

# Advanced Regulating Pulse Width Modulators

## FEATURES

- Dual Uncommitted 40V, 200mA Output Transistors
- 1% Accurate 5V Reference
- Dual Error Amplifiers
- Wide Range, Variable Deadtime
- Single-ended or Push-pull Operation
- Under-voltage Lockout With Hysteresis
- Double Pulse Protection
- Master or Slave Oscillator Operation
- UC495A: Internal 39V Zener Diode
- UC495A: Buffered Steering Control

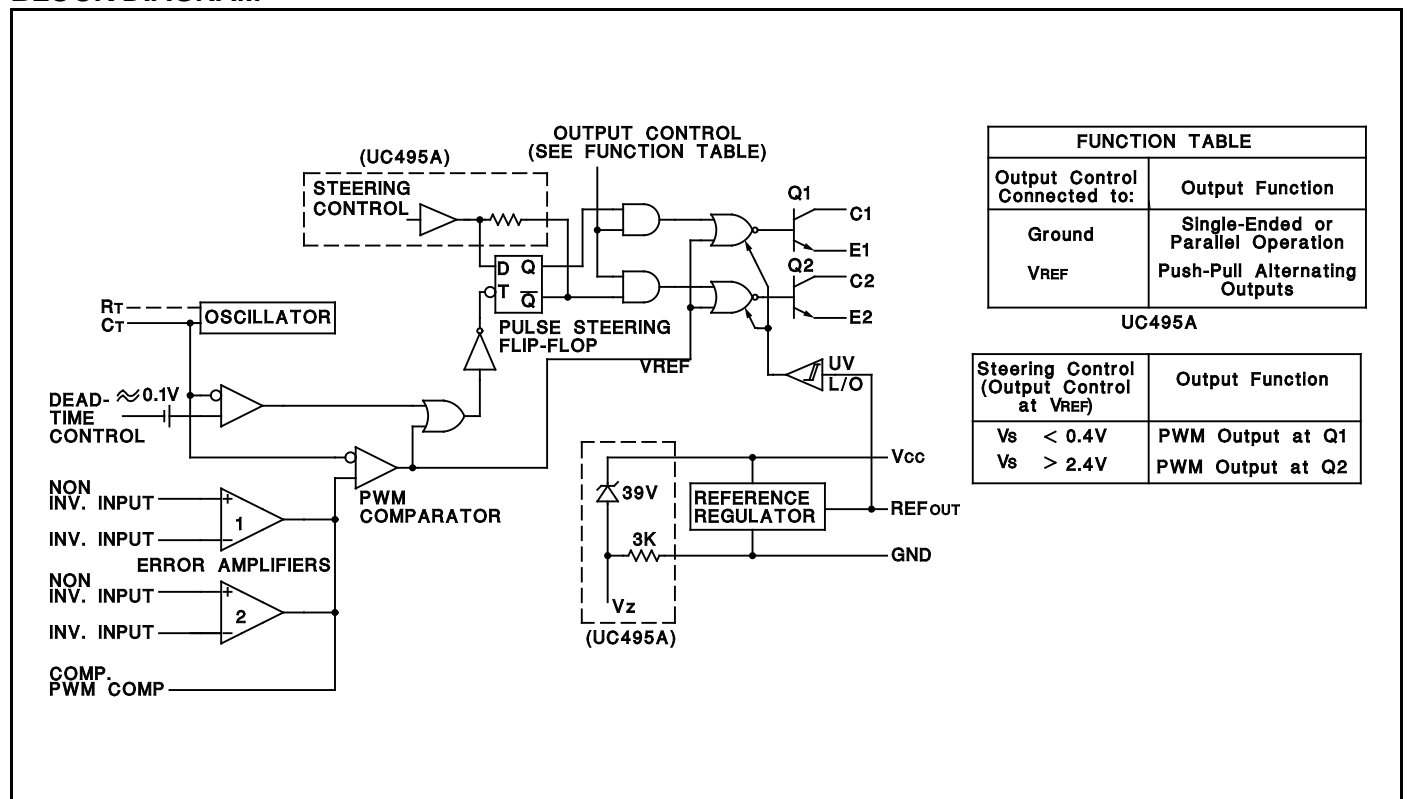
## DESCRIPTION

This entire series of PWM modulators each provide a complete pulse width modulation system in a single monolithic integrated circuit. These devices include a 5V reference accurate to  $\pm 1\%$ , two independent amplifiers usable for both voltage and current sensing, an externally synchronizable oscillator with its linear ramp generator, and two uncommitted transistor output switches. These two outputs may be operated either in parallel for single-ended operation or alternating for push-pull applications with an externally controlled dead-band. These units are internally protected against double-pulsing of a single output or from extraneous output signals when the input supply voltage is below minimum.

