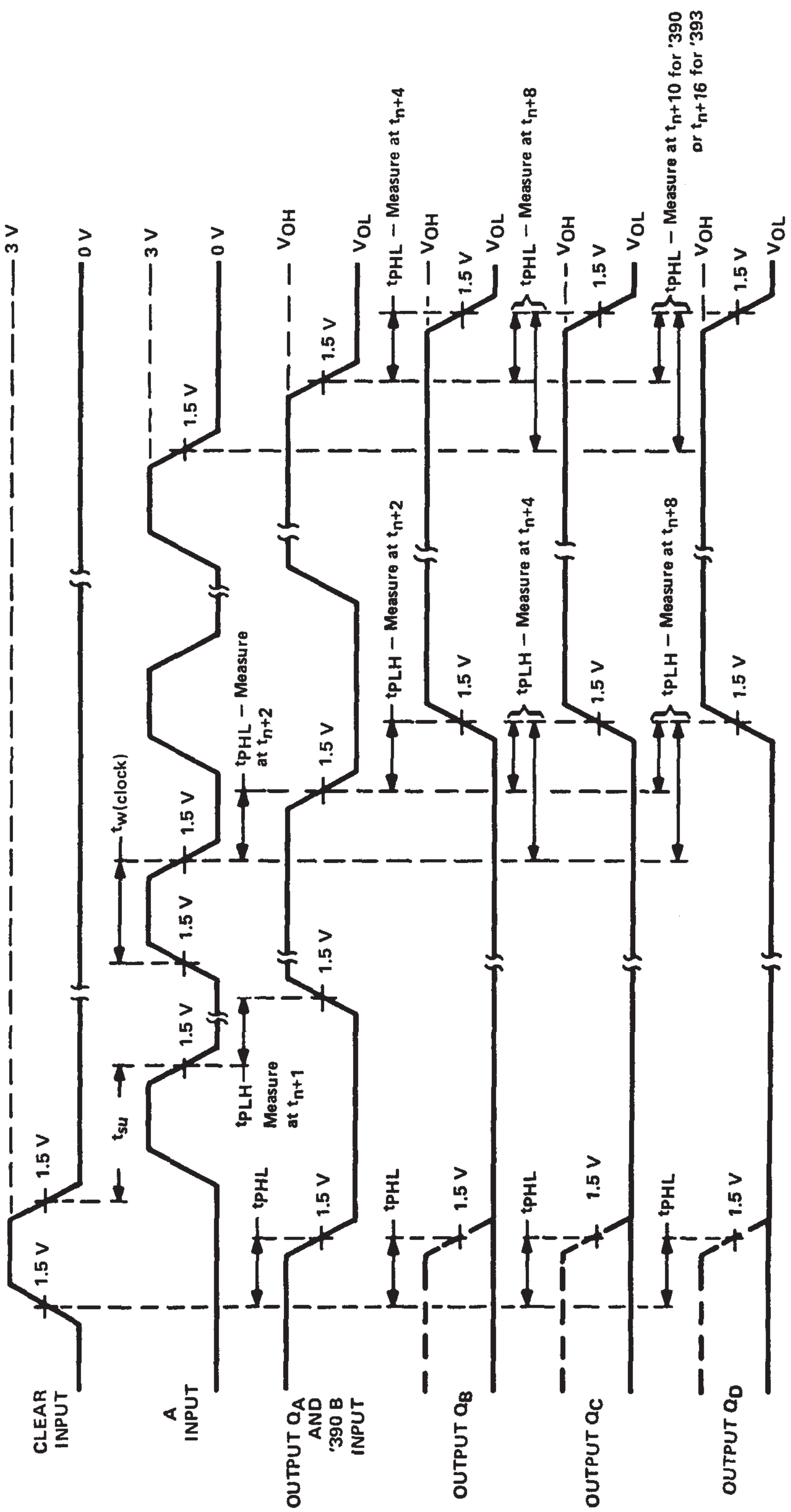
NOTE 2: I_{CC} is measured with all outputs open, both clear inputs grounded following momentary connection to 4.5 V, and all other inputs grounded.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'390			'393			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
f_{max}	A	Q_A	C_L = 15 pF, R_L = 400 Ω, See Note 3 and Figure 1	25	35		25	35		MHz
	B	Q_B		20	30					
t_{PLH}	A	Q_A			12	20		12	20	ns
t_{PHL}					13	20		13	20	
t_{PLH}	A	Q_C of '390 Q_D of '393			37	60		40	60	ns
t_{PHL}					39	60		40	60	
t_{PLH}	B	Q_B			13	21				ns
t_{PHL}					14	21				
t_{PLH}	B	Q_C			24	39				ns
t_{PHL}					26	39				
t_{PLH}	B	Q_D			13	21				ns
t_{PHL}					14	21				
t_{PHL}	Clear	Any			24	39		24	39	ns

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS

NOTE A: Input pulses are supplied by a generator having the following characteristics $t_r \leq 5$ ns, $t_f \leq 5$ ns, PRR = 1 MHz, duty cycle = 50%, $Z_{out} \approx 50$ ohms.

FIGURE 1

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

Supply voltage, V_{CC} (see Note 1) . . . . 7 V
Clear input voltage . . . . 7 V
Any A or B clock input voltage . . . . 5.5 V
Operating free-air temperature range: SN54LS390, SN54LS393 . . . . −55°C to 125°C
SN74LS390, SN74LS393 . . . . 0°C to 70°C
Storage temperature range . . . . −65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

		SN54LS390 SN54LS393 MIN	NOM	MAX	SN74LS390 SN74LS393 MIN	NOM	MAX	UNIT
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}				−400			−400	μA
Low-level output current, I_{OL}				4			8	mA
Count frequency, f_{count}	A input	0		25	0		25	MHz
	B input	0		12.5	0		12.5	
Pulse width, t_w	A input high or low	20			20			ns
	B input high or low	40			40			
	Clear high	20			20			
Clear inactive-state setup time, t_{su}		25↓			25↓			ns
Operating free-air temperature, T_A		−55		125	0		70	°C

↓ The arrow indicates that the falling edge of the clock pulse is used for reference.

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER			TEST CONDITIONS†		SN54LS' MIN	TYP‡	MAX	SN74LS' MIN	TYP‡	MAX	UNIT
V_{IH}	High-level input voltage				2			2			V
V_{IL}	Low-level input voltage						0.7			0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN, I_I = −18 mA				−1.5			−1.5	V
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL}max, I_{OH} = −400 μA		2.5	3.4		2.7	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V,	I_{OL} = 4 mA¶		0.25	0.4		0.25	0.4	V
				I_{OL} = 8 mA¶					0.35	0.5	
I_I	Input current at maximum input voltage	Clear	V_{CC} = MAX	V_I = 7 V			0.1			0.1	mA
		Input A		V_I = 5.5 V			0.2			0.2	
		Input B					0.4			0.4	
I_{IH}	High-level input current	Clear	V_{CC} = MAX, V_I = 2.7 V				0.02			0.02	mA
		Input A					0.1			0.1	
		Input B					0.2			0.2	
I_{IL}	Low-level input current	Clear	V_{CC} = MAX, V_I = 0.4 V				−0.4			−0.4	mA
		Input A					−1.6			−1.6	
		Input B					−2.4			−2.4	
I_{OS}	Short-circuit output current§		V_{CC} = MAX		−20		−100	−20		−100	mA
I_{CC}	Supply current		V_{CC} = MAX, See Note 2	'LS390		15	26		15	26	mA
				'LS393		15	26		15	26	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
§ Not more than one output should be shorted at a time, and duration of the short-circuit should not exceed one second.
¶ The Q_A outputs of the 'LS390 are tested at I_{OL} = MAX plus the limit value for I_{IL} for the clock B input. This permits driving the clock B input while maintaining full fan-out capability.

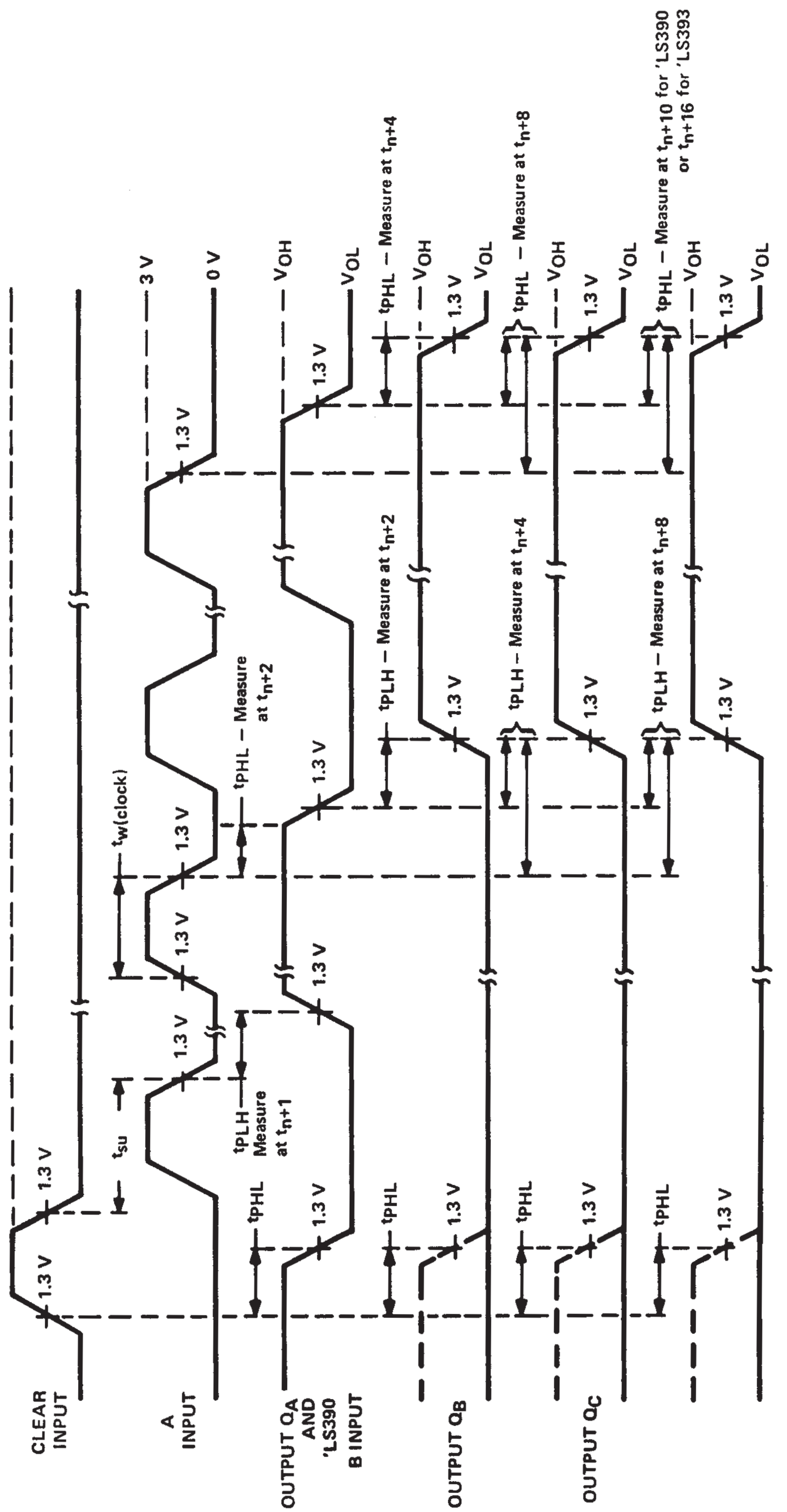
NOTE 2: I_{CC} is measured with all outputs open, both clear inputs grounded following momentary connection to 4.5 V, and all other inputs grounded.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER	FROM (INPUT)	TO (OUTPUT)	TEST CONDITIONS	'LS390			'LS393			UNIT
				MIN	TYP	MAX	MIN	TYP	MAX	
f_{max}	A	Q_A	C_L = 15 pF, R_L = 2 kΩ, See Note 4 and Figure 2	25	35		25	35		MHz
	B	Q_B		12.5	20					
t_{PLH}	A	Q_A			12	20		12	20	ns
t_{PHL}					13	20		13	20	
t_{PLH}	A	Q_C of 'LS390 Q_D of 'LS393			37	60		40	60	ns
t_{PHL}					39	60		40	60	
t_{PLH}	B	Q_B			13	21				ns
t_{PHL}					14	21				
t_{PLH}	B	Q_C			24	39				ns
t_{PHL}					26	39				
t_{PLH}	B	Q_D			13	21				ns
t_{PHL}					14	21				
t_{PHL}	Clear	Any			24	39		24	39	ns

NOTE 4: Load circuits and voltage waveforms are shown in Section 1.

PARAMETER MEASUREMENT INFORMATION



VOLTAGE WAVEFORMS

NOTE A: Input pulses are supplied by a generator having the following characteristics $t_r \leq 15$ ns, $t_f \leq 6$ ns, PRR = 1 MHz, duty cycle = 50 %, $Z_{out} \approx 50$ ohms.

FIGURE 2

’46A, ’47A, ’LS47 feature

- **Open-Collector Outputs Drive Indicators Directly**
- **Lamp-Test Provision**
- **Leading/Trailing Zero Suppression**

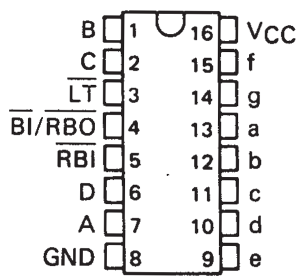
’48, ’LS48 feature

- **Internal Pull-Ups Eliminate Need for External Resistors**
- **Lamp-Test Provision**
- **Leading/Trailing Zero Suppression**

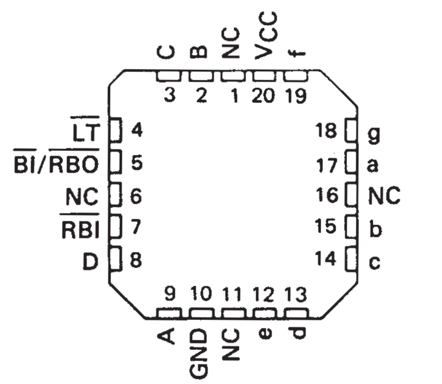
’LS49 feature

- **Open-Collector Outputs**
- **Blanking Input**

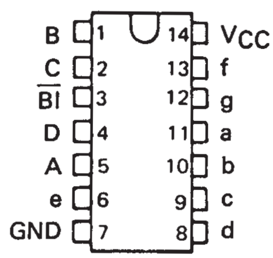
SN5446A, SN5447A, SN54LS47, SN5448, SN54LS48 . . . J PACKAGE
SN7446A, SN7447A, SN7448 . . . N PACKAGE
SN74LS47, SN74LS48 . . . D OR N PACKAGE
(TOP VIEW)



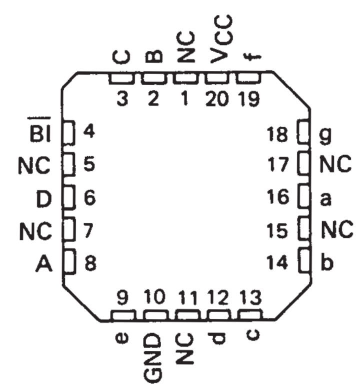
SN54LS47, SN54LS48 . . . FK PACKAGE
(TOP VIEW)



SN54LS49 . . . J OR W PACKAGE
SN74LS49 . . . D OR N PACKAGE
(TOP VIEW)



