

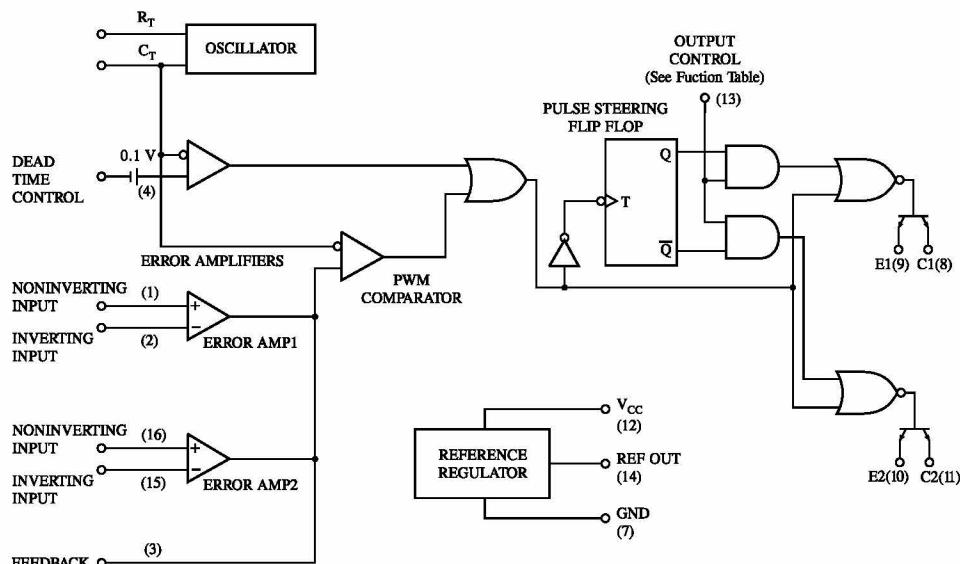
PWM Control Circuit

The TK494 incorporates on a single monolithic chip all the functions required in the construction of a pulse-width-modulation control circuit. Designed primarily for power supply control, the TK494 contains an on-chip 5-volt regulator, two error amplifiers, adjustable oscillator, dead-time control comparator, pulse-steering flip-flop, and output-control circuitry. The uncommitted output transistors provide either common-emitter or emitter-follower output capability. Push-pull or single-ended output operation may be selected through the output-control function. The architecture of the TK494 prohibits the possibility of either output being pulsed twice during push-pull operation.

FEATURE

- Complete PWM Power Control Circuitry
- Uncommitted Outputs for 200 mA Sink or Source
- Output Control Selects Single-Ended or Push-Pull Operation
- Internal Circuitry Prohibits Double Pulse at Either Output
- Internal Regulator Provides a Stable 5 V Reference Supply
- Variable Dead-Time Provides Control Over Total Range

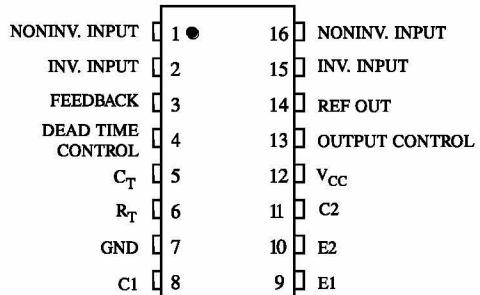
LOGIC DIAGRAM



ORDERING INFORMATION

Part Number	Package	Packing	Temperature(TA)	Package Qty
TK494CB	SOIC-16	Reel	0°C ~ 70°C	2500
TK494IB	SOIC-16	Reel	-40°C ~ 85°C	2500
TK494CG	TSSOP-16	Reel	0°C ~ 70°C	2500
TK494IG	TSSOP-16	Reel	-40°C ~ 85°C	2500

