



Switch-Mode PWM Controller

Description

TL494 is a switch-mode pulse width modulation (PWM) control circuit primarily designed for power supply control. It allows flexible customization of power supply control circuits according to specific applications. The TL494 integrates two error amplifiers, an on-chip adjustable oscillator, a Dead Time Control (DTC) comparator, a pulse steering flip-flop, a 5V voltage regulator, and various output control circuits.

The TL494 is available in SOP16 or DIP16 package.

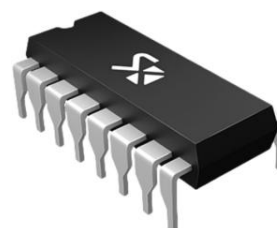
Features

- Push-pull or single-ended output control modes
- Dual error amplifiers included
- 5V reference power supply(accuracy up to $\pm 2\%$)
- Adjustable dead time control
- Independent output transistors
- sink or source current up to 200mA
- Comprehensive PWM control circuitry
- Active or slave oscillator capability

Package Outline Drawing



SOP-16

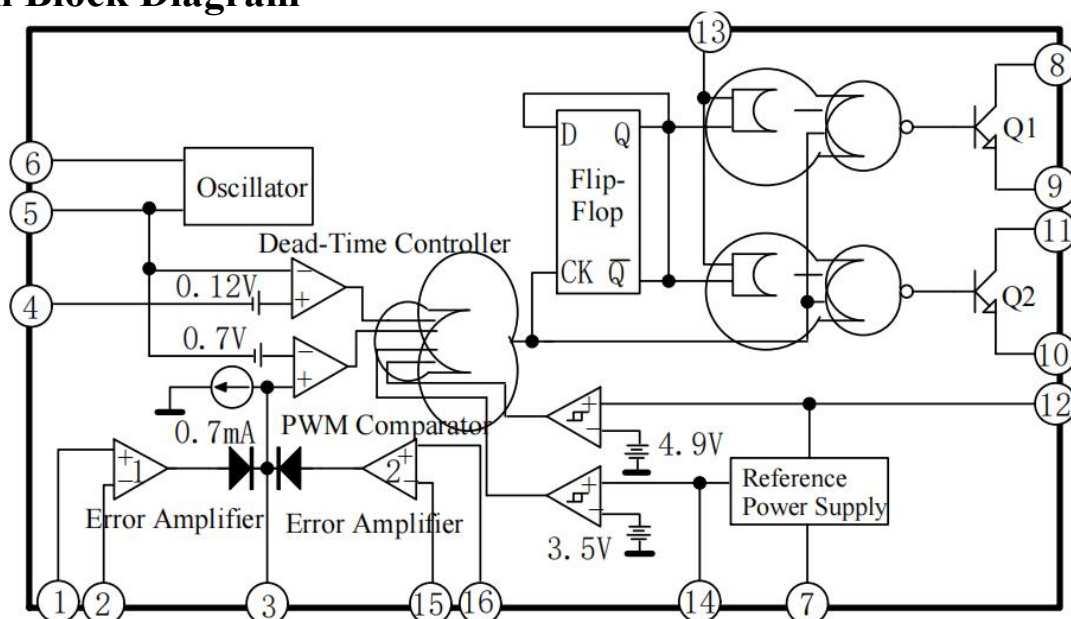


DIP-16

Application

- PC power supplies
- Inverter power supplies
- Forward dual-transistor, half-bridge, and full-bridge switch-mode power supplies

Function Block Diagram





TL494

Ordering Information

Type	Marking	Package
TL494-D16	TL494	DIP-16
TL494-P16	TL494	SOP-16

Pin Description

Pin Number	Pin Name	Description	Pin Configuration
1	1IN+	Non-inverting input of Error Amplifier 1	
2	1IN-	Inverting input of Error Amplifier 1	
3	FEEDBACK	Feedback input	
4	DTC	Dead time control comparator input	
5	C _T	Oscillation frequency adjustment capacitor	
6	R _T	Oscillation frequency adjustment resistor	
7	GND	Ground	
8	C1	Collector output 1	
9	E1	Emitter output 1	
10	E2	Emitter output 2	
11	C2	Collector output 2	
12	V _{CC}	Positive power supply	
13	OUTPUT CTRL	Output mode selection	
14	V _{ref}	Reference voltage output	
15	2IN-	Inverting input of Error Amplifier2	
16	2IN+	Non-inverting input of Error Amplifier 2	



