



## ULN2003R

Preliminary

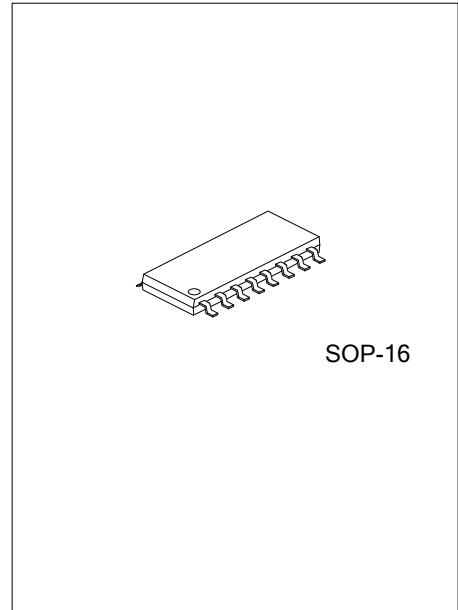
LINEAR INTEGRATED CIRCUIT

### HIGH VOLTAGE HIGH CURRENT DARLINGTON TRANSISTOR ARRAY

#### DESCRIPTION

The UTC **ULN2003R** is high-voltage, high-current darlington transistor arrays. Each consists of seven NPN darlington pairs that feature high-voltage outputs with common-cathode clamp diodes for switching inductive loads. The collector-current rating of a single darlington pair is 500mA. All units feature integral clamp diodes for switching inductive loads. Applications include relay, hammer, lamp and display (LED) drivers.

The UTC **ULN2003R** has a 2.7kΩ series base resistor for each darlington pair for operation directly with TTL or 5V CMOS devices.



#### FEATURES

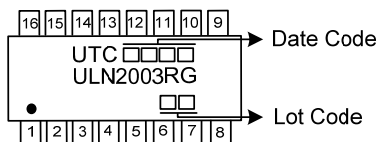
- \* Output Current (Single Output): 500mA max
- \* High Sustaining Voltage Output: 50V min
- \* Inputs Compatible with Various Types of Logic
- \* Output Clamp Diodes
- \* Relay-Driver Applications

#### ORDERING INFORMATION

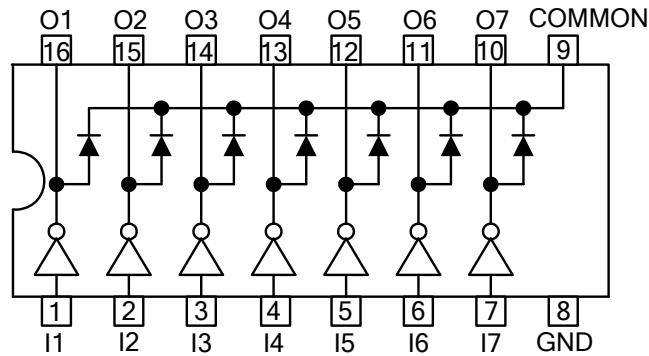
| Ordering Number | Package | Packing   |
|-----------------|---------|-----------|
| ULN2003RG-S16-R | SOP-16  | Tape Reel |

|   |   |
|---|---|
| <p>ULN2003RG-S16-R</p> <p>(1) Packing Type</p> <p>(2) Package Type</p> <p>(3) Green Package</p> | <p>(1) R: Tape Reel</p> <p>(2) S16: SOP-16</p> <p>(3) G: Halogen Free and Lead Free</p> |
|---|---|

