DATA SHEET

74F109

Positive J-$\overline{K}$ positive edge-triggered flip-flops

Product specification

1990 Oct 23

IC15 Data Handbook

Philips
Semiconductors

PHILIPS

Postive J-$\overline{K}$ positive edge-triggered flip-flops 74F109

FEATURE

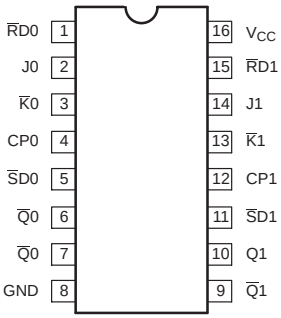
- Industrial temperature range available (–40°C to +85°C)

DESCRIPTION

The 74F109 is a dual positive edge-triggered JK-type flip-flop featuring individual J, $\overline{K}$, clock, set, and reset inputs; also true and complementary outputs. Set ($\overline{SD}$) and reset ($\overline{RD}$) are asynchronous active low inputs and operate independently of the clock (CP) input. The J and $\overline{K}$ are edge-triggered inputs which control the state changes of the flip-flops as described in the function table. Clock triggering occurs at a voltage level and is not directly related to the transition time of the positive-going pulse. The J and $\overline{K}$ inputs must be stable just one setup time prior to the low-to-high transition of the clock for predictable operation. The J$\overline{K}$ design allows operation as a D flip-flop by tying J and $\overline{K}$ inputs together. Although the clock input is level sensitive, the positive transition of the clock pulse between the 0.8V and 2.0V levels should be equal to or less than the clock to output delay time for reliable operation.

TYPE	TYPICAL f_{max}	TYPICAL SUPPLY CURRENT (TOTAL)
74F109	125MHz	12.3mA

PIN CONFIGURATION



SF00135

ORDERING INFORMATION

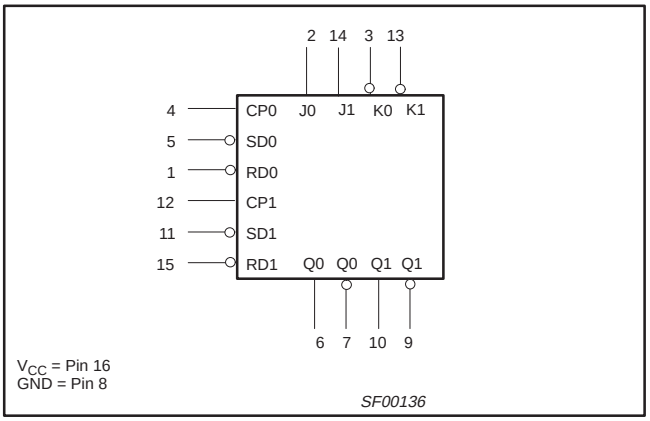
DESCRIPTION	ORDER CODE		PKG DWG #
	COMMERCIAL RANGE V_{CC} = 5V ±10%, T_{amb} = 0°C to +70°C	INDUSTRIAL RANGE V_{CC} = 5V ±10%, T_{amb} = –40°C to +85°C	
16-pin plastic DIP	N74F109N	I74F109N	SOT38-4
16-pin plastic SO	N74F109D	I74F109D	SOT109-1

INPUT AND OUTPUT LOADING AND FAN OUT TABLE

PINS	DESCRIPTION	74F (U.L.) HIGH/LOW	LOAD VALUE HIGH/LOW
J0, J1	J inputs	1.0/1.0	20µA/0.6mA
$\overline{K}$0, $\overline{K}$1	K inputs	1.0/1.0	20µA/0.6mA
CP0, CP1	Clock inputs (active rising edge)	1.0/1.0	20µA/0.6mA
$\overline{SD}$0, $\overline{SD}$1	Set inputs (active Low)	1.0/3.0	20µA/1.8mA
$\overline{RD}$0, $\overline{RD}$1	Reset inputs (active Low)	1.0/3.0	20µA/1.8mA
Q0, Q1, $\overline{Q}$0, $\overline{Q}$1	Data outputs	50/33	1.0mA/20mA

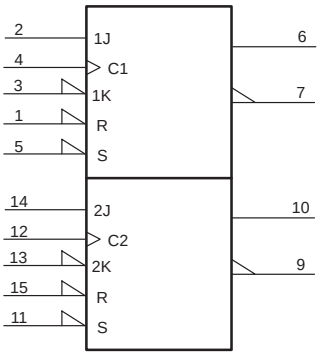
NOTE: One (1.0) FAST unit load is defined as: 20µA in the High state and 0.6mA in the Low state.

