

TL494, NCV494

SWITCHMODE™ Pulse Width Modulation Control Circuit

The TL494 is a fixed frequency, pulse width modulation control circuit designed primarily for SWITCHMODE power supply control.

Features

- Complete Pulse Width Modulation Control Circuitry
- On-Chip Oscillator with Master or Slave Operation
- On-Chip Error Amplifiers
- On-Chip 5.0 V Reference
- Adjustable Deadtime Control
- Uncommitted Output Transistors Rated to 500 mA Source or Sink
- Output Control for Push-Pull or Single-Ended Operation
- Undervoltage Lockout
- NCV Prefix for Automotive and Other Applications Requiring Site and Control Changes
- Pb-Free Packages are Available*

MAXIMUM RATINGS (Full operating ambient temperature range applies, unless otherwise noted.)

| Rating | Symbol | Value | Unit |
|--|------------------------|--|--------------------|
| Power Supply Voltage | V_{CC} | 42 | V |
| Collector Output Voltage | V_{C1} , V_{C2} | 42 | V |
| Collector Output Current (Each transistor) (Note 1) | I_{C1} , I_{C2} | 500 | mA |
| Amplifier Input Voltage Range | V_{IR} | -0.3 to +42 | V |
| Power Dissipation @ $T_A \leq 45^\circ\text{C}$ | P_D | 1000 | mW |
| Thermal Resistance, Junction-to-Ambient | $R_{\theta JA}$ | 80 | $^\circ\text{C/W}$ |
| Operating Junction Temperature | T_J | 125 | $^\circ\text{C}$ |
| Storage Temperature Range | T_{stg} | -55 to +125 | $^\circ\text{C}$ |
| Operating Ambient Temperature Range | T_A | -40 to +125 0 to +70 -40 to +85 -40 to +125 | $^\circ\text{C}$ |
| Derating Ambient Temperature | T_A | 45 | $^\circ\text{C}$ |

Maximum ratings are those values beyond which device damage can occur. Maximum ratings applied to the device are individual stress limit values (not normal operating conditions) and are not valid simultaneously. If these limits are exceeded, device functional operation is not implied, damage may occur and reliability may be affected.

1. Maximum thermal limits must be observed.

*For additional information on our Pb-Free strategy and soldering details, please download the ON Semiconductor Soldering and Mounting Techniques Reference Manual, SOLDERRM/D.

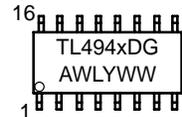


ON Semiconductor®

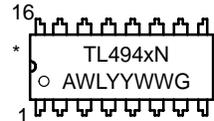
MARKING DIAGRAMS



SOIC-16
D SUFFIX
CASE 751B



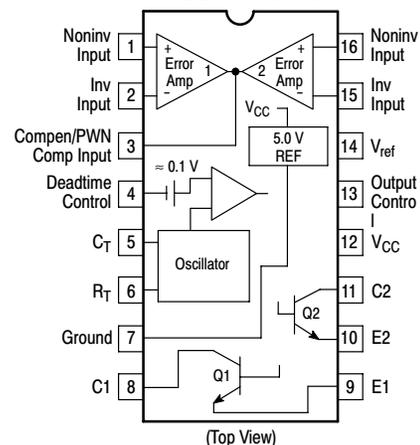
PDIP-16
N SUFFIX
CASE 648



X = B, C or I
A = Assembly Location
WL = Wafer Lot
YY, Y = Year
WW, W = Work Week
G = Pb-Free Package

*This marking diagram also applies to NCV494.

PIN CONNECTIONS



ORDERING INFORMATION

See detailed ordering and shipping information in the package dimensions section on page 4 of this data sheet.

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RECOMMENDED OPERATING CONDITIONS

| Characteristics | Symbol | Min | Typ | Max | Unit |
|--|------------------|--------|-------|----------------|------------|
| Power Supply Voltage | V_{CC} | 7.0 | 15 | 40 | V |
| Collector Output Voltage | V_{C1}, V_{C2} | – | 30 | 40 | V |
| Collector Output Current (Each transistor) | I_{C1}, I_{C2} | – | – | 200 | mA |
| Amplified Input Voltage | V_{in} | –0.3 | – | $V_{CC} - 2.0$ | V |
| Current Into Feedback Terminal | I_{fb} | – | – | 0.3 | mA |
| Reference Output Current | I_{ref} | – | – | 10 | mA |
| Timing Resistor | R_T | 1.8 | 30 | 500 | k Ω |
| Timing Capacitor | C_T | 0.0047 | 0.001 | 10 | μ F |
| Oscillator Frequency | f_{osc} | 1.0 | 40 | 200 | kHz |

ELECTRICAL CHARACTERISTICS ($V_{CC} = 15$ V, $C_T = 0.01$ μ F, $R_T = 12$ k Ω , unless otherwise noted.)