PIN ASSIGNMENT



Pin Functions

PIN		TYPE	DESCRIPTION
NAME	NO.		
NONINV IN+	1	I	Noninverting input to error amplifier 1
INV IN-	2	I	Inverting input to error amplifier 1
NONINV IN+	16	I	Noninverting input to error amplifier 2
INV IN-	15	I	Inverting input to error amplifier 2
C1	8	O	Collector terminal of BJT output 1
C2	11	O	Collector terminal of BJT output 2
C _T	5	—	Capacitor terminal used to set oscillator frequency
DEAD CON	4	I	Dead-time control comparator input
E1	9	O	Emitter terminal of BJT output 1
E2	10	O	Emitter terminal of BJT output 2
FEEDBACK	3	I	Input pin for feedback
GND	7	—	Ground
OUTPUT CON	13	I	Selects single-ended/parallel output or push-pull operation
REF OUT	14	O	5-V reference regulator output
R _T	6	—	Resistor terminal used to set oscillator frequency
V _{CC}	12	—	Positive Supply

MAXIMUM RATINGS

Symbol	Parameter	Value	Unit
V _{CC}	Supply Voltage	41	V
V _I	Amplifier Input Voltage	V _{CC} +0.3	V
V _O	Collector Output Voltage	41	V
	Collector Output Current	250	mA
T _{stg}	Storage Temperature	-65 to +150	°C

* 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.

RECOMMENDED OPERATING CONDITIONS

Symbol	Parameter	Min	Max	Unit
V _{CC}	Supply Voltage	7	40	V
V _I	Amplifier Input Voltage	-0.3	V _{CC} - 2	V
V _O	Collector Output Voltage		40	V
	Collector Output Current (Each Transistor)		200	mA
	Current Into Feed back Terminal		0.3	mA
C _T	Timing Capacitor	0.47	10.000	nF
R _T	Timing Resistor	1.8	500	KΩ
	Oscillator Frequency	1	300	KHz
T _A	Operating Free-Air Temperature, Industrial grade	-40	+85	°C
T _A	Operating Free-Air Temperature, Commercial grade	-0	+70	°C

ELECTRICAL CHARACTERISTICS (Temperature -20 ~ 85°C, V_{CC} = 15 V, f=10 kHz))

Symbol	Parameter	Test Conditions	Min	Max	Unit
Reference Section					
V _{ref}	Output Voltage	I _O =1 mA	4.90	5.10	V
V _{regin}	Output regulation	V _{CC} =7 V to 40 V, T _A =25°C		25	mV
V _{regout}	Input regulation	I _O =1 to 10 mA, T _A =25°C		15	mV
ΔV _{ref}	Output Voltage change with temperature	T _A = -20°C to 85°C		1	%
I _{SC}	Short-circuit output current (Note 1)	V _{ref} =0		50	mA
Oscillator Section					
f _{OSC}	Frequency	C _T =0.01 μF, R _T =12 kΩ	6	14	KHz
δf _{OSC}	Standard deviation of frequency (Note 2)	All values of V _{CC} , C _T , R _T , T _A Constant		15	%
δf _{OSC(ΔV)}	Frequency change with voltage	V _{CC} = 7 V to 40 V, T _A =25°C		10	%
δf _{OSC(ΔT)}	Frequency change with temperature	C _T =0.01 μF, R _T =12 kΩ T _A = -20°C to 85°C		2	%
Dead Time Control Section					
I _{IB(2T)}	Input bias current (pin 4)	V _I = 0 to 5.25 V		-10	μA
DC _{max}	Maximum duty cycle, each output	V _{I(pin 4)} =0 V	45		%
V _{THD}	Input threshold voltage (pin 4)	Zero duty cycle		3.3	V
		Maximum duty cycle	0		
Error Amp Section					
V _{IO}	Input offset voltage	V _{O(pin 3)} =2.5 V		10	mV
I _{IO}	Input offset current	V _{O(pin 3)} =2.5 V		250	nA
I _{IB}	Input bias current	V _{O(pin 3)} =2.5 V		1	μA
	Common-mode input voltage range	V _{CC} = 7 V to 40 V	LOW	-0.3	V
			HIGH	V _{CC} - 2	
A _{vol}	Open-loop voltage amplification	ΔV _O =3 V, V _O =0.5 to 3.5 V	70		dB
f _b	Unity-gain bandwidth		100		kHz
CMRR	Common-mode rejection ratio	V _{CC} =40 V, T _A =25°C	65		dB
I _O	Output sink current (pin 3)	V _{ID} =-15 mV to -5 V, V _{O(pin 3)} =0.7 V	0.3		mA
I _{O+}	Output source current (pin 3)	V _{ID} =15 mV to 5 V, V _{O(pin 3)} =3.5 V	-2		mA

