



**TS861  
TS862  
TS864**

## RAIL TO RAIL MICROPOWER BICMOS COMPARATORS

- ULTRA LOW CURRENT CONSUMPTION (**6 $\mu$ A/comp at V<sub>CC</sub>=2.7V**)
- RAIL TO RAIL CMOS INPUTS
- PUSH PULL OUTPUTS
- SUPPLY OPERATION FROM **2.7V TO 10V**
- LOW PROPAGATION DELAY
- LOW FALL AND RISE TIME: 20ns
- ESD PROTECTION (**2kV**)
- LATCH-UP IMMUNITY (**Class A**)
- AVAILABLE IN **SOT23-5 MICROPACKAGE**

### DESCRIPTION

The TS86x (Single, Dual & Quad) is a Rail to Rail comparator characterized for 2.7V to 10V operation over -40°C to +85°C temperature range. It exhibits an excellent speed to power ratio, featuring a current consumption of 6 $\mu$ A per comparator and a response time of 500ns at 2.7V for 100mV overdrive.

Due to its ultra low power consumption and its availability in tiny package, the TS86x comparator family is perfectly suited to battery powered systems. The output stage is designed with a push pull structure allowing a direct connection to microcontroller without additional pull-up resistor.

### APPLICATION

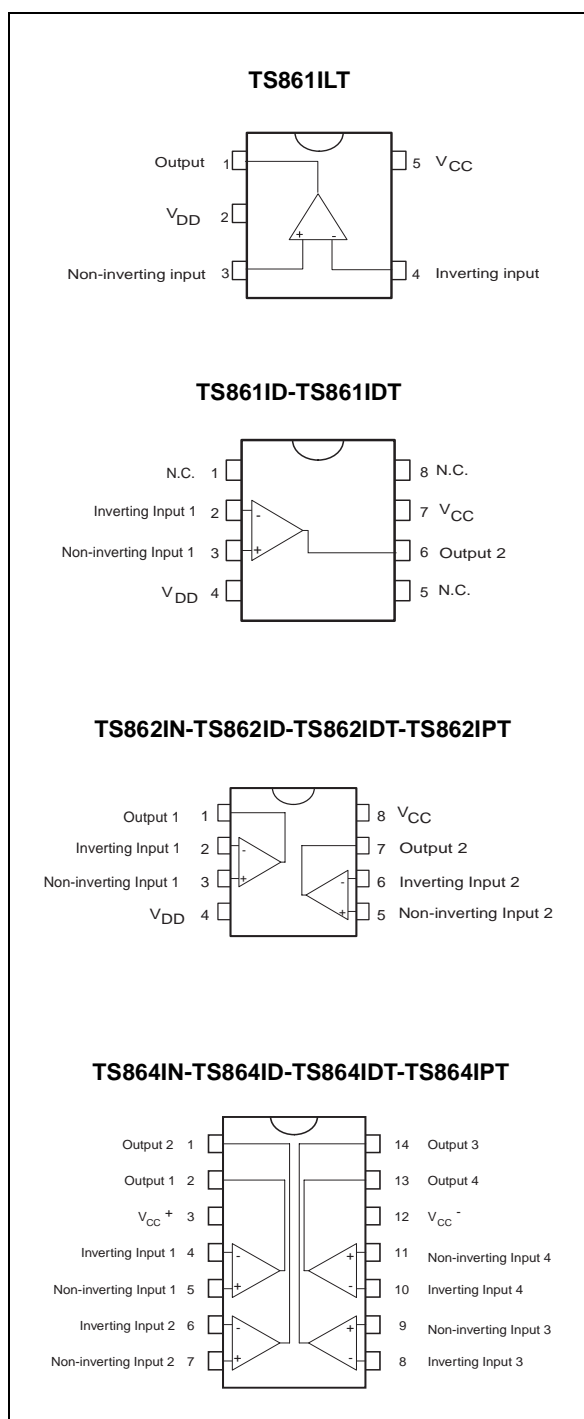
- Battery-powered systems (eg: Alarm)
- Portable communication systems
- Smoke/gas/fire detectors
- Portable computers

### ORDER CODE

Part Number	Temperature Range	Package				SOT23 Marking
		N	D	P	L	
TS861I TS861AI	-40, +85°C	•	•		•	K501 K502
TS862I TS862AI	-40, +85°C	•	•	•		
TS864I TS864AI	-40, +85°C	•	•	•		

**N** = Dual in Line Package (DIP)  
**D** = Small Outline Package (SO) - also available in Tape & Reel (DT)  
**P** = Thin Shrink Small Outline Package (TSSOP) - only available in Tape & Reel (PT)  
**L** = Tiny Package (SOT23-5) - only available in Tape & Reel (LT)

### PIN CONNECTIONS (top view)



**ABSOLUTE MAXIMUM RATINGS**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply voltage <sup>1)</sup>	12	V
$V_{id}$	Differential Input Voltage <sup>2)</sup>	$\pm 12$	V
$V_{in}$	Input Voltage Range <sup>3)</sup>	-0.3 to 12.3	V
$T_{std}$	Storage Temperature Range	-65 to +150	°C
$T_j$	Maximum Junction Temperature	150	°C
$P_D$	Power dissipation <sup>4)</sup>		mW
	SOT23-5	500	
	DIP8	1250	
	DIP14	1560	
	SO8	710	
	SO14	830	
	TSSOP8	625	
TSSOP14	710		
ESD	Human Body Model	2	kV
	Machine Model	200	V
	Latch-up Immunity	Class A	
	Lead Temperature (soldering, 10 sec)	250	°C

1. All voltages values, except differential voltage are with respect to network terminal.
2. Differential voltages are non-inverting input terminal with respect to the inverting input terminal.
3. The magnitude of input and output voltages must never exceed  $V_{CC} + 0.3V$ .
4. Short-circuits can cause excessive heating and destructive dissipation.  $P_D$  is calculated with  $T_{amb} = +25^\circ C$ ,  $T_j = +150^\circ C$  and  
 $R_{thja} = 250^\circ C/W$  for SOT23-5 package  
 $= 100^\circ C/W$  for DIP8 package  
 $= 80^\circ C/W$  for DIP14 package  
 $= 175^\circ C/W$  for SO8 package  
 $= 150^\circ C/W$  for SO14 package  
 $= 200^\circ C/W$  for TSSOP8 package  
 $= 175^\circ C/W$  for TSSOP14 package

**OPERATING CONDITIONS**

Symbol	Parameter	Value	Unit
$V_{CC}$	Supply Voltage	2.7 to 10	V
$V_{icm}$	Common Mode Input Voltage Range	$V_{CC}^- - 0.3$ to $V_{CC}^+ + 0.3$	V
$T_{oper}$	Operating Free Air Temperature Range	-40 to + 85	°C