#### MARKING



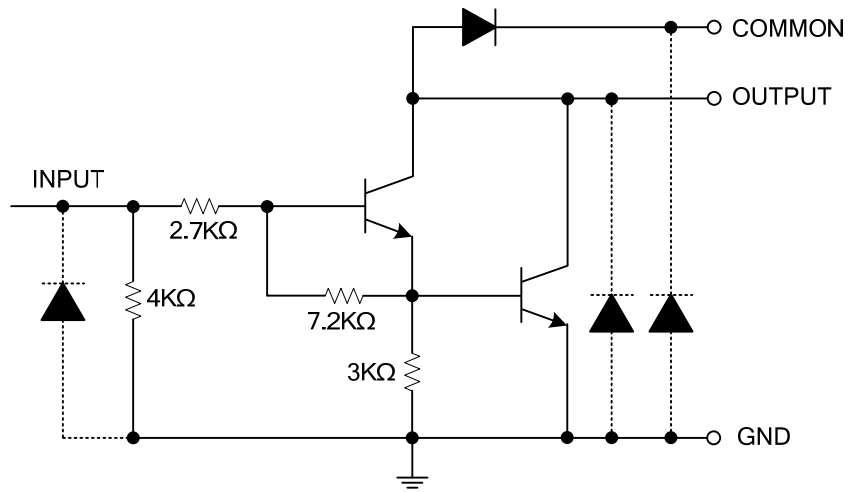
■ PIN CONFIGURATION



■ PIN DESCRIPTION

| PIN NO. | PIN NAME | DESCRIPTION          |
|---------|----------|----------------------|
| 1       | I1       | 1 Channel Input Pin  |
| 2       | I2       | 2 Channel Input Pin  |
| 3       | I3       | 3 Channel Input Pin  |
| 4       | I4       | 4 Channel Input Pin  |
| 5       | I5       | 5 Channel Input Pin  |
| 6       | I6       | 6 Channel Input Pin  |
| 7       | I7       | 7 Channel Input Pin  |
| 8       | GND      | Ground               |
| 9       | COMMON   | Clamp Diode          |
| 10      | O7       | 7 Channel Output Pin |
| 11      | O6       | 6 Channel Output Pin |
| 12      | O5       | 5 Channel Output Pin |
| 13      | O4       | 4 Channel Output Pin |
| 14      | O3       | 3 Channel Output Pin |
| 15      | O2       | 2 Channel Output Pin |
| 16      | O1       | 1 Channel Output Pin |

■ BLOCK DIAGRAM



UTC ULN2003R Drive Circuit

■ ABSOLUTE MAXIMUM RATING ( $T_A=25^{\circ}\text{C}$ , unless otherwise specified)

| PARAMETER                      | SYMBOL    | RATINGS               | UNIT               |
|--------------------------------|-----------|-----------------------|--------------------|
| Collector-Emitter Voltage      | $V_{CE}$  | -0.5~50               | V                  |
| Clamp Diode Reverse Voltage    | $V_{COM}$ | 50                    | V                  |
| Input Voltage                  | $V_I$     | -0.5~30               | V                  |
| Peak Collector Current         | $I_{CP}$  | 500                   | mA                 |
| Output Clamp Current           | $I_{OK}$  | 500                   | mA                 |
| Total Emitter-Terminal Current | $I_{ET}$  | -2.5                  | A                  |
| Power Dissipation (Note 1, 2)  | $P_D$     | 0.54 / 0.065 (Note 3) | W                  |
| Junction Temperature (Note 2)  | $T_J$     | 150                   | $^{\circ}\text{C}$ |
| Storage Temperature            | $T_{STG}$ | -60~+150              | $^{\circ}\text{C}$ |

Notes: 1. Absolute maximum ratings are those values beyond which the device could be permanently damaged.

Absolute maximum ratings are stress ratings only and functional device operation is not implied.