SN54LS49 . . . FK PACKAGE
(TOP VIEW)



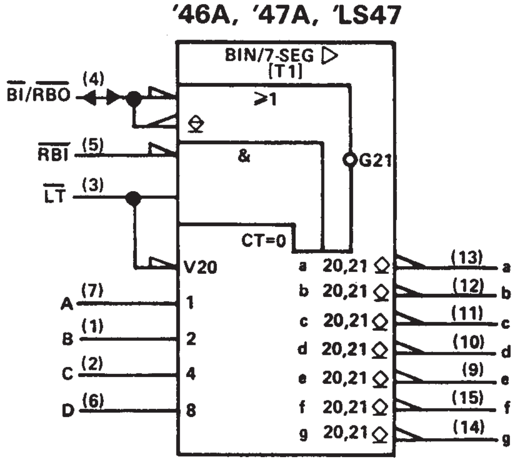
NC — No internal connection

- **All Circuit Types Feature Lamp Intensity Modulation Capability**

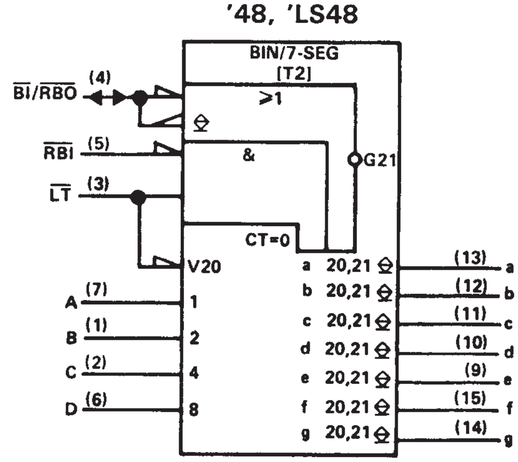
TYPE	DRIVER OUTPUTS				TYPICAL POWER DISSIPATION	PACKAGES
	ACTIVE LEVEL	OUTPUT CONFIGURATION	SINK CURRENT	MAX VOLTAGE		
SN5446A	low	open-collector	40 mA	30 V	320 mW	J, W
SN5447A	low	open-collector	40 mA	15 V	320 mW	J, W
SN5448	high	2-kΩ pull-up	6.4 mA	5.5 V	265 mW	J,W
SN54LS47	low	open-collector	12 mA	15 V	35 mW	J, W
SN54LS48	high	2-kΩ pull-up	2 mA	5.5 V	125 mW	J, W
SN54LS49	high	open-collector	4 mA	5.5 V	40 mW	J, W
SN7446A	low	open-collector	40 mA	30 V	320 mW	J, N
SN7447A	low	open-collector	40 mA	15 V	320 mW	J, N
SN7448	high	2-kΩ pull-up	6.4 mA	5.5 V	265 mW	J, N
SN74LS47	low	open-collector	24 mA	15 V	35 mW	J, N
SN74LS48	high	2-kΩ pull-up	6 mA	5.5 V	125 mW	J, N
SN74LS49	high	open-collector	8 mA	5.5 V	40 mW	J, N

logic symbols†

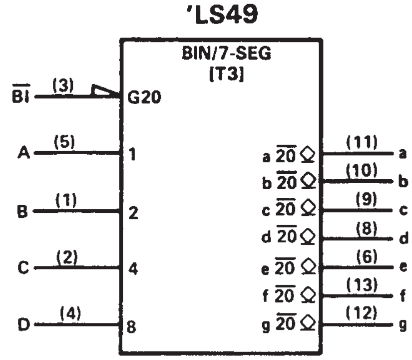
'46A, '47A, 'LS47



'48, 'LS48



'LS49



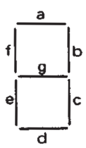
†These symbols are in accordance with ANSI/IEEE Std 91-1984 and IEC Publication 617-12.
Pin numbers shown are for D, J, N, and W packages.

description

The ’46A, ’47A, and ’LS47 feature active-low outputs designed for driving common-anode LEDs or incandescent indicators directly. The ’48, ’LS48, and ’LS49 feature active-high outputs for driving lamp buffers or common-cathode LEDs. All of the circuits except ’LS49 have full ripple-blanking input/output controls and a lamp test input. The ’LS49 circuit incorporates a direct blanking input. Segment identification and resultant displays are shown below. Display patterns for BCD input counts above 9 are unique symbols to authenticate input conditions.

The ’46A, ’47A, ’48, ’LS47, and ’LS48 circuits incorporate automatic leading and/or trailing-edge zero-blanking control ($\overline{RBI}$ and $\overline{RBO}$). Lamp test ($\overline{LT}$) of these types may be performed at any time when the $\overline{BI}/\overline{RBO}$ node is at a high level. All types (including the ’49 and ’LS49) contain an overriding blanking input ($\overline{BI}$), which can be used to control the lamp intensity by pulsing or to inhibit the outputs. Inputs and outputs are entirely compatible for use with TTL logic outputs.

The SN54246/SN74246 and ’247 and the SN54LS247/SN74LS247 and ’LS248 compose the 6 and the 9 with tails and were designed to offer the designer a choice between two indicator fonts.



SEGMENT IDENTIFICATION

0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15

NUMERICAL DESIGNATIONS AND RESULTANT DISPLAYS

’46A, ’47A, ’LS47 FUNCTION TABLE (T1)

DECIMAL OR FUNCTION	INPUTS						$\overline{BI}/\overline{RBO}$†	OUTPUTS							NOTE
	$\overline{LT}$	$\overline{RBI}$	D	C	B	A		a	b	c	d	e	f	g	
0	H	H	L	L	L	L	H	ON	ON	ON	ON	ON	ON	OFF	1
1	H	X	L	L	L	H	H	OFF	ON	ON	OFF	OFF	OFF	OFF	
2	H	X	L	L	H	L	H	ON	ON	OFF	ON	ON	OFF	ON	
3	H	X	L	L	H	H	H	ON	ON	ON	ON	OFF	OFF	ON	
4	H	X	L	H	L	L	H	OFF	ON	ON	OFF	OFF	ON	ON	
5	H	X	L	H	L	H	H	ON	OFF	ON	ON	OFF	ON	ON	
6	H	X	L	H	H	L	H	OFF	OFF	ON	ON	ON	ON	ON	
7	H	X	L	H	H	H	H	ON	ON	ON	OFF	OFF	OFF	OFF	
8	H	X	H	L	L	L	H	ON	ON	ON	ON	ON	ON	ON	
9	H	X	H	L	L	H	H	ON	ON	ON	OFF	OFF	ON	ON	
10	H	X	H	L	H	L	H	OFF	OFF	OFF	ON	ON	OFF	ON	
11	H	X	H	L	H	H	H	OFF	OFF	ON	ON	OFF	OFF	ON	
12	H	X	H	H	L	L	H	OFF	ON	OFF	OFF	OFF	ON	ON	
13	H	X	H	H	L	H	H	ON	OFF	OFF	ON	OFF	ON	ON	
14	H	X	H	H	H	L	H	OFF	OFF	OFF	ON	ON	ON	ON	
15	H	X	H	H	H	H	H	OFF	OFF	OFF	OFF	OFF	OFF	OFF	
BI	X	X	X	X	X	X	L	OFF	OFF	OFF	OFF	OFF	OFF	OFF	2
RBI	H	L	L	L	L	L	L	OFF	OFF	OFF	OFF	OFF	OFF	OFF	3
LT	L	X	X	X	X	X	H	ON	ON	ON	ON	ON	ON	ON	4

H = high level, L = low level, X = irrelevant

NOTES: 1. The blanking input ($\overline{BI}$) must be open or held at a high logic level when output functions 0 through 15 are desired. The ripple-blanking input ($\overline{RBI}$) must be open or high if blanking of a decimal zero is not desired.

2. When a low logic level is applied directly to the blanking input ($\overline{BI}$), all segment outputs are off regardless of the level of any other input.

3. When ripple-blanking input ($\overline{RBI}$) and inputs A, B, C, and D are at a low level with the lamp test input high, all segment outputs go off and the ripple-blanking output ($\overline{RBO}$) goes to a low level (response condition).

4. When the blanking input/ripple blanking output ($\overline{BI}/\overline{RBO}$) is open or held high and a low is applied to the lamp-test input, all segment outputs are on.

† $\overline{BI}/\overline{RBO}$ is wire AND logic serving as blanking input ($\overline{BI}$) and/or ripple-blanking output ($\overline{RBO}$).

’48, ’LS48
FUNCTION TABLE (T2)

DECIMAL OR FUNCTION	INPUTS						$\overline{BI}/\overline{RBO}$†	OUTPUTS							NOTE
	$\overline{LT}$	$\overline{RBI}$	D	C	B	A		a	b	c	d	e	f	g	
0	H	H	L	L	L	L	H	H	H	H	H	H	H	L	1
1	H	X	L	L	L	H	H	L	H	H	L	L	L	L	
2	H	X	L	L	H	L	H	H	H	L	H	H	L	H	
3	H	X	L	L	H	H	H	H	H	H	H	L	L	H	
4	H	X	L	H	L	L	H	L	H	H	L	L	H	H	
5	H	X	L	H	L	H	H	H	L	H	H	L	H	H	
6	H	X	L	H	H	L	H	L	L	H	H	H	H	H	
7	H	X	L	H	H	H	H	H	H	H	L	L	L	L	
8	H	X	H	L	L	L	H	H	H	H	H	H	H	H	
9	H	X	H	L	L	H	H	H	H	H	L	L	H	H	
10	H	X	H	L	H	L	H	L	L	L	H	H	L	H	
11	H	X	H	L	H	H	H	L	L	H	H	L	L	H	
12	H	X	H	H	L	L	H	L	H	L	L	L	H	H	
13	H	X	H	H	L	H	H	H	L	L	H	L	H	H	
14	H	X	H	H	H	L	H	L	L	L	H	H	H	H	
15	H	X	H	H	H	H	H	L	L	L	L	L	L	L	
BI	X	X	X	X	X	X	L	L	L	L	L	L	L	L	2
RBI	H	L	L	L	L	L	L	L	L	L	L	L	L	L	3
LT	L	X	X	X	X	X	H	H	H	H	H	H	H	H	4

H = high level, L = low level, X = irrelevant

NOTES: 1. The blanking input ($\overline{BI}$) must be open or held at a high logic level when output functions 0 through 15 are desired. The ripple-blanking input ($\overline{RBI}$) must be open or high, if blanking of a decimal zero is not desired.

2. When a low logic level is applied directly to the blanking input ($\overline{BI}$), all segment outputs are low regardless of the level of any other input.

3. When ripple-blanking input ($\overline{RBI}$) and inputs A, B, C, and D are at a low level with the lamp-test input high, all segment outputs go low and the ripple-blanking output ($\overline{RBO}$) goes to a low level (response condition).

4. When the blanking input/ripple-blanking output ($\overline{BI}/\overline{RBO}$) is open or held high and a low is applied to the lamp-test input, all segment outputs are high.

†$\overline{BI}/\overline{RBO}$ is wire-AND logic serving as blanking input ($\overline{BI}$) and/or ripple-blanking output ($\overline{RBO}$).

’LS49
FUNCTION TABLE (T3)

DECIMAL OR FUNCTION	INPUTS					OUTPUTS							NOTE
	D	C	B	A	$\overline{BI}$	a	b	c	d	e	f	g	
0	L	L	L	L	H	H	H	H	H	H	H	L	1
1	L	L	L	H	H	L	H	H	L	L	L	L	
2	L	L	H	L	H	H	H	L	H	H	L	H	
3	L	L	H	H	H	H	H	H	H	L	L	H	
4	L	H	L	L	H	L	H	H	L	L	H	H	
5	L	H	L	H	H	H	L	H	H	L	H	H	
6	L	H	H	L	H	L	L	H	H	H	H	H	
7	L	H	H	H	H	H	H	H	L	L	L	L	
8	H	L	L	L	H	H	H	H	H	H	H	H	
9	H	L	L	H	H	H	H	H	L	L	H	H	
10	H	L	H	L	H	L	L	L	H	H	L	H	
11	H	L	H	H	H	L	L	H	H	L	L	H	
12	H	H	L	L	H	L	H	L	L	L	H	H	
13	H	H	L	H	H	H	L	L	H	L	H	H	
14	H	H	H	L	H	L	L	L	H	H	H	H	
15	H	H	H	H	H	L	L	L	L	L	L	L	
BI	X	X	X	X	L	L	L	L	L	L	L	L	2

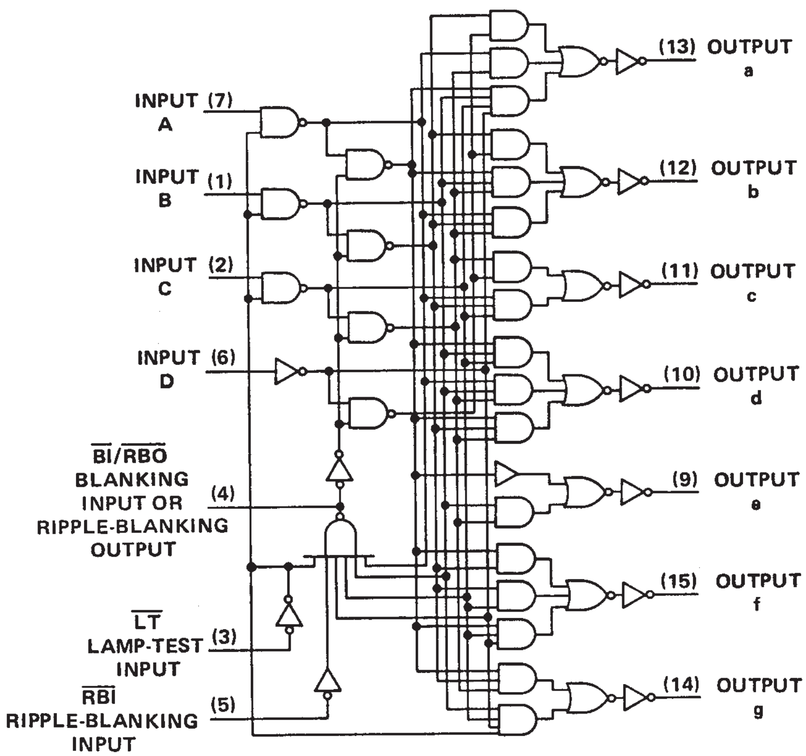
H = high level, L = low level, X = irrelevant

NOTES: 1. The blanking input ($\overline{BI}$) must be open or held at a high logic level when output functions 0 through 15 are desired.