Absolute Maximum Ratings ($T_A=25^{\circ}\text{C}$ unless otherwise noted)

Parameter	Symbol	Value	Unit
Supply Voltage	V_{CC}	7~42	V
Amplifier Input Voltage	V_{IN}	$V_{CC}+0.3$	V
Collector Output Voltage	V_C	42	V
Collector Output Current	I_O	250	mA
Operating Temperature Range	T_A	-20~+85	$^{\circ}\text{C}$
Operating Junction Temperature Range	T_J	-20~+125	$^{\circ}\text{C}$
Soldering Temperature(10s)	T_W	260	$^{\circ}\text{C}$
Storage Temperature Range	T_S	-55~+150	$^{\circ}\text{C}$

Recommended Operating Conditions ($T_A=25^{\circ}\text{C}$ unless otherwise noted)

Parameter	Symbol	Min	Typ	Max	Unit
Supply Voltage	V_{CC}	7	15	40	V
Collector Output Voltage	V_{C1}, V_{C2}	-	30	40	V
Collector Output Current(Single Transistor)	I_{C1}, I_{C2}	-	-	200	mA
Amplifier Input Voltage	V_{IN}	-0.3	-	$V_{CC}-2$	V
Feedback Current	I_{FB}	-	-	0.3	mA
Reference Output Current	I_{REF}	-	-	10	mA
Timing Resistor	R_T	1.8	30	500	$\text{K}\Omega$
Timing Capacitor	C_T	0.0047	0.001	10	μF
Oscillation Frequency	F_{OSC}	1	40	200	KHz
PWM Input Voltage	V_{IN_PWM}	0.3	-	5.3	V

Electrical Characteristics

($T_A=-20\sim+85^{\circ}\text{C}$, $V_{CC}=15\text{ V}$, $R_T=12\text{K}\Omega$, $C_T=0.01\mu\text{F}$ unless otherwise noted)

Parameter	Symbol	Test Condition	Min	Typ	Max	Unit
Reference Section						
Reference Voltage	V_{ref}	$T_A=25^{\circ}\text{C}, I_O=1\text{mA}$	4.75	5.0	5.25	V



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Reference Voltage Temperature Coefficient	$\Delta V_{ref}/\Delta T$	T _A =-20~+85℃	-	1.3	2.6	%
Voltage Linearity	Reg _{Line}	7V≤V _{CC} ≤40V	-	30	50	mV
Load Regulation	Reg _{Load}	1mA≤I _O ≤20mA	-	3	25	mV
Output Short-Circuit Current	I _{SC}	V _O =0V	10	32	50	mA
Oscillator Section						
Frequency	F _{OSC}	T _A =25℃,R _T =12KΩ,C _T =0.01μF	9.2	10	10.8	KHz
Frequency Voltage Coefficient	ΔF _{OSC} /ΔV	T _A =25℃,7V≤V _{CC} ≤40V	-	0.1	-	%
Frequency Temperature Coefficient	ΔF _{OSC} /ΔT	T _A =-20~+85℃	-	2	-	%
Dead Time Control Section(See Test Circuit Diagram 2)						
Input Bias Current	I _{IB(DT)}	0V≤V ₄ ≤5.25	-	-2	-10	μA
Maximum Duty Cycle(Per Output)	D _(MAX)	V ₄ =0V,Pin 13=V _{ref}	45	-	-	%
Input Threshold Voltage(Pin 4)	V _{TH}	Zero duty cycle	-	3.0	3.3	V
		Maximum duty cycle	0	-	-	
Error Amplifier Section						
Input Offset Voltage	V _{IO}	V ₃ =2.5V	-	2	10	mV
Input Offset Current	I _{IO}	V ₃ =2.5V	-	25	250	nA
Input Bias Current	I _{IB}	V ₃ =2.5V	-	0.2	1.0	μA
Input Common-Mode Voltage Range	V _{CIM}	7V≤V _{CC} ≤40V	-0.3	-	V _{CC}	V
Open-Loop Voltage Gain	G _{VO}	0.5V≤V ₃ ≤3.5V	70	95	-	dB
Unity-Gain Bandwidth	B _W		-	650	-	KHz
Common-Mode Rejection Ratio	C _{MRR}	7V≤V _{CC} ≤40V	65	90	-	dB
PWM Comparator Section(See Test Circuit Diagram 2)						
Input Threshold Voltage	V _{ITH}	Zero duty cycle	-	4	4.5	V
Output Source Current	I _{SOURCE}	V ₃ =3.5V	-2	-4	-	mA



