

**PULSE-WIDTH-MODULATION CONTROL CIRCUITS****AZ494A/C****General Description**

The AZ494A/C is a voltage mode pulse width modulation switching regulator control circuit designed primarily for power supply control.

The AZ494A/C 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 precision of voltage reference ( $V_{REF}$ ) is improved up to  $\pm 1\%$  through trimming and this provides a better output voltage regulation. The AZ494A/C provides for push-pull or single-ended output operation, which can be selected through the output control.

The difference between AZ494A and AZ494C is that they have 4.95V and 5V reference voltage respectively.

The AZ494A/C is available in standard packages of DIP-16 and SOIC-16.

**Features**

- Stable 4.95V/5V Reference Voltage Trimmed to  $\pm 1.0\%$  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

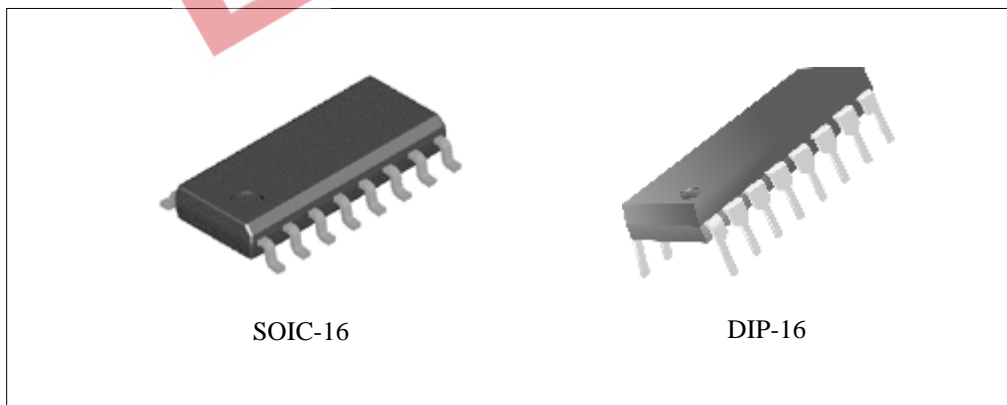


Figure 1. Package Types of AZ494A/C



**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494A/C**

**Pin Configuration**

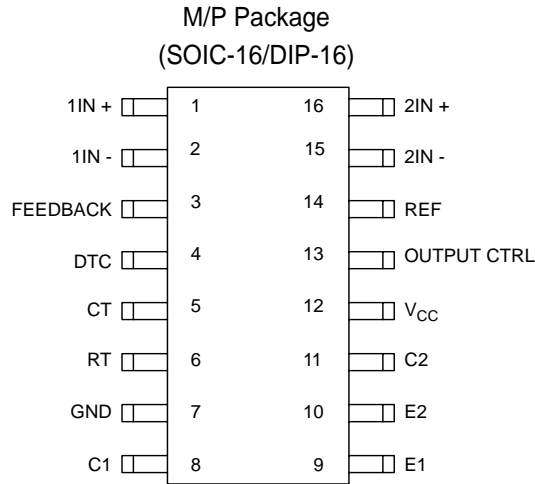


Figure 2. Pin Configuration of AZ494A/C (Top View)