**ELECTRICAL CHARACTERISTICS** $V_{CC} = +2.7V$  $T_{amb} = 25^{\circ}C$  (unless otherwise specified)

Symbol	Parameter	Min.	Typ.	Max.	Unit
$V_{io}$	Input Offset Voltage TS861/2/4 $T_{min} < T < T_{max}$		3	15 18	mV
	TS861/2/4A $T_{min} < T < T_{max}$		3	7 10	
$\Delta V_{io}$	Input Offset Voltage Drift		6		$\mu V/^{\circ}C$
$I_{io}$	Input Offset Current <sup>1)</sup> $T_{min} < T < T_{max}$		1	150 300	pA
$I_{ib}$	Input Bias Current <sup>1)</sup> $T_{min} < T < T_{max}$		1	300 600	pA
$V_{OH}$	High Level Output Voltage $I_{source} = 2.5mA$ $T_{min} < T < T_{max}$	2.35 2.15	2.45		V
$V_{OL}$	Low Level Output Voltage $I_{sink} = 2.5mA$ $T_{min} < T < T_{max}$		0.2	0.35 0.45	V
$A_{vd}$	Large Signal Voltage Gain <sup>2)</sup>		240		dB
CMR	Common Mode Rejection Ratio $0 < V_{ICM} < 2.7V$		65		dB
SVR	Supply Voltage Rejection Ratio $0 < V_{CC} < 10V$		80		dB
$I_{CC}$	Supply current per comparator no load, output low no load, output high		6 8	12 14	$\mu A$
$T_{plh}$	Propagation delay from output low to output high $V_{ICM} = 1.35V$ , $f = 10kHz$ , $C_L = 50pF$ overdrive = 10mV overdrive = 100mV		1.5 0.6		$\mu s$
$T_{phl}$	Propagation delay from output high to output low $V_{ICM} = 1.35V$ , $f = 10kHz$ , $C_L = 50pF$ overdrive = 10mV overdrive = 100mV		1.5 0.5		$\mu s$
$T_f$	Fall time $f = 10kHz$ , $C_L = 50pF$ , overdrive = 100mV		20		ns
$T_r$	Rise time $f = 10kHz$ , $C_L = 50pF$ , overdrive = 100mV		20		ns

1. Maximum values including unavoidable inaccuracies of the industrial test.

2. Design evaluation

3. Limits are 100% production tested at 25°C. Limits over temperature are guaranteed through correlation and by design.

**ELECTRICAL CHARACTERISTICS**
**V<sub>CC</sub> = +5V**
**T<sub>amb</sub> = 25°C (unless otherwise specified)**

Symbol	Parameter	Min.	Typ.	Max.	Unit
V <sub>io</sub>	Input Offset Voltage TS861/2/4 Tmin<T<Tmax		3	15 18	mV
	TS861/2/4A Tmin<T<Tmax		3	7 10	
ΔV <sub>io</sub>	Input Offset Voltage Drift		6		μV/°C
I <sub>io</sub>	Input Offset Current <sup>1)</sup> Tmin<T<Tmax		1	150 300	pA
I <sub>ib</sub>	Input Bias Current <sup>1)</sup> Tmin<T<Tmax		1	300 600	pA
V <sub>OH</sub>	High Level Output Voltage I <sub>source</sub> =5mA Tmin<T<Tmax	4.6 4.45	4.8		V
V <sub>OL</sub>	Low Level Output Voltage I <sub>sink</sub> =5mA Tmin<T<Tmax		0.2	0.4 0.55	V
A <sub>vd</sub>	Large Signal Voltage Gain <sup>2)</sup>		240		dB
CMR	Common Mode Rejection Ratio 0 < V <sub>ICM</sub> < 5V		70		dB
SVR	Supply Voltage Rejection Ratio 2.7 < V <sub>CC</sub> < 10V		80		dB
I <sub>CC</sub>	Supply current per comparator no load, output low no load, output high		6 8	12 14	μA
T <sub>plh</sub>	Propagation delay from output low to output high V <sub>ICM</sub> =2.5V, f=10kHz, C <sub>L</sub> =50pF overdrive = 10mV overdrive = 100mV		2 0.5		μs
T <sub>phl</sub>	Propagation delay from output high to output low V <sub>ICM</sub> =2.5V, f=10kHz, C <sub>L</sub> =50pF overdrive = 10mV overdrive = 100mV		2 0.4		μs
T <sub>f</sub>	Fall time f=10kHz, C <sub>L</sub> =50pF, overdrive=100mV		20		ns
T <sub>r</sub>	Rise time f=10kHz, C <sub>L</sub> =50pF, overdrive=100mV		20		ns

1. Maximum values including unavoidable inaccuracies of the industrial test..

2. Design evaluation

3. Limits are 100% production tested at 25°C. Limits over temperature are guaranteed through correlation and by design

**ELECTRICAL CHARACTERISTICS****V<sub>CC</sub> = +10V**T<sub>amb</sub> = 25°C (unless otherwise specified)

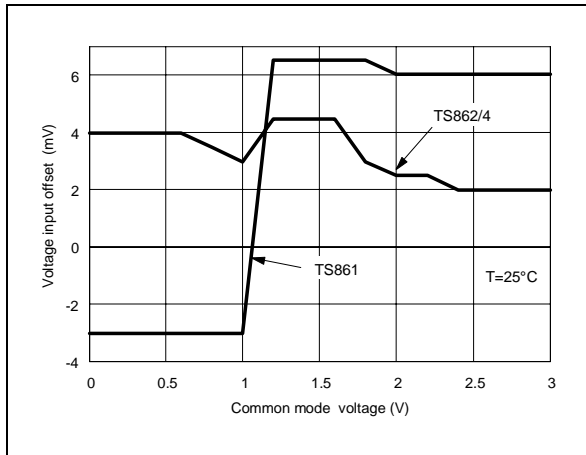
Symbol	Parameter	Min.	Typ.	Max.	Unit
V <sub>io</sub>	Input Offset Voltage (V <sub>ICM</sub> = V <sub>CC</sub> / 2 ) TS861/2/4 Tmin<T<Tmax		3	15 18	mV
ΔV <sub>io</sub>	Input Offset Voltage Drift		6		μV/°C
I <sub>io</sub>	Input Offset Current <sup>1)</sup> Tmin<T<Tmax		1	150 300	pA
I <sub>ib</sub>	Input Bias Current <sup>1)</sup> Tmin<T<Tmax		1	300 600	pA
V <sub>OH</sub>	High Level Output Voltage I <sub>source</sub> =5mA Tmin<T<Tmax	9.6 9.45	9.8		V
V <sub>OL</sub>	Low Level Output Voltage I <sub>sink</sub> =5mA Tmin<T<Tmax		0.2	0.4 0.55	V
A <sub>vd</sub>	Large Signal Voltage Gain <sup>2)</sup>		240		dB
CMR	Common Mode Rejection Ratio 0 < V <sub>ICM</sub> < 10V		75		dB
SVR	Supply Voltage Rejection Ratio 2.7 < V <sub>CC</sub> < 10V		80		dB
I <sub>CC</sub>	Supply current per comparator no load, output low no load, output high		7 10	14 16	μA
T <sub>plh</sub>	Propagation delay from output low to output high V <sub>ICM</sub> =5V, f=10kHz, C <sub>L</sub> =50pF overdrive = 10mV overdrive = 100mV		3 0.5		μs
T <sub>phl</sub>	Propagation delay from output high to output low V <sub>ICM</sub> =5V, f=10kHz, C <sub>L</sub> =50pF overdrive = 10mV overdrive = 100mV		2.6 0.4		μs
T <sub>f</sub>	Fall time f=10kHz, C <sub>L</sub> =50pF, overdrive=100mV		20		ns
T <sub>r</sub>	Rise time f=10kHz, C <sub>L</sub> =50pF, overdrive=100mV		20		ns