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Output Sink Current	I _{SINK}	V ₃ =0.7V	0.3	0.7	-	mA
Output Section						
Output Saturation Voltage	V _{CE(SAT)}	Common-emitter: V _E =0V,I _C =200mA	-	1.1	1.3	V
	V _{CC(SAT)}	Emitter-follower: V _C =15V,I _E =-200mA	-	1.5	2.5	
Collector Leakage Current	I _{C(OFF)}	V _{CC} =40V,V _{CE} =40V	-	2	100	μA
Emitter Leakage Current	I _{E(OFF)}	V _{CC} =V _C =40V,V _E =0V	-	-	-100	μA
Rise Time	t _R	Common-emitter: Test diagram 3	-	100	200	ns
		Emitter-follower: Test diagram 4	-	100	200	ns
Fall Time	t _F	Common-emitter: Test diagram 3	-	25	100	ns
		Emitter-follower: Test diagram 4	-	40	100	ns
Entire Device						
Standby Current	I _{CC}	Pin 6=V _{ref} ,V _{CC} =15V	-	6	10	mA
		Pin 6=V _{ref} ,V _{CC} =40V	-	9	15	
Average Supply Current		RT=12KΩ,CT=0.01μF, V ₄ =2V,V _{CC} =15C	-	7.5	-	

Test Circuit Diagrams($T_A=25^\circ C$, $V_{CC}=15V$ unless otherwise specified)