**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**

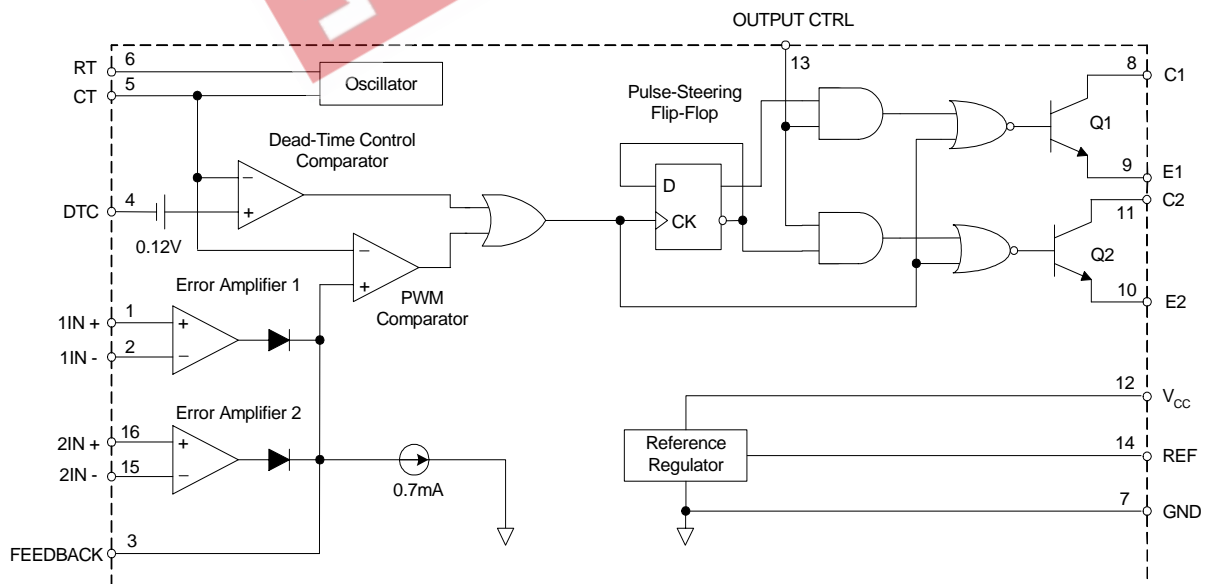


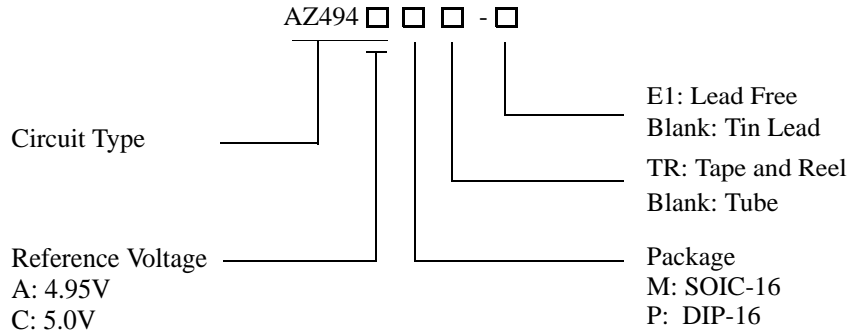
Figure 3. Functional Block Diagram of AZ494A/C



**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494A/C**

**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       | AZ494AM     | AZ494AM-E1   | AZ494AM    | AZ494AM-E1 | Tube         |
|         |                   | AZ494AMTR   | AZ494AMTR-E1 | AZ494AM    | AZ494AM-E1 | Tape & Reel  |
|         |                   | AZ494CM     | AZ494CM-E1   | AZ494CM    | AZ494CM-E1 | Tube         |
|         |                   | AZ494CMTR   | AZ494CMTR-E1 | AZ494CM    | AZ494CM-E1 | Tape & Reel  |
| DIP-16  |                   | AZ494AP     | AZ494AP-E1   | AZ494AP    | AZ494AP-E1 | Tube         |
|         |                   | AZ494CP     | AZ494CP-E1   | AZ494CP    | AZ494CP-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****AZ494A/C****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)              | $R\theta_{JA}$ | 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  $T_J(\max)$ ,  $R\theta_{JA}$  and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\max) - T_A) / R\theta_{JA}$ . Operating at the absolute maximum  $T_J$  of 150°C can affect reliability.

**Recommended Operating Conditions**

| Parameter                                  | Symbol           | Min     | Typ   | Max          | Unit |
|--|------------------|---------|-------|--------------|------|
| Supply Voltage                             | $V_{CC}$         | 7       | 15    | 36           | V    |
| Collector Output Voltage                   | $V_{C1}, V_{C2}$ |         | 30    | 36           | V    |
| Collector Output Current (Each Transistor) | $I_{C1}, I_{C2}$ |         |       | 200          | mA   |
| Amplifier Input Voltage                    | $V_I$            | 0.3     |       | $V_{CC} - 2$ | V    |
| Current Into Feedback Terminal             | $I_{FB}$         |         |       | 0.3          | mA   |
| Reference Output Current                   | $I_{REF}$        |         |       | 10           | mA   |
| Timing Capacitor                           | $C_T$            | 0.00047 | 0.001 | 10           | μF   |
| Timing Resistor                            | $R_T$            | 1.8     | 30    | 500          | KΩ   |
| Oscillator Frequency                       | $f_{osc}$        | 1.0     | 40    | 200          | KHz  |
| PWM Input Voltage (Pin 3, 4, 14)           |                  | 0.3     |       | 5.3          | V    |
| Operating Free-Air Temperature             | $T_A$            | -40     |       | 85           | °C   |



**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494A/C**

**Electrical Characteristics**

T<sub>A</sub> = 25°C, V<sub>CC</sub>=20V, f=10KHz unless otherwise noted.

