Ordering number : EN2644A

CMOS LSI

SANYO No. 2644A

# LC7730,7730M

## Timer

**Overview:**

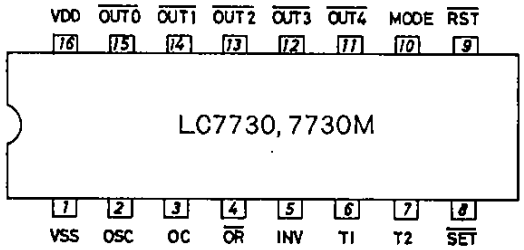
The LC7730s are the stable long-running timers that consists of a CR oscillator and multi-stage counters. If a 4.66kHz clock is used as a standard clock input, they can be used as an hour-long timer.

**Features:**

- Elapsed time display function
- Two operation modes
- 15V withstand voltage open drain output for switching output (NPN and PNP type transistors directly drivable by the INV input selection)
- Various timer values can be set by changing the oscillator CR value properly (from 10 minutes to several hours).

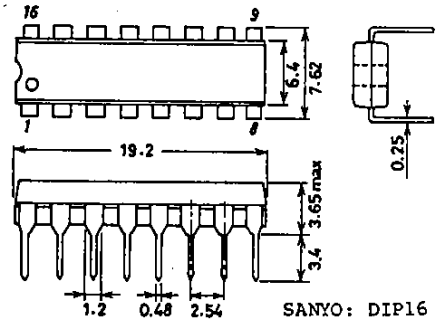
**Applications:**

- Sleep timer for radios and radio cassette players
- Battery charger timer
- Ultra-low frequency signal generator




**Package Dimensions**
**( unit: mm )**
3006B-D16IC

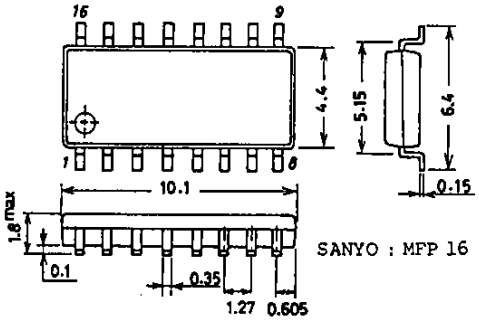
[LC7730]




SANYO: DIP16

**Package Dimensions**
**( unit: mm )**
3035A-M16IC

[LC7730M]




SANYO : MFP 16

**Absolute Maximum Ratings**/Ta=25±2℃, Vss=0V

| Parameter | Symbol | Conditions | Limits | unit |
|---|---|---|---|---|
| Maximum Supply Voltage | $V_{DD}$ max | | −0.3~7.0 | V |
| Input Voltage | $V_{IN}$ | | −0.3~$V_{DD}$+0.3 | |
| Output Voltage | $V_{OUT1}$ | Pin $\overline{OUT0}$ | −0.3~15.0 | |
| | $V_{OUT2}$ | Pins $\overline{OUT1}$ to $\overline{OUT4}$ | −0.3~$V_{DD}$+0.3 | |
| Output Current | $I_{OUT1}$ | Pin $\overline{OUT0}$ | 15 | mA |
| | $I_{OUT2}$ | Pins $\overline{OUT1}$ to $\overline{OUT4}$ | ±5 | |
| Power Dissipation | Pd max | DIP, Ta≦75℃ | 300 | mW |
| | | MFP, Ta≦75℃ | 150 | |
| Operating Temperature | Topr | | −10~+75 | ℃ |
| Storage Temperature | Tstg | | −55~+125 | |

**Allowable Operating Range**/Ta=-10 to +75℃, Vss=0V

| Parameter | Symbol | Conditions | Limits | | | unit |
|---|---|---|---|---|---|---|
| | | | min | typ | max | |
| Supply Voltage | $V_{DD}$ | Topg | 1.8 | | 6.0 | V |
| Input Voltage | $V_{IN}$ | Topg | 0 | | $V_{DD}$ | |
| Output Voltage | $V_{OUT1}$ | Topg, pin $\overline{OUT0}$ | 0 | | 15.0 | |
| | $V_{OUT2}$ | Topg, Pins $\overline{OUT1}$ to $\overline{OUT4}$ | 0 | | $V_{DD}$ | |