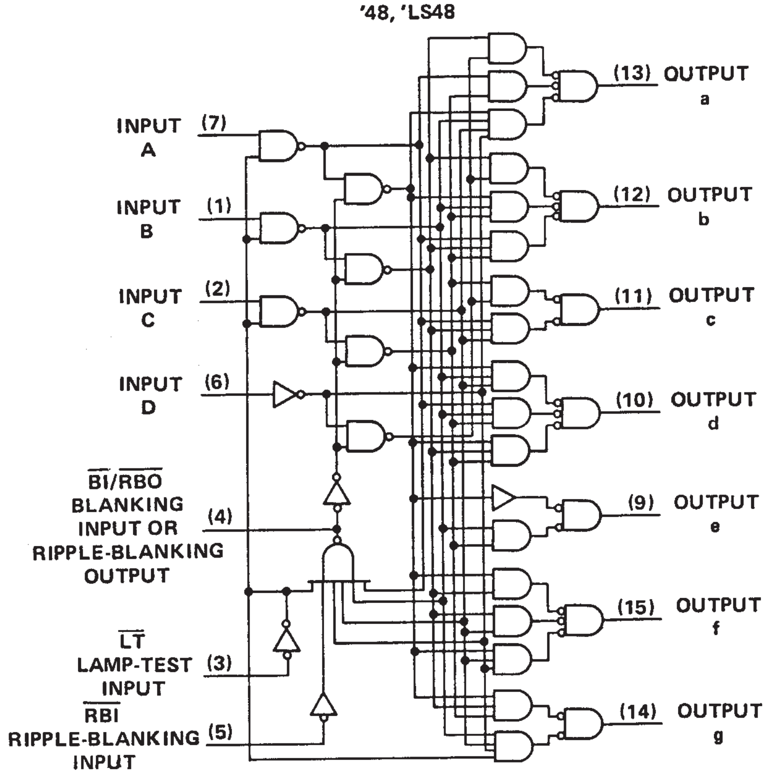
2. When a low logic level is applied directly to the blanking input ($\overline{BI}$), all segment outputs are low regardless of the level of any other input.

logic diagrams (positive logic)

'46A, '47A, 'LS47

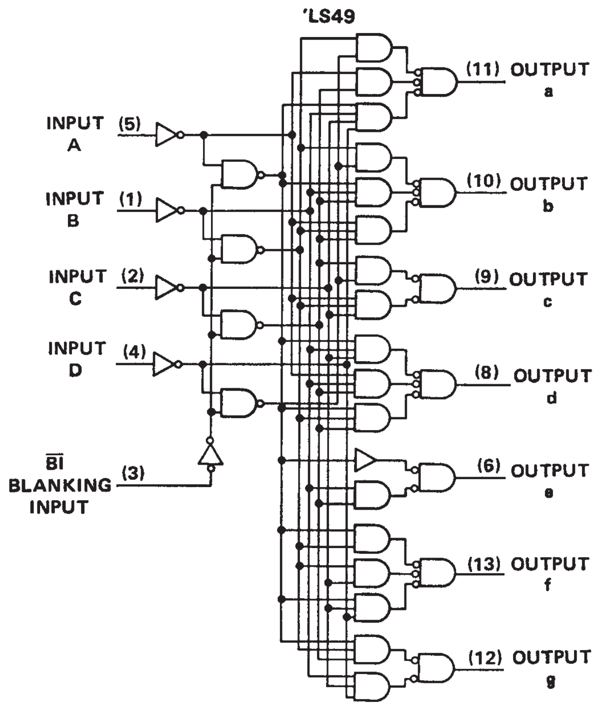


'48, 'LS48



Pin numbers shown are for D, J, N, and W packages.

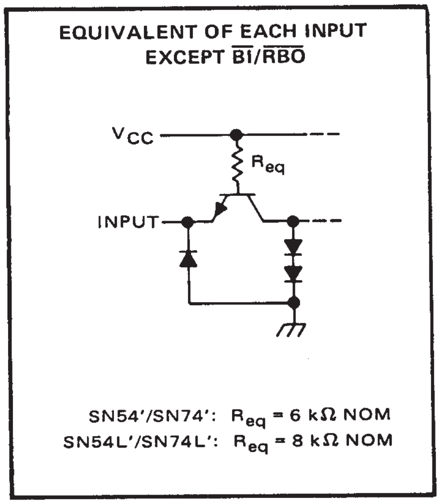
logic diagrams (continued)



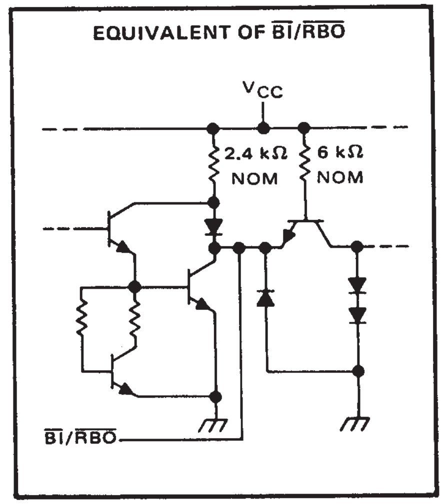
Pin numbers shown are for D, J, N, and W packages.

schematics of inputs and outputs

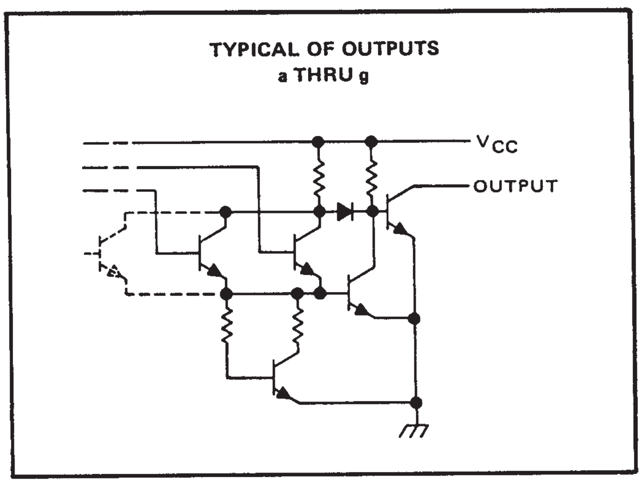
’46A, ’47A, ’48



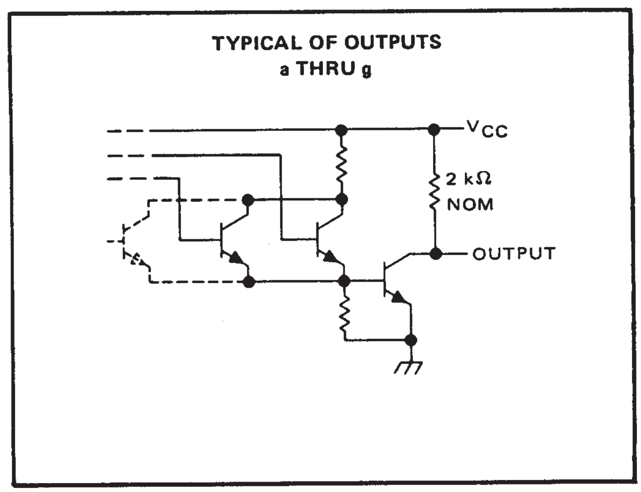
’46A, ’47A, ’48



’46A, ’47A

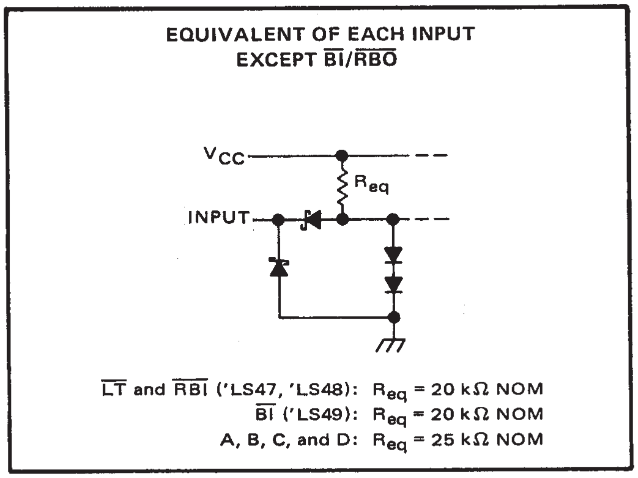


’48

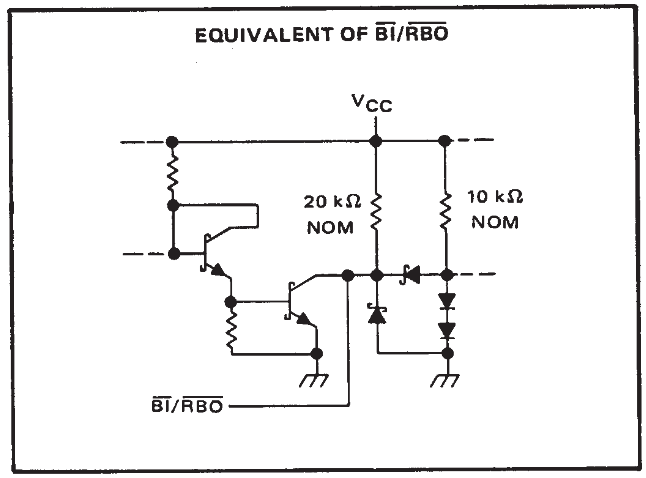


schematics of inputs and outputs

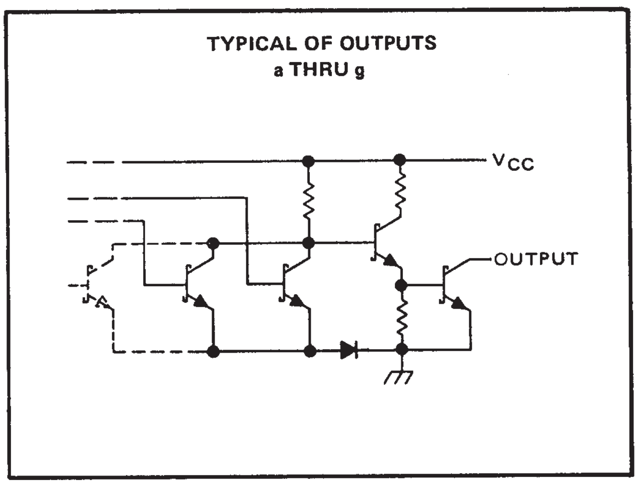
'LS47, 'LS48, 'LS49



'LS47, 'LS48, 'LS49



'LS47



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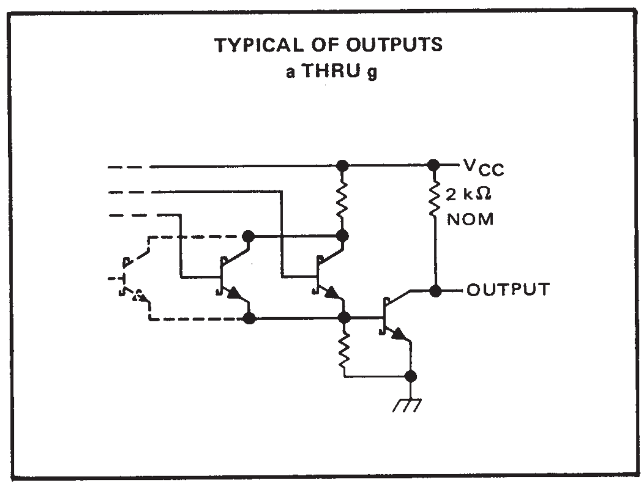
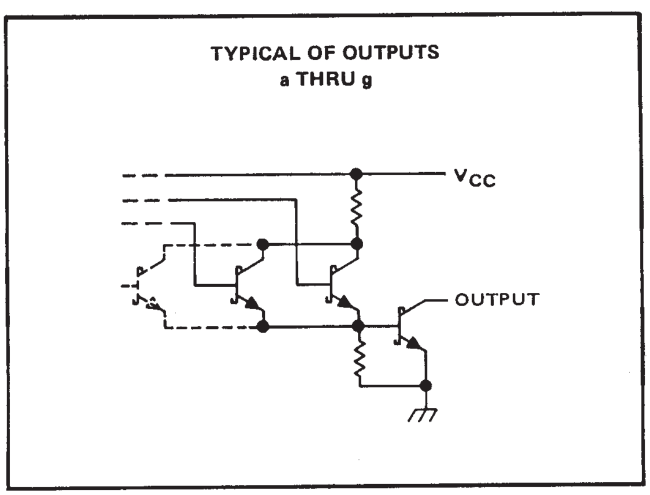


'LS49



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

Supply voltage, V_{CC} (see Note 1) . . . 7 V
Input voltage . . . 5.5 V
Current forced into any output in the off state . . . 1 mA
Operating free-air temperature range: SN5446A, SN5447A . . . −55°C to 125°C
SN7446A, SN7447A . . . 0°C to 70°C
Storage temperature range . . . −65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

		SN5446A			SN5447A			SN7446A			SN7447A			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		4.5	5	5.5	4.5	5	5.5	4.75	5	5.25	4.75	5	5.25	V
Off-state output voltage, $V_{O(off)}$	a thru g			30			15			30			15	V
On-state output current, $I_{O(on)}$	a thru g			40			40			40			40	mA
High-level output current, I_{OH}	$\overline{BI}/\overline{RBO}$			−200			−200			−200			−200	μA
Low-level output current, I_{OL}	$\overline{BI}/\overline{RBO}$			8			8			8			8	mA
Operating free-air temperature, T_A		−55		125	−55		125	0		70	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER			TEST CONDITIONS†		MIN	TYP‡	MAX	UNIT
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN, I_I = −12 mA				−1.5	V
V_{OH}	High-level output voltage	$\overline{BI}/\overline{RBO}$	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OH} = −200 μA		2.4	3.7		V
V_{OL}	Low-level output voltage	$\overline{BI}/\overline{RBO}$	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = 8 mA			0.27	0.4	V
$I_{O(off)}$	Off-state output current	a thru g	V_{CC} = MAX, V_{IH} = 2 V, V_{IL} = 0.8 V, $V_{O(off)}$ = MAX				250	μA
$V_{O(on)}$	On-state output voltage	a thru g	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, $I_{O(on)}$ = 40 mA			0.3	0.4	V
I_I	Input current at maximum input voltage	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX, V_I = 5.5 V				1	mA
I_{IH}	High-level input current	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX, V_I = 2.4 V				40	μA
I_{IL}	Low-level input current	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX, V_I = 0.4 V				−1.6	mA
		$\overline{BI}/\overline{RBO}$					−4	
I_{OS}	Short-circuit output current	$\overline{BI}/\overline{RBO}$	V_{CC} = MAX				−4	mA
I_{CC}	Supply current		V_{CC} = MAX, See Note 2	SN54'		64	85	mA
				SN74'		64	103	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
NOTE 2: I_{CC} is measured with all outputs open and all inputs at 4.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{off}	Turn-off time from A input	C_L = 15 pF, R_L = 120 Ω, See Note 3			100	ns
t_{on}	Turn-on time from A input				100	
t_{off}	Turn-off time from $\overline{RBI}$ input				100	ns
t_{on}	Turn-on time from $\overline{RBI}$ input				100	

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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

Supply voltage, V_{CC} (see Note 1) . . . . 7 V
Input voltage . . . . 5.5 V
Operating free-air temperature range: SN5448 . . . . −55°C to 125°C
SN7448 . . . . 0°C to 70°C
Storage temperature range . . . . −65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

		SN5448			SN7448			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}	a thru g			−400			−400	μA
	$\overline{BI}/\overline{RBO}$			−200			−200	
Low-level output current, I_{OL}	a thru g			6.4			6.4	mA
	$\overline{BI}/\overline{RBO}$			8			8	
Operating free-air temperature, T_A		−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER			TEST CONDITIONS†		MIN	TYP‡	MAX	UNIT
V_{IH}	High-level input voltage				2			V
V_{IL}	Low-level input voltage						0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN, I_I = −12 mA				−1.5	V
V_{OH}	High-level output voltage	a thru g	V_{CC} = MIN, V_{IH} = 2 V,		2.4	4.2		V
		$\overline{BI}/\overline{RBO}$	V_{IL} = 0.8 V, I_{OH} = MAX		2.4	3.7		
I_O	Output current	a thru g	V_{CC} = MIN, V_O = 0.85 V, Input conditions as for V_{OH}		−1.3	−2		mA
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = 0.8 V, I_{OL} = MAX			0.27	0.4	V
I_I	Input current at maximum input voltage	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX, V_I = 5.5 V				1	mA
I_{IH}	High-level input current	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX, V_I = 2.4 V				40	μA
I_{IL}	Low-level input current	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX, V_I = 0.4 V				−1.6	mA
		$\overline{BI}/\overline{RBO}$					−4	
I_{OS}	Short-circuit output current	$\overline{BI}/\overline{RBO}$	V_{CC} = MAX				−4	mA
I_{CC}	Supply current		V_{CC} = MAX, See Note 2	SN5448		53	76	mA
				SN7448		53	90	