ELECTRICAL CHARACTERISTICS (Temperature -20 ~ 85°C, V_{CC} = 15 V, f=10 kHz))

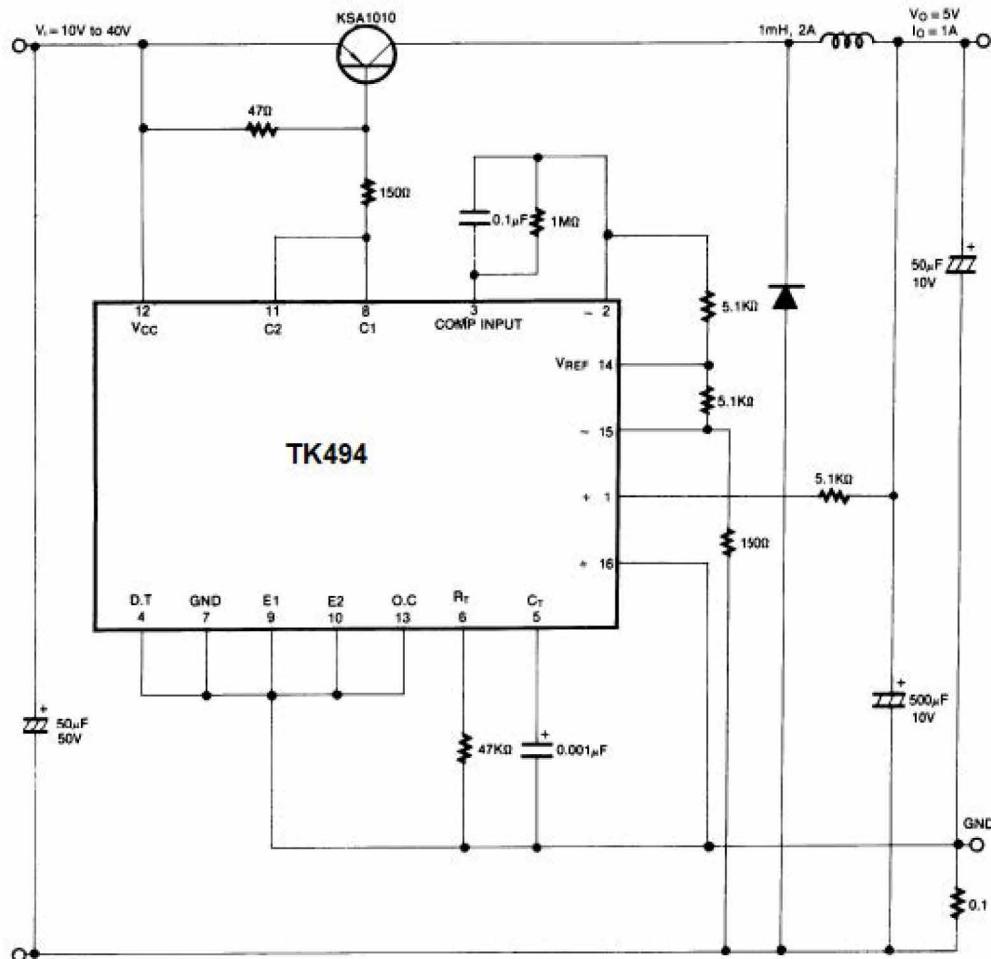
Symbol	Parameter	Test Conditions	Min	Max	Unit
PWM Comparator Section					
V _{THP}	Input threshold voltage (pin 3)	Zero duty cycle		4.5	V
I _I	Input sink current (pin 3)	V _{O(pin 3)} =0.7 V	0.3		mA
Switching Characteristics					
t _{rc}	Output voltage rise time	Common-emitter configuration		200	ns
t _{fc}	Output voltage fall time	Common-emitter configuration		100	ns
t _{rf}	Output voltage rise time	Emitter-follower configuration		200	ns
t _{ff}	Output voltage fall time	Emitter-follower configuration		100	ns
Output Section					
I _{C(off)}	Collector off-state current	V _{CE} =40 V, V _{CC} =40 V		100	μA
I _{E(off)}	Emitter off-state current	V _{CC} =V _C =40 V, V _E =0		-100	μA
V _{SAT}	Collector-emitter saturation voltage	Common-emitter	V _E =0, I _C =200 mA	1.3	V
		Emitter-follower	V _C =15 V, I _E =-200 mA	2.5	
I _{OCH}	Output control input current	V _I =V _{ref}		3.5	mA
Total Device					
I _{CC}	Standby supply current	All other inputs & outputs open	V _{CC} =15 V	10	mA
			V _{CC} =40 V	15	
I _{CCA}	Average supply current	V _(pin 4) =2 V		17	mA

