

**PULSE-WIDTH-MODULATION CONTROL CIRCUITS****AZ494B/D****General Description**

The AZ494B/D is a voltage mode pulse width modulation switching regulator control circuit designed primarily for power supply control.

The AZ494B/D consists of a reference voltage circuit, two error amplifiers, an on-chip adjustable oscillator, a dead-time control (DTC) comparator, a pulse-steering control flip-flop, and an output control circuit. The AZ494B/D is capable for push-pull or single-ended output operation, which can be selected through the output control.

AZ494B has 4.95V and AZ494D has 5V reference voltage respectively. The precision of voltage reference ( $V_{REF}$ ) is improved up to  $\pm 1.5\%$  through trimming and this provides a better output voltage regulation.

The AZ494B/D is available in standard packages of DIP-16 and SOIC-16.

**Features**

- Stable 4.95V for AZ494B or 5V for AZ494D Reference Voltage Trimmed to  $\pm 1.5\%$  Accuracy
- Uncommitted Output TR for 200mA Sink or Source Current
- Single-End or Push-Pull Operation Selected by Output Control
- Internal Circuitry Prohibits Double Pulse at Either Output
- Complete PWM Control Circuit with Variable Duty Cycle
- On-Chip Oscillator with Master or Slave Operation

**Applications**

- SMPS
- Back Light Inverter
- Charger

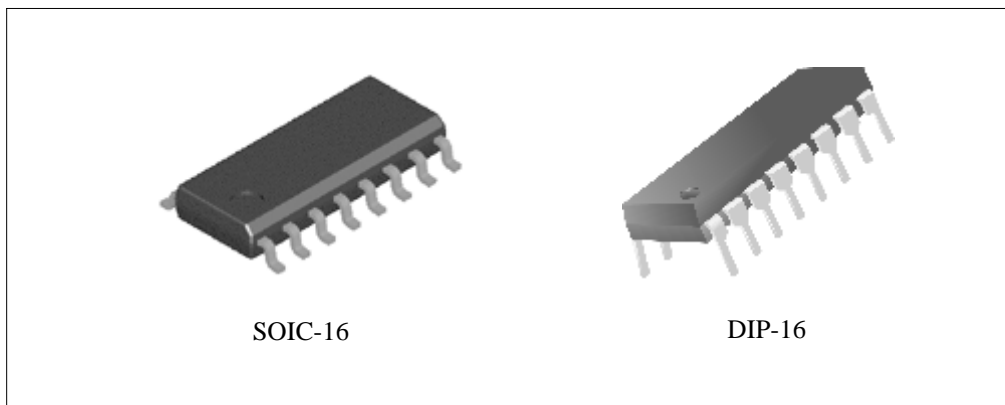


Figure 1. Package Types of AZ494B/D



**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494B/D**

**Pin Configuration**

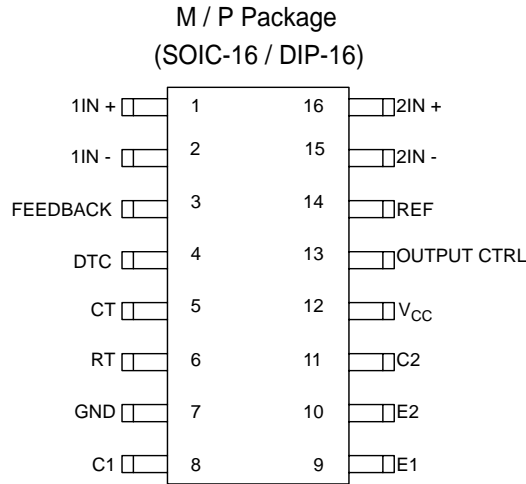


Figure 2. Pin Configuration of AZ494B/D (Top View)

**Output Function Control Table**

Signal for Output Control	Output Function
$V_I = GND$	Single-ended or parallel output
$V_I = V_{REF}$	Normal push-pull operation