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
NOTE 2: I_{CC} is measured with all outputs open and all inputs at 4.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PHL}	Propagation delay time, high-to-low-level output from A input	C_L = 15 pF, R_L = 1 kΩ, See Note 3			100	ns
t_{PLH}	Propagation delay time, low-to-high-level output from A input				100	
t_{PHL}	Propagation delay time, high-to-low-level output from $\overline{RBI}$ input				100	ns
t_{PLH}	Propagation delay time, low-to-high-level output from $\overline{RBI}$ input				100	

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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

Supply voltage, V_{CC} (see Note 1) . . . . 7 V
Input voltage . . . . 7 V
Peak output current ($t_w \leq 1$ ms, duty cycle $\leq 10\%$) . . . . 200 mA
Current forced into any output in the off state . . . . 1 mA
Operating free-air temperature range: SN54LS47 . . . . −55°C to 125°C
SN74LS47 . . . . 0°C to 70°C
Storage temperature range . . . . −65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

		SN54LS47 MIN	SN54LS47 NOM	SN54LS47 MAX	SN74LS47 MIN	SN74LS47 NOM	SN74LS47 MAX	UNIT
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
Off-state output voltage, $V_{O(off)}$	a thru g			15			15	V
On-state output current, $I_{O(on)}$	a thru g			12			24	mA
High-level output current, I_{OH}	$\overline{BI}/\overline{RBO}$			−50			−50	μA
Low-level output current, I_{OL}	$\overline{BI}/\overline{RBO}$			1.6			3.2	mA
Operating free-air temperature, T_A		−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER			TEST CONDITIONS†		SN54LS47 MIN	SN54LS47 TYP‡	SN54LS47 MAX	SN74LS47 MIN	SN74LS47 TYP‡	SN74LS47 MAX	UNIT
V_{IH}	High-level input voltage				2			2			V
V_{IL}	Low-level input voltage						0.7			0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN, $I_I = -18$ mA				−1.5			−1.5	V
V_{OH}	High-level output voltage	$\overline{BI}/\overline{RBO}$	V_{CC} = MIN, V_{IH} = 2 V, $V_{IL} = V_{IL}$ max, $I_{OH} = -50$ μA		2.4	4.2		2.4	4.2		V
V_{OL}	Low-level output voltage	$\overline{BI}/\overline{RBO}$	V_{CC} = MIN, V_{IH} = 2 V, $V_{IL} = V_{IL}$ max	I_{OL} = 1.6 mA		0.25	0.4		0.25	0.4	V
				I_{OL} = 3.2 mA					0.35	0.5	
$I_{O(off)}$	Off-state output current	a thru g	V_{CC} = MAX, V_{IH} = 2 V, $V_{IL} = V_{IL}$ max, $V_{O(off)}$ = 15 V				250			250	μA
$V_{O(on)}$	On-state output voltage	a thru g	V_{CC} = MIN, V_{IH} = 2 V, $V_{IL} = V_{IL}$ max	$I_{O(on)}$ = 12 mA		0.25	0.4		0.25	0.4	V
				$I_{O(on)}$ = 24 mA					0.35	0.5	
I_I	Input current at maximum input voltage		V_{CC} = MAX, V_I = 7 V				0.1			0.1	mA
I_{IH}	High-level input current		V_{CC} = MAX, V_I = 2.7 V				20			20	μA
I_{IL}	Low-level input current	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX, V_I = 0.4 V				−0.4			−0.4	mA
		$\overline{BI}/\overline{RBO}$					−1.2			−1.2	
I_{OS}	Short-circuit output current	$\overline{BI}/\overline{RBO}$	V_{CC} = MAX		−0.3		−2	−0.3		−2	mA
I_{CC}	Supply current		V_{CC} = MAX, See Note 2			7	13		7	13	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
NOTE 2: I_{CC} is measured with all outputs open and all inputs at 4.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{off}	Turn-off time from A input	C_L = 15 pF, R_L = 665 Ω, See Note 3			100	ns
t_{on}	Turn-on time from A input				100	
t_{off}	Turn-off time from $\overline{RBI}$ input, outputs (a-f) only				100	ns
t_{on}	Turn-on time from $\overline{RBI}$ input, outputs (a-f) only				100	

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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

Supply voltage, V_{CC} (see Note 1)	7 V
Input voltage	7 V
Operating free-air temperature range: SN54LS48	−55°C to 125°C
SN74LS48	0°C to 70°C
Storage temperature range	−65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

		SN54LS48			SN74LS48			UNIT
		MIN	NOM	MAX	MIN	NOM	MAX	
Supply voltage, V_{CC}		4.5	5	5.5	4.75	5	5.25	V
High-level output current, I_{OH}	a thru g			−100			−100	μA
	$\overline{BI}/\overline{RBO}$			−50			−50	
Low-level output current, I_{OL}	a thru g			2			6	mA
	$\overline{BI}/\overline{RBO}$			1.6			3.2	
Operating free-air temperature, T_A		−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER			TEST CONDITIONS†		SN54LS48			SN74LS48			UNIT
					MIN	TYP‡	MAX	MIN	TYP‡	MAX	
V_{IH}	High-level input voltage				2			2			V
V_{IL}	Low-level input voltage						0.7			0.8	V
V_{IK}	Input clamp voltage		V_{CC} = MIN,	I_I = −18 mA			−1.5			−1.5	V
V_{OH}	High-level output voltage	a thru g and $\overline{BI}/\overline{RBO}$	V_{CC} = MIN, V_{IL} = V_{IL} max,	V_{IH} = 2 V, I_{OH} = MAX	2.4	4.2		2.4	4.2		V
I_O	Output current	a thru g	V_{CC} = MIN, Input conditions as for V_{OH}	V_O = 0.85 V,	−1.3	−2		−1.3	−2		mA
V_{OL}	Low-level output voltage	a thru g	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max	I_{OL} = 2 mA		0.25	0.4		0.25	0.4	V
				I_{OL} = 6 mA					0.35	0.5	
		$\overline{BI}/\overline{RBO}$	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max	I_{OL} = 1.6 mA		0.25	0.4		0.25	0.4	V
				I_{OL} = 3.2 mA					0.35	0.5	
I_I	Input current at maximum input voltage	Any input except $\overline{BI}/\overline{BRO}$	V_{CC} = MAX,	V_I = 7 V			0.1			0.1	mA
I_{IH}	High-level input current	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX,	V_I = 2.7 V			20			20	μA
I_{IL}	Low-level input current	Any input except $\overline{BI}/\overline{RBO}$	V_{CC} = MAX,	V_I = 0.4 V			−0.4			−0.4	mA
		$\overline{BI}/\overline{RBO}$					−1.2			−1.2	
I_{OS}	Short-circuit output current	$\overline{BI}/\overline{RBO}$	V_{CC} = MAX		−0.3		−2	−0.3		−2	mA
I_{CC}	Supply current		V_{CC} = MAX,	See Note 2		25	38		25	38	mA

†For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡All typical values are at V_{CC} = 5 V, T_A 25°C.
NOTE 2: I_{CC} is measured with all outputs open and all inputs at 4.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PHL}	Propagation delay time, high-to-low-level output from A input	C_L = 15 pF, R_L = 4 kΩ, See Note 3			100	ns
t_{PLH}	Propagation delay time, low-to-high-level output from A input				100	
t_{PHL}	Propagation delay time, high-to-low-level output (a-f only) from $\overline{RBI}$ input	C_L = 15 pF, R_L = 6 kΩ, See Note 3			100	ns
t_{PLH}	Propagation delay time, low-to-high-level output (a-f only) from $\overline{RBI}$ input				100	

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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

Supply voltage, V_{CC} (see Note 1) . . . . 7 V
Input voltage . . . . 7 V
Current forced into any output in the off state . . . . 1 mA
Operating free-air temperature range: SN54LS49 . . . . −55°C to 125°C
SN74LS49 . . . . 0°C to 70°C
Storage temperature range . . . . −65°C to 150°C

NOTE 1: Voltage values are with respect to network ground terminal.

recommended operating conditions

	SN54LS49 MIN	SN54LS49 NOM	SN54LS49 MAX	SN74LS49 MIN	SN74LS49 NOM	SN74LS49 MAX	UNIT
Supply voltage, V_{CC}	4.5	5	5.5	4.75	5	5.25	V
High-level output voltage, V_{OH}			5.5			5.5	V
Low-level output current, I_{OL}			4			8	mA
Operating free-air temperature, T_A	−55		125	0		70	°C

electrical characteristics over recommended operating free-air temperature range (unless otherwise noted)

PARAMETER		TEST CONDITIONS†		SN54LS49 MIN	SN54LS49 TYP‡	SN54LS49 MAX	SN74LS49 MIN	SN74LS49 TYP‡	SN74LS49 MAX	UNIT
V_{IH}	High-level input voltage			2			2			V
V_{IL}	Low-level input voltage					0.7			0.8	V
V_{IK}	Input clamp voltage	V_{CC} = MIN,	I_I = −18 mA			−1.5			−1.5	V
I_{OH}	High-level output current	V_{CC} = MIN, V_{IL} = V_{IL} max,	V_{IH} = 2 V, V_{OH} = 5.5 V			250			250	μA
V_{OL}	Low-level output voltage	V_{CC} = MIN, V_{IH} = 2 V, V_{IL} = V_{IL} max	I_{OL} = 4 mA		0.25	0.4		0.25	0.4	V
			I_{OL} = 8 mA					0.35	0.5	
I_I	Input current at maximum input voltage	V_{CC} = MAX,	V_I = 7 V			0.1			0.1	mA
I_{IH}	High-level input current	V_{CC} = MAX,	V_I = 2.7 V			20			20	μA
I_{IL}	Low-level input current	V_{CC} = MAX,	V_I = 0.4 V			−0.4			−0.4	mA
I_{CC}	Supply current	V_{CC} = MAX,	See Note 2		8	15		8	15	mA

† For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.
‡ All typical values are at V_{CC} = 5 V, T_A = 25°C.
NOTE 2: I_{CC} is measured with all outputs open and all inputs at 4.5 V.

switching characteristics, V_{CC} = 5 V, T_A = 25°C

PARAMETER		TEST CONDITIONS	MIN	TYP	MAX	UNIT
t_{PHL}	Propagation delay time, high-to-low-level output from A input	C_L = 15 pF, R_L = 4 kΩ, See Note 3			100	ns
t_{PLH}	Propagation delay time, low-to-high-level output from A input				100	
t_{PHL}	Propagation delay time, high-to-low-level output (a-f only) from $\overline{RBI}$ input	C_L = 15 pF, R_L = 6 kΩ, See Note 3			100	ns
t_{PLH}	Propagation delay time, low-to-high-level output (a-f only) from $\overline{RBI}$ input				100	

NOTE 3: Load circuits and voltage waveforms are shown in Section 1.

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一華半導體股份有限公司
MOSDESIGN SEMICONDUCTOR CORP.

TAIPEI : TEL : 886-2- 22783733
FAX : 886-2- 22783633
H.K. TEL : 852- 27569109
FAX : 852- 27566961

TO-92 MELODY TRANSISTOR TYPE

電晶體包裝音樂 IC

MELODY
M66T.

EFEATURES 功能敘述

・ Operating mode :

Continuous mode : Normal.

OSH mode : Optional.

P/N	SONG LIST
M66T.-32	CUCKOO WALTZ
M66T.-19	FOR ALICE
M66T.-08	HAPPY BIRTHDAY
M66T.-05	SWEET HOME
M66T.-68	SMALL WORLD
M66T.-11	LOVE ME TENDER
M66T.-26	ROCK-A-BY BABY
M66T.-18	WEDDING MARCH
M66T.-01	XMAS 3 SONGS

APPLICATION 產品應用

・ Telephone system, Musical instruments etc..

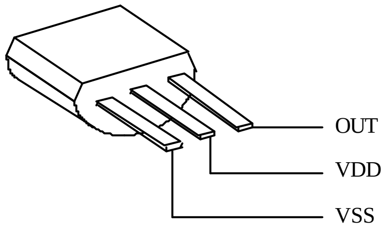
ELECTRICAL CHARACTERISTICS 電氣規格

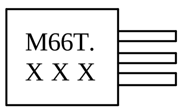
(@V_{DD}=3V unless otherwise specified)

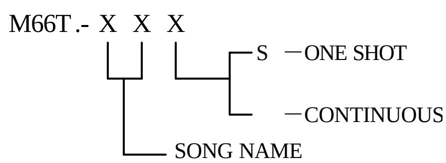
Characteristics	Sym.	Min.	Typ.	Max.	Unit	REMARKS
工作電壓 Operating Voltage	V_{DD}	—	3	3.5	V	
工作電流 Operating Current	I_{OP}	—	0.1	0.5	mA	No load
推動電流 BZ Driving Current	I_O	1	—	—	mA	@ V_{DS}=1V
振盪頻率 Oscillator Frequency	F_{OSC}	—	100	—	KHz	±30% TOL.
工作溫度 Operating Temperature	Temp.	0	25	60	℃	

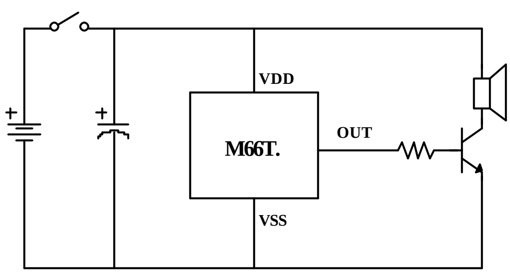
APPLICATION DIAGRAM 參考電路圖

TO92-3L









*All specs and applications shown above subject to change without prior notice.
（ 以上電路及規格僅供參考,本公司得逕行修正 ）

TAIWAN OASIS LED DATA SHEET

PART NO. : TOL-30aUReDAa-U4M

DESCRIPTION

SOURCE MATERIAL ---------- AlGaInP

COLOR ---------- Ultra Red

LENS ---------- Red Diffused

ABSOLUTE MAXIMUM RATING (Ta=25°C)

PULSE CURRENT (1/10 DUTY, CYCLE 0.1mS PULSE WIDTH) ---------- 100mA

REVERSE VOLTAGE ---------- 5.0V

CONTINUOUS FORWARD CURRENT ---------- 25mA

RECOMMEND OPERATING CURRENT ---------- 15mA

OPERATING TEMPERATURE ---------- -25°C TO 85°C

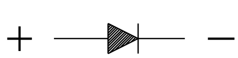
STORAGE TEMPERATURE ---------- -30°C TO 100°C

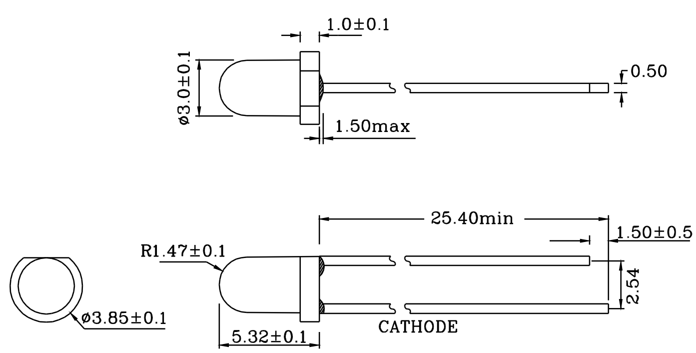
LEAD SOLDERING TEMPERATURE ---------- 260°C FOR 3 SECONDS (2mm from body)

CHARACTERISTICS (Ta=25°C)

PARAMETER	CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNITS
POWER DISSIPATION		Pd			90	mW
DOMINANT WAVELENGTH	If=20mA	λd		630		nm
SPECTRUM HALF WIDTH	If=20mA	$\triangle\lambda$		15		nm
FORWARD VOLTAGE	If=20mA	V_F		2.0	2.3	V
REVERSE CURRENT	V_R=5V	I_R			100	μA
LUMINOUS INTENSITY	If=20mA	I_v	75	150		mcd
FULL VIEWING ANGLE	If=20mA	$2\theta_{1/2}$		50		deg.

