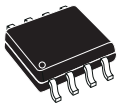
L4989

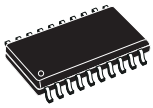
LOW POWER VOLTAGE REGULATOR

PRODUCT PREVIEW

- OPERATING DC SUPPLY VOLTAGE RANGE 5.6V TO 31V
- VERY LOW QUIESCENT CURRENT WITH WATCHDOG DISABLED
- PRECISION OUTPUT VOLTAGE (3%)
- LOW-DROP VOLTAGE (180mV typ at I_o = 150mA)
- RESET CIRCUIT SENSING THE OUTPUT VOLTAGE DOWN TO 1V
- PROGRAMMABLE RESET DELAY WITH EXTERNAL CAPACITOR
- WATCHDOG DISABLE INPUT
- PROGRAMMABLE WATCHDOG TIMER WITH EXTERNAL CAPACITOR
- THERMAL SHUTDOWN AND SHORT CIRCUIT PROTECTION
- WIDE TEMPERATURE RANGE (T_j = -40°C TO 150°C)



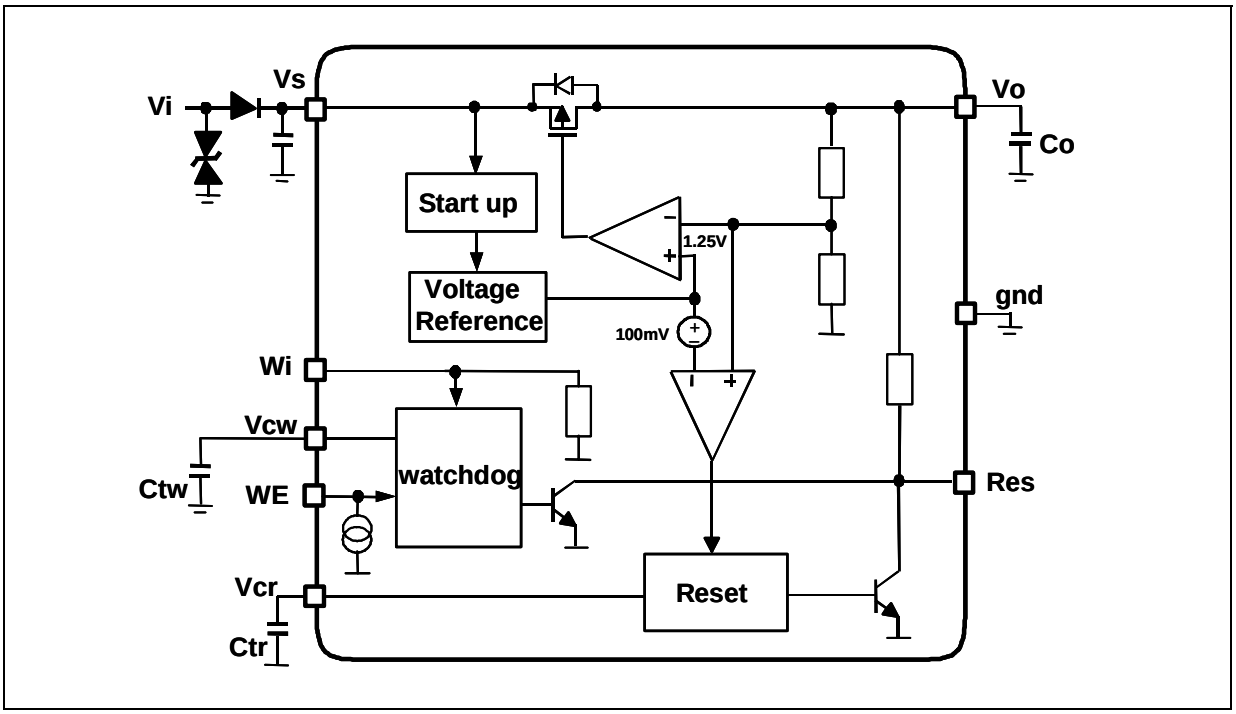
SO8



SO20

ORDERING NUMBERS: L4989D (SO8)
L4989 (SO20)