Notes: 1. Duration of the short circuit should not exceed one second.

2. Standard deviation is a measure of the statistical distribution about the mean as derived from the formula

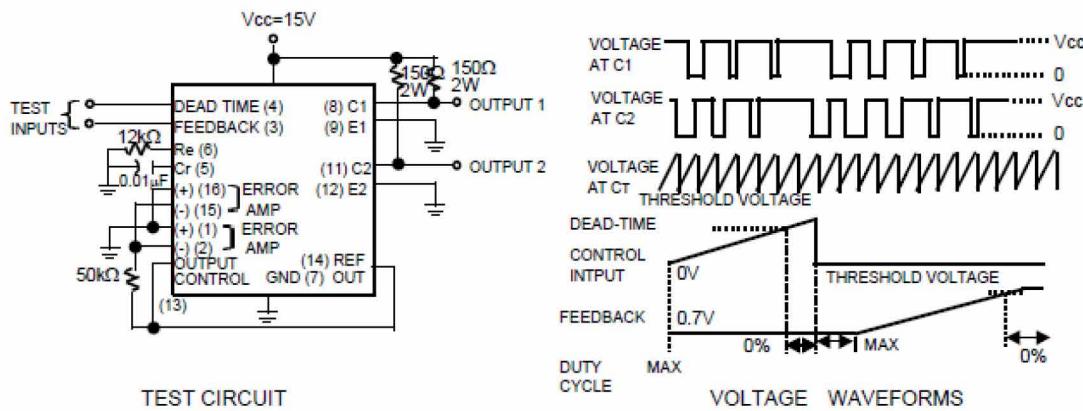
$$\sigma = \sqrt{\frac{\sum_{n=1}^N (x_n - \bar{x})^2}{N - 1}}$$