**Functional Block Diagram**

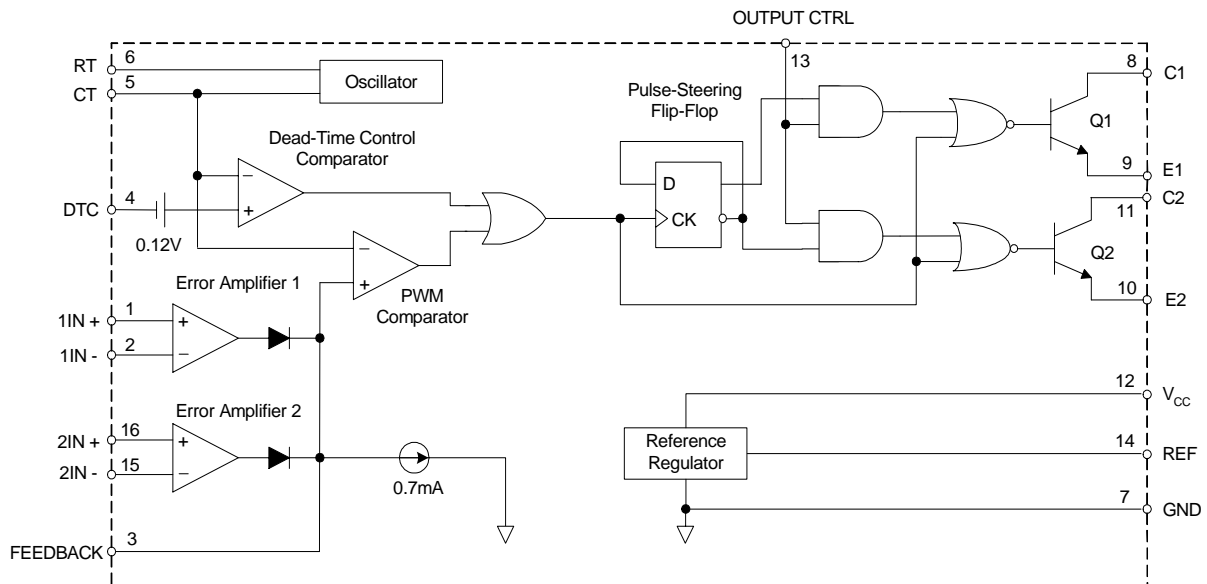


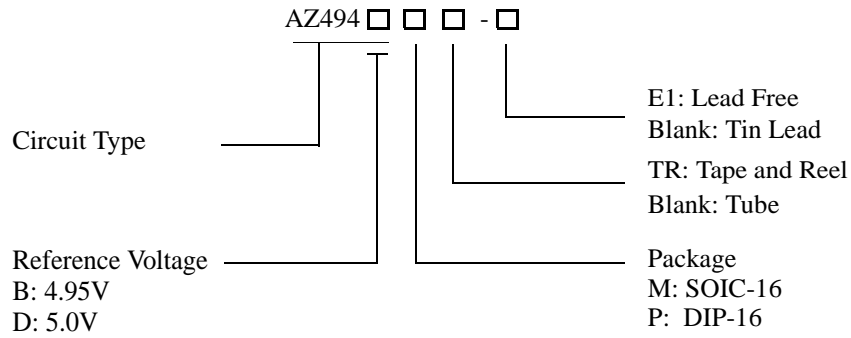
Figure 3. Functional Block Diagram of AZ494B/D



**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494B/D**

**Ordering Information**



Package	Temperature Range	Part Number		Marking ID		Packing Type
		Tin Lead	Lead Free	Tin Lead	Lead Free	
SOIC-16	-40 to 85°C	AZ494BM	AZ494BM-E1	AZ494BM	AZ494BM-E1	Tube
		AZ494BMTR	AZ494BMTR-E1	AZ494BM	AZ494BM-E1	Tape & Reel
		AZ494DM	AZ494DM-E1	AZ494DM	AZ494DM-E1	Tube
		AZ494DMTR	AZ494DMTR-E1	AZ494DM	AZ494DM-E1	Tape & Reel
DIP-16		AZ494BP	AZ494BP-E1	AZ494BP	AZ494BP-E1	Tube
		AZ494DP	AZ494DP-E1	AZ494DP	AZ494DP-E1	Tube

BCD Semiconductor's Pb-free products, as designated with "E1" suffix in the part number, are RoHS compliant.



**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494B/D**

**Absolute Maximum Ratings (Note 1)**

Parameter	Symbol	Value	Unit
Supply Voltage (Note 2)	$V_{CC}$	40	V
Amplifier Input Voltage	$V_I$	-0.3 to $V_{CC} + 0.3$	V
Collector Output Voltage	$V_O$	40	V
Collector Output Current	$I_O$	250	mA
Package Thermal Impedance (Note 3)	$\theta_{JA}$	M Package	73
		P Package	67
Lead Temperature 1.6mm from case for 10 seconds		260	°C
Storage Temperature Range	$T_{STG}$	-65 to 150	°C
ESD rating (Machine Model)		200	V

Note 1: Stresses greater than 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 Ratings" for extended periods may affect device reliability.

