Low-power dual CMOS timer

Features

- Very low power consumption:
  220 µA typ at V_{CC} = 5 V
  180 µA typ at V_{CC} = 3 V
- High maximum astable frequency 2.7 MHz
- Pin-to-pin and functionally compatible with bipolar NE556
- Wide voltage range: 2 V to 16 V
- Supply current spikes reduced during output transitions
- High input impedance: 10^{12} Ω
- Output compatible with TTL, CMOS and logic MOS

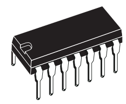
Description

The TS556 is a dual CMOS timer which offers a very low consumption:
($I_{cc(TYP)}$ TS556 = 220 µA at V_{CC} = +5 V versus $I_{cc(TYP)}$ NE556 = 6 mA),
and high frequency:
($f_{(max.)}$ TS556 = 2.7 MHz versus $f_{(max.)}$ NE556 = 0.1 MHz).

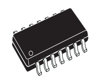
In both monostable and astable modes, timing remains very accurate.

The TS556 provides reduced supply current spikes during output transitions, which enable the use of lower decoupling capacitors compared to those required by bipolar NE556.

Due to the high input impedance (10^{12}Ω), timing capacitors can also be minimized.

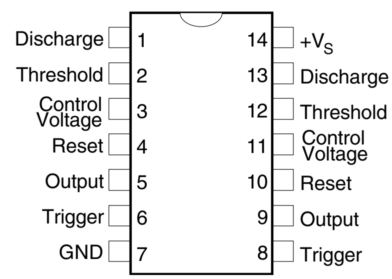


N
DIP14
(Plastic package)



D
SO14
(Plastic micropackage)

Pin connections
(top view)



1 Absolute maximum ratings and operating conditions

Table 1. Absolute maximum ratings

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	+18	V
I_{OUT}	Output current	± 100	mA
R_{thja}	Thermal resistance junction to ambient DIP14 (1) SO14 (2)	 80 105	°C/W
R_{thjc}	Thermal resistance junction to case DIP14(1) SO14(2)	 33 31	°C/W
T_j	Junction Temperature	+150	°C
T_{stg}	Storage Temperature Range	-65 to +150	°C
ESD	Human body model (HBM)(3)	1200	V
	Machine model (MM)(4)	200	
	Charged device model (CDM)(5)	1000	

1. Short-circuits can cause excessive heating. These values are typical and specified for a single layer PCB.
2. Short-circuits can cause excessive heating. These values are typical and specified for a four layers PCB.
3. Human body model: a 100 pF capacitor is charged to the specified voltage, then discharged through a 1.5kΩ resistor between two pins of the device. This is done for all couples of connected pin combinations while the other pins are floating.
4. Machine model: a 200 pF capacitor is charged to the specified voltage, then discharged directly between two pins of the device with no external series resistor (internal resistor < 5 Ω). This is done for all couples of connected pin combinations while the other pins remain floating.
5. Charged device model: all pins plus package are charged together to the specified voltage and then discharged directly to the ground.

Table 2. Operating conditions

Symbol	Parameter	Value	Unit
V_{CC}	Supply voltage	2 to 16	V
I_{OUT}	Output sink current Output source current	10 50	mA
T_{oper}	Operating free air temperature range: TS556C TS556I TS556M	 0 to +70 -40 to +125 -55 to +125	°C

2 Schematic diagram

Figure 1. Schematic diagram (1/2 TS556)