1. Maximum values including unavoidable inaccuracies of the industrial test.

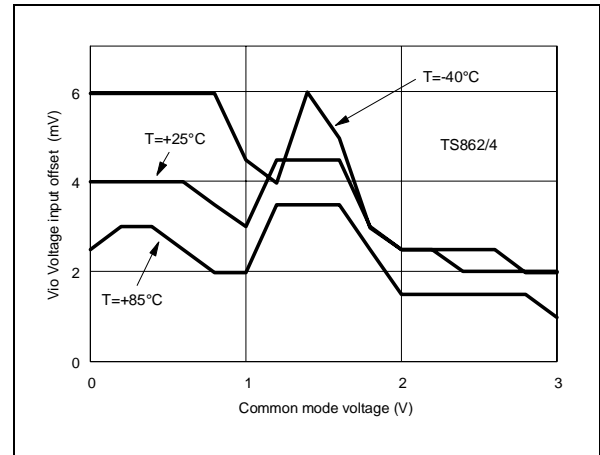
2. Design evaluation

3. Limits are 100% production tested at 25°C. Limits over temperature are guaranteed through correlation and by design.

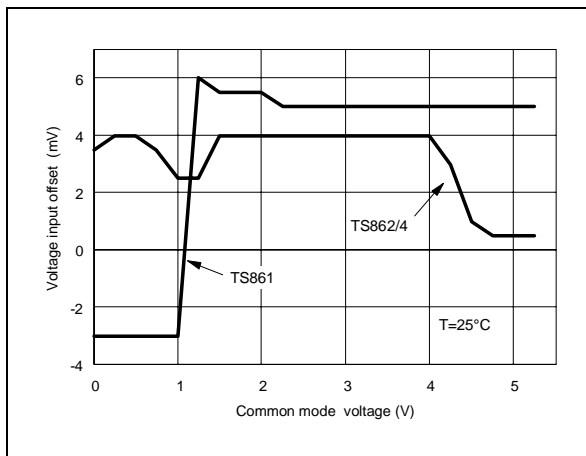
$V_{IO}$  versus  $V_{ICM}$  at  $V_{CC}= 2.7V$



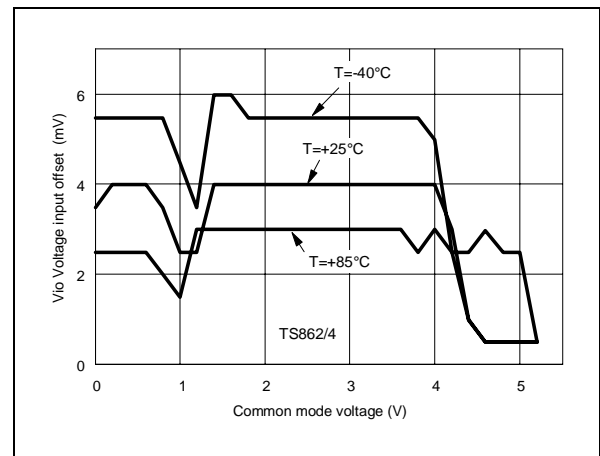
$V_{IO}$  versus  $V_{ICM}$  and temperature at  $V_{CC}= 2.7V$



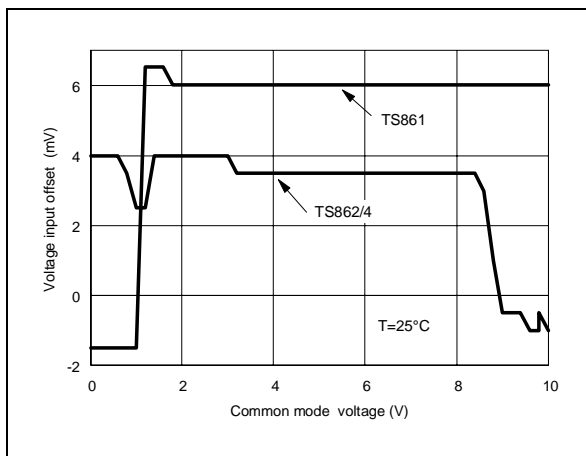
$V_{IO}$  versus  $V_{ICM}$  at  $V_{CC}= 5V$



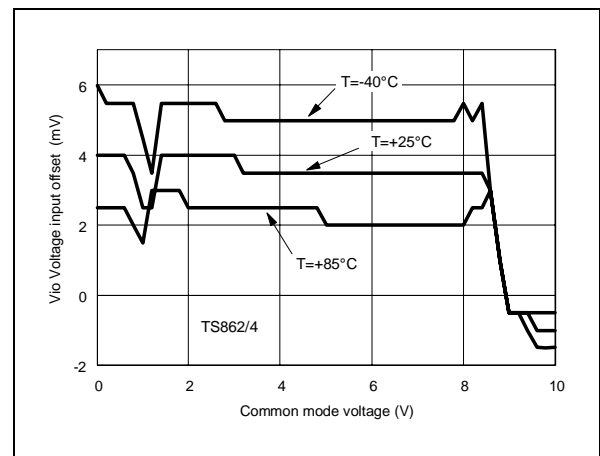
$V_{IO}$  versus  $V_{ICM}$  and temperature at  $V_{CC}= 5V$



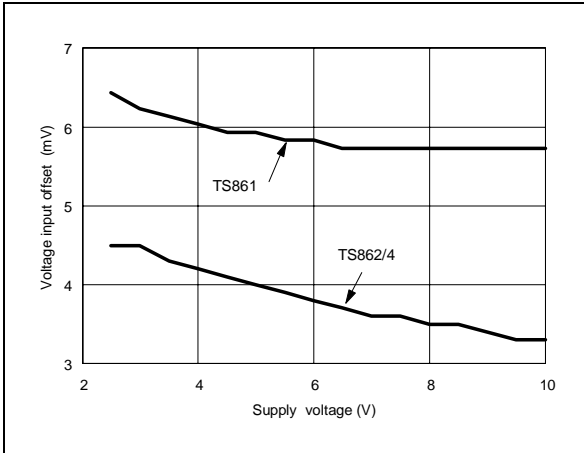
$V_{IO}$  versus  $V_{ICM}$  at  $V_{CC}= 10V$



