# DATA SHEET

## 74LV4799
## Timer for NiCd and NiMH chargers

Product specification
Supersedes data of 1998 Apr 07
IC24 Data Handbook

1998 Apr 20

Philips
Semiconductors

PHILIPS

# Timer for NiCd and NiMH chargers 74LV4799

## FEATURES

- Wide supply voltage range of 0.9 V to 6 V allows 1 to 4-cell applications
- 10 V allowed on special inputs
- Supports virtually all battery chargers, including switched-mode power supplies
- On-chip timer calculates the actual capacity of the battery by measuring the charger time, discharge time and self-discharge time
- Automatic switch-over to trickle charge after completion of the charge time
- Can be adjusted for use with different types of batteries:
  - Charge time: 4 to 16 hours
  - Discharge time: 15 minutes to 4.7 hours
  - Self-discharge time: 50 to 100 days
- Battery status indication included:
  - $\overline{\text{LED}}$ output for charging/full indication
  - $\overline{\text{MOLLI}}$ output for battery-low indication
- LED mode select allows two different methods of indication
- Automatic power-ON reset
- Low-power consumption
- Requires only a few peripheral components
- Very accurate on-chip oscillator
- Scan test facilities included
- $I_{CC}$ category: non-standard.

## APPLICATIONS

- Time-controlled NiCd and NiMH low-current chargers
- Domestic appliances such as rechargeable battery shavers, electric toothbrushes etc.
- Portable equipment such as notebook PCs, laptop PCs, camera flash units etc.
- Personal communications like cordless telephones, personal mobile radios, pagers, etc.

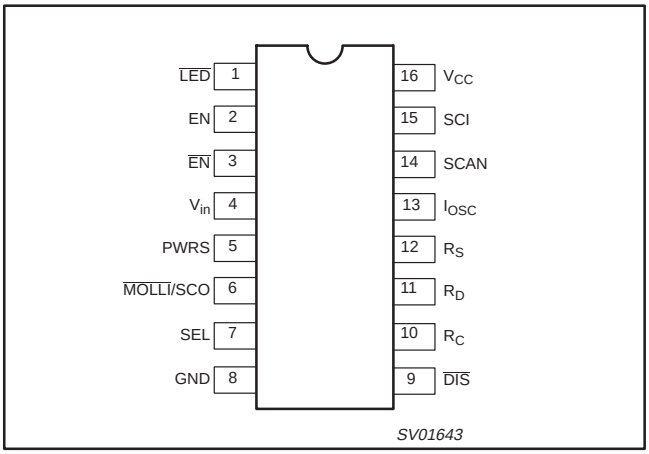
## DESCRIPTION

The 74LV4799 is a low-voltage Si-gate CMOS control IC for battery management. It consists of:

- 17-stage divider
- 10-stage up/down counter
- Control logic
- Integrated precision oscillator (using external timing components)
- Automatic power-ON reset
- Scan test facilities
- Battery charging/full indication output ($\overline{\text{LED}}$)
- Battery-low indication output ($\overline{\text{MOLLI}}$)
- Open-drain-N outputs for driving the load transistor

Battery management with the 74LV4799 is based on the principle of time measurement. It measures the charge time, discharge time and self-discharge time by means of a very accurate on-chip oscillator, a divider and an up/down counter.

## PIN CONFIGURATION




## QUICK REFERENCE DATA

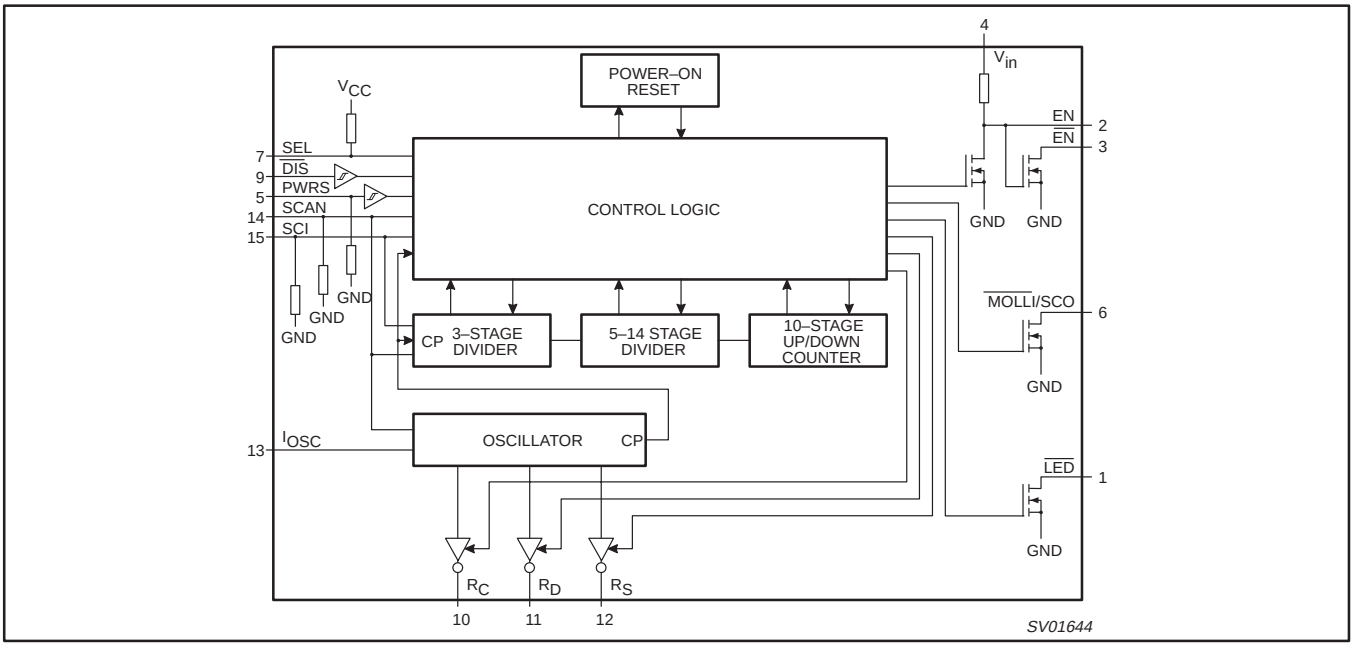
GND = 0V; $T_{amb}$ = 25°C

| SYMBOL | PARAMETER | CONDITIONS | TYPICAL | TYPICAL | TYPICAL | UNIT |
|---|---|---|---|---|---|---|
| $V_{CC}$ | DC supply voltage | | 0.9 | | 6.0 | V |
| $I_{CC}$ | Operating supply current | $V_{CC}$ = 3.3V; self-discharge mode; $R_S$ = 100 kΩ; $C_1$ = 220nF | | 36 | | µA |
| Δf | Oscillator frequency tolerance | $V_{CC}$ = 1 to 6 V | | | 7 | % |