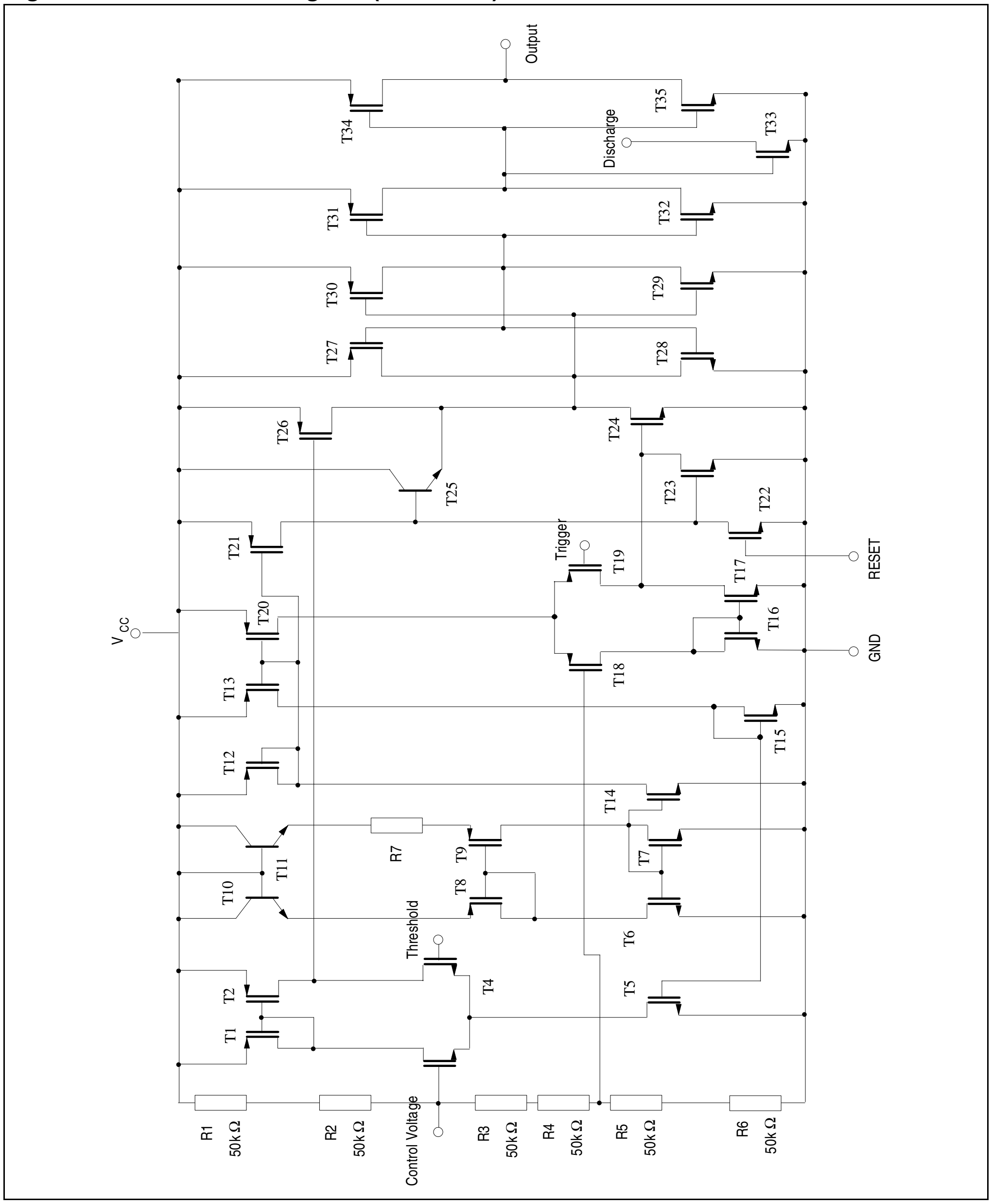


Figure 2. Block diagram

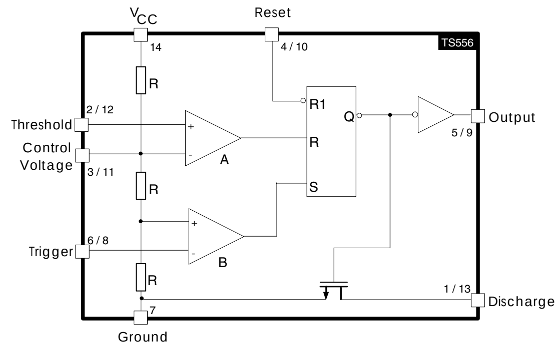


Table 3. Functions table

Reset	Trigger	Threshold	Output
Low	x	x	Low
High	Low	x	High
High	High	High	Low
High	High	Low	Previous State

Note: *LOW: level voltage ≤ minimum voltage specified*
HIGH: level voltage ≥ maximum voltage specified
x: irrelevant.