Typical Application
Pulse Width Modulated Step-down Converter

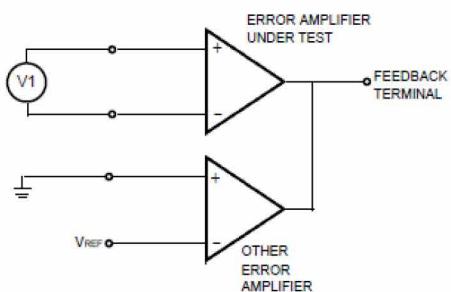


Parameter Measurement Information

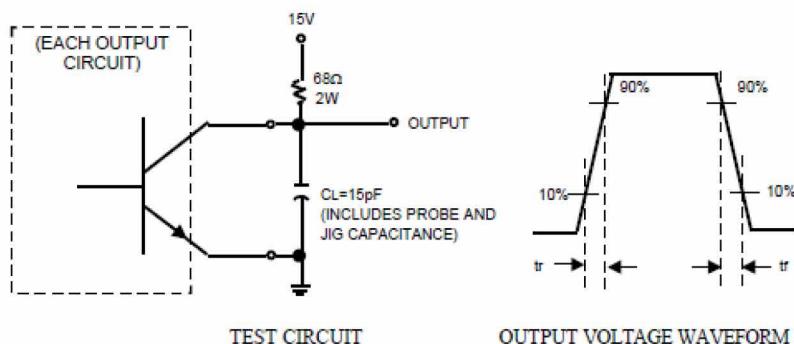
1. Dead time and Feedback Control



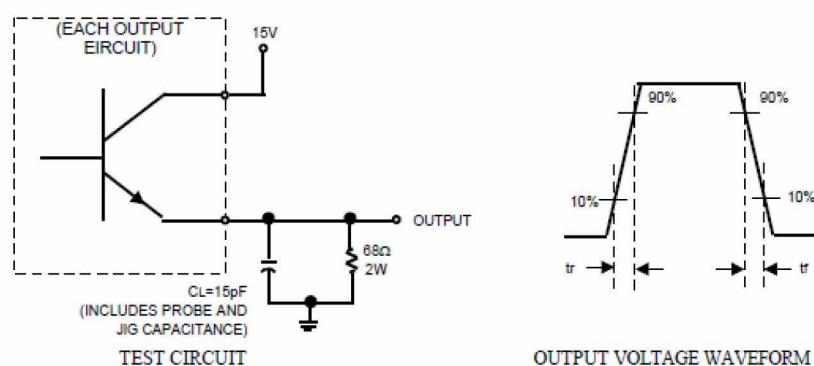
2. Error Amplifier Characteristics



3. Common-Emitter Configuration

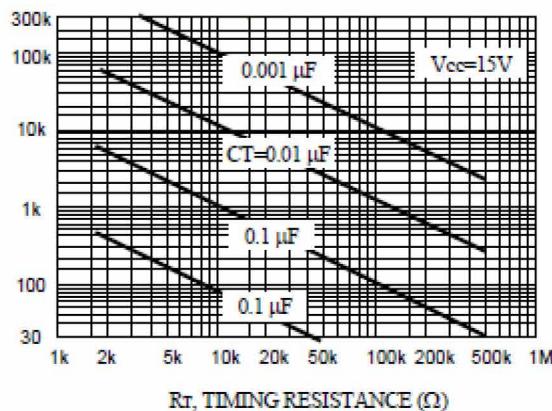


4. Emitter-Follower Configuration

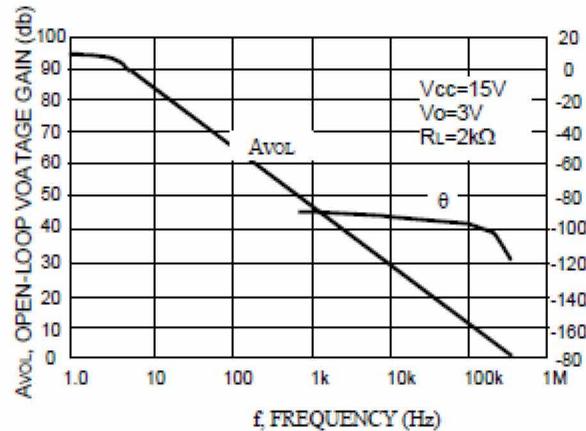


Typical Performance Curves

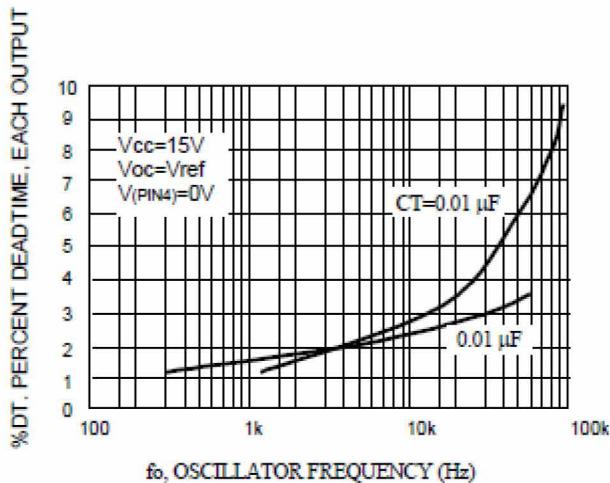
**FIGURE 1 – OSCILLATOR FREQUENCY vs.
TIMING RESISTANCE**