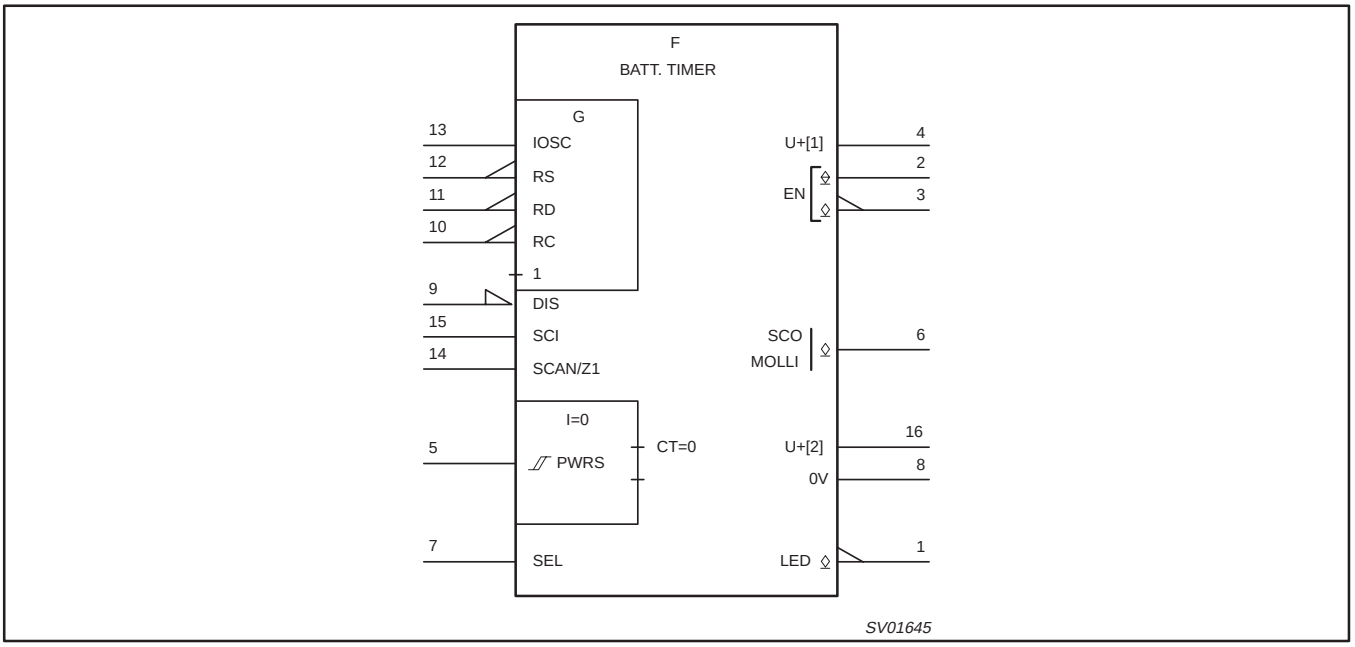
## ORDERING INFORMATION

| PACKAGES | TEMPERATURE RANGE | OUTSIDE NORTH AMERICA | NORTH AMERICA | CODE |
|---|---|---|---|---|
| 16-Pin Plastic DIL | 0°C to +70°C | 74LV4799 N | 74LV4799 N | SOT38-4 |
| 16-Pin Plastic SO | 0°C to +70°C | 74LV4799 D | 74LV4799 D | SOT109-1 |
| 16-Pin Plastic SSOP Type II | 0°C to +70°C | 74LV4799 DB | 74LV4799 DB | SOT338-1 |
| 16-Pin Plastic TSSOP Type I | 0°C to +70°C | 74LV4799 PW | 74LV4799PW DH | SOT403-1 |

## FUNCTIONAL DIAGRAM




## IEC LOGIC SYMBOL



## PIN DESCRIPTION

| PIN NO. | SYMBOL | NAME AND FUNCTION |
|---|---|---|
| 1 | $\overline{LED}$ | LED driver output pin (active LOW) |
| 2 | EN | Enable output (active HIGH) |
| 3 | $\overline{EN}$ | Enable output (active LOW) |
| 4 | $V_{in}$ | External power input |
| 5 | PWRS | Power sense input |
| 6 | $\overline{MOLLI}$/SCO | More-or-less-low-indication output (active LOW)/scan test output |
| 7 | SEL | LED mode select input |
| 8 | GND | Ground (0 V) |
| 9 | $\overline{DIS}$ | Discharge input (active LOW) |
| 10 | $R_C$ | External resistor pin 3-State oscillator output (charge) |
| 11 | $R_D$ | External resistor pin 3-State output (discharge) |
| 12 | $R_S$ | External resistor pin 3-State output (self-discharge) |
| 13 | $I_{OSC}$ | Oscillator input |
| 14 | SCAN | Scan test mode select input (active HIGH) |
| 15 | SCI | Scan test input |
| 16 | $V_{CC}$ | Positive supply voltage |

**Power On Reset.**
An automatic Power On Reset initiates the IC when the battery is discharged and power is connected to the circuit. The initial condition is the charge mode in which the counter is reset and counts from zero up to maximum. At start up, the battery therefore always receives a full charge cycle. When a partially charged battery is inserted, it may be over-charged during the first cycle. To guard against this, simply replace the resistor at the $R_C$ pin with an NTC type which is in good thermal contact with the battery. If the temperature of the battery increases, the frequency of the oscillator also increases to quickly reach a counter full indication and switch-over to trickle charge. With a battery that is almost completely discharged, the POR input can also be activated during discharge or self-discharge. The counter will then be reset to zero. This is a correct action while returning to the initial condition.

**Power-on sensing.**
Because this IC supports virtually all battery chargers, the PWRS input has a broad input frequency spectrum (active HIGH to 100 kHz). A pull-down circuit at the PWRS input allows detection of the open state which corresponds to an inactive charger. A HIGH level on the PWRS input, or an AC signal up to 100 kHz, enables the charge mode.

**Start-up with low battery voltage.**
Good start-up, even with an un-charged battery, is assured by using the $V_{IN}$ input. The voltage on the $V_{IN}$ input biases the external bipolar transistors at the EN or $\overline{EN}$ output, even if the IC is not yet functioning. After the battery has received sufficient charge, the internal control logic takes over control of the EN and $\overline{EN}$ outputs.

**Charge mode.**
This mode is selected when PWRS is active (HIGH or pulsed) and the discharge input $\overline{DIS}$ is HIGH. The EN output is HIGH, and the $\overline{EN}$ output is LOW initiating continuous charge of the battery. The counter then counts from the zero state up to the maximum value. The clock frequency is determined by the external capacitor and resistor connected to the $R_C$ output. The counter stops when it reaches its maximum value and the EN and $\overline{EN}$ outputs switch over from the continuous charge to the trickle charge mode.

**Trickle charge mode.**
At the maximum counter value, it is assumed that the battery is fully charged. The counter stops and remains on this maximum value.

The EN and $\overline{EN}$ outputs switch over from the continues charge to the trickle charge mode. In the trickle charge mode, the average charge current is reduced to only compensate the self-discharge of the battery by using the dedicated duty cycle control. The control is dedicated because it adjusts the duty cycle in inverse proportion to the load current, resulting in a fixed charger current irrespective of the kind of charger (e.g. 4-hour or 16-hour charger). In the trickle charge mode, the oscillator circuitry alternately generates 4 periods of $R_C$ -C1 time-constant, and 3 periods of the $R_S$ -C1 time-constant (See Figure 1).

**Discharge mode.**
The discharge input ($\overline{DIS}$) is used to detect the discharge of the battery. If $\overline{DIS}$ is LOW, the counter counts down. The clock frequency is determined by the external capacitor and resistor at the $R_D$ output. If PWRS is inactive (LOW or open), the EN output is LOW, and the $\overline{EN}$ output is in the high impedance OFF-state (no charge of the battery). This is called the discharge mode. If PWRS is active, the circuit is in the charge/discharge mode.

**Charge/Discharge mode.**
If $\overline{DIS}$ is LOW and PWRS is active (HIGH or pulsed), the circuit is in the charge/discharge mode. The counter counts down. The clock frequency is determined by the external capacitor and resistor tied at the $R_D$ output. The EN output is HIGH, and the $\overline{EN}$ output is LOW initiating continuous charge of the battery. The battery is therefore charged and discharged at the same instant, thereby maintaining a better load condition of the battery.

**Self-discharge mode.**
If $\overline{DIS}$ is HIGH and PWRS is inactive (LOW or open), the battery is being neither charged nor discharged. The circuit is in the self-discharge mode. This mode represents the battery leakage (self-discharge). The counter counts down. The clock frequency is determined by the external capacitor and resistor at the $R_S$ output. When the counter reaches the zero state, it stops.

**LED mode select.**
The $\overline{LED}$ output drives a battery status LED which indicates the charge/full status of the battery. For optimum flexibility, two modes of operation are built-in.

- Mode 1: If SEL is LOW, the $\overline{LED}$ output is active LOW in the charge mode, and the LED blinks with a frequency of about 1 Hz during trickle charge.
- Mode 2: If SEL is HIGH or open, the LED output blinks with a frequency of about 0.25 Hz in the charge mode, and is active LOW during trickle charge. In the discharge or self-discharge mode, the $\overline{LED}$ output is open except when PWRS is active (HIGH or pulsed). Then, the battery is charging and discharging simultaneously. Although the discharge mode is dominant, the LED output is active when PWRS is also active.

**NOTE:** The blink frequency depends on the oscillator frequency. (See application information)

**Low indication.**
As part of the user interface, the $\overline{MOLLI}$ output shows when the battery needs to be charged. $\overline{MOLLI}$ stands for More Or Less Low Indication (active LOW). The function is as follows: In the discharge mode, ($\overline{DIS}$ is active LOW), the counter counts down and, when it reaches the zero state, it stops. If $\overline{DIS}$ is switched HIGH, the $\overline{MOLLI}$ output gives an output signal of four periods of about one second, with a 50% duty cycle. This can be used to activate a buzzer. The $\overline{MOLLI}$ output signal of four periods will be interrupted as soon as PWRS is activated.

**Alarm indication**.
If an almost completely discharged battery is connected to the charger, it may not be noticed by the user if the load switch is still on. To prevent damaging the battery, an alarm signal on the $\overline{LED}$ output will alert the user to switch off the load. The alarm signal is easily recognized, because the $\overline{LED}$ output will blink at a higher frequency than normal (about 5 Hz instead of 1 Hz). This alarm indication is only active if the SEL input is HIGH or open. If the SEL input is LOW, no alarm indication is present, because in many applications simultaneous charging and discharging is quite acceptable. (See charge/discharge mode)

**Scan test mode.**
If the SCAN input (pin 14) is made active HIGH, the circuit is in the test mode. The tester clock is connected to the $I_{OSC}$ pin (pin 13). In the scan mode, the on–chip oscillator is bypassed to allow rapid testing of the divider/counter. The scan test patterns are available on request. The scan test data is entered serially through the SCI input (pin 15). The scan out data is present on the $\overline{MOLLI}$/SCO output (pin 6), which then acts as a scan output.