LOGIC SYMBOL



SF00136

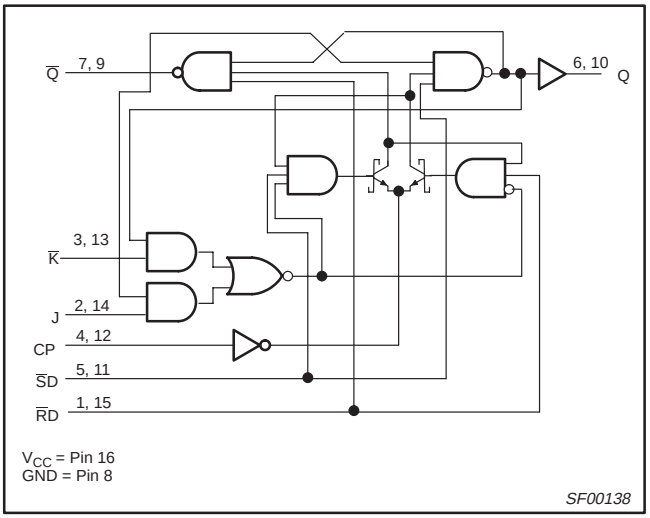
IEC/IEEE SYMBOL



SF00137

Postive J-$\overline{K}$ positive edge-triggered flip-flops 74F109

LOGIC DIAGRAM



FUNCTION TABLE

INPUTS					OUTPUTS		OPERATING MODE
$\overline{SD}$	$\overline{RD}$	CP	J	$\overline{K}$	Q	$\overline{Q}$	
L	H	X	X	X	H	L	Asynchronous set
H	L	X	X	X	L	H	Asynchronous reset
L	L	X	X	X	H	H	Undetermined*
H	H	↕	X	X	q	$\overline{q}$	Hold
H	H	↑	h	l	$\overline{q}$	q	Toggle
H	H	↑	h	h	H	L	Load "1" (set)
H	H	↑	l	l	L	H	Load "0" (reset)
H	H	↑	l	h	q	$\overline{q}$	Hold 'no change"

NOTES:
H = High-voltage level
h = High-voltage level one setup time prior to low-to-high clock transition
L = Low-voltage level
l = Low-voltage level one setup time prior to low-to-high clock transition
q = Lower case indicate the state of the referenced output prior to the low-to-high clock transition
X = Don't care
↑ = Low-to-high clock transition
↕ = Not low-to-high clock transition
* = Both outputs will be high if both $\overline{SD}$ and $\overline{RD}$ go low simultaneously

ABSOLUTE MAXIMUM RATINGS

(Operation beyond the limit set forth in this table may impair the useful life of the device. Unless otherwise noted these limits are over the operating free air temperature range.)

SYMBOL	PARAMETER		RATING	UNIT
V_{CC}	Supply voltage		–0.5 to +7.0	V
V_{IN}	Input voltage		–0.5 to +7.0	V
I_{IN}	Input current		–30 to +5	mA
V_{OUT}	Voltage applied to output in High output state		–0.5 to V_{CC}	V
I_{OUT}	Current applied to output in Low output state		40	mA
T_{amb}	Operating free-air temperature range	Commercial range	0 to +70	°C
		Industrial range	–40 to +85	°C
T_{stg}	Storage temperature range		–65 to +150	°C

RECOMMENDED OPERATING CONDITIONS

SYMBOL	PARAMETER		LIMITS			UNIT
			MIN	NOM	MAX	
V_{CC}	Supply voltage		4.5	5.0	5.5	V
V_{IN}	High-level input voltage		2.0			V
V_{IL}	Low-level input voltage				0.8	V
I_{IK}	Input clamp current				–18	mA
I_{OH}	High-level output current				–1	mA
I_{OL}	Low-level output current				20	mA
T_{amb}	Operating free-air temperature range	Commercial range	0		+70	°C
		Industrial range	–40		+85	°C

DC ELECTRICAL CHARACTERISTICS

(Over recommended operating free-air temperature range unless otherwise noted.)