| Parameter                           | Symbol              | Conditions   | Min  | Typ  | Max                | Unit |
|-------------------------------------|---------------------|--|------|------|--------------------|------|
| <b>Reference Section</b>            |                     |  |      |      |                    |      |
| Output Reference Voltage for AZ494A | V <sub>REF</sub>    | I <sub>REF</sub> =1mA  | 4.90 | 4.95 | 5.0                | V    |
|                                     |                     | I <sub>REF</sub> =1mA, T <sub>A</sub> = -40 to 85°C                        | 4.85 | 4.95 | 5.05               | V    |
| Output Reference Voltage for AZ494C | V <sub>REF</sub>    | I <sub>REF</sub> =1mA  | 4.95 | 5.0  | 5.05               | V    |
|                                     |                     | I <sub>REF</sub> =1mA, T <sub>A</sub> = -40 to 85°C                        | 4.9  | 5.0  | 5.1                | V    |
| Line Regulation                     | R <sub>LINE</sub>   | V <sub>CC</sub> = 7V to 36V  |      | 2    | 25                 | mV   |
| Load Regulation                     | R <sub>LOAD</sub>   | I <sub>REF</sub> =1mA to 10mA  |      | 1    | 15                 | mV   |
| Short-Circuit Output Current        | I <sub>SC</sub>     | V <sub>REF</sub> = 0V  | 10   | 35   | 50                 | mA   |
| <b>Oscillator Section</b>           |                     |  |      |      |                    |      |
| Oscillator Frequency                | f <sub>OSC</sub>    | C <sub>T</sub> =0.001μF, R <sub>T</sub> =30KΩ                              |      | 40   |                    | KHz  |
|                                     |                     | C <sub>T</sub> =0.01μF, R <sub>T</sub> =12KΩ                               | 9.2  | 10   | 10.8               |      |
|                                     |                     | C <sub>T</sub> =0.01μF, R <sub>T</sub> =12KΩ, T <sub>A</sub> = -40 to 85°C | 9.0  |      | 12                 |      |
| Frequency Change with Temperature   | Δf /ΔT              | C <sub>T</sub> =0.01μF, R <sub>T</sub> =12KΩ, T <sub>A</sub> = -40 to 85°C |      |      | 1                  | %    |
| <b>Dead-Time Control Section</b>    |                     |  |      |      |                    |      |
| Input Bias Current                  | I <sub>BIAS</sub>   | V <sub>CC</sub> =15V, V <sub>4</sub> = 0 to 5.25V                          |      | -2   | -10                | μA   |
| Maximum Duty Cycle,                 | D(MAX)              | V <sub>CC</sub> =15V, V <sub>4</sub> = 0V, Pin 13= V <sub>REF</sub>        | 45   |      |                    | %    |
| Input Threshold Voltage             | V <sub>ITH</sub>    | Zero Duty Cycle  |      | 3    | 3.3                | V    |
|                                     |                     | Maximum Duty Cycle   | 0    |      |                    |      |
| <b>Error-Amplifier Section</b>      |                     |  |      |      |                    |      |
| Input Offset Voltage                | V <sub>IO</sub>     | V <sub>3</sub> = 2.5V  |      | 2    | 10                 | mV   |
| Input Offset Current                | I <sub>IO</sub>     | V <sub>3</sub> = 2.5V  |      | 25   | 250                | nA   |
| Input Bias Current                  | I <sub>BIAS</sub>   | V <sub>3</sub> = 2.5V  |      | 0.2  | 1                  | μA   |
| Common-Mode Input Voltage Range     | V <sub>CM</sub>     | V <sub>CC</sub> =7V to 36V   | -0.3 |      | V <sub>CC</sub> -2 | V    |
| Open-Loop Voltage Gain              | G <sub>VO</sub>     | V <sub>O</sub> =0.5V to 3.5V   | 70   | 95   |                    | dB   |
| Unity-Gain Bandwidth                | BW                  |  |      | 650  |                    | KHz  |
| Common-Mode Rejection Ratio         | CMRR                |  | 65   | 80   |                    | dB   |
| Output Sink Current (Feedback)      | I <sub>SINK</sub>   | V <sub>ID</sub> = -15mV to -5V, V <sub>3</sub> = 0.7V                      | -0.3 | -0.7 |                    | mA   |
| Output Source Current (Feedback)    | I <sub>SOURCE</sub> | V <sub>ID</sub> =15mV to 5V, V <sub>3</sub> = 3.5V                         | 2    |      |                    | mA   |



