

---

# **ML9298**

---

## **12-Hour System Clock IC for 1/2 Duty Fluorescent Display Tubes**

---

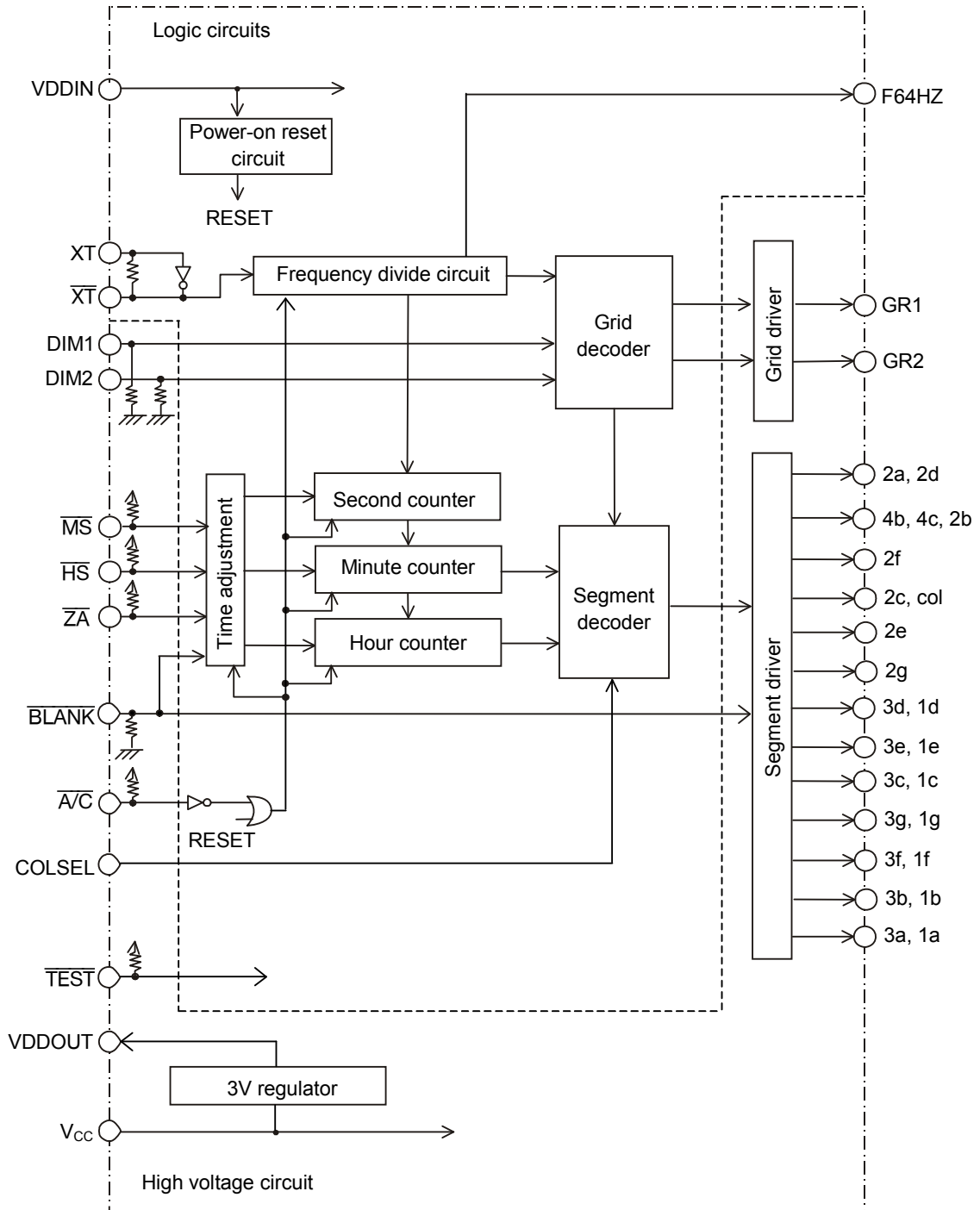
### **GENERAL DESCRIPTION**

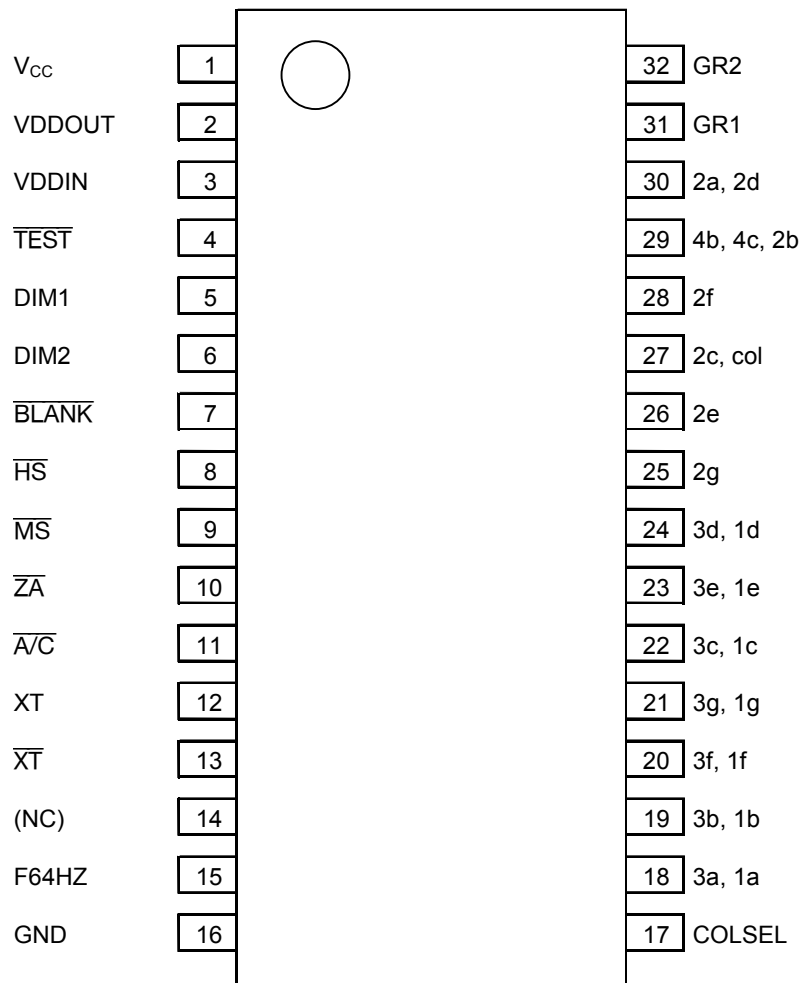
The ML9298 is a 12-hour system clock IC that drives 1/2 duty fluorescent display tubes. It has a wide range of power supply using an oscillation source of 4.194304 MHz. The ML9298 has a time adjustment function in hour, minute and 30-minute units, and the function has two adjustment modes, 1 Push 1 ADJ and 2Hz fast forward. Additionally, it has a brightness adjustment function for the fluorescent display tube, providing four levels of brightness settings.

### **FEATURES**

- 12-hour system
- Wide power supply range from 4 to 18V (built-in voltage regulator circuit)
- Designed for 1/2 duty fluorescent display tubes
- 4.194304MHz (crystal oscillation)
- Four levels of brightness settings
- Package: 32-pin plastic SSOP (SSOP32-P-430-1.00-K) (ML9298MB)