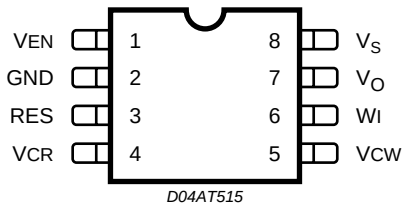
BLOCK DIAGRAMt



PIN DESCRIPTION

N. (SO8)	N. (SO20)	NAME	FUNCTION
1	1	WEn	Watchdog enable input. If high it activates the watchdog operation.
2	4	gnd	Ground reference
	5,6,15,16	gnd	Ground Connected these pins to a heat spreader ground
3	7	Res	Reset output. It is pulled down when output voltage goes below Vo_th or frequency at Wi is too low.
4	10	Vcr	Reset timing adjust. A capacitor between Vcr pin and gnd, sets the reset delay time (trd)
5	11	Vcw	Watchdog timer adjust A capacitor between Vcw pin and gnd, sets the time response of the watchdog monitor.
6	14	Wi	Watchdog input. If the frequency at this input pin is too low, the Reset output is activated.
7	17	Vo	Voltage regulator output Block to ground with a capacitor >100nF (needed for regulator stability)
8	20	Vs	Supply voltage Block to ground directly at IC pin with a ceramic capacitor
	2,3,8,9,12, 13,18,19	N. C.	not connected

PIN CONNECTIONS



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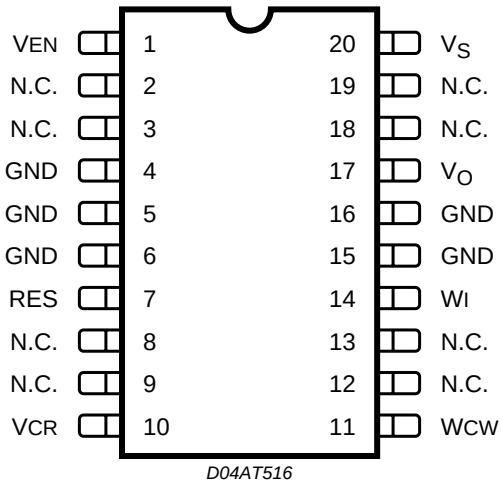


SO20

ABSOLUTE MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V_{Vsdc}	DC supply voltage	-0.3 to 40	V
I_{Vsdc}	Input current	internally limited	
V_{Vo}	DC output voltage	-0.3 to 6	V
I_{Vo}	DC output current	internally limited	
V_{Wi}	Watchdog input voltage	-0.3 to VVo + 0.3	V
V_{od}	Open drain output voltage (RES)	-0.3 to VVo + 0.3	V
I_{od}	Open drain output current (RES)	internally limited	
V_{cr}	Reset delay voltage	-0.3 to VVo + 0.3	V
V_{cw}	Watchdog delay voltage	-0.3 to VVo + 0.3	V
V_{WEn}	Watchdog enable input	-0.3 to 40	V
T_j	Junction temperature	-40 to 150	°C
V_{ESD}	ESD voltage level (HBM-MIL STD 883C)	±2	kV

Note:
Maximum ratings are absolute ratings; exceeding any one of these values may cause perma-nent damage to the integrated circuit.

THERMAL DATA

Symbol	Parameter	SO8	SO12+4+4	Unit
$R_{th\text{-}j\ amb}$	Thermal Resistance Junction to ambient	130 to 180	50(*)	°C/W

(*) with 6 sq. cm on board heat sink

ELECTRICAL CHARACTERISTICS (Vs = 5.6V to 31V, Tj = -40°C to +150°C unless otherwise specified)

Pin	Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
GENERAL							
Vo	V_{o_ref}	Output voltage	Vs=5.6 to 31V Io=1 to 150mA	4.85	5.00	5.15	V
Vo	I_{short_13}	Short circuit current (1)	Vs=13.5V	160	210	250	mA
Vo	I_{lim}	Output current limitation (1)	Vs=13.5V	170	250	290	mA
Vs, Vo	V_{line}	Line regulation voltage	Vs=5.6 to 31V Io=1 to 150mA			25	mV
Vo	V_{load}	Load regulation voltage	Io=1 to 150mA			25	mV
Vs, Vo	V_{dp}	Drop voltage	Io=150mA		180	400	mV
Vs, Vo	SVR	Ripple rejection	fr = 100 Hz	55			dB
Vs, Vo	I_{qs_1}	Current consumption with watchdog not active $I_{qs\_1} = I_{Vs} - I_o$	Vs=13.5V, Io<1mA, WEn low		69	115	µA