The UC495A contains an on-chip 39V zener diode for high-voltage applications where  $V_{CC}$  would be greater than 40V, and a buffered output steering control that overrides the internal control of the pulse steering flip-flop.

The UC494A is packaged in a 16-pin DIP, while the UC495A is packaged in an 18 pin DIP. The UC494A, UC495A are specified for operation over the full military temperature range of  $-55^{\circ}\text{C}$  to  $+125^{\circ}\text{C}$ , while the UC494AC, UC495AC are designed for industrial applications from  $0^{\circ}\text{C}$  to  $+70^{\circ}\text{C}$ .

## BLOCK DIAGRAM



## ABSOLUTE MAXIMUM RATINGS (Note 1, 2, 3)

|   |                 |
|---|-----------------|
| Supply Voltage, $V_{CC}$ (Note 2)                                     | 45V             |
| Amplifier Input Voltages  | $V_{CC} + 0.3V$ |
| Collector Output Voltage  | 41V             |
| Collector Output Current  | 250mA           |
| Continuous Total Dissipation  | 1000mW          |
| @ (or below) 25°C free air temperature range (Note 3)                 |                 |
| Storage Temperature Range   | -65° to +150°C  |
| Lead Temperature 1/16" (1.6mm) from case for 60 seconds,<br>J Package | 300°C           |
| Lead Temperature 1/16" (1.6mm) from case for 10 seconds,<br>N Package | 260°C           |

Note 1: Over operating free air temperature range unless otherwise noted.

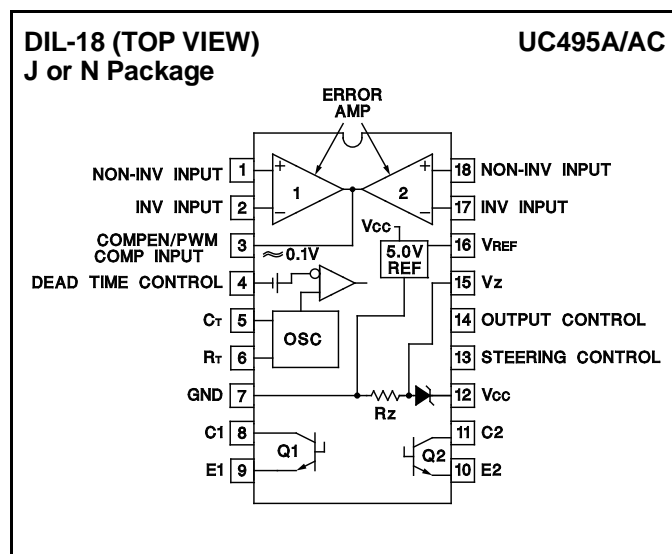
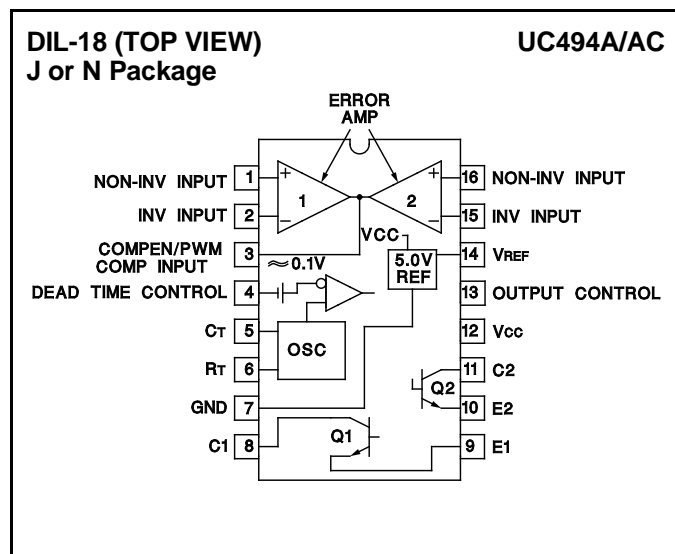
Note 2: All voltage values are with respect to network ground terminal 3.

Note 3: Consult Packaging Section of Databook regarding thermal specifications and limitations of packages.