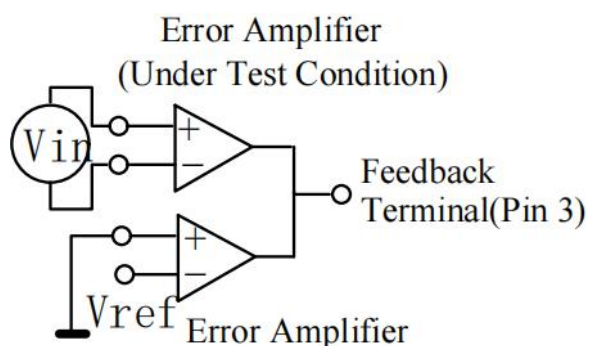


Figure 1. Error Amplifier Characteristics

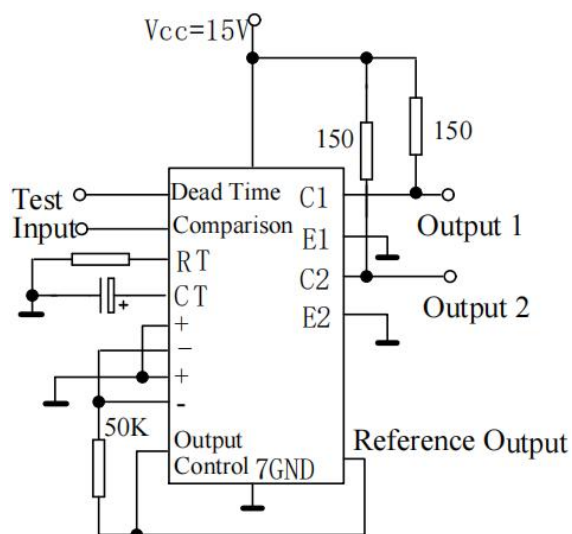


Figure 2. Dead Time and Feedback Control Test Circuit

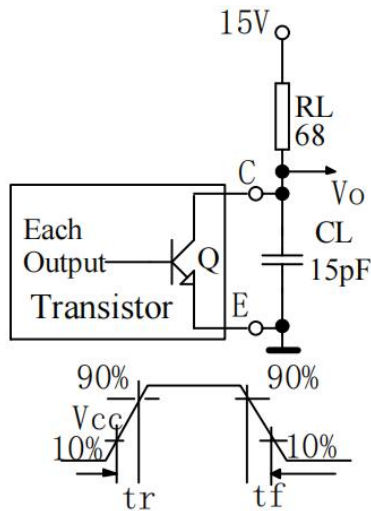


Figure 3. Common-Emitter Connection Test Circuit and Waveform

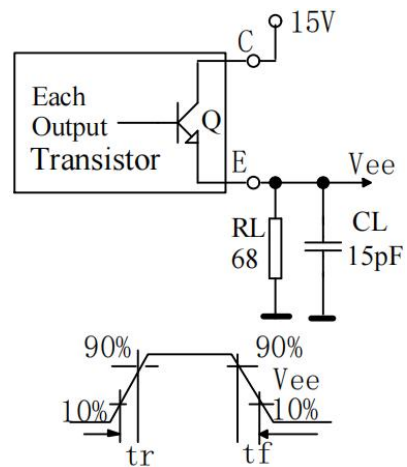


Figure 4. Emitter-Follower Connection Test Circuit and Waveform

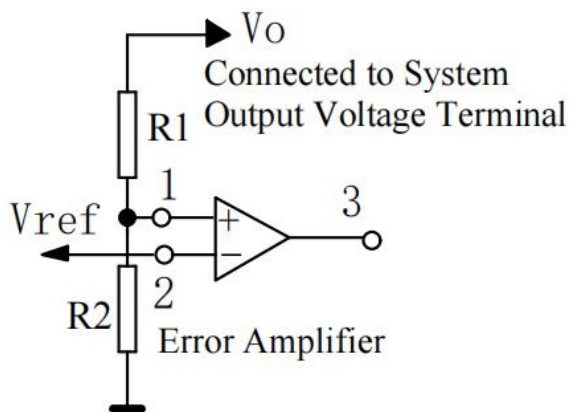


Figure 5. Error Amplifier Sensor Technology Positive Output Voltage: $V_O = V_{ref}(1 + R_1/R_2)$

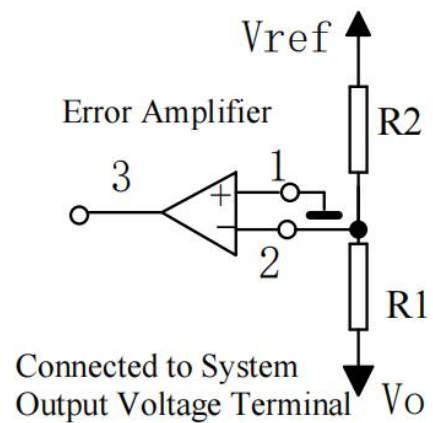


Figure 6. Error Amplifier Sensor Technology Negative Output Voltage: $V_O = V_{ref} * 1 + R_1/R_2$

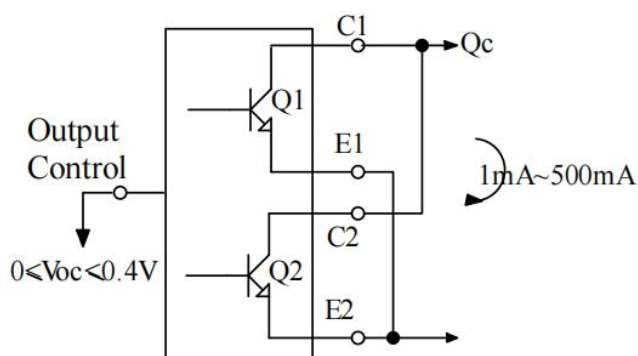
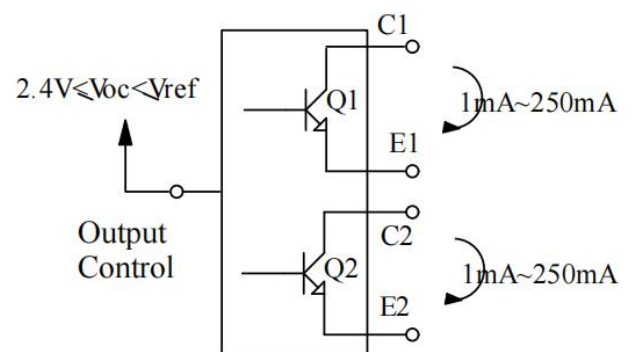