2. The maximum allowable power dissipation at any allowable ambient temperature is  $P_D = (T_J - T_A) / \theta_{JA}$ .

3. On glass epoxy PCB (30x30x1.6mm Cu 50%).

■ RECOMMENDED OPERATING CONDITIONS ( $T_A=25^{\circ}\text{C}$ , unless otherwise specified)

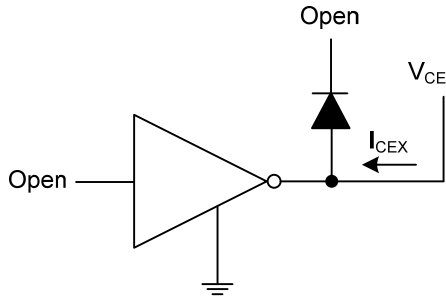
| PARAMETER                   | SYMBOL        | TEST CONDITIONS  | MIN | TYP | MAX   | UNIT               |
|-----------------------------|---------------|--|-----|-----|-------|--------------------|
| Output Sustaining Voltage   | $V_{CE}$      |  | 0   |     | 50    | V                  |
| Output Current              | $I_{OUT}$     | $T_{PW}=25\text{ms}$ ,<br>$T_A=85^{\circ}\text{C}$ , $T_J=120^{\circ}\text{C}$ |     |     | 233   | mA/ch              |
|                             |               | Duty=10%   | 0   |     | 70    | mA/ch              |
|                             |               | Duty=50%   | 0   |     |       |                    |
| Input Voltage               | $V_{IN}$      |  | 0   |     | 24    | V                  |
| Input Voltage (Output On)   | $V_{IN(ON)}$  | $I_{OUT}=400\text{mA}$   | 2.8 |     | 24    | V                  |
| Input Voltage (Output Off)  | $V_{IN(OFF)}$ |  | 0   |     | 0.7   | V                  |
| Clamp Diode Reverse Voltage | $V_R$         |  |     |     | 50    | V                  |
| Clamp Diode Forward Current | $I_F$         |  |     |     | 350   | mA                 |
| Operating Temperature Range | $T_A$         |  | -40 |     | +85   | $^{\circ}\text{C}$ |
| Power Dissipation           | $P_D$         | $T_A=85^{\circ}\text{C}$   |     |     | 0.325 | W                  |

■ ELECTRICAL CHARACTERISTICS ( $T_A=25^{\circ}\text{C}$ , unless otherwise specified)

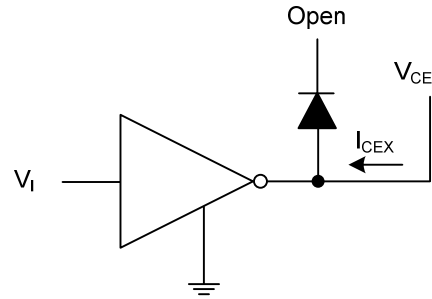
| PARAMETER                             | SYMBOL        | TEST CIRCUIT | TEST CONDITIONS  | MIN                                       | TYP  | MAX  | UNIT          |
|---------------------------------------|---------------|--------------|--|---|------|------|---------------|
| Input Voltage (Output On)             | $V_{I(ON)}$   | 4            | $V_{CE}=2\text{V}$   | $I_C=200\text{mA}$                        | 1.9  | 2.4  | V             |
|                                       |               |              |  | $I_C=250\text{mA}$                        | 2.0  | 2.7  | V             |
|                                       |               |              |  | $I_C=300\text{mA}$                        | 2.1  | 3    | V             |
| Collector-Emitter Saturation Voltage  | $V_{CE(SAT)}$ | 5            | $V_{IN}=2.4\text{V}$ , $I_C=30\text{mA}$                         | $V_{IN}=2.4\text{V}$ , $I_C=60\text{mA}$  | 0.78 |      | V             |
|                                       |               |              |  | $V_{IN}=2.4\text{V}$ , $I_C=120\text{mA}$ | 0.82 |      | V             |
|                                       |               |              |  | $V_{IN}=2.4\text{V}$ , $I_C=240\text{mA}$ | 0.9  |      | V             |
|                                       |               |              |  | $V_{IN}=2.4\text{V}$ , $I_C=350\text{mA}$ | 1.1  |      | V             |
|                                       |               |              |  |   | 1.25 |      | V             |
| Clamp Diode Forward Voltage           | $V_F$         | 8            | $I_F=350\text{mA}$   |   | 1.6  | 2.0  | V             |
| Output Leakage Current                | $I_{CEX}$     | 1            | $V_{CE}=50\text{V}$ , $I_I=0$                                    |   |      | 50   | $\mu\text{A}$ |
|                                       |               | 2            | $V_{CE}=50\text{V}$ , $T_A=85^{\circ}\text{C}$ , $V_I=0\text{V}$ |   |      | 100  | $\mu\text{A}$ |
| Input Current                         | $I_I$         | 4            | $I_C=60\text{mA}$  | $V_{IN}=12\text{V}$                       |      | 7    | mA            |
|                                       |               |              |  | $V_{IN}=6\text{V}$                        |      | 3.2  | mA            |
|                                       |               |              |  | $V_{IN}=4.5\text{V}$                      |      | 2.3  | mA            |
|                                       |               |              |  | $V_{IN}=2.4\text{V}$                      |      | 0.95 | mA            |
| Clamp Diode Reverse Current           | $I_R$         | 7            | $V_R=50\text{V}$   |   |      | 100  | $\mu\text{A}$ |
| Input Capacitance                     | $C_{IN}$      |              |  |   | 15   |      | pF            |
| Propagation Delay Time, Low- to High  | $t_{PLH}$     | 9            | $V_L=12\text{V}$ , $R_L=45\Omega$                                |   | 0.15 | 1    | $\mu\text{s}$ |
| Propagation Delay Time, High - to Low | $t_{PHL}$     | 9            | $V_L=12\text{V}$ , $R_L=45\Omega$                                |   | 0.15 | 1    | $\mu\text{s}$ |