For typical values $T_A = 25^\circ\text{C}$, for min/max values T_A is the operating ambient temperature range that applies, unless otherwise noted.

| Characteristics | Symbol | Min | Typ | Max | Unit |
|-----------------|--------|-----|-----|-----|------|
|-----------------|--------|-----|-----|-----|------|

REFERENCE SECTION

| | | | | | |
|---|--------------|------|-----|------|----|
| Reference Voltage ($I_O = 1.0$ mA) | V_{ref} | 4.75 | 5.0 | 5.25 | V |
| Line Regulation ($V_{CC} = 7.0$ V to 40 V) | Reg_{line} | – | 2.0 | 25 | mV |
| Load Regulation ($I_O = 1.0$ mA to 10 mA) | Reg_{load} | – | 3.0 | 15 | mV |
| Short Circuit Output Current ($V_{ref} = 0$ V) | I_{SC} | 15 | 35 | 75 | mA |

OUTPUT SECTION

| | | | | | |
|---|------------------------------|--------|------------|------------|---------------|
| Collector Off–State Current ($V_{CC} = 40$ V, $V_{CE} = 40$ V) | $I_{C(off)}$ | – | 2.0 | 100 | μ A |
| Emitter Off–State Current $V_{CC} = 40$ V, $V_C = 40$ V, $V_E = 0$ V) | $I_{E(off)}$ | – | – | –100 | μ A |
| Collector–Emitter Saturation Voltage (Note 2) Common–Emitter ($V_E = 0$ V, $I_C = 200$ mA) Emitter–Follower ($V_C = 15$ V, $I_E = -200$ mA) | $V_{sat(C)}$ $V_{sat(E)}$ | – – | 1.1 1.5 | 1.3 2.5 | V |
| Output Control Pin Current Low State ($V_{OC} \leq 0.4$ V) High State ($V_{OC} = V_{ref}$) | I_{OCL} I_{OCH} | – – | 10 0.2 | – 3.5 | μ A mA |
| Output Voltage Rise Time Common–Emitter (See Figure 12) Emitter–Follower (See Figure 13) | t_r | – – | 100 100 | 200 200 | ns |
| Output Voltage Fall Time Common–Emitter (See Figure 12) Emitter–Follower (See Figure 13) | t_f | – – | 25 40 | 100 100 | ns |

2. Low duty cycle pulse techniques are used during test to maintain junction temperature as close to ambient temperature as possible.

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ELECTRICAL CHARACTERISTICS ($V_{CC} = 15\text{ V}$, $C_T = 0.01\ \mu\text{F}$, $R_T = 12\ \text{k}\Omega$, unless otherwise noted.)

For typical values $T_A = 25^\circ\text{C}$, for min/max values T_A is the operating ambient temperature range that applies, unless otherwise noted.

| Characteristics | Symbol | Min | Typ | Max | Unit |
|-----------------|--------|-----|-----|-----|------|
|-----------------|--------|-----|-----|-----|------|