Figure 7. Single-Ended and Push-Pull Connection



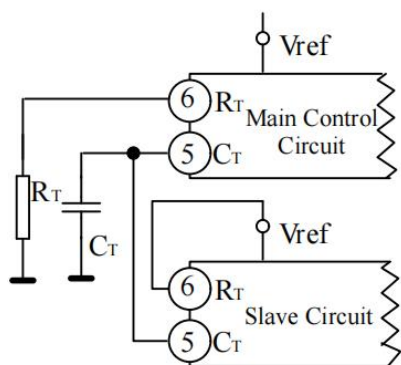


Figure8. Two or More Slave Control Circuits

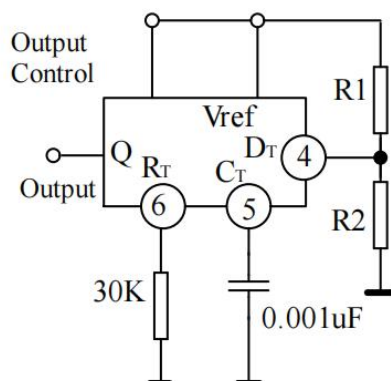


Figure9. Dead Time Control Circuit

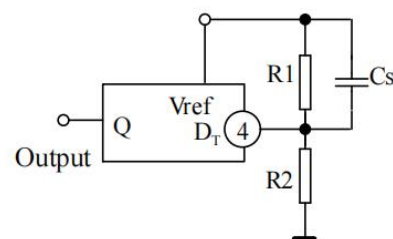


Figure10. Soft-Start Circuit

Typical Applications

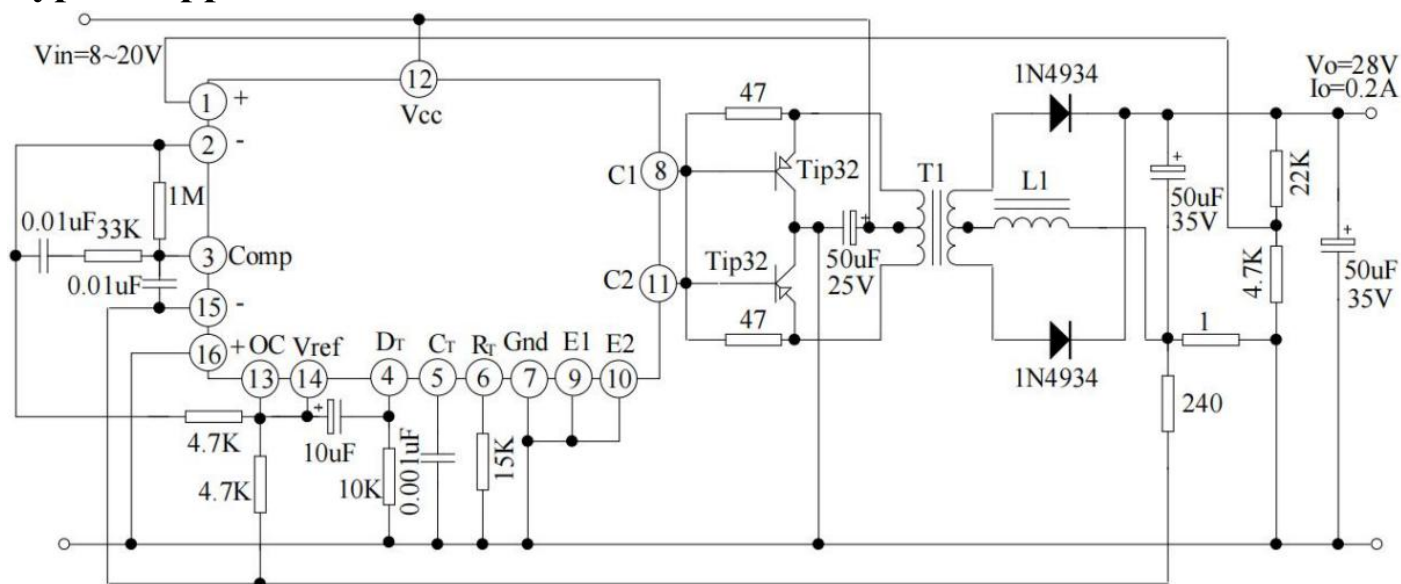


Figure11. PWM Push-Pull Converter

Test Item	Test Conditions	Result
Line Regulation	$V_{IN}=10V\sim40V$	14mV 0.28%
Load Regulation	$V_{IN}=28V, I_O=1.0mA\sim1.0A$	3.0mV 0.06%
Output Ripple Voltage	$V_{IN}=28V, I_O=1.0A$	65mV _{PP} P.A.R.D
Short-Circuit Current	$V_{IN}=28V, R_L=0.1\Omega$	1.6A
Efficiency	$V_{IN}=28V, I_O=1.0A$	71%