SYMBOL	PARAMETER		TEST CONDITIONS[1]			LIMITS			UNIT
						MIN	TYP[2]	MAX	
V_{OH}	High-level output voltage		V_{CC} = MIN, V_{IL} = MAX, V_{IH} = MIN	I_{OH} = MAX	±10%V_{CC}	2.5			V
					±5%V_{CC}	2.7	3.4		V
V_{OL}	Low-level output voltage		V_{CC} = MIN, V_{IL} = MAX, V_{IH} = MIN	I_{OL} = MAX	±10%V_{CC}		0.30	0.50	V
					±5%V_{CC}		0.30	0.50	V
V_{IK}	Input clamp voltage		V_{CC} = MIN, I_I = I_{IK}				–0.73	–1.2	V
I_I	Input current at maximum input voltage		V_{CC} = MAX, V_I = 7.0V					100	µA
I_{IH}	High-level input current		V_{CC} = MAX, V_I = 2.7V					20	µA
I_{IL}	Low-level input current	J, $\overline{K}$, CPn	V_{CC} = MAX, V_I = 0.5V					–0.6	mA
		$\overline{S}$Dn, $\overline{R}$Dn	V_{CC} = MAX, V_I = 0.5V					–1.8	mA
I_{OS}	Short-circuit output current[3]		V_{CC} = MAX			-60		–150	mA
I_{CC}	Supply current[4] (total)		V_{CC} = MAX				12.3	17	mA

NOTES:

1. For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions for the applicable type.
2. All typical values are at V_{CC} = 5V, T_{amb} = 25°C.
3. Not more than one output should be shorted at a time. For testing I_{OS}, the use of high-speed test apparatus and/or sample-and-hold techniques are preferable in order to minimize internal heating and more accurately reflect operational values. Otherwise, prolonged shorting of a high output may raise the chip temperature well above normal and thereby cause invalid readings in other parameter tests. In any sequence of parameter tests, I_{OS} tests should be performed last.
4. Measure I_{CC} with the clock input grounded and all outputs open, then with Q and $\overline{Q}$ outputs high in turn.

AC ELECTRICAL CHARACTERISTICS

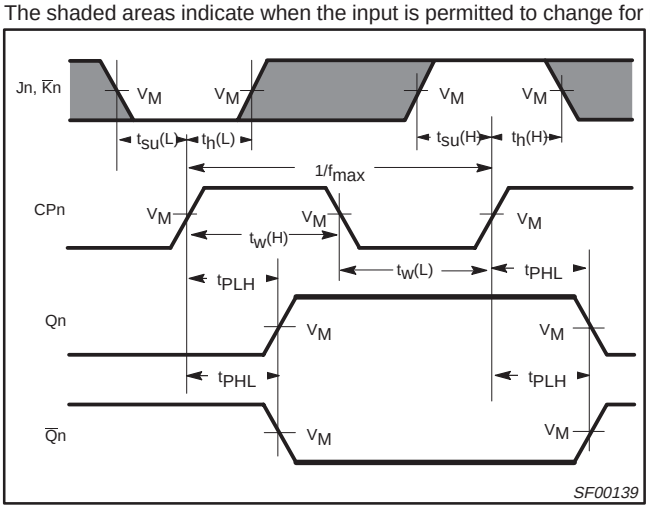
SYMBOL	PARAMETER	TEST CONDITION	LIMITS							UNIT
			V_{CC} = +5.0V T_{amb} = +25°C C_L = 50pF R_L = 500Ω			V_{CC} = +5.0V ± 10% T_{amb} = 0°C to +70°C C_L = 50pF R_L = 500Ω		V_{CC} = +5.0V ± 10% T_{amb} = –40°C to +85°C C_L = 50pF R_L = 500Ω		
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
f_{MAX}	Maximum clock frequency	Waveform 1	90	125		90		90		MHz
t_{PLH} t_{PHL}	Propagation delay CPn to Qn or $\overline{Q}$n	Waveform 1	3.8 4.4	5.3 6.2	7.0 8.0	3.8 4.4	8.0 9.2	3.8 4.4	9.0 9.2	ns
t_{PLH} t_{PHL}	Propagation delay $\overline{S}$Dn, $\overline{R}$D to Qn or $\overline{Q}$n	Waveform 2, 3	3.2 3.5	5.2 7.0	7.0 9.0	3.2 3.5	8.0 10.5	2.8 3.5	9.0 10.5	ns