**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494A/C**

**Electrical Characteristics (Continued)**

| Parameter                               | Symbol           | Conditions                         | Min                          | Typ  | Max  | Unit    |   |
|---|------------------|------------------------------------|------------------------------|------|------|---------|---|
| <b>PWM Comparator Section</b>           |                  |                                    |                              |      |      |         |   |
| Input Threshold Voltage                 | $V_{ITH}$        | Zero duty cycle                    |                              | 4    | 4.5  | V       |   |
| Input Sink Current                      | $I_{SINK}$       | $V_3 = 0.7V$                       | -0.3                         | -0.7 |      | mA      |   |
| <b>Output Section</b>                   |                  |                                    |                              |      |      |         |   |
| Output Saturation Voltage               | Common Emitter   | $V_{CE(SAT)}$                      | $V_E = 0V, I_C = 200mA$      |      | 1.1  | 1.3     | V |
|   | Emitter Follower | $V_{CC(SAT)}$                      | $V_{CC} = 15V, I_E = -200mA$ |      | 1.5  | 2.5     |   |
| Collector Off-State Current             | $I_C(OFF)$       | $V_{CE} = 36V, V_{CC} = 36V$       |                              | 2    | 100  | $\mu A$ |   |
| Emitter Off-State Current               | $I_E(OFF)$       | $V_{CC} = V_C = 36V, V_E = 0$      |                              |      | -100 | $\mu A$ |   |
| <b>Total Device</b>                     |                  |                                    |                              |      |      |         |   |
| Supply Current                          | $I_{CC}$         | Pin 6 = $V_{REF}$ , $V_{CC} = 15V$ |                              | 6    | 10   | mA      |   |
| <b>Output Switching Characteristics</b> |                  |                                    |                              |      |      |         |   |
| Rise Time                               | $t_R$            | Common Emitter<br>Common Collector |                              | 100  | 200  | ns      |   |
| Fall Time                               | $t_F$            | Common Emitter<br>Common Collector |                              | 25   | 100  | ns      |   |



**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494A/C**

**Parametr Measurement information**

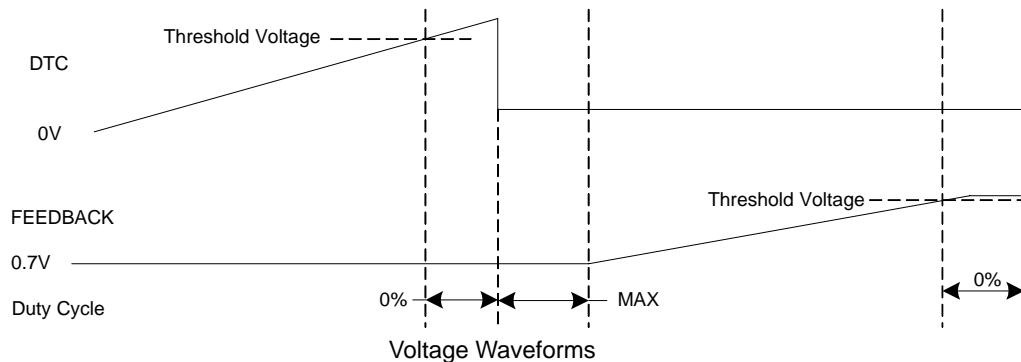
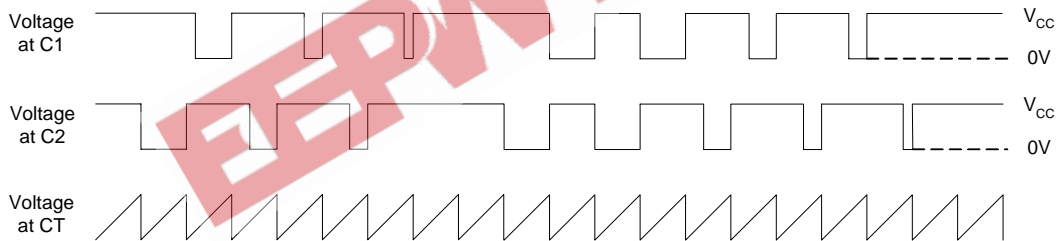
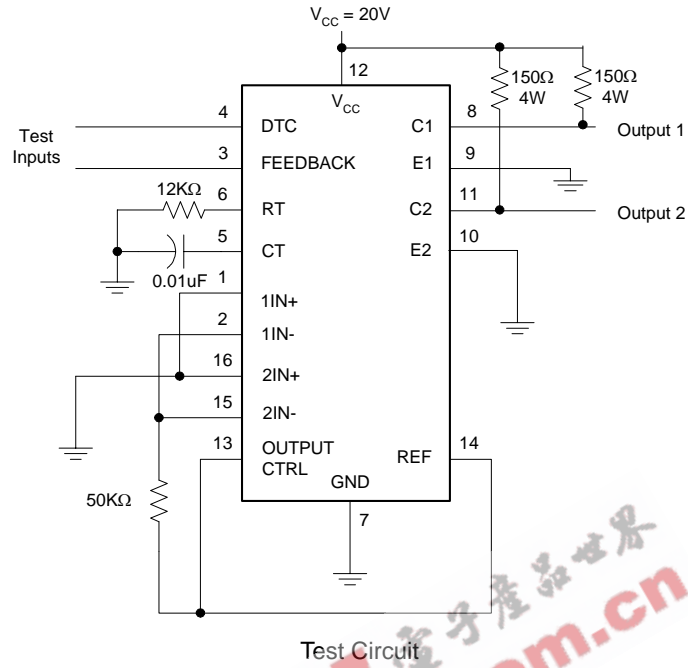