**BLOCK DIAGRAM**



**PIN CONFIGURATION (TOP VIEW)**

**PIN DESCRIPTION**

Pin	I/O	Pull-up/ Pull-down	Description
DIM1	I	Pull-down	Brightness switching pin.
DIM2	I	Pull-down	
$\overline{A/C}$	I	Pull-up	Input pin with a pull-up resistor to reset the circuits inside this LSI at a "L" level. Set the reset pulse width to 2 ms or more.
$\overline{ZA}$	I	Pull-up	Zero adjust pin.
$\overline{HS}$	I	Pull-up	Hour digit adjustment pin.
$\overline{MS}$	I	Pull-up	Minute digit adjustment pin.
BLANK	I	Pull-down	Blank input pin. Display disappears at a "L" level.
COLSEL	I	—	This is the input pin for selecting flashing or lighting of the colon output. "L" level : Flashing, "H" level : Lighting
XT	I	—	Crystal oscillation pin to connect a crystal and capacitors Cx and Cy externally.
$\overline{XT}$	O		
$\overline{TEST}$	I	Pull-up	IC testing pin. Leave this pin open or fix it to a "H" level.
F64Hz	O	—	64Hz signal output pin for oscillation frequency adjustment.
GR1	O	—	Output pins for the 1/2 duty fluorescent display tube grids.
GR2			
1a, 3a to 2b, 4b, 4c	O	—	Output pins for the 1/2 duty fluorescent display tube anodes.
V <sub>cc</sub>	—	—	Power supply pin for high voltage.
GND	—	—	Ground pin.
VDDOUT	O	—	built-in regulator output pin for logic circuits. Connect the pin to the VDDIN pin.
VDDIN	I	—	Power supply pin for logic circuits. Connect the pin to the VDDOUT pin.
NC	—	—	NC pin. Leave the pin open.

**ABSOLUTE MAXIMUM RATINGS**

Parameter	Symbol	Condition	Rating	Unit
Power supply voltage (High voltage)	V <sub>CC</sub>	T <sub>a</sub> = 25°C	-0.3 to 20	V
Power supply voltage (Logic)	VDDIN	T <sub>a</sub> = 25°C	-0.3 to 6.5	V
Input voltage (High voltage)	V <sub>HI</sub>	T <sub>a</sub> = 25°C	-0.3 to V <sub>CC</sub> +0.3	V
Input voltage (Logic)	V <sub>LI</sub>	T <sub>a</sub> = 25°C	-0.3 to VDDIN+0.3	V
Output voltage (High voltage)	V <sub>HO</sub>	T <sub>a</sub> = 25°C	-0.3 to V <sub>CC</sub> +0.3	V
Output voltage (Logic)	V <sub>LO</sub>	T <sub>a</sub> = 25°C	-0.3 to VDDIN+0.3	V
Output current (High voltage)	I <sub>HO</sub>	T <sub>a</sub> = 25°C	-30 to 3	mA
Output current (Logic)	I <sub>LO</sub>	T <sub>a</sub> = 25°C	-5 to 5	mA
Power dissipation	P <sub>D</sub>	T <sub>a</sub> ≤ 85°C	350	mW
Storage temperature	T <sub>STG</sub>	—	-55 to 150	°C

**RECOMMENDED OPERATING CONDITIONS**

Parameter	Symbol	Condition	Min.	Typ.	Max.	Unit
Power supply voltage (High voltage)	V <sub>CC</sub>	—	4.0	12.0	18.0	V
Power supply voltage (Logic)	VDDIN	—	2.8	3.2	3.6	V
Operating temperature	T <sub>a</sub>	—	-40	25	85	°C
Crystal frequency	f(X'tal)	—	4.194304			MHz

## ELECTRICAL CHARACTERISTICS

## DC Characteristics

(V<sub>CC</sub> = 4.0 to 18.0 V, V<sub>DDIN</sub> = 2.8 to 3.6 V, T<sub>a</sub> = -40 to 85°C)