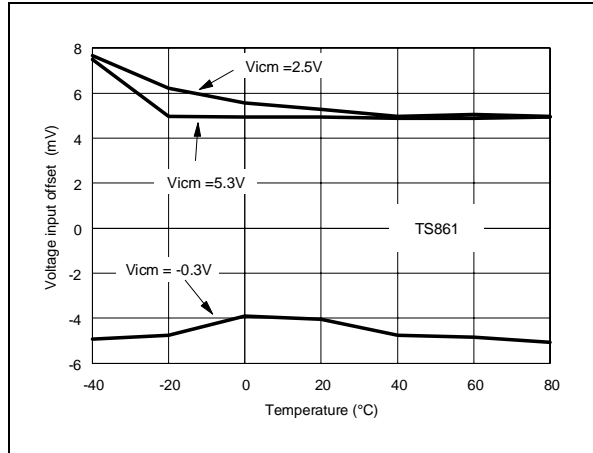
$V_{IO}$  versus  $V_{ICM}$  and temperature at  $V_{CC}= 10V$



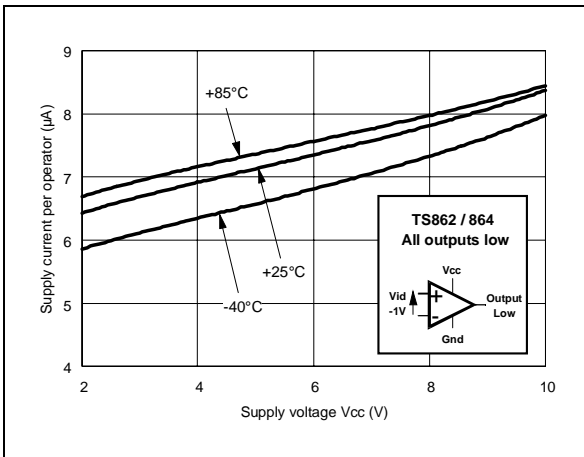
$V_{IO}$  versus  $V_{CC}$  at  $V_{ICM} = V_{CC} / 2$



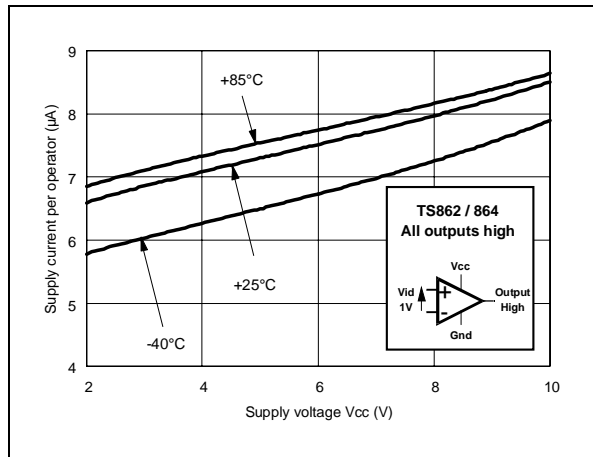
$V_{IO}$  versus temperature at  $V_{CC} = 5V$



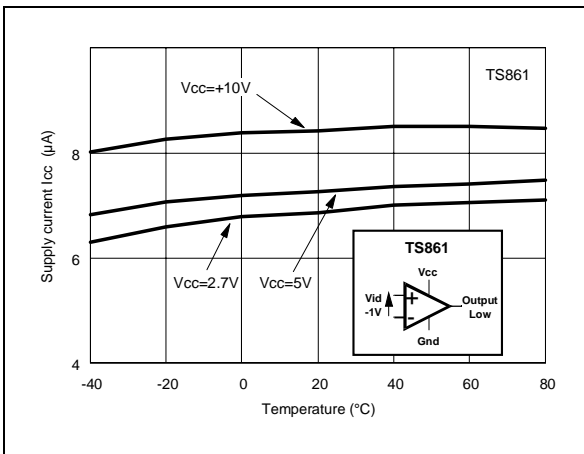
Supply Current ( $I_{CC}$ ) vs Supply Voltage ( $V_{CC}$ )



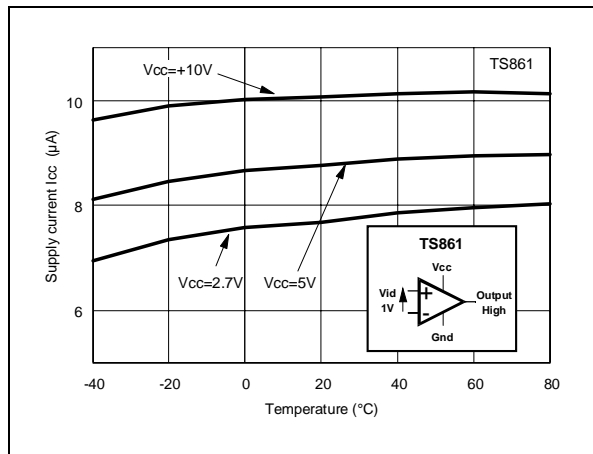
Supply Current ( $I_{CC}$ ) vs Supply Voltage ( $V_{CC}$ )



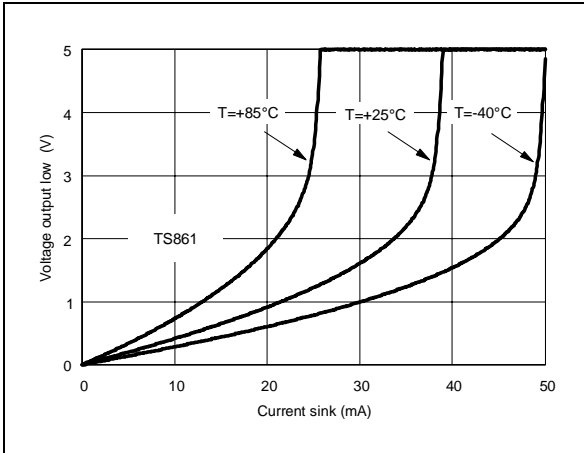
Supply Current ( $I_{CC}$ ) vs Temperature