3 Electrical characteristics

Table 4. Static electrical characteristics
V_{CC} = +2 V, T_{amb} = +25 °C, Reset to V_{CC} (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{CC}	Supply current (no load, high and low states) $T_{min.} \leq T_{amb} \leq T_{max}$		130	400 400	µA
V_{CL}	Control voltage level $T_{min.} \leq T_{amb} \leq T_{max}$	1.2 1.1	1.3	1.4 1.5	V
V_{DIS}	Discharge saturation voltage (I_{dis} = 1 mA) $T_{min.} \leq T_{amb} \leq T_{max}$		0.05	0.2 0.25	V
I_{DIS}	Discharge pin leakage current		1	100	nA
V_{OL}	Low level output voltage (I_{sink} = 1 mA) $T_{min.} \leq T_{amb} \leq T_{max}$		0.1	0.3 0.35	V
V_{OH}	High level output voltage (I_{source} = -0.3 mA) $T_{min.} \leq T_{amb} \leq T_{max}$	1.5 1.5	1.9		V
V_{TRIG}	Trigger voltage $T_{min.} \leq T_{amb} \leq T_{max}$	0.4 0.3	0.67	0.95 1.05	V
I_{TRIG}	Trigger current		10		pA
I_{TH}	Threshold current		10		pA
V_{RESET}	Reset voltage $T_{min.} \leq T_{amb} \leq T_{max}$	0.4 0.3	1.1	1.5 2.0	V
I_{RESET}	Reset current		10		pA

Table 5. Static electrical characteristics
V_{CC} = +3 V, T_{amb} = +25 °C, Reset to V_{CC} (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{CC}	Supply current (no load, high and low states) $T_{min} \leq T_{amb} \leq T_{max}$		180	460 460	µA
V_{CL}	Control voltage level $T_{min} \leq T_{amb} \leq T_{max}$	1.8 1.7	2	2.2 2.3	V
V_{DIS}	Discharge saturation voltage (I_{dis} = 1 mA) $T_{min} \leq T_{amb} \leq T_{max}$		0.05	0.2 0.25	V
I_{DIS}	Discharge pin leakage current		1	100	nA
V_{OL}	Low level output voltage (I_{sink} = 1 mA) $T_{min.} \leq T_{amb} \leq T_{max}$		0.1	0.3 0.35	V
V_{OH}	High level output voltage (I_{source} = -0.3 mA) $T_{min.} \leq T_{amb} \leq T_{max}$	2.5 2.5	2.9		V
V_{TRIG}	Trigger voltage $T_{min.} \leq T_{amb} \leq T_{max}$	0.9 0.8	1	1.1 1.2	V
I_{TRIG}	Trigger current		10		pA
I_{TH}	Threshold current		10		pA
V_{RESET}	Reset voltage $T_{min.} \leq T_{amb} \leq T_{max}$	0.4 0.3	1.1	1.5 2.0	V
I_{RESET}	Reset current		10		pA

Table 6. Dynamic electrical characteristics
V_{CC} = +3 V, T_{amb} = +25 °C, Reset to V_{CC} (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
	Timing accuracy (monostable) (1) R = 10 kΩ, C = 0.1 µF V_{CC}=+2 V, V_{CC} = +3 V		1 1		%
	Timing shift with supply voltage variations (Monostable) (1) R = 10 kΩ, C = 0.1 µF, V_{CC} = +3 V ±0.3 V		0.5		%/V
	Timing shift with temperature (1) $T_{min.} \leq T_{amb} \leq T_{max}$		75		ppm/°C
f_{max}	Maximum astable frequency (2) R_A = 470 Ω, R_B = 200 Ω, C = 200 pF		2		MHz
	Astable frequency accuracy (2) R_A = R_B = 1 kΩ to 100 kΩ, C = 0.1 µF		5		%
	Timing shift with supply voltage variations (astable mode) (2) R_A = R_B = 10 kΩ, C = 0.1 µF, V_{CC} = +3 to +5 V		0.5		%/V
t_R	Output rise time (C_{load} = 10 pF)		25		ns
t_F	Output fall time (C_{load} = 10 pF)		20	-	ns
t_{PD}	Trigger propagation delay		100		ns
t_{RPW}	Minimum reset pulse width (V_{trig} = +3 V)		350		ns