**Remaining energy indication.**
The scan test facility can be used as a remaining energy indication because the value of the counter can be read out at the scan output ($\overline{MOLLI}$/SCO). This is done by briefly interrupting the normal mode of operation, putting the circuit in the scan mode, and reading out the counter value. The circuit then reverts to the normal mode. This only works correctly with the $\overline{MOLLI}$/SCO output and SCI input linked (round coupled loop) and with exactly 49 clock pulses applied to the $I_{OSC}$ input.

The serial scan-out data is available on the $\overline{MOLLI}$/SCO output. The value of the counter can be decoded by reading the correct bits. Details are given later in the section “Application information”.

**Output drivers EN and $\overline{EN}$.**
In one-cell battery (low-voltage) applications, the drive from the ENABLE output ($\overline{EN}$) is insufficient to provide the base current directly for the external bipolar PNP regulator transistor. The inverse signal has therefore been made available at the ENABLE output (EN) to drive an extra bipolar NPN transistor that can provide the base current for the bipolar PNP regulator transistor as shown in Figure 2.

## FUNCTION TABLE 1

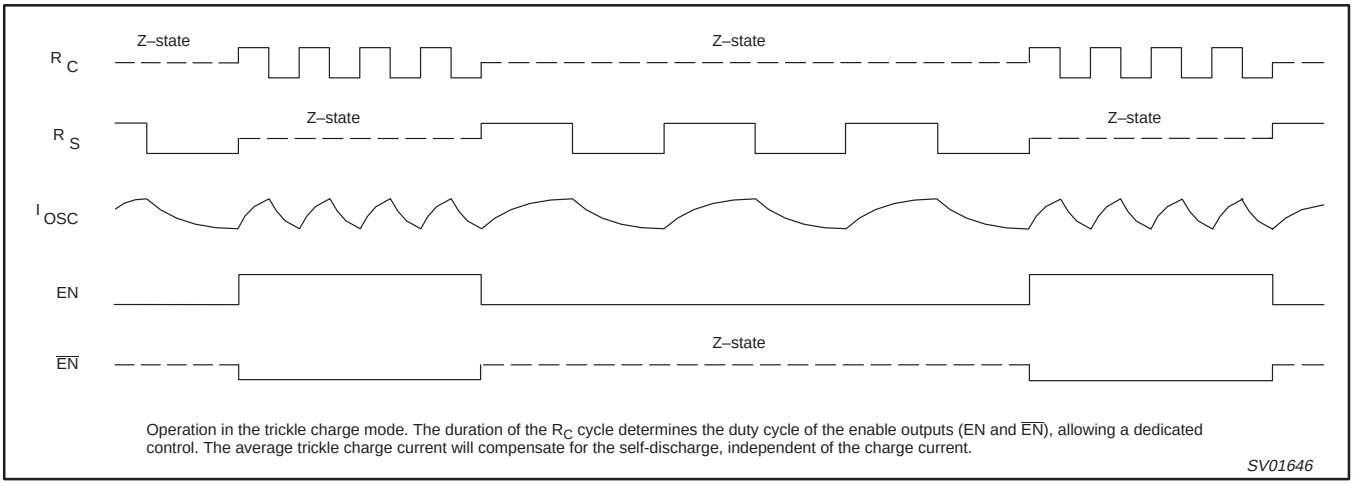
| OPERATING MODES | INPUTS | | | OUTPUTS | | | | | DIVIDER/COUNTER | |
|---|---|---|---|---|---|---|---|---|---|---|
| | PWRS | $V_{IN}$ | $\overline{DIS}$ | EN | $\overline{EN}$ | $R_C$ | $R_D$ | $R_S$ | MODE | VALUE |
| Charge | H or ⎍⎍ | H | H | H | L | ⎍⎍ | Z | Z | Count up 22 sections | < max |
| Trickle charge | H or ⎍⎍ | H | H | ⎍⎍ | ⎍⎍ | ⎍⎍ | Z | ⎍⎍ | Stop | max |
| Charge/discharge | H or ⎍⎍ | H | L | H | L | Z | ⎍⎍ | Z | Count down 18 sections | ≥ min |
| Discharge | L or open | X | L | L | Z | Z | ⎍⎍ | Z | Count down 18 sections | ≥ min |
| Self-discharge | L or open | X | H | L | Z | Z | Z | ⎍⎍ | Count down 27 sections | ≥ min |

## FUNCTION TABLE 2

| STATUS INDICATION | INPUTS | | | OUTPUTS | | COUNTER | |
|---|---|---|---|---|---|---|---|
| | PWRS | $\overline{DIS}$ | SEL[1] | $\overline{LED}$ | $\overline{MOLLI}$ | MODE | VALUE |
| Charge | H or ⎍⎍ | H | L | L | Z | Count up | < max |
| | H or ⎍⎍ | H | H or open | ⎍⎍ | Z | Count up | < max |
| Charge/discharge | H or ⎍⎍ | L | L | L | Z | Count down | ≥ min |
| Trickle charge | H or ⎍⎍ | H | L | ⎍⎍ | Z | Stop | max |
| | H or | H | H or open | L | Z | Stop | max |
| Discharge | L or open | L | X | Z | Z | Count down | > min |
| Self-discharge | L or open | H | X | Z | Z | Count down | > min |
| Low | L or open | ↑ | X | Z | ⎍ | Stop | min |
| Low | ↑ | ↑ | X | Z | Z[2] | Count up | ≥ min |
| Alarm | H or | L | H or open | ⎍⎍ | Z | Count down | ≥ min |

**NOTES:**
1. Don't change SEL during operation.
2. The $\overline{MOLLI}$ function will be interrupted as soon as PWRS is activated.

H = HIGH voltage level
L = LOW voltage level
Z = high impedance OFF-state
X = don't care
⎍⎍ = pulsed (H/L)
⎍⎍ = pulsed (Z/L)
⎍ = 4 periods of about one second (Z/L)
↑ = LOW-to-HIGH level transition




Operation in the trickle charge mode. The duration of the $R_C$ cycle determines the duty cycle of the enable outputs (EN and $\overline{EN}$), allowing a dedicated control. The average trickle charge current will compensate for the self-discharge, independent of the charge current.

*SV01646*

**Figure 1. Trickle charge mode characteristics.**

## RECOMMENDED OPERATING CONDITIONS

| SYMBOL | PARAMETER | CONDITIONS | MIN | TYP | MAX | UNIT |
|---|---|---|---|---|---|---|
| $V_{CC}$ | DC supply voltage | See Note 1 | 0.9 | 1.2 | 6 | V |
| $V_I$ | Input voltage pins 4, 5, and 9<br>Input voltage pins 7, 13, 14, and 15 | | 0<br>0 | –<br>– | 10<br>$V_{CC}$ | V |
| $V_O$ | Output voltage pins 10, 11, and 12<br>Output voltage pins 1, 2, 3, and 6 | | 0<br>0 | –<br>– | $V_{CC}$<br>10 | V |
| $T_{amb}$ | Operating ambient temperature range in free air | See DC and AC characteristics per device | 0 | | +70 | °C |
| $t_r$, $t_f$ | Input rise and fall times pin 5 | | – | – | 10 | ms |
| | Input rise and fall times pins 7, 14 and 15 | $V_{CC}$ = 1.0V; $V_I$ = 1.0V<br>$V_{CC}$ = 2.0V; $V_I$ = 2.0V<br>$V_{CC}$ = 3.0V; $V_I$ = 4.5V<br>$V_{CC}$ = 3.6V; $V_I$ = 6.0V | –<br>–<br>–<br>– | –<br>–<br>–<br>– | 500<br>200<br>100<br>50 | ns |
| | Input rise and fall times pin 9 | | – | – | 2 | µs |

**NOTE:**
1. Single sided input protection applied on pins 4, 5, and 9.

## ABSOLUTE MAXIMUM RATINGS[2, 3]

In accordance with the Absolute Maximum Rating System (IEC 134).
Voltages are referenced to GND (ground = 0 V).