Parameter	Applicable pin	Symbol	Condition	Min.	Typ.	Max.	Unit
"H" input voltage	*1)	V <sub>IH</sub>	V <sub>CC</sub> = 4 to 18 V	V <sub>CC</sub> ×0.8	—	—	V
"L" input voltage	*1)	V <sub>IL</sub>	V <sub>CC</sub> = 4 to 18 V	—	—	V <sub>CC</sub> ×0.2	V
Input current	DIM1, DIM2, BLANK, COLSEL	I <sub>IH1</sub>	V <sub>CC</sub> = 12 V V <sub>IN</sub> = V <sub>CC</sub>	20	65	200	μA
		I <sub>IL1</sub>	V <sub>CC</sub> = 12 V V <sub>IN</sub> = 0 V	-2	—	2	μA
	$\overline{ZA}$ , $\overline{HS}$ , $\overline{MS}$ , $\overline{A/C}$ , $\overline{TEST}$	I <sub>IH2</sub>	V <sub>CC</sub> = 12 V V <sub>IN</sub> = V <sub>CC</sub>	-2	—	2	μA
		I <sub>IL2</sub>	V <sub>CC</sub> = 12 V V <sub>IN</sub> = 0 V	-200	-65	-20	μA
	COLSEL	I <sub>IH3</sub>	V <sub>CC</sub> = 12 V V <sub>IN</sub> = V <sub>CC</sub>	-2	—	2	μA
		I <sub>IL3</sub>	V <sub>CC</sub> = 12 V V <sub>IN</sub> = 0 V	-2	—	2	μA
Output voltage	*2)	V <sub>OH1</sub>	V <sub>CC</sub> = 12 V I <sub>OH1</sub> = -1 mA	V <sub>CC</sub> -2.0	—	—	V
		V <sub>OL1</sub>	V <sub>CC</sub> = 12 V I <sub>OL1</sub> = 0.55 mA	—	—	2	V
	*3)	V <sub>OH2</sub>	V <sub>CC</sub> = 12 V I <sub>OH2</sub> = -2 mA	V <sub>CC</sub> -2.0	—	—	V
		V <sub>OL2</sub>	V <sub>CC</sub> = 12 V I <sub>OL2</sub> = 0.55 mA	—	—	2	V
	GRID1, GRID2	V <sub>OH3</sub>	V <sub>CC</sub> = 12 V I <sub>OH3</sub> = -15 mA	V <sub>CC</sub> -2.0	—	—	V
		V <sub>OL3</sub>	V <sub>CC</sub> = 12 V I <sub>OL3</sub> = 0.55 mA	—	—	2	V
	F64HZ	V <sub>OH4</sub>	V <sub>DDIN</sub> = 3.0V I <sub>OH4</sub> = -0.1mA	V <sub>DDIN</sub> -0.5	—	—	V
		V <sub>OL4</sub>	V <sub>DDIN</sub> = 3.0V I <sub>OL4</sub> = 0.1mA	—	—	0.5	V
Dynamic supply current	V <sub>CC</sub>	I <sub>CC</sub>	*4)	—	400	600	μA

\*1) Applicable to the following pins:

DIM1, DIM2,  $\overline{BLANK}$ ,  $\overline{TEST}$ ,  $\overline{ZA}$ ,  $\overline{HS}$ ,  $\overline{MA}$ ,  $\overline{A/C}$ , and COLSEL

\*2) Applicable to the following SEGMENT output pins:

1a and 3a, 1b and 3b, 1c and 3c, 1d and 3d, 1e and 3e, 1f and 3f, 1g and 3g, 2g, 2e, and 2f

\*3) Applicable to the following SEGMENT output pins:

2a, 2d, 2b and 4b, 4c and 2c, and col

\*4) f = 4.194304 MHz, C<sub>g</sub> = C<sub>d</sub> = 33pF, V<sub>CC</sub> = 12V, open input, and non-loaded output