1. See *Figure 4*.
2. See *Figure 6*.

Table 7. Static electrical characteristics
V_{CC} = +5 V, T_{amb} = +25 °C, Reset to V_{CC} (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{CC}	Supply current (no load, high and low states) $T_{min.} \leq T_{amb} \leq T_{max}$		220	500 500	µA
V_{CL}	Control voltage level $T_{min.} \leq T_{amb} \leq T_{max}$	2.9 2.8	3.3	3.8 3.9	V
V_{DIS}	Discharge saturation voltage (I_{dis} = 10 mA) $T_{min.} \leq T_{amb} \leq T_{max}$		0.2	0.3 0.35	V
I_{DIS}	Discharge pin leakage current		1	100	nA
V_{OL}	Low level output voltage (I_{sink} = 8 mA) $T_{min.} \leq T_{amb} \leq T_{max}$		0.3	0.6 0.8	V
V_{OH}	High level output voltage (I_{source} = -2 mA) $T_{min.} \leq T_{amb} \leq T_{max}$	4.4 4.4	4.6		V
V_{TRIG}	Trigger voltage $T_{min.} \leq T_{amb} \leq T_{max}$	1.36 1.26	1.67	1.96 2.06	V
I_{TRIG}	Trigger current		10		pA
I_{TH}	Threshold current		10		pA
V_{RESET}	Reset voltage $T_{min.} \leq T_{amb} \leq T_{max}$	0.4 0.3	1.1	1.5 2.0	V
I_{RESET}	Reset current		10		pA

Table 8. Dynamic electrical characteristics
V_{CC} = +5 V, T_{amb} = +25 °C, Reset to V_{CC} (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
	Timing accuracy (monostable) (1) R = 10 kΩ, C = 0.1 µF		2		%
	Timing shift with supply voltage variations (monostable) (1) R = 10 kΩ, C = 0.1 µF, V_{CC} = +5 V ±1 V		0.38		%/V
	Timing shift with temperature (1) $T_{min.} \leq T_{amb} \leq T_{max}$		75		ppm/°C
f_{max}	Maximum Astable Frequency (2) R_A = 470 Ω, R_B = 200 Ω, C = 200 pF		2.7		MHz
	Astable Frequency Accuracy (2) $R_A = R_B$ = 1 kΩ to 100 kΩ, C = 0.1 µF		3		%
	Timing shift with supply voltage variations (astable mode) (2) $R_A = R_B$ = 1 kΩ to 100 kΩ, C = 0.1 µF, V_{CC} = +5 to +12 V		0.1		%/V
t_R	Output rise time (C_{load} = 10 pF)		25		ns
t_F	Output fall time (C_{load} = 10 pF)		20	-	ns
t_{PD}	Trigger propagation delay		100		ns
t_{RPW}	Minimum reset pulse width (V_{trig} = +5 V)		350		ns

1. See *Figure 4*.
2. See *Figure 6*.

Table 9. Static electrical characteristics
V_{CC} = +12 V, T_{amb} = +25 °C, Reset to V_{CC} (unless otherwise specified)