AC SETUP REQUIREMENTS

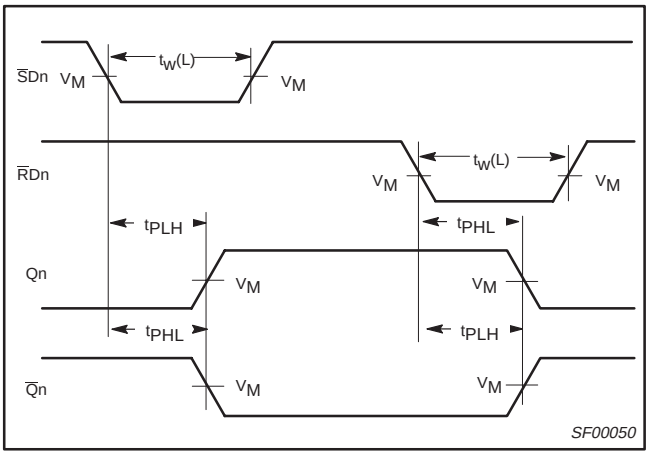
SYMBOL	PARAMETER	TEST CONDITION	LIMITS							UNIT
			V_{CC} = +5.0V T_{amb} = +25°C C_L = 50pF R_L = 500Ω			V_{CC} = +5.0V ± 10% T_{amb} = 0°C to +70°C C_L = 50pF R_L = 500Ω		V_{CC} = +5.0V ± 10% T_{amb} = –40°C to +85°C C_L = 50pF R_L = 500Ω		
			MIN	TYP	MAX	MIN	MAX	MIN	MAX	
t_{su} (H) t_{su}(L)	Setup time, high or low Dn to CPn	Waveform 1	3.0 3.0			3.0 3.0		3.0 3.0		ns
t_h (H) t_h (L)	Hold time, high or low Dn to CPn	Waveform 1	1.0 1.0			1.0 1.0		1.0 1.0		ns
t_w (H) t_w (L)	CP pulse width, high or low	Waveform 1	4.0 5.0			4.0 5.0		4.0 5.0		ns
t_w (L)	$\overline{S}$Dn or $\overline{R}$Dn pulse width, low	Waveform 2	4.0			4.0		4.0		ns
t_{rec}	Recovery time $\overline{S}$Dn or $\overline{R}$Dn to CP	Waveform 3	2.0			2.0		2.0		ns

AC WAVEFORMS

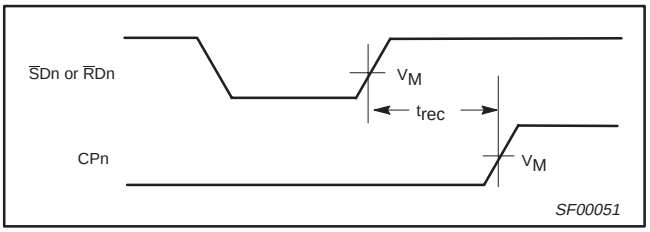
For all waveforms, V_M = 1.5V.
The shaded areas indicate when the input is permitted to change for predictable output performance.



Waveform 1. Propagation Delay for Data to Output, Data Setup Time and Hold Times, and Clock Width,and Maximum Clock Frequency

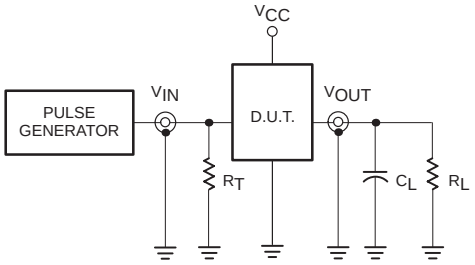


Waveform 2. Propagation Delay for Set and Reset to Output, Set and Reset Pulse Width

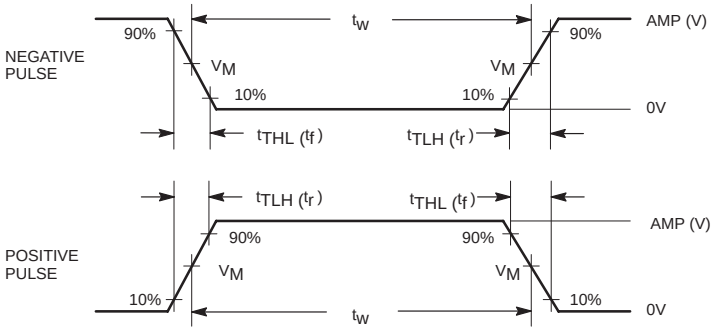


Waveform 3. Recovery Timer for Set or Reset to Clock

TEST CIRCUIT AND WAVEFORMS



Test Circuit for Totem-Pole Outputs



DEFINITIONS:

R_L = Load resistor; see AC ELECTRICAL CHARACTERISTICS for value.