Note 2: All voltage values are with respect to the network ground terminal.

Note 3: Maximum power dissipation is a function of  $T_J(\max)$ ,  $\theta_{JA}$  and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\max) - T_A) / \theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.

**Recommended Operating Conditions**

Parameter	Symbol	Min	Max	Unit
Supply Voltage	$V_{CC}$	7	36	V
Amplifier Input Voltage	$V_I$	-0.3	$V_{CC} - 2$	V
Collector Output Voltage	$V_O$		36	V
Collector Output Current (Each Transistor)			200	mA
Current Into Feedback Terminal			0.3	mA
Oscillator Frequency	$f_{osc}$		300	KHz
Timing Capacitor	$C_T$	0.47	10000	nF
Timing Resistor	$R_T$	1.8	500	K $\Omega$
Operating Free-Air Temperature	$T_A$	-40	85	°C
Reference Output Current	$I_{REF}$		10	mA



**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494B/D**

**Electrical Characteristics**

$T_A = 25^{\circ}\text{C}$ ,  $V_{CC}=15\text{V}$ ,  $f=10\text{KHz}$  unless otherwise noted.

Parameter	Symbol	Conditions (Note 4)	Min	Typ	Max	Unit	
<b>Reference Section</b>							
Output Reference Voltage	for AZ494B	$V_{REF}$	$I_{REF}=1\text{mA}$	4.875	4.95	5.025	V
	for AZ494D	$V_{REF}$	$I_{REF}=1\text{mA}$	4.925	5.0	5.075	V
Line Regulation	$R_{LINE}$	$V_{CC} = 7\text{V to } 36\text{V}$		2	25	mV	
Load Regulation	$R_{LOAD}$	$I_{REF}=1\text{mA to } 10\text{mA}$		1	15	mV	
Short-Circuit Output Current(Note 5)	$I_{SC}$	$V_{REF} = 0\text{V}$		25		mA	
<b>Oscillator Section, <math>C_T = 0.01\mu\text{F}</math>, <math>R_T = 12\text{K}\Omega</math> (See Figure 4)</b>							
Frequency	$f_{osc}$			10		KHz	
Standard Deviation of Frequency (Note 6)		All values of $V_{CC}$ , $C_T$ , $R_T$ and $T_A$ constant		100		Hz/KHz	
Frequency Change with Voltage		$V_{CC}=7\text{V to } 36\text{V}$ , $T_A = 25^{\circ}\text{C}$		1		Hz/KHz	
Frequency Change with Temperature (Note 7)		$\Delta T_A = \text{MIN to MAX}$			10	Hz/KHz	
<b>Error-Amplifier Section</b>							
Input Offset Voltage	$V_{IO}$	$V_O (\text{FEEDBACK}) = 2.5\text{V}$		2	10	mV	
Input Offset Current	$I_{IO}$	$V_O (\text{FEEDBACK}) = 2.5\text{V}$		25	250	nA	
Input Bias Current	$I_{BIAS}$	$V_O (\text{FEEDBACK}) = 2.5\text{V}$		0.2	1	$\mu\text{A}$	
Common-Mode Input Voltage Range	$V_{CM}$	$V_{CC}=7\text{V to } 36\text{V}$	-0.3		$\frac{V_{CC}-2}{2}$	V	
Large-Signal Open-Loop Voltage Gain	$A_{VO}$	$\Delta V_O = 3\text{V}$ , $R_L = 2\text{K}\Omega$ , $V_O = 0.5\text{V to } 3.5\text{V}$	70	95		dB	
Unity-Gain Bandwidth	GB			800		KHz	
Common-Mode Rejection Ratio	CMRR	$V_{CC}=7\text{V to } 36\text{V}$	65	80		dB	
Output Sink Current (FEEDBACK)	$I_{SINK}$	$V_{ID} = -15\text{mV to } -5\text{V}$ , $V(\text{FEEDBACK}) = 0.7\text{V}$	- 0.3	- 0.7		mA	
Output Source Current (FEEDBACK)	$I_{SOURCE}$	$V_{ID} = 15\text{mV to } 5\text{V}$ , $V(\text{FEEDBACK}) = 3.5\text{V}$	2			mA	
<b>Output Section</b>							
Collector Off-State Current	$I_{C, OFF}$	$V_{CE} = 36\text{V}$ , $V_{CC}=36\text{V}$		2	100	$\mu\text{A}$	
Emitter Off-State Current	$I_{E, OFF}$	$V_{CC} = V_C = 36\text{V}$ , $V_E = 0$			-100	$\mu\text{A}$	
Collector-Emitter Saturation Voltage	Common Emitter	$V_E = 0$ , $I_C = 200\text{mA}$		1.1	1.3	V	
	Emitter Follower	$V_O (C1 \text{ or } C2) = 15\text{V}$ , $I_E = -200\text{mA}$		1.5	2.5		