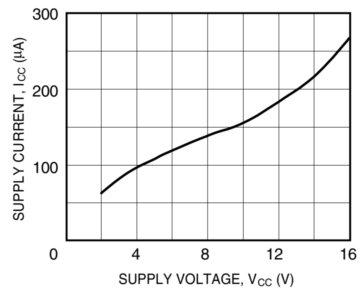
Symbol	Parameter	Min.	Typ.	Max.	Unit
I_{CC}	Supply current (no load, high and low states) $T_{min.} \leq T_{amb} \leq T_{max}$		340	800 800	µA
V_{CL}	Control voltage level $T_{min.} \leq T_{amb} \leq T_{max}$	7.4 7.3	8	8.6 8.7	V
V_{DIS}	Discharge saturation voltage (I_{dis} = 80 mA) $T_{min.} \leq T_{amb} \leq T_{max}$		0.09	1.6 2.0	V
I_{DIS}	Discharge pin leakage current		1	100	nA
V_{OL}	Low level output voltage (I_{sink} = 50 mA) $T_{min.} \leq T_{amb} \leq T_{max}$		1.2	2 2.8	V
V_{OH}	High level output voltage (I_{source} = -10 mA) $T_{min.} \leq T_{amb} \leq T_{max}$	10.5 10.5	11		V
V_{TRIG}	Trigger voltage $T_{min.} \leq T_{amb} \leq T_{max}$	3.2 3.1	4	4.8 4.9	V
I_{TRIG}	Trigger current		10		pA
I_{TH}	Threshold current		10		pA
V_{RESET}	Reset voltage $T_{min.} \leq T_{amb} \leq T_{max}$	0.4 0.3	1.1	1.5 2.0	V
I_{RESET}	Reset current		10		pA

Table 10. Dynamic electrical characteristics
V_{CC} = +12 V, T_{amb} = +25 °C, Reset to V_{CC} (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
	Timing accuracy (monostable) [(1)] R = 10 kΩ, C = 0.1 µF		4		%
	Timing shift with supply voltage variations (monostable) R = 10 kΩ, C = 0.1 µF, V_{CC} = +5 V ±1 V		0.38		%/V
	Timing shift with temperature $T_{min.} \leq T_{amb} \leq T_{max.}$, V_{CC} = +5 V		75		ppm/°C
f_{max}	Maximum astable frequency R_A = 470 Ω, R_B = 200 Ω, C = 200 pF, V_{CC} = +5 V		2.7		MHz
	Astable frequency accuracy [(2)] R_A = R_B = 1 kΩ to 100 kΩ, C = 0.1 µF		3		%
	Timing shift with supply voltage variations (astable mode) R_A = R_B = 1 kΩ to 100 kΩ, C = 0.1 µF, V_{CC} = 5 to +12 V		0.1		%/V

1. See *Figure 4*.
2. See *Figure 6*.

Figure 3. Supply current (per timer) versus supply voltage

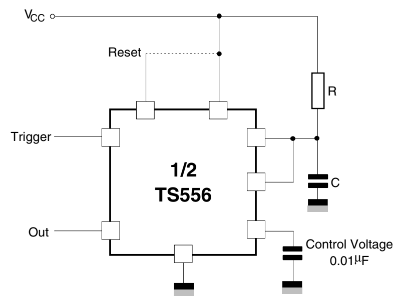


4 Application information

4.1 Monostable operation

In the monostable mode, the timer operates like a one-shot generator. Referring to figure 2, the external capacitor is initially held discharged by a transistor inside the timer, as shown in *Figure 4*.

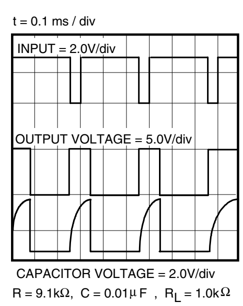
Figure 4. Application schematic



The circuit triggers on a negative-going input signal when the level reaches 1/3 V_{CC}. Once triggered, the circuit remains in this state until the set time has elapsed, even if it is triggered again during this interval. The duration of the output HIGH state is given by t = 1.1 R x C.