■ TEST CIRCUIT

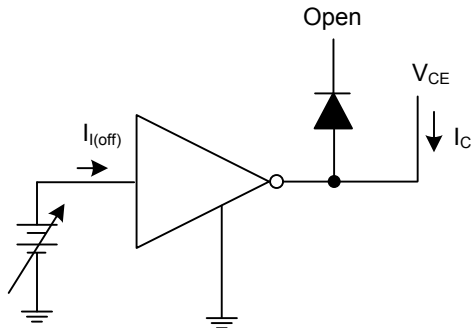
1.  $I_{CEX}$



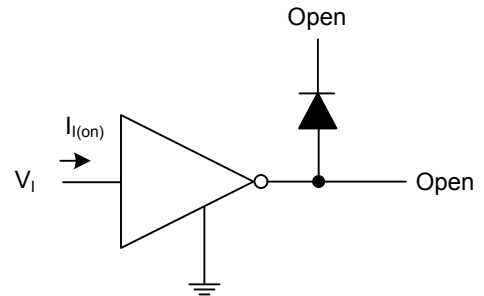
2.  $I_{CEX}$



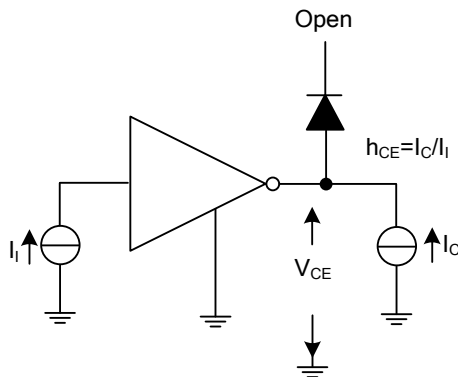
3.  $I_{I(off)}$



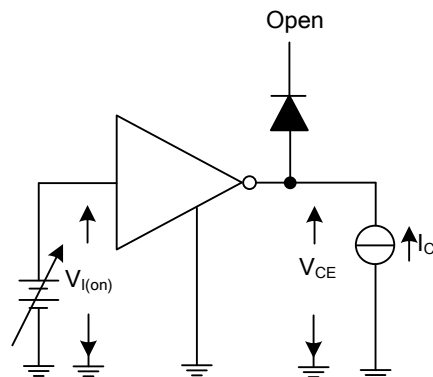
4.  $I_I$



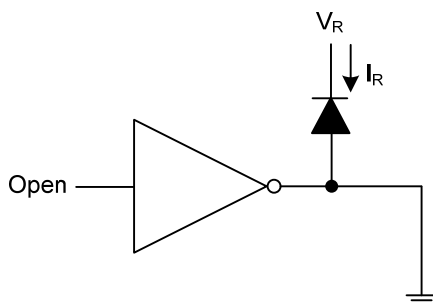
5.  $h_{FE}, V_{CE(sat)}$



