

**PULSE-WIDTH-MODULATION CONTROL CIRCUITS****AZ7500C****General Description**

The AZ7500C is a voltage mode pulse width modulation switching regulator control circuit designed primarily for power supply control.

The AZ7500C 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 AZ7500C provides for push-pull or single-ended output operation, which can be selected through the output control.

The difference between AZ7500B and AZ7500C is that they have 4.95V and 5V reference voltage respectively.

The AZ7500C is available in standard package of SOIC-16.

**Features**

- Stable 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

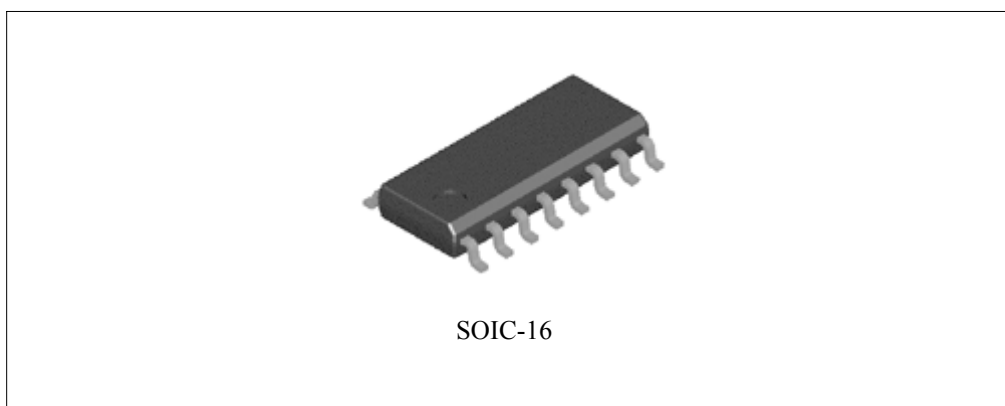


Figure 1. Package Type of AZ7500C



# PULSE-WIDTH-MODULATION CONTROL CIRCUITS

AZ7500C

## Pin Configuration

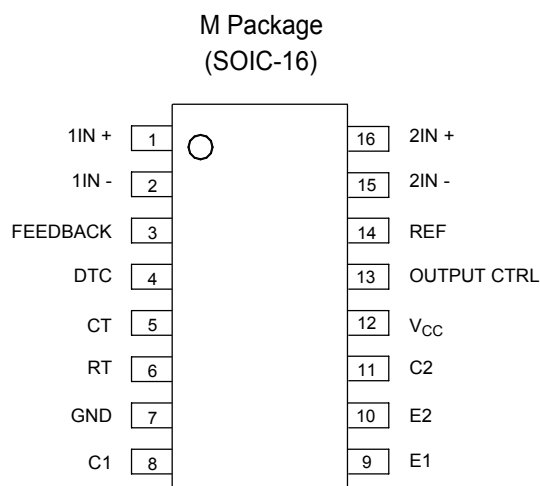


Figure 2. Pin Configuration of AZ7500C (Top View)