**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494B/D**

**Electrical Characteristics (Continued)**

Parameter	Symbol	Conditions (Note 4)	Min	Typ	Max	Unit	
Output Control Input Current		$V_1 = V_{REF}$			3.5	mA	
<b>Dead-Time Control Section</b>							
Input Bias Current		$V_1 = 0$ to 5.25V		-2	-10	$\mu$ A	
Maximum Duty Cycle, Each Output		$V_1$ (DEAD-TIME CTRL) = 0, $C_T = 0.01\mu$ F, $R_T = 12K\Omega$		45		%	
Input Threshold Voltage		Zero Duty Cycle		3	3.3	V	
		Maximum Duty Cycle	0				
<b>PWM Comparator Section (See Figure 4)</b>							
Input Threshold Voltage (FEEDBACK)		Zero duty cycle		4	4.5	V	
Input Sink Current (FEEDBACK)		$V(\text{FEEDBACK}) = 0.7V$	-0.3	-0.7		mA	
<b>Total Device</b>							
Standby Supply Current	$I_{STDBY}$	$V_{RT} = V_{REF}$ , All other inputs and outputs open	$V_{CC} = 15V$		6	10	mA
			$V_{CC} = 36V$		9	15	
Average Supply Current		$V_1$ (DEAD-TIME-CTRL) = 2V See Figure 4.		7.5		mA	
<b>Switching Characteristics</b>							
Rise Time	$t_r$	Common-emitter Configuration See Figure 6		100	200	ns	
Fall Time	$t_f$			25	100	ns	
Rise Time	$t_r$	Emitter-follower Configuration See Figure 7		100	200	ns	
Fall Time	$t_f$			40	100	ns	

Note 4: For conditions shown as MIN or MAX, use the appropriate value specified under recommended operating conditions.

Note 5: Duration of the short circuit should not exceed one second.

Note 6: Standard deviation is a measure of the statistical distribution about the mean as derived from the formula:

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

Note 7: Temperature coefficient of timing capacitor and timing resistor are not taken into account.