**Electrical Characteristics**/Ta=25±2℃, Vss=0V

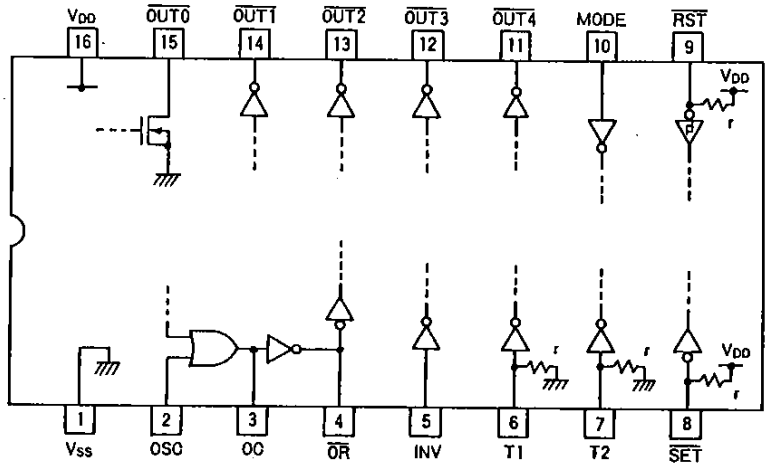
| Parameter | Symbol | Conditions | | Limits | | | unit |
|---|---|---|---|---|---|---|---|
| | | | $V_{DD}$(V) | min | typ | max | |
| Current Dissipation | $I_{DD1}$ | fosc=4.66kHz | 5 | | | 1.0 | mA |
| | $I_{DD2}$ | OSC stop | 5 | | | 1.0 | μA |
| 'L' Level Output Current | $I_{OL1}$ | Pin $\overline{OUT0}$, $V_{OL}$=1V | 2 | 1.0 | | | mA |
| | $I_{OL2}$ | Pin $\overline{OUT0}$, $V_{OL}$=1V | 3 | 5.0 | | | |
| Output Off-leakage Current | $I_{OFF}$ | Pin $\overline{OUT0}$, $V_O$=15V | 5 | | | 10 | μA |
| 'H' Level Output Current | $I_{OH}$ | Pins $\overline{OUT1}$ to $\overline{OUT4}$, $V_{OH}$=2.5V | 3 | | | −200 | μA |
| 'L' Level Output Current | $I_{OL3}$ | Pins $\overline{OUT1}$ to $\overline{OUT4}$, $V_{OL}$=0.5V | 3 | 200 | | | |
| 'H' Level Input Current | $I_{IH1}$ | Pins $\overline{RST}$ and $\overline{SET}$ (50kΩ pull-up resistance) | 5 | | | 1.0 | μA |
| 'L' Level Input Current | $I_{IL1}$ | | 5 | | −100 | | |
| 'H' Level Input Current | $I_{IH2}$ | Pins T1 and T2 (50kΩ pull-down resistance) | 5 | | 100 | | μA |
| 'L' Level Input Current | $I_{IL2}$ | | 5 | −1.0 | | | |
| 'H' Level Input Current | $I_{IH3}$ | Pins INV and MODE | 5 | | | 1.0 | μA |
| 'L' Level Input Current | $I_{IL3}$ | | 5 | −1.0 | | | |
| 'H' Level Input Voltage | $V_{IH}$ | | | 0.7$V_{DD}$ | | $V_{DD}$ | V |
| 'L' Level Input Voltage | $V_{IL}$ | | | 0 | | 0.3$V_{DD}$ | |

## ● Pin Description

| Pin No. | Pin Name | Functional Description | Input/Output |
|---|---|---|---|
| 1 | Vss | Power supply pin (0V) | — |
| 2 | OSC | Oscillation pins for external CR addition | Input |
| 3 | OC | | Input/output |
| 4 | $\overline{OR}$ | | Input/output |
| 5 | INV | Input pin for $\overline{OUT0}$ output inversion (normally, this pin level is 'L'). H level: Output transistor OFF at the timer run time. L level: Output transistor ON at the timer run time. | Input |
| 6 | T1 | Test pin (Normally, this pin is connected with the Vss pin or left open). | Input with a pull-down resistor |
| 7 | T2 | | Input with a pull-down resistor |
| 8 | $\overline{SET}$ | Set pin (for control input to the timer) If the MODE input = 'H', this pin is used to input a start/preset signal to the timer. If the MODE input = 'L', this pin is used to input a start/stop signal to the timer. | Input with a pull-up resistor |
| 9 | $\overline{RST}$ | Reset pin (for reset or stop input to the timer) If a capacitor is added externally to this pin, a power-on reset circuit can be formed. | Input with a pull-up resistor (Schmitt input) |
| 10 | MODE | Operation mode select pin ($\overline{SET}$ input function) | Input |
| 11 | $\overline{OUT4}$ | Output pins for elapsed time display If the chip is used as an hour-long timer, these pins become active ('L') every 15 minutes in the order of $\overline{OUT1}$, $\overline{OUT2}$, $\overline{OUT3}$ and $\overline{OUT4}$. | Output |
| 12 | $\overline{OUT3}$ | | Output |
| 13 | $\overline{OUT2}$ | | Output |
| 14 | $\overline{OUT1}$ | | Output |
| 15 | $\overline{OUT0}$ | Switching output pin Output pin for switching the timer loads in radio circuits, etc. Normally, buffered by an external PNP transistor. | Open drain output |
| 16 | VDD | Power supply pin (1.8V to 6.0V) | — |