## Output Function Control Table

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

## Functional Block Diagram

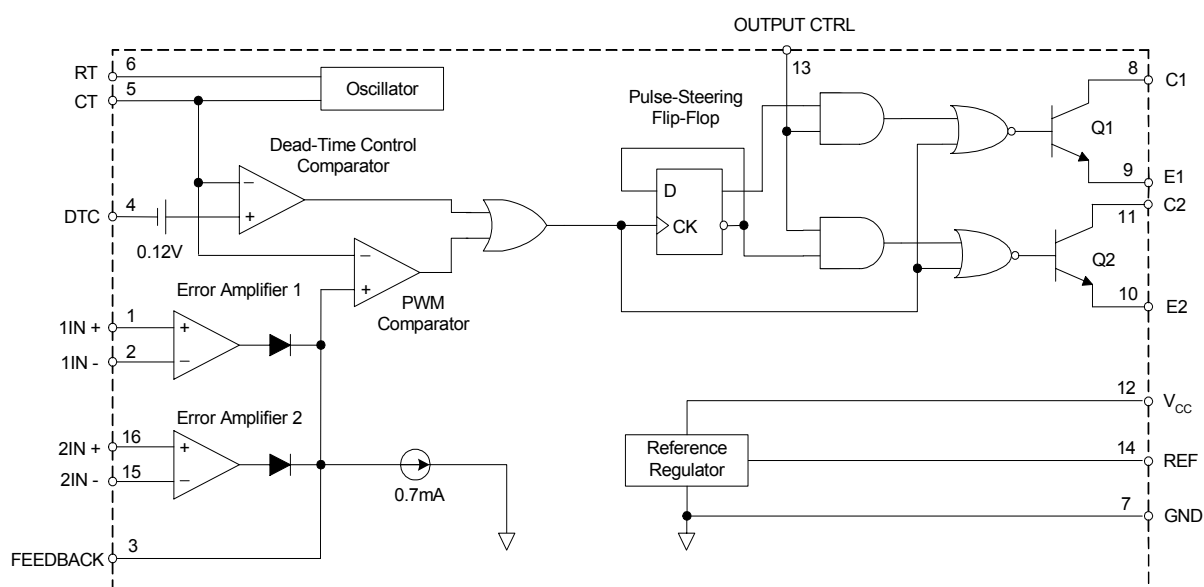
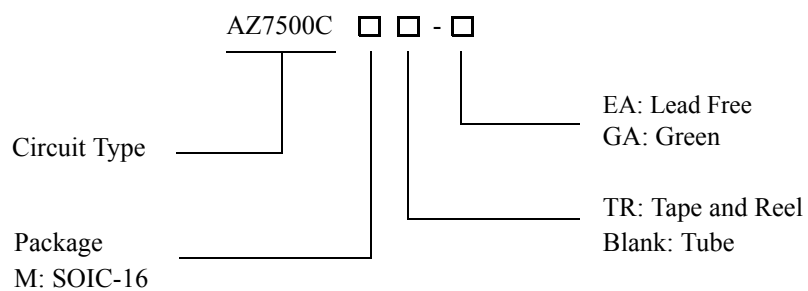


Figure 3. Functional Block Diagram of AZ7500C

**PULSE-WIDTH-MODULATION CONTROL CIRCUITS****AZ7500C****Ordering Information**

| Package | Temperature Range | Part Number   |               | Marking ID  |             | Packing Type |
|---------|-------------------|---------------|---------------|-------------|-------------|--------------|
|         |                   | Lead Free     | Green         | Lead Free   | Green       |              |
| SOIC-16 | -40 to 85°C       | AZ7500CM-EA   | AZ7500CM-GA   | AZ7500CM-EA | AZ7500CM-GA | Tube         |
|         |                   | AZ7500CMTR-EA | AZ7500CMTR-GA | AZ7500CM-EA | AZ7500CM-GA | Tape & Reel  |

BCD Semiconductor's Pb-free products, as designated with "EA" suffix in the part number, are RoHS compliant. Products with "GA" suffix are available in green packages.

**PULSE-WIDTH-MODULATION CONTROL CIRCUITS****AZ7500C****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                       | $R_{\theta JA}$ | 73                     | $^{\circ}\text{C/W}$ |
| Lead Temperature 1.6mm from case for 10 seconds |                 | 260                    | $^{\circ}\text{C}$   |
| Junction Temperature                            | $T_J$           | 150                    | $^{\circ}\text{C}$   |
| Storage Temperature Range                       | $T_{STG}$       | -65 to 150             | $^{\circ}\text{C}$   |
| 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  $T_J(\text{max})$ ,  $R_{\theta JA}$  and  $T_A$ . The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J(\text{max}) - T_A) / R_{\theta JA}$ . Operating at the absolute maximum  $T_J$  of 150 $^{\circ}\text{C}$  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           | $\mu\text{F}$      |
| Timing Resistor                            | $R_T$            | 1.8     | 30    | 500          | $\text{K}\Omega$   |
| 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           | $^{\circ}\text{C}$ |