Pin	Symbol	Parameter	Test Condition	Min.	Typ.	Max.	Unit
Vs, Vo	I_{qs_10}	Current consumption with watchdog not active $I_{qs\_10} = I_{Vs} - I_o$	Vs=13.5V, Io=10mA, WEn low		127	300	µA
Vs, Vo	I_{qs_50}	Current consumption with watchdog not active $I_{qs\_50} = I_{Vs} - I_o$	Vs=13.5V, Io=50mA, WEn low		498	900	µA
Vs, Vo	I_{qs_150}	Current consumption with watchdog not active $I_{qs\_150} = I_{Vs} - I_o$	Vs=13.5V, Io=150mA, WEn low		1.40	2	mA
Vs, Vo	I_{qn_1}	Current consumption with watchdog active $I_{qn\_1} = I_{Vs} - I_o$	Vs=13.5V, Io<1mA, WEn high		110	170	µA
Vs, Vo	I_{qn_10}	Current consumption with watchdog active $I_{qn\_10} = I_{Vs} - I_o$	Vs=13.5V, Io=10mA, WEn high		168	350	µA
Vs, Vo	I_{qn_50}	Current consumption with watchdog active $I_{qn\_50} = I_{Vs} - I_o$	Vs=13.5V, Io=50mA, WEn high		538	1000	µA
Vs, Vo	I_{qn_150}	Current consumption with watchdog active $I_{qn\_150} = I_{Vs} - I_o$	Vs=13.5V, Io=150mA, WEn high		1.45	2.00	mA
	Tw	Thermal protection temperature		150		190	°C
	Tw_hy	Thermal protection temperature hysteresis			10		°C

Note: 1. see fig1 (behavior of output current versus regulated voltage Vo)

RESET

Pin	Symbol	Parameter	Test condition	min	typ	max	Unit
Res	Vres_l	Reset output low voltage	Rext = 5kΩ to Vo, Vo > 1V			0.4	V
Res	I_{Res_lkg}	Reset output high leakage current	V_{Res} = 5V			1	µA
Res	R_{Res}	Internal Pull up resistance	versus Vo	10	20	40	kΩ
Res	Vo_th	Reset threshold voltage	Vs = 5.6 to 31V Io = 1 to 150mA	6%	8%	10%	below V_{o_ref}
Vcr	Vrhth	Reset timing low threshold	Vs =13.5V	10%	13%	16%	V_{o_ref}
Vcr	Vrlth	Reset timing high threshold	Vs =13.5V	44%	47%	50%	V_{o_ref}
Vcr	Icr	Charge current	Vs =13.5V	8	15	30	µA
Vcr	Idr	Discharge current	Vs =13.5V	8	15	30	µA
Res	trr_2	Reset reaction time (2)	Vo = V_{o_th} - 100mV	100	250	700	µs
Res	trd	Reset delay time	Vs =13.5V, Ctr =1nF	65	115	165	ms

2. When Vo becomes lower than 4V, the reset reaction time decreases down to 2 s assuring a faster reset condition in this particular case.

WATCHDOG

Pin	Symbol	Parameter	Test condition	min	typ	max	Unit
Wi	Vih	Input high voltage	Vs=13.5V	3.5			V
Wi	Vil	Input low voltage	Vs=13.5V			1.5	V
Wi	Vih	Input hysteresis	Vs=13.5V		500		mV
Wi	Rwi	Pull down resistor	Vs=13.5V	30	100	250	kΩ
Vcw	Vwhth	Low threshold	Vs=13.5V	10%	13%	16%	V_{o_ref}
Vcw	Vwlth	High threshold	Vs=13.5V	44%	47%	50%	V_{o_ref}
Vcw	Icwc	Charge current	Vs=13.5V, Vcw=0.1V	5	10	20	µA
Vcw	Icwd	Discharge current	Vs=13.5V, Vcw=2.5V	1.25	2.5	5	µA
Vcw	Twop	Watchdog period	Vs=13.5V, Ctw=47nF	20	40	80	ms
Res	twol	Watchdog output low time	Vs=13.5V, Ctw=47nF	4	8	16	ms