INTERNAL CIRCUIT DIAGRAM





DATE	2002/3/20'	SCALE	2.5:1	TOLERANCE	±0.25 ANGLE ±5°	DRAWN	D Q H	CHECKED	
UNIT	M/M	SHEET NO.	1/1	DRAWING NO.	S-30aUReDAa-U4M-A	CUSTOMER		APPROVED	

TAIWAN OASIS LED DATA SHEET

PART NO. : TOL-30aUGbCAa-U4M

DESCRIPTION

SOURCE MATERIAL ---------- AlGaInP
COLOR ---------- Super Green
LENS ---------- Water Clear

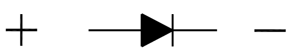
ABSOLUTE MAXIMUM RATING (Ta=25°C)

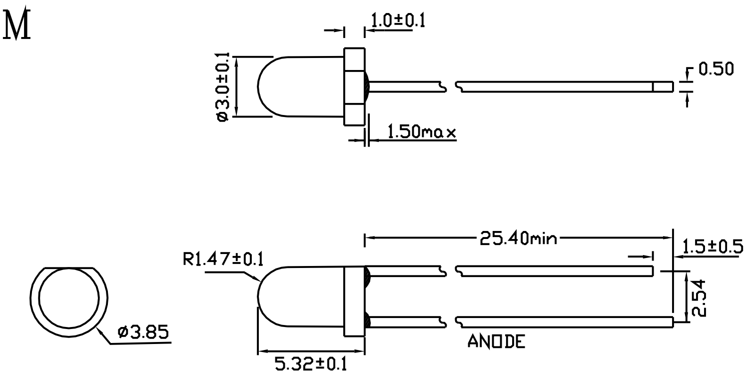
PULSE CURRENT (1/10 DUTY, CYCLE 0.1mS PULSE WIDTH) ---------- 100mA
REVERSE VOLTAGE ---------- 5.0V
CONTINUOUS FORWARD CURRENT ---------- 25mA
RECOMMEND OPERATING CURRENT ---------- 15mA
OPERATING TEMPERATURE ---------- -25°C TO 85°C
STORAGE TEMPERATURE ---------- -30°C TO 100°C
LEAD SOLDERING TEMPERATURE ---------- 260°C FOR 3 SECONDS (2mm from body)

CHARACTERISTICS (Ta=25°C)

PARAMETER	CONDITION	SYMBOL	MIN.	TYP.	MAX.	UNITS
POWER DISSIPATION		Pd			90	mW
DOMINANT WAVELENGTH	If=20mA	λ_d		574		nm
SPECTRUM HALF WIDTH	If=20mA	$\Delta\lambda$		15		nm
FORWARD VOLTAGE	If=20mA	V_F		2.0	2.3	V
REVERSE CURRENT	VR=5V	I_R			100	µA
LUMINOUS INTENSITY	If=20mA	I_V	560	1000		mcd
FULL VIEWING ANGLE	If=20mA	$2\Theta_{1/2}$		18		deg.

PACKAGE DIMENSIONS & INTERNAL CIRCUIT DIAGRAM





DATE	2002/9/4'	SCALE	2.5:1	TOLERANCE	±0.25 ANGLE ±6°	DRAWN	Daisy	CHECKED	
UNIT	M/M	SHEET NO.	1/1	DRAWING NO.	S-30aUGbCAa-U4M-A	CUSTOMER		APPROVED	

TAIWAN OASIS LED DATA SHEET (FOR INFRARED)

PART NO. : TOIR-50b94bCEa

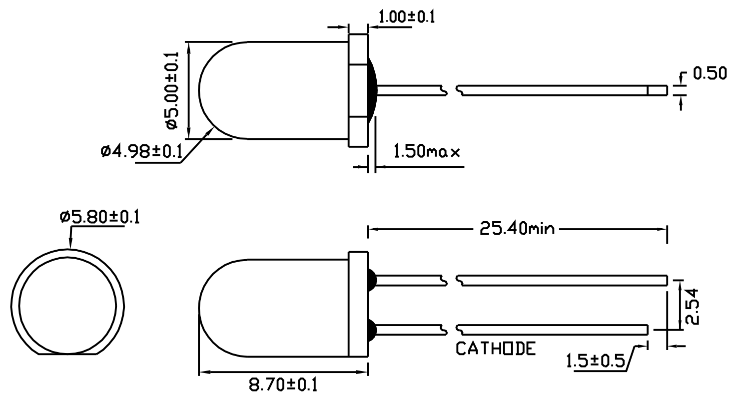
ABSOLUTE MAXIMUM RATINGS AT TA=25°C

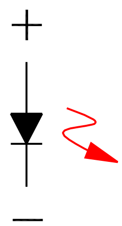
PARAMETER	SYMBOL	DATA	UNIT
Forward Current	I_{FM}	100	mA
Peak Forward Current (duty=1:100, f=100KHZ)	I_{FP}	1000	mA
Reverse Voltage	V_R	6	V
Power Disspation	P_D	150	mW
Operating Temperature Range		-25 to +85	°C
Storage Temperature Range		-30 to +85	°C
Lead Sold Temperature (1/10 Inch Below Seating Plane)		260°C for 3 sec.	

ELECTRICAL/OPTICAL CHARACTERISTICS AT TA=25°C

PARAMETER	SYMBOL	DATA	UNIT	TEST CONDITION
Radiated Output Power	$P_{O(Typ.)}$	12.0	mW	Distance: 10cm I_F=50mA Detector Area: $1cm^2$
Forward Voltage	V_F	TYP: 1.25 MAX: 1.45	V	I_F=20mA
Wavelength	λp	940	nm	I_F=20mA
Spectrum Width of Half Value	$\triangle\lambda$	50	nm	I_F=20mA
Reverse Current	I_R	10	uA	V_R=5V
Full Viewing Angle	$2x\frac{1}{2}\theta$	25	°	I_F=20mA
Lens		Water Clear		
Radiation Material		GaAs/GaAs		

PACKAGE DIMENSIONS & INTERNAL CIRCUIT DIAGRAM





DATE	01/10/01'	SCALE	2.5:1	TOLERANCE	±0.25 ANGLE ±6°	DRAWN	华明亮	CHECKED	
UNIT	M/M	SHEET NO.	1/2	DRAWING NO.	S-50b94bCEa-A	CUSTOMER		APPROVED	

Silicon PIN Photodiode
Silizium-PIN-Fotodiode
Version 1.1

SFH 213, SFH 213 FA

SFH 213

SFH 213 FA

Features:
- Wavelength range ($S_{10\%}$) 400 nm to 1100 nm (SFH 213) and 750 nm to 1100 nm (SFH 213 FA)
- Short switching time (typ. 5 ns)
- 5 mm LED plastic package

Besondere Merkmale:
- Wellenlängenbereich ($S_{10\%}$) 400nm bis 1100nm (SFH 213) und 750 nm bis 1100 nm (SFH 213 FA)
- Kurze Schaltzeit (typ. 5 ns)
- 5 mm-Plastikbauform im LED-Gehäuse

Applications
- High speed photointerrupters
- Industrial electronics
- For control and drive circuits

Anwendungen
- Schnelle Lichtschranken
- Industrieelektronik
- Messen / Steuern / Regeln

Ordering Information
Bestellinformation

Type: **Typ:**	**Photocurrent** **Fotostrom** V_R = 5 V, Std. Light A, E_V = 1000 lx (SFH 213) V_R = 5 V, λ = 870 nm, E_e = 1 mW/cm^2 (SFH 213 FA) I_P [µA]	**Ordering Code** **Bestellnummer**
SFH 213	135 (≥ 100)	Q62702P0930
SFH 213 FA	90 (≥ 65)	Q62702P1671

Maximum Ratings (T_A = 25 °C)
Grenzwerte

Parameter Bezeichnung	Symbol Symbol	Values Werte		Unit Einheit
		SFH 213	SFH 213 FA	
Operating and storage temperature range Betriebs- und Lagertemperatur	T_{op}; T_{stg}	-40 ... 100		°C
Reverse voltage Sperrspannung	V_R	20		V
Reverse voltage Sperrspannung (t < 2 min)	V_R	50		V
Total power dissipation Verlustleistung	P_{tot}	150		mW

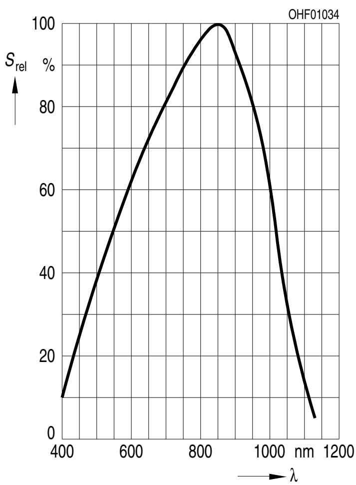
Characteristics (T_A = 25 °C)
Kennwerte

Parameter Bezeichnung	Symbol Symbol	Values Werte		Unit Einheit
		SFH 213	SFH 213 FA	
Photocurrent Fotostrom (E_v = 1000 lx, Std. Light A, V_R = 5 V, T = 2856 K)	I_P	135 (≥ 100)		µA
Photocurrent Fotostrom (V_R = 5 V, λ = 870 nm, E_e = 1 mW/cm^2)	I_P		90 (≥ 65)	µA
Wavelength of max. sensitivity Wellenlänge der max. Fotoempfindlichkeit	$\lambda_{S\ max}$	850	900	nm
Spectral range of sensitivity Spektraler Bereich der Fotoempfindlichkeit	$\lambda_{10\%}$	400 ... 1100	750 ... 1100	nm
Radiant sensitive area Bestrahlungsempfindliche Fläche	A	1.00		mm^2
Dimensions of radiant sensitive area Abmessung der bestrahlungsempfindlichen Fläche	L x W	1 x 1		mm x mm
Half angle Halbwinkel	φ	± 10		°

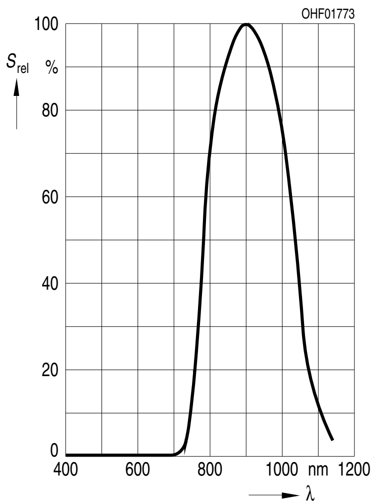
Parameter Bezeichnung	Symbol Symbol	Values Werte		Unit Einheit
		SFH 213	SFH 213 FA	
Dark current Dunkelstrom (V_R = 20 V)	I_R	1 (≤ 5)		nA
Spectral sensitivity of the chip Spektrale Fotoempfindlichkeit des Chips (λ = 870 nm)	$S_{\lambda\ typ}$	0.65		A / W
Quantum yield of the chip Quantenausbeute des Chips (λ = 870 nm)	η	0.93		Electrons /Photon
Open-circuit voltage Leerlaufspannung (E_v = 1000 lx, Std. Light A)	V_O	430 (≥ 350)		mV
Open-circuit voltage Leerlaufspannung (E_e = 0.5 mW/cm², λ = 870 nm)	V_O		380 (≥ 300)	mV
Short-circuit current Kurzschlussstrom (E_v = 1000 lx, Std. Light A)	I_{SC}	125		µA
Short-circuit current Kurzschlussstrom (E_e = 0.5 mW/cm², λ = 870 nm)	I_{SC}		42	µA
Rise and fall time Anstiegs- und Abfallzeit (V_R = 20 V, R_L = 50 Ω, λ = 850 nm)	t_r, t_f	0.005		µs
Forward voltage Durchlassspannung (I_F = 100 mA, E = 0)	V_F	1.3		V
Capacitance Kapazität (V_R = 0 V, f = 1 MHz, E = 0)	C_0	11		pF
Temperature coefficient of V_O Temperaturkoeffizient von V_O	TC_V	-2.6		mV / K
Temperature coefficient of I_{SC} Temperaturkoeffizient von I_{SC} (Std. Light A)	TC_I	0.18		% / K

Parameter Bezeichnung	Symbol Symbol	Values Werte		Unit Einheit
		SFH 213	SFH 213 FA	
Temperature coefficient of I_{SC} Temperaturkoeffizient von I_{SC} (λ = 870 nm)	TC_I		0.1	% / K
Noise equivalent power Rauschäquivalente Strahlungsleistung (V_R = 20 V, λ = 870 nm)	NEP	0.028		pW / $Hz^{½}$
Detection limit Nachweisgrenze (V_R = 20 V, λ = 870 nm)	D^*	3.6e12		cm x $Hz^{½}$ / W

Relative Spectral Sensitivity
Relative spektrale Empfindlichkeit
SFH 213 $S_{rel} = f(\lambda)$

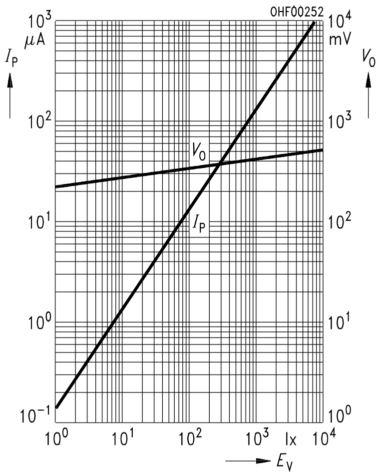


Relative Spectral Sensitivity
Relative spektrale Empfindlichkeit
SFH 213 FA $S_{rel} = f(\lambda)$

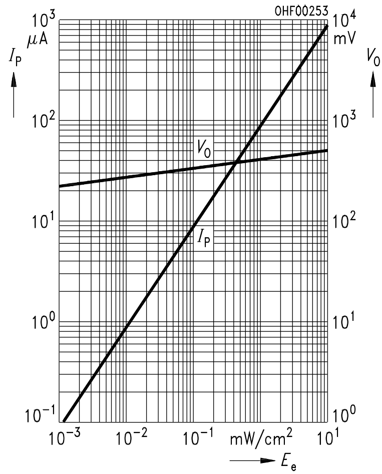


OSRAM
Opto Semiconductors

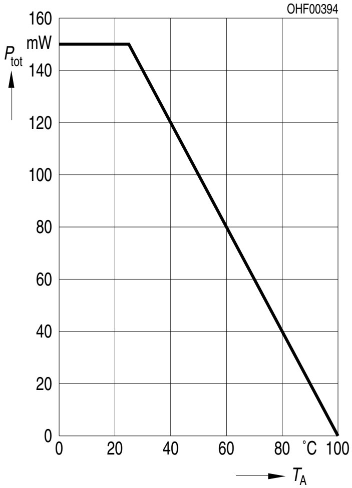
Photocurrent / Open-Circuit Voltage
Fotostrom / Leerlaufspannung
SFH 213 I_P (V_R = 5 V) / V_O = f(E_V)