Figure 4. Operational Test Circuit and Waveforms



**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494A/C**

**Parametr Measurement information (Continued)**

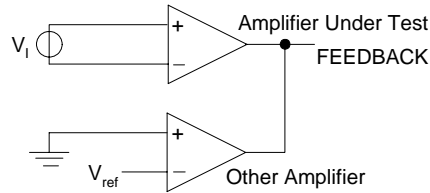
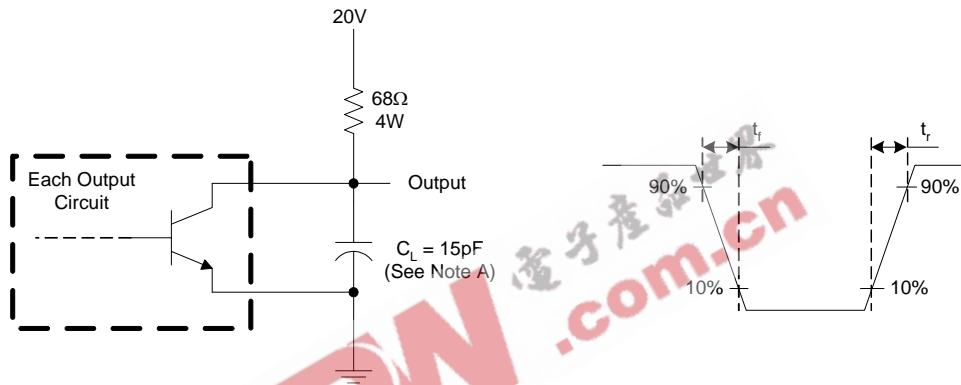
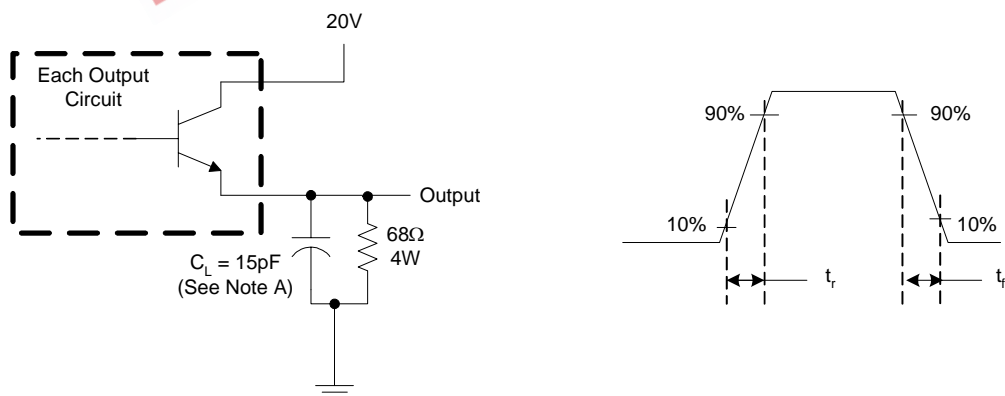