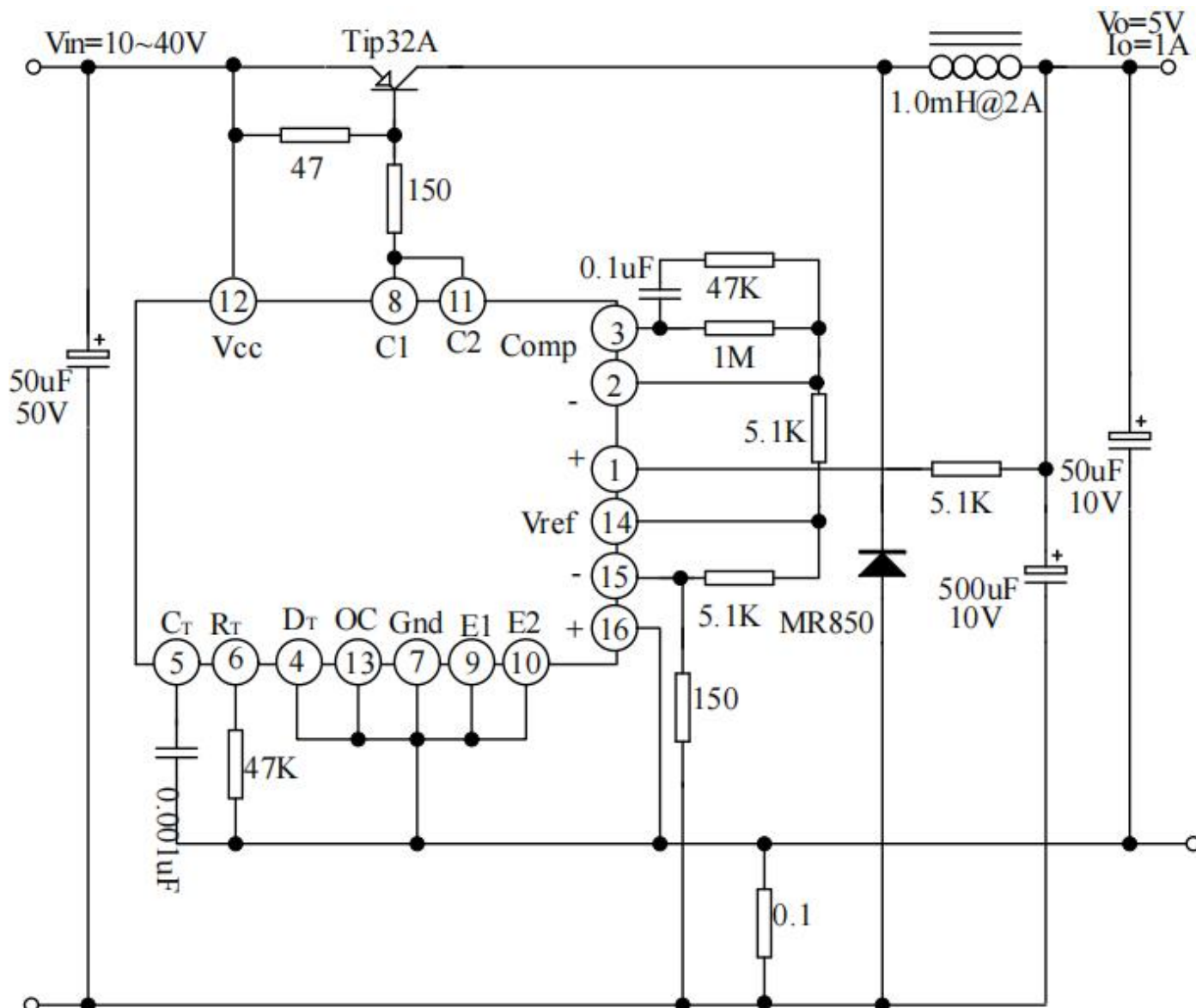


Figure12. PWM Buck Converter

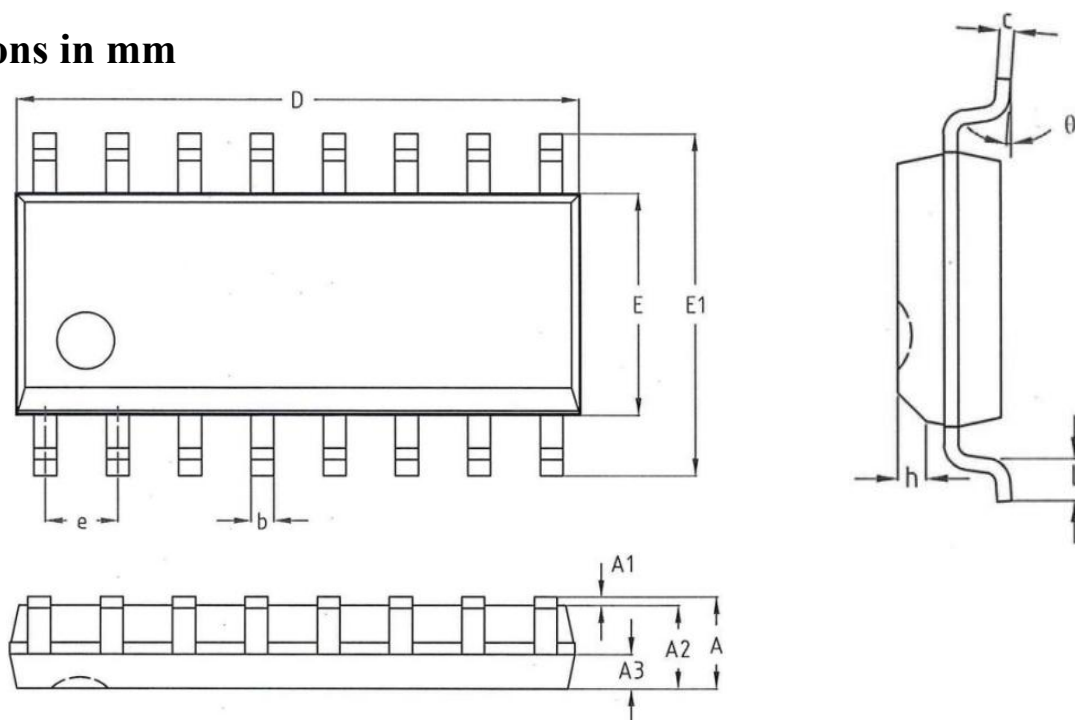
Test Item	Test Conditions	Result
Line Regulation	$V_{IN}=8V\sim40V$	3.0mV 0.01%
Load Regulation	$V_{IN}=12.6V, I_O=0.2mA\sim200A$	5.0mV 0.02%
Output Ripple Voltage	$V_{IN}=12.6V, I_O=200mA$	40mV _{PP} P.A.R.D
Short-Circuit Current	$V_{IN}=12.6V, R_L=0.1\Omega$	250mA
Efficiency	$V_{IN}=12.6V, I_O=200mA$	72.1%