It can be noticed that since the charge rate and the threshold level of the comparator are both directly proportional to the supply voltage, the timing interval is independent of the supply. Applying a negative pulse simultaneously to the Reset terminal (pin 4) and the Trigger terminal (pin 2) during the timing cycle discharges the external capacitor and causes the cycle to start over. The timing cycle now starts on the positive edge of the reset pulse. While the reset pulse is applied, the output is driven to the LOW state.
When a negative trigger pulse is applied to pin 2, the flip-flop is set, releasing the short circuit across the external capacitor and driving the output HIGH. The voltage across the capacitor increases exponentially with the time constant τ = R x C.
When the voltage across the capacitor equals 2/3 V_{CC}, the comparator resets the flip-flop which then discharges the capacitor rapidly and drives the output to its LOW state.
Figure 5 shows the actual waveforms generated in this mode of operation.
When Reset is not used, it should be tied high to avoid any possible or false triggering.

Figure 5. Timing diagram



4.2 Astable operation

When the circuit is connected as shown in *Figure 6* (pins 2 and 6 connected) it triggers itself and runs as a multivibrator. The external capacitor charges through R_A and R_B and discharges through R_B only. Thus the duty cycle may be precisely set by the ratio of these two resistors.

In the astable mode of operation, C charges and discharges between 1/3 V_{CC} and 2/3 V_{CC}. As in the triggered mode, the charge and discharge times and therefore frequency, are independent of the supply voltage.

Figure 6. Application schematic

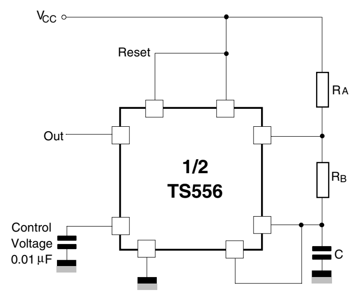


Figure 7 shows actual waveforms generated in this mode of operation.

The charge time (output HIGH) is given by:

$$t1 = 0.693\ (R_A + R_B)\ C$$

and the discharge time (output LOW) by:

$$t2 = 0.693 \times R_B \times C$$

Thus the total period T is given by:

$$T = t1 + t2 = 0.693\ (R_A + 2R_B)\ C$$

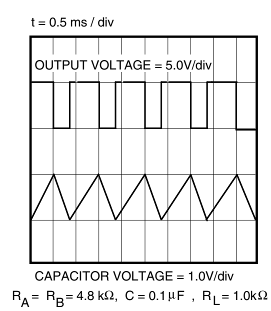
The frequency of oscillation is then:

$$f = \frac{1}{T} = \frac{1.44}{(RA + 2RB)C}$$

The duty cycle is given by:

$$D = \frac{RB}{RA + 2RB}$$

Figure 7. Timing diagram



5 Package information

In order to meet environmental requirements, STMicroelectronics offers these devices in ECOPACK® packages. These packages have a lead-free second level interconnect. The category of second level interconnect is marked on the package and on the inner box label, in compliance with JEDEC Standard JESD97. The maximum ratings related to soldering conditions are also marked on the inner box label. ECOPACK is an STMicroelectronics trademark. ECOPACK specifications are available at: www.st.com.