Figure 5. Error Amplifier Characteristics



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





**Typical Performance Characteristics**

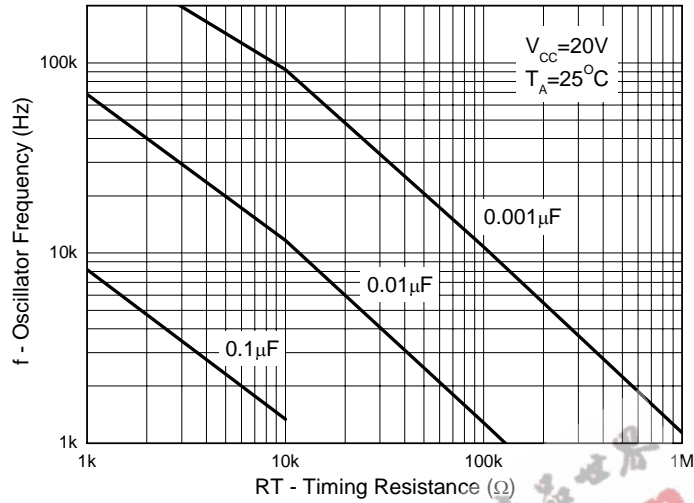


Figure 8. Oscillator Frequency vs. RT and CT

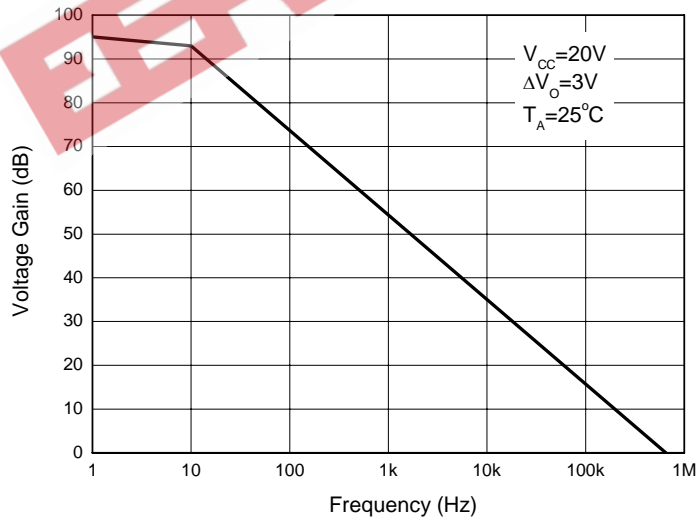


Figure 9. Error Amplifier Small-Signal Voltage Gain vs. Frequency