## FUNCTIONAL DESCRIPTION

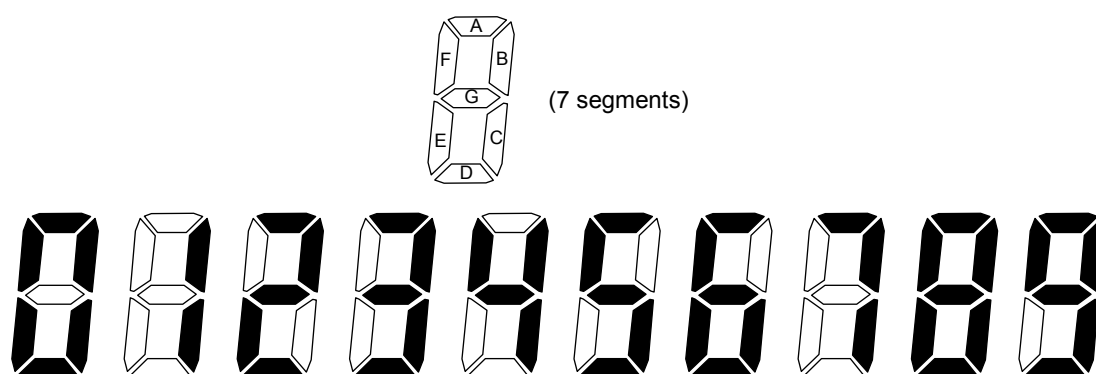
### Time Base

Built-in 4.194304MHz crystal oscillation circuit (AMP, feedback resistor)

\* Keep crystal and external capacitors as close to this LSI as possible to minimize connection wiring.

\* The values of external components, such as crystal and capacitors, should be determined including capacitance of user's circuit boards. It is recommended to contact a crystal manufacturer.

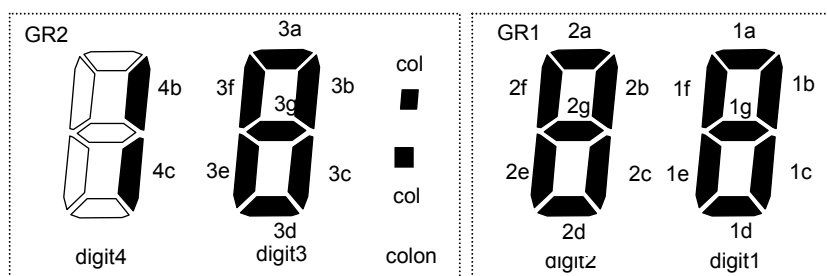
### 7-Segment Display Format



### Display Device

Dynamic drive 4-digit fluorescent display tube (with colon)

### Relationship Between Anode/Grid Output and Display



### Brightness Switching Function

4-level brightness settings (frequency = 256 Hz, gap between GR1 and GR2 at 1/2 duty = 32 μs)

Switch pin name		Operating mode
DIM1	DIM2	
L	L	f = 256 Hz, 1/2 duty (50% display)
H	L	f = 256 Hz, 1/4 duty (25% display)
L	H	f = 256 Hz, 1/8 duty (12.5% display)
H	H	f = 256 Hz, 1/16 duty (6.25% display)

### Display Mode

4-digit hour and minute display in 12-hour system

Hour display ..... 1 to 12

Minute display ..... 00 to 59

No time display when the most significant digit is 0 (Most Significant Digit Zero Suppress function)

**Time Adjustment****Hour/Minute Fast-forwarding Function**

Hour and minute can be fast-forwarded separately. The  $\overline{HS}$  (Hours Set) pin fast-forwards the hour digits, and the  $\overline{MS}$  (Minutes Set) pin fast-forwards the minute digits individually at 2Hz. One push counts one hour or one minute. When continuously pushed, hour or minute is incremented at 2Hz.

The  $\overline{HS}$  and  $\overline{MS}$  pins are held at a “H” level by a pull-up resistor in the open state, being in the no active state.

These pins are placed in the active state by driving them at a “L” level externally.

The fast-forwarding of the hour and minute digits can be performed simultaneously.

When fast-forwarding the hour digits, the lower counter continues a regular operation, but the carry-over from the minute to the hour is not performed.

When fast-forwarding the minute digits, carry over to the hour digits is not performed.

**Zero Adjustment Function ( $\pm 30$  minute reset to zero)**

The  $\overline{ZA}$  (Zero Adjust) pin is held at a “H” level by a pull-up resistor in the open state, being in the no active state. This pin is placed in the active state by driving it at a “L” level externally so that hours, minutes and seconds can be adjusted to zeros.

If the minute digits is less than 30 minutes, the minute and second digits are reset to 00'00”.