**PULSE-WIDTH-MODULATION CONTROL CIRCUITS****AZ7500C****Electrical Characteristics** $T_A = 25^{\circ}\text{C}$ ,  $V_{CC} = 20\text{V}$ ,  $f = 10\text{KHz}$  unless otherwise noted.

| Parameter                         | Symbol              | Conditions                                                                 | Min  | Typ  | Max                | Unit |
|-----------------------------------|---------------------|----------------------------------------------------------------------------|------|------|--------------------|------|
| Reference Section                 |                     |                                                                            |      |      |                    |      |
| Output Reference Voltage          | 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   |
| Oscillator Section                |                     |                                                                            |      |      |                    |      |
| 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    |                    | %    |
| Dead-Time Control Section         |                     |                                                                            |      |      |                    |      |
| Input Bias Current                | I <sub>BIAS</sub>   | V <sub>CC</sub> =15V, V4= 0 to 5.25V                                       |      | -2   | -10                | μA   |
| Maximum Duty Cycle                | D(MAX)              | V <sub>CC</sub> =15V, V4= 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    |      |                    |      |
| Error-Amplifier Section           |                     |                                                                            |      |      |                    |      |
| Input Offset Voltage              | V <sub>IO</sub>     | V3 = 2.5V                                                                  |      | 2    | 10                 | mV   |
| Input Offset Current              | I <sub>IO</sub>     | V3 = 2.5V                                                                  |      | 25   | 250                | nA   |
| Input Bias Current                | I <sub>BIAS</sub>   | V3 = 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, V3 = 0.7V                                  | -0.3 | -0.7 |                    | mA   |
| Output Source Current (Feedback)  | I <sub>SOURCE</sub> | V <sub>ID</sub> =15mV to 5V V3 = 3.5V                                      | 2    |      |                    | mA   |