**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494A/C**

**Typical Applications**

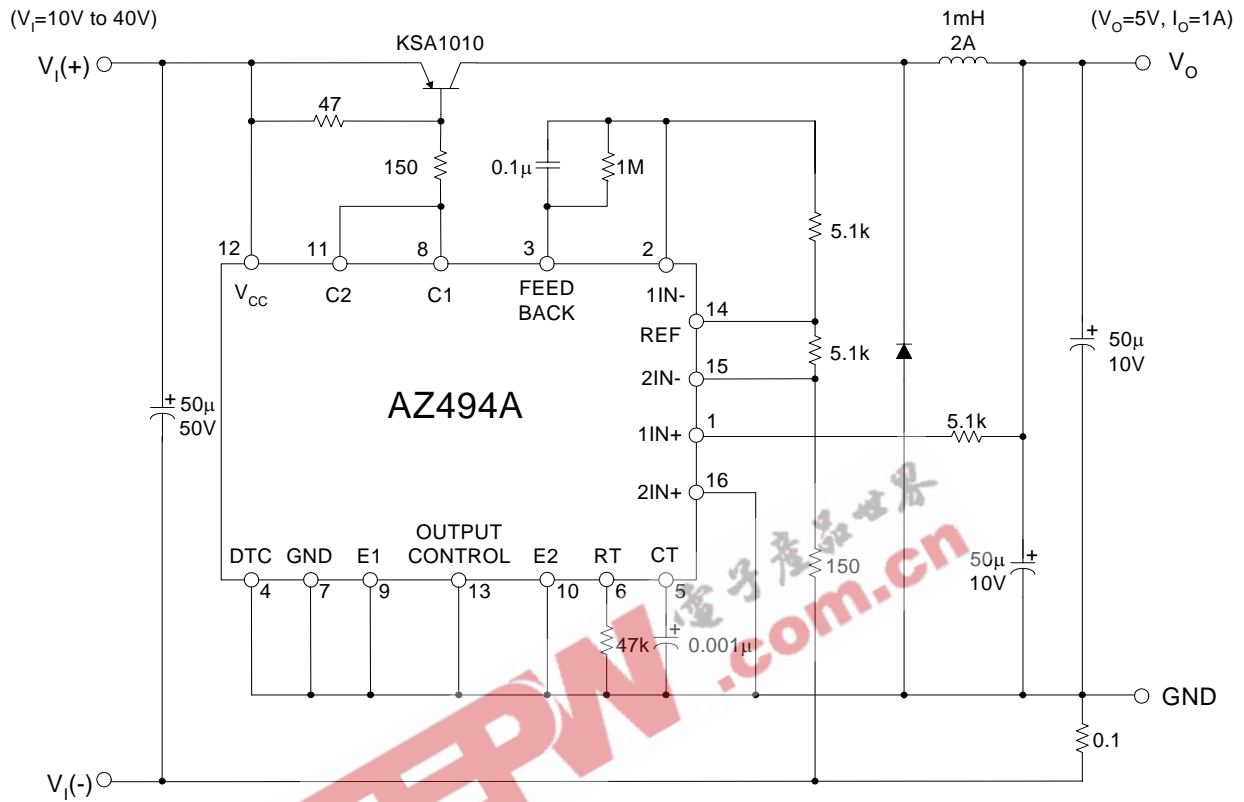


Figure 10. Pulse Width Modulated Step-Down Converter



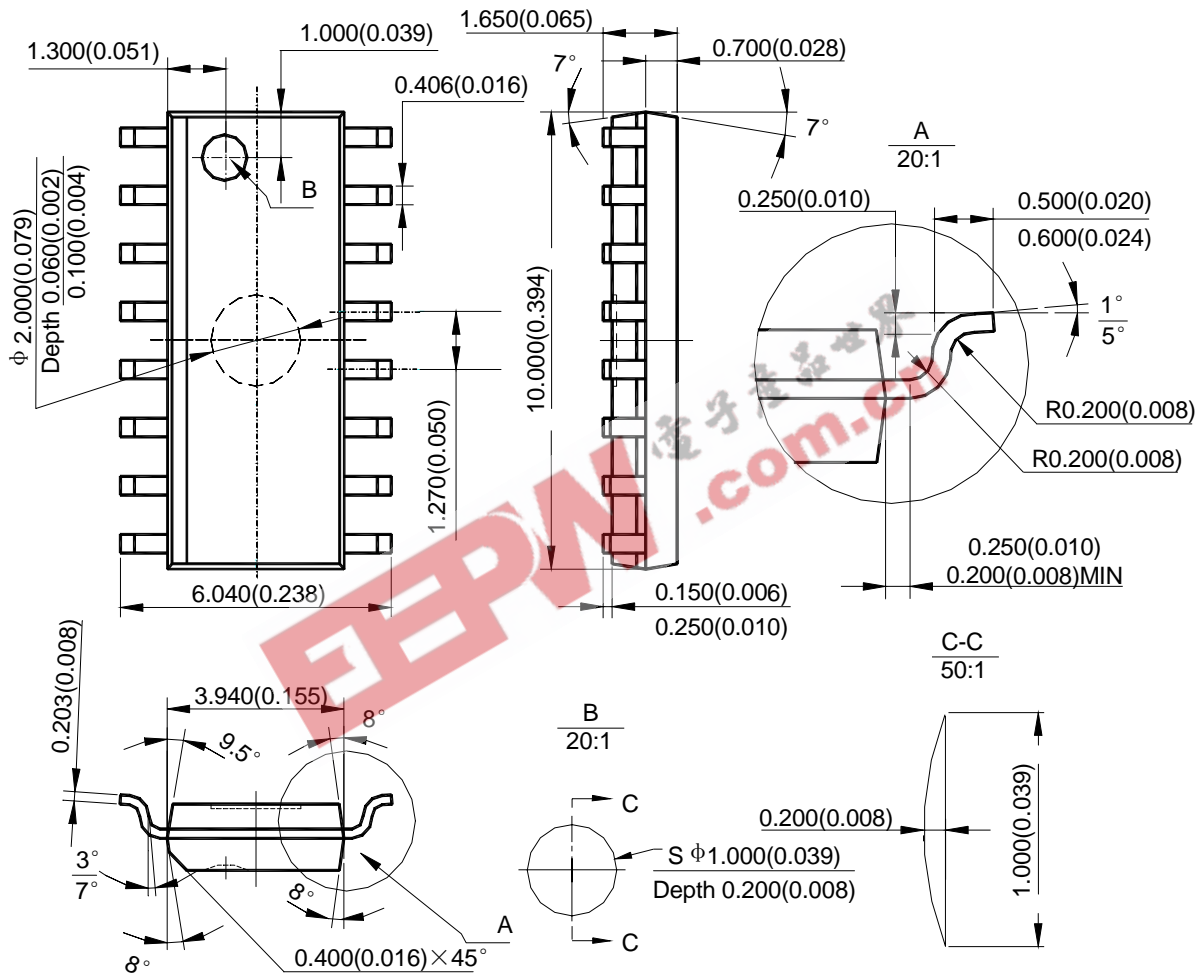
**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494A/C**