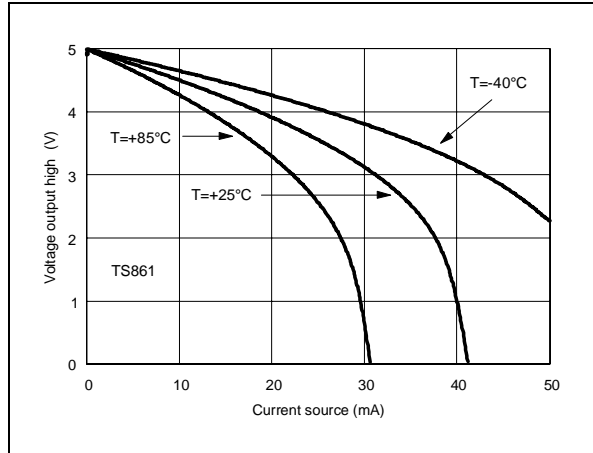
Supply Current ( $I_{CC}$ ) vs Temperature



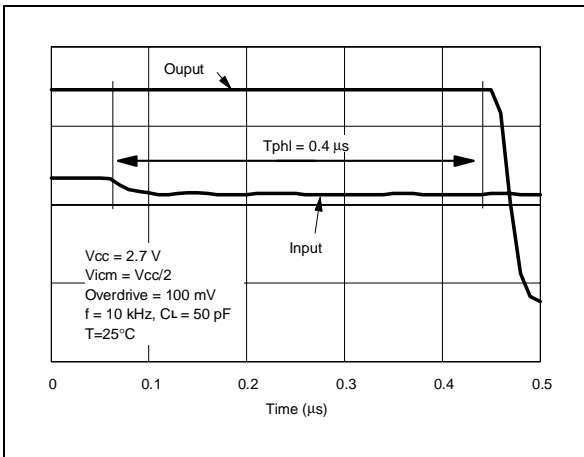
$V_{OL}$  versus  $I_{SINK}$  and temperature at  $V_{CC}=5V$



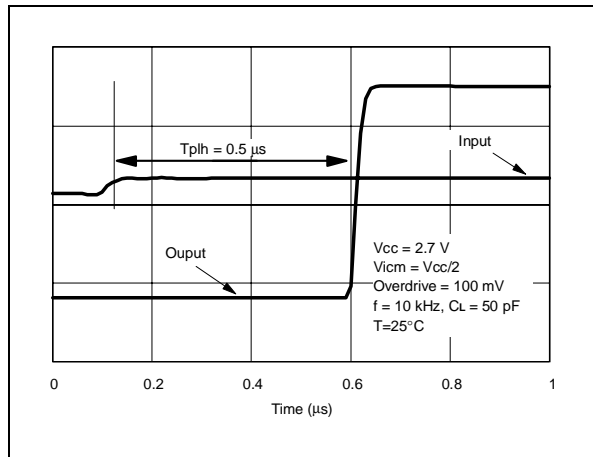
$V_{OH}$  vs  $I_{SOURCE}$  and temperature at  $V_{CC}=5V$



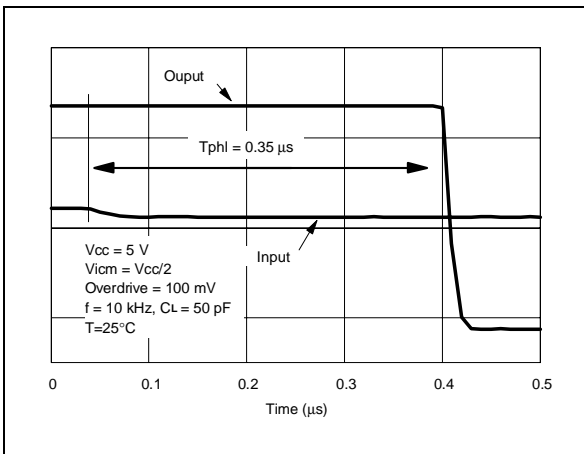
Response time  $T_{PHL}$  at  $V_{CC}= 2.7V$



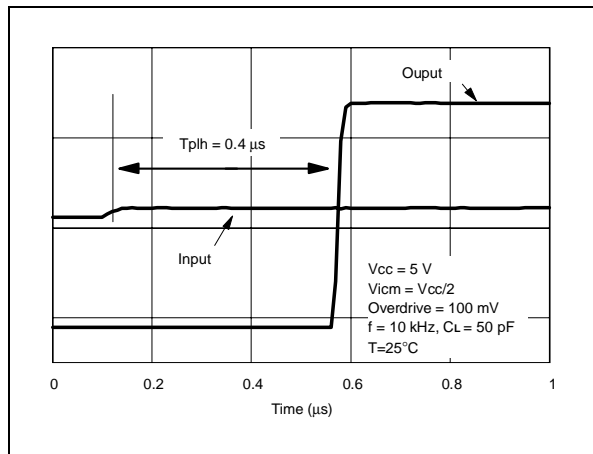
Response time  $T_{PLH}$  at  $V_{CC}= 2.7V$