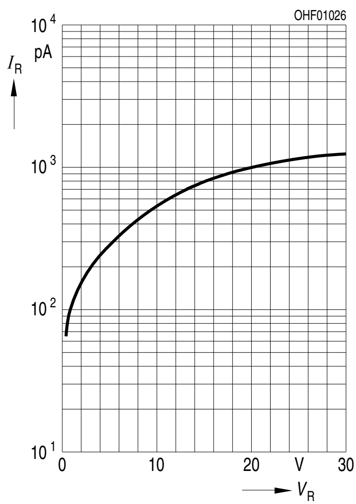
Photocurrent / Open-Circuit Voltage
Fotostrom / Leerlaufspannung
SFH 213 FA I_P (V_R = 5 V) / V_O = f(E_e)



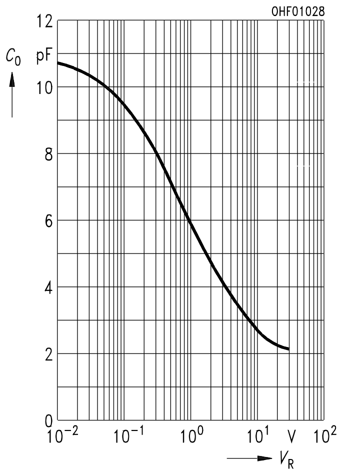
Total Power Dissipation
Verlustleistung
P_{tot} = f(T_A)



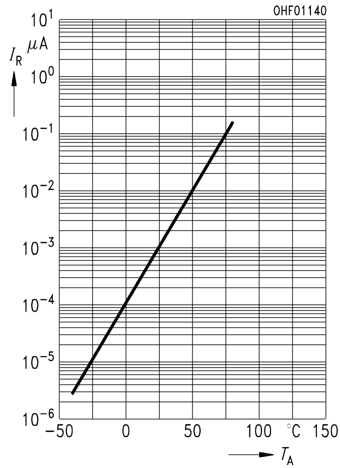
Dark Current
Dunkelstrom
I_R = f(V_R), E = 0



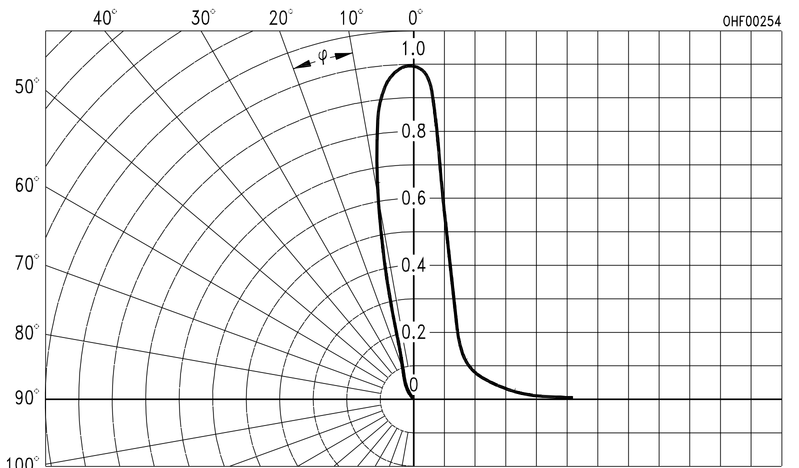
Capacitance
Kapazität
$C = f(V_R)$, f = 1 MHz, E = 0



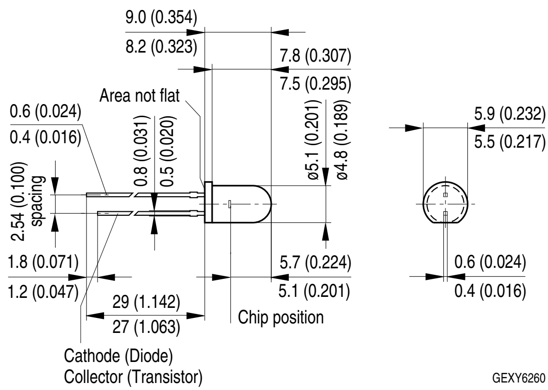
Dark Current
Dunkelstrom
$I_R = f(T_A)$, V_R = 20 V, E = 0



Directional Characteristics
Winkeldiagramm
$S_{rel} = f(\varphi)$



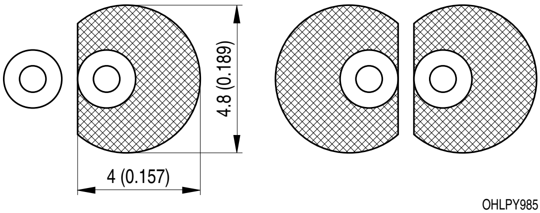
Package Outline
Maßzeichnung



Dimensions in mm (inch). / Maße in mm (inch).

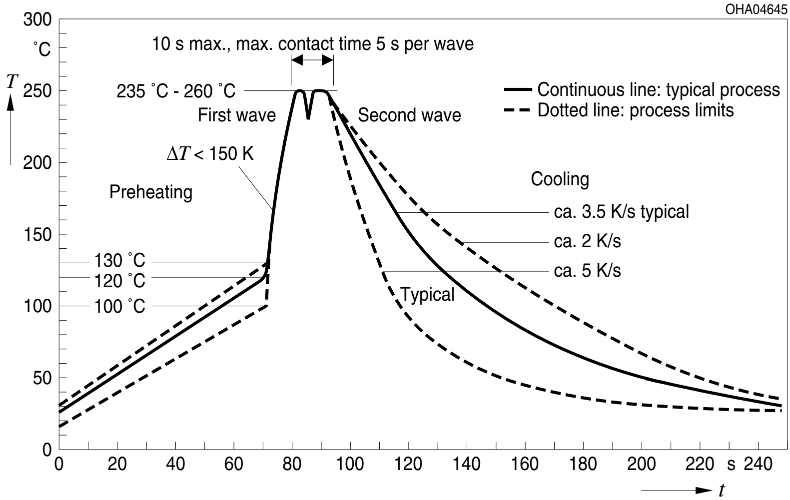
Package	5mm Radial (T 1 ¾), Epoxy
Gehäuse	5mm Radial (T 1 ¾), Harz

Recommended Solder Pad
Empfohlenes Lötpaddesign
TTW Soldering / Wellenlöten (TTW)



Dimensions in mm (inch). / Maße in mm (inch).

TTW Soldering
Wellenlöten (TTW)
IEC-61760-1 TTW / IEC-61760-1 TTW



Disclaimer

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Terms of delivery and rights to change design reserved. Due to technical requirements components may contain dangerous substances.
For information on the types in question please contact our Sales Organization.
If printed or downloaded, please find the latest version in the Internet.

Packing
Please use the recycling operators known to you. We can also help you – get in touch with your nearest sales office.
By agreement we will take packing material back, if it is sorted. You must bear the costs of transport. For packing material that is returned to us unsorted or which we are not obliged to accept, we shall have to invoice you for any costs incurred.

Components used in life-support devices or systems must be expressly authorized for such purpose!
Critical components* may only be used in life-support devices** or systems with the express written approval of OSRAM OS.

*) A critical component is a component used in a life-support device or system whose failure can reasonably be expected to cause the failure of that life-support device or system, or to affect its safety or the effectiveness of that device or system.
**) Life support devices or systems are intended (a) to be implanted in the human body, or (b) to support and/or maintain and sustain human life. If they fail, it is reasonable to assume that the health and the life of the user may be endangered.

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**) Lebenserhaltende Apparate oder Systeme sind für (a) die Implantierung in den menschlichen Körper oder (b) für die Lebenserhaltung bestimmt. Falls Sie versagen, kann davon ausgegangen werden, dass die Gesundheit und das Leben des Patienten in Gefahr ist.

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Leibnizstraße 4, D-93055 Regensburg

EU RoHS and China RoHS compliant product

此产品符合欧盟 RoHS 指令的要求；

按照中国的相关法规和标准，不含有毒有害物质或元素。

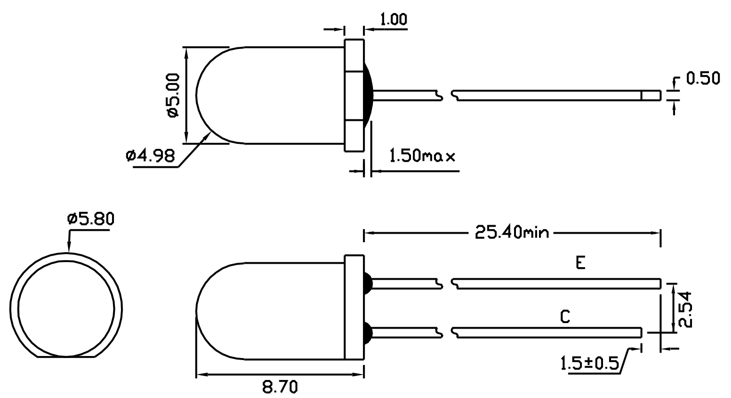
TAIWAN OASIS LED DATA SHEET

PART NO. : TOPS−050aTB2

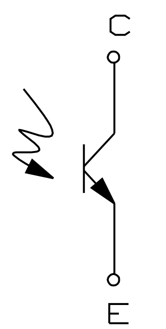
ABSOLUTE MAXIMUM RATING (Ta = 25°C)

Parameter	Symbol	Data	Unit	Test Condition
Collector−Emitter Breakdown Voltage	BVceo	30	v	Ic=100uA Ib=0
Emitter−Collector Breakdown Voltage	BVeco	5	v	Ie=100uA Ib=0
Collector Dark Current	Id	0.1	uA	Vce=10v $H=0mW/cm^2$
Collector Light Current	IL	4.0	mA	Vce=10v 2856k 1000lx
Collect Power Dissipation	Pcm	140	mW	
Rise/Fall Time	Tr/Tf	5	uS	R=50 Vce=10v Ic=1mA
Life Time	H	100'000	Hrs	Vce=10v
Peak collection Wavelength	P	900	nm	
Spectral Range		750~1050	nm	
Operating Temperature Rang		−25 °C to 70 °C		
Storage Tenperature Range		−30 °C to 100° C		
Lens Color		Black		

PACKAGE DIMENSIONS:



INTERNAL CIRCUIT DIAGRAM:



DATE	11/07/00'	SCALE	2.5:1	TOLERANCE	±0.25 ANGLE ±5°	DRAWN	华明亮	CHECKED	
UNIT	M/M	SHEET NO.	1/1	DRAWING NO.	S-050aTB2-A	CUSTOMER		APPROVED	

WAITRONY 慧創就

Photo Conductive Cell, CdS, LDR

1-07-04-11

Model No. : KE-10715

General Description:

By using the sintering film fabrication method, the manufacturing process of the photo conductive layer can offer high sensitivity and easy fabrication of large sensitive areas, a large mass production effect, and relatively superior production profitability

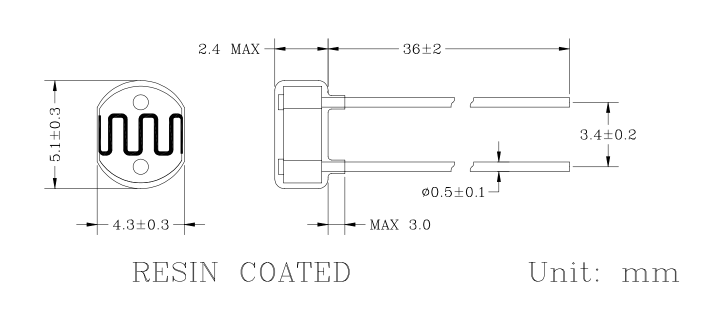
Features:

- Low Cost
- Exceptional temperature stability
- Fast response time
- Excellent chopping capability

Applications:

- Automatic dimmer
- Automatic flasher
- Optical relay

Outline Dimensional Drawing



Electrical Characteristics

(Ta=25°C)

Descriptions	Symbol	Min.	Typ.	Max.	Unit
Photo Resistance at 10 Lux (Light Source: 2856K)	R_L	10		15	kΩ
Dark Resistance After 10 sec. Removal of 10 Lux	R_D	0.5			MΩ
Gamma Value at 10 ~ 100 Lux	γ_{10}^{100}		0.7		
Maximum Power Dissipation	P_D			35	mW
Maximum Breakdown Voltage	V_{MAX}			100	V_{DC}
Peak Spectral Response	λp	550		650	nm
Rise Response Time at 1 fc	tr		35		ms
Fall Response Time at 1 fc	tf		5		ms
Ambient Temperature	T_A	-30 ~ +60			°C

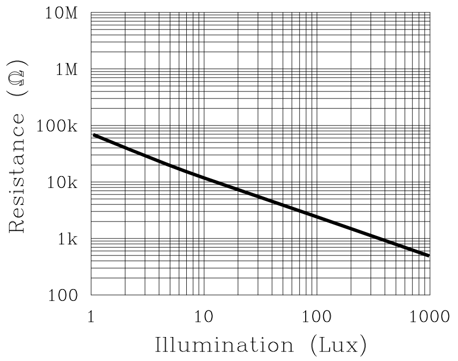
* Pre-measurement condition: Exposed in 500 Lux for more than 3 hours.