## RECOMMENDED OPERATING CONDITIONS

|  |                                |
|--|--------------------------------|
| Supply Voltage $V_{CC}$                    | 7V to 40V                      |
| Error Amplifier Input Voltages             | -0.3V to $V_{CC}-2V$           |
| Collector Output Voltage                   | 40V                            |
| Collector Output Current (each transistor) | 200mA                          |
| Current into Feedback Terminal             | 0.3mA                          |
| Timing Capacitor, $C_T$                    | 0.47nF to 10,000nF             |
| Timing Resistor, $R_T$                     | 1.8k $\Omega$ to 500k $\Omega$ |
| Oscillator Frequency                       | 1kHz to 300kHz                 |
| Operating Free Air Temperature             |                                |
| UC494A, UC495A                             | -55°C to +125°C                |
| UC494AC, UC495AC                           | 0°C to +70°C                   |

## CONNECTION DIAGRAMS



**ELECTRICAL CHARACTERISTICS:** Unless otherwise stated, over recommended operating free-air temperature range,  $V_{CC} = 15V$ ,  $f = 10kHz$ ,  $T_A = T_J$ .

| PARAMETER  | TEST CONDITIONS  | MIN  | TYP | MAX  | UNITS   |
|--|--|------|-----|------|---------|
| <b>Reference Section</b>   |  |      |     |      |         |
| Output Voltage $V_{REF}$   | $I_O = 1mA$ , $T_A = 25^\circ C$   | 4.95 | 5   | 5.05 | V       |
| Input Regulation   | $V_{CC} = 7V$ to $40V$   |      | 2   | 25   | mV      |
| Output Regulation  | $I_O = 1mA$ to $10mA$  |      | 1   | 15   | mV      |
| Output Voltage Over Temperature  | $\Delta T_A = \text{Min. to Max.}$   | 4.90 |     | 5.10 | V       |
| Short Circuit Output Current   | $V_{REF} = 0$ , $T_A = 25^\circ C$ (Note 1)                                | 10   | 35  | 50   | mA      |
| <b>Oscillator Section</b>  |  |      |     |      |         |
| Frequency (Note 2)   | $C_T = 0.01\mu F$ , $R_T = 12k\Omega$                                      |      | 10  |      | kHz     |
| Standard Deviation Of Frequency (Note 3)                                 | All Values of $V_{CC}$ , $C_T$ , $R_T$ , $T_A$ Constant                    |      | 10  |      | %       |
| Frequency Change With Voltage  | $V_{CC} = 7V$ to $40V$ , $T_A = 25^\circ C$                                |      | 0.1 |      | %       |
| Frequency Change With Temperature  | $C_T = 0.01\mu F$ , $R_T = 12k\Omega$ , $\Delta T_A = \text{Min. to Max.}$ |      |     | 2    | %       |
| <b>Deadtime Control Section</b> (Output Control Connected to $V_{REF}$ ) |  |      |     |      |         |
| Input Bias Current (Pin 4)   | $V_{(PIN 4)} = 0V$ to $5.25V$  |      | -2  | -10  | $\mu A$ |
| Maximum Duty-Cycle (Each Output)   | $V_{(PIN 4)} = 0V$   | 45   |     |      | %       |

**ELECTRICAL CHARACTERISTICS:** Unless otherwise stated, over recommended operating free-air temperature range,  $V_{CC} = 15V$ ,  $f = 10kHz$ ,  $T_A = T_J$ .