Note: If a pin is low active, it is indicated by a 'top bar'.

### -Input/Output Configuration




r ≒ 50kΩ

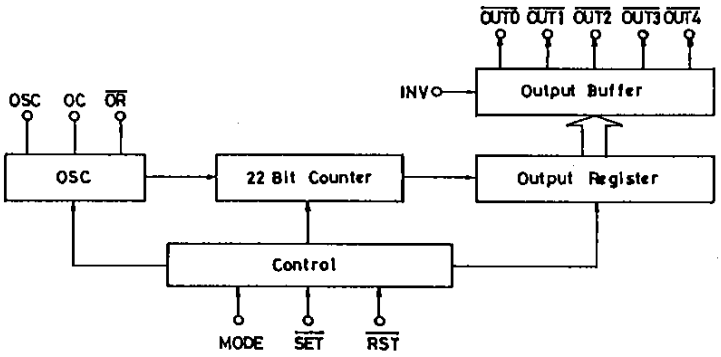



Figure-1. LC7730 Configuration

1. Oscillation Circuit

The LC7730 uses a CR oscillation circuit to generate various timing signals.

The C and R shown in Figure-2 determine a time constant to generate required timing signals. The RS is a resistance to limit the current that flows into the input protection circuit, thereby reducing the total power dissipation of the oscillation circuit.

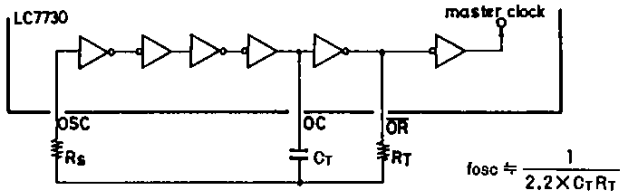



Figure-2. Oscillation Circuit

If the LC7730 uses an oscillation frequency of 4.66kHz, it can work as an hour-long timer. As the oscillation frequency can be changed, the LC7730 can be used as various types of timers. The relation between oscillation frequencies and timer values is as follows:

$$f_{OSC}(Hz) = \frac{2^{24}}{\text{Timer value} \times 60\ (\text{min.})} \qquad \left(f_{OSC} \fallingdotseq \frac{1}{2.2 \times C_T R_T}\right)$$

·Timer values and Oscillation frequencies

| Timer value | Oscillation frequency | Timer value | Oscillation frequency |
|---|---|---|---|
| 10 minutes | 28.0kHz | 1 hour | 4660Hz |
| 20 minutes | 14.0kHz | 2 hours | 2330Hz |
| 30 minutes | 9320Hz | 3 hours | 1554Hz |
| 40 minutes | 6991Hz | 4 hours | 1165Hz |
| 50 minutes | 5592Hz | 5 hours | 932Hz |