| SYMBOL | PARAMETER | CONDITIONS | MIN | MAX | UNIT |
|---|---|---|---|---|---|
| $V_{CC}$ | DC supply voltage | | –0.5 | +7.0 | V |
| $I_{IK}$ | DC input diode current pins 4, 5 and 9 | $V_I < –0.5$ or $V_I > 12$ V | | ±20 | mA |
| | DC input diode current pins 7, 13, 14 and 15 | $V_I < –0.5$ or $V_I > V_{CC} + 0.5$ V | | +20 | |
| | NON repetitive peak DC input diode current pin 9 | $V_I > 10$ V and t < 10 µs; see note 1 | | 10 | |
| $V_I$ | DC input voltage range pins 4, 5 and 9 | | –0.5 | +12 | V |
| | DC input voltage range pins 7, 13, 14 and 15 | | –0.5 | $V_{CC}$ + 0.5 | V |
| $I_{OK}$ | DC output diode current pins 1, 2, 3 and 6 | $V_O < –0.5$ V | | –20 | mA |
| $I_O$ | DC output sink current pins 1, 2, 3 and 6 | $V_O > 0$ V | | –25 | mA |
| $I_{OK}$ | DC output diode current pins 10, 11 and 12 | $V_O < –0.5$ or $V_O > V_{CC} + 0.5$ V | | ±20 | mA |
| $I_O$ | DC output sink or source current pins 10, 11 and 12 | $–0.5 V < V_O < V_{CC} + 0.5$ V | | ±25 | mA |
| $I_{GND}$, $I_{CC}$ | DC GND or $V_{CC}$ current | | | ±50 | mA |
| $T_{stg}$ | Storage temperature range | | –65 | +150 | °C |
| $P_{tot}$ | Power dissipation per package<br>Plastic DIL<br>Plastic mini-pack (SO)<br>Plastic shrink mini-pack (SSOP and TSSOP) | for temperature range: –40 to +125 °C<br>above + 70 °C derate linearly with 12 mW/K<br>above + 70 °C derate linearly with 8 mW/K<br>above + 60 °C derate linearly with 5.5 mW/K | | <br>750<br>500<br>400 | mW |

**NOTES:**
1. In applications where a motor is present, the input voltage may exceed the maximum $V_I$, level of 10 V at the $\overline{DIS}$ input for a very short period when the motor is switched off.
2. Stresses beyond those listed 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 under “recommended operating conditions” is not implied. Exposure to absolute maximum rated conditions for extended periods may affect device reliability.
3. The input and output voltage ratings may be exceeded if the input and output current ratings are observed.

## DC ELECTRICAL CHARACTERISTICS

Over recommended operating conditions.
Voltages are referenced to GND (ground = 0 V).

| SYMBOL | PARAMETER | TEST CONDITIONS | LIMITS | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | +25°C | | | 0°C to +70°C | | |
| | | | MIN | TYP | MAX | MIN | MAX | |
| $V_{IH}$ | HIGH level Input voltage | $V_{CC}$ = 1.0 V | 0.8 | 0.5 | – | 0.8 | – | V |
| | | $V_{CC}$ = 4.5 V | 3.6 | 2.4 | – | 3.6 | – | |
| | | $V_{CC}$ = 6.0 V | 4.8 | 3.2 | – | 4.8 | – | |
| $V_{IL}$ | LOW level Input voltage | $V_{CC}$ = 1.0 V | – | 0.5 | 0.2 | – | 0.2 | V |
| | | $V_{CC}$ = 4.5 V | – | 2.1 | 0.9 | – | 0.9 | |
| | | $V_{CC}$ = 6.0 V | – | 2.8 | 1.2 | – | 1.2 | |
| $V_{OH}$ | HIGH level output voltage; $R_C$, $R_D$ outputs | $V_{CC}$ = 1.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ = –190µA | 0.90 | 0.96 | – | 0.89 | – | V |
| | | $V_{CC}$ = 6.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ = –6.1mA | 5.73 | 5.84 | – | 5.66 | – | |
| | HIGH level output voltage; $R_S$ output | $V_{CC}$ = 1.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ =–24µA | 0.90 | 0.96 | – | 0.89 | – | |
| | | $V_{CC}$ = 6.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ =–760µA | 5.73 | 5.84 | – | 5.66 | – | |
| $V_{OL}$ | LOW level output voltage; $R_C$, $R_D$ outputs | $V_{CC}$ = 1.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ = 190µA | – | 0.04 | 0.10 | – | 0.11 | V |
| | | $V_{CC}$ = 6.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ = 6.1mA | – | 0.16 | 0.26 | – | 0.33 | |
| | LOW level output voltage; $R_S$ output | $V_{CC}$ = 1.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ =24µA | – | 0.04 | 0.10 | – | 0.11 | |
| | | $V_{CC}$ = 6.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ =760µA | – | 0.16 | 0.26 | – | 0.33 | |
| | LOW level output voltage; $\overline{MOLLI}$, $\overline{LED}$ outputs | $V_{CC}$ = 1.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ = 220µA | – | 0.04 | 0.10 | – | 0.11 | |
| | | $V_{CC}$ = 6.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ = 7.4mA | – | 0.17 | 0.26 | – | 0.33 | |
| | LOW level output voltage; EN output | $V_{CC}$ = 1.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ =360µA; pin 4 open | – | 0.04 | 0.10 | – | 0.11 | |
| | | $V_{CC}$ = 6.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ =13.0mA; pin 4 open | – | 0.17 | 0.26 | – | 0.33 | |
| | LOW level output voltage; EN output | $V_{CC}$ = 1.3 V; $V_I$ = $V_{IH}$ or $V_{IL}$; pin 4 = 10 V[1] | – | 0.12 | 0.35 | – | 0.40 | |
| | LOW level output voltage; $\overline{EN}$ output | $V_{CC}$ = 1.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ =140µA; pin 4 HIGH | – | 0.04 | 0.10 | – | 0.11 | |
| | | $V_{CC}$ = 6.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $I_O$ =5.0mA; pin 4 HIGH | – | 0.17 | 0.26 | – | 0.33 | |
| $V_{CC}$ | POR level<br>active<br>inactive | | 0.25<br>– | –<br>– | 0.65<br>0.9 | –<br>– | –<br>– | V |
| $I_{CC}$ | Quiescent supply current | $V_{CC}$ = 6.0 V; $V_I$ = $V_{CC}$ or GND; pins 5, 14, and 15 at GND; pins 7 and 9 at $V_{CC}$[2] | – | 34 | 50 | – | 400 | µA |
| $I_I$ | Input leakage current pins 4 and 9 | $V_{CC}$ = 1.0 V; $V_I$ = 10 V | – | – | 500 | – | – | nA |
| | Input leakage current pins 14 and15 | $V_{CC}$ = 6.0 V; $V_I$ = $V_{CC}$ or GND | – | – | 100 | – | – | |
| | Pull-up current pin 7 | $V_{CC}$ = 1.0 V; $V_I$ = GND | –0.5 | –2.4 | –10 | – | – | µA |
| | | $V_{CC}$ = 6.0 V; $V_I$ = GND | –0.5 | –2.4 | –10 | – | – | |
| | Pull-down current pin 5 | $V_{CC}$ = 1.0 V; $V_I$ = $V_{CC}$ | 0.5 | 2.4 | 10 | – | – | |
| | | $V_{CC}$ = 6.0 V; $V_I$ = $V_{CC}$ | 0.5 | 2.4 | 10 | – | – | |
| $I_{OZH}$ | OFF-state current pin 1, 3, and 6 | $V_{CC}$ = 6.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $V_O$ = 10 V | – | – | 500 | – | – | nA |
| | OFF-state current pin 2 | $V_{CC}$ = 6.0 V; $V_O$ = 6 V; $V_{in}$ = open | – | – | 100 | – | – | |
| | OFF-state current pin 3 | $V_{CC}$ = 6.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $V_O$ = 6 V | – | – | 100 | – | – | |
| $I_{OZ}$ | OFF-state current pins 10, 11, and 12 | $V_{CC}$ = 6.0 V; $V_I$ = $V_{IH}$ or $V_{IL}$; $V_O$ = $V_{CC}$ or GND | – | – | ±100 | – | – | nA |

**NOTE:**
1. This item guarantees that an external bipolar NPN-transistor can be switched off by the EN output.
2. Oscillator disabled. This can be done by $I_{OC}$ = HIGH or LOW.