Response time  $T_{PHL}$  at  $V_{CC}= 5V$

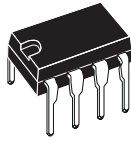


Response time  $T_{PLH}$  at  $V_{CC}= 5V$

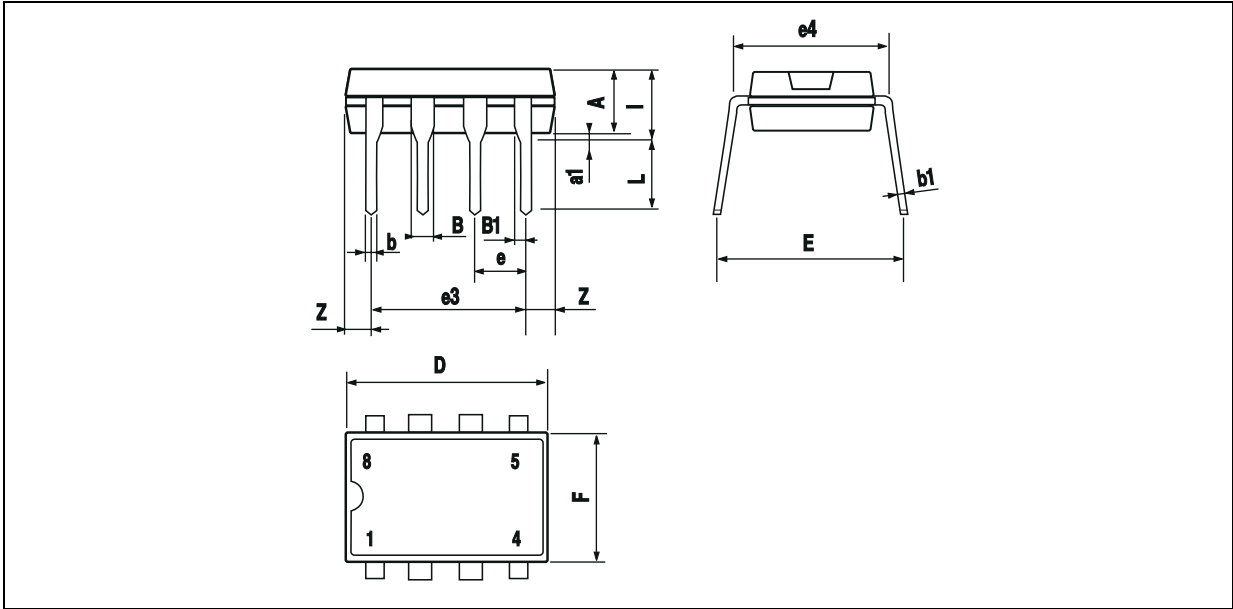




TS861IN - TS862IN

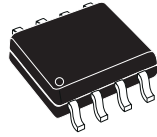


**PACKAGE MECHANICAL DATA**  
8 PINS - PLASTIC PACKAGE

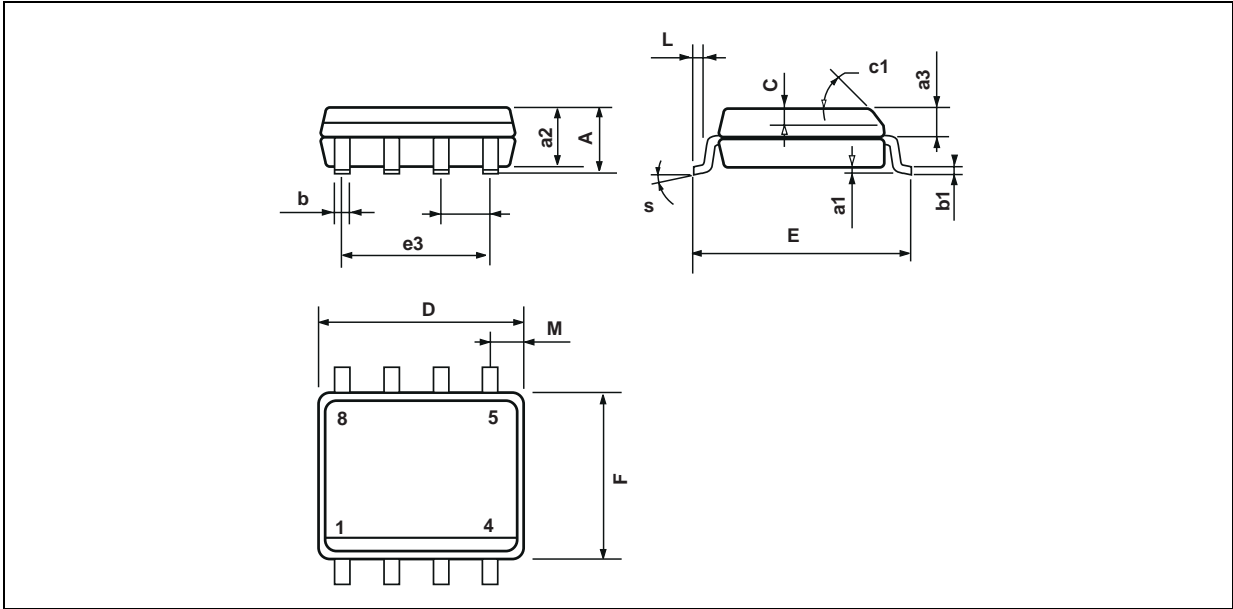


Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A		3.32			0.131	
a1	0.51			0.020		
B	1.15		1.65	0.045		0.065
b	0.356		0.55	0.014		0.022
b1	0.204		0.304	0.008		0.012
D			10.92			0.430
E	7.95		9.75	0.313		0.384
e		2.54			0.100	
e3		7.62			0.300	
e4		7.62			0.300	
F			6.6			0.260
i			5.08			0.200
L	3.18		3.81	0.125		0.150
Z			1.52			0.060

TS861ID - TS862ID

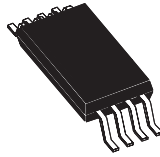


**PACKAGE MECHANICAL DATA**  
8 PINS - PLASTIC MICROPACKAGE (SO)

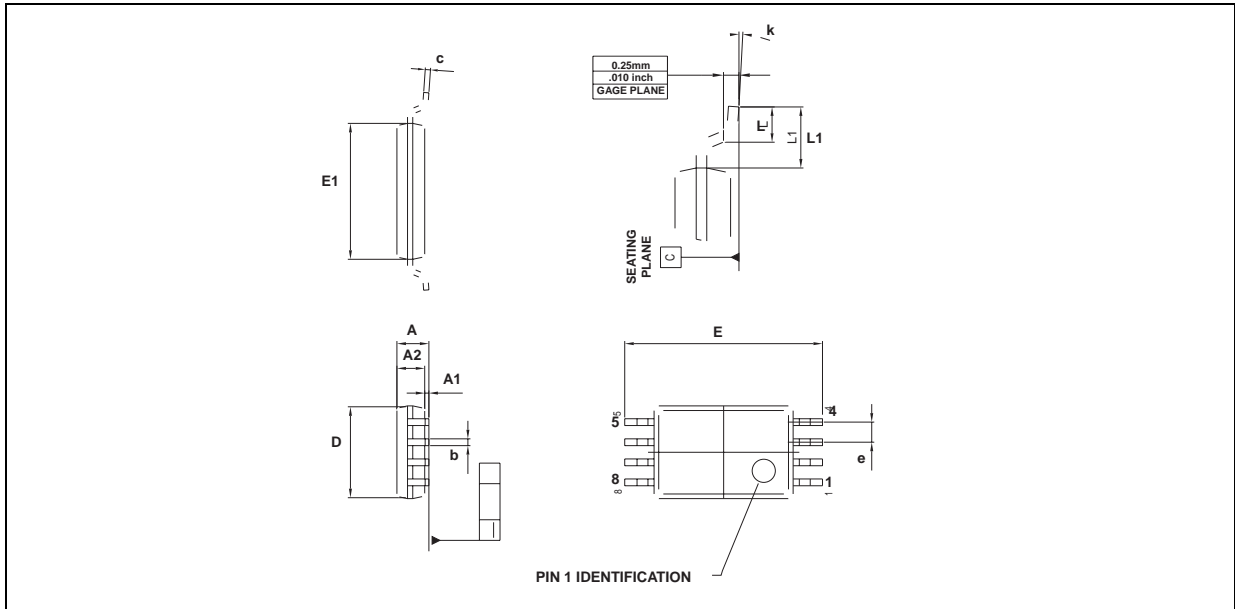


Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.25	0.004		0.010
a2			1.65			0.065
a3	0.65		0.85	0.026		0.033
b	0.35		0.48	0.014		0.019
b1	0.19		0.25	0.007		0.010
C	0.25		0.5	0.010		0.020
c1	45° (typ.)					
D	4.8		5.0	0.189		0.197
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		3.81			0.150	
F	3.8		4.0	0.150		0.157
L	0.4		1.27	0.016		0.050
M			0.6			0.024
S	8° (max.)					