**PULSE-WIDTH-MODULATION CONTROL CIRCUITS****AZ7500C****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

**AZ7500C**

## Parametr Measurement information

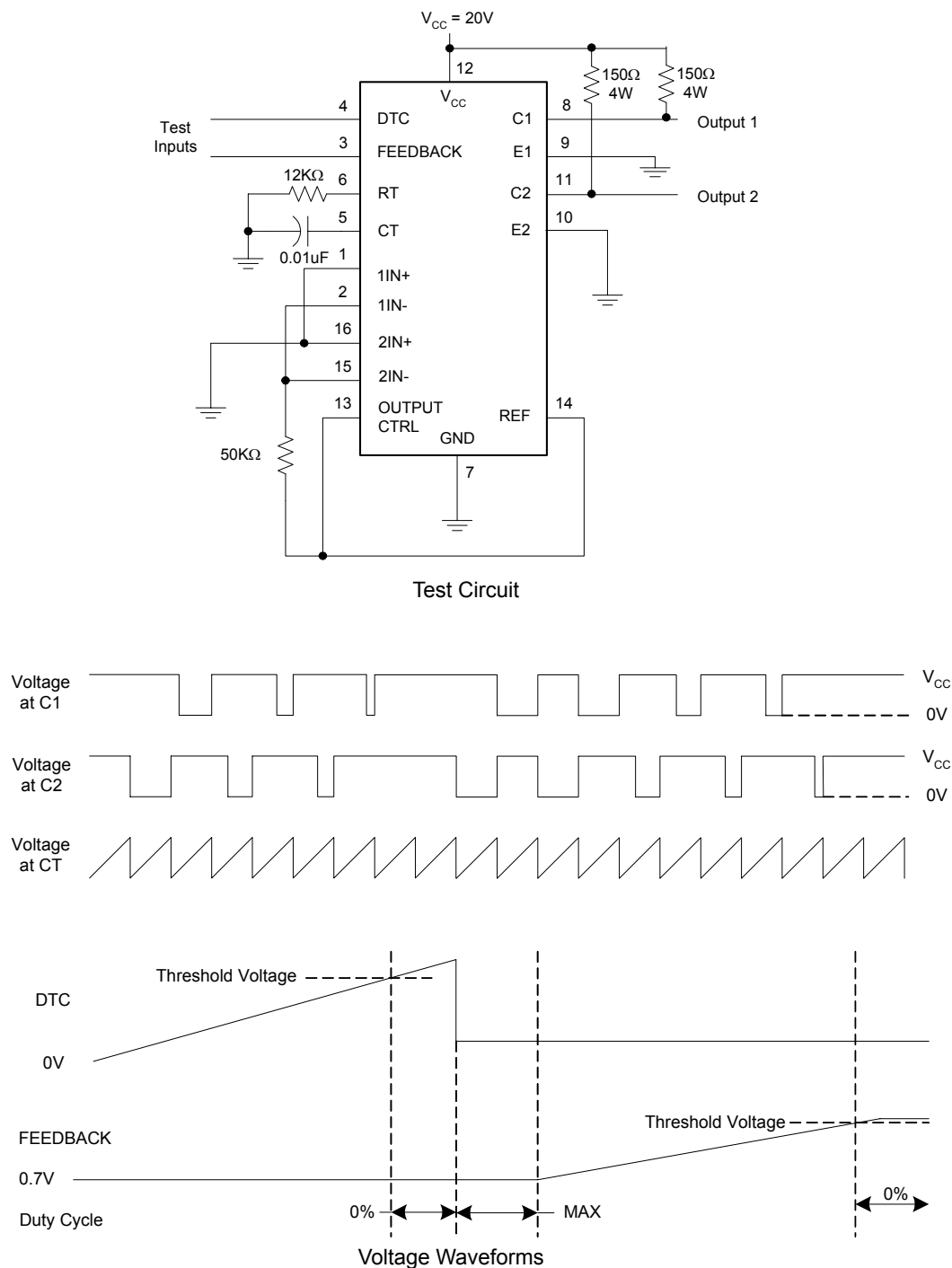


Figure 4. Operational Test Circuit and Waveforms