## AC CHARACTERISTICS

GND = 0V; $t_r = t_f \leq 2.5ns$; $C_L = 50pF$

| SYMBOL | PARAMETER | TEST CONDITIONS | | $T_{amb}$ (°C) | | | | | UNIT |
|---|---|---|---|---|---|---|---|---|---|
| | | | | +25 | | | 0 to +70 | | |
| | | $V_{CC}$(V) | | MIN | TYP | MAX | MIN | MAX | |
| $\Delta f$ | Oscillator frequency spread | 1.0 | Any resistor or capacitor according to the application information, see note 1 | –11 | –4 | +3 | | | % |
| | | 6.0 | | –9 | –2 | +5 | | | |
| $\delta_{LED}$ | Duty factor at pin 1 | 1.0 | See Note 2 | – | 50 | | | | % |
| | | 6.0 | | – | 50 | | | | |
| $\delta_{MOLLI}$ | Duty factor at pin 6 | 1.0 | See Note 3 | – | 50 | | | | % |
| | | 6.0 | | – | 50 | | | | |
| $t_{deb}$ | Debounce suppression at pin 9 | 1.0 | | – | 67 | | | | ms |
| | | 6.0 | | – | 65 | | | | |
| $f_{i(max)}$ | Maximum frequency at power sense input | 1.0 | | 100 | | | | | kHz |
| | | 6.0 | | 100 | | | | | |
| $f_{i(min)}$ | Minimum frequency at power sense input | 1.0 | | | | 50 | | | Hz |
| | | 6.0 | | | | 50 | | | |

**NOTES:**

1. The oscillator frequency can be calculated by: $f = \frac{0.36}{R \times C1}$
2. During blinking.
3. An output signal of four periods will appear in case of discharged batteries and $\overline{DIS}$ is switched HIGH.

## APPLICATION INFORMATION

**Oscillator.**

The frequency will be determined by the external components $R_C$, $R_D$, $R_S$, and $C_1$. The frequencies can be calculated by the following expressions: $f = \frac{0.36}{R_C \times C1}$; $f = \frac{0.36}{R_D \times C1}$; $f = \frac{0.36}{R_S \times C1}$.

$R_C$ and C1 determine the charge time.
$R_D$ and C1 determine the discharge time.
$R_S$ and C1 determine the self-charge time.

The charge, discharge and self-discharge times can be calculated as follows:

$$\text{Charge time} = \frac{2^{22}}{f_C}; \text{ Discharge time} = \frac{2^{18}}{f_D}; \text{ Self-discharge time} = \frac{2^{27}}{f_S}$$

In the trickle charge mode, the average charge current will be reduced by a factor: $\frac{1}{1 + \frac{3 \times R_S}{4 \times R_C}}$

**External components range**

| SYMBOL | PARAMETER | TEST CONDITIONS | | | $T_{amb}$ (°C) | | | UNIT |
|---|---|---|---|---|---|---|---|---|
| | | | | | +25 | | | |
| | | $V_{CC}$(V) | $V_1$ | OTHER | MIN | TYP | MAX | |
| $R_C/R_D$ | Resistor range | 1.0 | | C1 = 0.22 µF | 5.360 | | 100 | kΩ |
| | | 2.0 | | | 1.150 | | 100 | |
| | | 4.5 | | | 0.562 | | 100 | kΩ |
| | | 6.0 | | | 0.511 | | 100 | |
| $R_S$ | Resistor range | 1.0 | | C1 = 0.22 µF | 42.20 | | 825 | kΩ |
| | | 2.0 | | | 9.09 | | 825 | |
| | | 4.5 | | | 4.22 | | 825 | kΩ |
| | | 6.0 | | | 3.32 | | 825 | |
| C1 | Capacitor range | 1.0 | | | | | no limit | pF |
| | | 2.0 | | | | | no limit | |
| | | 4.5 | | | | | no limit | pF |
| | | 6.0 | | | | | no limit | |

**Charge discharge times**

| PARAMETER | TIME RANGE | CONDITIONS |
|---|---|---|
| Charge time | 4 hours to 16 hours | Components ranges are within the values given in Section “External components range” |
| Discharge time | 15 minutes to to 4.7 hours | |
| Self-discharge time | 50 days to 100 days | |

**LED frequency**
The frequency of the $\overline{LED}$ output (pin1) is determined by the oscillator frequency.
Three modes of operation, each with its own frequency, are possible.

| Mode | SEL | $\overline{LED}$ frequency |
|---|---|---|
| Charge | H or open | $\frac{f_C}{256}$ |
| Trickle charge | L | $\frac{1}{\frac{8}{f_C}+\frac{6}{f_S}}$ |
| Alarm | H | $\frac{f_D}{32}$ |

**$\overline{MOLLI}$ pulse duration**
The MOLLI output gives an output signal of four periods with a 50% duty cycle. The duration of one period is determined by: $16/f_S$

**Timing accuracy.**
The timing accuracy depends on the accuracy of the on–chip oscillator and on the external R and C components. The inaccuracy of the on–chip oscillator is specified as maximum +/–7%. In most cases the actual inaccuracy will be significantly lower. This depends on the supply voltage as well as the value of the external components.

**Influence of Resistor value.**
Low resistor values cause some spread because the RC combination is biased by a 3–State push–pull output. The spread of the $R_{on}$ of the push–pull stage will contribute to the frequency spread. When high–value resistors are used, any possible output leakage of the not–selected 3–State outputs will cause a frequency deviation. For these reasons, the resistor values must be within the specified ranges.

**Influence of supply voltage**
The trip levels of the oscillator are fixed at 20% and 80% of $V_{cc}$. At higher supply voltages the spread of the trip levels decreases in greater proportion because the offset voltage remains constant, and the propagation delay decreases. Furthermore, the $R_{on}$ values of the push–pull driving stage decrease at higher voltages.

## SPREAD-CAUSING FACTORS

| SYMBOL | PARAMETER | $V_{CC}$ (V) | $T_{amb}$ (°C) | | | UNIT |
|---|---|---|---|---|---|---|
| | | | MIN | TYP | MAX | |
| $V_{off}$ | Offset voltage | 1.0 | | 7 | | mV |
| | | 6.0 | | 7 | | mV |
| $t_P$ | Propagation delay | 1.0 | | 22 | | µs |
| | | 6.0 | | 5.5 | | µs |
| $R_{ON}$ | P-channel resistance $R_C$, $R_D$ outputs | 1.0 | | 170 | | Ω |
| | | 6.0 | | 25 | | Ω |
| $R_{ON}$ | N-channel resistance $R_C$, $R_D$ outputs | 1.0 | | 250 | | Ω |
| | | 6.0 | | 35 | | Ω |
| $R_{ON}$ | P-channel resistance $R_S$ output | 1.0 | | 1300 | | Ω |
| | | 6.0 | | 180 | | Ω |
| $R_{ON}$ | N-channel resistance $R_S$ output | 1.0 | | 1300 | | Ω |
| | | 6.0 | | 180 | | Ω |

**Error free operation, even under extreme conditions.**
Several measures are taken in the circuit design to ensure error–free operation, even with very low supply voltages. Moreover, the circuit has been made very insensitive to the effects of external fields. The measures taken during the design are:

- Use of synchronous logic
- Bistable POR instead of monostable POR
- Data retention assured below a supply voltage of 0.9 V.
- Debounce circuitry on $\overline{DIS}$ input (maximum expected debounce time = 10 ms)
- Schmitt trigger on PWRS (power sense) input and on $\overline{DIS}$ input
- Special oscillator security to prevent any malfunction.

**Synchronous logic and bistable POR.**
Use of synchronous logic results in much lower sensitivity to spikes on input pins. The POR is adapted to fit well into a synchronous environment. An increasing supply voltage sets the POR. The POR output signal is routed to the control logic and divider/counter. it is synchronized with the on–chip clock. After all flip–flops are reset, a reset acknowledge signal is generated which resets the POR. This method ensures that the POR signal is acknowledged in all cases, even at very low voltages.

**Data retention.**
The circuit may be used in an application where an electric motor is present. When the motor is switched on, it will disturb the supply voltage for a short period. The POR level is set at such a level that, even with very low supply voltages, the POR will not respond during motor switch on. The flip–flops will retain their data during the supply voltage disturbance because of the inherent data retention of any CMOS gate. However, when the battery is almost completely discharged and the motor switch is activated, the dip on the supply voltage line can be too large. The retention of the POR is therefore made deliberately worse than that of the internal flip–fops. The POR will therefore respond long before the flip–flops will loose their data. This results in a proper start condition for a new charge cycle.

**Debounce circuitry on $\overline{DIS}$ input.**
A discharge cycle is activated by a switch. To protect the circuit from any bounce of the switch contacts, de–bounce circuitry is provided at the $\overline{DIS}$ input. The circuitry allows a switch de–bounce time of max. 10 ms.

**Schmitt trigger on PWRS (power sense) input.**
The PWRS input can be corrupted by high transients due to disturbances on the mains supply. To suppress any false triggering, the PWRS input is provided with a Schmitt–trigger. However, for some applications, it is advisable to connect a low–value capacitor (150 pF min.) between the PWRS input and GND.

**Special oscillator security to prevent any malfunction.**
The excellent performance of the oscillator is achieved by using linear op–amp techniques. The oscillator consists of an internal reference, two comparators and a latch. Care was taken to design a very reliable oscillator even with a supply voltage below 0.9 V. If one of the comparators ceases to operate with a supply voltage below 0.9 V, the latch will not be corrupted. Priority was given to stop the oscillator rather than allow uncontrolled oscillation.