**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494B/D**

**Parametr Measurement information**

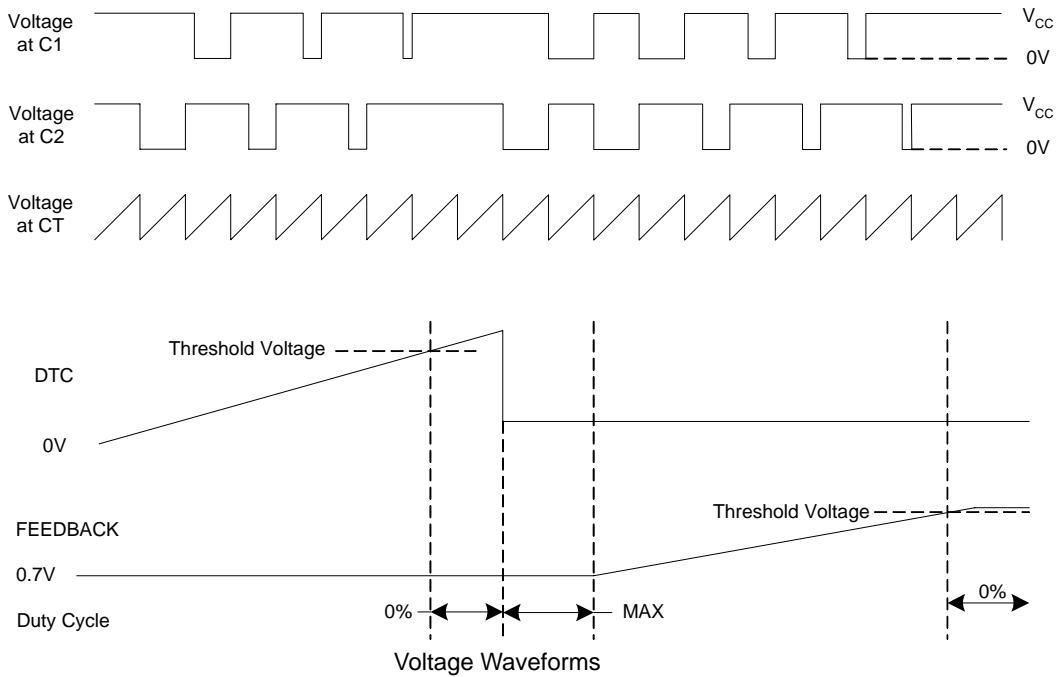
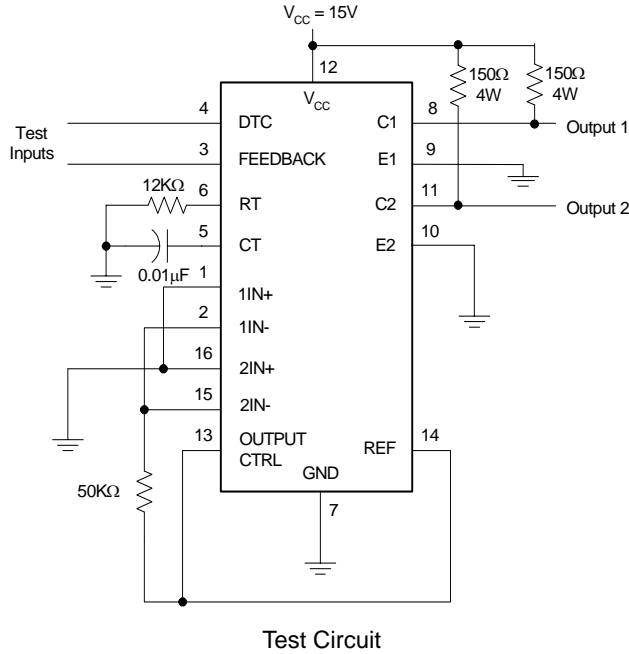


Figure 4. Operational Test Circuit and Waveforms