2. Basic LC7730 Operations

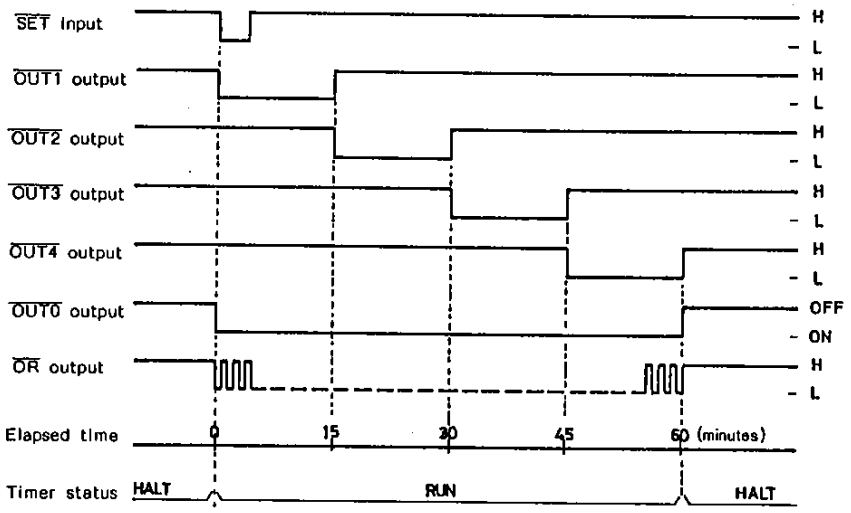



Figure-3. Basic operational timing chart
(fosc=4.66kHz/$\overline{RST}$ input pin = 'H' level, INV input pin = 'L' level)

If the SET pin of the timer currently in the stop mode becomes active (active low), the timer will enter the 'run' status. When the timer is started, it turns on the $\overline{OUT0}$ output pin to drive a external load and then outputs an 'L' level signal from the $\overline{OUT1}$ pin. Output pins from $\overline{OUT1}$ to $\overline{OUT4}$ are provided to display timer elapsed times. They become active ('L' level) very 15 minutes in the order of $\overline{OUT1}$, $\overline{OUT2}$, $\overline{OUT3}$ and $\overline{OUT4}$.
If an hour elapses after the timer is started (with the fosc=4.66kHz), the timer turns off the $\overline{OUT1}$ pin, inactivates output pins $\overline{OUT1}$ to $\overline{OUT4}$, and then enters the stop mode.
When the timer enters the stop mode, it stops the oscillation to reduce the power dissipation.
Note that if the INV input pin changes to the 'H' level, the $\overline{OUT0}$ output will be inverted.

Table-1. Operational Status-Output level (fosc=4.66kHz)

| Operational status | | Output | | | | | |
|---|---|---|---|---|---|---|---|
| Status | Time elapsed (minute) | $\overline{OUT0}$ INV input L level | $\overline{OUT0}$ INV input H level | $\overline{OUT1}$ | $\overline{OUT2}$ | $\overline{OUT3}$ | $\overline{OUT4}$ |
| HALT | — | 1 | 0 | 1 | 1 | 1 | 1 |
| RUN | 0~15 | 0 | 1 | 0 | 1 | 1 | 1 |
| RUN | 15~30 | 0 | 1 | 1 | 0 | 1 | 1 |
| RUN | 30~45 | 0 | 1 | 1 | 1 | 0 | 1 |
| RUN | 45~60 | 0 | 1 | 1 | 1 | 1 | 0 |

HALT: Stop
RUN : In action
0: L level
1: H level
Note: The $\overline{OUT0}$ H level means that the open drain output transistor is in the OFF state.

3. LC7730 Control
The LC7730 can be controlled by using three pins $\overline{RST}$(active low), $\overline{SET}$ (active low) and MODE (active high).
If the $\overline{RST}$ (reset) pin changes its level to 'L' from 'H', the timer will stop and its internal circuitry will be reset. This pin has the schimitt input specification with an internal pull-up resistance. If a capacitor is added to this pin externally, the power-on reset circuit will be formed.
The $\overline{SET}$ (active low) pin is used to input a start/stop and start/preset signal to the timer. The pin functions depend on the MODE pin level. The $\overline{SET}$ pin has a chattering elimination circuit with an internal pull-up resistance. The timer will start its operation at the moment when this pin becomes active.
The MODE pin has the functions as shown in Table-2. It is used to select one of the $\overline{SET}$ pin functions.

Table-2. MODE input pin and $\overline{SET}$ pin functions

| MODE input | $\overline{SET}$ pin function |
|---|---|
| 0 | Start/stop input |
| 1 | Start/preset input |

(1) Start/stop function (MODE pin = 'L' level)
If MODE pin = 'L', the $\overline{SET}$ pin can be used for start/stop input. When the timer is in the stop state and the $\overline{SET}$ pin becomes active (active low), the timer is started. If the timer is in action and the $\overline{SET}$ pin becomes inactive, the timer stops.

(2) Start/preset function (MODE pin = 'H' level)
If MODE pin = 'H', the $\overline{SET}$ pin can be used for start/preset input. When the timer is in the stop state and the $\overline{SET}$ pin becomes active (active low), the timer is started. If the $\overline{SET}$ pin becomes active immediately after the timer is started, the timer value advances 15 minutes.