TS862IPT

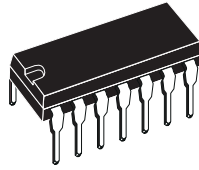


**PACKAGE MECHANICAL DATA**  
8 PINS - THIN SHRINK SMALL OUTLINE PACKAGE



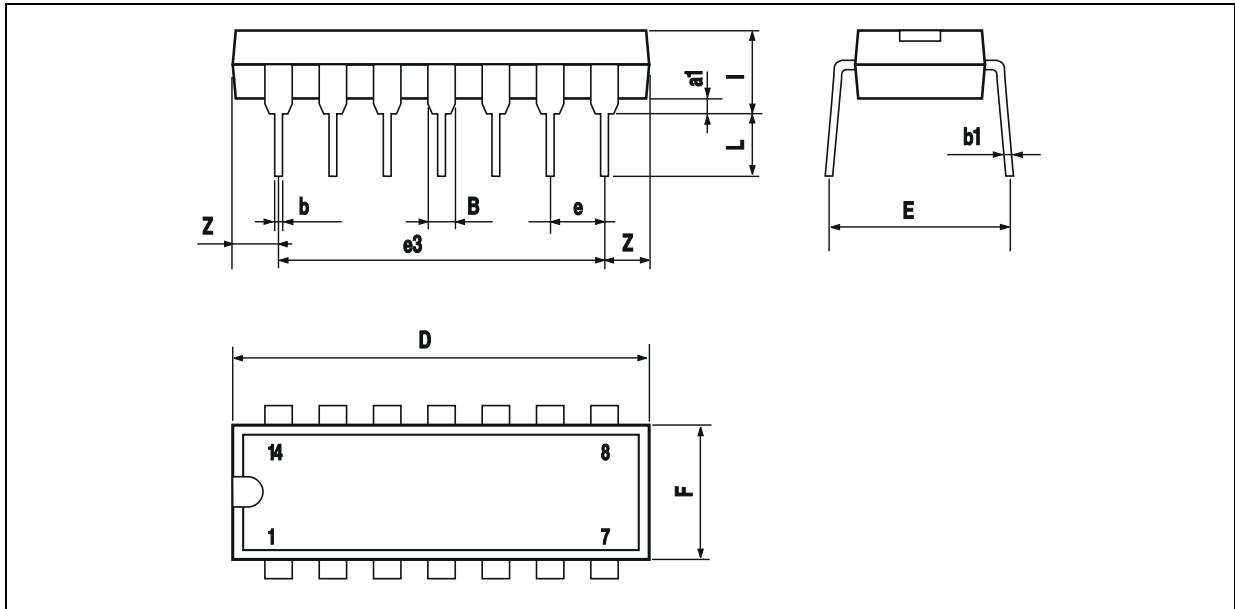
Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.05
A1	0.05		0.15	0.01		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.15
c	0.09		0.20	0.003		0.012
D	2.90	3.00	3.10	0.114	0.118	0.122
E		6.40			0.252	
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.025	
k	0°		8°	0°		8°
l	0.50	0.60	0.75	0.09	0.0236	0.030
L	0.45	0.600	0.75	0.018	0.024	0.030
L1		1.000			0.039	

TS864IN



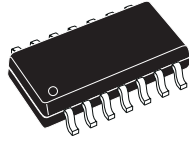
**PACKAGE MECHANICAL DATA**

14 PINS - PLASTIC PACKAGE

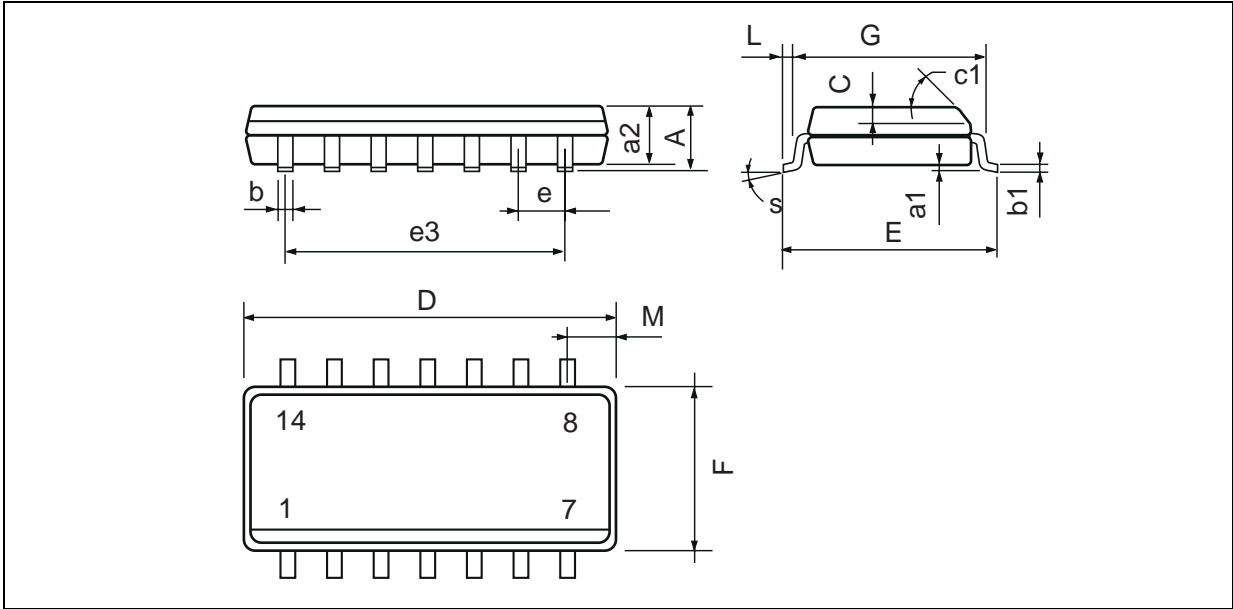


Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
a1	0.51			0.020		
B	1.39		1.65	0.055		0.065
b		0.5			0.020	
b1		0.25			0.010	
D			20			0.787
E		8.5			0.335	
e		2.54			0.100	
e3		15.24			0.600	
F			7.1			0.280
i			5.1			0.201
L		3.3			0.130	
Z	1.27		2.54	0.050		0.100

TS864ID



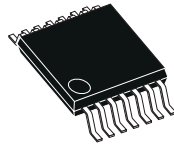
**PACKAGE MECHANICAL DATA**  
14 PINS - PLASTIC MICROPACKAGE (SO)



Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.75			0.069
a1	0.1		0.2	0.004		0.008
a2			1.6			0.063
b	0.35		0.46	0.014		0.018
b1	0.19		0.25	0.007		0.010
C		0.5			0.020	
c1	45° (typ.)					
D (1)	8.55		8.75	0.336		0.344
E	5.8		6.2	0.228		0.244
e		1.27			0.050	
e3		7.62			0.300	
F (1)	3.8		4.0	0.150		0.157
G	4.6		5.3	0.181		0.208
L	0.5		1.27	0.020		0.050
M			0.68			0.027
S	8° (max.)					