γ value: Standard gradient rate of resistance ranged by 10 ~ 100 Lux
(±0.1 unless otherwise stated)

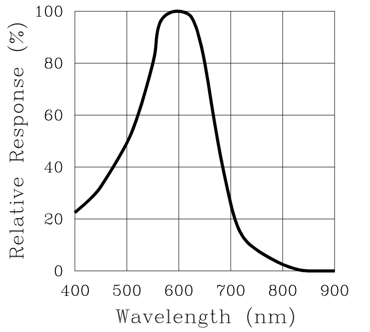
$$\gamma_a^b = \left| \frac{\text{Log}(R_b) - \text{Log}(R_a)}{\text{Log}(E_b) - \text{Log}(E_a)} \right|$$

Where: R_x : Photo resistance as lighting x
E_x : Illumination as lighting x

Resistance vs Illumination



Relative Spectral Response



POWER RELAY

2 POLES—5 A LOW PROFILE TYPE

FTR-F1 SERIES

■ FEATURES

- Low profile power relay (height 16.5 mm) employing unique construction
  DPST/DPDT 5 A, TV-3 rating available
- Higher isolation by employing reinforced insulation construction
  Insulation distance: 8 mm (between coil and contact)
  Dielectric strength: 5 kV (between coil and contact)
  Surge strength: 10 kV (between coil and contact)
- Plastic sealed relay
- Pin configuration compatible to VB/FBR620
- UL, CSA, VDE, SEMKO, BSI recognized
- Conforms to FIMKO, IMQ, DEMKO (under approval)
- Environmentally friendly cadmium free contact type is available

■ ORDERING INFORMATION

[Example]	FTR-F1	A	A	005	V	– **
	(a)	(b)	(c)	(d)	(e)	(f)

(a)	Series Name	FTR-F1: FTR-F1 Series
(b)	Contact Arrangement	A : 2 form A (DPST-NO) C : 2 form C (DPDT)
(c)	Coil Type	A : Standard type (0.53 W) D : High sensitive type (0.4W)
(d)	Nominal Voltage	005 : 5 VDC 012: 12 VDC 006 : 6 VDC 024: 24 VDC 009 : 9 VDC 048: 48 VDC
(e)	Contact Material/TV Type	V : Gold plate silver alloy (standard type) T : Gold plate silver alloy (TV-3 rating type, only standard make type)
(f)	Custom Designation	To be assigned custom specification

Ordering Code: FTR-F1AA005V
Actual Marking: F1AA005V

■ SAFETY STANDARD AND FILE NUMBERS

UL508, 873 (File No. E63614)
C 22.2 No. 14 (File No. LR40304-30/ LR107822)
VDE 0435, 0631, 0700, 0860 (File No. 11039-4940-1019)

	Type	Nominal voltage	Contact rating
TV-Rating	FTR-F1AA( )T	5 to 48 VDC	TV-3 120 VAC 1/6 HP 125 VAC 1/4 HP 250 VAC 5 A 24 VDC/250 VAC resistive Pilot duty R 300
Standard/ sensitive	FTR-F1CA()V	5 to 48 VDC	Same as above without TV-3 2A 250VAC inductive (PF=0.4)

■ SPECIFICATIONS

Item			Standard Type	Sensitive Type	TV-3 Rating Type
Contact	Arrangement		2 form A (DPST-NO), 2 form C (DPDT)		2 form A (DPST-NO)
	Material		Gold plate silver alloy		
	Style		Single		
	Resistance (initial)		Maximum100 mΩ (at 1 A 6 VDC)		
	Rating (resistive)		5 A 250 VAC/24 VDC		
	Maximum Carrying Current		7 A		
	Maximum Switching Rating		1,250 VA/120 W		
	Maximum Switching Voltage		400 VAC 300 VDC		
	Maximum Switching Current		5 A		
	Minimum Switching Load*[1]		10 mA 5 VDC		
	Maximum Inrush Current		—		51 A 120 VAC (at lamp load)
Coil	Nominal Power (at 20°C)		0.53 W	0.4 W	0.53 W
	Operate Power (at 20°C)		0.26 W	0.225W	0.26W
	Operating Temperature		–40°C to +75°C (no frost) (refer to the CHARACTERISTIC DATA)		
Time Value	Operate (at nominal voltage)		Maximum 15 ms		
	Release (at nominal voltage)		Maximum 5 ms		
Insulation	Resistance (at 500 VDC)		Minimum 1,000 MΩ		
	Dielectric Strength	between open contacts	1,000 VAC 1 minute (3,000 VAC between adjacent contacts)		
		between coil and contacts	5,000 VAC 1 minute		
	Surge Strength		10,000 V (at 1.2 × 50 µs)		
Life	Mechanical		2×10^7 operations minimum		
	Electrical	Contact Rating	1×10^5 operations minimum		
		Lamp Load	—		2.5×10^4 ops. minimum
Other	Vibration Resistance	Misoperation	10 to 55 Hz (double amplitude of 1.65 mm)		
		Endurance	10 to 55 Hz (double amplitude of 3.3 mm)		
	Shock Resistance	Misoperation	100 m/s^2 (11 ±1 ms)		
		Endurance	1,000 m/s^2 (6 ±1 ms)		
	Weight		Approximately 12 g		

*[1] Minimum switching loads mentioned above are reference values. Please perform the confirmation test with the actual load before production since reference values may vary according to switching frequencies, environmental conditions and expected reliability levels.

■ COIL DATA CHART

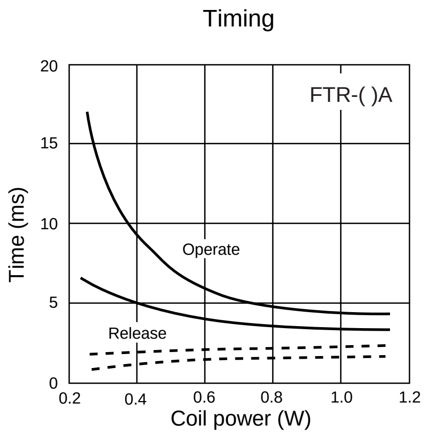
MODEL		Nominal voltage	Coil resistance (±10%)	Must operate voltage	Must release voltage
Standard Type	TV-3 Rating Type				
FTR-F1 (C, A) A005 V	FTR-F1AA005 T	5 VDC	47 Ω	3.5 VDC	0.5 VDC
FTR-F1 (C, A) A006 V	FTR-F1AA006 T	6 VDC	68 Ω	4.2 VDC	0.6 VDC
FTR-F1 (C, A) A009 V	FTR-F1AA009 T	9 VDC	155 Ω	6.3 VDC	0.9 VDC
FTR-F1 (C, A) A012 V	FTR-F1AA012 T	12 VDC	270 Ω	8.4 VDC	1.2 VDC
FTR-F1 (C, A) A024 V	FTR-F1AA024 T	24 VDC	1,100 Ω	16.8 VDC	2.4 VDC
FTR-F1 (C, A) A048 V	FTR-F1AA048 T	48 VDC	4,400 Ω	33.6 VDC	4.8 VDC

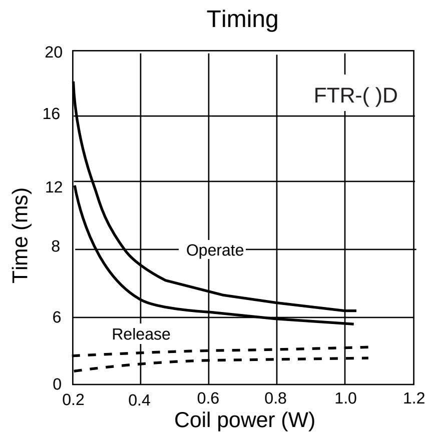
Note: All values in the table are measured at 20°C.

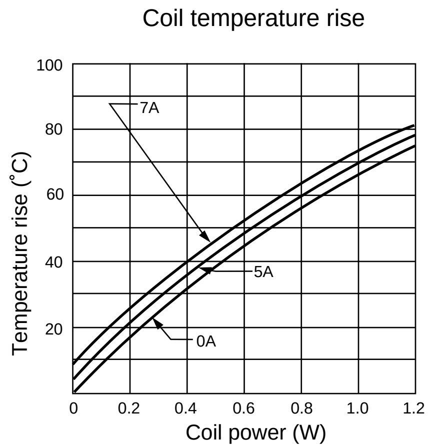
Sensitive Type

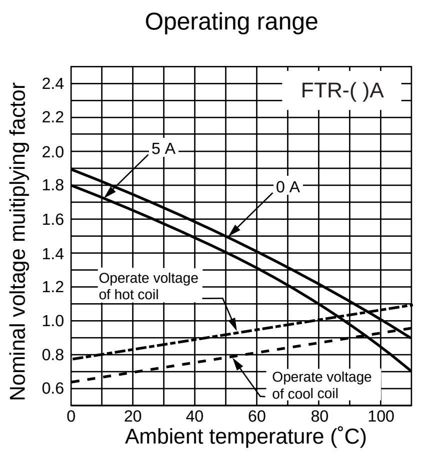
MODEL	Nominal voltage	Coil resistance (±10%)	Must operate voltage	Must release voltage
Standard Type				
FTR-F1 (C, A) D005 V	5 VDC	62 Ω	3.75 VDC	0.5 VDC
FTR-F1 (C, A) D006 V	6 VDC	90 Ω	4.5 VDC	0.6 VDC
FTR-F1 (C, A) D009 V	9 VDC	202 Ω	6.75 VDC	0.9 VDC
FTR-F1 (C, A) D012 V	12 VDC	360 Ω	9.0 VDC	1.2 VDC
FTR-F1 (C, A) D024 V	24 VDC	1,440 Ω	18.0 VDC	2.4 VDC
FTR-F1 (C, A) D048 V	48 VDC	5,760 Ω	36.0 VDC	4.8 VDC

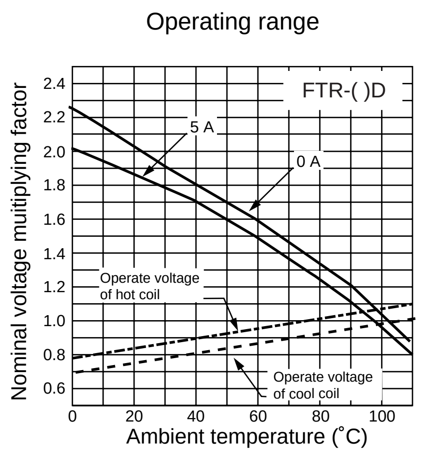
■ CHARACTERISTIC DATA

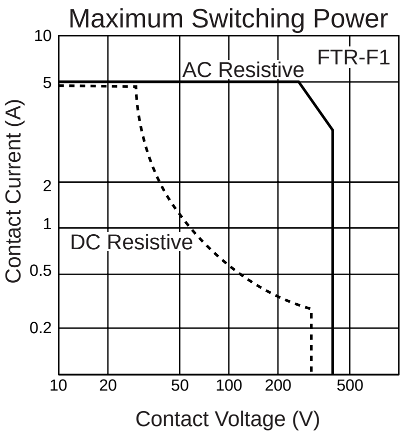


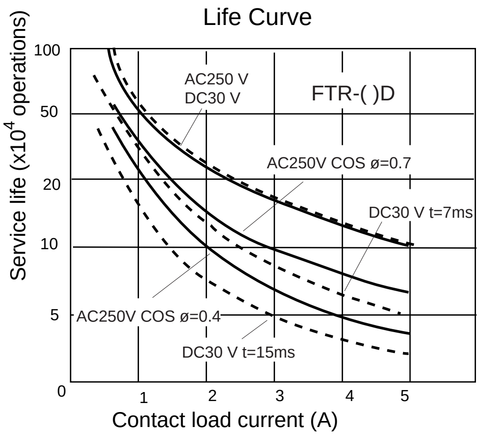






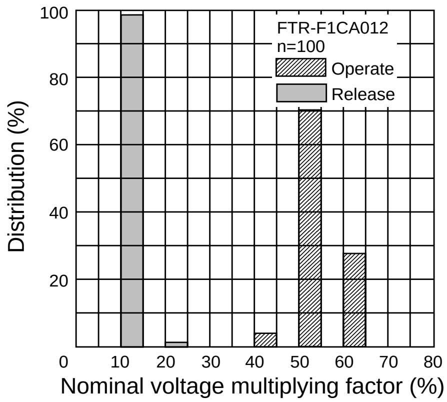




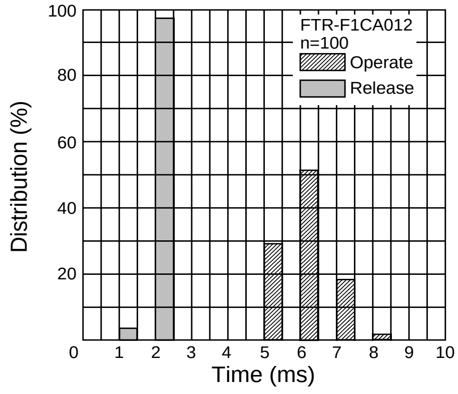


■ REFERENCE DATA

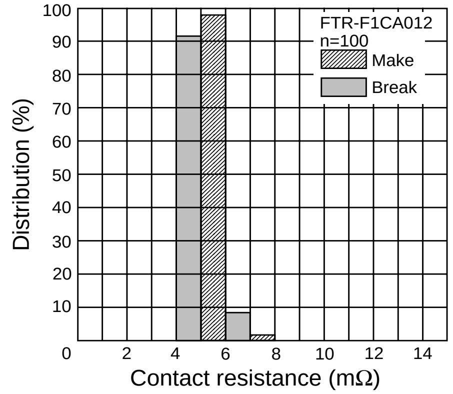
Distribution of operate and release voltage



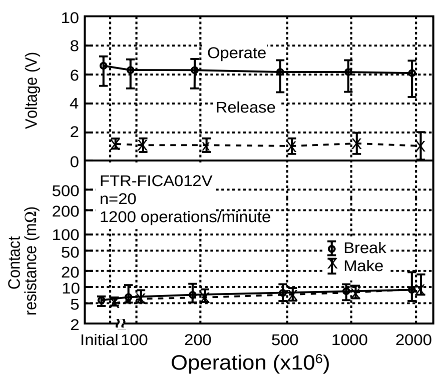
Distribution of operate and release time



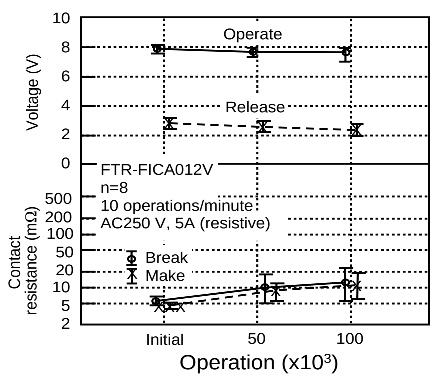
Distribution of contact resistance



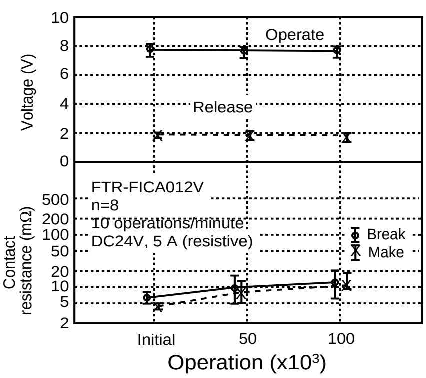
Mechanical life test



Electrical life test



Electrical life test



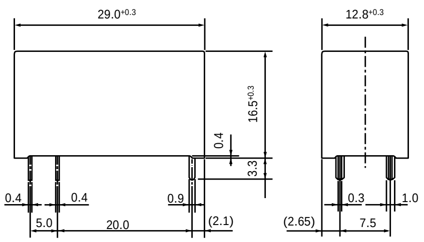
■ DIMENSIONS

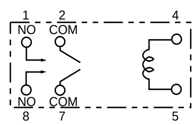
● Dimensions

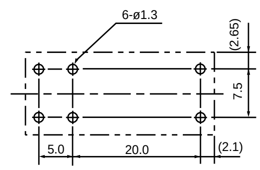
● Schematics
(BOTTOM VIEW)

● PC board mounting hole layout
(BOTTOM VIEW)

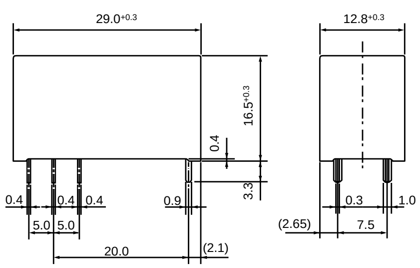
FTR-F1A type

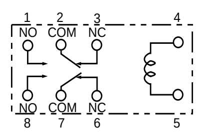


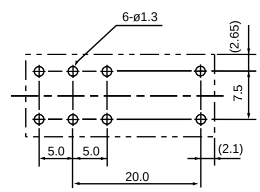




FTR-F1C type







Unit: mm

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TOD-2281BG-4G

Dual Digit Display LED

Part Number	Chip		Face Color	Segment Color
	Material	Source Color		
TOD-2281BG-4G	GaP	Green	Gray	Green

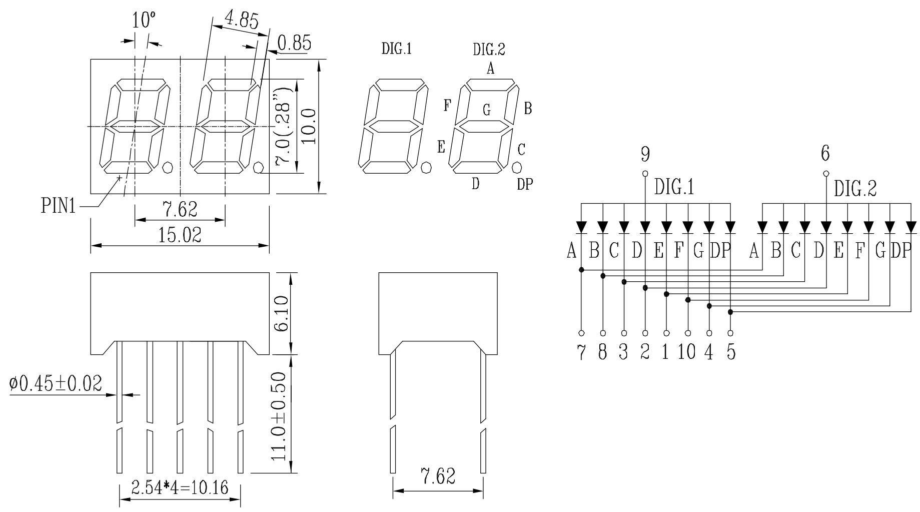
Features

- (0.28”) 7.00mm digit height
- Common anode
- I.C. compatible
- Low power requirement
- RoHS compliant

Applications

- Audio equipment
- Instrument panels
- Digital read out display

Package Dimensions & Internal Circuit Diagram



Notes:
1. All dimensions are in millimeters, tolerance: ±0.25 ; Angle: ±0.1° unless otherwise noted.
2. Specifications are subject to change without notice.