**FIGURE 2 – OPEN LOOP VOLTAGE GAIN AND
PHASE vs. FREQUENCY**



**FIGURE 3 – PERCENT DEAD TIME
vs. OSCILLATOR FREQUENCY**



**FIGURE 4 – PERCENT DUTY CYCLE vs.
DEAD-TIME CONTROL VOLTAGE**

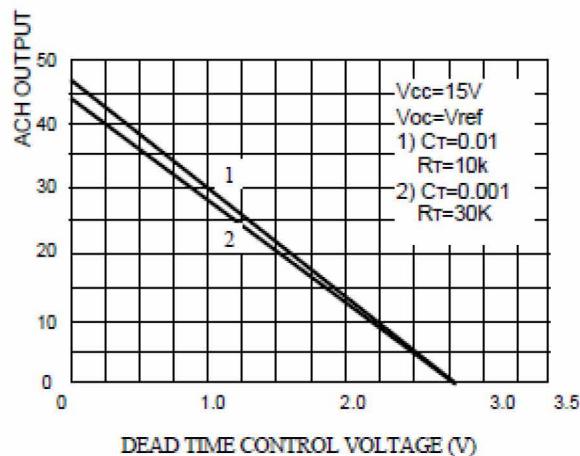


FIGURE 5 – Emitter-Follower Configuration Output-Saturation Voltage vs. Emitter Current

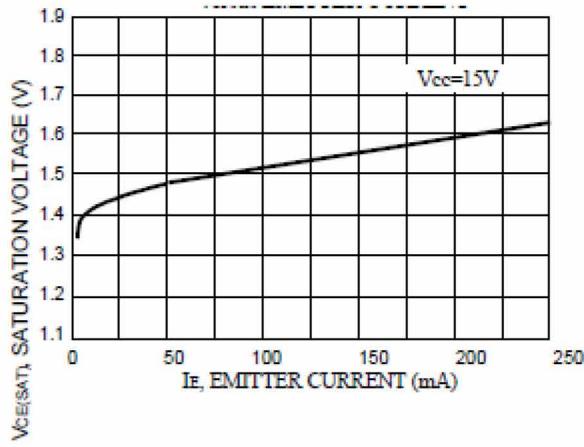


FIGURE 6 – COMMON-EMITTER Configuration Output-Saturation Voltage vs. Collector Current