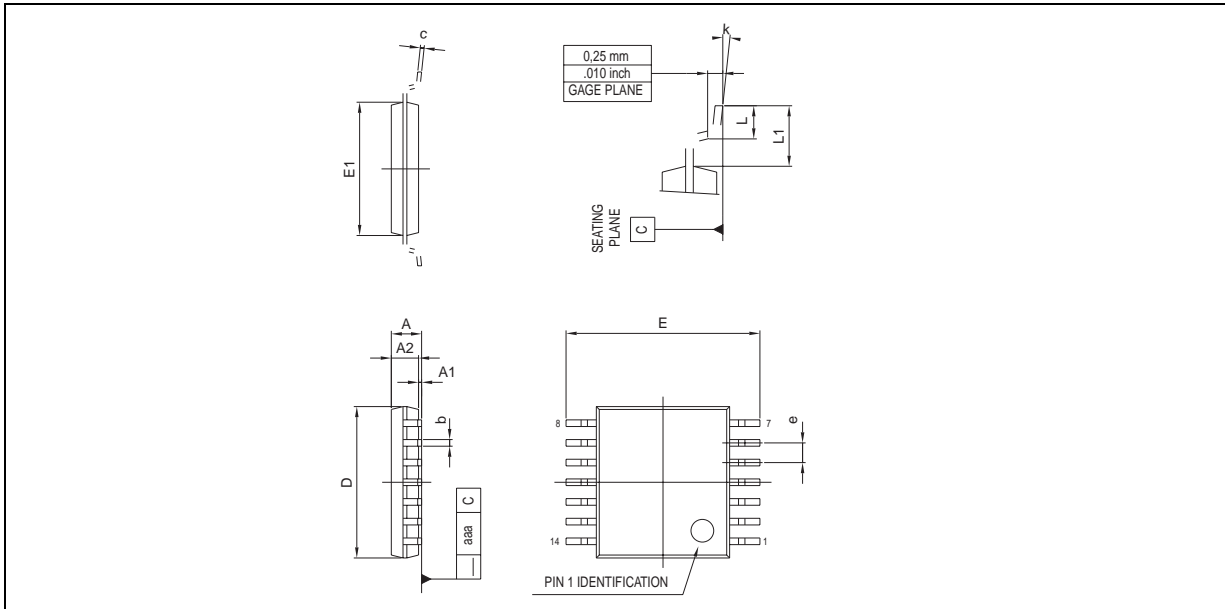
Note : (1) D and F do not include mold flash or protrusions - Mold flash or protrusions shall not exceed 0.15mm (.066 inc) ONLY FOR DATA BOOK.

TS864IPT



**PACKAGE MECHANICAL DATA**

14 PINS - THIN SHRINK SMALL OUTLINE PACKAGE

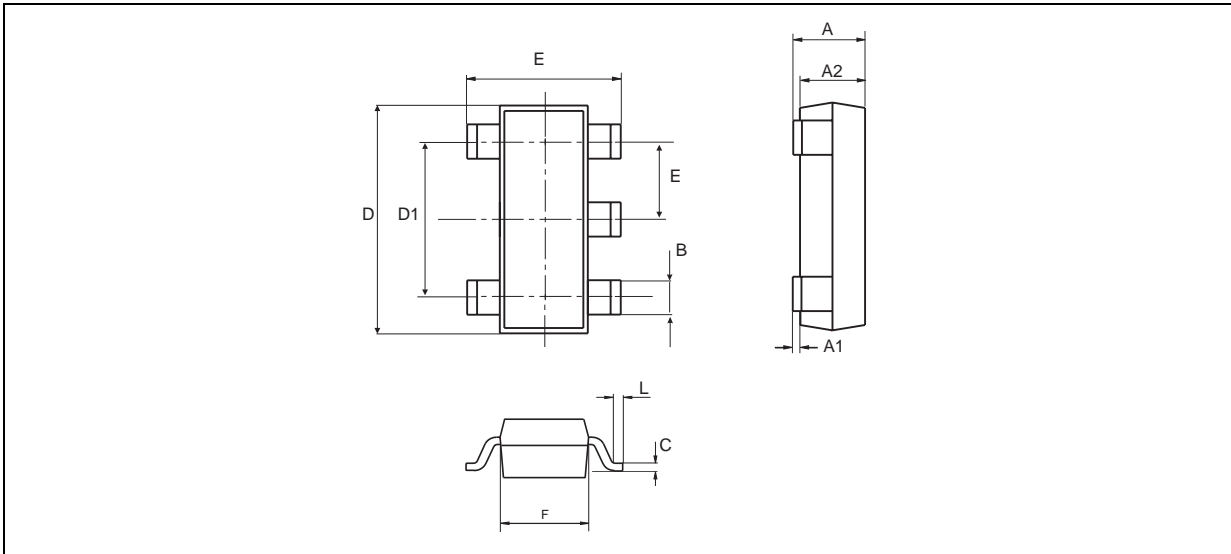


Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A			1.20			0.05
A1	0.05		0.15	0.01		0.006
A2	0.80	1.00	1.05	0.031	0.039	0.041
b	0.19		0.30	0.007		0.15
c	0.09		0.20	0.003		0.012
D	4.90	5.00	5.10	0.192	0.196	0.20
E		6.40			0.252	
E1	4.30	4.40	4.50	0.169	0.173	0.177
e		0.65			0.025	
k	0°		8°	0°		8°
L	0.450	0.600	0.750	0.018	0.024	0.030
L1		1.00			0.039	
aaa			0.100			0.004

TS861ILT



**PACKAGE MECHANICAL DATA**  
5 PINS - TINY PACKAGE (SOT23)



Dimensions	Millimeters			Inches		
	Min.	Typ.	Max.	Min.	Typ.	Max.
A	0.90	1.20	1.45	0.035	0.047	0.057
A1	0		0.15			0.006
A2	0.90	1.05	1.30	0.035	0.041	0.051
B	0.35	0.40	0.50	0.014	0.016	0.020
C	0.09	0.15	0.20	0.004	0.006	0.008
D	2.80	2.90	3.00	0.110	0.114	0.118
D1		1.90			0.075	
e		0.95			0.037	
E	2.60	2.80	3.00	0.102	0.110	0.118
F	1.50	1.60	1.75	0.059	0.063	0.069
L	0.3	0.5	0.60	0.012	0.014	0.024
K	0d		10d	0d		10d

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