WEn

Pin	Symbol	Parameter	Test condition	min	typ	max	Unit
WEn	V_{WEn_low}	WEn input low voltage				1	V
WEn	V_{WEn_high}	WEn input high voltage		3			V
WEn	V_{WEn_hyst}	WEn input hysteresis		600	920	1300	mV
WEn	R_{WEn}	Pull down current	Vs=13.5V	1	2.5	5	µA

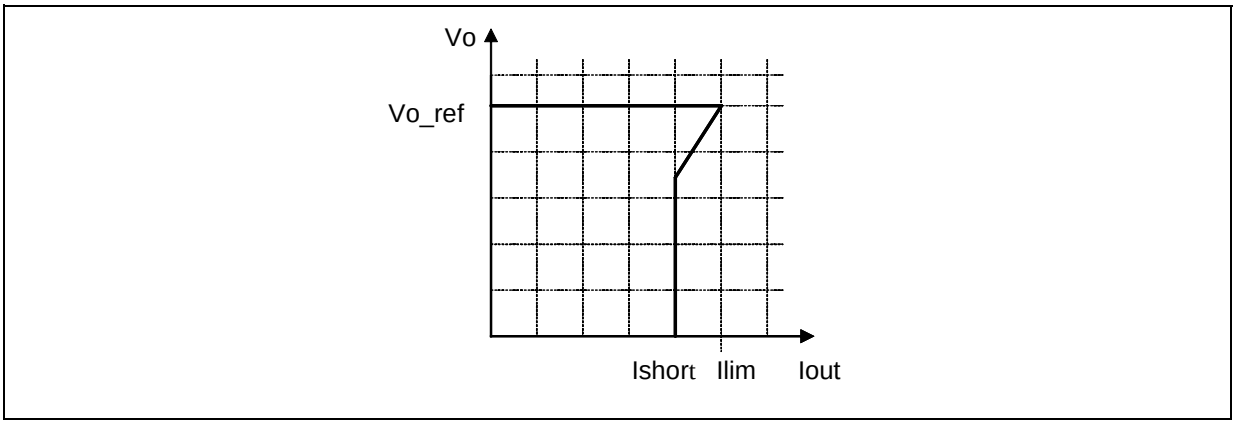
VOLTAGE REGULATOR

The voltage regulator uses a p-channel MOS transistor as a regulating element. With this structure a very low dropout voltage at current up to 150mA is obtained. The output voltage is regulated up to transient input supply voltage of 40V. No functional interruption due to over-voltage pulses is generated.

The voltage Regulator is always active and not depending on the state of WEn input pin.

A short circuit protection to GND is provided.

Figure 1. Behavior of output current versus regulated voltage Vo



The reset circuit monitors the output voltage Vo. If the output voltage stays lower than Vo_th for filter time trr, then Res goes low. If the output voltage Vo becomes lower than 2.0V (typ) than Res goes immediately low. The reset low signal is guaranteed for an output voltage Vo greater than 1V.

When the output voltage goes back higher than Vo_th then Res goes high with a delay trd. This delay is obtained by 512 period of an oscillator. The oscillator period is given by:

$$T_{osc} = \frac{(V_{rhth} - V_{rlth}) \cdot Ctr}{Icr} + \frac{(V_{rhth} - V_{rlth}) \cdot Ctr}{Id}$$

trd is given by

$$trd = 512 \times Tosc$$

where:

Icr = 15µA is an internally generated charge current,

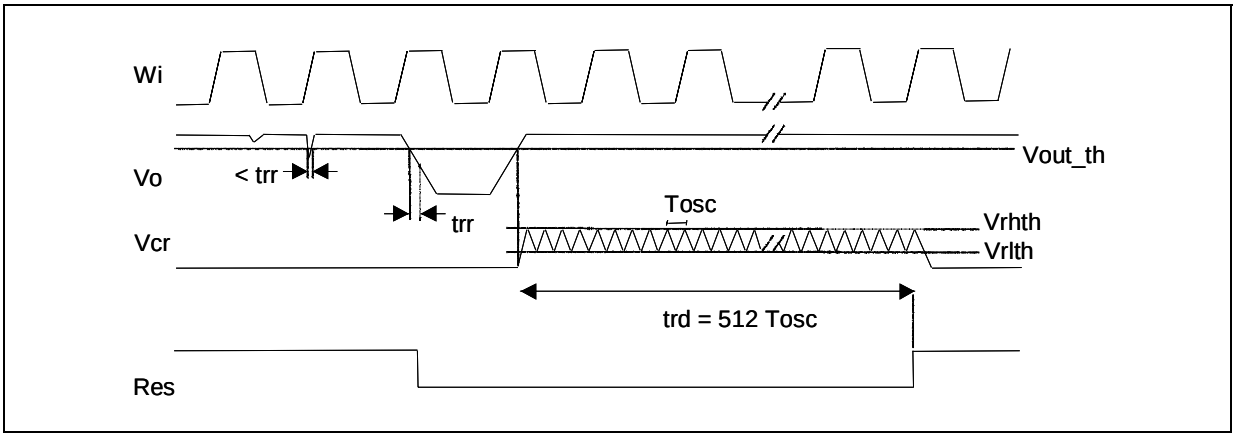
Idr = 15µA is an internally generated discharge current,

Vrhth=2.35V and Vrlth=0.65V are two typ thresholds,

Ctr is an external capacitance.

The Reset is always active and not depending on the state of WEn input pin.

Figure 2. Reset Time Diagram



Watchdog

The watchdog input Wi monitors a connected microcontroller. If pulses are missing, the Reset output Res is set to low. The pulse sequence time can be set within a wide range with the external capacitor Ctw. The watchdog circuit discharges the capacitor Ctw with the con-stant current Icwd. If the lower threshold Vwlth is reached, a watchdog reset is generated.

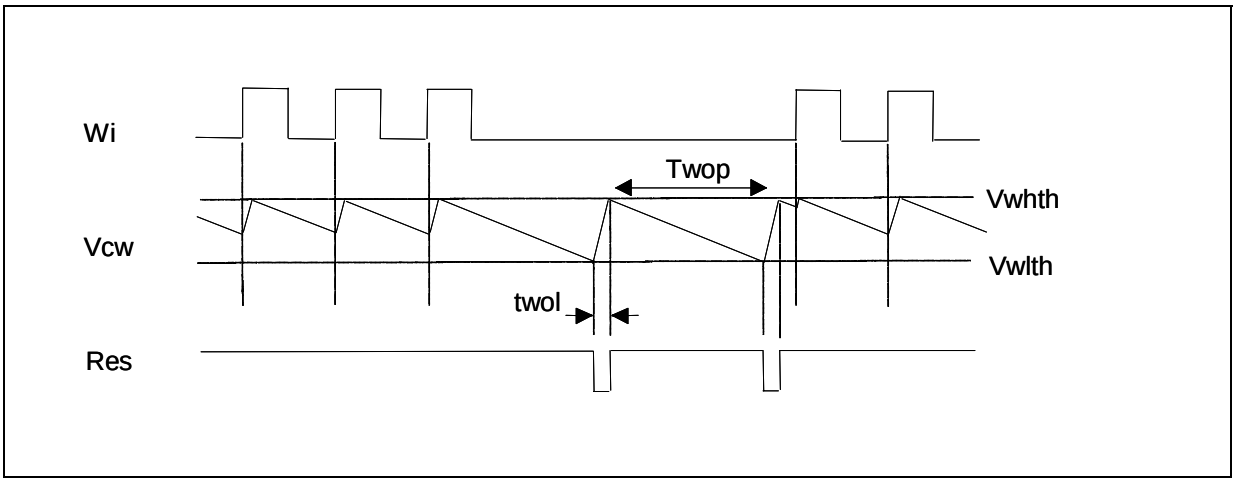
To prevent this reset the microcontroller must generate a positive edge during the discharge of the capac-itor before the voltage has reached the threshold Vwlth. In order to calculate the minimum time t_{dis} during which the microcontroller must output the positive edge the fol-lowing equation can be used

$$(Vwhth-Vwlth) \times Ctw = Icwd \times t_{dis}$$

Every Wi positive edge switches the current source from discharging to charging, the same happens when the lower threshold is reached. When the voltage reaches the upper threshold Vwhth the current switches from charging to discharging. The result is a saw toothwaveform at the watchdog timer capacitor Ctw.

The Watchdog operation is active only if WEn input pin is set to logic state high.