**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494B/D**

**Parametr Measurement information (Continued)**

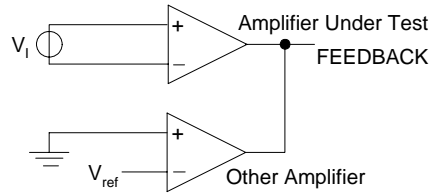
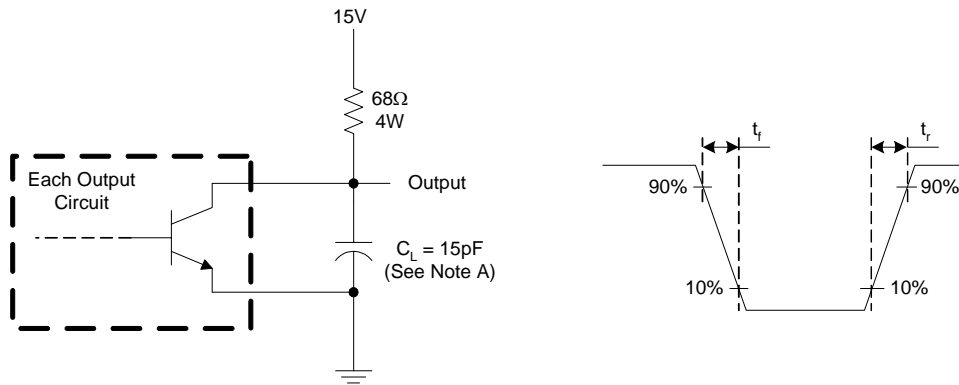
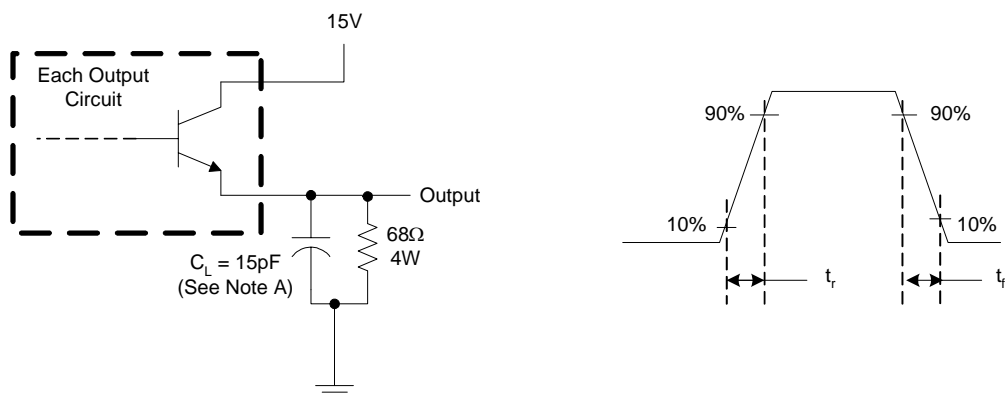