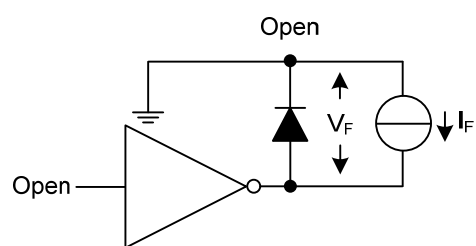
6.  $V_{I(on)}$



7.  $I_R$

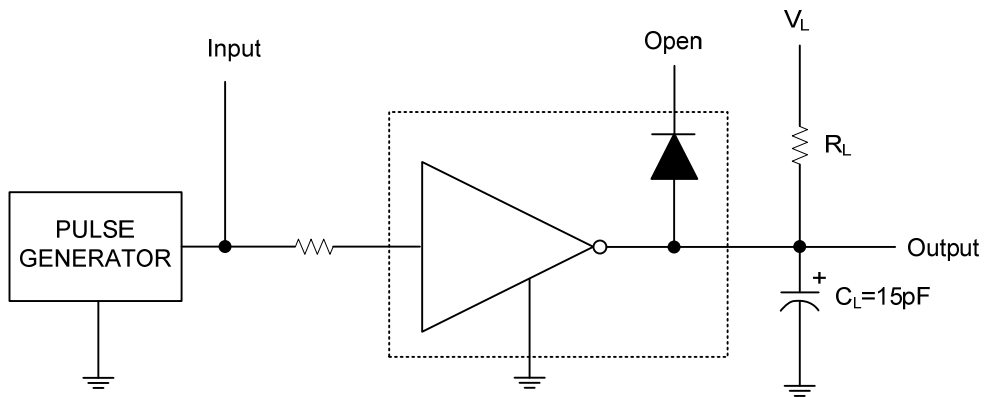


8.  $V_R$

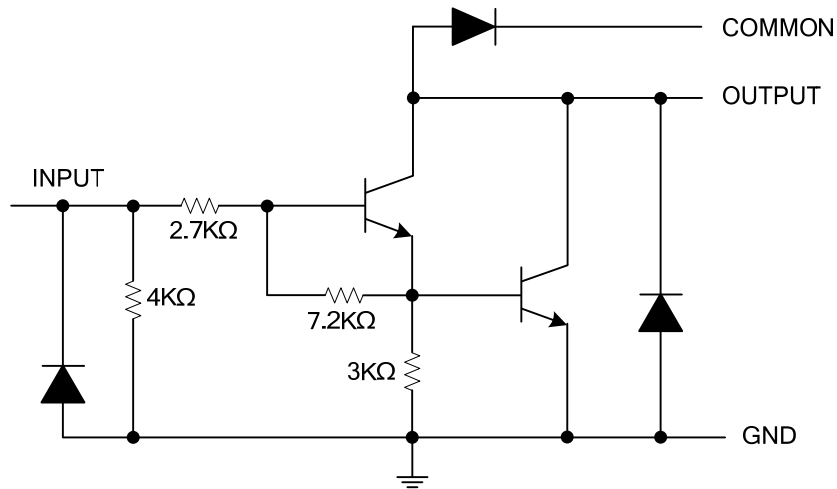


■ TEST CIRCUIT (Cont.)

9. Propagation Delay-Time Waveforms



■ TYPICAL APPLICATION CIRCUIT



UTC ULN2003R Drive Circuit

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