# PULSE-WIDTH-MODULATION CONTROL CIRCUITS

AZ7500C

## Parametr Measurement information (Continued)

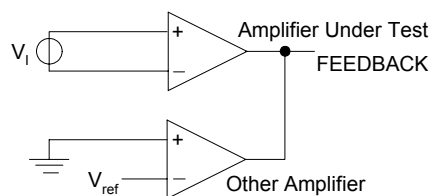
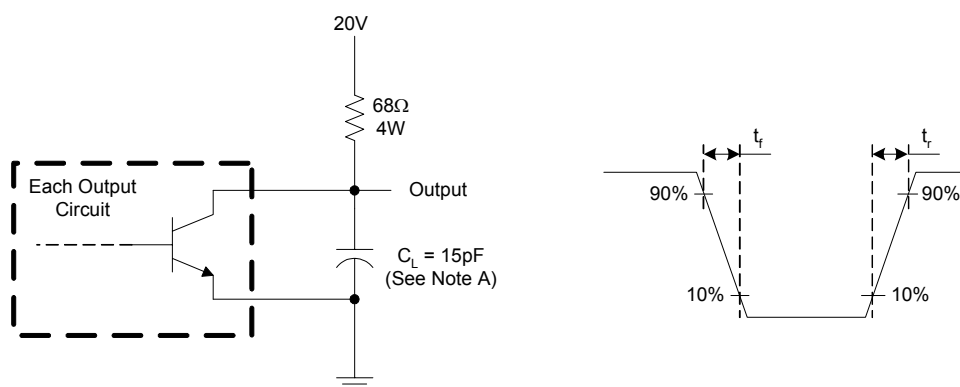
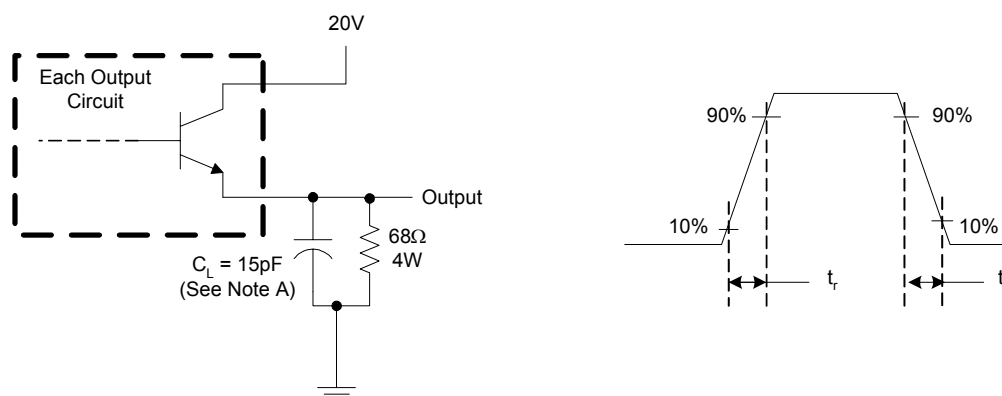