Also, if the minute digits exceed 30 minutes, the minute and second digits are reset to 00'00”, and the hour digits are carried over.

Moreover, the counter below seconds is reset up to 8 Hz.

<Examples of Zero Adjustments>

(X-1) hours 30 minutes 00 seconds	}	→ X hours 00 minutes 00 seconds
X hours 00 minutes 00 seconds		
(X) hours 29 minutes 59 seconds	}	→ (X+1) hours 00 minutes 00 seconds
(X) hours 30 minutes 00 seconds		
X hours 59 minutes 59 seconds	}	
(X+1) hours 29 minutes 59 seconds		

**Blanking of Display**

Blanking occurs in display by driving the  $\overline{BLANK}$  pin at a “L” level externally.

Inputs from  $\overline{HS}$ ,  $\overline{MS}$ , and  $\overline{ZA}$  pins are disabled during blanking.

**F64Hz Pin**

This is the output pin for oscillation frequency adjustment, and constantly outputs a 64Hz signal.

**External Reset**

This device can be reset by placing the  $\overline{A/C}$  pin at a “H” level.

After reset, the display starts at “1: 00”.

**Built-in Regulator Circuit**

The built-in regulator circuit reduces the power supply voltage ( $V_{CC}$ ) for the high voltage to the power supply voltage for logic, which is output to the VDDOUT pin.

Power is supplied to logic circuitry by connecting the VDDOUT pin to the VDDIN pin.

**Power-on Reset**

The power-on reset circuit built in this device eliminates the need for providing an external reset circuit.

\* Do the followings to operate the power-on reset circuit properly:

- Make a slope of a rise time of  $V_{CC}$  to a voltage equal to or larger than 8V/ms.
- Connect a smoothing capacitor of 1000 pF $\pm 20\%$  or more between the VDDOUT pin and GND.

**TEST pin**

This is the pin for testing this device.

This pin should be left open or fixed at a “H” level when not used.

**Removal of Chatters**

Three  $\overline{MS}$ ,  $\overline{HS}$  and  $\overline{ZA}$  input pins are connected to the chatter removing circuits internally, and therefore chatters within 15.625 msec for each pin can be removed inside the device.

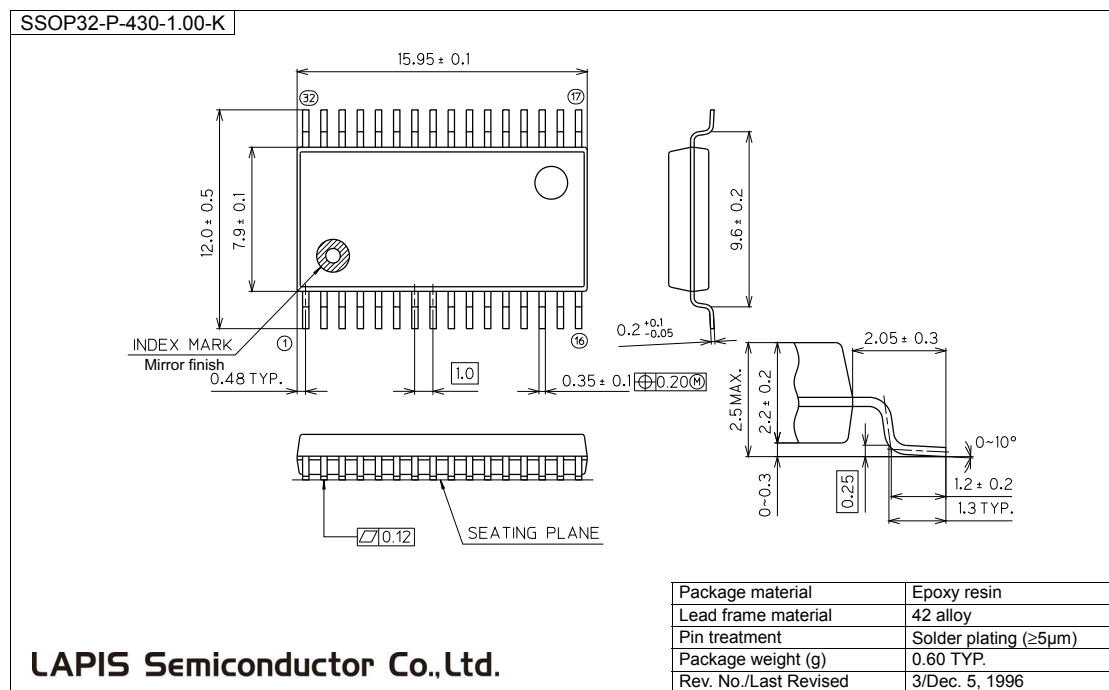
**Colon Flashing/Lighting Select Function**