Figure 5. Error Amplifier Characteristics



Note A:  $C_L$  includes probe and jig capacitance.

Figure 6. Common-Emitter Configuration



Note A:  $C_L$  includes probe and jig capacitance.

Figure 7. Emitter-Follower Configuration





**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494B/D**

**Typical Performance Characteristics**

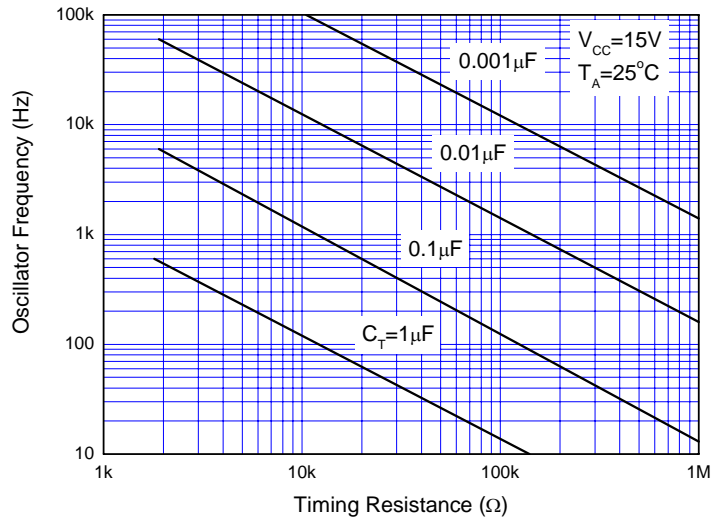


Figure 8. Oscillator Frequency vs.  $R_T$  and  $C_T$

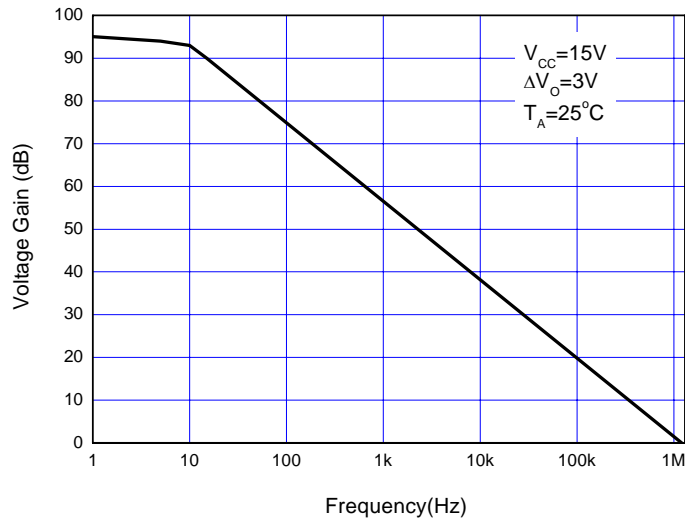


Figure 9. Error Amplifier Small-Signal Voltage Gain vs. Frequency



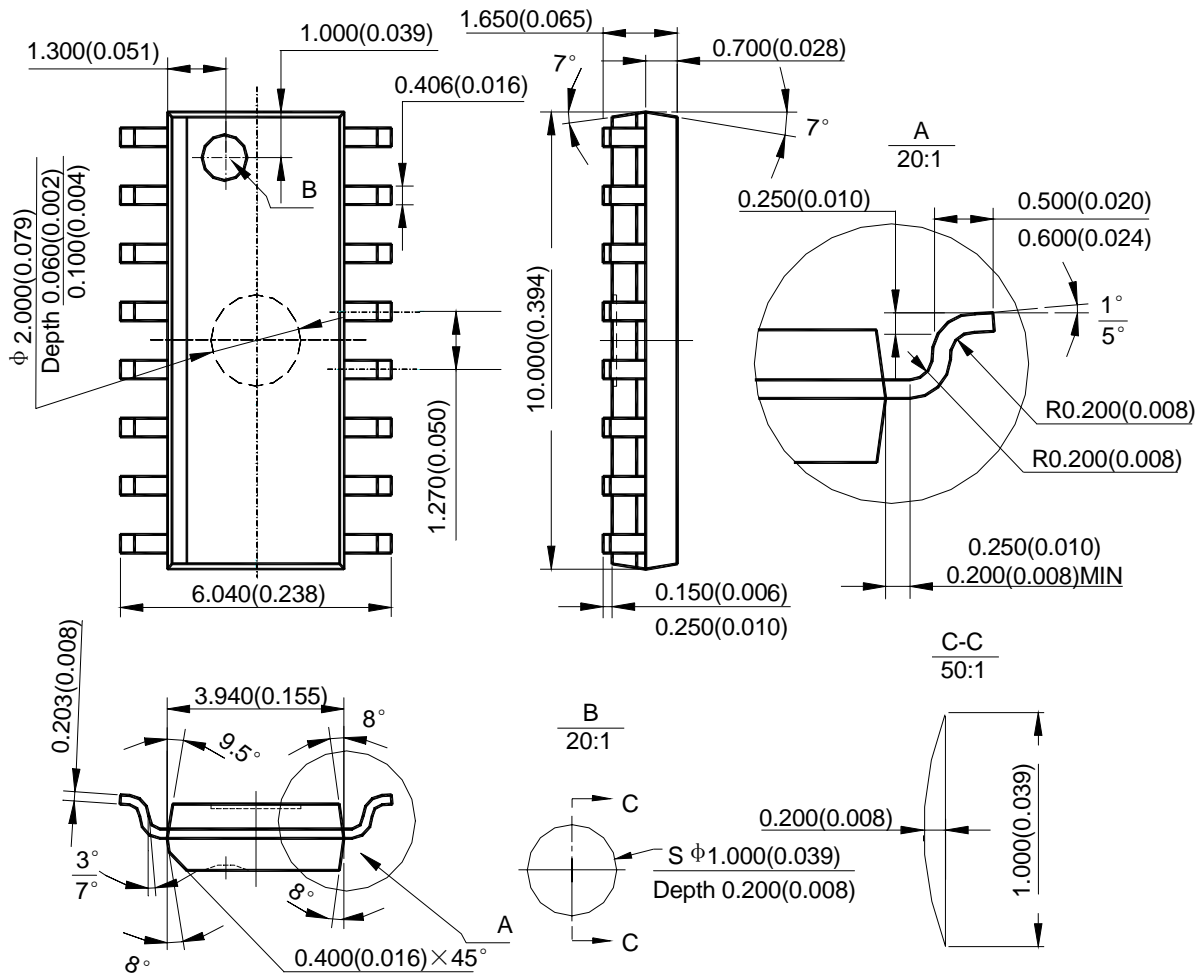
**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494B/D**