Absolute Maximum Rating @ Ta=25°C

Parameter	Maximum Rating	Unit
Peak Forward Current (1/10 Duty Cycle, 0.1ms Pulse Width) Per Dice	80	mA
Power Dissipation Per Dice	75	mW
Continuous Forward Current Per Dice	20	mA
Recommend Operating Current Per Dice	12	mA
Reverse Voltage Per Dice	5	V
Operating Temperature Range	-25°C to +85°C	
Storage Temperature Range	-30°C to +85°C	
Lead-Free Solder Temperature(1/16 Inch Below Seating Plane)	260°C for 3 Sec	

Electrical / Optical Characteristic @ Ta=25°C

Parameter	Symbol	Min.	Typ.	Max.	Unit	Test Condition	Grade
Luminous Intensity Per Segment	Iv		4113		ucd	I_F=1mA	
Dominant Wavelength	λ_d		570		nm	I_F=20mA	
Spectral Line Half-Width	$\triangle\lambda$		30		nm	I_F=20mA	
Forward Voltage Per Dice	V_F	1.9	2.2	2.5	V	I_F=20mA	
Reverse Current Per Dice	I_R			20	μA	V_R=5V	
Luminous Intensity Matching Rate	Iv-m			1.5:1		I_F=20mA	

The DISPLAYS should be kept at 30°C or less and 60%RH or less. The DISPLAYS should be used within one year.

MODEL NO : OBO-1206C-A2

Features : Conformity RoHS Directive (2002/95/EC) Requests.
Wave Solder and Wash Allowed

1.General Specifications :

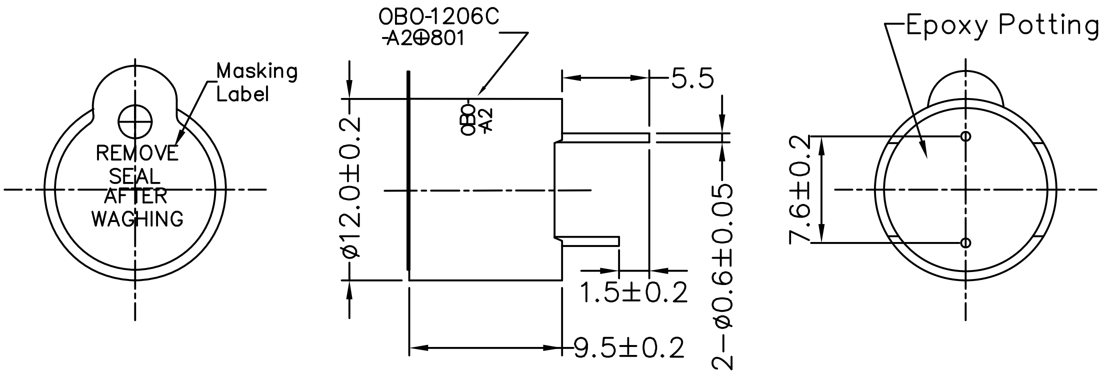
Items	Specification
※Sound Pressure Level	85 dB min./10cm/DC 6.0V
Rated Voltage	DC 6.0V
※Resonant Frequency	2300 ± 300 Hz
※Rated Current	30 mA max./DC 6.0V
Operating Voltage	DC 3 to 8V
Housing Material	NORYL
Pin Material	Red Copper
Operating Temp. Range	−20℃ to +70℃
Storage Temp Range	−30℃ to +80℃
Weight	2.0 gms

2.Mechanical Layout and Dimensions :

※ Value applying rated voltage.(DC)

2.1 Shape & Dimensions

Unit: mm Tolerance: ±0.5



2.2 Meaning of Stamp Mark

801 : Production Period

8 : Year 2008 (last 1 figures of the year)

01 : Week (01~55)

3. Soldering Condition : *2

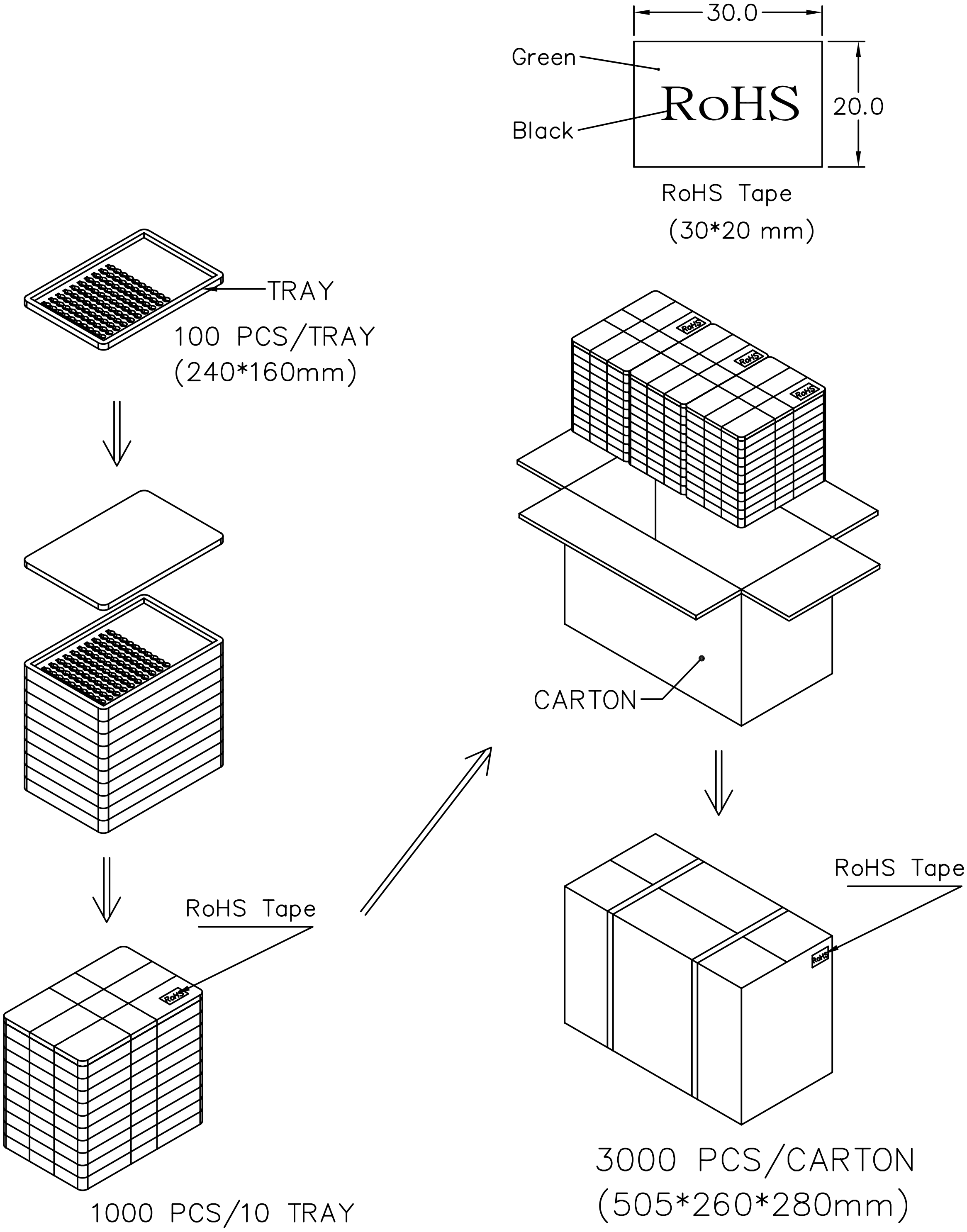
3.1 Wave Soldering

Peak temperature	Dipping time	Soldering
+ 260℃	5 seconds	1 time

3.2 Hand Soldering

Iron Tip Temperature	Soldering time
+ 380℃ Max.	Duration 3 seconds Max.

4.Packing Information:

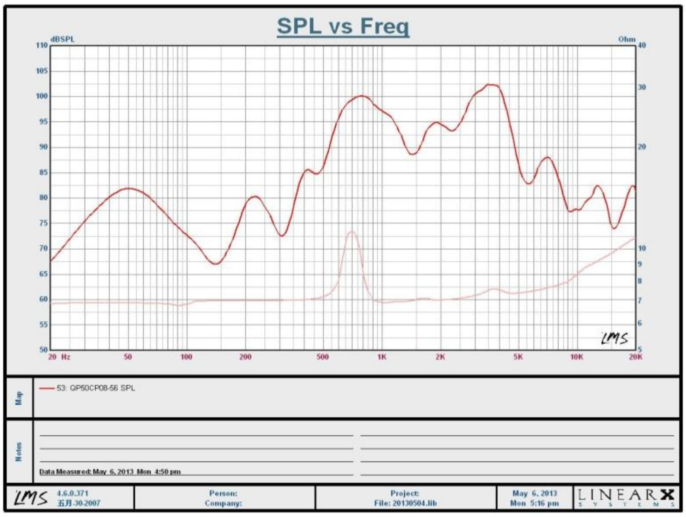


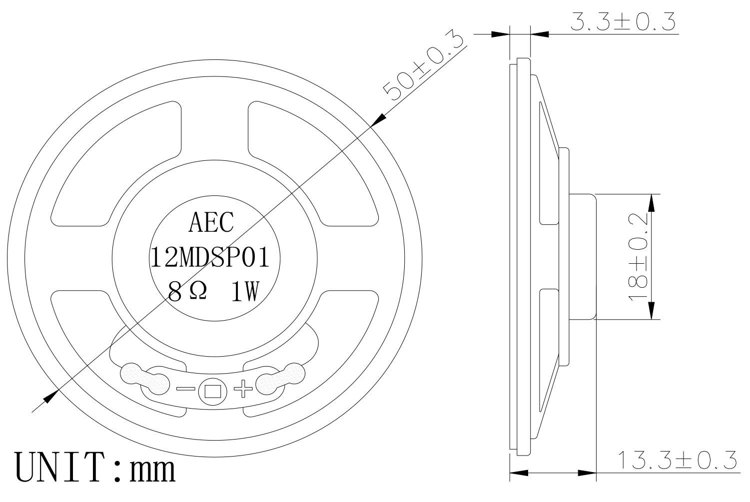
泉 州 强 盛 电 子 有 限 公 司

QUANZHOU QIANGSHENG ELECTRONIC CO.,LTD

TEL:+86-0595-28290669 FAX:22356508   Email: fiona@aecspeaker.cn
Http://www.laba.co   ADD:中国福建省泉州市浔美工业区海西电子信息产业育成基地

型号 Model	QP50CP08-66-R
尺寸 Dimension	Outer Diameter50mm Baffle Opening13.3mm Height Refer to drawing in details;
阻抗 Nominal Impedance	8 Ohm±15% At1000 HZ
额定功率 Power Rating	1.0 watt Maximum 1.5 Watt
最低共振频率 Lowest Resonant Frequency	630±20% HZ.
灵敏度 Output Sound Pressure Level(S.P.L)	93 ± 3db/1 Watt.1Meter.Average at800,1000,1200,1500HZ.
频率范围 Frequency Range	F0-5KHZ,Average SPL±10db
失真率 Distortion	3%Maximum At1000HZ 1.0 W
极性 Polarity	Diaphragm shall move forward when Apply a Postive DC current the "+" or"Marked" Terminal
寿命测试 Load Test	Bt Audio Singnal Generator At 2.83 Volts.total 48 hours and20~20KHZ Resonant Frequency
异音测试 Abnormal Sound Test	Must be Normally tested Bt 2.83 Volts Sinwave
工作温度 Operation Temperature	-20℃ ~ +50℃
储藏温度 Storage Temperature	-40℃ ~ +60℃

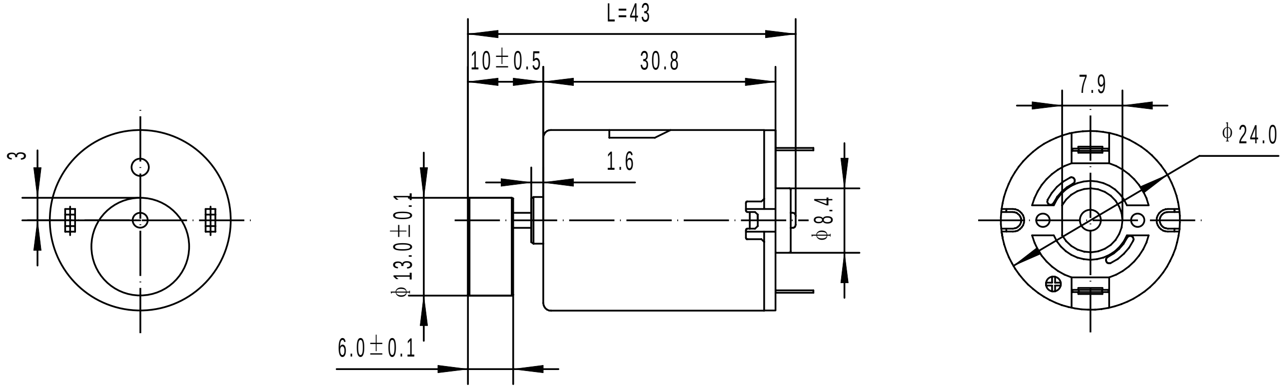




A B C D E F G H

1 2 3 4 5 6

TRE-280SA VIBRATION MOTOR



MOTOR Specification(For Reference):

Operation voltage:12.0V DC

Rated Load:φ13×6mm Eccentric Weight

1、Load Speed:4150±10%rpm

2、load current:50mA(100mA)

TITLE:TRE-280SA VIBRATION MOTOR	Customer No： ES	Drafted By: kevin Checked By:
Dwg. NO: 10440-001	Date: 2011.04.08	Approved By:

TT MOTOR (HK) INDUSTRAIL CO.,LTD	Scale: 1:1	Units: mm	EDITION No: A
		Angular: =1°	Decimal: X.XX ±0.05 X.X ±0.2 X ±0.3