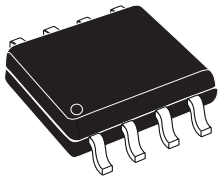
Figure 3. Watchdog time diagram



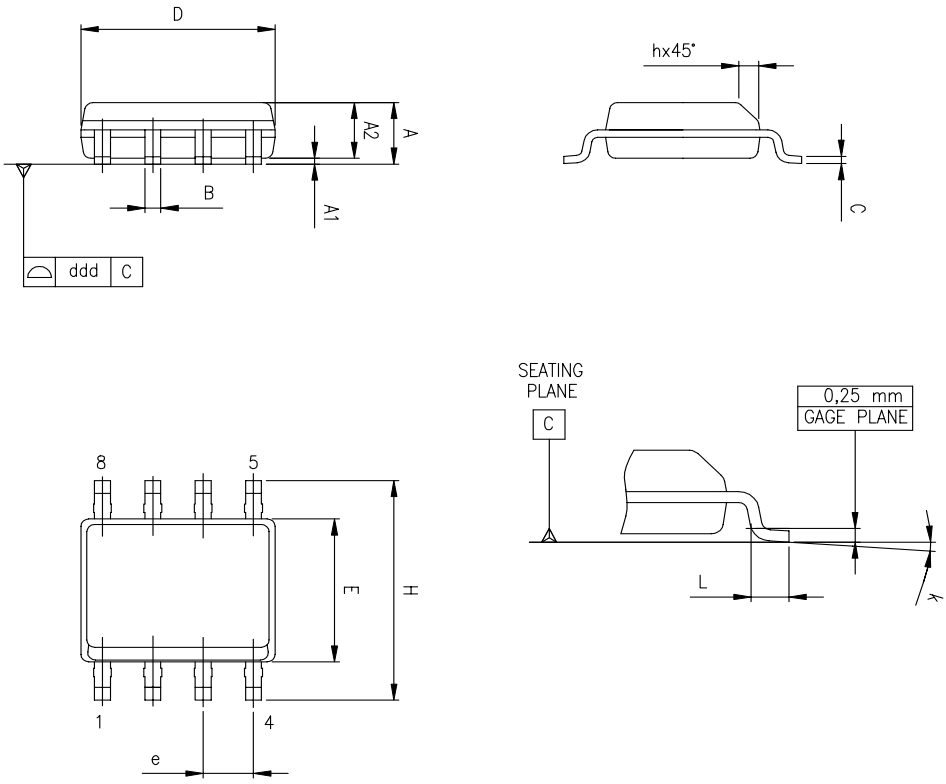
DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	1.35		1.75	0.053		0.069
A1	0.10		0.25	0.004		0.010
A2	1.10		1.65	0.043		0.065
B	0.33		0.51	0.013		0.020
C	0.19		0.25	0.007		0.010
D (1)	4.80		5.00	0.189		0.197
E	3.80		4.00	0.15		0.157
e		1.27			0.050	
H	5.80		6.20	0.228		0.244
h	0.25		0.50	0.010		0.020
L	0.40		1.27	0.016		0.050
k	0° (min.), 8° (max.)					
ddd			0.10			0.004

Note: (1) Dimensions D does not include mold flash, protrusions or gate burrs.
Mold flash, potrusions or gate burrs shall not exceed 0.15mm (.006inch) in total (both side).

OUTLINE AND MECHANICAL DATA



SO-8

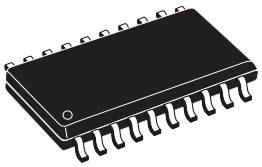


0016023 C

DIM.	mm			inch		
	MIN.	TYP.	MAX.	MIN.	TYP.	MAX.
A	2.35		2.65	0.093		0.104
A1	0.10		0.30	0.004		0.012
B	0.33		0.51	0.013		0.200
C	0.23		0.32	0.009		0.013
D (1)	12.60		13.00	0.496		0.512
E	7.40		7.60	0.291		0.299
e		1.27			0.050	
H	10.0		10.65	0.394		0.419
h	0.25		0.75	0.010		0.030
L	0.40		1.27	0.016		0.050
k	0° (min.), 8° (max.)					
ddd			0.10			0.004

(1) "D" dimension does not include mold flash, protusions or gate burrs. Mold flash, protusions or gate burrs shall not exceed 0.15mm per side.

OUTLINE AND MECHANICAL DATA



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