Table-3. Preset time value (fosc=4.66kHz)

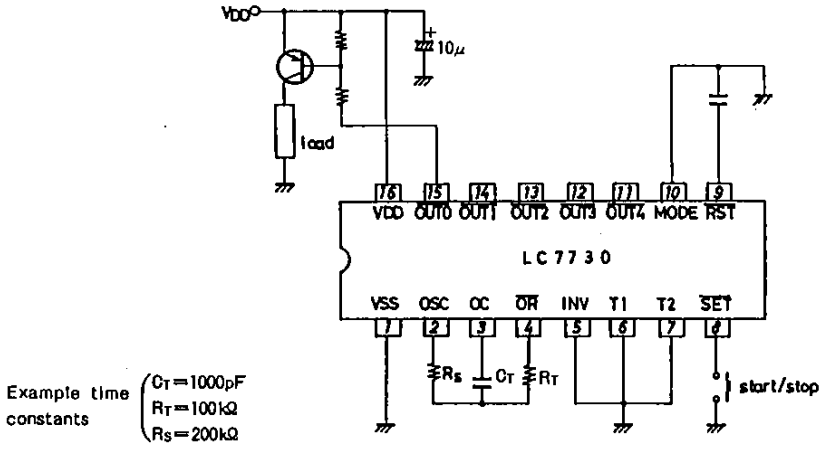
| Elapse time (minute) | Preset time (minute) |
|---|---|
| 0 to 15 | 15 |
| 15 to 30 | 30 |
| 30 to 45 | 45 |
| 45 to 60 | 60 |

Table-4. Input-operational status relationship

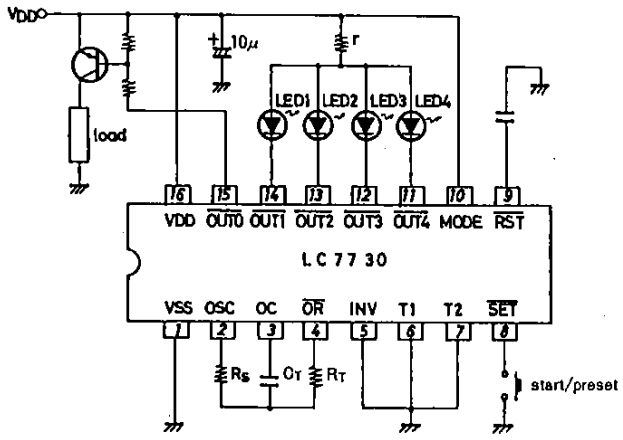
| Input | | | | Resulted status | Remarks |
|---|---|---|---|---|---|
| Status | $\overline{RST}$ | $\overline{SET}$ | MODE | | |
| HALT | 0 | × | × | HALT | Reset |
| RUN | 0 | × | × | HALT | |
| HALT | 1 | ↓ | 0 | RUN | Start/stop mode |
| RUN | 1 | ↓ | 0 | HALT | |
| HALT | 1 | ↓ | 1 | RUN | Start/preset mode |
| RUN | 1 | ↓ | 1 | RUN (preset) | |

HALT : Stop  0 : 'L' level  × : Don't care
RUN : In action  1 : 'H' level  ↓ : Falling signal edge

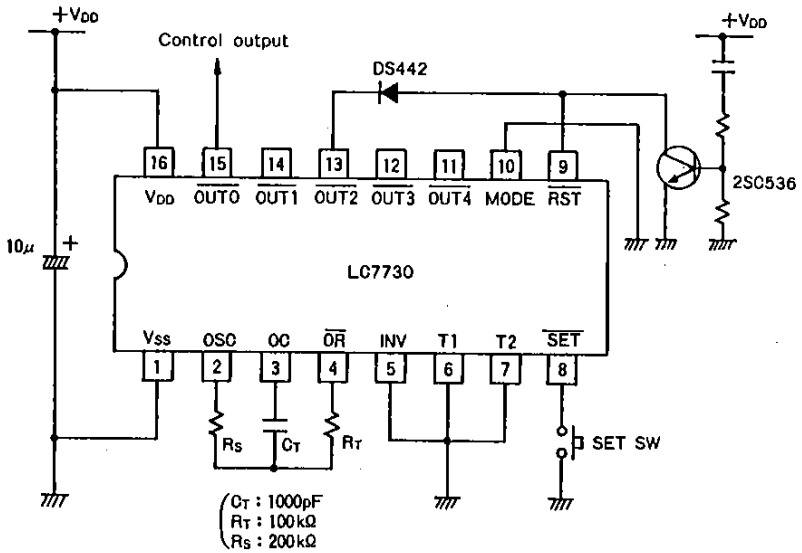
4. Sample Application Circuits
(1) Sleep timer I (minimum configuration)