**Mechanical Dimensions**

**SOIC-16**

**Unit: mm(inch)**





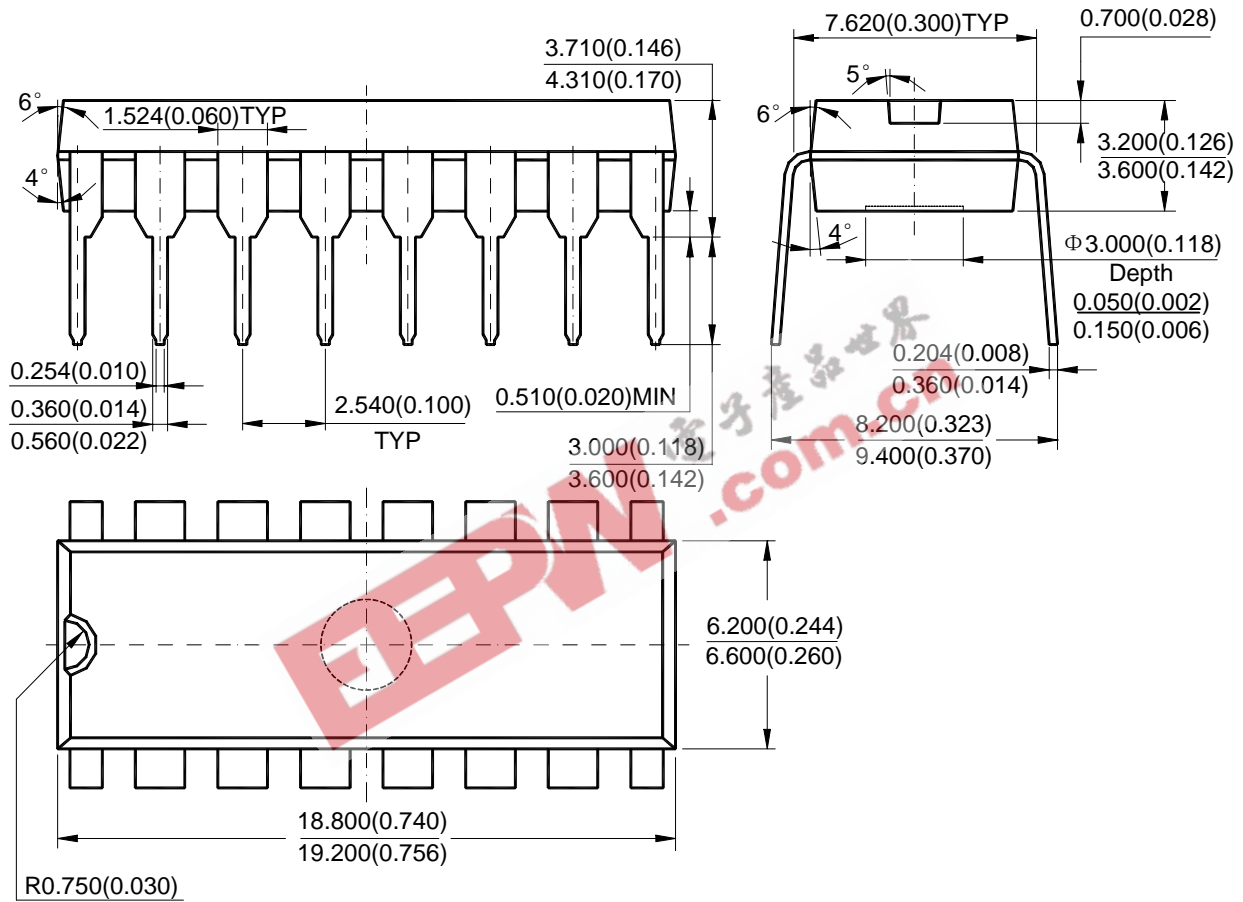
**PULSE-WIDTH-MODULATION CONTROL CIRCUITS**

**AZ494A/C**

**Mechanical Dimensions (Continued)**

**DIP-16**

**Unit: mm(inch)**





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