C_L = Load capacitance includes jig and probe capacitance; see AC ELECTRICAL CHARACTERISTICS for value.

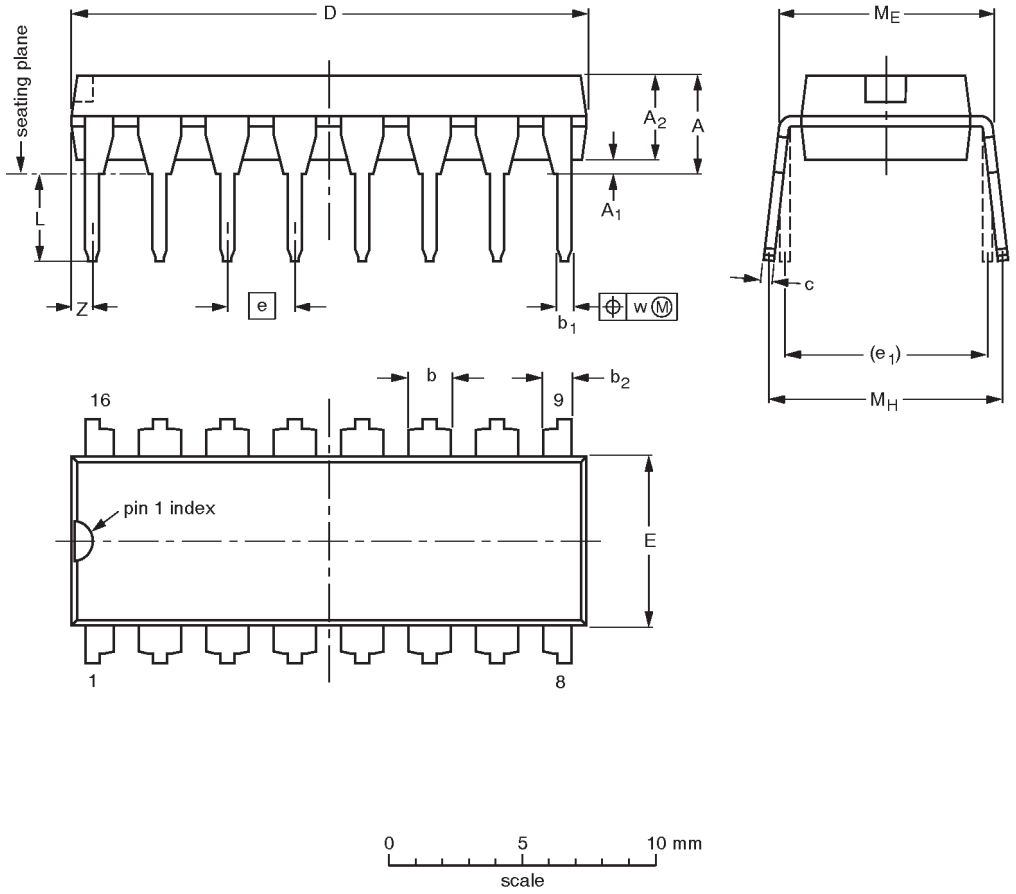
R_T = Termination resistance should be equal to Z_{OUT} of pulse generators.

Input Pulse Definition

family	INPUT PULSE REQUIREMENTS					
	amplitude	V_M	rep. rate	t_w	t_{TLH}	t_{THL}
74F	3.0V	1.5V	1MHz	500ns	2.5ns	2.5ns

SF00006

DIP16: plastic dual in-line package; 16 leads (300 mil) **SOT38-4**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