ERROR AMPLIFIER SECTION

| | | | | | |
|--|-----------|----------------------|------|------|---------------|
| Input Offset Voltage ($V_{O(Pin\ 3)} = 2.5\ \text{V}$) | V_{IO} | – | 2.0 | 10 | mV |
| Input Offset Current ($V_{O(Pin\ 3)} = 2.5\ \text{V}$) | I_{IO} | – | 5.0 | 250 | nA |
| Input Bias Current ($V_{O(Pin\ 3)} = 2.5\ \text{V}$) | I_{IB} | – | –0.1 | –1.0 | μA |
| Input Common Mode Voltage Range ($V_{CC} = 40\ \text{V}$, $T_A = 25^\circ\text{C}$) | V_{ICR} | –0.3 to $V_{CC}-2.0$ | | | V |
| Open Loop Voltage Gain ($\Delta V_{O} = 3.0\ \text{V}$, $V_{O} = 0.5\ \text{V}$ to $3.5\ \text{V}$, $R_L = 2.0\ \text{k}\Omega$) | A_{VOL} | 70 | 95 | – | dB |
| Unity-Gain Crossover Frequency ($V_{O} = 0.5\ \text{V}$ to $3.5\ \text{V}$, $R_L = 2.0\ \text{k}\Omega$) | f_{C-} | – | 350 | – | kHz |
| Phase Margin at Unity-Gain ($V_{O} = 0.5\ \text{V}$ to $3.5\ \text{V}$, $R_L = 2.0\ \text{k}\Omega$) | ϕ_m | – | 65 | – | deg. |
| Common Mode Rejection Ratio ($V_{CC} = 40\ \text{V}$) | CMRR | 65 | 90 | – | dB |
| Power Supply Rejection Ratio ($\Delta V_{CC} = 33\ \text{V}$, $V_{O} = 2.5\ \text{V}$, $R_L = 2.0\ \text{k}\Omega$) | PSRR | – | 100 | – | dB |
| Output Sink Current ($V_{O(Pin\ 3)} = 0.7\ \text{V}$) | I_{O-} | 0.3 | 0.7 | – | mA |
| Output Source Current ($V_{O(Pin\ 3)} = 3.5\ \text{V}$) | I_{O+} | 2.0 | –4.0 | – | mA |

PWM COMPARATOR SECTION (Test Circuit Figure 11)

| | | | | | |
|---|----------|-----|-----|-----|----|
| Input Threshold Voltage (Zero Duty Cycle) | V_{TH} | – | 2.5 | 4.5 | V |
| Input Sink Current ($V_{(Pin\ 3)} = 0.7\ \text{V}$) | I_{I-} | 0.3 | 0.7 | – | mA |

DEADTIME CONTROL SECTION (Test Circuit Figure 11)

| | | | | | |
|--|--------------|---------|----------|----------|---------------|
| Input Bias Current (Pin 4) ($V_{Pin\ 4} = 0\ \text{V}$ to $5.25\ \text{V}$) | $I_{IB(DT)}$ | – | –2.0 | –10 | μA |
| Maximum Duty Cycle, Each Output, Push-Pull Mode ($V_{Pin\ 4} = 0\ \text{V}$, $C_T = 0.01\ \mu\text{F}$, $R_T = 12\ \text{k}\Omega$) ($V_{Pin\ 4} = 0\ \text{V}$, $C_T = 0.001\ \mu\text{F}$, $R_T = 30\ \text{k}\Omega$) | DC_{max} | 45 – | 48 45 | 50 50 | % |
| Input Threshold Voltage (Pin 4) (Zero Duty Cycle) (Maximum Duty Cycle) | V_{th} | – 0 | 2.8 – | 3.3 – | V |

OSCILLATOR SECTION

| | | | | | |
|--|----------------------------|---|-----|----|-----|
| Frequency ($C_T = 0.001\ \mu\text{F}$, $R_T = 30\ \text{k}\Omega$) | f_{osc} | – | 40 | – | kHz |
| Standard Deviation of Frequency* ($C_T = 0.001\ \mu\text{F}$, $R_T = 30\ \text{k}\Omega$) | $\sigma_{f_{osc}}$ | – | 3.0 | – | % |
| Frequency Change with Voltage ($V_{CC} = 7.0\ \text{V}$ to $40\ \text{V}$, $T_A = 25^\circ\text{C}$) | $\Delta f_{osc}(\Delta V)$ | – | 0.1 | – | % |
| Frequency Change with Temperature ($\Delta T_A = T_{low}$ to T_{high}) ($C_T = 0.01\ \mu\text{F}$, $R_T = 12\ \text{k}\Omega$) | $\Delta f_{osc}(\Delta T)$ | – | – | 12 | % |

UNDERVOLTAGE LOCKOUT SECTION

| | | | | | |
|---|----------|-----|------|-----|---|
| Turn-On Threshold (V_{CC} increasing, $I_{ref} = 1.0\ \text{mA}$) | V_{th} | 5.5 | 6.43 | 7.0 | V |
|---|----------|-----|------|-----|---|