**Mechanical Dimensions**

**SOIC-16**

**Unit: mm(inch)**





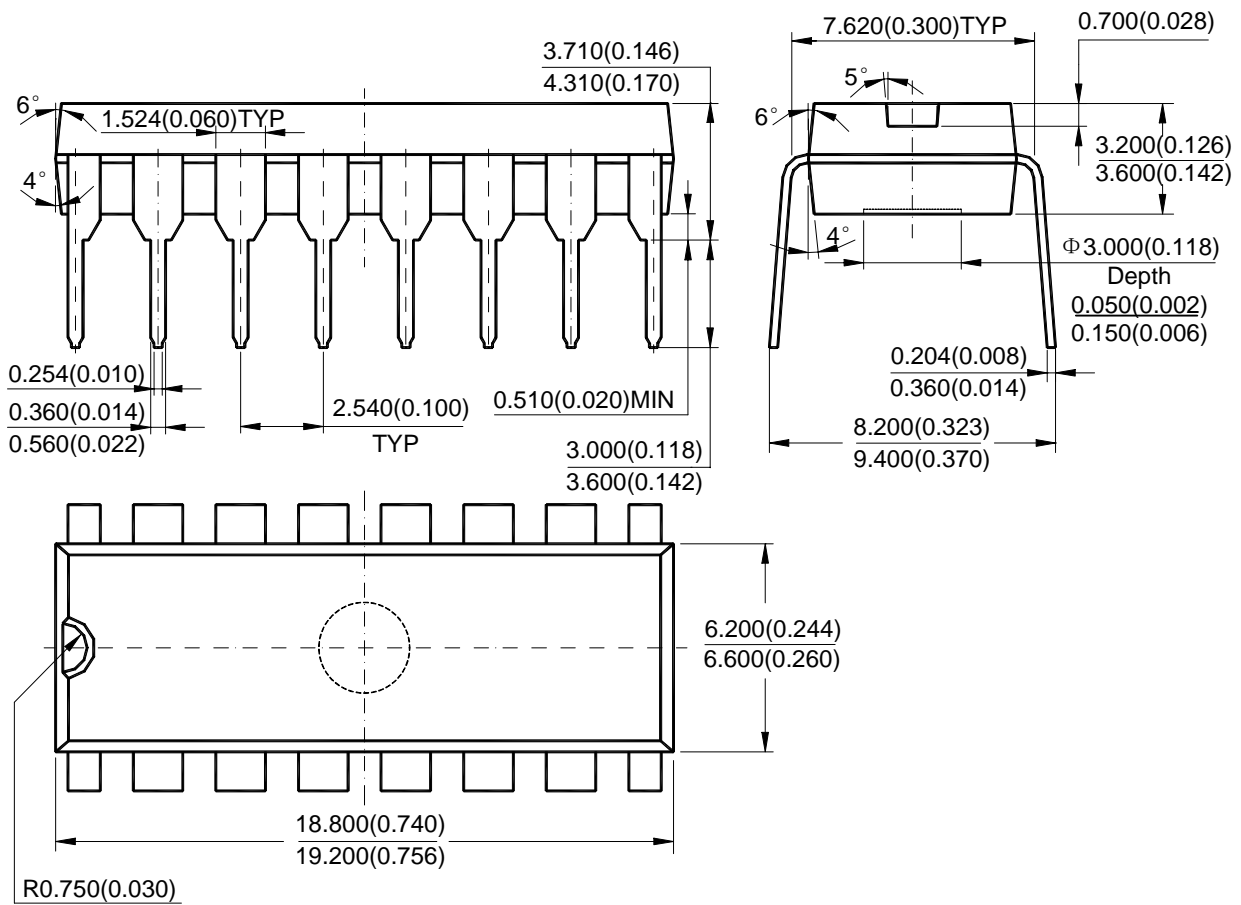
**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494B/D**

**Mechanical Dimensions (Continued)**

**DIP-16**

**Unit: mm(inch)**





BCD Semiconductor Manufacturing Limited

<http://www.bcdsemi.com>

---

**BCD Semiconductor Corporation**

3170 De La Cruz Blvd, Suite # 105 Santa Clara, CA 95054-2411, U.S.A

Tel: +1-408-988 6388, Fax: +1-408-988 6386

**Shanghai SIM-BCD Semiconductor Manufacturing Co., Ltd.**

800 Yi Shan Road, Shanghai 200233, PRC

Tel: +86-21-6485 1491, Fax: +86-21-5450 0008

**Advanced Analog Circuits (Shanghai) Corporation**

8F, B Zone, 900 Yi Shan Road, Shanghai 200233, PRC

Tel: +86-21-6495 9539, Fax: +86-21-6485 9673

**BCD Semiconductor (Taiwan) Company Limited**

4F, 298-1 Rui Guang Road, Nei-Hu District, Taipei, Taiwan

Tel: +886-2-2656-2808, Fax: +886-2-2656-2806

**IMPORTANT NOTICE**

BCD Semiconductor Manufacturing Limited reserves the right to make changes without further notice to any products or specifications herein. BCD Semiconductor Manufacturing Limited does not assume any responsibility for use of any its products for any particular purpose, nor does BCD Semiconductor Manufacturing Limited assume any liability arising out of the application or use of any its products or circuits. BCD Semiconductor Manufacturing Limited does not convey any license under its patent rights or other rights nor the rights of others.