All these measures result in reliable 1-cell to 4-cell battery charge management.

**Remaining energy indication:**
The scan test facility can be used as a remaining energy indication because the value of the counter can be read–out at the scan output ($\overline{MOLLI}$/SCO). This is achieved by briefly interrupting the normal mode of operation, putting the circuit in the scan mode (pin 14 = HIGH), and reading–out of the counter value. The circuit is then returned to the normal mode (pin 14 = LOW or open).

Read–out procedure: The contents of the counter flip–flops can be read–out in the scan mode. To ensure that there is no disturbance of the circuit function, it is essential to either create a round coupled loop by linking the $\overline{MOLLI}$/SCO output (pin 6) directly to the SCI input pin 15), or to shift–in the serial data of the scan line at the SCI input after completion of the read out cycle. 49 clock pulses are needed on the Iosc input (pin 13) to shift–out the contents of the whole scan line. The most–significant bit of the counter will appear at the $\overline{MOLLI}$/SCO output after the last clock pulse. The least–significant bit after the penultimate clock pulse, etc. Selecting the last three or four bits will yield sufficiently high accuracy to obtain the counter value which represents the remaining energy of the battery.

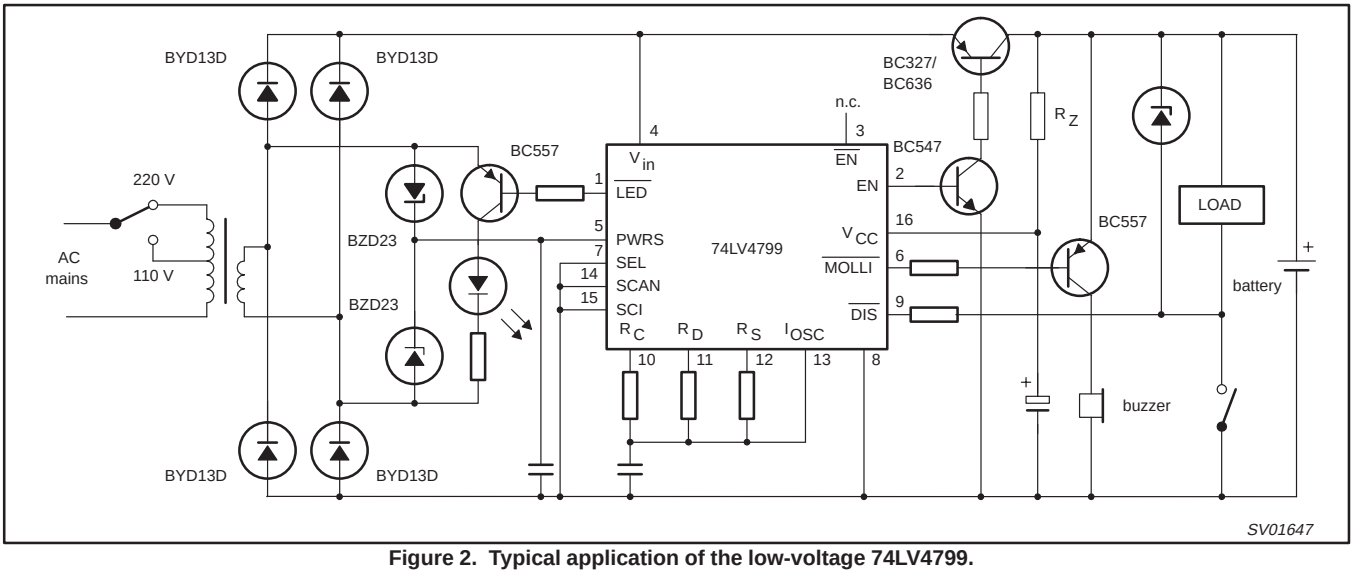



**Figure 2. Typical application of the low-voltage 74LV4799.**

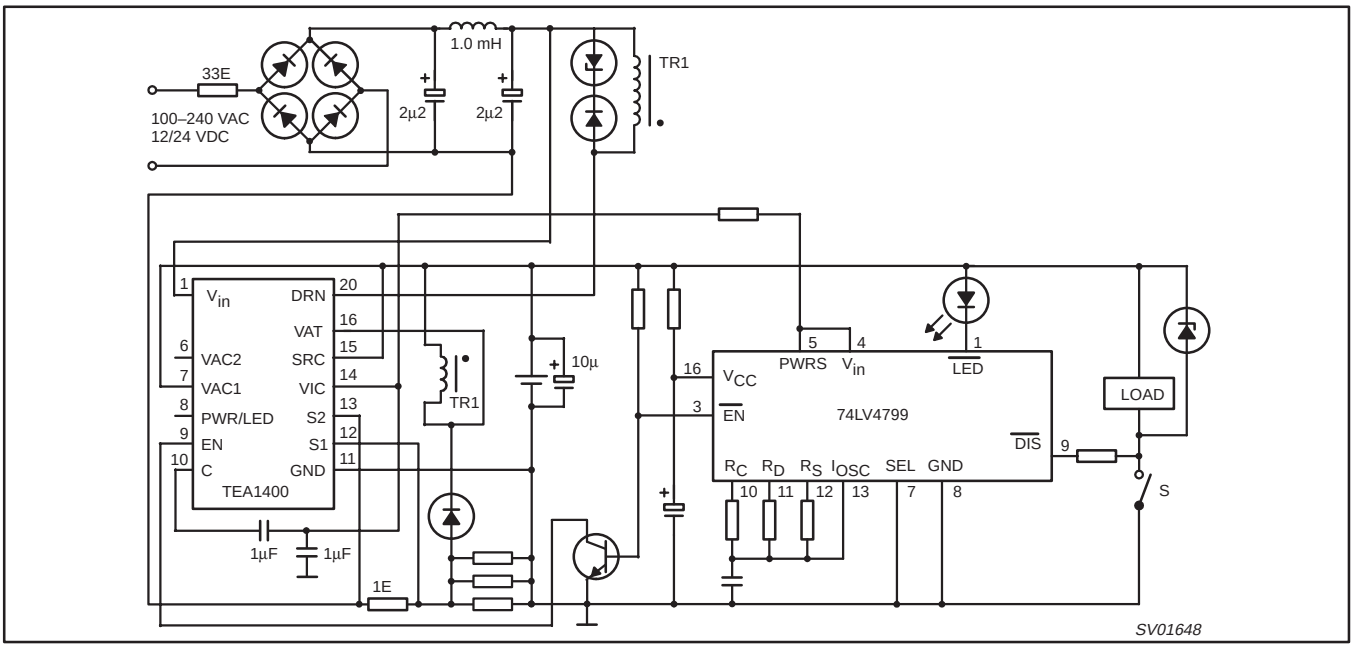



**Figure 3. Application diagram of the 74LV4799 in combination with the high-voltage IC TEA1400.**

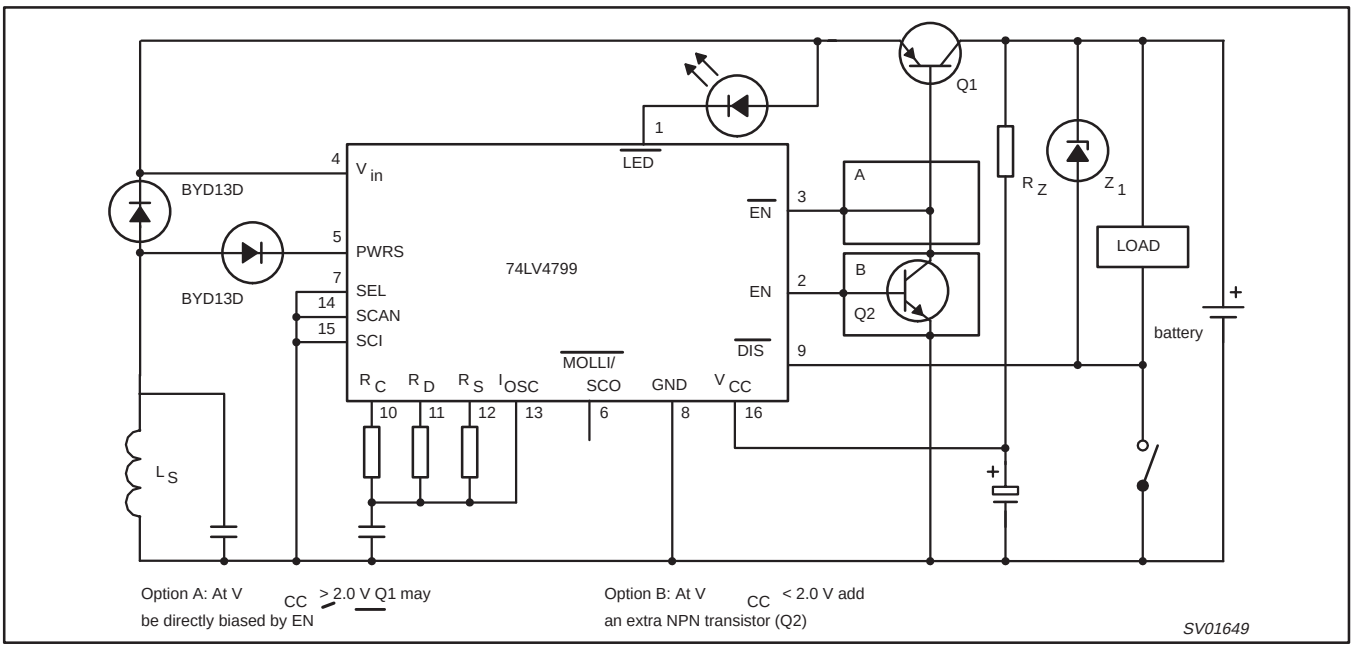
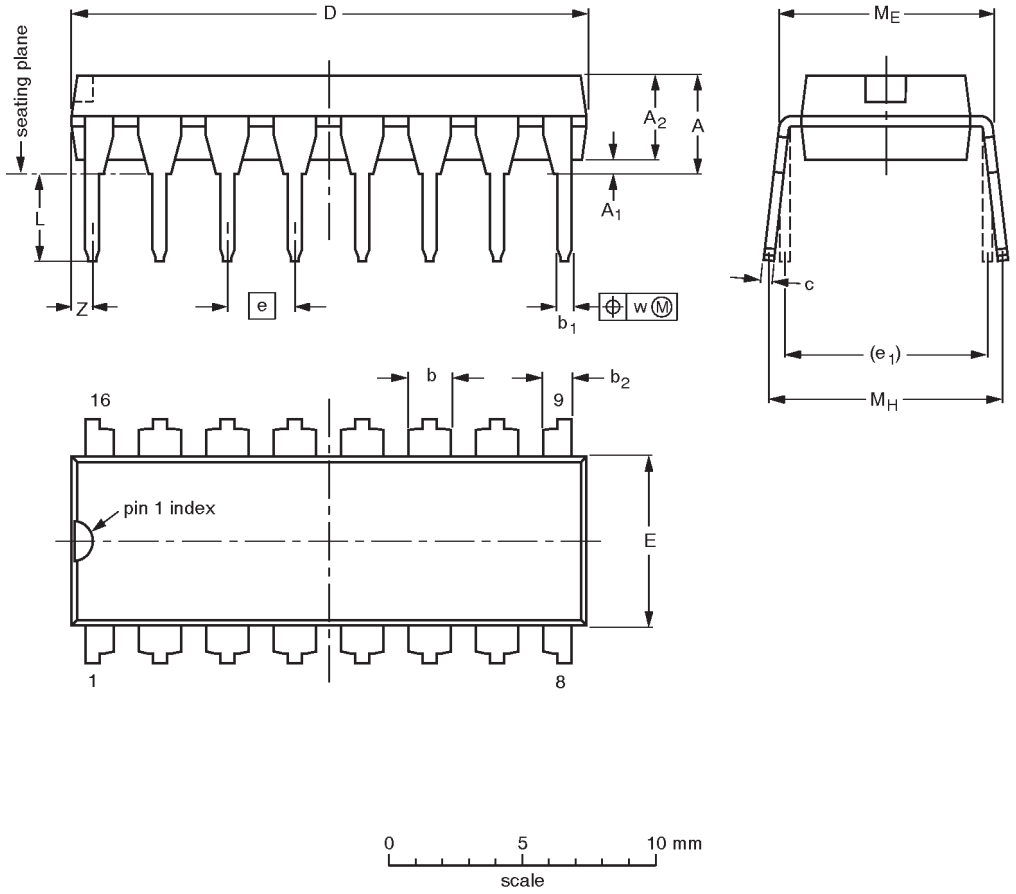



**Figure 4. Inductive loader, showing the two options A and B.**

**DIP16: plastic dual in-line package; 16 leads (300 mil)** **SOT38-4**




**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

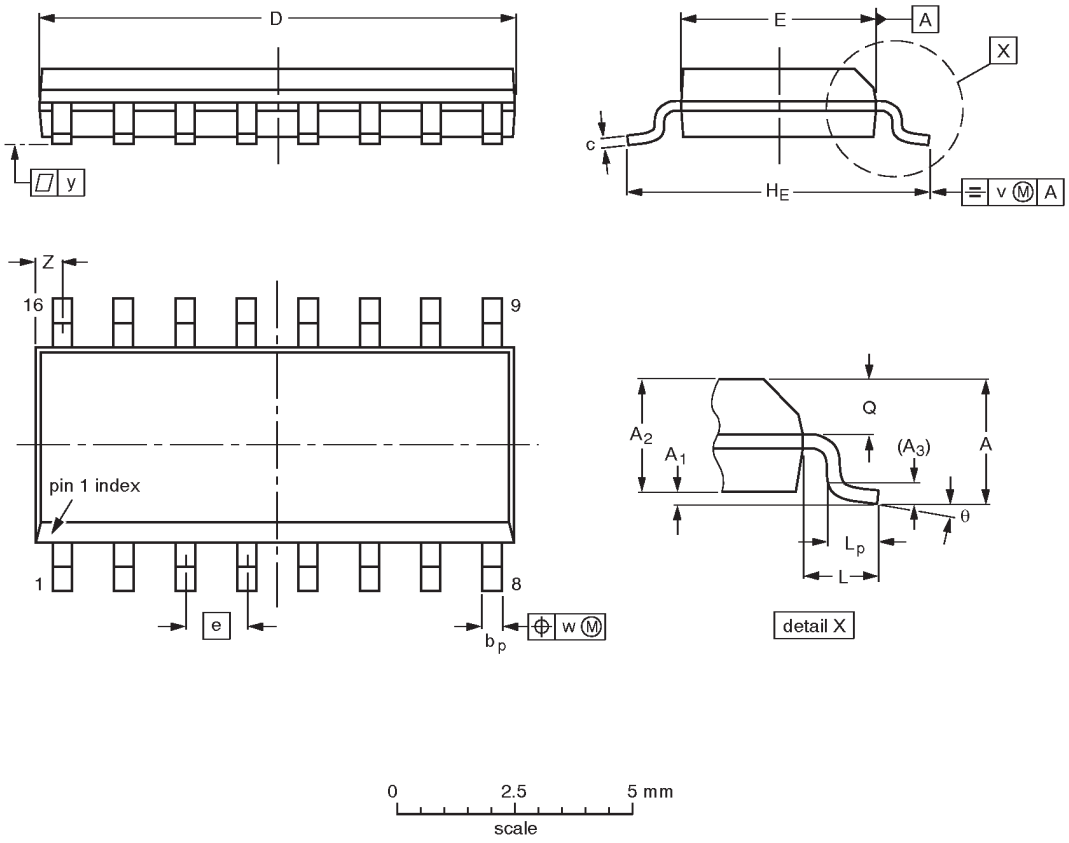
| UNIT | A max. | $A_1$ min. | $A_2$ max. | b | $b_1$ | $b_2$ | c | D (1) | E (1) | e | $e_1$ | L | $M_E$ | $M_H$ | w | Z (1) max. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 4.2 | 0.51 | 3.2 | 1.73<br>1.30 | 0.53<br>0.38 | 1.25<br>0.85 | 0.36<br>0.23 | 19.50<br>18.55 | 6.48<br>6.20 | 2.54 | 7.62 | 3.60<br>3.05 | 8.25<br>7.80 | 10.0<br>8.3 | 0.254 | 0.76 |
| inches | 0.17 | 0.020 | 0.13 | 0.068<br>0.051 | 0.021<br>0.015 | 0.049<br>0.033 | 0.014<br>0.009 | 0.77<br>0.73 | 0.26<br>0.24 | 0.10 | 0.30 | 0.14<br>0.12 | 0.32<br>0.31 | 0.39<br>0.33 | 0.01 | 0.030 |

**Note**

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT38-4 | | | | | | ~~92-11-17~~<br>95-01-14 |