5.1 DIP14 package information

Figure 8. DIP14 package mechanical drawing

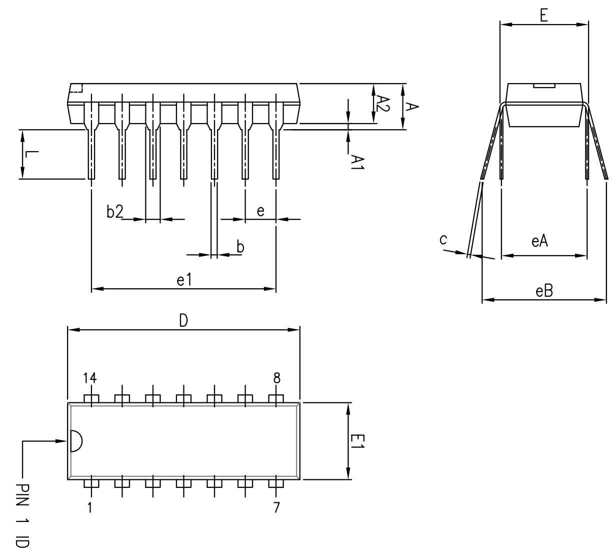


Table 11. DIP14 package mechanical data

Dimensions						
Ref.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			5.33			0.21
A1	0.38			0.015		
A2	2.92	3.30	4.95	0.11	0.13	0.19
b	0.36	0.46	0.56	0.014	0.018	0.022
b2	1.14	1.52	1.78	0.04	0.06	0.07
c	0.20	0.25	0.36	0.007	0.009	0.01
D	18.67	19.05	19.69	0.73	0.75	0.77
E	7.62	7.87	8.26	0.30	0.31	0.32
E1	6.10	6.35	7.11	0.24	0.25	0.28
e		2.54			0.10	
e1		15.24			0.60	
eA		7.62			0.30	
eB			10.92			0.43
L	2.92	3.30	3.81	0.11	0.13	0.15

Note: D and E1 dimensions do not include mold flash or protrusions. Mold flash or protrusions shall not exceed 0.25 mm.

5.2 SO-14 package information

Figure 9. SO-14 package mechanical drawing

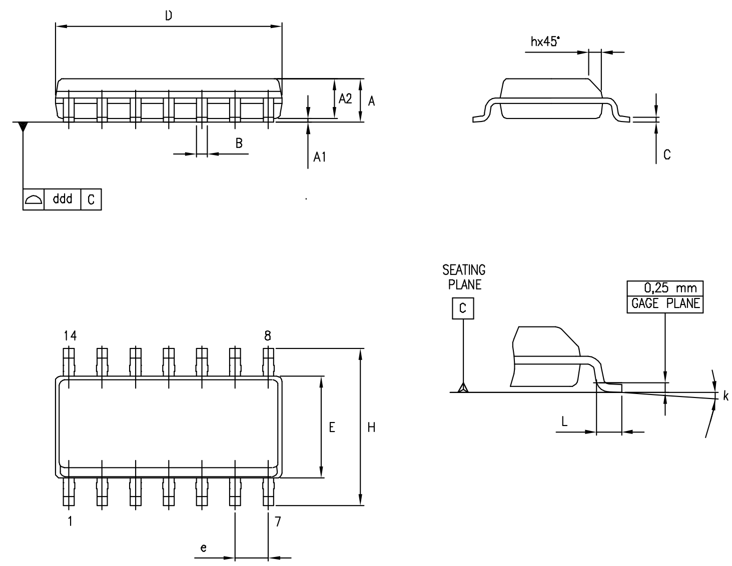


Table 12. SO-14 package mechanical data

Dimensions						
Ref.	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	1.35		1.75	0.05		0.068
A1	0.10		0.25	0.004		0.009
A2	1.10		1.65	0.04		0.06
B	0.33		0.51	0.01		0.02
C	0.19		0.25	0.007		0.009
D	8.55		8.75	0.33		0.34
E	3.80		4.0	0.15		0.15
e		1.27			0.05	
H	5.80		6.20	0.22		0.24
h	0.25		0.50	0.009		0.02
L	0.40		1.27	0.015		0.05
k	8° (max.)					
ddd			0.10			0.004

Note: D and F dimensions do not include mold flash or protrusions. Mold flash or protrusions must not exceed 0.15 mm.

6 Ordering information

Table 13. Order codes

Order code	Temperature range	Package	Packaging	Marking
TS556CN	0°C, +70°C	DIP14	Tube	TS556CN
TS556CD TS556CDT		SO-14	Tube or Tape & reel	556C
TS556IN	-40°C, +125°C	DIP14	Tube	TS556IN
TS556ID TS556IDT		SO-14	Tube or Tape & reel	556I
TS556MN	-55°C, +125°C	DIP14	Tube	TS556MN
TS556MD TS556MDT		SO-14	Tube or Tape & reel	556M

7 Revision history

Table 14. Document revision history

Date	Revision	Changes
01-Feb-2003	1	Initial release.
28-Oct-2008	2	Document reformatted. Added output current, ESD and thermal resistance values in *Table 1: Absolute maximum ratings*. Added output current values in *Table 2: Operating conditions*. Updated *Section 5.1: DIP14 package information* and *Section 5.2: SO-14 package information*.

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