| PARAMETER   |                  | TEST CONDITION                                   | MIN           | TYP  | MAX  | UNITS |    |
|---|------------------|--|---------------|------|------|-------|----|
| Deadtime Control Section (cont.) (Output Control Connected to VREF) |                  |  |               |      |      |       |    |
| Input Threshold Voltage (Pin 4)                                     |                  | Zero Duty-Cycle                                  |               | 3    | 3.3  | V     |    |
|   |                  | Maximum Duty-Cycle                               | 0             |      |      | V     |    |
| Amplifier Section   |                  |  |               |      |      |       |    |
| Input Offset Voltage  |                  | VO (PIN 3) = 2.5V                                |               | 2    | 10   | mV    |    |
| Input Offset Current  |                  | VO (PIN 3) =2.5V                                 |               | 25   | 250  | nA    |    |
| Input Bias Current  |                  | VO (PIN 3) = 2.5V                                |               | -0.2 | -1   | μA    |    |
| Common-Mode Input Voltage Range                                     |                  | VCC = 7V to 40V                                  | .03 to VCC -2 |      |      | V     |    |
| Open Loop Voltage Gain  |                  | ΔVo = 3V, Vo = 0.5V to 3.5 V                     | 70            | 95   |      | dB    |    |
| Unity Gain Bandwidth  |                  |  |               | 800  |      | kHz   |    |
| Common-Mode Rejection Ratio   |                  | VCC = 40V, TA = 25°C                             | 65            | 80   |      | dB    |    |
| Output Sink Current (Pin 3)   |                  | VID = -15mV to -5V, V(PIN 3) = 0.7V              | 0.3           | 0.7  |      | mA    |    |
| Output Source Current (Pin 3)                                       |                  | VID = 15mV to 5V, V(PIN 3) = 3.5V                | -2            |      |      | mA    |    |
| Output Section  |                  |  |               |      |      |       |    |
| Collector Off-State Current   |                  | VCE = 40V, VCC = 40V                             |               | 2    | 100  | μA    |    |
| Emitter Off-State Current   |                  | VCC = VC = 40V, VE = 0                           |               |      | -100 | μA    |    |
| Collector - Emitter Saturation Voltage                              | Common-Emitter   | VE = 0, IC = 200mA                               |               | 1.1  | 1.3  | V     |    |
|   | Emitter-Follower | VC = 15V, IE = -200mA                            |               | 1.5  | 2.5  | V     |    |
| Output Control Input Current  |                  | VI = VREF  |               |      | 3.5  | mA    |    |
| PWM Comparator Section  |                  |  |               |      |      |       |    |
| Input Threshold Voltage (Pin 3)                                     |                  | Zero Duty-Cycle                                  |               | 4    | 4.5  | V     |    |
| Input Sink Current (Pin 3)  |                  | V(PIN 3) = 0.7V                                  | 0.3           | 0.7  |      | mA    |    |
| Steering Control (UC495A, See Function Table)                       |                  |  |               |      |      |       |    |
| Input Current   |                  | V(PIN 13) = 0.4V, Q1 ACTIVE                      |               |      | -200 | μA    |    |
|   |                  | V(PIN 13) = 2.4V, Q2 ACTIVE                      |               |      | 300  | μA    |    |
| Deadband  |                  |  |               | 500  |      | mV    |    |
| Zener Diode Circuit (UC495A)  |                  |  |               |      |      |       |    |
| Breakdown Voltage   |                  | VCC = 45V, IZ = 2mA                              | 36            | 39   | 45   | V     |    |
| Sink Current  |                  | V(PIN 15) = 1V                                   | 0.2           | 0.3  | 0.6  | mA    |    |
| Total Device  |                  |  |               |      |      |       |    |
| Standby Supply Current  |                  | Pin 6 at VREF, All other inputs and outputs open | VCC = 15V     |      | 6    | 10    | mA |
|   |                  |  | VCC = 40V     |      | 9    | 15    | mA |
| Under Voltage Lockout   |                  |  | 3.5           |      | 6.5  | V     |    |
| Hysteresis  |                  |  |               | 300  |      | mV    |    |
| Switching Characteristics (TA = 25°C)                               |                  |  |               |      |      |       |    |
| Output Voltage Rise Time  |                  | Common-Emitter Configuration                     |               | 100  | 200  | ns    |    |
| Output Voltage Fall Time  |                  | RL = 68Ω, CL = 15pF                              |               | 25   | 100  | ns    |    |
| Output Voltage Rise Time  |                  | Emitter-Follower Configuration                   |               | 100  | 200  | ns    |    |
| Output Voltage Fall Time  |                  | RL = 68Ω, CL=15pF                                |               | 40   | 100  | ns    |    |

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

Note 2: Frequency for other values of  $C_T$  and  $R_T$  is approximately  $f = \frac{1.1}{RTCT}$

Note 3: Standard deviation is a measure of the statistical distribution about the mean as derived from the formula:

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

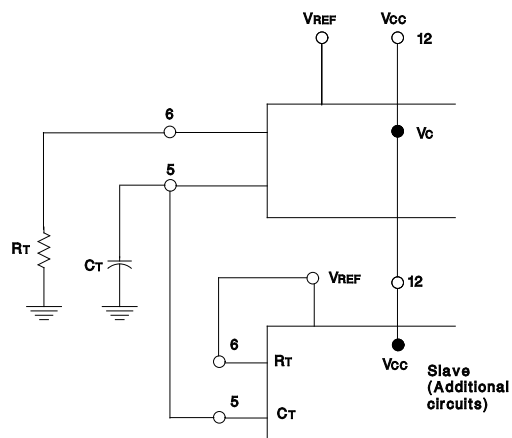


Figure 1. Slaving Two or More Control Circuits

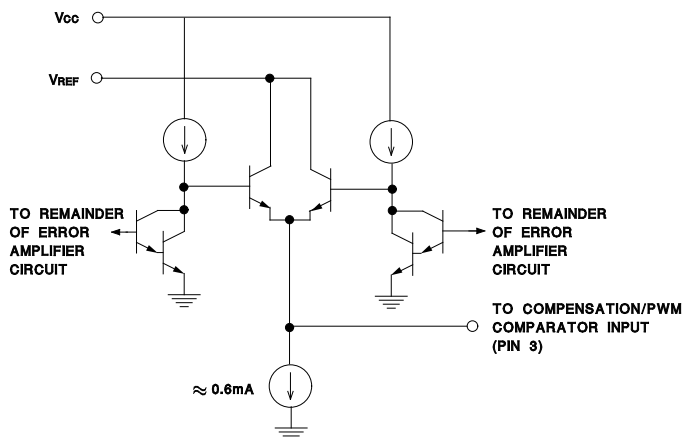
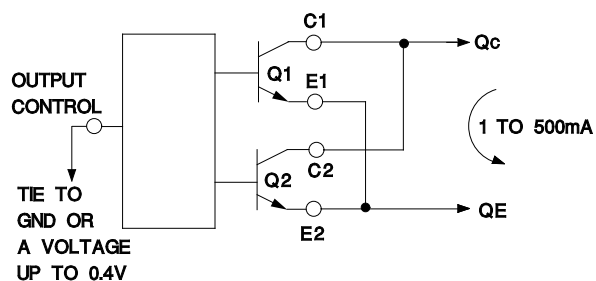
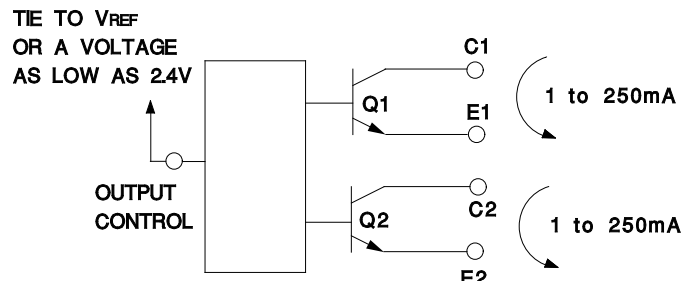


Figure 2. Output Circuit of Error Amplifiers



SINGLE - ENDED CONFIGURATION



PUSH - PULL CONFIGURATION

Figure 3. Output Connections for Single-Ended and Push-Pull Configurations

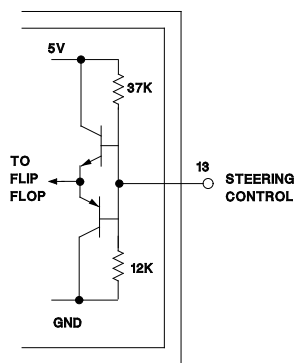


Figure 4. Internal Buffer with Deadband for Steering Control on UC495A

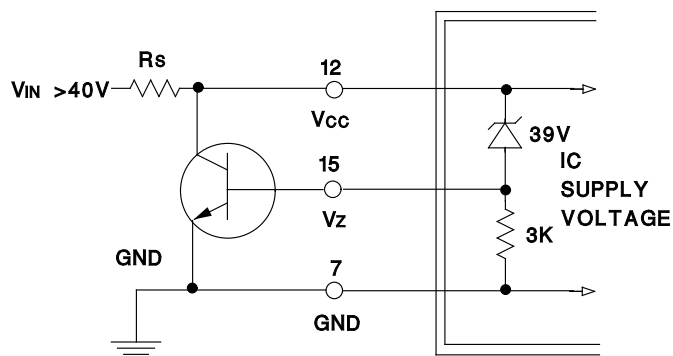


Figure 5. Operation with  $V_{IN} > 40V$  Using Internal Zener

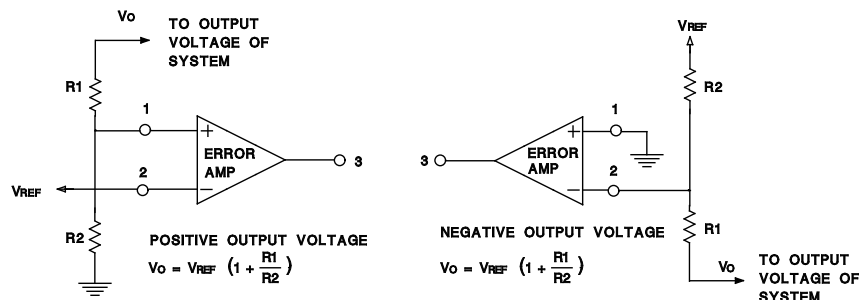


Figure 6. Error Amplifier Sensing Techniques

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