**SO16: plastic small outline package; 16 leads; body width 3.9 mm** **SOT109-1**




**DIMENSIONS (inch dimensions are derived from the original mm dimensions)**

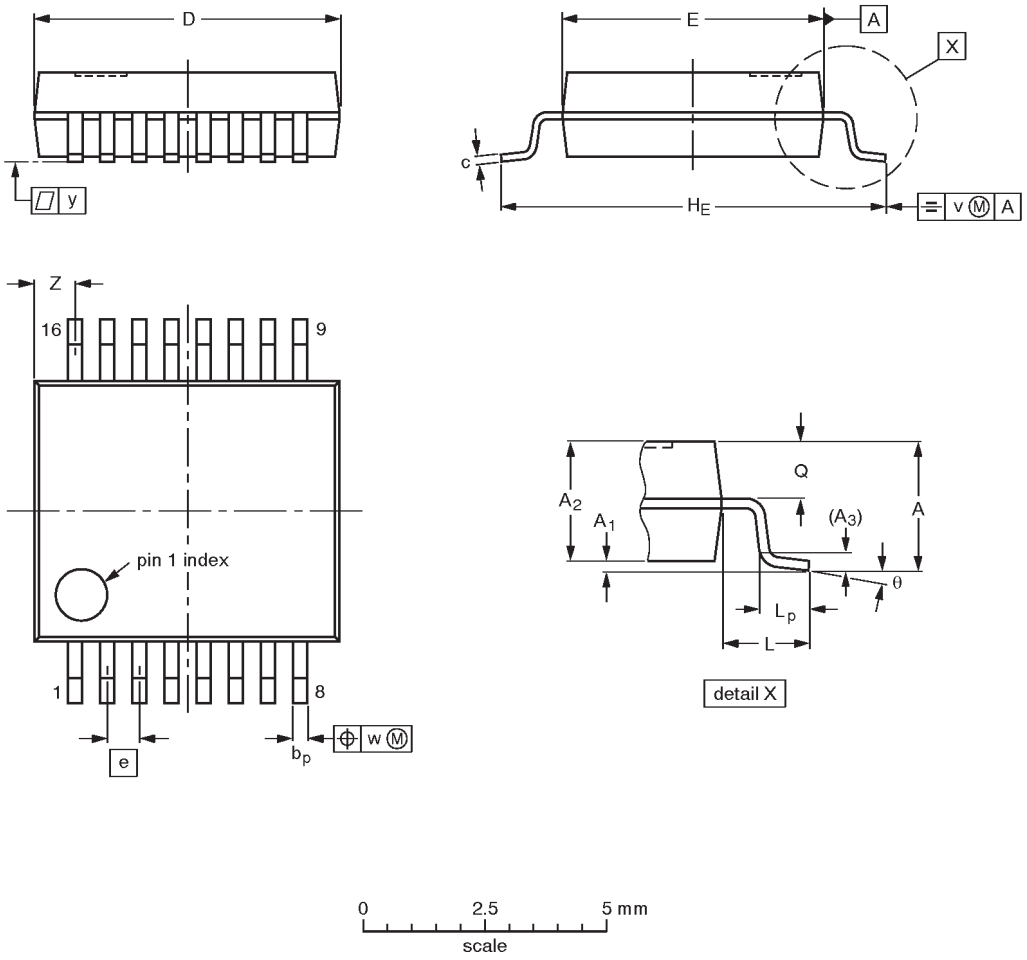
| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | $D^{(1)}$ | $E^{(1)}$ | e | $H_E$ | L | $L_p$ | Q | v | w | y | $Z^{(1)}$ | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.75 | 0.25<br>0.10 | 1.45<br>1.25 | 0.25 | 0.49<br>0.36 | 0.25<br>0.19 | 10.0<br>9.8 | 4.0<br>3.8 | 1.27 | 6.2<br>5.8 | 1.05 | 1.0<br>0.4 | 0.7<br>0.6 | 0.25 | 0.25 | 0.1 | 0.7<br>0.3 | 8°<br>0° |
| inches | 0.069 | 0.0098<br>0.0039 | 0.057<br>0.049 | 0.01 | 0.019<br>0.014 | 0.0098<br>0.0075 | 0.39<br>0.38 | 0.16<br>0.15 | 0.050 | 0.24<br>0.23 | 0.041 | 0.039<br>0.016 | 0.028<br>0.020 | 0.01 | 0.01 | 0.004 | 0.028<br>0.012 | |

**Note**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT109-1 | 076E07S | MS-012AC | | | | ~~91-08-13~~<br>95-01-23 |

**SSOP16: plastic shrink small outline package; 16 leads; body width 5.3 mm** **SOT338-1**




**DIMENSIONS (mm are the original dimensions)**

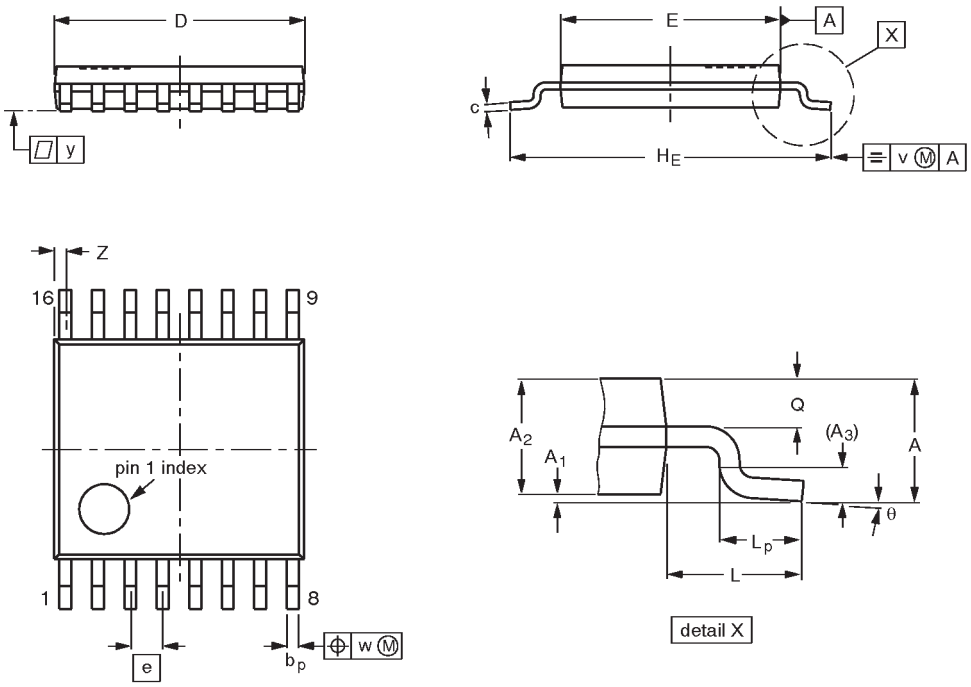
| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | D (1) | E (1) | e | $H_E$ | L | $L_p$ | Q | v | w | y | Z (1) | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 2.0 | 0.21<br>0.05 | 1.80<br>1.65 | 0.25 | 0.38<br>0.25 | 0.20<br>0.09 | 6.4<br>6.0 | 5.4<br>5.2 | 0.65 | 7.9<br>7.6 | 1.25 | 1.03<br>0.63 | 0.9<br>0.7 | 0.2 | 0.13 | 0.1 | 1.00<br>0.55 | 8°<br>0° |

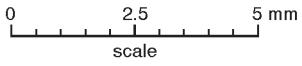
**Note**

1. Plastic or metal protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT338-1 | | MO-150AC | | | | ~~94-01-14~~<br>95-02-04 |

**TSSOP16: plastic thin shrink small outline package; 16 leads; body width 4.4 mm** **SOT403-1**




**DIMENSIONS (mm are the original dimensions)**

| UNIT | A max. | $A_1$ | $A_2$ | $A_3$ | $b_p$ | c | D (1) | E (2) | e | $H_E$ | L | $L_p$ | Q | v | w | y | Z (1) | θ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| mm | 1.10 | 0.15<br>0.05 | 0.95<br>0.80 | 0.25 | 0.30<br>0.19 | 0.2<br>0.1 | 5.1<br>4.9 | 4.5<br>4.3 | 0.65 | 6.6<br>6.2 | 1.0 | 0.75<br>0.50 | 0.4<br>0.3 | 0.2 | 0.13 | 0.1 | 0.40<br>0.06 | 8°<br>0° |

**Notes**

1. Plastic or metal protrusions of 0.15 mm maximum per side are not included.
2. Plastic interlead protrusions of 0.25 mm maximum per side are not included.

| OUTLINE VERSION | REFERENCES | | | | EUROPEAN PROJECTION | ISSUE DATE |
|---|---|---|---|---|---|---|
| | IEC | JEDEC | EIAJ | | | |
| SOT403-1 | | MO-153 | | | | ~~94-07-12~~<br>95-04-04 |

**NOTES**

## Data sheet status

| Data sheet status | Product status | Definition [1] |
|---|---|---|
| Objective specification | Development | This data sheet contains the design target or goal specifications for product development. Specification may change in any manner without notice. |
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[1] Please consult the most recently issued datasheet before initiating or completing a design.

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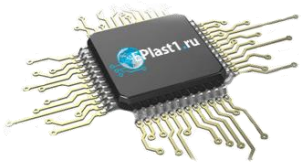
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- Подбор аналогов;
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- Поставка образцов и прототипов;
- Техническая поддержка проекта;
- Защита от снятия компонента с производства.




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