Flashing or lighting of a colon can be selected by this COLSEL pin.

COLSEL	Operating mode
L	Flashing at 1 Hz
H	Lighting

## PACKAGE DIMENSIONS

(Unit: mm)



## Notes for Mounting the Surface Mount Type Package

The surface mount type packages are very susceptible to heat in reflow mounting and humidity absorbed in storage. Therefore, before you perform reflow mounting, contact ROHM's responsible sales person for the product name, package name, pin number, package code and desired mounting conditions (reflow method, temperature and times).

**REVISION HISTORY**

Document No.	Date	Page		Description
		Previous Edition	Current Edition	
PEDL9298-01	Dec. 1, 2004	–	–	Preliminary edition 1
FEDL9298-01	July. 11, 2005	–	–	Final edition 1

NOTICE

No copying or reproduction of this document, in part or in whole, is permitted without the consent of LAPIS Semiconductor Co., Ltd.

The content specified herein is subject to change for improvement without notice.

The content specified herein is for the purpose of introducing LAPIS Semiconductor's products (hereinafter "Products"). If you wish to use any such Product, please be sure to refer to the specifications, which can be obtained from LAPIS Semiconductor upon request.

Examples of application circuits, circuit constants and any other information contained herein illustrate the standard usage and operations of the Products. The peripheral conditions must be taken into account when designing circuits for mass production.

Great care was taken in ensuring the accuracy of the information specified in this document. However, should you incur any damage arising from any inaccuracy or misprint of such information, LAPIS Semiconductor shall bear no responsibility for such damage.

The technical information specified herein is intended only to show the typical functions of and examples of application circuits for the Products. LAPIS Semiconductor does not grant you, explicitly or implicitly, any license to use or exercise intellectual property or other rights held by LAPIS Semiconductor and other parties. LAPIS Semiconductor shall bear no responsibility whatsoever for any dispute arising from the use of such technical information.

The Products specified in this document are intended to be used with general-use electronic equipment or devices (such as audio visual equipment, office-automation equipment, communication devices, electronic appliances and amusement devices).

The Products specified in this document are not designed to be radiation tolerant.

While LAPIS Semiconductor always makes efforts to enhance the quality and reliability of its Products, a Product may fail or malfunction for a variety of reasons.

Please be sure to implement in your equipment using the Products safety measures to guard against the possibility of physical injury, fire or any other damage caused in the event of the failure of any Product, such as derating, redundancy, fire control and fail-safe designs. LAPIS Semiconductor shall bear no responsibility whatsoever for your use of any Product outside of the prescribed scope or not in accordance with the instruction manual.

The Products are not designed or manufactured to be used with any equipment, device or system which requires an extremely high level of reliability the failure or malfunction of which may result in a direct threat to human life or create a risk of human injury (such as a medical instrument, transportation equipment, aerospace machinery, nuclear-reactor controller, fuel-controller or other safety device). LAPIS Semiconductor shall bear no responsibility in any way for use of any of the Products for the above special purposes. If a Product is intended to be used for any such special purpose, please contact a ROHM sales representative before purchasing.

If you intend to export or ship overseas any Product or technology specified herein that may be controlled under the Foreign Exchange and the Foreign Trade Law, you will be required to obtain a license or permit under the Law.

Copyright 2005 - 2011 LAPIS Semiconductor Co., Ltd.