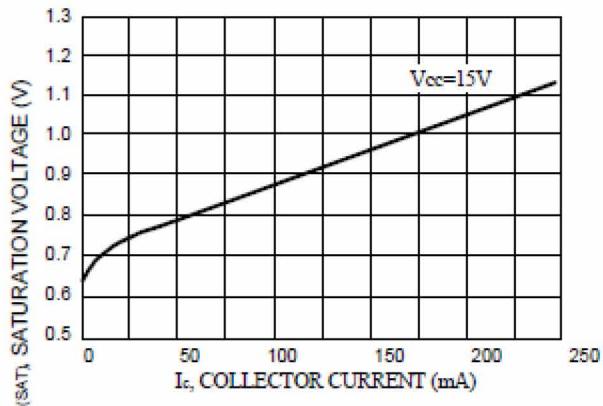
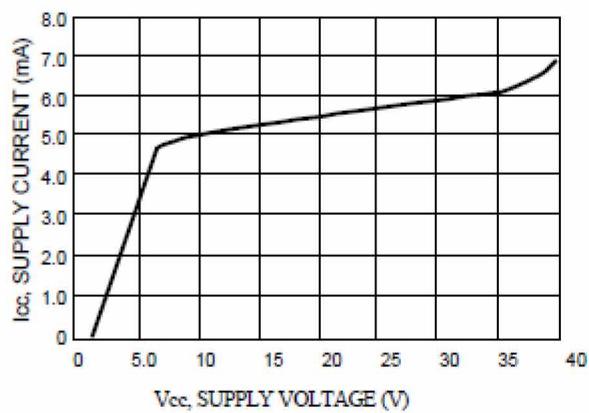
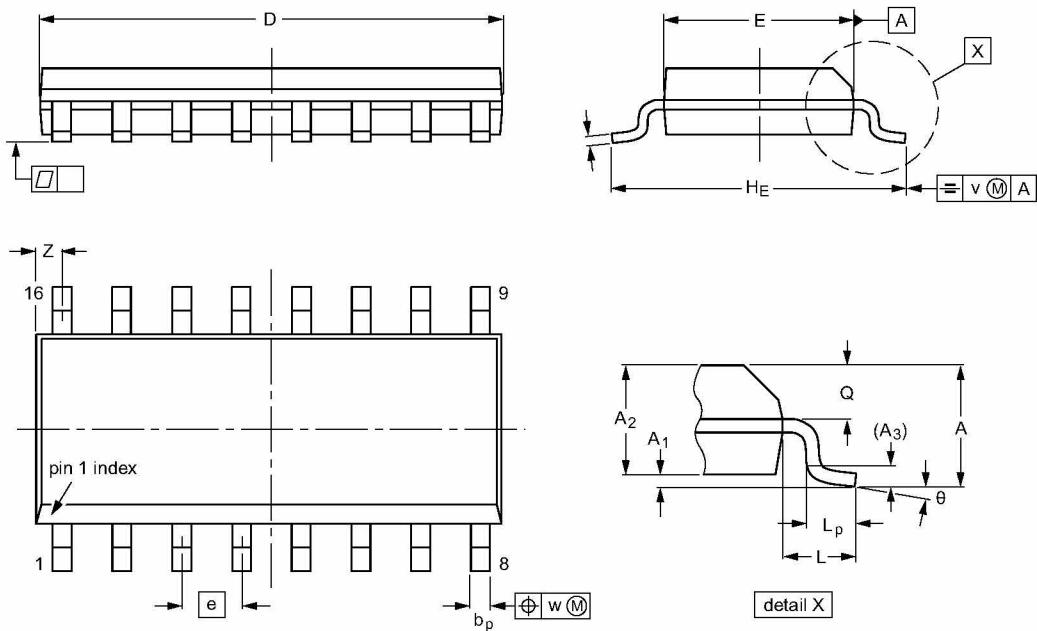
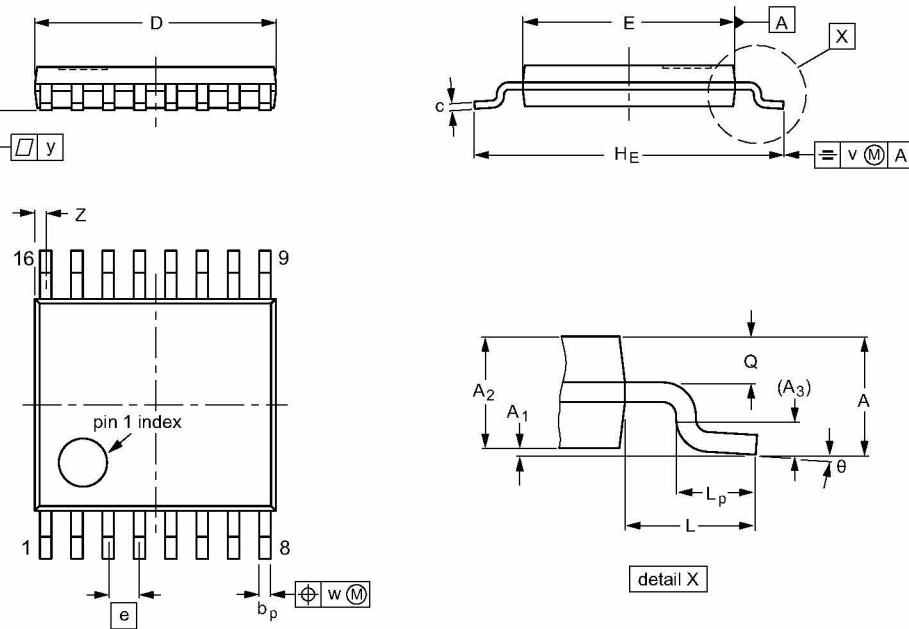


FIGURE 7 – STANDBY-SUPPLY CURRENT vs. SUPPLY VOLTAGE



SOIC16: plastic small outline package; 16 leads; body width 3.9 mm

DIMENSIONS (mm are the original 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 0.10	0.25 1.25	1.45	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° 0

TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm

DIMENSIONS (mm are the original dimensions)

UNIT	A max.	A ₁	A ₂	A ₃	b _p	c	D ⁽¹⁾	E ⁽²⁾	e	H _E	L	L _p	Q	v	w	y	Z ⁽¹⁾	θ
mm	1.1 0.05	0.15 0.80	0.95	0.25	0.30 0.19	0.2 0.1	5.1 4.9	4.5 4.3	0.65	6.6 6.2	1	0.75 0.50	0.4 0.3	0.2	0.13	0.1	0.40 0.06	8° 0°