TOTAL DEVICE

| | | | | | |
|--|----------|--------|------------|----------|----|
| Standby Supply Current (Pin 6 at V_{ref} , All other inputs and outputs open) ($V_{CC} = 15\ \text{V}$) ($V_{CC} = 40\ \text{V}$) | I_{CC} | – – | 5.5 7.0 | 10 15 | mA |
| Average Supply Current ($C_T = 0.01\ \mu\text{F}$, $R_T = 12\ \text{k}\Omega$, $V_{(Pin\ 4)} = 2.0\ \text{V}$) ($V_{CC} = 15\ \text{V}$) (See Figure 12) | | – | 7.0 | – | mA |

* Standard deviation is a measure of the statistical distribution about the mean as derived from the formula, σ

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

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ORDERING INFORMATION

| Device | Package | Shipping† |
|--------------|----------------------|------------------|
| TL494BD | SOIC-16 | 48 Units / Rail |
| TL494BDG | SOIC-16 (Pb-Free) | 48 Units / Rail |
| TL494BDR2 | SOIC-16 | 2500 Tape & Reel |
| TL494BDR2G | SOIC-16 (Pb-Free) | 2500 Tape & Reel |
| TL494CD | SOIC-16 | 48 Units / Rail |
| TL494CDG | SOIC-16 (Pb-Free) | 48 Units / Rail |
| TL494CDR2 | SOIC-16 | 2500 Tape & Reel |
| TL494CDR2G | SOIC-16 (Pb-Free) | 2500 Tape & Reel |
| TL494CN | PDIP-16 | 25 Units / Rail |
| TL494CNG | PDIP-16 (Pb-Free) | 25 Units / Rail |
| TL494IN | PDIP-16 | 25 Units / Rail |
| TL494ING | PDIP-16 (Pb-Free) | 25 Units / Rail |
| NCV494BDR2* | SOIC-16 | 2500 Tape & Reel |
| NCV494BDR2G* | SOIC-16 (Pb-Free) | 2500 Tape & Reel |

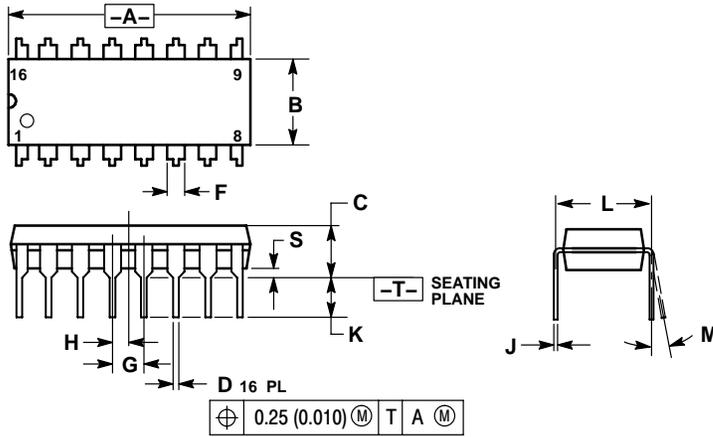
†For information on tape and reel specifications, including part orientation and tape sizes, please refer to our Tape and Reel Packaging Specifications Brochure, BRD8011/D.

*NCV494: $T_{low} = -40^{\circ}\text{C}$, $T_{high} = +125^{\circ}\text{C}$. Guaranteed by design. NCV prefix is for automotive and other applications requiring site and change control.

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PACKAGE DIMENSIONS

PDIP-16
N SUFFIX
CASE 648-08
ISSUE T



NOTES:

1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
2. CONTROLLING DIMENSION: INCH.
3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
5. ROUNDED CORNERS OPTIONAL.

| DIM | INCHES | | MILLIMETERS | |
|-----|-----------|-------|-------------|-------|
| | MIN | MAX | MIN | MAX |
| A | 0.740 | 0.770 | 18.80 | 19.55 |
| B | 0.250 | 0.270 | 6.35 | 6.85 |
| C | 0.145 | 0.175 | 3.69 | 4.44 |
| D | 0.015 | 0.021 | 0.39 | 0.53 |
| F | 0.040 | 0.70 | 1.02 | 1.77 |
| G | 0.100 BSC | | 2.54 BSC | |
| H | 0.050 BSC | | 1.27 BSC | |
| J | 0.008 | 0.015 | 0.21 | 0.38 |
| K | 0.110 | 0.130 | 2.80 | 3.30 |
| L | 0.295 | 0.305 | 7.50 | 7.74 |
| M | 0° | 10° | 0° | 10° |
| S | 0.020 | 0.040 | 0.51 | 1.01 |