Package Information

SOP-16

Dimensions in mm



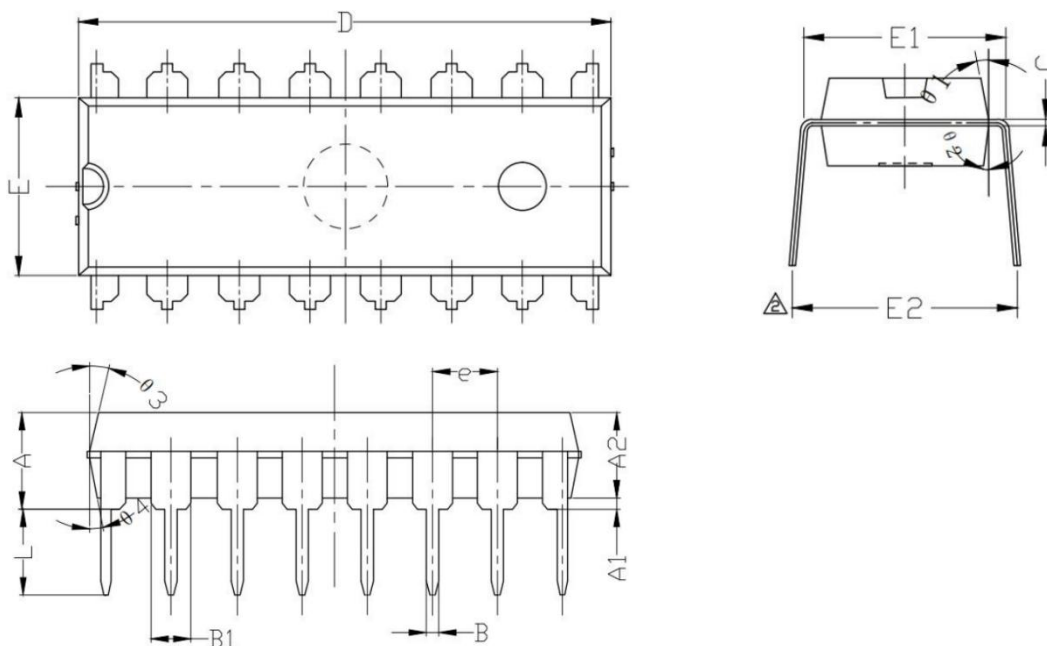
Symbol	Dimensions In Millimeters		
	Min	Nom	Max
A	-	-	1.75
A1	0.10	-	0.25
A2	1.35	1.45	1.55
A3	0.60	0.65	0.70
b	0.35	-	0.50
c	0.19	-	0.25
D	9.80	9.90	10.00
E	3.80	3.90	4.00
E1	5.80	6.00	6.20
e	1.27 BSC		
h	0.30	-	0.50
L	0.40	-	0.80
θ	0°	-	8°



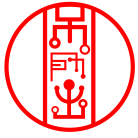
Package Information

DIP-16

Dimensions in mm



Symbol	Dimensions In Millimeters			Symbol	Dimensions In Millimeters		
	Min	Nom	Max		Min	Nom	Max
A	3.75	3.90	4.05	E1	7.35	7.62	7.85
A1	0.51	-	-	e	2.54 (BSC)		
A2	3.20	3.30	3.45	L	3.00	3.30	3.60
B	0.38	0.48	0.56	E2	8.00	8.40	8.80
B1	1.52 (BSC)			θ1	9°	-	15°
C	0.20	0.25	0.34	θ2	7°	-	13°
D	18.80	19.05	19.30	θ3	8°	-	14°
E	6.20	6.35	6.50	θ4	5°	-	12°



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