(2) Sleep timer II (preset function/elapsed time display)




(3) Application example using smaller timer value

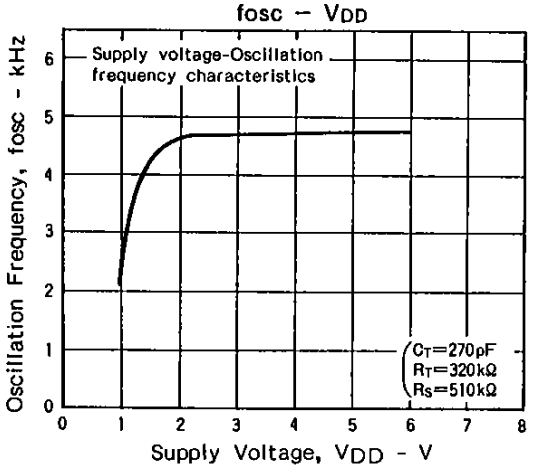



In this application circuit, the $\overline{OUT2}$ pin output signal causes the timer to be forcibly reset. This can be called a self-reset function. As a result, this timer value can be reduced to the 1/4 of a normal time value. The CR time constant is given for an hour-long timer. However, this timer can work as a 15-minute timer.

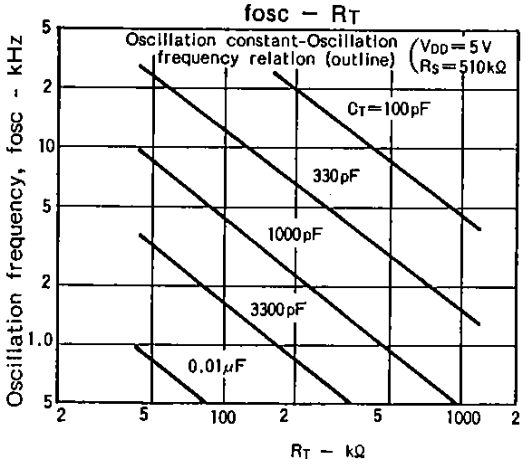
The time value for this circuit is calculated in the following manner:

$$fosc(Hz) = \frac{2^{22}}{\text{Timer value} \times 60\ (\text{min.})}$$

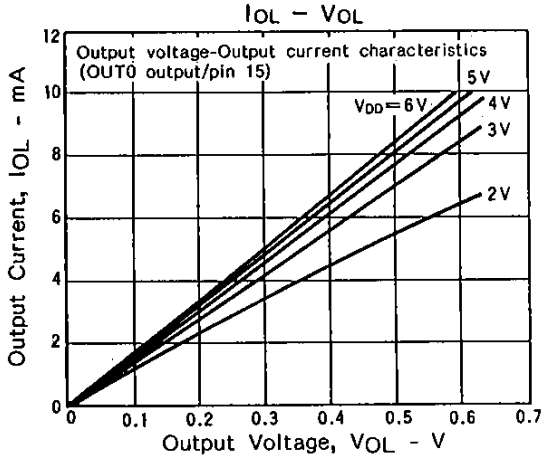
fosc – $V_{DD}$



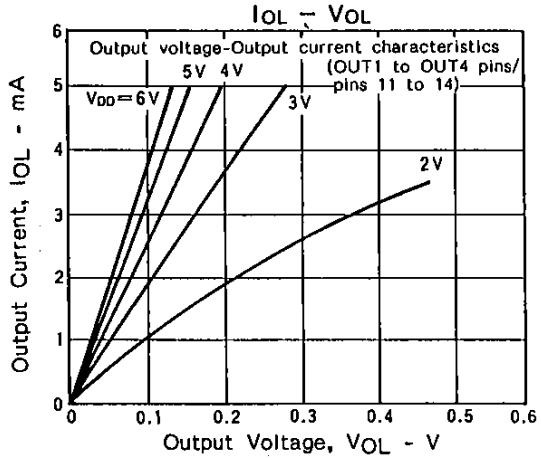

fosc – $R_T$




$I_{OL}$ – $V_{OL}$




$I_{OL}$ – $V_{OL}$




$I_{OH}$ – $V_{OH}$