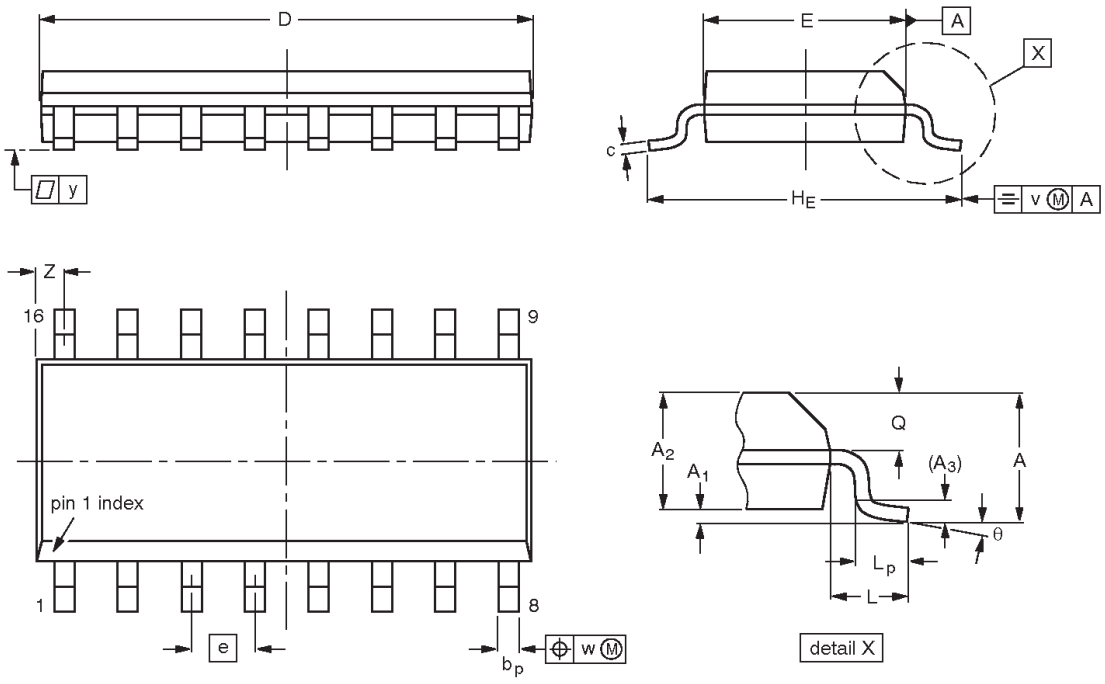
UNIT	A max.	A_1 min.	A_2 max.	b	b_1	b_2	c	D (1)	E (1)	e	e_1	L	M_E	M_H	w	Z (1) max.
mm	4.2	0.51	3.2	1.73 1.30	0.53 0.38	1.25 0.85	0.36 0.23	19.50 18.55	6.48 6.20	2.54	7.62	3.60 3.05	8.25 7.80	10.0 8.3	0.254	0.76
inches	0.17	0.020	0.13	0.068 0.051	0.021 0.015	0.049 0.033	0.014 0.009	0.77 0.73	0.26 0.24	0.10	0.30	0.14 0.12	0.32 0.31	0.39 0.33	0.01	0.030

Note

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT38-4						~~92-11-17~~ 95-01-14

SO16: plastic small outline package; 16 leads; body width 3.9 mm **SOT109-1**



DIMENSIONS (inch dimensions are derived from the original mm dimensions)

UNIT	A max.	A_1	A_2	A_3	b_p	c	$D^{(1)}$	$E^{(1)}$	e	H_E	L	L_p	Q	v	w	y	$Z^{(1)}$	θ
mm	1.75	0.25 0.10	1.45 1.25	0.25	0.49 0.36	0.25 0.19	10.0 9.8	4.0 3.8	1.27	6.2 5.8	1.05	1.0 0.4	0.7 0.6	0.25	0.25	0.1	0.7 0.3	8^o 0^o
inches	0.069	0.010 0.004	0.057 0.049	0.01	0.019 0.014	0.0100 0.0075	0.39 0.38	0.16 0.15	0.050	0.244 0.228	0.041	0.039 0.016	0.028 0.020	0.01	0.01	0.004	0.028 0.012	

Note

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

OUTLINE VERSION	REFERENCES				EUROPEAN PROJECTION	ISSUE DATE
	IEC	JEDEC	EIAJ			
SOT109-1	076E07S	MS-012AC				~~95-01-23~~ 97-05-22

NOTES

Data sheet status

Data sheet status	Product status	Definition [1]
Objective specification	Development	This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice.
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[1] Please consult the most recently issued datasheet before initiating or completing a design.

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print code Date of release: 10-98

Document order number: 9397-750-05069

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