Figure 5. Error Amplifier Characteristics



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



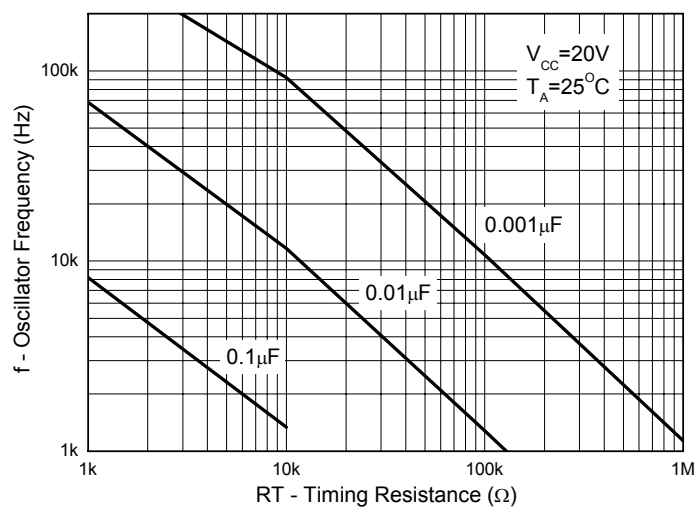
**Typical Performance Characteristics**

Figure 8. Oscillator Frequency vs. RT and CT

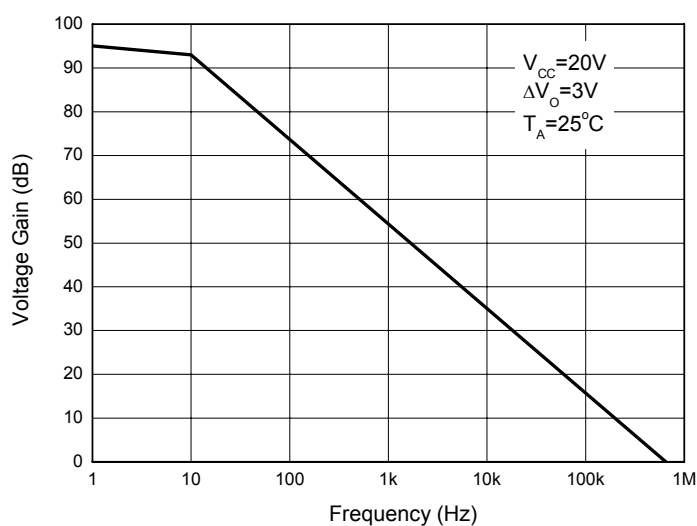


Figure 9. Error Amplifier Small-Signal Voltage Gain vs. Frequency

## PULSE-WIDTH-MODULATION CONTROL CIRCUITS

# AZ7500C

## Typical Application

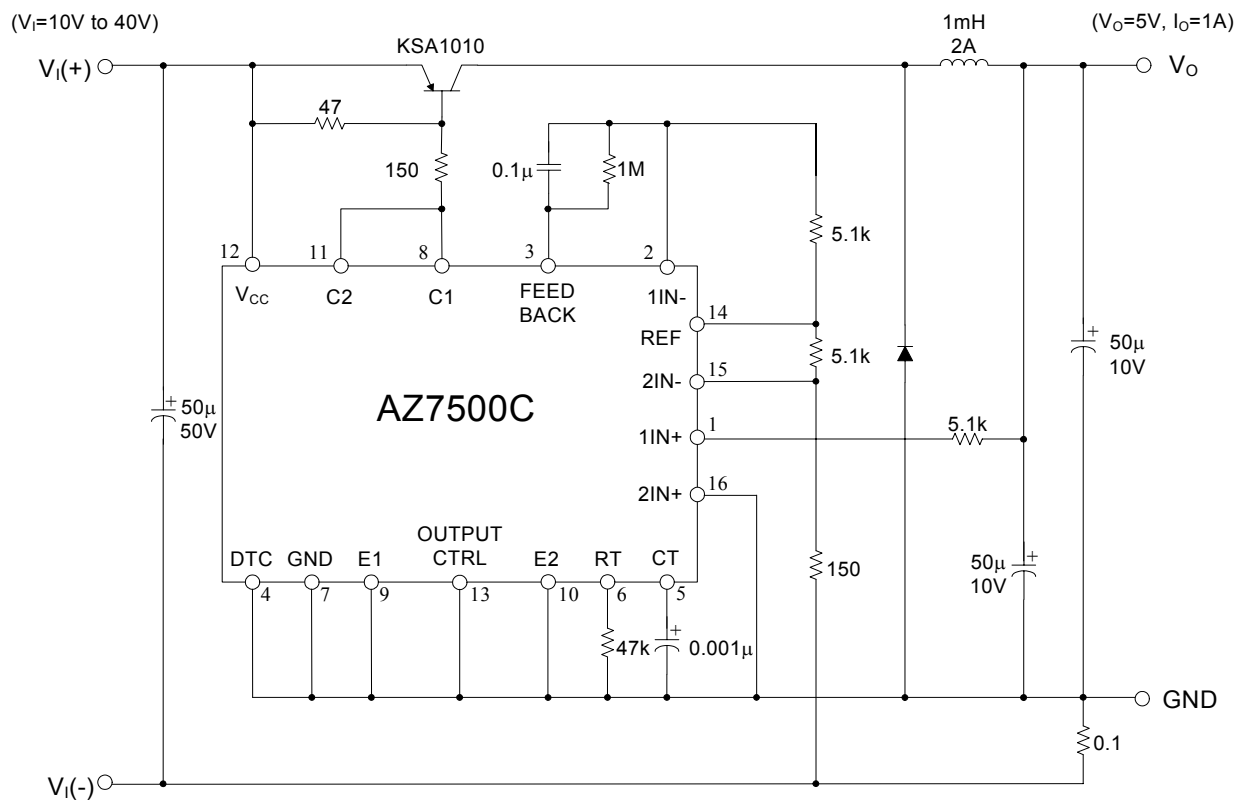
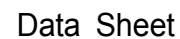


Figure 10. Pulse Width Modulated Step-Down Converter

**AZ7500C****SOIC-16**

Unit: mm(inch)





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